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‘Blackout Blues’: A Socio-cultural History of Vulnerable Electricity Networks and Resilient Users in Dar es Salaam, 1920–2020

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Doctoral Dissertation
by Emanuel Lukio Mchome

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DEDICATION

To my family, wife, and children

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ABSTRACT

Blackouts in African cities have received little attention from historians. Using archival and other written primary sources collected from Tanzania, Britain, and Sweden, as well as oral-history interviews, this study examines the socio-cultural history of blackouts in colonial and postcolonial Tanzania while employing critical infrastructure concepts of vulnerability and resilience in the Global South context. In five substantive chapters, the dissertation discusses the socio-economic, political, and technological factors which shaped the expansion of Tanzania's power networks between 1920 and the mid-1990s and how such expansion set the stage for persistent blackouts witnessed in the country from the 1980s onward. It also analyses the growth of household electricity usage and consumers' attempts to circumvent and adapt to frequent failure of power grid in Dar es Salaam from the 1980s to 2020. This study found that the power crises and blackouts which emerged in Tanzania from the 1980s cannot be understood without reference to the historical legacy in the planning and construction of power systems in the colonial and postcolonial periods. While the British colonial government had left electricity enterprises to be run by private companies, the postcolonial Tanzanian government nationalised it because it considered electricity as an important tool for its development and self-reliance policies. It built large, centralised hydropower infrastructure and integrated them to form a national grid using foreign multilateral and bilateral financial and technological assistance. Although foreign technologies and funds enabled the government of Tanzania to build large power networks to modernise and develop the country, the foreign development assistance provided in forms of fund, technologies and expertise was never smooth and without difficulties. The process was influenced by the Cold War, high modernism, and decolonisation politics. Both donors and recipients desired for political and economic gains something which led to overlooking of some vital technology transfer issues and underperformance of power networks. Donors' assistance also created long-term economic and technological dependency on western technologies and expertise in the everyday operations of electric networks such as meeting growing power demand, repair, and maintenance of infrastructure. Despite that Tanzania's power networks became more interconnected and interdependent from the 1970s, the technical system vulnerabilities witnessed in form of blackouts since the 1980s were largely due to technological and financial dependency on donors than due to technical interconnectedness and interdependence. Tanzania's national grid began to face critical failures

in the 1980s and 1990s when electricity had become a household and urban technology. Frequent power outages crippled people's socio-economic and cultural lives. It ruined electrical appliances, created discomforts in homes and reduced people's productivity. However, such failures and associated impacts on people's livelihoods influenced electricity consumers to develop distinct socio-technical adaptation measures to reduce the socio-economic consequences of power disruptions in homes. The study shows that households and urban spaces were socio-technical, contested environments in which electricity users innovatively tinkered electric technologies to enhance their resilience to power blackouts. Therefore, even though power networks continued to be vulnerable, electricity users in Dar es Salam were not simply passive and vulnerable consumers but they were active agents who adopted new artefacts and modified working schedules to cope with vulnerable power networks.

ZUSAMMENFASSUNG IN DEUTSCHER SPRACHE

Die Ausfälle der Infrastruktur zur Stromversorgung in afrikanischen Städten sind bisher aus historischer Perspektive kaum erforscht worden. Basierend auf Archiv- und anderen schriftlichen Primärquellen aus Tansania, Großbritannien und Schweden, sowie auf Oral History Interviews, untersucht diese historische Studie die sozio-kulturellen Dimension von Stromausfällen und Spannungsabfällen („Brownouts") im kolonialen und postkolonialen Tansania. Die Studie wendet dabei Konzepte aus dem aufstrebenden Feld der Studien kritischer Infrastrukturen wie Vulnerabilität und Resilienz auf die Fallstudie an. In fünf inhaltlichen Kapiteln zeichnet die Arbeit nach, wie das Netz in den 1920er bis 1990er Jahren ausgebaut wurde und identifiziert die sozioökonomischen, politischen und technologischen Faktoren, die dieser Expansion zugrunde lagen – und gleichzeitig den wiederkehrenden Stromausfällen in Tansania ab den 1980er Jahren den Boden bereiteten. Die Studie untersucht weiterhin das Wachstum des Stromverbrauchs von Haushalten sowie die Reaktionen und Anpassungsstrategien, mit denen Verbraucher in Dar es Salaam diesen Stromausfällen zwischen den 1980er und 2010er Jahren begegneten. Die Versorgungskrisen der letzten drei bis vier Jahrzehnte lassen sich nur vor dem Hintergrund des kolonialen und postkolonialen Erbes bei der Strominfrastruktur verstehen. Während die britische Kolonialregierung die Stromversorgung privaten Unternehmen überlassen hatte, verstaatlichte die Regierung des unabhängigen Tansania die Stromversorger, weil sie Elektrizität als wichtiges Instrument für ihre angestrebte Politik der wirtschaftlichen und politischen Unabhängigkeit und industriellen Entwicklung betrachtete. Mit internationaler technischer und finanzieller Unterstützung baute die Regierung ein zentralisierte und integrierte nationale Strominfrastruktur auf, die von großen, neu gebauten Wasserkraftwerken gespeist wurde.

Zwar ermöglichten ausländische Technologien und Gelder es den Führern der postkolonialen Regierung Tansanias große Stromnetze aufzubauen, um die sozio-ökonomische Entwicklung voranzutreiben; gleichzeigt zeigt diese Studie, dass der Transfer von Elektrotechnologien nach Tansania mit vielen Schwierigkeiten behaftet war. Einerseits war der Prozess stark vom Kalten Krieg, der Ideologie des High Modernism und der Dekolonisierungspolitik geprägt, andererseits verfolgten ausländische Geldgeber das Ziel, technische Maschinen und Fähigkeiten exportieren und somit im Globalen Süden neue Märkte für ihre heimische Industrie zu erschließen. Diese geopolitischen, ideologischen und

wirtschaftlichen Motive erschwerten die Abschätzung und Diagnose technischer Probleme, was nicht nur zu einer unerwarteten Leistungsschwäche der Stromnetze führte, sondern auch zu unvorhergesehenen wirtschaftlichen und technologischen Abhängigkeiten im täglichen Betrieb elektrischer Infrastrukturen sowie bei deren Reparatur und Wartung. Die Ergebnisse dieser Studie legen die Schlussfolgerung nahe, dass die seit den 1980er Jahren im Land beobachteten Vulnerabilitäten (Stromausfälle) hauptsächlich auf technologische und finanzielle Abhängigkeiten zurückzuführen sind, die noch aus der Bauphase der Infrastrukturen in den 1960er bis 1980er Jahren stammen. Trotz fortschreitender Integration der Netze und Ausdifferenzierung der Erzeugung nahmen diese Vulnerabilitäten eher zu als ab. Auf diese Weise ermöglichen es die empirischen Ergebnisse dieser Studie, den weitgehend über die Vernetzung und Interdependenz technischer Systeme definierten Begriff der Infrastrukturschwachstellen auf finanzielle und technologische Abhängigkeiten zwischen Herstellern und Nutzern von Technologien auszudehnen.

Tansanias nationales Stromnetz, das in den 1970er Jahren aufgebaut worden war, war ab den 1980er und 1990er Jahren zunehmend von kritischen Ausfällen betroffen – gerade zu jener Zeit in der Elektrizität zu einer lebenswichtigen Haushaltstechnologie und städtischen Infrastruktur wurde. Häufige Stromausfälle lähmten das sozioökonomische und kulturelle Leben der Menschen, indem sie produktive Tätigkeiten zum Erliegen brachten, Elektrogeräte ruinierten und Unannehmlichkeiten in den Häusern verursachten. Solche Ausfälle und die damit verbundenen Auswirkungen auf die Lebensgrundlagen der Menschen ermutigten die Nutzer, eigene sozio-technische Anpassungsstrategien zu entwickeln, um die sozioökonomischen Folgen von Stromausfällen in Haushalten zu reduzieren. Während das Wachstum des sozioökonomischen und kulturellen Bereichs Strom zu einer lebenswichtigen Versorgungsleitung machten, erzeugten häufige Stromunterbrechungen ein ständig umkämpftes Terrain zwischen Bewohnern und den maroden Stromsystemen. Die Nutzung verschiedener Energietechnologien im Alltag war ein stetiger Aushandlungsprozess, gleichzeitig griffen Nutzer auf die in der Stadt vorhandenen elektrotechnische Fähigkeiten und Kenntnisse und passten sich soziokulturell an, um die Auswirkungen von Stromausfällen zu umgehen. Haushalte und städtische Räume waren umkämpfte sozio-technische Arenen, in denen Stromnutzer innovativ tüftelten, um ihre Widerstandsfähigkeit gegen Stromausfälle in Dar es Salaam zu steigern. Sie argumentiert, dass Stromnetze in Tansania zwar weiterhin vulnerabel sind, ihre Nutzer jedoch nicht einfach als vulnerabel bezeichnet werden können.

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LIST OF TABLES AND FIGURES

ACRONYMS AND ABBREVIATIONS

AC	Alternative Current
AEG	Allgemeine Elektricitäts Gesellschaft
CD & W	Colonial Development & Welfare Fund/Act
CDC	Colonial Development Corporation
CDF	Colonial and Development Fund
CDFC	Commonwealth Development Fund Company
CIDA	Canadian International Development Agency
CO	Colonial Office
DARESCO	Dar es Salaam and district Electric Power Supply Company
DC	Direct Current
EAF	East Africana Files of the Library of the University of Dar es Salaam
EAP&L	East African Power and Lighting Company
ESMAP	Energy Sector Management Assistance Programme
FAO	United Nations Food and Agriculture Organisation
FRG	Federal Republic of Germany
GDP	Gross Domestic Product
GDR	German Democratic Republic
GRPP	Great Ruaha Power Project
IBRD	International Bank of Reconstruction and Development
IFIs	International Financial Institutions
IMF	International Monetary Fund
IPTL	Independent Power Tanzania Limited
JICA	Japanese International Cooperation Agency
JMT	Jamhuri ya Muungano wa Tanzania
KNA	Kenya National Archives
kV	Kilovolt
KW	Kilowatt
Kwh	Kilowatt hour
LPG	Liquified Petroleum Gas
MW	Megawatt
NEMC	The National Environment Management Council of Tanzania
OAU	Organisation of African Unity
PSC	Power Securities Companies
PSRC	Parastatal Sector Reform Commission
PWD	Public Works Department
RBS	Rufiji Basin Survey
SADC	Southern African Development Community
SAPs	Structural Adjustment Policies
SIDA	Swedish International Development Cooperation Agency
SIDO	Small-scale Industrial Development Organisation
SNA	Swedish National Archives
STS	Science, Technology and Society

SWECO	Swedish Architectural Firm
TANESCO	Tanzania National Electric Supply Company Limited
TANU	Tanganyika African National Union
TNA	Tanzania National Archives
TZS	Tanzanian Shillings
UDI	Unilateral Declaration of Independence in Southern Rhodesia
UDSM	University of Dar es Salaam
UKNA	United Kingdom National Archives
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
USD	United States Dollar
WB	World Bank
WDID	Water Development and Irrigation Department
WWI	World War One
WWII	World War Two

INTRODUCTION

HISTORY OF ELECTRICITY AND BLACKOUTS IN TANZANIA

1. Context and Argument

When I was doing research for my master's dissertation in History in August 2015, I came across an article published on 3 December 1994 in the *Daily News*, one of Tanzania's government newspapers. The article titled "And the Blackouts Embraced Us" and it was written by an environmental journalist, Michael Andindilile. Andindilile was one of the journalists who had joined the Tanzanian government's official team to examine the fall in water levels at Kidatu and Mtera, the country's largest interconnected hydropower systems in the 1990s.[1] The article disclosed how power disruptions had become part of Tanzanians' everyday socioeconomic and cultural lives at a time when electricity had become one of the most vital services to industrial and domestic users. The erratic power supply was reportedly caused by the fall in water levels at Mtera and Kidatu dams and had a devastating impact on the national economy. What astonished Andindilile was that Tanzania's National Electric Supply Company (TANESCO) had no alternative except to cast the power shedding net creating blackouts that spared nobody.[2] Andindilile finally remarked that Tanzanians were "ready to use be it solar, thermal, hydro, nuclear, or even gas power introduced to them so long as they are saved from the blackout blues" because they wanted to march with modernity.[3] The article raised my curiosity for two reasons. First, I was researching the transformations of energy technologies in rural Tanzania including electricity. Second, it was about a common phenomenon that I had been experiencing within and outside the university campus in Dar es Salaam, a major source of complaints in all life spheres in the city. I came to realise that power outages were not recent technical failures, as TANESCO regularly reported in the media, but were rather a historical issue that Tanzanian society had been facing for a very long time.

Called "Blackout Blues", this dissertation takes power outages as its point of departure to study electricity infrastructure in colonial and postcolonial Dar es Salaam from a historical perspective. It employs a socio-cultural approach to power failures as used in David Nye's *When the Lights Went Out*. Nye follows Paul Edwards' ideas that blackouts should not be reduced to

[1] Michael Andindilile, "And the Blackouts Embraced Us," *Daily News*, 3 December 1994.
[2] *Ibid*.
[3] *Ibid*.

the nuts and bolts. Power breakdowns need to be interpreted from a socio-cultural perspective and must be understood in five ways: "as a disruption of social experience, as a military tactic, as a crisis in the networked city, as the failure of an engineering system, as the outcome of inconsistent political and economic decisions, as a sudden encounter with sublimity, and as memory, aestheticized in photographs."[4] Unlike the North American society that Nye examines, Tanzanian power outages are not a "sudden encounter with sublimity" but are everyday lived experiences. This calls for a socio-cultural perspective to understand power failures and the ways people have adapted, rather than analysing failures from the technical perspective only. This thesis is, therefore, a socio-cultural history of electrical power systems and what they mean to the everyday life of Tanzanians. It foregrounds power disruptions as engineering failures, as the outcome of inconsistent political, technological, and economic decisions, as a crisis in networked cities, and as the disruption of daily socio-cultural realities and experiences. Blackouts, as they have been conceived in this dissertation, do not necessarily mean total darkness or absence of electrical light in a whole city or country, but they do mean all forms of power interruptions—planned and unplanned. A cessation of the normal operation of grids over large or small parts of a city.

The power outages which Andindilile described in his article were not new, however. They date as far back as 1908 when the German East African Railway Company installed the first electrical infrastructure in the country. The problems of uneconomical load, overloading during peak hours, the infancy of the grid on which power systems operated without power reserves, as well as insufficient experts and funds led to frequent breakdowns.[5] The colonial government in collaboration with the Dar es Salaam and District Electric Supply Company (DARESCO) initiated efforts to transmit hydroelectricity from Tanga in the north-eastern coast of the country to improve power provision to Dar es Salaam. Hydroelectricity from the Hale hydropower plant in the 1960s and, later, from the Great Ruaha in the 1970s improved electricity supply. Nevertheless, hydroelectricity did not put an end to power outages in the city

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[4] David E. Nye, *When the Lights Went Out: A History of Blackouts in America* (Cambridge, Mass.: MIT Press, 2010), 2; Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *Modernity and Technology,* eds. T. J. Misa, P. Brey, A. Feenberg (Mass: MIT Press, 2003), 185-225.

[5] Tanzania National Archives, (henceforth TNA), File No. 18878: Street Lighting in Dar es Salaam; *Dar es Salaam Times*, 19 November 1919; *Dar es Salaam Times*, 4 February 1921; Letters of dissatisfaction from customers to the District Office, Central Province, Dodoma Ref. 35/2/2/29, 10 December 1929, in TNA File A35/1/42: Electric Light; The Electricity Department, Annual Report 1926, in TNA Acc. 5 File 13694; TNA File A35/1/42: Electric Light – General: Letter dated 16 September 1932.

but increased their frequency and duration. The most severe periods occurred during the shortage of oil and spare parts required to sustain electrical power generation and grid operation caused by the global and national 1980s economic crisis, and the 1990s–2000s power shedding caused by the fall in water levels at the Tanzania's largest hydropower plants at Kidatu and Mtera dams.[6]

The Tanzanian government took measures since the 1980s to improve grid reliability by expanding generation capacity, by avoiding overdependency of hydropower, by signing power generation contracts with Independent Power Producers (IPPs),[7] by strengthening emergency power generation plants, and by extensive maintenance and repair of its power systems. Still, but power outages continued to affect electricity users. The decades-long strategy to bolster Tanzania's power systems was primarily to increase generation capacity, which included the building of the Stiegler's Gorge power plant (now Julius Nyerere Hydropower dam) in the south-east of the country. But the decisions to achieve this goal were hard to reach. More than thirty (30) planning studies were conducted in the Gorge mainly by foreign technical experts since the first German technical expeditions to the site at the beginning of the 20th century.[8] Tanzania's electricity industry actors from the 1960s to 1980s anticipated that the building of the Stiegler's Gorge dam would be a panacea for critical power disruptions in the country. The opinions on Stiegler's Gorge were divided with regard to its environmental impact and power markets, leading to its shelving in the mid-1980s.[9] The view that Stieglers Gorge is the solution to Tanzania's power infrastructure challenges has dominated more recently following the revival of the project by the late Tanzanian President John Pombe Magufuli in 2017.[10] Julius Nyerere dam, as it will be called, involves the construction of a 134-metre double curvature concrete

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[6]The International Monetary Fund, "Tanzania: Enhanced Structural Adjustment Facility Policy Framework Paper, 1998-99 – 2000-01"; United Republic of Tanzania, "TANESCO Master Plan 2012," (The Ministry of Energy and Minerals, 2012), 6.
[7] Katherine Gratwick, Rebecca Ghanadan, and Anton Eberhard, "Generating Power Controversy: Understanding Tanzania's Independent Power Project," *Management Programme of Infrastructure Regulation,* (MIR), Working Paper (2007).
[8] Kjell J. Havnevik, *Tanzania: The Limits to Development from Above,* (Dar es Salaam, Mkuki na Nyota, 2013), 263-283; Heather J. Hoag, *Designing the Delta: A History of Water and Development in the Lower Rufiji River Basin, Tanzania, 1945-1985,* (PhD Diss.: Boston University, 2003); Heather J. Hoag, *Developing the Rivers of East and West Africa: An Environmental History*, (London, New Delhi, NY, and Sydney: Bloomsbury, 2013), 187-199; Heather J. Hoag and May-Britt Öhman, "Turning Water into Power: Debates Over the Development of Tanzania's Rufiji River Basin, 1945-1985," *Technology and Culture* 49, no. 3, (2008): 624-651.
[9] Havnevik, *Tanzania*, 263-283; Hoag, *Developing Rivers*, 188-192.
[10] Barnaby Dye, "Heritage Dammed: Water Infrastructure Impacts on World Heritage Sites and Free Flowing Rivers," (Draft Report presented at the UNESCO World Hydropower Congress, 2019), 23.

dam to generate a total of 2,115 megawatts (MW).[11] If completed as designed, it will be among the largest hydropower infrastructure in Africa, ahead of Egypt's Aswan High (2100 MW), Mozambique's Cahora Bassa (2075 MW), and Angola' Lauca (2069 MW).[12]

Electrical power systems have increasingly become vital infrastructure in the everyday life of modern societies. They bolster other technological infrastructures such as roads, water pipes, sanitation networks, telecommunications, railways, and the internet. But in the last few decades, the world has witnessed the failure of electrical systems in different cities leading to devastating socioeconomic and political repercussions to millions of people. The Italian blackouts in 2003, the Madrid and London blackouts in 2005, the German blackouts of 2006, the Northeast blackouts in Canada and United States in 2003, the Indian blackouts in 2001 and 2012 are but some cases in point.[13] In many Global South cities, blackouts caused by the accidental collapse of power systems and power load shedding are common occurrences since the 1970s. In Tanzania, power interruptions have become part of the everyday socioeconomic and cultural lives of urban communities since the 1980s. Electricity users experience rolling blackouts due to everyday maintenance works, installation of new equipment, expansion of the grid to new areas, scarcity of spare parts and prolonged repair works, as well as shortage in electricity generation. The disruptions can range up to 8 hours, from 6:00 a.m. to 2:00 p.m. or from 2:00 p.m. to 10:00 p.m. or from 10:00 p.m. to 6:00 a.m. in several towns.[14] TANESCO sheds electricity up to 14 hours per day, a higher rate than Africa's monthly average outage frequency of 11 outages per week lasting for about 7 hours. The World Bank Africa's Infrastructure

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[11] Dye, "Heritage Dammed," 24; Barnaby Dye, "The Stiegler's Gorge Hydropower Dam Project: A briefing Report for WWF," (University of Oxford, 2017).

[12] Dye, "Heritage Dammed," 23.

[13] Cf. Timothy W. Luke, "Power Loss or Blackout: The Electricity Network Collapse of August 2003 in North America," in *Disrupted Cities: When Infrastructure Fails* ed. Stephen Graham (New York and London: Routledge, 2010), 55-68; Nye, *When the Lights Went Out;* Anubhav Rath, "Indian Blackouts of July 2012: What Happened and Why?," Available at: https://medium.com/clean-energy-for-billions/indian-blackouts-of-july-2012-what-happened-and-why-639e31fb52ad. Vincent Lagendijk and Erik van der Vleuten, "Inventing Electrical Europe: Interdependencies, Borders, Vulnerabilities," in The *Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities*, eds. Per Högselius, Anique Hommels, Arne Kaijser, and Erik van der Vleuten (London: Macmillan, 2013), 62-101.

[14] Alban D. Mchopa, Isaac Kazungu and John Moshi, "Power Rationing Dilemma: A Blow to Small and Medium Enterprises (SMEs) Performance in Moshi Municipality, Tanzania," *International Journal of Economics, Commerce and Management* 2, no. 7 (2014): 1–4 available at: https://www.researchgate.net/profile/Isaac-Kazungu/publication/293098284pdf?origin=publication_detail; Theodora Ephrem Kavishe, "Coping with Power Interruptions in Tanzania: An Industrial Perspective: A Case Study of One Small-Scale Animal Food Processing Industry in Moshi Municipality," (MPhil., Diss.: University of Oslo, 2015).

Diagnostic Report listed Tanzania in 2010 as one the countries with highest amount of power outages every year.[15]

Blackouts have received considerable attention from scholars in the Global North due to the extreme nature of their impact on national economies and people's well-being.[16] Despite being daily realities, power disruptions have escaped scholarly interests in the Global South, and it is more of a topic for residents, politicians, and media houses rather than academia. There are a few studies by sociologists, urban planners, geographers, and anthropologists that examine the causes and impacts of power failures. They link power breakdowns with overdependence on hydropower technologies and the failed World Bank electricity reforms in the 1990s and 2000s, political corruption in government and power utilities in Africa. Some of the scholars have also examined how electricity users and power utilities have coped with such interruptions.[17] The article "Never Expect Power Always" by Ayojedi Olukoju remains the main attempt to document historical power failures in postcolonial sub-Saharan Africa. The article details how the failed privatisation, mismanagement, and corruption in the Nigerian national power company (NEPA) has led persistent power outages in Lagos. Olukoju also examines the ways inhabitants of Lagos have responded by adopting off-grid lighting and power technologies as well as violent acts against NEPA staff and power infrastructure.[18] In Tanzania, several nonhistorical studies have linked the regular collapse of TANESCO's power grid to failed privatisation, overdependence on hydropower, droughts, and high levels of corruption and mismanagement.[19] Theodora Kavishe and Alban Mchopa *et al*. have used anthropological and

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[15] The World Bank, "Tanzania's Infrastructure: A Continental Perspective," (The World Bank: Washington, DC, 2010), 8; Unknown author and date, "Tanzania: Learning the Hard way," retrieved from www.gsb.uct.ac.tz on 21.03.2018; Thomas Barnebeck Andersen and Carl-Johan Dalgaard, "Power Outages and Economic Growth in Africa," *Energy Economics,* 38 (2013): 19-23, 19.

[16] Nye, *When the Lights Went Out*; Luke, "Power Loss or Blackout", 55-68; Lagendijk and Van der Vleuten, "Inventing Electrical Europe", 62-101.

[17] Jonathan Silver, "Disrupted Infrastructures: An Urban Political Ecology and Interrupted Electricity in Accra," *International Journal of Urban and Regional Research* 39 no. 5 (2016): 984-1003; Rita Kesselring "The electricity Crisis in Zambia: Blackouts and Social Stratification in new Mining Towns," *Energy Research & Social Science* 30 (2017): 94-102; Kobina Aidoo and Ryan C. Briggs, "Underpowered: Rolling Blackouts in Africa Disproportionately Hurt the Poor," *African Studies Review*, (2018): 1-20; Daniel Mains, "Blackouts and Progress: Privatization, Infrastructure, and a Developmentalist State in Jimma," *Cultural Anthropology* 27, no. 1 (2012): 3-27; Pauline Destrée, "Power Flashes: The Political and Visual Cultures of Electricity in Accra, Ghana," (PhD Diss.: University College London, 2018).

[18] Ayodeji Olukoju, "'Never Expect Power Always': Electricity Consumers' Response to Monopoly, Corruption and Inefficient Services in Nigeria", *African Affairs* 103, no. 410, (2004): 51-71.

[19] For general literature on the linkages between corruption and blackouts in Tanzania, see, for instance, Michael Degani, "Emergency Power: Time, Ethics, and Electricity in Post-socialist Tanzania," in *Cultures of Energy: Power, Practices, Technologies*, eds. Sarah Strauss, Stephanie Rupp, and Thomas Love (Walnut Creek CA**:** Left Coast Press Inc., 2013), 177-181; Rebecca Hansing Ghanadan, "Public Service or Commodity Goods?

business methods, respectively, to analyse the causes and effects of power outages and how power consumers in small business enterprises have responded.[20] Alfred Burlando[21] and Elisabeth Ilskog[22] described single blackout events, especially the one-month and the three-month blackouts in Zanzibar in 2008 and 2009-2010, respectively, caused by the collapse of the sea power cable that transmits electricity from mainland Tanzania to Zanzibar, their sociocultural and economic effects and how people responded. Authors of those studies provide valuable insights into blackouts. However, although blackouts are historical sociocultural, political, economic, and technical issues, they have neglected the historical and technological spectrum of power interruptions.

Severe and daily power disruptions in Tanzania have prevailed for more than four decades. Since electricity infrastructure operates through broader local and global contexts, they require historical analysis. A fuller understanding of their day-to-day operations and challenges requires a multifaceted analysis of technical, scientific, economic, and socio-political forces. As Thomas Hughes notes, historical approaches and methods explore "a broad range of factors, events, institutions, men and women involved in complex networks of power—technical, economic, political and social."[23] A historical study illustrates socioeconomic, political, and technical forces that have shaped the development of infrastructure, the actors involved, and their failures over time. In a similar thread, Per Högselius *et al.* have argued that the daily operation of infrastructure systems is influenced by how they grow over time because they develop in a particular historical time beyond individual, political, and media time—they are time-bound entities. Thus, technologies and breakdowns need revisiting as well as explaining

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Electricity Reforms, Access, and the Politics of Development in Tanzania," (PhD Diss.: University of California Berkeley, 2008); Brian Cooksey, "The Power and The Vainglory: Anatomy of a Malaysian IPP in Tanzania," in *Ugly Malaysians? South-South Investment Abused* ed. Jomo Kwame Sundaram, (K.S. Durban: Centre for Black Research, 2002), 47-76; Hazel S. Gray, "The Political Economy of Grand Corruption in Tanzania," *African Affairs* 114/456 (2015): 382-403*;* Katherine Gratwick, Rebecca Ghanadan and Anton Eberhard, "Generating Power Controversy: Understanding Tanzania's Independent Power Project," *Management Programme of Infrastructure Regulation* (MIR), Working Paper (2007); Catrina Godinho and Anton Eberhard, "Power Sector Reform and Regulation in Tanzania-Tanzania Institutional Diagnostic," available at: edi.opml.co.uk/resource/tanzania-institutional-diagnostic-chapter-7, accessed on 27 June 2021; Anton Eberhard and Catrina Godinho, "A Review and Exploitation of the Status, Context and Political Economy of Power Sector Reforms in Sub-Saharan Africa, South Asia and Latin America," EEG State-of-Knowledge Paper Series, available at: https://escholarship.org/uc/item/11k4210h, accessed on 27 June 2021.

[20] Kavishe, "Coping with Power Interruptions in Tanzania"; Mchopa *et al.,* "Power Rationing Dilemma".

[21] Alfredo Burlando, "Power Outages, Power Externalities, and Baby Booms," *Demography* 51, no. 4 (2014): 1477-1500; Elisabeth Ilskog "The Zanzibar Blackout: A Case Study on Consequences from an Electricity Power Crisis", (undated), available at https://www.diva-portal.org/smash/get/diva2:450394/FULLTEXT01.pdf.

[22] Ilskog "The Zanzibar Blackout".

[23] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880 -1930* (Baltimore and London: The Johns Hopkins University Press, 1983), 1.

the concerns, priorities, choices, and conflicts of their builders, and to this end, "[w]e need to engage with history."[24] It was against this backdrop that the present study has been conceived.

This dissertation focuses on Dar es Salaam from 1920, the year in which the British administration established the Electricity Department in Tanganyika (now Tanzania), to 2020, intending to capture recent developments in electricity uses and consumers' responses to power outages. The choice of Dar es Salaam was deliberate. Dar es Salaam continues to be a major sociocultural, political, economic, and technological infrastructure hub. Its history is basically the history of infrastructure and how its inhabitants have struggled for survival in colonial and postcolonial periods. It served as the headquarters of German East Africa and later of British colonial rule. The colonial occupation by the Germans in 1891 not only changed the way the town was spatially organised but also established various infrastructure services to meet colonial goals. The German colonial administration introduced the Building Ordinance known as *die Bauordnung* on 14 May 1891, which racially divided the town into three zones based on building standards.[25] The British maintained such racialised urban planning introduced different residential and economic zones when they occupied the territory in 1919. Zone I, which also served as an administrative and European residential area in the eastern part of the town, required buildings of permanent materials. Zone III, *Negerteil* as it was called, was populated by native villages comprised of mud-walled and grass-thatched non-permanent houses where Africans lived. Zone II, mostly settled by Indians, operated as a commercial zone and a buffer zone between African Zone III and European Zone I. The provision of infrastructure in the colonial period followed these zones, privileging Zone I and II and excluding Zone III. In the postcolonial period, Dar es Salaam as the country's metropolitan city continued to receive attention from planners both in socialist and liberal periods. Almost all small and large hydropower infrastructure in the country were designed to transmit electricity to the city. It is

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[24] Erik van der Vleuten, Per Högselius, Anique Hommels, and Arne Kaijser, "Europe's Critical Infrastructure and Its Vulnerabilities – Promises, Problems, Paradoxes," in "*The Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities*, eds. Per Högselius, Anique Hommels, Arne Kaijser and Erik van der Vleuten (London: Palgrave Macmillan, 2013), 5.

[25]For studies on the socioeconomic and environmental history of Dar es Salaam, see, for instance, James R. Brennan and Andrew Burton, "The Emerging Metropolis: A History of Dar es Salaam, circa 1862-2000," in *Dar es Salaam: Histories from an African Emerging Metropolis,* eds. James Brennan, Andrew Burton and Yusufu Lawi (Dar es Salaam: Mkuki na Nyota, 2007), 13-15; Sarah L. Smiley, "The City of Three Colors: Segregation in Colonial Dar es Salaam, 1891-1961," *Historical Geography* 37 (2009): 178-196; J. M. Lusugga Kironde, "The Evolution of the Land Use Structure of Dar es Salaam 1890-1990: A Study in the Effects of Land Policy, vol. 1," (PhD Diss.: University of Nairobi, 1994); Kathryn E. Owens, "Negotiating the City: Urban Development in Tanzania," (PhD Diss.: University of Michigan, 2014); Emily Brownell, *Gone to Ground: A History of Environment and Infrastructure in Dar es Salaam*, (Pittsburgh: University of Pittsburgh Press, 2020).

the central point from which TANESCO distributes to all the regions connected to the national power grid. Since the establishment of the first power plant in Dar es Salaam by the German East African Company in 1908, the city remained a centre for infrastructure, and has, therefore, a longer, richer history of electrical infrastructure than the rest of the towns in Tanzania. Scholars have elaborated on some aspects of the development and growth of infrastructures, such as roads, railways, water supply, sanitation systems, and the socio-cultural lives of people.[26] Generally speaking, these scholars have employed a political perspective linking the provision of infrastructure services with colonial and postcolonial urban planning policies while superficially documenting the technical terrains. This thesis takes the socio-technical approach to understand the development of electrical systems in the colonial and postcolonial periods.

This dissertation is not about the collapse of electrical power systems and resultant blackouts only. It is also about the development of Tanzania's electrical power networks, electricity uses, and power consumers' reactions to such power disruptions. The main question is to understand how Tanzania's power systems grew from small and isolated systems in 1920 to large interconnected systems in the 1990s, as well as the influence that growth had on power disruptions experienced from the 1980s onward and how electricity users grappled with erratic power supply. The analysis in this study is grounded in "critical infrastructure" concepts such as vulnerability and resilience. Critical infrastructure in this thesis refers to networked technological systems that sustain modern human life such as road and highway networks, railways, internet, water, and sanitation systems, telecommunication networks, and power grids, to mention but a few. They are called 'critical' not only because they are vital to modern societies or, as Matthew Gandy calls them, a "series of interconnecting life-support systems",[27] but also because they lead to disastrous effects on national and individual economies and on socio-cultural lives when they fail.[28] Vulnerability and resilience have been defined as the technical condition of critical infrastructure as they expand and operate daily. Vulnerability is defined in terms of the degree to which technological systems, social groups, and communities

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[26] Brennan and Burton, "The Emerging Metropolis," 13-51.

[27] Matthew Gandy, "Cyborg Urbanization: Complexity and Monstrosity in the Contemporary City," *International Journal of Urban and Regional Research* 29, no. 1, (2005): 26-49, 28.

[28] Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review Anthropology* 42, (2013): 327-43, 328-329; Kelley A. Pecsh-Cronin and Nancy E. Marion, C*ritical Infrastructure Protection, Risk Management, and Resilience: A Policy Perspective*, (London and New York: CRC Press, 2017); Polinpapilinho F. Katina and Patrick T. Hester, "Systemic Determination of Infrastructure Criticality," *International Journal of Critical Infrastructures* 9 no. 3, (2013): 211-225; Kristof Lukitsch, Marcel Müller, and Chris Stahlhut, "Criticality," in *Key Concepts for Critical Infrastructure Research*, ed. Jens Ivo Engels (Wiesbaden: Springer, 2018), 11-20.

are exposed to stress and shocks—predisposition to threats which lead to failures or problems that arise as systems become more interdependent,[29] whereas resilience is associated with the ability to resist disorder. It is the capacity to exist and remain stable when faced with disruptions—the ability to make failures less disastrous or improve people's capacity in coping with interruptions.[30]

Vulnerability and resilience as recent concepts in critical infrastructure studies were coined in disciplines other than history and were first applied in the Global North. Thus, their usage their usage in the Global South's history of technological systems runs the risk of potential misconception. Clapperton Mavhunga warns historians to avoid the direct transfer and imposition of Western notions on the South, but they should rather seek to understand what such notions mean *from* Africa because concepts do not have universal meanings.[31] Indeed, this thesis underscores how vulnerability and resilience concepts can be explained *from* the South in connection with the building and usage of electricity, and people's everyday handling of power failures in Tanzania. To what extent can we explain power failures in Tanzania based on the Global North's concepts of interdependence and interconnectedness of systems? How did Tanzanian electricity consumers' ability to withstand power breakdowns fit into or differ from Western resilience frameworks of smart technology innovation, institutional robustness, and disaster responsiveness? These are some questions which this dissertation pursues. As this dissertation shows, Tanzania's technological and economic dependency on Western and other developed countries in the circulation of electrical materials and skills explains the concept of vulnerability better than technical system interconnectedness and interdependence narratives

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[29] W. Neil Adger, "Vulnerability," *Global Environmental Change*, 16, (2006): 268-281; Charles Perrow, *Normal Accidents: Living with High-Risk Technologies*, (New York: Basic Books, 1984); Richard G. Little, "Controlling Cascading Failure: Understanding the Vulnerabilities of Interconnected Infrastructures," *Journal of Urban Technology* 9, no. 1 (2002): 109-123.

[30] See, for instance, Mark de Bruijne, Arjen Boin and Michel van Eeten, "Resilience: Exploring the Concept and its Meanings," in *Designing Resilience: Preparing for Extreme Events*, eds. Louise K. Comfort, Arjen Boin and Chris C. Demchak (Pittsburgh: University of Pittsburgh Pres, 2010), 13-32; Bernard Manyena, Fortunate Machingura and Phil O'Keefe, "Disaster Resilience Integrated Framework for Transformation (DRIFT): A new approach to theorising and operationalising resilience," *World Development* 123, (2019): 2; Gabriela B. Christmann and Oliver Ibert, "Vulnerability and Resilience in a Socio-Spatial Perspective: A Social-Scientific Approach," *Raumforschung und Raumordnung* 70, no. 4 (2012): 259-272, available at https://doi.org/10.1007/s13147-012-0171-1; Sara Meerow, Joshua P. Newell, and Melissa Stults, "Defining Urban Resilience: A Review," *Landscape and Urban Planning* 147 (2016): 38-49, 39; 100 Resilient Cities (100RC), *Cities taking action: How the 100RC network is building Urban Resilience*, (New York, 2017), 10; All Authors, "Relations Between the Concepts," in *Key Concepts for Critical Infrastructure Research*, ed. Jens Ivo Engels (Wiesbaden: Springer VS, 2018), 49.

[31] Clapperton Chakanesta Mavhunga, *What Do Science, Technology, and Innovation Mean from Africa?* (Cambridge and Mass.: MIT Press, 2017), 1.

which are dominant in the Global North's case.[32] In a similar vein, the everyday electricity users' socio-cultural practices and experiences capture the notion of resilience better than technological and institutional robustness and responsive measures in the Global North context.

This study investigates the complexities of planning and decision-making among system builders and the ways their choices have shaped the growth and operation of electrical power systems. It enquires on the way residents in Dar es Salaam have organised their material world in terms of energy sources, skills and knowledge, and socio-cultural experiences and practices to reduce the impact of power failures. The main argument is that the vulnerabilities of Tanzanian power systems are historically grounded in the politics and economics of electrical technologies which have dominated the technology transfers in the building of and everyday operations of power systems in the colonial and postcolonial periods. While the bilateral and multilateral economic assistance programmes offered from the 1960s to 1980s were based on promoting development through the expansion of power systems and making them more resilient and reliable, technologies transferred during the construction of Tanzania's power infrastructure created unforeseen and detrimental dependencies on Western technologies and expertise. The transfer was not only coloured by high modernist tendencies which overlooked many ecological and engineering efficiencies, but it also involved the transfer of partial skills that constrained the efficient and resilient operation of TANESCO's networks. Despite decades-long repetitive disruptions of power networks, electricity users in Dar es Salaam through their daily life practices and experiences innovated preparedness strategies that made them less vulnerable to recurring blackouts.

2. Locating the Study in Electrification Research

At the beginning of the 21st century, Catherine Coquery-Vidrovith observed that there was a general lack of studies on electrification in Africa when she commented that: "electricity in Africa has been very little studied. Bibliographical material is nearly non-existent. Works that treat the history of urban electricity are rare."[33] This observation was correct until the 2010s. Earlier studies on electrification focused mostly on Global North societies rather than on Africa. Such disregard for the study of technological infrastructures including electricity is apparent in

[32] Lagendijk and Van der Vleuten, "Inventing Electrical Europe," 62-101; Per Högselius, Arne Kaijser and Erik Van Der Vleuten, *Europe's Infrastructure Transition: Economy, War, Nature",* (London: Palgrave Macmillan, 2016).
[33] Catherine Coquery-Vidrovith, "Electricity Networks in Africa: A Comparative Study or How to Write Social History from Economic Sources," in *Sources and Methods in African History* eds. Toyin Falola and Christian Jennings (Rochester & New York: University of Rochester Press, 2013), 346-361, 346.

Tanzania. Tanzanian historians have until recently concentrated on nationalist histories and disregarded the history of technology or urban history. Electricity and other infrastructures, when they appear in their narratives, are mentioned as colonial tools for exploitation of African resources.[34] There has been a growing number of electrification studies globally and in Sub-Saharan Africa in particular. Therefore, the literature review in this section does not cover every study but will keep the findings of this dissertation in perspective in its five empirical chapters.

Until recently, technological infrastructure studies in the colonies have followed Headrick's "tools of empire" narrative. Headrick contends that European powers exported, developed, and used technologies, such as guns and gunpowder, quinine, steamboats, roads, water supply and sewage systems, railways, and electricity in the colonies for the purposes of conquest, domination, and exploitation.[35] Like in Michael Adas's *Machines as the Measure of Men,* Western technologies were the standard scale in which the European "race" and "superior" cultures were measured against the "other" weak and barbaric cultures of the colonised people.[36] Based on these conventional narratives, many electrification scholars in the colonial worlds, especially India and Africa, have examined electrical infrastructure as tools of empire, contending that colonisers remodelled electricity infrastructure into a spatial apartheid and left the 'natives' in premodern and non-electrified zones. Electricity providers denied colonised people access to such vital services, or only very tardily provided this access, meaning they lacked agency and became victims of electrification processes.[37] Some scholars have provided complex accounts on electrification and other technical infrastructure to critique Headrick's thesis. They have generally contended that, contrary to Headrick, the indigenous, colonised people did have some level of agency in the electrification process, that means, they

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[34] On materialist conceptions of colonial infrastructure and technology, see, for instance, Walter Rodney, *How Europe Underdeveloped Africa*, (Dar es Salaam: Tanzanian Publishing House, 1973).

[35] Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century,* (Oxford: Oxford University Press, 1981).

[36] Michael Adas, *Machines as the Measure of Men: Science Technology and Ideologies of Western Dominance,* (Ithaca and London: Cornell University Press, 1989).

[36] Ute Hasenöhrl, "Rural Electrification in the British Empire," *History of Retailing and Consumption* 4, no. 1 (2018): 10-27.

[37] Gyan Prakash, *Another Reason: Science and the Imagination of Modern India,* (Princeton: Princeton University Press, 1999), 2-3; Moses Chikowero, "Subalternating Currents: Electrification and Power Politics in Bulawayo, Colonial Zimbabwe, 1894-1939," *Journal of Southern African Studies* 33 no. 2 (2007): 287-306; Hasenöhrl, "Rural Electrification in the British Empire," 10-27; Rebecca Hansing Ghanadan dedicated one chapter of her PhD Dissertation to narrating how the distribution of electrical systems reflected colonial racial separation in Dar es Salaam (44-52).

influenced colonial decisions regarding electricity generation and usage.[38] By drawing examples from Dar es Salaam, this study contributes to the existing studies which have challenged the tools of empire idea by showing how technological restrictions (poor generation capacity, safety, and security) and the economics of electricity contributed to late electrification of African villages rather than purely colonial motives. The tools of empire debates do not entirely explain the technical and economic limitations in electrifying colonial Dar es Salaam.

By and large, Thomas Hughes' *Networks of Power* remains the main framework from which scholars have drawn the analysis of electrification in the Global North and South. In his work, Hughes studies the growth of electrical technologies in Chicago, Berlin, and London. He shows that electrical infrastructure in Chicago developed into a world-class system due to the American engineers' go-ahead attitudes and the observance of technological standards. Similarly, sound coordination among politicians and technologists in Berlin fostered the growth of elaborate grids by the end of the nineteenth century. In contrast, London's power systems failed to achieve rapid development until the first decades of the twentieth century because of political lethargy.[39]

Hughes identifies five linear phases in which electrical systems develop and grow in time and space to attain stability. He shows that system development begins with technology inventions and innovations by experts, which develop to a certain level before they can be transferred to other places. After being transferred, technologies experience growth, gain "technological momentum" (a stage where power networks consist of interconnections among large technical systems covering thousands of kilometres, millions of users, administrators, industries, and institutions capable of manufacturing and producing all the materials and expertise required for the day-to-day operation of grids), and engage in complex management structures, finance capital, and expertise—they become large technical systems (LTS).[40] Hughes' central idea is that power systems are not just technically determined but are also shaped by a myriad of socioeconomic, environmental, and technological factors. Hence, large

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[38] Srinivasa Rao and John Lourdusamy, "Colonialism and the Development of Electricity: The Case of Madras Presidency, 1900-47," *Science, Technology, Society* 15, no. 27 (2010): 27-54; Sunila S. Kale, "Structures of Power: Electrification in Colonial India," *Comparative Studies of South Asia, Africa, and the Middle East,* 34 (2015): 455-58; Adewumi Damilola Adebayo, "A Socioeconomic History of Electrification in Southern Nigeria, 1898-1972, (Unpublished PhD Diss.: St. John's College, 2020); Jonas van der Straeten and Ute Hasenöhrl, "Connecting the Empire: New Research Perspectives on Infrastructures and the Environment in the (Post)colonial World," *N.M.T* 24, (2016): 355-391; Animesh Chatterjee, "Conflict and Identity in the Social Life of Electricity in Colonial Calcutta *c.* 1880-1925," (Unpublished PhD Diss.: University of Leeds, 2020).
[39] Hughes, *Networks of Power*.
[40] *Ibid.*

electrical power systems are socio-technical entities.[41] This idea influenced generations of researchers since the 1980s especially those who investigated specific national styles of power system growth. They have focused on technological, economic, and institutional issues as well as the role of national and multinational capital investments in the growth of global electrical networks. They also concentrate on economic choices, plant capacity, local socioeconomic forces, the role of different actors, such as governments and utility companies in shaping electricity generation technologies, location of plants, transmission, and grid direction.[42]

Hughes work has received criticism from scholars particularly regarding the lack of agency of electricity users while ignoring the influence of local and global socio-technical factors beyond the control and imagination of systems builders to whom Hughes assigned all the agency. They also contend that Hughes model cannot be applied globally since electrical systems in the colonial world started with the transfer of technology rather than local inventions.[43] Whilst it is true that Hughes electrical system building narratives differ from the developments of Dar es Salaam since they have not attained 'technological momentum', this thesis is in line with Hughes model. By examining how electrical power systems developed from isolated, small grids in the colonial period to large, interconnected networks in the postcolonial period, this study agrees with the idea that power systems are socio-technical systems. From the 1960s to 1980s, they were shaped by socioeconomic, political, and economic factors, such as flows of financing, electrical equipment, materials, skills, and knowledge between donor countries (the inventors of technologies) and recipient countries (users of technologies), which affected grid operations from the 1980s.

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[41] *Ibid.*

[42]William J. Hausmann, Peter Hertner, and Mira Wilkins, *Global Electrification; Multinational Enterprise and International Finance in the History of Light and Power, 1878-2000,* (Cambridge: Cambridge University Press, 2008); Ronald C. Tobey, *Technology as a Freedom: The New Deal and the Electrical Modernization of the American Homes*, (Berkeley: University of California Press, 1996); Julie A. Cohn, *The Grid: Biography of an American Technology*, (Cambridge and Mass.: MIT Press, 2017); John L. Neufeld, *Selling Power: Economics, Policy, and Electric Utilities Before 1940*, (Chicago: University of Chicago Press, 2016); Vincent Lagendijk, *Electrifying Europe; The Power of Europe in the Construction of Electricity Networks* (Amsterdam: Aksant, 2008); Lagendijk and Vleuten, "Inventing Electrical Europe," 62-101; Richard F. Hirsh, *Technology and Transformation in the American Electric Utility Industry,* (Cambridge: Cambridge University Press, 1989); Jonathan Coppersmith, *Electrification of Russia, 1880-1926*, (Ithaca: Cornell University Press, 1992); Ronen Shamir, *Current Flow: The Electrification of Palestine,* (California: Stanford University Press, 2013); Fredrik Meiton, *Electrical Palestine: Capital and Technology from Empire to Nation*, (Oakland, California: University of California Press, 2019).

[43] Ronen Shamir, "Electricity and Empire in 1920s Palestine under British Rule," *Journal for the History of Science, Technology and Medicine* 25, (2016): 451-480; Shamir, *Current Flow*; Rao and Lourdusamy, "Colonialism and the Development of Electricity"; Jonas van der Straeten, *Capital Grids: A Global History of Electricity in East Africa* (New York: Palgrave Macmillan, forthcoming).

Scholars have also studied electrification from a socio-cultural perspective. They have emphasised electricity usage, and the socio-cultural meanings that have influenced the consumers' appropriation of electrical technologies in their homes. Their narratives are about how electrical appliances, daily routines, gender, modernity, aesthetics, and ideologies shaped the coming of electricity to households. They view the use of electrical technologies in homes as a complex process rather than a straightforward one. Utility managers and engineers had to advertise and promote electricity to compete with the existed household energy providers and gain acceptance from users.[44] The other main idea connecting these studies is that users were part of the electrification process, and that the appropriation of domestic electrical technologies was a multifaceted process. It was shaped by users' socio-cultural and economic contexts, rather than as a top-down force dictated by colonial motives. Electricity users adjusted their domestic space to accommodate electrical technologies.[45] One of the limitations of these studies is that, while they have acknowledged that the coming of technologies to homes have some socio-cultural consequences, they have neglected to discuss in any depth the risks and vulnerabilities associated to this process.

Technical things have socioeconomic and technical vulnerabilities. Ruth Cowan throws light on the unexpected consequences of electrical technologies in the domestic sphere. She has shown that while people domesticated to make their homes modern and comfortable, as well as reduce women's domestic tasks, these technologies have had the opposite effect, indeed increasing these tasks. Graeme Gooday's study on *Domesticating Electricity* gives more insights on the vulnerabilities associated to the electrification of homes. He points out that people hesitated to electrify their homes because they considered electricity as "dangerous", but he neglects to examine how people live with electrical technologies at home after having been connected to the grid and the impact this has had on the domestic sphere. A deeper discussion on consumer vulnerabilities as they domesticated electrical technologies is crucial,

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[44] Ruth Schwartz Cowan, *More Work For Mother: The Ironies of Household Technology from the Open Hearth to the Microwaves,* (New York: Basic Books, 1983); David E. Nye, *Electrifying America: Social Meanings of a New Technology*, (Cambridge, London, and Mass.: MIT Press, 1990); Graeme Gooday, *Domesticating Electricity: Technology, Uncertainty and Gender, 1880-1914,* (London: Pickering & Chatto, 2008); Tobey, *Technology as Freedom*; Jenifer L. Lieberman, *Power Lines; Electricity in American Life and Letters, 1882-1952,* (Cambridge, Mass.: MIT Press, 2017); Ronald R. Kline, *Consumers in the Country: Technology and Social Change in Rural America,* (Baltimore: Johns Hopkins University Press, 2002); Wilfred L. Randell, *Electricity and Woman: Twenty-One Years of Progress*, (London, 1945); Robert L. Frost, "Inventing Housewives and Home Appliances in Interwar France," *French Historical Studies* 18, no. 1 (1993): 109-13; Carroll Prusell: "Domesticating Modernity: the Electrical Association for Women, 1924-86," *BJHS*, (1999): 32, 47-67.

[45] Adebayo, "A Socioeconomic History"; Chatterjee, "Conflict and Identity".

especially in Sub-Saharan African cities because they have experienced erratic supply ever since. The case of Tanzania will show that while consumers did not perceive electrical technologies as "dangerous" in the way Gooday discusses them, they continued to feel that their electrical devices were vulnerable to the unreliable electrical power systems. One important issue this study brings to the history of electrical technologies is that the introduction of domestic electrical technologies in homes has not only shaped people's household routines but also brought new socioeconomic risks and vulnerabilities.

This dissertation also draws on and contributes to electrification studies on postcolonial Africa. Scholars have largely examined electrification through the lens of the techno-politics of funding and the flow of capital, expertise, and technologies from the Global North to the South. They have shown that the planning and construction of large hydropower dams was an emblem of postcolonial modernity, development, and independence. In line with James Scott's *Seeing like a State*, they were uncoordinated, hasty, and forceful transfers of funds and technology. Studies have also shown that builders of grandiose postcolonial electrical infrastructure ignored indigenous knowledge while extolling Western technologies, which led to the failure of such schemes and caused devastating economic and environmental repercussions to indigenous populations.[46] What is missing in these studies, nevertheless, is that they have not properly linked the weaknesses involved in the planning and transfer of technologies with the vulnerabilities of electrical power systems in Sub-Saharan Africa. By paying attention to system building and postcolonial leaders' perceptions of large-scale hydropower projects, their analysis fell short in describing how electricity reached domestic users. This work contributes to this body of literature by examining the domesticity of electrical technologies, paying particular

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[46] See, for instance, Christopher Gore, *Electricity in Africa: The Politics of Transformation in Uganda*, (Woodbrigde: James Currey, 2017); Allen F. Isaacman and Barbara S. Isaacman, *Dams, Displacement, and the Delusion of Development: Cahora Bassa and Its Legacies in Mozambique, 1965-2007,* (Athens: Ohio University Press, 2013); Hoag, *Developing Rivers of East and West Africa*; Heather J. Hoag "Transplanting the TVA? International contributions to post-war river development in Tanzania," *Comparative Technology Transfer, Society* 4 no. 3 (2006): 247-267; May-Britt Öhman, "Taming Exotic Beauties: Swedish Hydropower Constructions in Tanzania in the Era of Development Assistance, 1960s-1990s," (PhD Diss.: KTH Stockholm, 2007); Stephan F. Miescher "'Nkrumah's Baby'': The Akosombo Dam and the Dream of Development in Ghana, 1952-1966," *Water History* 6, (2014): 341-366; Stephan F. Miescher and D. Tsikata, "Hydro-power and the Promise of Modernity and Development in Ghana: Comparing the Akosombo and Bui Dam projects," *Ghana Studies* 12 no. 13 (2010): 15-53; Julia Tischler, *Light and Power for a Multiracial Nation: The Kariba Dam Scheme in the Central African Federation,* (Houndmills: Palgrave Macmillan, 2013); Dzodzi Tsikata, *Living in the Shadow of the Large Dams: Long term Responses of Downstream and Lake-side Communities of Ghana's Volta River Project*, (Leiden: Brill, 2006); James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed,* (New Haven and London: Yale University Press, 1998).

attention on how people electrified their homes, used electricity and electrical items, as well as the associated vulnerabilities and coping strategies they developed.

This study pushes the discussion on the manner and extent to which Global South cities have responded to frequent breakdowns. Because these cities lack large technological inventions and experience the constant breakdown of their large, centralised technical systems, some scholars have simply classified them as vulnerable and non-resilient. The main terms employed in describing these cities, people, and infrastructures have been poverty, slums, failures, breakdowns, absence, infeasible, informal, and inadequacies,[47] or as Ferguson said, the Global South has been treated as "a scar on the conscience of the world."[48] However, there has been growing interest in Global South urbanism, particularly in how people deal with different infrastructural challenges. While centralised networks lack universality and are vulnerable in diverse ways, a recent shift in focus gives agency to residents in the Global South cities, highlighting that they are not as vulnerable as previous studies have portrayed them. They have succeeded in developing innovative ways of living to bridge the scarcities they experience—they tinker and co-produce hybrid and heterogenous survival strategies.[49] This dissertation joins recent research that has taken failures and breakdowns in Global South cities as a window to understand how cities operate and people live daily despite the vulnerabilities surrounding them. It contends that even though the TANESCO power grid fails frequently, the life experience, practices, skills, knowledge, and creativity of Dar es Salaam's residents has

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[47] For instance, in *Urban Geography,* a 28-chapter textbook, Michael Pacione describes African cities as dangerous places which lack agency—where no one does anything good to address infrastructural inadequacies; Jochen Monstadt and S. Schramm, "Towards the networked city? Translating Technological Ideals and Planning Models in Water and Sanitation Systems in Dar es Salaam," *International Journal of Urban and Regional Research* 41 no. 1, (2017): 104-125.

[48] James Ferguson, *Global Shadows: Africa in the Neoliberal World Order* (Durham: Duke University Press,2006), 2.

[49] See, for instance, Colin McFarlane, "Infrastructure, Interruption, and Inequality: Urban Life in the Global South," in *Disrupted Cities: When Infrastructure Fails,* ed. Stephen Graham (New York and London: Taylor and Francis Group, 2010), 131-145; Colin McFarlane and Jonathan Silver, "Navigating the City: Dialects of Everyday Urbanism," *Transactions of the Institute of British Geographers,* 42 (2017): 458-471; Shaun Smith, "Hybrid Networks, Everyday Life and Social Control: Electricity Access in Urban Kenya," *Urban Studies* 00:0 (2018): 1-17; Elizabeth Wamuchiru, *Rethinking the Networked City: The (Co-)Production of Heterogeneous Water Supply Infrastructure in Nairobi, Kenya,* (PhD Diss.: TU Darmstadt, 2017); Jethron Ayumba Akala, *In the Technological Footprints of Urbanity: A Socio-political History of Water and Sanitation in Nairobi, 1899-2015*, (PhD Diss.: TU Darmstadt, 2018); Sylvy Jaglin, "Is the network challenged by the pragmatic turn in African cities? Urban Transition and Hybrid Delivery Configurations," in *Beyond the Networked City: Infrastructure Configurations and Urban Change in the North and South*, eds. O. Coutard and J. Rutherford (London and New York: Routledge, 2016), 182-203; Sarah L. Smiley, "Heterogeneous Water Provision in Dar es Salam: The Role of Networked Infrastructures and Alternative Systems in Informal Areas," *Nature and Space,* (2020): 1-17; Jethron Ayumbah Akallah and Mikael Hård, "Under the Historian's Radar: Local Water Supply Practices in Nairobi, 1940-1980," *Water Alternatives* 13 no.3, (2020): 886-901.

bolstered their ability to adapt to power outages by adopting different power disruption preparedness measures.

3. Researching Electricity in Colonial and Postcolonial Tanzania

This study employed qualitative methods in data collection and analysis to obtain an in-depth understanding of the historical development of power networks, electricity usage, and people's perceptions and strategies in grappling with power outages.[50] Various thematic and temporal aspects of this study are based on written materials from archives and libraries, oral interviews, personal experiences and observation in Dar es Salaam, as well as a critical review of published and unpublished literature. The information obtained from these sources was analysed and triangulated to bring a coherent, meaningful, and complete picture of the trajectories of electrical power building and breakdowns, electricity usage, and everyday electricity users' responses.

The field research for this study began in February 2018 with archival research at the Tanzania National Archives (TNA) in Dar es Salaam. It involved reading and collecting information from official correspondence between the British colonial government and the Electricity Department, Township Authority, and Colonial Office in London. I also read monthly and annual reports from the Public Works Department (PWD) and Electricity Department, and minutes and agendas of meetings among different electricity stakeholders or actors to obtain information about the provision and expansion of electricity, how colonial authorities and subjects used electricity, and the challenges encountered by the British colonial government in the provision and expansion of electrical infrastructure in Tanganyika. At TNA, I gathered information particularly on how the Electricity Department, later replaced by the Dar es Salaam and District Electric Supply Company (DARESCO), handled the development of electrical infrastructure including installing and repairing electrical lights in the town, electricity policy, and tariff structure issues.

However, the available information was fragmented and scant to draft a coherent history of electrification during British colonial times. Sarah Smiley describes the state of inaccessibility in Tanzania National Archives saying that many files were "lost" and misallocated in the reading rooms. I also experienced similar situation as staff members could not locate

[50] For the benefits of a qualitative strategy in studying social phenomenon, see, for instance, A. Bryman, *Social Research Methods,* 4th Edition, (Oxford: Oxford University Press, 2012), 408.

many of the files I wanted to read, as they were unavailable because they had not been returned to their respective catalogue.[51] Considering that two public electrical companies which operated in colonial Tanganyika, DARESCO and the Tanganyika Electric Power Company (TANESCO), were subsidiaries of the East African Power & Lighting Company (EAP&L) in Nairobi, I visited the Kenyan National Archives (KNA) in July 2018, to gather more information on electrical undertakings particularly in the last 30 years of the British colonial period in Tanganyika. It was during this period that DARESCO and TANESCO operated in Tanganyika as subsidiaries of the EAP&L. At KNA, I succeeded in obtaining further information on the economics and planning of power supply in Tanganyika and the ways the British Colonial Development and Welfare (CD&W) policy promoted electrification in the post-WWII period. Such information filled the existing gaps which I found in the TNA.

I was initially prepared to supplement the archival materials I obtained from Tanzania by visiting the British National Archives (UKNA) at Kew and the School of Oriental and African Studies (SOAS) in London. UKNA was essential for this research because the correspondence, discussions, and decisions on colonial Tanganyika's electrification from the Colonial Office and British electrical companies were made in London and the files were properties of the Colonial Office. They were stored in London and never reached colonial Tanganyika. I encountered several challenges in executing this plan. As a researcher, I received three refusals for entry visas from the British authorities between June 2018 and July 2019 which meant I was unable to obtain archival materials from UKNA personally. I only managed to gain access to important files for this research from the British Archives via some help from colleagues. Many thanks to Dr. Jonas van der Straeten, a colleague in the project funded by the European Research Council (ERC), Global History of Technology (GHoT) at TU Darmstadt, who was generous enough to share files he had collected from UKNA and the Bodleian Library in London between 2014 and 2017 during his own research on the electrification of British East Africa. The contribution from Van der Straeten is invaluable as he also provided a list of more scanned files from the UKNA during his research visit to London in 2019. The files from UKNA offered detailed information on colonial electricity plans and usage as viewed by British actors such as the Colonial Office,

[51] Sarah L. Smiley, "Researching Housing, Water, and Sanitation in the British and Tanzania National Archives," *History in Africa* 40, (2013): 353– 364, 360.

the Crown Agents for the Colonies, and London-based electrical firms which the East African archives I visited could not provide.

For the archival and additional written primary sources covering the postcolonial period, the National Record Centre (NRC) in Dodoma (where postcolonial Tanzanian government ministerial files are kept) and the East African Section in the University of Dar es Salaam were expected to provide sufficient information. But I encountered long, protracted processes in obtaining permission from the competent Tanzanian authorities to access the Ministry of Energy files they preserved. Whilst the Ministry of Energy and the Director of the Tanzania Archives had given me permission to consult the files, authorities at NRC denied me access on the grounds that the files had not yet been appraised to be used as archival material although some of them were more than 50 years old. My two-month efforts to obtain permission was thus fruitless and I resolved this challenge by turning to the Swedish National Archives (SNA) in Stockholm. This was because most of Tanzania's postcolonial power infrastructure projects from the late 1960s were co-financed by Nordic countries including Sweden, Norway, and Finland, as well as the World Bank. I visited SNA in February 2019 where I read well-kept files from the Swedish International Development Authority (SIDA). The files contained official correspondence, reports, policies, regulations, and funding contracts to build power infrastructure from the 1960s to 1990s. They also contained funding and organisational booklets, publications, and newspapers, as well as other energy development aspects that provided contextual and practical information on the development of Tanzania's existing electrical networks.

The East African Section of the University of Dar es Salaam (EAF-UDSM Library) also provided important colonial and postcolonial primary written sources. The EAF-UDSM Library contained materials such as the Public Works Department (PWD) reports and TANESCO journals and reports, memoranda, circulars, secretariat files, as well as district and provincial books that offered clues on electrical power development in the colonial and early postcolonial periods. The study also benefited from parliamentary reports (Hansards), Tanzanian government development plans and reports in which plans for electricity were central. Newspaper reports and letters to editors concerning electrification and everyday electricity usage were another vital source of written primary data in both the colonial and postcolonial period which I obtained from the EAF-UDSM Library. They helped in triangulating information I gathered from oral interviews with electricity users especially about electricity usage and their perceptions on power failures and their consequences.

Although the bulk of primary data used in this dissertation came from written materials, historians have aptly noted that established official archives are full of stories of technology inventors, engineers, promoters, and government plans and strategies. The voices of everyday technology users seldom find their way into the archives, which obscures everyday uses and consumer initiatives. This bias has led to top-down institutional measures and views on technologies.[52] Historians of technology such as Alejandra Tarazona, David Drengk and Animesh Chatterjee have gone as far as to propose the need for "alternative" archives, so as to avoid technology invention narratives and let the voice of marginalised actors such as technology users speak for themselves. By "alternative" archives, these scholars mean the need for researchers to execute deep analyses of the material available in the traditional archives, as well as discover new and unexplored sources, places, and materials, playing an active role in the "curation of 'alternative' sources" to write the history of technology.[53] Jethron Akallah and Mikael Hård call on historians of technology to unearth daily socio-technical practices and local perspectives. In so doing, historians indubitably broaden their methods and sources by considering people's life experiences. Oral accounts, according to them, when carefully done, can capture the practices and voices of the forgotten local users and how they tinker with different technologies in their daily lives. Interviews enable historians to uncover the silenced, suppressed, and ignored voices of everyday technology users.[54] This study used oral interviews as "alternative" archives to study and document electricity consumers' daily practices and create narratives in this understudied topic in Tanzania's history. The interviews helped to understand the complexities of the socio-cultural, economic, and technological practices and perceptions that have shaped the residents' usage of electricity and electrical items in their daily lives and how they cope with frequent power breakdowns.

Oral interviews for this study were conducted during a four-month research trip to Tanzania from July to October 2018. My main interview partners were residential electricity

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[52]Gesa E. Kirsch and Liz Rohan, "Introduction: The Role of Serendipity, Family Connections, and Cultural Memory in Historical Research," in *Beyond the Archives: Research as a Lived Process*, eds. Gesa E. Kirsch and Liz Rohan, 1-12, (Southern Illinois University Press, 2008), 3; Akallah and Hård, "Local Water Supply Practices in Nairobi," 888-889.

[53] Alejandra Osorio Tarazona, David Drengk, and Animesh Chaterjee, "Rethinking Global History of Technology from Alternative Archives", *Technikgeschichte* 88, no. 2 (2021): 202 – 206, 203.

[54] Akallah and Hård, "Under the Historian's Radar," 886-901; Smiley, "Researching Housing", 360.

users, who installed and used electricity, but also faced frequent outages in Dar es Salaam. I interviewed men and women aged over 50 years, who had lived in the city for the last 30 years, and who had witnessed its socioeconomic and power infrastructure changes and continuities. For this category of informants, my first interviewees were indicated by local government leaders in the different localities in the city. They connected me with a resident in each area who had extensive knowledge of the city' development. That first interviewee would then identify subsequent informants. I also interviewed some residents unofficially. My interview questions were about daily and personal life in the city, such as how households used different energy sources, installation and usage of electricity, power outages and how they affected their everyday lives, and their connections with the socioeconomic and political trends in Tanzania. The questions were semi-structured and allowed me to elicit more detailed narratives when informants demonstrated good knowledge on some matters. However, the main limitations were the presentism of the informants since they related electricity use and outages with present-day political and economic conditions, hiding thus some information which they considered sensitive to the political context. I resolved these challenges with more questions that probed into their lives between the 1970s and early 2000s, and changes since that time. I also cross-checked their oral accounts with written sources especially newspaper reports and letters to editors. By documenting people's lived experiences, memories, routinised practices, household practices and materiality, I was able to gauge how residents used electricity, how power failures impacted on their lives and the strategies they used to reduce such impacts.

My second interview partners were local electricians. Locally knowns as *mafundi*, electrical technicians are a vital group of people as far as electricity usage, power outages and adaptation in Dar es Salaam is concerned. They own electronic repair kiosks where people's electrical appliances damaged by power outages are redesigned and repaired. Every day, the installation and repair of domestic electrical wiring, appliances, and electricity usages in households in Dar es Salaam relies on their expertise. I asked the *mafundi* for information about technical aspects of electrical appliances and how power cuts burdened electricity users. I also asked about how they had obtained their repair and maintenance skills and how such activities are essential for everyday electricity usage and their socioeconomic wellbeing. The interviews with the *mafundi* were both challenging and rewarding. Despite having visited them and scheduling the interview beforehand to avoid interfering in their activities, the *mafundi* tended to be busy as usual. They requested the interviews take place in their repair shops which are normally at road junctions or busy streets where many customers regularly interrupted us. However, this interview environment provided me with opportunity to take part in the encounters between electricity consumers and these repair experts and how repair practices bolstered household resilience to power outages.

Lastly, I interviewed government officials at the Ministry of Energy and TANESCO staff. I basically enquired on various strategies taken by the government and TANESCO to develop power infrastructure and redress power failures. The identification of informants followed strict official channels and were selected based on their job positions. The officials I interviewed at TANESCO, for instance, were engineers and managers in the five departments, namely, generation, transmission, distribution and sales, grid control and customer services. My interview questions asked about the regular operations and the challenges involved in the daily execution of duties in their respective department. I also interviewed a few retired officials and workers who had worked at TANESCO during the building the Great Ruaha Power Project in the late 1960s to 1980s. Because of the busy schedules of some important TANESCO workers I had to interview, I rescheduled their interviews even during weekends, which helped me to obtain their personal views on electricity provision, uses, and power outages. The limitation with this category of informants was that they were relatively hesitant to give detailed information on critical issues such as transfer of technologies, funding, drawbacks regarding different electrical power projects, and daily operation of the grid. They considered some information as internal, confidential, and sensitive to government politics. However, I obtained additional information from archival materials collected from the Swedish National Archives in Stockholm. I also consulted retired TANESCO and government workers during interviews with electricity users. They offered valuable information about the company, government views, and electrification projects as well as how they shaped electricity provision and usage in the city since the 1960s. Unless otherwise stated, all quotes from the oral interviews are my own translation from original interviews which were held in the Kiswahili language.

4. Chapter Summaries

The development of electrical power infrastructure in the colonial and postcolonial periods were shaped by different political, economic, and technological factors. In Chapter 1, I examine the expansion of power networks during the British colonial period from 1920 to the independence of Tanganyika in 1961. I show how the British administration encountered and resolved various economic and technical challenges in their efforts to create and expand reliable power systems. The chapter maintains that although the British colonial administration privatised electrical undertakings in the 1930s with the aim of expanding supply to new areas, the development of electrical power infrastructure remained parochial. For instance, only small segments of Dar es Salaam had electricity until independence. Such limited expansion was due to restrictions posed by the Colonial Office in London which perceived electrification in Tanganyika as unprofitable and did not require huge investment from public funds. As a result, low domestic consumption of electricity hindered DARESCO from obtaining the revenue required to extend the system to new areas. The chapter proposes that focusing on these technical and economic rationalities and limitations in power supply in colonial Dar es Salaam offers a broader understanding of the colonial provision of electricity beyond the 'tool of empire' thesis. The leaders of postcolonial African governments and other global actors such as the World Bank and international cooperation agencies from different developed nations viewed electricity as a tool for national socioeconomic development and modernisation.

Chapter 2 details how this vision unfolded in the development of power networks in Tanzania between 1961 and the mid-1990s while tracing colonial-postcolonial (dis)continuities. The chapter shows that postcolonial leaders and actors viewed electricity as "critical" infrastructure for promoting national socioeconomic development and modernisation. They promoted the application of Western funds, science, and technologies to the building of large hydropower dams and transmission systems as symbols of independence, freedom, modernity, and progress. Hence, Tanzania became a place for wide-ranging Western financial and technical assistance in the form of electrical power expertise, equipment, and materials. Like in the colonial period, the grid connected those profitable regions and towns first in accordance with national socioeconomic development plans before it was extended to less profitable villages. The grid acquired greater momentum and coverage. More new areas were electrified when compared to colonial parochial enclaves of electrification. However, the dominance of Western funds, science and technologies in the planning and construction of postcolonial power infrastructure in Tanzania sowed the seeds of the power system vulnerabilities observed from the 1980s onwards. Despite huge investments in electrical power infrastructure between the 1960s and 1980s, Tanzania witnessed unexpected power breakdowns since the 1980s. This was contrary to the expectation of the Tanzanian government leaders and funders of electrical power infrastructure.

Chapter 3 employs the notion of 'vulnerability' to explains why Tanzania's power systems malfunctioned since the 1980s. It highlights three main historical reasons. First, Tanzania's economic crisis of the 1970s and the 1980s which not only led to a shortage of spare parts and fuel, but also made life much harder, forcing people to loot electrical materials such as cables, wires, copper, and transformer oil for private gain. Second, the problem was also connected to the fact that the planning of the largest hydropower plants overlooked ecological issues and ignored opinions of the local experts, a characteristic feature of the high modernity development discourse of the 1960s–1980s. Inappropriate planning led to long-term drying up of the Kidatu and Mtera hydropower system since 1992, pushing cities connected to the national grid into acute power load shedding. Third, repair and maintenance activities which largely depended on experts, spare parts, and funds from abroad, as well as the techno-politics involved in the transfer of technologies also contributed to prolonged power outages. The main idea to note in the Chapter is that the vulnerabilities of power systems in Tanzania were, by and large, not due to the interconnectedness and interdependence of infrastructures, but rather to overdependency on foreign expertise, technologies, and funding which had its roots between the 1960s and 1980s modernity ideologies and development discourse.

The question of how residents in Tanzania use electricity in their homes is central to grasp the criticality of electricity and user vulnerabilities and resilience. In this case, Chapters 4 and 5 of this thesis explore the electrification narratives from power system building, repair, and operations to examine electricity usage in homes. They analyse how inhabitants in Dar es Salaam have appropriated and used electricity and electrical items at home and how that has helped them to grapple with regular power outages. Chapter 4 examines how electricity usage expanded in homes since the late 1990s. It shows that electricity in Tanzanians homes was insignificant between the 1920s to the 1990s due to colonial and postcolonial socialist policies. The 1980s liberalisation policies changed the situation. They altered urban political economy and urban life, enlarged informal activities and household income, expanded electricity supply and availability of electrical devices in Tanzanian towns and cities. The growth of electricity connection and usage of electrical items not only made electricity grid become a critical infrastructure to people's everyday lives but also a source of new vulnerabilities.

Electricity users faced frequent power failures which interrupted socioeconomic activities and brought their electrical devices to a halt. However, electricity users never remained passive. They developed different alternatives to offset the impact caused by regular, inconsistent breakdowns of power infrastructure. Employing the concept of resilience, Chapter 5 analyses various measures adopted by electricity users in Dar es Salaam to cope with power disruptions. The chapter examines the technological skills and knowledge that enabled electricity users to withstand regular power breakdowns. It broadly contributes to “technology user-based studies.” It unveils how electricity users in Dar es Salaam interacted with electrical technologies, skills, and other sources of energy, confirming Wiebe Bijker’s and others argument in *Vulnerability in Technological Cultures*, that a certain level of vulnerability is necessary for people to develop preparedness measures which enhanced their ability to grapple with power failures. The chapter argues that vulnerability and resilience in critical infrastructure studies need to go beyond the robustness of technological systems and institutions and consider landscapes of co-existing technical artefacts and socio-cultural practices in societies.

CHAPTER ONE
ELECTRIFYING THE EMPIRE: ELECTRICITY PROVISION IN BRITISH COLONIAL DAR ES SALAAM, 1920–1961

1.1 Introduction

Some recent studies on infrastructure in colonial worlds have challenged Daniel Headrick's 'tools of empire' perspective by maintaining that the provision and uses of infrastructures such as transport and communication networks, roads, water and sewerage systems, electricity as well as other technologies in the colonies were not entirely influenced by colonial racial and economic exploitation policies. In electricity, they argue, for instance, that electrification was a complex process that was shaped by local socio-cultural and environmental conditions, capital investments, provincial and urban class politics. Some decisions to electrify or not to electrify a particular place were beyond the decisions and choices of colonial governance and racial policies.[1] This chapter contributes to and broadens this line of argument by using electricity provision in British Tanganyika. It delineates how socio-technical and economic factors, beyond the British administration wishes, influenced growth of the power networks in colonial Dar es Salaam. However, it is significant to note that the chapter does not completely denounce the tools of empire thesis. Electrical power infrastructure was built under British colonial context between 1920 and 1961, hence, as it will be seen in this chapter, colonial aspects such as economic and political class and race played significant role. But the chapter maintains that the provision of electricity in British colonial period were not entirely based on the tools of empire despite that Europeans and Indians were highly privileged than Africans. Diverse institutional, economic, and technological factors contributed to the late electrification of Africans and not the colonial racial politics. The economic and technological parameters that favoured them rather than the colour of their skins. As such, Africans socio-economic conditions such as poor economic power (inability to pay for connection and monthly electricity bills), poor housing

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[1] Rao Srinivasa and John Lourdusamy, "Colonialism and the Development of Electricity: The case of Madras Presidency, 1900 – 47", *Science, Technology, Society* 15, no.1 (2010): 27-54; Sunila S. Kale, "Structures of Power: Electrification in Colonial India," *Comparative Studies of South Asia, Africa, and the Middle East*, 34, (2015): 455-58; Animesh Chatterjee, "'New Wine in new Bottles': Class Politics and the 'Uneven Electrification' of Colonial India," *History of Retailing and Consumption* (2018): 6–10; Jonas van der Straeten and Ute Hasenöhrl, "Connecting the Empire: New Research Perspectives on Infrastructures and the Environment in the (Post)Colonial World," *N.M.T* 24, (2016): 355 – 391.

conditions and technical electricity regulations and safety and security measures also prevented early electrification of African homes. Power networks expanded to Europeans, Indians, and Africans based on how electricity providers resolved different technical and socioeconomic constraints. To this end, the chapter presents the initiatives of electricity providers such as the Electricity Department and Colonial State in Dar es Salaam, the Colonial Office in London, and the Dar es Salaam and District Electric Supply Company (DARESCO) to show that the British colonial administration in Tanganyika faced technical and financial limitations in expanding electrical power infrastructure something which hindered grid growth and delayed grid extension to African premises. It unveils that the questions such as *who* was electrified, and *how*, *where,* and *when,* in many instances, depended on the technical capacity of power system and the profitability of supply than the question of class and race.

1.2 The Nature of Electricity Networks in the 1920s

In 1920, when the British occupied Tanganyika as a Mandate Territory, they found that the Germans had installed small electricity generator units in Dar es Salaam and four upcountry towns, along the central railway lines such as Dodoma, Tabora, and Kigoma and North-eastern railway line in Tanga, operated by a private German farmer, Mr. Bauer. As the headquarters of the former German East Africa, Dar es Salaam had a larger power system unlike other electrified towns in Tanganyika. As Kate Showers described electrical power systems in colonial Africa, Dar es Salaam systems were small. Electricity was generated from firewood burning generators and it supplied only a small 'urban enclave'.[2] The Germans primarily used electricity for lighting and powering a few governments' works and private consumers in the centre of Dar es Salaam (modern-day city centre areas of Posta and Kurasini).

The technical efficiency of the existing systems was poor due to the impact of the First World War. The war broke out before Germans had completed the installation of the new and large generator to expand the system in 1914. Moreover, the British warships also attacked the electrical plant at Kurasini, destroying generators' dynamos, cracked the wheels, and demolished the accumulator room completely. British war lorries driving through the town destroyed electrical posts and electrical transmission lines in different streets.[3] Although the

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[2] Kate B. Showers, "Electrifying Africa: An Environmental History with Policy Implications," *Geografiska Annaler: Series B, Human Geography* 93, no. 3 (2011): 193 – 221.

[3] British National Archives (henceforth UKNA) File No. T161/1049, a letter from Horace A. Byatt to the Principal Secretary of State for the Colonies, 22 July 1920.

British forces captured Dar es Salaam by late 1916, no essential repairs of the electrical systems were made until the early 1920The existing power systems were heavily overloaded. They operated without 'reserves' and therefore experienced frequent and prolonged failures during peak hours (6.30 pm to 8.30 pm). Domestic electricity users, basically, Europeans, Indians, and a few Greeks who lived in Dar es Salaam, complained regularly of how vulnerable they were due to unreliable electricity.[4] Public supply continued to face critical failures.

Lighting in the streets in Dar es Salaam only lasted about 4 hours due to the low capacity of the existing firewood-powered plants and load factor challenges.[5] Town dwellers began to question power cuts at night in the late 1910s since they wanted to enjoy electricity for longer periods of time than the German Railway company and later the British Electricity Department could supply. The *Dar es Salaam Times* established a special column for residents to air their views on different social aspects in the town. In 1919, for instance, they asked the British authorities in Dar es Salaam "why do the electric lights go out just as an evening begins to be interesting?"[6] This question implies not only that power infrastructure in British colonial Dar es Salaam was inadequate and how electric utilities were dealt with the load factor but also that residents, particularly European electrified majority, considered electricity as vital amenity in Dar es Salaam life. The inhabitants wanted to enjoy their evenings recreationally, but the electricity providers were unable to fulfil this demand. It also reflects how power networks required intensive repair and expansion to restore its resilience, bring supply to commercial levels, meet new demands, and satisfy the needs of its users.

Sir Horace Byatt, the first British governor of Tanganyika, explained in a letter to the Colonial Office in London in 1920 that power infrastructure in the town and the whole territory were "by no means reliable."[7] Byatt's letter stated explicitly that electrical infrastructure required improvement and expansion to keep up with town's socioeconomic developments. It puts forward two main proposals. First, the British colonial government had to acquire the German electrical plants in Dar es Salaam. Second, the state should increase intervention by

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[4] UKNA File no. T161/1049, Report on Existing Plant and Future Requirements, by H. King, Manager, Electricity Department, 1 June 1920.
[5] EAF-UDSM Library, Tanganyika Territory Annual Reports of the Public Works Department, 1933–1938; also, TNA File No. 18878, correspondence on street lighting in Dar es Salaam; also, UKNA File no. T161/1049, Report on Existing Plant and Future Requirements, by H. King, Manager, Electricity Department, 1 June 1920.
[6] *Dar es Salaam Times*, 19 November 1919; Residents also complained in the *Dar es Salaam Times* on 4 February 1921.
[7] UKNA T161/1049: Letter from H.A. Byatt to the Principal Secretary for the Colonies.

funding the provision of electricity.[8] Byatt wrote: "an efficient electrical installation [was] both a necessity and source of steady revenue."[9] He thought electrical technologies could be employed to achieve economic and other colonial goals. He did not consider electricity a symbol of modernity nor a representation of colonial power, but a vital service from which government could generate revenue. Byatt, thus, wanted to improve power system efficiency, capacity, and expand to new areas both as a tool of empire and utility that would serve to generate revenue like modern-day electrical utilities.

Byatt's position on electricity influenced the British colonial government to take initiatives to improve the reliability of electricity services and expand the grid into new areas in the 1920s. The first initiative was to expand the generation capacity because the existing power infrastructure was unable to meet demand. High demand of electricity was revealed by new applicants who were often refused on the basis that the system was fully loaded. The first report from the Electricity Department uncovers that both connected and prospective electricity users needed reliable power supply and network expansion. Therefore, the construction of an economically and technically efficient power plant in the Kurasini area in April 1922 could not only add new consumers but also strengthen the existing electrical network in Dar es Salaam.[10] The report to the Colonial Office in London reads:

> It is submitted that it is in the interest of the community that an efficient electric power supply be maintained. The capacity of the existing plants [. . .] is insufficient for present needs and besides leaves no reserve in the event of breakdown. The capacity of new plant will supply 7000 lamps with normal reserve. To bring the Electricity supply up to the present requirement and to meet future demands, it is necessary in addition to completing the new Power Station to lay additional Mains to feed the existing network and to extend the network.[11]

This excerpt highlights that if the generation and transmission capacity were large enough, more people would be able to have electrical power in their homes and businesses since many private consumers were waiting for connection. In addition, it highlights the need to build reliable or resilient power systems which were aggravated by low voltage and poor-quality lighting.

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[8] UKNA T161/1049: Letter from H. Read, Under Secretary of State, to the Secretary of the Treasury, 4 August 1920.
[9] UKNA T161/1049: Letter from H.A. Byatt to the Principal Secretary for the Colonies.
[10] UKNA T161/1046: L. H. King, Report on the First Years' Working of New Power Station Dar es Salaam.
[11] UKNA T161/1046: L. H. King, Manager, Electricity Department, Report on Existing Plant and Future Requirements, 1 June 1920.

The focus of the Electricity Department was on improving the operation and reliability of power infrastructure rather than expanding the grid to new areas. It therefore re-engineered the transmission systems to bolster the existing power infrastructure between 1920 and 1922. As M. Finster and others have highlighted that infrastructure's vulnerability and resilience were also due to the way technical systems were engineered,[12] the Department reengineered its system in such a way that was possible to locate power failures and restore grid operation rapidly in the event of breakdowns. The *Dar es Salaam Times* reported during the building of the transmission system that the lines were "interconnected with light fuses, so that a fault developing in any of the above sections will confine itself to that section only; this arrangement reduces the inconvenience of any trouble to the smallest possible point, which also gives an immediate indication of the locality of the fault at the Power Station."[13] The electrical material and cables used were imported from Manchester, Glasgow and London, and the work was done and supervised by the Electricity Department. The Department also employed Indians and Africans in laying cables and erecting posts.[14] This shows that while electrification politics excluded access and use to local Africans, they participated as technicians in the building of electrical power infrastructure even before WWII, a rarely emphasised point in the colonial electrification history.

By June 1922, the reengineering works and expansion of the electricity infrastructure in Dar es Salaam was almost complete. These developments made power systems more stable and expanded the network to new areas. The expansion of power infrastructure in Dar es Salaam increased the "resilience" of power networks by reducing internal pressure from the demand side. It reduced the overload of the power network that caused breakdowns. Moreover, the systems functioned with standby reserve for the first time. As heralded in the *Dar es Salaam Times* in 1922, "all restrictions as to supply [were] removed, and the public can make the fullest use of the supply for lighting and power."[15] More lamps were made available in streets, people's homes, and government works and they were sufficient to meet demand in 1922–1924.[16] But electricity supply continued to be largely in places that had already been electrified by the Germans in the pre-war period, areas around the Boma, Bank, and Speke

[12]M. Finster, J. Phillips, and K. Wallace, "Front-Line Resilience Perspectives: The Electric Grid," *Global Security Sciences Division. Argonne National Laboratory*, (2016): xiii.
[13] *Dar es Salaam Times*, 10 June 1922.
[14] *Ibid.*
[15]*Dar es Salaam Times,* 10 June 1922.
[16] UKNA T161/1046: L. H. King, Report on the First Years' Working of New Power Station Dar es Salaam.

Streets, the Prince of Wales Hotel, Indian markets, the railway workshop, and the dockyard. Other areas included laying new mains to the Kurasini area, the Kaiserhoff hotel, the Secretariat, the Hospital, and the Burger Hotel rather than extending grid to new areas.[17] This made electricity to be largely amenity of a few Europeans and Indians population and for government buildings and works.

However, whenever the technological capacity of the networks and financial position allowed, the Electricity Department electrified new areas. The number of electricity users rose, and government works increased as the town was gradually transformed to respond to the British colonial economy. By the mid-1920s, the consumption of electricity in Dar es Salaam expanded slightly to occupy new areas such as Eastern Upanga, Indian residential areas, and European residential areas in the North-eastern part of the town. Electricity users grew by 11 percent in 1925 due to the increase in government public works and privately-owned industries.[18] The Department also conducted regular repair and maintenance to make power supply more stable and reliable. The annual electricity report in 1926 shows that the Department had succeeded in resolving frequent power breakdowns, stating that "supply [was] unbroken throughout the year" and the town's public lighting supply had been improved, overhauled and all the posts repainted.[19] The thermal electricity generation plants which the Department installed during this time in Tanganyika were small and could not meet the growing demand for a long time. Shortly, the Electricity Department began to use the standby plant to boost the power system and ensure reliable supply.[20]

The British administration in Tanganyika was only capable of relieving the poor functioning of the power systems temporarily. Despite the improvements obtained in the early 1920s, power supply in colonial Tanganyika deteriorated again from the mid-1920s. Electrified towns such as Kigoma, Tabora, and Dodoma was also in a state of disrepair and unable to keep up with demand to the extent that the number of electricity users began to decline. For instance, in Tabora, the number of electricity users decreased from 183 in March 1927 to 166 in November 1966 before they dropped to 150 in January 1928. The number of consumers in Kigoma almost halved from 150 in March 1927 to 77 in January 1928. A similar trend was observed in Dodoma where users dropped from 29 in November 1927 to 22 in January 1928

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[17] *Ibid*.
[18] EAF-UDSM Library: Tanganyika Territory: Provincial Commissioner's Report Dar es Salaam.
[19] TNA Acc. 5 File 13694: Electricity Department; 1926 Annual Report to the Chief Secretary, Dar es Salaam.
[20] *Ibid*.

due to intermittent supply and economic losses.[21] The breakdown was since the Electricity Department had not completed the repair and renovation of the power infrastructure since the end of the First World War Elsewhere in the territory, consumers complained about poor electricity supply and lighting. One of them noted that the electric light resembled "Japanese lantern luminosity."[22] The electric light was dim to the extent that one could not use it for reading. Z. A. Georgio, a European and a power consumer, complained in a letter to the District Commissioner about lighting and poor electrical services during this period. He wrote:

> I am very sorry to make the following complaints and hope that you will see your way to recommend for better working and facility. I am the only person on the hill amongst European customers who got 45 lamps and that they are so unsatisfactory to me and my customers that we get disgusted about them. In the first instance the light is dim and secondly very often it goes off. I am paying about Shs 150/- to Shs 200/- per month and must expect satisfaction. [. . .] May I suggest, and I got right too, when I pay so heavily that the dynamo be exchanged and am sure all the Europeans will agree to this as we all are in the same boat.[23]

This quote reveals the malfunctioning of electricity infrastructure in British colonial Dar es Salaam. As Jens Ivo Engels highlighted that "no city, no state, and no private company would pay for a technical system that does not fulfil specific functions,"[24] electricity consumers in Tanganyika expected good electricity services because they paid for them. They wanted the Department to improve its service because electricity consumers considered it a vital technology for lighting and powering their homes and businesses.

The Dar es Salaam Town Authority was also concerned by the erratic power supply. A letter from E. Dennis, an electrical engineer at the Electricity Department, to the Director of Public works in 1930 is a snapshot of how the networks failed frequently and were unsafe to urban dwellers. Dennis drew the attention of the Director of Public Works on the poor state of street lighting infrastructure in the following words:

> 268 of the Existing Street Lamps have been in use since before 1907. The bulk of the Standards are so far corroded as to be unsafe. The cables are at the end of their useful life and it may be thus assumed that the whole of the original Street Lighting Scheme requires re-constructing. It is becoming yearly more expensive to maintain by means of repairs and in

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[21] UKNA CO 691/98/3: Report by Sparks & Partners, dated 20.04. 1928.

[22] TNA File No. A35/1& A35/1/42: Letters of dissatisfaction from customers to the District Office, Central Province, Dodoma, ref. 35/2/2/29, 10 December 1929; See also letters of dissatisfaction from the District Office, Dodoma, ref. 35/2/2/29, 10 December 1929.

[23] *Ibid.*

[24] Jens Ivo Engels, *Key Concepts for Critical Infrastructure Research* (Springer VS, 2018), 9.

> the main, as the system has now become grossly in-efficient for its purpose. I beg to suggest that you keep in view the necessity of providing funds for its complete renewal.[25]

R. E. Surridge, the Chief Secretary of the Tanganyika Government, replied to the Public Works Department, informing them that the repair and improvement of supply was costly and had to wait for negotiations between the government and other stakeholders regarding the transfer of Dar es Salaam's electrical undertakings to private companies.[26] This further speaks to the critical financial position of the British government in the late 1920s and early 1930s in ensuring reliable electricity services.

Repair and maintenance services of electrical systems had to wait for privatisation of electrical undertakings whose discussions were underway.[27] Such delayed actions also testify to the way the British handled their colonial policy in the interwar period and how it affected electrification. The policy aimed to promote overseas trade and solve unemployment at home by promoting activities that would increase flow of raw materials to revive industries and give employment to British citizens. It discouraged flow of government funds from London to the colonies. Colonies were, therefore, required to expand power infrastructure by using local funds to make the colonies and crown lands self-sufficient. A maximum of one million pounds only was voted by Parliament annually for development schemes in the colonies, and in East African colonies, a large slice of these funds was invested in building transport infrastructure such as railways, harbours, and road networks to facilitate export of raw materials than expanding electricity.[28]

Moreover, the Colonial Office and the Treasury were unwilling to support electricity projects in the colonies. They saw electricity development as matter of less urgency to the interwar British economy since electrical projects took longer time to make returns. They, therefore, considered electricity supply a matter the colonial government had to arrange independently in collaboration with London-based private enterprises.[29] Because Tanganyika

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[25] Frank Edward and Mikael Hård, "Maintaining the Local Empire: The Public Works Department in Dar es Salaam, 1920–60," *The Journal of Transport History* 41, no.1 (2019): 1–20, 2; also, TNA 18878: Letter from E. Dennis to the Director of Public Works dated 14 March 1930.

[26] TNA File no.18878: Letter from E.R.E. Surridge to the Director of Public Works dated 7.4.1930.

[27] UKNA CO 691/98/3: Report by Sparks & Partners, dated 20.04.1928.

[28] Stephen Constantine, *The Making of British Colonial Development Policy, 1914-1940,* (London; Frank Cass and Company Limited, 1984), 77–79; David John Morgan, *The Official History of Colonial Development Vol.1: The Origins of the British Aid Policy, 1924–1945*, (London and Basingstoke: The Macmillan Press, 1980), 35.

[29] Morgan, *The Official History of Colonial Development*, 52; Constantine, *ibid*., 79–80; See also Jonas van der Straeten, *Capital Grids: A Global History of Electricity in East Africa,* (New York: Palgrave Macmillan, (forthcoming).

was a new Mandate Territory, the Colonial Office supported its electric development through a long-term, low interest rate loan, repayable within a suitable period by means of a sinking fund.[30] This kind of financial arrangement also illustrates that the development of power systems in Tanganyika in the interwar period was neither a direct 'tool of empire', which the colonial authorities in London promoted as a means of exploiting resources and instigating racial divide, nor did the colonial state have clear guidelines on how electricity infrastructure should be developed. Its growth faced financial difficulties and colonial officials in London never promoted it.

When Sir Donald Cameron replaced Byatt as British Governor of Tanganyika in 1925, he initiated more efforts to improve electricity services. Cameron perceived electricity as an essential utility to the public in Tanganyika. He stated that in his letter to the Colonial Office in London saying that: "the public are entitled to expect more efficient and cheap services than they are receiving now."[31] 'Public' here seems to suggest that he was referring to the European and Indian populations in Tanganyika rather than the Africans. One of the reasons to assume this was his meaning is that, in the 1920s, most Africans lived in rural villages (zone III) outside the area which was regarded as Dar es Salaam town and had no access to electricity services. During this period, electricity was basically supplied to European residential areas, government buildings and the area opposite the railway station where Indians lived, but not to the modern-day Kariakoo where the Africans resided.[32] Since the Governor aimed to improve the supply to those who already had access, it is obvious that Africans were not part of the 'public' he was referring to.

Before his appointment to Tanganyika, Cameron was a Chief Secretary to Lord Frederick Lugard, British colonial Governor in Southern Nigeria. Adewumi Damilola Adebayo paints a picture of state electrification that the Sothern Nigeria colony had elaborated electrical infrastructure than that of Tanganyika. He shows that in 1917 under the leadership of Sir Lugard, the Legislative Council passed the Electricity Supply Ordinance which placed electrical

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[30] UKNA T161/1046: Letter from the Secretary of the Treasury to the Secretary of State for the Colonies, 29 September 1920; Letter from Sir H. Read to the Secretary of State for the Colonies, 2 December 1920: Letter from R.S. Meikle John, Secretary of the Treasury to the Under Secretary of State, Colonial Office, 6 April 1921.

[31] UKNA CO 691/98/1: Sir Donald Cameron, Governor of Tanganyika to L.M.S. Amery, MP, London, on 29 February 1928.

[32] On building ordinances and residential areas in colonial Dar es Salaam, see James R. Brennan and Andrew Burton, "The Emerging Metropolis: A History of Dar es Salaam, circa 1862-2000," in *Dar es Salaam: Histories from an African Emerging Metropolis*, eds. Brennan, Burton and Lawi, (Dar es Salaam: Mkuki na Nyota, 2007); Smiley, "The City of Three Colors," 178-191.

undertakings into strict government control. Through this ordinance, government's role in the provision and control of electrical infrastructure increased and it promoted electrification in the colony.[33] It seems to suggest that, working as Lord Lugard Secretary, Cameron was influenced not only by Lugard's indirect rule policy but also on how he dealt with electrification of the colony. When he moved to Tanganyika as the second British colonial governor, Cameron not only introduced indirect rule administration, but he also required greater government interventions in electricity provision. Cameron himself explained in a letter to the Colonial Office in London in 1928, "in my experience, here and elsewhere, the Government cannot exercise the close and constant supervision that is requisite."[34] For him, inefficient technical supervision and low government investment and administration were two problems which hindered proper development of electrical technologies in Tanganyika. He believed that state cannot avoid financial investment because power infrastructure had to be kept running. He, therefore, proposed a partnership between the Tanganyika Government and private companies with the intention of developing electrical power infrastructure.[35]

The letter reached London in April 1928. Sir Henry Lambert, the Secretary of State for the Colonies, claimed to be ignorant of electricity services in Tanganyika. In consultation with Sir Cameron and Sir Montague Barlow, the director of Armstrong-Witworth company (he was also a Conservative Part politicians and Minister of Labour in 1922 – 1922) whose company had interest in developing electrical infrastructure in British East African territories, Lambert proposed a detailed survey of electrification in Tanganyika to provide adequate consideration on the situation.[36] M. C. P. Sparks, a senior electrical engineer of Messrs. Sparks & Partners and the adviser to other large commercial and municipal electricity undertakings in Britain, was appointed to the task of evaluating electrical infrastructure in Tanganyika in December 1927. E.V. Richards, a graduate civil engineer from London University in civil works, assisted Sparks.[37]

The terms of reference were to investigate the economic profitability and technical analysis of electrical systems in Tanganyika, to determine prospective electricity uses and demand including the building of a hydropower plant at Pangani, as well as to assess the

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[33] Adewumi Damilola Adebayo, "A Socioeconomic History of Electrification in Southern Nigeria, 1898-1972, (Unpublished PhD Diss.: St. John's College, 2020), 167 – 168.

[34]UKNA CO 691/98/1: Sir Donald Cameron, Governor of Tanganyika to L.M.S. Amery, MP, London, on 29 February 1928.

[35]*Ibid.*

[36] UKNA CO 691/93/9: Correspondence: The Governor of Tanganyika, the Colonial Office and Sir Montague Barlow. Also, UKNA CO 691/98/1 and UKNA CO 691/98/3.

[37] Ibid.

possibility of forming a public-private company. Messrs. Sparks and Richards completed their study in April 1928, and the British consulting engineers, Preece, Cardew and Rider, helped the Colonial Office in assessing the report.[38] Their report found that electrical infrastructure in Tanganyika were non-resilient in diverse ways. They were non-resilient in the sense that most existing electricity generating plants operated without power reserves and had unreliable wood-burning locomobile engines which were unable to withstand shocks and stress such as overloads and heavy rains in Dar es Salam. In addition, the Electricity Department lacked sufficient financial and technical competences to ensure regular maintenance and repair that could have made the systems more reliable. Indeed, they suggested "immediate expenditure of considerable sums of money to bring them into satisfactory condition."[39] The recommended expenditure on repairs focused on converting the systems from DC to AC and changing the underground cables to overhead ones. The report also recommended the need to privatise the public electricity supply.[40]

The Colonial Office and Cameron implemented recommendations by Sparks and Richards. They shaped the direction of electrification in the Territory in the 1930s and post-WWII period. They started immediately with the arrangements for the privatisation of electrical undertakings. The process was characterised by imperial competitiveness and lobbying from London electrical firms. Barlow and his African General Development Company Ltd was the first in this race. In 1928, he secretly submitted an agreement to Cameron in Dar es Salaam proposing the formation of the Tanganyika Light and Power Company, which would be a coalition between Barlow's Company and the Tanganyika Government to be registered in London. Barlow had gone as far as proposing that the new Company should be offered two licences: one to supply the already electrified towns such as Dar es Salaam, Dodoma, Tabora, Kigoma, and Mwanza within a radius of 60 miles from the post office. The other licence would be to install hydroelectric power at the Pangani River and exclusive rights to supply electricity within 60 miles on both sides of the Pangani River, to reach all the productive sisal plantations in the basin.[41] Due to the imperial competitiveness of the electrical industry in the 1920s, as Van der Straeten shows, other companies also noticed Barlow's intentions and made efforts to stall him. After protracted negotiations and the fact that Barlow's Company faced a financial crisis due to

[38] Van der Straeten, *Capital Grids* (forthcoming).
[39] UKNA CO 691/98/3 and UKNA CO 691/101/4: Report by Sparks & Partners, dated 20.4.1928.
[40] *Ibid*.
[41] For a detailed study on these companies, see Van der Straeten, *Capital Grids.*

the 1929-1933 economic depression. The project was taken by the Power Securities Companies (PSC) and its East African subsidiary, the East African Power & Lighting Company (EAP&L).[42]

1.3 Electricity undertakings under the private company in the 1930s

The negotiations for the privatisation of electricity were over in January 1931. They were concluded by the signing of two agreements between Tanganyika and PSC as proposed by Barlow's Company with only some slight changes. The main difference was that the contract required the PSC to have two companies; the main one, which would operate in the Pangani area, and another one for Dar es Salaam and upcountry towns. Under this license, the PSC formed the Tanganyika Electric Power Company (TANESCO) to install a hydropower plant at Pangani and supply electricity within 60 miles on both sides of the Pangani Basin in the Tanga Province. It established another subsidiary company, the Dar es Salaam and District Electric Company (DARESCO) to generate and supply Dar es Salaam and upcountry towns within a radius of 1.5 miles from each post office. DARESCO was officially incorporated and registered in Tanganyika as a power utility company to supply electricity to all towns in Tanganyika except those which were under the TANESCO license in the Pangani area. It also had options to provide power to the towns of Morogoro, Moshi and Arusha.[43] Furthermore, both sides agreed that DARESCO had to be consulted first, whenever individuals or the company intended to electrify any other towns in the Territory.[44] Individual producers of electricity were also allowed in Tanganyika, but they were prohibited from supplying to the public. Hence, DARESCO was given the monopoly in the generation, supply, and sale of electricity to the public.

The founding of DARESCO marked the end of the Electricity Department in the supply of public electricity. The Department's staff members were incorporated into the new company and the government contracted DARESCO and TANESCO to install, repair, and maintain street lighting. DARESCO installed and maintained street lighting in Dar es Salaam, Tabora, Kigoma, and Dodoma, while TANESCO did the same for towns in the Tanga Province in the north-eastern part of the Territory.[45] The government retained £20,000 as a preferential share and £25,000 as an ordinary share in the company, but it became largely a "controlling agency" to ensure that

[42] *Ibid.*
[43] UKNA CO 691/98/1: Licence given to the Tanganyika Light and Power Company.
[44] UKNA CO 822/148/3 and KNA File CP 12/54/5. C. R. Westlake's Report on the Electricity Undertakings in East Africa.
[45] EAF-UDSM Library: Tanganyika Territory, Public Works Department Annual Reports 1932–1938 and The Tanganyika Territory, District Officer's Reports, Dar es Salaam District 1931, 42.

electrical companies complied with stipulations in their licences.[46] It drafted the 1931 Electricity Ordinance and the 1932 Electricity Rules to maintain, guide, and control the electrification process in the Territory. A London-based company, Preece, Cardew and Rider, who were Crown Agents consulting engineers, drafted Tanganyika's electricity rules. They mostly copied and adapted them from the 1928 British Palestine Electricity Rules. Later, the government electrical engineers in Tanganyika included the 1910 Indian Electricity Act as well.[47]

The primary role of these regulations was to facilitate and regulate the generation, transmission, distribution, and use of electricity for power and lighting in Tanganyika. As a principle, any proposal for supply had to be approved by the government electrical engineer and governor before doing any extensions of the networks or connections. The rules required the companies to supply power to all consumers upon application without showing any discrimination or granting any "preferences as between consumers in the same locality, and where conditions of supply, including power factor, are similar."[48] They also directed the company to observe all technical, economic, and safety parameters. It had to supply consumers or areas after having been "reasonably satisfied that the service lines, fittings, and apparatus therein are in good order and condition, and not calculated to affect injuriously the use of energy by the licensee or other persons."[49] The last essential regulation was that all the electrical fittings, meters, and cables for wiring and electricity installation in consumers' houses and premises had to meet the standards stipulated by the Electrical Equipment of Buildings of the Institute of Electrical Engineers of Great Britain.[50] These regulations were vital in ensuring that the supply of electricity was safe and secure to the company, users, and people's properties in the Territory.

The takeover of electrical power undertakings by a private company only moderately improved power supply in Dar es Salaam. DARESCO expanded electricity generation capacity and introduced new power generation technologies. For instance, the installed capacity in all towns under its sphere of supply was about 1.3 megawatts in 1931. Dar es Salaam had 1.0 megawatts produced from diesel and firewood-powered engines. The grid reached new

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[46] UKNA CO 691/93/9 and 18507: The Draft Instruction to Messrs. Sparks and Partners, dated 1 December 1927.
[47] Shamir, C*urrent Flow;* Van der Straeten, *Capital Grids.* Hege and Van der Straeten, "Enclaves of Light and Citadels of Profit,".
[48]Hege and Van der Straeten, "Enclaves of Light and Citadels of Profit,"; also, UKNA CO 691/120/4: Tanganyika Electricity Ordinance.
[49] *Ibid.*
[50] *Ibid.*

European residential areas such as Oyster-Bay and Sea View in the North of the city in the early 1930s after these places had been integrated into the town.[51] The company also extended the grid to other essential areas such as golf clubs and other European social amenities. It also installed new street lighting in areas such as those around Bagamoyo Road, Gillman Avenue, Ring Street, Acacia Avenue, Oyster-Bay and the Sea View area. The new electricity power network covering Oyster-Bay and Sea View started operation in 1934.[52]

The company also improved street lighting, one of the crucial electricity uses in colonial Dar es Salaam. It introduced a special lighting scheme known as the Dar es Salaam Municipality Better Lighting Scheme in 1938 which expanded to many parts of the town, including Zone III where Africans lived.[53] The installation of street lighting in some points involved erecting new electrical posts, lamps and brackets, as well as wiring of areas which thus expanded the grid.[54] The available records reveal that DARESCO installed about ten lamps each year in different place parts of the town. When Dar es Salaam became a municipality in January 1949, the responsibility of erecting, repairing, and maintaining street lighting was transferred from DARESCO to the municipal authority.[55] DARESCO converted the poorly functioned direct current (DC) networks to alternating currents (AC) as required by the power supply license.[56] This improved the quality of lighting by reducing transmission losses and voltage fluctuations.[57] During this time, the growth of workers' associations, such as the Tanganyika Railways and Ports Services Asian Association, influenced the expansion of electricity lighting in residential zones as an "essential public service" which the Town Authority had to provide.[58] Subsequently, the Town Authority also placed great emphasis on electrifying streets from the 1930s in its efforts to change Dar es Salaam from a town to a municipality.

The available sources do not reveal the actual number by which private consumers increased in the 1930s, but they seem to suggest their number had grown. Within nine years,

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[51] TNA 19825: Dar es Salaam Township: Inclusion of Oyster Bay.
[52] TNA File E. L. /14/32: Letter from the Electrical Inspector to the Senior Government Engineer, dated 19 February 1934.
[53] TNA 18878: Dar es Salaam Street Lighting.
[54] *Ibid*.
[55] EAF-UDSM Library: Annual Reports, Public Works Department (PWD) from 1934–1950: Street Lighting.
[56]UKNA CO 691/98/1: Licence given to the Tanganyika Light and Power Company.
[57] TNA File Misc/120/148: The Acting Director of Public work to DARESCO in The Colonial Governor's Report, League of Nations 1939, 232; see also EAF-UDSM Library: Tanganyika Territory Report for the year 1937, submitted to the League of Nations on the Administration of the Tanganyika Territory 1937; 1938, 170.
[58]TNA File 18878: Letter from the President of the Asian Association to the Honourable General Manager.

DARESCO's capacity had doubled and reached 2.1 megawatts.[59] Furthermore, the company introduced several diesel oil electricity generators and a few industrial gas generators to replace wood-burning steam generators. Between 1933 and 1936, the company installed diesel oil generators with a capacity to produce 1134 kilowatts.[60] It built a largest diesel-powered generator that enabled further expansion of the electrical supply in Dar es Salaam reducing the vulnerabilities of using firewood-powered generators.

Figure 1.1: Dar es Salaam's first Ruston Lincoln diesel generation unit for public supply
Source: Photo taken by the author in Dar es Salaam in April 2021.

One of the remarkable steps which DARESCO brought to colonial Dar es Salaam's electrification was an attempt to electrify African households in the 1930s. The company submitted its proposal to the government to supply electricity to African residential areas in New Street, Pugu Road, and Msimbazi Street at the cost of 2.50 shillings per month for one lamp of 40 watts without meter charges. It also proposed that more lights should be made available

[59]UKNA File No. CO 691/98/3 and KNA File CP 12/54/5: Westlake Preliminary Report in 1946 on Electricity Supply in East Africa, Kenya National Archives and from the Sparks & Partners Report.
[60] KNA File CP 12/54/5 & UKNA CO 822/148/3: Westlake's Report on the Electricity Undertakings in East Africa.

for Africans with larger houses. It requested the government to relax the electricity rule that prohibited the discrimination of supply to customers in a similar locality so as to allow reduction of tariffs for Africans as a way of motivating them to electrify. The government denied the request by claiming that it contradicted the electricity rules which prohibited discrimination of tariffs to consumers in DARESCO's areas of supply. The company believed that the government misinterpreted the electricity rules because in the United Kingdom, where such rule of no discrimination originated, consumers in the same town were differently charged depending on their level of electricity consumption.[61] DARESCO insisted that the extension of power infrastructure to Africans without reducing tariffs to affordable rates was an obstacle to them connecting to the grid.[62] This shows that despite the unequal investment expenditures, discussions and plans to ensure the power infrastructure crossed to African residential areas were in place even before the Second World War.

These findings also corroborate other scholars' observation that there were many reasons beyond the colonial racial discrimination which made electricity in colonial Sub-Saharan African to become an amenity for Europeans prior to WWII. Bernward Joerges in "Do Politics Have Artefacts?" reminds us that while designing, building, and using infrastructures might politically and racially exclude people, it is not always the case that system builders intentionally do so.[63] Having published his article in 1999, almost two decades after Langdon Winner's "Do Artifacts Have Politics?", Joerges criticised Winner's main argument that technical things, including large technical systems, are naturally engrained with socio-political desires and objectives. One of the examples Winner used in developing his proposition was the building of bridges in Long Island by Moses. He claimed that Moses intentionally designed the bridges in such a way that they prevented 'Black Americans' from having access to the beaches.[64] In his criticism, Joerges showed that in the 1920s and 1930s, at the time when Moses built the bridges, there were good transport options to Long Island, hence there was no need to incur the high costs of raising the bridges. He added that at the time all buses, trucks, and cars were prohibited from the parkways, thus, if the bridges had been raised, they would have increased construction costs and had a more severe impact on the environment. Hence, Joerges concluded that Moses'

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[61]TNA 24387: Memorandum to DARESCO Directors, from D. J. Don Small, "Experimental Lighting in Native Huts", dated 3 September 1937.
[62] *Ibid.*
[63] *Ibid.*
[64] Langdon Winner, "Do Artifacts Have Politics?" *Daedalus* 109, no. 1 (1980): 121-136.

low bridges never intended to racially exclude Africans, but their design was for commercial and environmental reasons.[65] While the Municipal took control over street lighting did not offer equitable street lighting. Yet, some technical and economic rationalities of electricity supply played a critical role something which affirms Joerges' observation that although infrastructural services can perpetuate racial discrimination, it is not necessarily true that their builders intended to do so.

First, in the 1930s, Tanganyika experienced what Van der Straeten calls the lost decade in electrification. The promoters of electricity technology in the three British East African colonies failed to bolster the growth of electrical networks due to financial and technical limitations, as well as conflicts over hydropower sources.[66] British colonial authorities lacked a clear policy on how electricity infrastructure should be developed, leading to conflicts among electrical companies and other water users in its territories. Hence, the British electrical firms hesitated to invest heavily in electrical power infrastructure in East African colonies and their investments remained 'piecemeal and low-risking'[67] due to the British colonial policy in the interwar period, which insisted on "capital works" that had immediate economic profit or could stimulate British overseas trade and home employment.[68] Electricity supply in Dar es Salaam especially to people's homes, even to Indians, was not a major priority for the British government. For instance, despite Tanganyika having received about £8.8 million from London between 1929 and 1940, more than any other colonial territory in East Africa, only 2% of these funds were invested in electricity supply. A large portion went to other infrastructures such as transport (30%), public health (16%), and water supply (8%), among other sectors.[69] Low British investment in electricity services had implications on supply. Even the extension of the power grid by installing one or two streetlights was problematic. For example, Edward and Hård highlight that supply of street lighting in Dar es Salaam in the 1930s was a matter of constant struggle even for the Indians. They show that the British colonial government refused to install electrical lighting in front of the Hindu Dispensary in Dar es Salaam claiming lack of funds until it became a public issue in the newspapers.[70] Similarly, it took the Indian Railway and Harbours

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[65] Bernward Joerges, "Do Politics Have Artefacts?" *Social Studies of Science,* 29, no.3 (1999): 411–31.
[66] Van der Straeten, *Capital Grids*.
[67] *Ibid.*
[68] The Overseas Development Institute, *Colonial Development: A Factual Survey of the Origins and History of British Aid to Developing Countries*, (London; The Overseas Development Institute Ltd, 1964), 16, 22.
[69] The Overseas Development Institute, *Colonial Development*, 16–17, 29.
[70] Edward and Hård, "Maintaining the Local Empire"; also, TNA, File No. 18878.

Association six years from 1932 to 1938 to get three additional electrical lamps in Indian quarters even though the lighting point was essential to Indians and other traffic users during night-time.[71]

Second, the British government intended to maintain safety and security, the most crucial issue in electrical engineering and the electrical industry. Unlike other technical systems such as roads, railways, sewerage, and water supply systems, the British colonial government considered electricity to be a great threat to people's lives and properties. The Electricity Rules required the company to be "reasonably satisfied that the service lines, fittings, and apparatus therein are in good order and condition",[72] before it could supply power to any premise. The rules also required that all fittings, cables, and meters had to meet United Kingdom standards to prevent injurious and unsafe electrical installations. The specified standard of electrical power components was expensive beyond what most Africans could afford. African houses were largely constructed from local materials such as mangrove posts and mud and roofed with palm-fronds. The colonial government considered these houses temporary, sub-standard, and incompatible with electricity safety rules.[73] Because electricity was not only a technical enterprise but also an expensive economic one, the colonial government believed that it was disadvantageous to extend supply to African residential areas, where only a few houses met the security and safety standards.[74]

Third, the Africans had poor economic conditions that made them unable to pay electricity bills at the established tariffs. For the Dar es Salaam and District Electric Power Company, electricity was not a 'tool of empire,' but an economic commodity that required customers for the company to make a profit, regardless of whether the generated electricity was used by Europeans, Indians, or Africans. In the mid-1930s, DARESCO proposed to electrify African households. It presented the government with its proposal to supply electricity to African residential areas in New Street, Pugu Road and Msimbazi Street at the cost of 2.50 shillings for one 40-watt lamp per month without meter charges in the mid-1930s. DARESCO stated in the proposal that more lights should be made available for Africans who had larger and more standard houses. As shown above, the company requested the government relax the

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[71] TNA, File No. 18878: Letters of correspondence between the Dar es Salaam Township Authority and The Asian Association of Railway Workers.
[72] UKNA CO 691/120/4: Tanganyika Electricity Rules 1932, from the 1931 Electricity Ordinance.
[73] Brennan and Burton, "The Emerging Metropolis," 32.
[74] *Ibid*.

electricity rule that prohibited the discrimination of supply to customers to make it affordable to Africans and motivate them to electrify, but the government refused, based on electricity rules that prohibited discriminated tariffs.[75] In the economics of power supply, DARESCO saw the need to supply African premises but the expansion of power infrastructure without reducing tariffs to affordable rates would have stopped them from connecting to the grid.

Jethron Akala claims that historians of technology need to go beyond the racial segregation policy narratives regarding the provision of large technical systems in African cities during the colonial period. In what he terms 'technomics', Akala shows that while Nairobi was entrenched based on several colonial segregationist ordinances, including the zoning of the city, the economics of large technical services dominated the provision of water services. Under the guise of the so-called 'public utilities', where consumers incurred both the cost of connection and everyday consumption, the provision modalities were dictated by billing systems and the consumers' ability to pay.[76] The colonial British government supplied electricity and water to those non-European communities in Nairobi, such as the Nubians, Asians, and Somalis who were able to build houses according to the established codes. He argues that infrastructure provision was not "elusively preceded by the race consideration but also anchored more in the financial clout. [. . .] Although legislation on paper may read exclusion, infrastructure deployment followed a path that was more economically deterministic than racially engineered."[77] Akala insists the study of the provision of technical infrastructures in colonial African cities like Nairobi has to go beyond the binary narratives of racial exclusion to the realities and nature of technical systems.

Technological systems are non-neutral entities, thus, who got what, how, how much and when was largely determined by affordability. In this regard, the provision, access, and uses of these infrastructural technologies in many cities became a question of economic class rather than race.[78] Akala further maintains that the question of class rather than race is crucial in large technical services because of affluence and affordability. Elsewhere, even in non-colonial settings, the provision of electricity was also based on class, that is, the ability to pay rather than

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[75] TNA File No. 24387: Memorandum from D. J. Don Small to DARESCO Directors, "Experimental Lighting in Native Huts," dated 3 September 1937; Also, TNA 24383: Extract from the Minutes of the 95th Meeting of DARESCO Directors, held on 22 May 1944.

[76] Jethron Akala, "In the Technological Footprints of Urbanity: A Socio-political History of Water and Sanitation in Nairobi, 1899-2015," (PhD Diss., TU Darmstadt, 2019), 98–102. Available at: https://tuprints.ulb.tu-darmstadt.de/8550/

[77] Ibid., 99–100.

[78] *Ibid*.

race. Electricity companies started to generate and expand their grids to wealthier urban populations and industries where they could harness consumers and make a profit. Taking economic parameters (social class) into account is essential to grasp the reality of social services because they were grounded in the consumers' economic status and the technological capacity of the systems to supply and obtain revenue. For instance, taking on the question of class in colonial electrification in "New Wine in New Bottles", Animesh Chatterjee uncovers how class identity politics shaped electrification and the appropriation of electrical appliances in Indian homes. He shows that in the early decades electricity, there were low consumption rates due to a lack of heavy industries in India. Electricity engineers and suppliers struggled constantly to raise their electricity load. The domestic supply was directly linked to the potential market sources; hence, engineers and promoters of electrical technologies harnessed and used identity politics, particularly of the Indian urban middle class to market electrical gadgets such as fans and bells.[79]

Chatterjee not only criticises the narratives that electrification in India was a highly regulated and controlled project by the British colonial government but also that it was a straightforward process to which the colonial government and electricity promoters simply applied racial rationalities. Thus, he proposes that the growth of urban electrical systems and the domestication of electrical technologies in the colonial South need to be contextualised in the broader political and cultural parameters of everyday socio-cultural and political lives.[80] One of the important points in Dar es Salaam that can be understood from the example of Calcutta is that while the urban middle class were successful in joining the Europeans in using electricity, the urban Indian poor continued to use other lighting and power technologies rather than electricity for economic reasons. Likewise, the provision and use of electricity until WWII should be examined in the specific contexts of the electricity infrastructure developed in Dar es Salaam. In the 1920s and 1930s, Kariakoo and Ilala were the main African residential streets. A few African houses were also built in the urban fringes of Gerezani and Keko. Most Africans lived predominantly in villages located in the towns' suburbs where networked infrastructure systems such as roads, sanitation, water, and electricity were non-existent.[81] As Hoag quoted Deputy General Manager, N. Ramsey, who said that Africans were "quite stoic about" the

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[79]Chatterjee, "'New wine in new bottles'," 6–10.
[80]*Ibid*.
[81] Brennan and Burton, "The Emerging Metropolis," 31–34.

company's street lighting programmes and such "ethnocentric attitudes led company officials to postpone investing in large-scale plants as they argued Africans were disinterested in electricity."[82] These words reveal that electricity promoters, especially the private company, DARESCO, were concerned with the electrification of African streets and homes even before WWII. This contrasts some existing studies which tend to view electricity in colonial Dar es Salaam as having been totally denied to natives based on racial reasons.

Most of the African villages beyond Kariakoo and Ilala were modest agricultural or maritime communities. They mainly interacted with the town intermittently during the day to grab any work in zone II, which also served as the town's commercial zone. In the European residential areas (zone I), Africans just passed through as hawkers selling petty commodities, as *shamba* boys (gardeners) and housemaids.[83] Moreover, the sources consulted in the course of this study provide no evidence that Africans viewed electricity as necessary in the interwar period, that they were capable of paying for it, or that they applied for connection. Nor is there any evidence the government or electrical power utility denied them access to electricity based on their race. But it is evident that Africans were 'third-class' residents, too poor to demand electricity or to pay for it. Electricity was an economic technology, supplied based on economic rationalities, and most Africans were poor and unable to pay for expensive, poorly developed electricity in the interwar period. Therefore, Africans were less interested in or could not afford electricity. By and large, DARESCO continued to dismiss Africans as electricity users.

1.4 The Welfare State: Electrification and the CD&W Policy in the 1940s

The provision of electricity services in Dar es Salaam and other towns in Tanganyika took a new impetus in the post-WWII period. The change was a result of British implementation of the Colonial Development and Welfare policy (CD&W). As noted in this chapter above, the interwar Colonial and Development Fund (CDF) was primarily designed to boost British overseas trade and reduce unemployment at home.[84] The interwar CDF came under vehement attacks in the 1930s due to its focus on solving only challenges in British domestic affairs at the expense of colonial affairs.[85] At home in Britain, it had failed to solve socioeconomic challenges and in the

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[82] Hoag, *Developing the Rivers of East and West Africa,* 159.
[83] *Ibid*.
[84] The Overseas Development Institute, *Colonial Development,* 15; See also, Morgan, *The Official History*, 45; Andrew Roberts, "The Imperial Mind," in *The Cambridge History of Africa vol. 7: from 1905 to 1940,* ed. Andrew Roberts (Cambridge; Cambridge University Press, 1986), 47.
[85] Roberts, "The Imperial Mind," 47; Morgan, *The Official History*, 34-37; Constantine, *The Making of British*, 77–79; Nina Pandit, "Expedient Benevolence: International Development and the United Kingdom," (Master Diss.:

colonies, it had failed to raise wages after the economic recession of 1929–1933. In Africa, for instance, CDF excluded natives from urban areas and denied them access to socio-technical infrastructures such as roads, housing, sewerage, clean water and electricity because of low budget and funds allocated for such services.[86] The British colonies such as in the West Indies and Africa were frequently faced with strikes and unrest, because the CDF demanded much more from the colonies than the investments they received.[87]

By the late 1930s, the British government in London had realised that the interwar colonial development policy had failed to meet its primary goal since it lacked consideration regarding the welfare of the colonised people. Serving his second term in office as Secretary of State for the Colonies, Sir Malcolm MacDonald, was determined to improve the situation. He claimed that British assistance to the colonies needed to focus on improving the standard of living in the colonies rather than in Britain.[88] On 16 June 1938, he requested his staff to prepare a memorandum that depicted CDF operations. After several debates in the British House of Commons in the late 1930s, a bill called "Statement of Policy on Colonial Development and Welfare" was put before the Cabinet on 15 February 1940 and the Act was passed in July 1940.[89]

The CD&W Act contained several changes which aimed to improve the welfare of people in the colonies and bolster colonial production. One of them was the broadening of scope of the development fund, to include welfare services such as education, public health, and housing in efforts to improve the living standards of the "natives" in the colonies. It also increased the development fund from £1 to £5 million annually. The research fund increased from £20,000 to £500,000 annually.[90] However, the Act was not implemented in the early1940s due to the outbreak of WWII. After the war, the British introduced another legislation known as the 1945 Colonial Development and Welfare Act. The 1945 Welfare Act expanded development and welfare per territory to £120 million (this amount was for ten years, which equal to £12 million annually). The Colonial Office, thus, required the colonies to prepare ten-year development

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Mass., 2009), 24; George C. Abbott, "A Re-Examination of the 1929 Colonial Development Act," *The Economic History Review* 24, no. 1 (1971): 68–69.

[86] Andrew Burton, "Townsmen in the Making: Social Engineering and Citizenship in Dar es Salaam, c.1945-1960", *International Journal of African Historical Studies* 36, no.2 (2003): 331-365.

[87] The Overseas Development Institute, *Colonial Development,* 35; Arthur Creech Jones "The British Experiment in Colonial Development and Welfare," *Civilisations*, 6, no. 4 (1956): 557-564: For an expanded discussion on the British Economic Depression see, for example, W. Hamish Fraser, *A History of British Trade Unionism, 1700–1998*, (London: Macmillan Press, 1999), 152-176.

[88] Morgan, *The Official History,* 35.

[89] Constantine, *The Making of British,* 206-210.

[90] *Ibid*., 206-208.

plans. CD&W established that it was the duty of the imperial government to provide funds for development in the colonies. It clearly stipulated that the British should not expect anything in return for the investments in the colonies.[91] Hence, it officially abandoned the old imperial colonial policy that purported self-financing, and piecemeal funds for electricity development in the colonies in different ways.

The preparation for the CD&W in Tanganyika started in 1938. Sir Mark Aitchinson Young, the governor of Tanganyika, appointed a Central Development Committee to draw up the development road map for Tanganyika under the leadership of G. R. Sandford, the State Secretary of the Government of Tanganyika. Tanganyika was the first British colonial territory to submit its development plans in May 1940.[92] The report intended to promote the development of healthy, prosperous, industrious, and self-reliant residents based on local resources. It also highlighted how the living standards, including of non-natives, could be improved.[93] Several preferential schemes were identified, such as communication systems like roads, encouraging the settlement of non-natives in towns, and relocating rural Africans to fertile lands.[94] But when the report was published, it made no mention of public electricity.

The Committee did not prioritise electrification as part of its colonisation project and that had to be dealt with private companies. Suffice to say, electricity was seen as less central infrastructure did not deserve to be part of the central colonial development plans. The Tanganyika Development committee submitted a “Draft of the Post-War Development Proposal” in 1946 which contained development plans for ten years between 1946 and 1956.[95] The new report identified four basic areas for development: (1) conservation and utilisation of the Territory’s natural resources so as to bolster agriculture, forestry, mining and industry development based on training, marketing systems and expanding the research development centres for crops and tropical plants; (2) provision of efficient communications systems; (3) expansion and improvement of health services; and (4) expansion of education services. Like in the first report, there was no official mention electricity development in the territory.

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[91] UKNA CO 691/190: *An Outline of the Post-war Development Proposal*s and Report of the Post-War Planning Advisory Committee: Government Circular of 12 November 1945.
[92] *Ibid.*
[93] UKNA CO 691/1791: Report by Development of Tanganyika Report of the Central Development Committee.
[94] Van der Straeten, *Capital Grids*; also, UKNA CO 691/1791: Development of Tanganyika Report of the Central Development Committee.
[95] *Ibid.*

The disregard of public electricity supply by the development committee doomed DARESCO's expectations. When the Committee was preparing the proposal, the company had stressed the need to include public electricity supply as an essential development scheme in executing the CD&W. In a letter to the Secretary of State of the Tanganyika government, DARESCO Manager said that his company was aware of the "Government's desire to carry out a programme of development" in Tanganyika and recommended the development committee consider the question of public electricity supply. The letter confirmed the view that the electricity utility did not receive much support from the government in the 1930s especially in the expansion of the electrical grid and usage in Europeans, Indians, and Africans homes. He wrote, "for your information and that of the Development Committee, may we respectfully put forward the case of the public supply of electricity as this is now recognised as one of the first vital steps to development and should be given every encouragement, facility and assistance from the Government."[96] For DARESCO, electricity was a critical tool for colonial development, but some of the existing electricity rules derailed the company from expanding the grid and obtaining profit. Although it did not mention public electricity development in plans of its implementation, CD&W Act still provides major insights into the development of electricity infrastructure in post-WWII Tanganyika.

One of the ways in which it contributed to electricity expansion is through what is known as Westlake Report of 1946. Following the poor performance of electrical power infrastructure in the late 1930s and during the war in British East African colonies such as Kenya, Uganda, and Tanganyika, it was obvious to the Colonial Office that the CD&W would not succeed without interventions.[97] Intervention to raise power supply was necessary to boost post-WWII developments. The Colonial Office started to view electricity in East Africa as important technology for colonial development.[98] Consequently, Oliver Stanley, the Secretary of State for the Colonies, appointed a special team to examine electrical undertakings in East Africa, to formulate coordinated plans for economic development as per CD&W policy. Charles Redvers Westlake, an electrical engineer and manager for the Northern Ireland Electricity Board, was appointed to lead the team. Three other engineers were Messrs Richards and Fforde, civil engineers, and J. G. Park, an electrical engineer.[99] The terms of reference were to investigate

[96] UKNA CO 691/175/2: Electricity Development: Tanganyika.
[97] Hoag, *Developing the Rivers of East and West Africa*, 153.
[98] *Ibid*.
[99] UKNA CO852/844/1: C. R. Westlake, preliminary report on electricity in East Africa.

potential demand for electricity, identify electricity resources, establish coordinated economic development for electrical power purposes, and make recommendations for the future development of electricity supply in the East African Territories.

Part of the team arrived in Nairobi in February 1946, with Westlake and J. G. Park joining them in April 1946. Westlake realised that his team lacked the necessary draughtsmen, surveyors, and clerks to conduct a comprehensive study, a limitation to organisational aspects on the how to improve electrical undertakings in East Africa. It is important to note that the team spent practically all their time in Nairobi Kenya to study the operation and power infrastructure of the East African Power and Lighting Company (EAP&L), rather than in Tanganyika.[100] Park visited Dar es Salaam for only a short time to investigate the potential for hydroelectrical power. Finally, after five months of study, Westlake published the report showing possible sources of electrical power generation and transmission systems. Generally, the report labelled the electrical infrastructure in the East African colonies "unsatisfactory" – most were obsolete and needed immediate replacement.[101]

Westlake's report changed the British perspective on the provision of public electricity in East Africa. It stated that the success of the different CD&W schemes in the East African territories depended on how the government dealt with the provision of electricity services. Westlake advised the British to view electricity supply not only "as a commercial service for those who can afford to pay for it" but also "as, what in truth it is, a fundamental public service vital to the economic and social progress of the three Territories."[102] The report found that that domestic household supply of electricity was low and most electrified homes lacked electrical appliances. The high cost of firewood in East Africa in the 1940s represented the potential for expanding electricity and electrical appliance markets. It concluded that, "social and economic development of East Africa requires a consideration in abundant supply of electricity."[103] The report changed the British attitudes on the provision of electricity in the colonies. Precisely, it advised the imperial government to view electricity provision as a necessary social amenity in the colonies both for native and non-native villages, in order to reduce forest degradation and

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[100] Hoag, *Developing the Rivers,* 157; UKNA CO852/844/1: C. R. Westlake, preliminary report on electricity in East Africa.
[101] UKNA CO852/844/1: C. R. Westlake, preliminary report on electricity in East Africa.
[102]*Ibid.*
[103] *Ibid.*

boost CD&W policy.[104] It "envisioned and expanded the domestic market that stretched beyond the [East African] region's cities and settler areas."[105]

The expansion and improvement of social services and housing in Post war era increased the demand for power, which in turn influenced the government to be proactive in electricity provision. The colonial government established its own branch for power supply in the 1940s to support its different social services and development projects. Electricity was supplied by two agencies; DARESCO supplied public in major urban towns, and the government branch which supplied government works and institutions located far from DARESCO's networks. The government also introduced several institutions to bolster electricity supply to government works and departments in Dar es Salaam and to oversee electrification in general. It formed the Electrical and Mechanical Branch in PWD, as a special body to facilitate the growth of power supply infrastructure. J. H. Griffiths, a senior government electrical engineer, headed the branch as its first Director. Among other things, the Branch had to supervise the expansion of electrical infrastructure in the territory to ensure that they complied with safety and technical standards.[106]

New government buildings for hospitals, schools, industries, businesses, and housing schemes with several storeys in Dar es Salaam forced the government to establish the Electrical Section in the mid-1950s. These buildings and services needed electricity and electrical appliances such as water heaters, refrigerators, electrical cookers, and air conditioners. Thus, the Electrical Section's main responsibilities were the installation, maintenance, and repair of electrical infrastructure in government facilities in Dar es Salaam.[107] By 1961, the government had installed about 2672 kilowatts in buildings—owned by different departments, such as agriculture and research, veterinary services, education, medical services, and the Public Works Department (PWD) in different parts of the Territory. Its largest plant was installed Ruvu with 1060 kilowatts to supply water to Dar es Salaam and 10.5 kilowatts plant at Ubungo to facilitate water supply infrastructure in the town.[108]

The expansion of power infrastructure to African areas and urban housing schemes gained political backing from the British parliament in London in the early 1940s. Some

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[104] Hoag*, Developing the Rivers of East and West Africa,* 159.
[105] UKNA CO852/844/1: C. R. Westlake, preliminary report on electricity in East Africa; also Hoag*, Developing the Rivers of East and West Africa,* 159.
[106] EAF-UDSM Library: Annual PWD Report 1953, 9.
[107] EAF-UDSM Library: PWD Report, 1959, 94.
[108] EAF-UDSM Library: Annual Report of the Ministry of Communications, Power and Works (1961), 95

parliamentarians considered electricity a basic service required to improve African livelihoods. Abraham Lyons, who had experience in urban development identified the need to electrify the homes of Africans as one of the critical issues.[109] The push was in the context of the African Urban Housing Scheme which was intended to improve the living condition of Africans. Before this period, African houses were considered not only non-permanent but were also an obstacle to hygiene due to lack of basic infrastructure services such as proper toilets, water supply, and electricity.

The implementation of the CD&W policy made colonial officials begin to consider the lack of electricity in African homes as a deficiency and a problem that needed to be solved.[110] In other British central and East African colonies, the British government had begun to electrify African villages by the late 1930s. For instance, the British Governor in Uganda ordered the electrification of all African urban housing in Kampala by 1939.[111] In Northern Rhodesia, African households in the Livingstone Municipality were electrified during this time. The Development Committee in British Nyasaland embarked on expanding electricity to African housing schemes in the large towns of Zomba, Blantyre and Limba, even before the end of the war, ultimately electrifying 245 houses in Zomba alone.[112] Towns in Tanganyika also benefited from these post-WWII colonial welfare developments. As the population of Africans in Dar es Salaam grew from 33,000 in 1939 to 50,000 in 1947, shortage of housing also grew.[113] The government planned to build 2,700 “modern and permanent” houses for Africans in Msimbazi Creek, Ilala, Kinondoni, Changómbe, Kinondoni and Magomeni in Dar es Salaam between 1946 and 1956.[114] The available sources indicate that in 1951–1952, a total of 800 houses were built in various towns, including Dar es Salaam.[115] This project also responded to the development of industries in the post-WWII period which needed the provision of permanent houses for Africans.[116] Houses built under the African urban housing scheme were improved versions of traditional African houses in permanent waterproofing materials, that is, cement blocks and corrugated sheets.[117] Still, African housing in many areas remained without electricity.

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[109] Van der Straeten, *Capital Grids*.
[110] *Ibid*.
[111] UKNA CO 822/112/6: Electrical Development East Africa.
[112] *Ibid*.
[113] TNA 32575: Native Housing Scheme Dar es Salaam Township-Ilala.
[114] UKNA CO 822/112/6: Electrical Development East Africa.
[115] TNA File No. 32575/2: African Housing Schemes-Magomeni.
[116] Van der Straeten, *Capital Grids*.
[117] *Ibid.*

The incorporation of Africans into urban areas was a way of assimilating them to respond to British culture. It was a colonial project to increase human happiness, self-government, better living standards and, above all, to imitate British urban ways of life. British administrators in Tanganyika wanted to create a new community of African urban dwellers who possessed new skills, social habits and materiality that resembled the Europeans in connection to the CD&W. Andrew Burton shows that the British encouraged “men and women to live fuller and happier lives in adjustment with their changing environment, to develop the best elements of their culture and to achieve the social and economic progress which will enable them to take part in the modern world.”[118] Like in the tools of empire, the provision of electricity and use of electrical power appliances was a way to create such an African elite urban community. For instance, in 1954, Michael Blundell, the European Minister without portfolio in the British Kenyan colony, reiterated that “it seems to me no good talking about the British way of life if it means continued grovelling under a Dietz Lamp.”[119] Dietz lamps, oil-fuel lanterns, were common lighting sources in well-off African families while the rest of natives depended on kerosene burners in the 1940s and 1950s. They represented backwardness while electricity represented British “modernity.” The instigation of socio-cultural change and making Africans imitate British living styles, required electricity and electrical devices in homes. Tanganyika colonial administrators expected that electricity would “modernise” and cultivate the Europeanisation of African consumption particularly among the African colonial government workers who received monthly wages.

The African government workers were such a small group that colonial administrators considered they could transmit European lifestyles to the larger urban society. As such, African urban houses especially those built for government workers in some areas were electrified by the late 1950s. For instance, by the end of the 1930s, Kinondoni had developed as an unplanned African suburb and residential area and the government incorporated it as quarters for African workers employed by the government and European firms in nearby Oyster-Bay.[120] Many Africans lived in this area in the 1940s and 1950s and were able to pay for electricity installation and monthly bills. The government expanded the electricity grid to this area in the 1950s and electrified African government workers’ houses. It also equipped them with a few “modern”

[118] Burton, “Townsmen in the Making,” 348.
[119] KNA File No. NHC 1/285, Ministry of Local Government, Health and Housing Department.
[120] Brennan and Burton, “The Emerging Metropolis,” 41-42; Smiley, “The City of Three Colors,” 185-187.

electrical appliances such as refrigerators, ceiling fans, and electrical cookers based on the monthly salary of such workers and their ability to pay electricity bills.[121]

DARESCO had attempted to electrify African homes in the 1930s, but the government refused to relax electricity tariffs to fit the Africans' socio-economic level, a factor which stopped further initiatives, as mentioned previously in this chapter. The political pressure from London led to some changes in the post war. DARESCO also revived its plan to electrify African households. On 8th July 1944, Don Small, DARESCO's secretary, informed the government that his company also shared the desire of the British Parliament to electrify African homes. Once again, the company placed its request for legislation to reduce tariffs so as to encourage Africans to install electricity.[122] A Municipal Secretary, F. A. Montague, informed DARESCO on 19th July 194 that the government's electrical engineer, A.W. Grant, had agreed to the proposed change in tariffs for Africans. The Municipal Secretary quoted Grant's comment as follows:

> Let the licensee [DARESCO] make application, without argument, for a supply to hereditary and indigenous Tanganyika Africans, with the due provision to exclude claims of the races locally born, at a fair and remunerative rate, which the average Africans can afford, and Government in its role of uplifter of the African cannot but give its enthusiastic support in principle.[123]

The phrase "Government in its role of uplifter of the African" in the above extract basically reveal the CD&W initiative where the British government started efforts to improve African living standards in the colonies. The local developments, including DARESCO's ambitions to make electricity more profitable, exploited the position of the London government to propel the electrification of African households in Tanganyika. Both individual households and those under the African urban housing schemes were eligible for electrification. The installations started from the mid-1940s, where 5/-shillings were charged for a three-bedroom house and 3.5/- shillings for monthly electricity for a standard 25-watt lamp installed in each room. DARESCO considered this amount to be within reach of the average African pocket.[124] The existing sources offer limited opportunity to detail the extent to which African villages were electrified in Dar es Salaam by the late 1940s and 1950s. But, in general, they indicate that the

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[121] EAF-UDSM Library: Public Department Reports, 195–1960.
[122] *Ibid.*
[123] TNA 24387: This quote comes from F. A Montague's letter to Don Small in "Model Native Houses-Electric Light", dated 19 July 1944.
[124]TNA File No. 24387: Letter from the DARESCO Secretary to the Municipal Secretary, Township Authority, Dar es Salaam, dated 8 June 1944.

government's introduction of special low electricity tariffs did not revolutionise African access to and usage of electricity services.

Although it is apparent that the CD&W policy did bring developments in the access of Africans to urban amenities such as water, sanitation, and housing, as we saw above, it also encouraged Africans to build their own houses in planned housing plots in the northern area of Kinondoni, in the western area of Magomeni, and in Temeke in the south of Dar es Salaam. African houses built privately in these new suburbs under the umbrella of the CD&W remained unelectrified.[125] The growth of power infrastructure was in line with great urbanisation that was accompanied by the development of other basic infrastructure services, making Dar es Salam not only a dynamic urban centre but also truly a city. Therefore, it is apparent in the available sources that, by the end of the 1950s, the power grid had grown considerably when compared to the interwar period. As Figure 1.2 below indicates, the grid expanded to the north to follow the growth of European settlements in Oyster-Bay and Msasani area. It also electrified government houses in Kinondoni. In the rest of the town, it followed government works such as airports, workshops, government houses and estates.

By the late 1950s, electricity network had grown geographically in line with post-WWII socioeconomic developments in Dar es Salaam, but it still covered only a small area of the modern-day city. This situation was due to the fact that the British colonial government allotted huge amounts of CD&W funds in ensuring that Europeans enjoyed life in Dar es Salaam like in western cities by improving infrastructures in their residential zones. Large portion of the colonial development and welfare funds continued to be spent in European areas. For instance, four million pounds was spent on European housing while only 1.6 million pounds was spent on African housing. A huge amount of the funds went to other government infrastructures. James Brennan, for instance, highlights that the British colonial government only spent £600 of the £2495 allocated for street lighting to electrify African residential zones.[126] Consequently, only a few lighting posts were installed in African areas when compared to the European and Indian ones. Most of the electrified homes were located in the older planned areas of Kariakoo and Ilala because they were closer to TANESCO's facilities, as shown in Figure 1.2 above. Sarah Smiley reveals that African villages (Zone III) in Kariakoo only had piped water, fifteen public

[125] Brennan and Burton, "The Emerging Metropolis," 42-43; TNA File No. 24387: Letter from the DARESCO Secretary to the Municipal Secretary, Township Authority, Dar es Salaam, dated 8 June 1944.

[126] Brennan as cited in Hege and van der Straeten, "Enclaves of Light and Citadels of Profit,".

kiosks and twenty-four streetlights by the late 1940s.[127] Furthermore, those electrified homes used electricity mainly for lighting and lacked electrical devices. Even in the African colonial residential area especially Kariakoo, roads were still unpaved, with poor drainage, a lack of piped water, and only a few of the houses were electrified.[128] Thus, while tools of empire were visible in the supply of electricity as European and Indian zones were well electrified than African zones, some economic and technological limitations also contributed to low electrification in African zones. Many Africans still built their houses in semi-permanent materials as only ten per cent of Swahili houses were built using cement blocks.

In terms of usage, domestic electric appliances were still low (this aspect is developed further in Chapter 4 of this dissertation). Household electricity, street lighting and electrical appliances in homes was limited due to the unequal distribution of the public funds for electrification. Godfrey Mwakikagile in *Life in Tanganyika in the Fifties* illustrates the state of electrification for most Africans in Dar es Salaam up to the 1950s. He shows that electrical infrastructure was low in many towns in the country. Moreover, some households did not even consider it a necessity for their everyday lives.[129] So too was this case with electrical appliances, as electrical devices were foreign to many Africans. Mwakikagile says that electricity was provided to very few homes and even the electrified homes had only a few electrical appliances. Even European households used refrigerators that ran on kerosene to make ice instead of electricity-powered refrigerators.[130]

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[127] Smiley, "The City of Three Colors," 185.
[128] Brennan and Burton, "The Emerging Metropolis," 56.
[129] Godfrey Mwakikagile, *Life in Tanganyika in the Fifties: My Reflections and Narratives from the White Settler Community and Others: with Photos*, (Continental Press, 2006), 214.
[130] *Ibid*., 231.

Figure 1.2: Map of Dar es Salaam outlining the growth of the power grid by the late 1950s.
Source: Modified from J. A. Leslie, *A Survey of Dar es Salaam* (Oxford: Oxford University Press, 1963).

1.5 In search of the appropriate electricity generation technology

From the early stages of electricity development in Tanganyika, the question of electricity generation technology and reliable power supply was paramount. When DARESCO took over public power supply in the early 1930s, it introduced diesel-powered plants, enlarged the capacity of power systems and extended street lighting to 11 hours, from 6 pm to 5 am.[131] Thermal generation technologies were a great challenge as they made the grid collapse so often

[131] EAF-UDSM Library: Tanganyika Territory Annual Reports of the Public Works Department, 1933-1938; also, UKNA CO 691/98: Licence to the Tanganyika Light and Power Company, Tanganyika.

that consumers were forced to adopt other resilience strategies. As one consumer stated, every month there were "maddening breakdowns in the service which have been so frequent as to force all-electric light consumers to keep a duplicating plant of oil or petrol lamps to tide over such breakdowns."[132] The consumers demanded reliable power supply, but DARESCO was unable to maintain reliable power due to technical challenges raised by its thermal generators. The electricity suppliers in Tanganyika considered thermal technologies fuelled by firewood and diesel as expensive and a hindrance to network growth and electricity reliability in the 1920s and 1930s. For them, hydroelectricity was a cheap generation technology that would revolutionise power supply.

Generating hydroelectricity would enable reliable power supply by expanding capacity and reducing the running costs of thermal plants. During this time, while coal technology dominated the early decades of electrification in Britain, debates emerged on the need to expand the use of water in electricity generation in British colonies. Water development was a major question and was central to Britain's colonial development policy in the interwar period.[133] The central thread of the discussions in Britain was that the British electrical power industry lagged behind to other western countries such as Germany and the United States of America. The British electrical entrepreneurs, engineers and planners called for the British imperial government to support the development of hydropower in the colonies as a way of boosting and harvesting abundant resources.[134] In Tanganyika, hydropower was non-existent in the early 1930s, but efforts were in place to develop hydroelectricity in the Territory as a solution to electricity provision. By the mid-1930s, electrical companies built two small hydropower plants, the Pangani Falls hydropower plant (17.5 megawatts) and the Kikuletwa (1.5 megawatts) in the Pangani River Basin in the north-eastern part of the Territory. However, these sites were less beneficial to urban dwellers in Dar es Salaam. The largest plant, at the Pangani Falls, was under TANESCO's concession area and not under that of the Dar es Salaam Electric Supply Company's.[135]

In the post-WWII period, DARESCO continued to supply Dar es Salaam from thermal plants powered by diesel oil in the Kurasini area. Oil prices hiked in the post-WWII period which

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[132]TNA File A35/1/42: Electric Light-General: Letter dated 16 September 1932 from the Manager, Dar es Salaam and District Electric Supply Company (DARESCO) to the government electrical engineer.
[133] Hoag, *Developing the Rivers of East and West Africa*.
[134] Van der Straeten, *Capital Grids*.
[135] *Ibid*.

escalated the cost of production.[136] This increased not only operating costs but also unreliable supply. In 1946, DARESCO added 1558 kilowatts in its system, but it met demand only shortly. Many consumers applied for connection but were unsuccessful due to low network capacity.[137] DARESCO applied to the British government for permission to increase electricity tariffs to cope with the high running costs, to improve supply, and to connect new consumers. The government challenged this request through the Board of Finance, Trade and Economics. It stated that the company had monopoly rights over electrical power supply, thus, it had to bear the loss caused by the hiking of prices rather than pass on the burden on to consumers. The Board informed the company that the "acceptance of such a loss is regarded as the inescapable price"[138] and that it had to learn that losses might happen from time to time due to its privileged position regarding power supply in Tanganyika.

DARESCO had to look for other alternatives to reduce its operational costs and increase its profit margin. One of the ways was to supply Dar es Salaam with hydroelectricity from Jinja in Uganda. The construction of the 150-megawatt Owen Falls Hydropower Dam in Uganda was decided in London in the late 1940s, after about 40 years of controversies between the Colonial Office in London and the British Colonial Government in Uganda over the development of reliable public power supply. The building contract was signed between Uganda's government and a consortium of Danish, Dutch, British and Italian companies, called the Owen Falls Construction Company.[139] The Owen was the largest power dam in East Africa, making Uganda the East and Central African powerhouse. In 1947, Charles Westlake estimated that the development of this dam would enable the East African towns under EAP&L including Dar es Salaam to be supplied at half a cent.[140] However, DARESCO failed to implement this project due to technical and financial challenges caused by the distance between the two cities.

The need to connect Dar es Salaam to reliable hydropower sources became more evident as the electricity demand in the city grew following the implementation of the CD&W schemes and cost of electricity generation. Electricity supply and especially power reliability continued to deteriorate and the need to improve the situation was apparent in the mid-1950s. Several hydropower options were available: the Rufiji River in the southern part of the town

[136] *Tanganyika Standard*, "DARESCO Comments on Mr. Rees-Williams 'Cost of Power' Statement," 15 May1948.
[137] UKNA CO 852/844/1: Report by E. V. Richards on Hydroelectric Power in East Africa.
[138] TNA File 30107: Letter draft from S. Leslie to the DARESCO Secretary, dated 17 September1948.
[139] Christopher D. Gore, *Electricity in Africa: The Politics of Transformation in Uganda,* (Boydell & Brewer Inc., 2017), 38 – 48.
[140] *Tanganyika Standard*, "DARESCO Comments on Mr. Rees-Williams 'Cost of Power' Statement," 15 May1948.

and the Ruvu River located between Dar es Salaam and Morogoro in the western part of the town, as well as developing a hydropower plant at Hale in the Pangani Basin. The annual fuel bill during this period was £100,000, an amount which was sufficient to transmit hydroelectricity from TANESCO's Pangani River.[141] The British colonial government in Tanganyika took a step-in collaboration with electrical supply companies, DARESCO and TANESCO. They commissioned F. P. Egerton, an experienced consultant in the electrical industry from Britain, to study public electricity supply.

In his study, Egerton had to examine ways of improving public supply and tariff revision, making electricity more commercial. He had also to study the benefits of merging TANESCO and DARESCO to form a single company.[142] Egerton travelled widely between 25 October and 15 November 1953 to meet and discuss with different stakeholders in Tanganyika, including Provincial Commissioners, Chambers of Commerce, Town Planners, Water Development Bodies, and Sisal Growers. He published his report in June 1954, with two major recommendations: the merging of TANESCO and DARESCO to form a single private electrical company and the construction of a hydroelectric power plant at Hale on the Pangani River, together with a 132-kilovolt transmission line to bring hydroelectricity to Dar es Salaam. The line should also supply power to the central sisal estates and townships as far as Kilosa.[143] Both the electrical companies and the British colonial government received the report favourably. By the time of independence, only one resolution had been reached: the merging of the companies. DARESCO was transferred to TANESCO with effect from 1st March 1957, by an ordinance of the Tanganyika Legislative Council, forming a new company known as the Tanganyika Electric Supply Company Limited (TANESCO).[144] The colonial authorities expected that the merging of these utilities would expand electrical power infrastructure, reduce tariffs and system breakdowns, and increase connections in Tanganyika.[145]

Concerning the Hale project, the initiatives were also taken, and the Power Securities Company of London started a survey in 1955 to detail hydrological, meteorological, and topographical data. The scheme stopped due to water rights politics in the Pangani River and

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[141] Tanganyika: A Review of its Resources and their Development (Tanganyika Government; Dar es Salaam, 1955), 706-716.
[142] EAF-UDAM Library: F. P. Egerton, Report on Electricity Supplies in Tanganyika.
[143] *Ibid*.
[144] EAF-UDSM Library: Annual Reports of the Public Works Department (1957), 15.
[145]TNA Acc. 5. File No. 31/8: Letter from J. D. Stinger, DARESCO General Manager to the Moshi District Commissioner, dated 11 June 1956. Stinger informed that they would improve the operation of the power systems, seeing as the thermal power plants would form "adequate reserves".

politics in financing the project in the 1950s.[146] However, as Tanganyika's independence came closer, African ministers in the Tanganyika Parliament pushed for injecting more funds into TANESCO and the end to the water rights issues. For them, electricity was necessary for the future development of the country which they were about to liberate. The increase of TANU seats in the Tanganyika's parliament led to five members appointed as Ministers. Amir Jamal, a business-minded Indian, a colleague of Nyerere, a TANU-committed cadre, became the Minister for Communications, Power and Works.[147] He quickly strategized and solved the water rights problem by persuading the Parliament to relax the water rights by signing the Hale Ordinance of 1961. It restricted abstractions of all water flows upstream and increased power to be generated from 14.1 to 21 MW.[148] Jamal insisted that the Hale project was the biggest single development project that would lower electricity costs and connect more consumers, and that Dar es Salaam should begin receiving hydroelectricity.[149]

The debates on the Hale project which started in the 1950s continued in the early 196s. How would the capital-intensive hydroelectric project be funded? This was the principal question during this time. It is important to note that, in the mid-1950s, the Colonial Office had agreed that the project would be funded from London by the Colonial Development Corporation (CDC) which would provide £1 million. The Commonwealth Development Finance Company (CDFC) would also fund £1 million, and these were among the shareholders of the Power Securities of London, which owned the East African Power & Lighting Company, in which TANESCO was a subsidiary company.[150] Later on, the CDFC withdrew its funds, which led the British Treasury to also change its mind. The Treasury proposed that TANESCO apply for funding from agencies such as the International Bank for Reconstruction and Development (IRBD) or individual donor countries, instead of London. This would make fair use of small funds allocated to East Africans in other projects. They thought that since the International Bank of Reconstruction and Development (IBRD) had agreed to fund road infrastructure in Tanganyika, the Hale project would also be a sound project for the Bank's soft loan scheme.[151]

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[146] For a detailed discussion on the Hale project, see, for instance, van der Straeten, *Capital Grids.*
[147] *Ibid.*
[148] EAF-UDSM Library: Report on the Development of the Pangani River Basin, dated October 1962, by Sir William Halcrow and Partners, Consulting engineer. Vol. 1.
[149] UKNA CO 822/2572 Tanganyika Development Plan 1955-1960.
[150] UKNA File No. 81/8/02 also CO 832/1792: File: Colonial Development Corporation: Tanganyika Power Line.
[151] UKNA CO 822/2715: Letter from Gordon Burret to J. M. Kirch, dated 13 February 1961; also, correspondence between Burret, Kirch and Morgan in the same file.

When Sir Ernest Vasey, the Minister for Finance, travelled to London in January 1960 to expedite the discussion between TANESCO and the CDC, most officials in the Colonial Office had different views from the Treasury. They perceived the advice for Tanganyika to approach IBRD had potential economic and political threats to the British government. They stated that should TANESCO's loan application get accepted by the IBRD, the company would have to wait for not less than a year to allow for loan processing. This would delay the project and affect the company economically based on the demand forecast. The Colonial Office believed the Bank's loan would threaten the British companies' involvement in the scheme. As a rule, the tendering of IBRD-funded projects had to be internationally competitive among the member states. Hence, raising funds from London was more commercially and politically beneficial to Britain as it would enable the tendering for the project to include British firms only. Rolfe, one of the officials in the Colonial Office, wrote: "I understand that one objection to IBRD finance for this project was that it was improbable that British firms would be successful in the tendering which would involve the Germans and others."[152]

In brief, the 1960 discussions among CDC, on the one hand, and Vasey and TANESCO, on the other, proved to be fruitful. CDC agreed to raise its funds to £3 million (for power plant construction), and the government of Tanganyika would contribute £1.5 million (for a transmission line to Dar es Salam) to be converted into equity capital in three years. TANESCO had to fund the sub-transmission line to the Central Line Estates and provide efficient distribution infrastructures in Dar es Salaam from its own resources.[153]

Despite the achievement of this step toward hydroelectricity in Dar es Salaam, electricity demand could not wait for all the parties involved in the Hale project to agree on how to finance it. The implementation of the CD&W raised the number of power-consuming industries in Dar es Salaam in areas such as Ilala, Chang'ombe, Kinondoni and the Tanganyika Packers.[154] Consumers in Dar es Salaam grew from 27,886 in 1959 to 32,546 in 1961.[155] Power provision continued to face constant breakdowns, and the situation worsened as the demand for power in Dar es Salaam continued to increase in the 1950s. This forced TANESCO to meet the growing

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[152] Van der Straeten, *Capital Grids*; also, UKNA CO 852/1792: Correspondence between Morgan, Kisch and Derx, dated 22nd February 1961.

[153] Van der Straeten, *Capital Grids*; TNA Acc. 563 File No. E5/06; Development Plans for Tanganyika, 1961/1962-1963/64, 58; UKNA CO 822/1792: Letter from F. G. Burrett to J. Kirsch dated 17th January 1961; see also, Colonial Development Corporation: Tanganyika Power Line (UKNA File No. 81/8/02 also CO 832/1792; Tanganyika Development Plan, 1962/63, 58:

[154] *The Tanganyika Standard*, Saturday, 10 April 1948; Brennan and Burton, 47.

[155] EAF-UDSM Library: Annual Public Works Department, 1958–1962.

demand through the periodical installation of costly thermal plants. It was estimated that the company "spent nearly £700,000 on imported fuel oil in four years between 1954 and 1958."[156] However, financing remained the main obstacle to the supply of reliable power in Dar es Salaam. In 1958, D. J. Don Small, the Chairman and Director of the EAP&L Company, said; "despite our continued discussions with the authorities in Dar es Salaam and at the Colonial Office, we are still without financial support."[157]

Until the independence of Tanganyika, TANESCO continued to supply electricity in Dar es Salaam at high tariffs, while the capacity of the infrastructure networks remained low compared to demand Restrictive supply and breakdowns in the system were caused by failure of the electrical utilities to develop reliable power infrastructure. Heather Hoag reports that the expensive nature of hydroelectricity and the British low development of hydropower technologies were among the reasons that made the Colonial Office in London less supportive of the expansion of electrical power infrastructure in East African cities. As Hoag noted that, hydroelectricity as a cheap source of electricity which would have ensured profit to power companies and low tariffs to consumers. But the building of hydroelectric power dams was expensive and "colonial coffers were empty"[158] and the government left power development in the hands of private enterprises that were also not ready to build large hydropower infrastructures.

Another reason for poor development of electricity in British East Africa is that British hydraulic engineering was delayed than other Western countries such as Germany and the United States of America. British hydroelectric engineering firms and manufacturing industries transferred the technology to the British colonies very late making East African towns to depend on expensive and technically challenging thermal electricity. These financial and technological limitations "impeded the development of electricity systems in the colonies".[159] The British colonial government hoped that the supply of Dar es Salaam from hydroelectricity from the Pangani River (Hale hydroelectricity project) in the early 1960s would improve the chaotic power supply and expand power infrastructure in the towns, including also African consumers.

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[156] UKNA CO 822/2572: Tanganyika Development Plan 1955–1960, Press Release.
[157] *The Tanganyika Standard*, 16 September 1958.
[158] Hoag, *Developing the Rivers of East and West Africa*, 166.
[159] *Ibid.*

1.6 Conclusion

By showing the economic and technological limitations in the expansion of electrical power systems during the British period in Dar es Salaam, this chapter has unpacked different aspects in the electrification history of colonial worlds. While Hughesian historians suggest that large technical systems follow certain predetermined paths to gain 'momentum' after inventors have resolved 'reverse salients', for more than forty years neither the British government nor the private company, DARESCO, and later TANESCO, had learnt how to follow the path required to expand electrical systems and provide reliable power in the territory. The provision of electricity, even to the European population in Dar es Salaam, was never a straightforward process. Some local conditions, including the unavailability of hydropower sources near Dar es Salaam, affected both the growth of systems and the reliability of supply. Electricity provision faced several economic limitations which affected its growth and reliability especially in the interwar period. As the government and the private electricity companies resolved some of those challenges, supply grew in the post-WWII period when compared to previous periods. Such expansion meant some African homes close to the grid were electrified, provided they were able to pay. Despite these post-WWII developments, the power networks never achieved a standardised, stable, and reliable supply.

The chapter has also revealed how the provision of electricity in colonial Dar es Salaam was not influenced by the tools of empire per se, but it was also influenced by other economic and technological rationalities. There were different actors with different interests. The British Colonial Office in London viewed electricity as unprofitable for the state to engage in and, thus, it left it to private enterprises from the 1930s. The British government viewed it as an essential public service and source of revenue, hence, it needed to be expanded and its reliability maintained. For DARESCO, it was a profit-making enterprise that needed investment and government support to reach as many consumers as possible regardless of their race, provided the required technical and financial parameters were met. The provision of electricity was controlled by a small group of technical expatriates and opportunist companies which lacked transparency, information asymmetries and contingencies, and unstable colonial relations. This made power infrastructure not only remain in restricted small areas and towns but also characterised by technical breakdowns. Both the government and TANESCO struggled to resolve several technological and financial obstacles which derailed the expansion of power infrastructure in different parts of the town. The expensive nature of firewood- and diesel-fuelled plants remained a thorny issue in the electricity providers' ability to expand the system geographically. Technological and economic meanings of electricity had an impact on the growth of electrical systems and the provision of electricity services. Until the end of British colonial rule in Tanganyika, the grid covered small areas and only a small portion of Dar es Salaam, mainly connecting Europeans, Indians, and a few Africans. This extends many electrification historians who follow Headrick's 'tools of empire' perspective, that is, electricity in the colonies was introduced as a motive and means for colonial exploitation and, therefore, the colonised populations were excluded. Such financial and technological challenges also contributed to late electrification of Africans who lived in the villages located outside the boundaries the colonial administrators considered as the town of Dar es Salaam. The next chapter presents statist narrative of electricity in the post colony.

CHAPTER TWO
DECOLONISING CRITICAL INFRASTRUCTURE: THE GROWTH OF TANZANIA'S POWER GRID, 1962–1995

2.1 Introduction

This chapter follows Hughes model to expound factors which shaped growth of Tanzania's power grid from small, colonial networks in the early 1960s to large and interconnected systems in the 1990s.[1] The existing literature on postcolonial electrification shows that African leaders in collaboration with Western bureaucrats, experts, and manufacturing firms interlinked electricity as a tool in decolonisation, development, and modernisation politics.[2] The chapter employs the concept of 'criticality' and adds to these studies that the postcolonial African leaders viewed electricity as "critical infrastructure" for development, they thus build large hydropower dams that expanded the system beyond the colonial electrification 'enclaves' in Tanganyika. Scholars have defined the criticality of infrastructures in terms of their vital nature for modern societies and as a condition that results from the increased complexity of technological systems causing devastating impacts when they fail.[3] This chapter goes beyond this conventional meaning of criticality which makes electrical networks critical by nature of interconnectedness in their building and usage. It concurs with Leon Hempel *et al*. suggestion that to understand the criticality of systems we need to go beyond their complexity and investigate the 'strategic consideration' that was at work during their planning and construction.[4] Therefore, this chapter underscores the criticality of Tanzania's grid both in terms of their complex technical design and in terms of meanings and strategic representation of electrical systems as essential infrastructure to national and human development done by

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[1] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880 -1930* (Baltimore and London: The Johns Hopkins University Press, 1983).

[2] See, for instance, Heather J. Hoag, *Designing the Delta: A History of Water and Development in the Lower Rufiji River Basin, Tanzania, 1945–1985* (PhD Diss.: Boston University, 2003); May-Britt Öhman, "Taming Exotic Beauties: Swedish Hydropower Constructions in Tanzania in the Era of Development Assistance, 1960s-1990s," (PhD Diss.: Stockholm, 2007); Heather J. Hoag, *Developing the Rivers of East and West Africa: An Environmental History* (London, New Delhi, NY, and Sydney: Bloomsbury, 2013; Julia Tischler, *Light and Power for a Multiracial Nation: The Kariba Dam Scheme in the Central African Federation* (Houndmills: Palgrave Macmillan, 2013. Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams: Enlarged and Updated Edition,* (London: Zed books, Limited, 2001).

[3] Kristof Lukitsch, Marcel Müller, Chris Stahlhut, "Criticality," in Jens Ivo Engels (ed), *Key Concepts in Critical Infrastructure Research* (Springer VS, 2018), 12; Leon Hempel, Benjamin D. Kraff, Robert Pelzer, "Dynamic Interdependencies: Problematising Criticality Assessment in the Light of Cascading Effects", *International Journal of Disaster Risk Reduction,* 30 (2018): 257–268.

[4] Hempel *et al*., "Dynamic Interdependencies," 258.

Tanzanian political leaders. To that end, it examines different electrical projects implemented between 1962 and 1995 in Tanzania and how states' rhetorical discourse and politics in engagement with bilateral and multilateral donors in the planning and construction process reflected the idea that electricity was a critical infrastructure for national and human development. It also analyses how such a perspective shaped the formation of the interconnected national grid in the mid-1970s and its eventual expansion in the 1980s and 1990s. By examining the criticality which postcolonial Tanzanian states assigned to electricity, it also contributes to a few existing studies by historians of technology which have employed critical infrastructure concepts such as resilience and vulnerability but have not engaged with the notion of criticality.[5]

2.2 Tanzania's Foreign Policy, Aid Dependency, and Power Development

Tanzanian domestic and foreign policy influenced the development of electrical power networks. It determined which project was to be implemented, donors to fund them, and experts to plan and build such infrastructure. The objectives to develop the country socio-economically and politically guided and dictated decisions and actions of the postcolonial state. The post colony state's meaning of development transcended narrower economic aspirations for material possession and growth of Gross Domestic Product (GDP) to human emancipation and freedom.[6] Julius K. Nyerere, the first President of Tanganyika, always connected development to decolonisation. He wrote in a policy booklet published in October 1968 that, "freedom and development are as completely linked together as are chickens and eggs! Without chickens you get no eggs; and without eggs you soon have no chickens. Similarly, without freedom you get no development, and without development you very soon lose your freedom."[7] The building of infrastructures such as roads, railways, and electricity to modernise industries and agriculture was, in Tanzania's perspective, a means of achieving human freedom and advancement.[8]

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[5] Per Högselius, Anique Hommels, Arne Kaijser, and Erik van der Vleuten (eds), *The Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities* (London: Macmillan, 2013),8; Jethron Ayumbah Akallah and Mikael Hård, "Under the Historian's Radar: Local Water Supply Practices in Nairobi, 1940-1980", *Water Alternatives* 13, no. 3 (2020): 886-90.
[6] Amartya Sen, *Development as Freedom,* (New York; Alfred a. Knopf, Inc., 1999), 3–4.
[7] Julius K. Nyerere, 'Freedom and Development', in Julius K. Nyerere, *Man and Development*, (Dar es Salaam: Oxford University Press, 1974), 25.
[8] Nyerere, 1962: 2 as cited in Rwekaza Mukandala, "From Proud Defiance to Beggary: A Recipient's Tale," in *Agencies in Foreign Aid: Comparing China, Sweden and the United States in Tanzania,* eds. Goran Hyden and

Tanzania achieved its political independence when the Cold War politics were at their peak. The country carved its foreign policy and development path along non-alignment strategies. As a newly independent state, Tanzania did not want to take sides in the Cold War divide. President Nyerere had announced at the United Nations Assembly in 1962 that, "our policy is one of non-alignment in world quarrels which do not concern us, and that policy will remain. If any nation tries to buy our votes at the UN—with that nation we shall quarrel. If any nation uses their aid as a basis for interference in our affairs, we shall refuse that aid…."[9] This position was due to the fact that Nyerere was aware that both the Eastern and Western blocs might use the economic and technical assistance, which Tanzania highly needed. To gain support as he expressed in one of his speeches that, "we have to recognise that some overseas nations will help us if they can, and if they do not believe that they will harm themselves while doing so; other nations will help us solely in the hope of some kind of return to themselves—whether this be diplomatic, political or economic."[10] As a non-align state, Tanzania sought to obtain a wide range of economic and technical assistance from the Eastern and Western blocs without getting involved in conflicts or to compromise its basic principles, such as independence and sovereignty, and support for liberation movements. Nevertheless, things did not turn out according to Tanzania's expectations. It found itself amidst political squabbles within three years of independence, which made it change its foreign policy and path to development.[11]

Tanzania's first dispute was with West Germany over Tanganyika's union with Zanzibar to form the modern-day Republic of Tanzania in 1964. The Federal Republic of Germany (FRG) demanded Zanzibar to terminate its diplomatic relations with the German Democratic Republic (GDR). Zanzibar had a GDR consulate and Tanganyika had FRG representation in Dar es Salaam. When the conflict broke out, Tanzania allowed both representations to operate in the country to benefit assistance from both countries, in fact, this was in line with its non-alignment policies.[12] The FRG was against Tanzania's position because of the Hallstein doctrine which postulated that a country that recognised the GDR was engaging in an unfriendly act against the

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Rwekaza S. Mukandala (Macmillan Press Ltd, 1999); see also Julius K. Nyerere, *Freedom and Development,* (Dar es Salaam; Oxford University Press, 1974).

[9] Christos. A. Frangonikolopoulos, "Tanzanian foreign policy: The Proportions of Autonomy," *The Round Table: The Commonwealth Journal of International Affairs*, 77 no. 307, (1988), 276-292, 277-78.

[10] Cranford Pratt, "Foreign-Policy Issues and the Emergence of Socialism in Tanzania 1961-1968," *International Journal* 30, no. 3, (1975): 446; Frangonikolopoulos, "Tanzanian Foreign Policy", 278.

[11] Sebastian Edwards, *Toxic Aid: Economic Collapse and Recovery in Tanzania,* (Oxford: Oxford University Press, 2014); Paul Bjerk, "Postcolonial Realism: Tanganyika's Foreign Policy Under Nyerere, 1960-1963," *The International Journal of African Historical Studies* 44, no. 2 (2011): 215-247.

[12] Frangonikolopoulos, "Tanzanian Foreign Policy," 278-79; Pratt, "Foreign-Policy Issues," 52-58.

FRG and had to suffer the consequences.[13] Hence, to maintain its stronghold in Tanzania, the FRG promised Tanzania that it would offer technical and economic support which had been offered to Zanzibar by the GDR. Nyerere interpreted this as blackmail and bribery and in February 1965 he announced that the GDR's consulate should be moved from Zanzibar to Dar es Salaam. That act provoked FRG, and it withdrew German technical personnel who were training Tanzania's air force to compel Tanzania to compromise. In response, Tanzania expelled all FRG technical personnel, and called back home Tanzanians who were receiving technical training in various FRG institutions to show that its diplomatic relations had "nothing to do with aid."[14] Tanzania was particularly against the FRG's attempt to seek diplomatic relations with Tanzania through its economic and technological aid under the condition of sole suspension of the GDR or its union with Zanzibar.

Tanzania faced another foreign disagreement leading to the suspension of diplomatic relations with its main economic and technical assistance provider, Britain. Britain had offered Tanzania about £10 of its £15 million development funds between 1961 and 1965. In addition to that large portion, 75 per cent of the foreign experts in Tanzania in the early 1960s were British citizens.[15] The conflict emerged from Britain's failure to contain Ian Smith's minority rule, famously known as the Unilateral Declaration of Independence (UDI) in Southern Rhodesia (today Zimbabwe). While different international communities had set oil embargoes on Smith's government, Britain had failed to take firm action. The meeting of African ministers under the Organisation of African Unity (OAU) agreed on 2 December 1965 that they had to terminate their diplomatic relations with Britain if it hesitated to act against Smith's government until 15 December 1965. Britain did not take any action and Tanzania acted as per the OAU agreement. In Tanzania's view, to declare minority rule before African Zimbabweans had the opportunity to gain political and economic power in the county was to create another "South Africa" (apartheid state owned by the white minority) in Africa. Consequently, Britain froze a £7.5 million loan to Tanzania which both parties had negotiated, and when Tanzania refused to pay pensions to retired British officers in 1966, Britain cancelled the loan altogether. This situation brought

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[13] Hallstein Doctrine simply means that former West Germany would not establish or maintain diplomatic relations with any government that recognised East Germany at the time. On Hallstein and its impact on Tanzania, see, for instance, Kapepwa I. Tambila, "Aid from the Recipient's Point of View: The Tanzanian Experience," in Marc Dierikx (ed), *Diplomacy and Development: Proceedings of the 10th International Conference of Editors of Diplomatic Documents*, (The Hague: Institute of Netherlands History, 2010), 82.
[14] Pratt, "Foreign-Policy Issues," 458; Frangonikolopoulos, "Tanzanian Foreign Policy," 279.
[15] Pratt, "Foreign-Policy Issues," 445; Frangonikolopoulos, "Tanzanian Foreign Policy," 277.

Tanzania's First Five-Year Development Plan practically to a halt, which compelled Tanzania to seek other donors and internal sources of funding.[16]

Following diplomatic challenges Tanzania changed its development path by adopting a policy of socialism and self-reliance coded in the 1967 Arusha Declaration. The declaration officially announced Tanzania as a socialist state and its development policy of self-reliance meant reduction of economic and technological dependence on the capitalist west based on the proper use of domestic resources. The declaration denounced Western aid as strategies for development and it considered aid as an enemy of independence, freedom, and self-reliance. Nyerere announced that: "The development of a country is brought about by people, not by money. Money, and the wealth it represents, is the result and not the basis of development."[17] He identified four foundations for development, people, land, good policies, and good leadership. He proclaimed further: "Even if there is a nation, or nations, prepared to give us all the money we need for our development, it would be improper for us to accept such assistance without asking ourselves how this would affect our independence and our very survival as a nation."[18] Self-reliance policies were strategies towards building internal economic and technological capacity and in uprooting all colonial remnants related to aid in the country. However, socialism and self-reliance were ambitious, complex, and utopic policies in an economically and technologically weak country which needed external aid to develop.[19]

Tanzania's foreign affairs policies and its crisis during the Cold War era influenced handling of financial and technological development assistance for construction of infrastructures. The started to receive more economic assistance from the Eastern bloc and the Nordic countries than from the former Western colonial masters. While Nyerere had considered Western donors as hypocritical to poor nations, he had a unique view of development assistance from the Nordic countries, especially from Sweden. He believed the Nordics nurtured a genuine desire to transfer wealth to the poor.[20] He expressed this perception in different rhetorical speeches following Sweden's opposition to the oppression of Vietnam in the 1960s. He openly said that he had "warm feelings towards Sweden"[21] and that "the Swedish people support

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[16] Edwards, *Toxic Aid,* 70
[17] Julius K. Nyerere, *Ujamaa: Essays on Socialism*, (Dar es Salaam: Oxford University Press, 1968), 28-29.
[18] Julius K. Nyerere, *The Arusha Declaration and TANU's Policy on Socialism and Self-Reliance, 5 Feb. 1967*, 6-7.
[19] Maria Nzomo, "Foreign Policy of Tanzania: From Cold War to Post-Cold War," in *African Foreign Policies*, ed. Stephen Wright, (New York: Routledge, 1999), 10 – 17.
[20] Mukandala, "From Proud Defiance to Beggary," 31-34.
[21] Julius K. Nyerere, *Freedom and Development*, (Oxford University Press: Dar es Salaam, 1974), 332.

human equality and oppose imperialism."[22] Aid from the Nordic states was perceived in Tanzania as altruistic and did not interfere with the internal affairs of state. They were, as Ole Elgström has called them, "Aid on the Recipient's Terms."[23] For this reason, Tanzania received significant financial and technical support from Nordic countries and Eastern bloc countries to develop infrastructures in the 1960s–1980s.

Since, electricity was at the heart of its development schemes, Tanzania's socialist government channelled a good portion of technological and economic assistance into building large hydropower projects. Other countries that were major funders and sources of electrical power expatriates and technologies in the 1960s – 1980s included Norway, Finland, Denmark, and Canada. For instance, the Great Ruaha Power Project (GRPP), the largest electrical power project as will be shown in this chapter was, to a large extent, financed by Sweden, World Bank, and other Nordic states. Large repair, and maintenance schemes of TANESCO's power systems in the 1980s also received greater economic and technical assistance from Nordic countries. Tanzania's financial dependence grew rapidly. As Rwekaza Mukandala points out, while Tanzania was a "proud and defiant state" in the 1960s because it had surplus budget, it ended as "a shameless beggar" in the 1980s.[24] We shall see in Chapter 3 that such economic and technological dependence made Tanzania's electrical infrastructure vulnerable.

2.3 You Have Not Forsaken Us: The Early Grid and British's Influence, 1961–1968

Tanganyika's self-rule came earlier than the Colonial Office in London had anticipated. The Office had expected if at all the East African colonies gain their self-rule, that would not happen before the mid-1980s. Such early independence, however, meant that many of the British Colonial Development and Welfare Schemes (CD&W) in Tanganyika were left unimplemented. Economically, Tanganyika continued to depend on exportable cash crops such as coffee, cotton, sisal, and pyrethrum, and import-substitution industries were owned by a few Europeans.[25] In terms of urban development, colonial urban planning schemes left many towns unplanned and with underdeveloped basic infrastructural amenities. Transport networks, like the railway

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[22] Ibid., 336.
[23] Ole Elgstrom, "Giving Aid on the Recipient's Terms: The Swedish Experience in Tanzania," in Goran Hyden and Rwekaza Mukandala, *Agencies in Foreign Aid: Comparing China, Sweden and the United States in Tanzania*, (New York: St. Martin's Press, 1999), 116-155.
[24] Mukandala, "From Proud Defiance to Beggary,"31.
[25] Andrew Coulson, *Tanzania: A Political Economy,* (Oxford: Oxford University Press, 1979), 1.

systems, operated poorly due to lack of repair and maintenance, and the roads and highways planned during the British CD&W were also largely left unfinished.

The electrical power system was no exception. Even though Tanganyika's grid was expanded widely between 1950 and 1961 by 200% and that the generated electricity grew by 585%, the grid generation capacity remained low when compared to demand.[26] The existing power generation plants were isolated and did not usually have robust backups. The systems were less resilient, and the towns which had electricity supply experienced failures and blackouts.[27] With regard to generation technologies, capacity, and systems expansion, the existing power plants were based mainly on expensive thermal infrastructure. Dar es Salaam had 17,964 installed kilowatts of diesel. Hydroelectric power was drawn mainly from the Pangani Falls in the Tanga Province with the largest plant (17,500 kilowatts), from the Kikuletwa River (1,160 kilowatts) south of Moshi, and from Mbeya (340 kilowatts) in the Southern Highlands. The whole country had about 21 megawatts (MW) of hydropower and about 28 MW of thermal plants, totalling 49 MW. This amount, nevertheless, excluded electrical infrastructure installed by the British colonial government in public institutions such as schools, prisons, research centres, and hospitals upcountry, and other privately-owned generation facilities beyond TANESCO's public supply. By December 1961 when Tanganyika became independent, electricity consumers in the whole territory were about 30,912. Most of them were Europeans and Asians who still owned businesses, enterprises, and dominated government civil services in the Territory. The insignificant number of African colonial government workers in the Kariakoo, Ilala, and Kinondoni suburbs also had access to the grid as we mentioned in Chapter 1.[28]

The postcolonial state perceived electricity as critical infrastructure for development. Hence, it strived to improve electricity provision so as to propel socioeconomic progress. The state linked high modernism socio-engineering programmes with electrification and it measured socio-economic advancement in terms of megawatts.[29] As noted in James C. Scott's *Seeing Like a State*, "electrification and tractors, those emblems of development were on the

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[26] Jonas Van der Straeten, *Capital Grids: A Global History of Electricity in East Africa* (New York: Palgrave Macmillan, forthcoming).

[27] EAF-UDSM Library: The Republic of Tanganyika, Annual Report 1961, (The Ministry of Communications, Power and Works; Dar es Salaam, 1961), 102.

[28] See detailed discussion in Chapter 1 of this dissertation.

[29] Jonas van der Straeten, "Measuring Progress in Megawatt: Colonialism, Development, and the "unseeing" Electricity Grid in East Africa", *Centaurus* 63, no 4, (2021): 651 – 674.

tip of Nyerere's tongue as well as Lenin's."[30] Postcolonial leaders considered electricity as the remedy to the country's ills—poverty, disease, and ignorance.[31] They ambitiously decided to undertake the complete electrification of urban and rural areas in stages as a necessary pre-condition for achieving development.[32]

Tanzania's first Minister for Industries, Commerce and Power, A. K. Hanga, laconically expressed such criticality of electricity to postcolonial development when he emphasised that electricity was an essential tool for the country's development and anti-colonial struggles, a remedy to a "ruined Peasant Country" like Tanzania. He urged Tanzania to seek nothing else except "the horse of large-scale machine industry and electrification."[33] Electricity was essential to the country's development at multiple levels, such as to power trains, hoist machinery, bolster massive construction works, and ultimately make its way into agricultural crop production. Moreover, it could boost industrial development, irrigation, and flood control and contain all inherited colonial inefficiencies and inequalities.[34]Therefore, the Tanzanian government made the expansion of electrical power infrastructure a fundamental issue in its national plans for socioeconomic development from the 1960s to 1980s. In the first decade of independence, Tanzania intervened to expand electrification by expanding generation and nationalising electricity provision in the country.

The first step to expand electricity generation was to build hydroelectric dams. The dams would ensure availability of cheap electricity in the country and reduce cost of thermal electricity technologies. As we have noted previously, the transition from colonial rule to independence in Tanganyika did not bring radical changes to Tanzania's foreign and domestic policies. In particular, the development of electrical power infrastructure continued to enjoy stable diplomatic relations between Tanzania and Britain in the early years of independence.

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[30] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, (New Haven and London: Yale University Press, 1998), 231.

[31] EAF–UDSM Library: The United Republic of Tanzania, The Second Five-Year Plan for Economic and Social Development, 1July 1969-30June 1974, Volume 1: General Analysis, (Dar es Salaam: Government Printer 1969), 121.See also, Julius Nyerere, *TANU Na Raia (TANU and the Citizen)*, Dar es Salaam, 1962.

[32] EAF-UDSM Library: Hansard, the Government of Tanganyika, Official Parliamentary Debates in the National Assembly, (10th Meeting), Minister's Speech of 30th June 1964), 914.

[33] EAF-UDSM Library: Hansard, A. K. Hanga, Minister for Industries, Commerce and Power, "The Government of Tanganyika, Parliamentary Debates (Hansard), National Assembly Official Report (10 Meeting), Speech of 30 June 1964, 909.

[34]EAF–UDSM Library: Hansard, A. K. Hanga, Minister for Industries, Commerce and Power, "The Government of Tanganyika, Parliamentary Debates (Hansard) National Assembly Official Report (10th Meeting), Speech of 30th June 1964, 909; see also, Hansard, the Government of Tanganyika, the Official Parliamentary Debates in National Assembly, (10 Meeting), Minister's Speech of 30 June 1964), 914.

The British continued to finance most of Tanganyika's development projects which it had started to implement in the 1950s.[35] As mentioned in Chapter 1, before independence, the governments of Britain and Tanganyika had agreed to implement the Hale hydropower project, to which the Colonial Development Corporation (CDC) in London would provide £3 million and the Tanganyika government would contribute £1.75 million.[36] Thus, the Hale hydropower scheme became the first postcolonial electricity scheme. The planned generation capacity was 21 megawatts, the largest in the country.[37]

The British company Balfour Beatty & Co. Limited (BB&Co.) began to build the Hale hydropower plant in October 1961. By 1964, BB&Co. had completed the building of generation infrastructure. The building of a 132-kilovolt transmission line to carry hydroelectricity from Hale to Dar es Salaam started in 1963 and completed in 1964. The transmission to Dar es Salaam aimed at connecting the city to hydropower sources because the city has since the first installation of electricity in Tanganyika in 1980s been depending on expensive thermal power technologies. Both the government and TANESCO expected the transmission line to reduce the costs of importing diesel oil used in running thermal plants at Kurasini.[38] It would also promote people's welfare by enabling more connections to the grid and reducing tariffs, as D. J. Stringer, TANESCO's Manager, had informed consumers in Dar es Salaam in 1963. The line would also improve electricity reliability and reduce outages caused by weak and costly thermal plants.[39] The coming of hydroelectricity to the city was celebrated as an outstanding achievement in electricity technology in Tanganyika as it brought hydroelectricity to Tanzania's metropolitan city for the first time. The line was also politically significant. The *Tanganyika Standard* heralded the event as, "TANESCO Preparing Dar es Salaam for Hydro-Electric Power" in one of its headlines,[40] symbolising the success of hydroelectrical supply to Dar es Salaam a few years after independence, a feat the British had failed to do in more than four decades of colonisation. The

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[35] Arigo Palotti, "Post-colonial Nation-building and Southern African Liberation: Tanzania and the Break of Diplomatic Relations with the United Kingdom, 1965–1968," *African Historical Review,* 41, no 2, (2010), 60-84, 66-67; see also, Cranford Pratt, "Foreign-policy Issues," 457–458.

[36] UKNA File No. 81/8/02, also CO 832/1792: Colonial Development Corporation: Tanganyika Power Line.

[37] Van der Straeten, *Capital Grids*; see also, UKNA File No. 81/8/02, also CO 832/1792: Colonial Development Corporation: Tanganyika Power Line.

[38] EAF-UDSM Library: Development Plans for Tanganyika 1961/1962–1963-1964; see also, Bashir A. Datoo, "The Generation of Hydroelectric Power in the Lower Pangani Valley", *East African Geographical Review*, 3 (1965), 47 – 49. He notes that Hale had reduced TANESCO's requirement of diesel oil by 75% and had led to annual savings of foreign exchange of about £270,000.

[39] *The Tanganyika Standard*, D. J. Stringer, General Manager of the Tanganyika Electric Supply Company Limited, "TANESCO Preparing Dar es Salaam for Hydro-Electric Power," 12 March 1963.

[40] *Ibid.*

Hale-Dar es Salaam transmission line represented significant progress in the provision of electricity and contributed to meeting electricity demand in Dar es Salaam between 1964 and 1970, which was estimated to grow at an annual rate of 12%.[41]

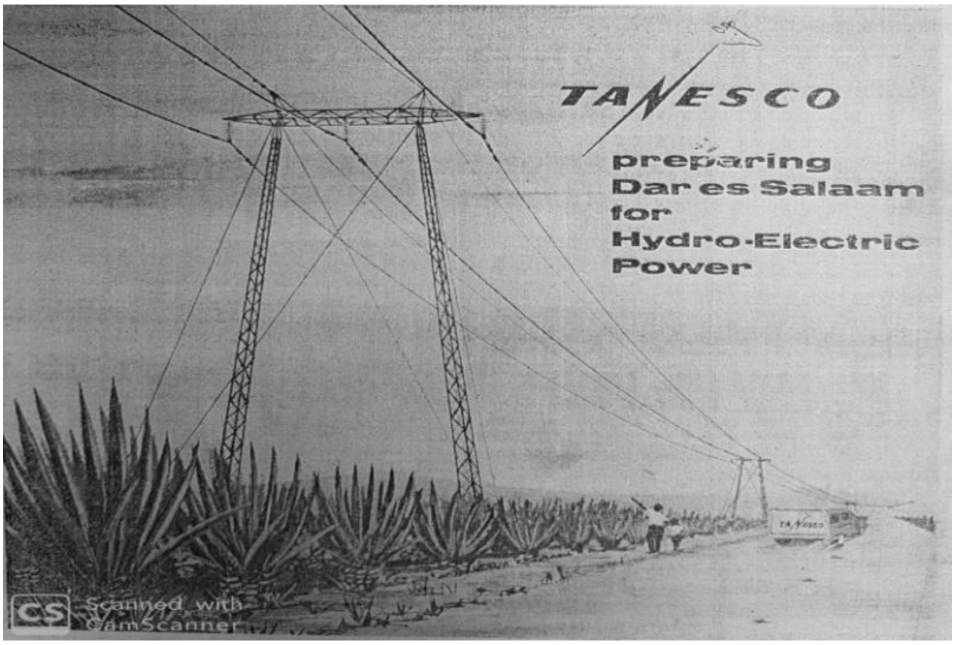

Figure 2.1: The Hale–Dar es Salaam transmission line under construction
Source: *The Tanganyika Standard*, 12.03.1963.

The second scheme which was implemented in the first decade of independence was the building of *Nyumba ya Mungu* hydropower dam south of Moshi and a transmission line to Moshi and Arusha towns. These towns were crucial for industrial and cash crops (coffee and sisal) production since the colonial period. They were also relatively densely populated, and thus provided electricity markets.[42] TANESCO estimated that electricity consumption would grow at 9.6 to 9.9% in the 1960s due to postcolonial development plans. Hence, the capacity of the existing infrastructures would not meet the demand in the early 1970s and required expansion in the late 1960s.[43] As a result, they had higher demand of electricity and received postcolonial attention in the 1960s. In 1962, the government of Tanganyika contracted the British consulting firm BB&Co. to examine the best options for expanding electricity supply in these towns.[44]

[41] EAF-UDSM Library: Tanzania, Plan for Social and Economic Development, 1964-1969, 52.
[42] EAF-UDSM Library: Report by Sir William Halcrow and Partners on the Development of the Pangani River Basin dated October 1962.
[43] EAF-UDSM Library: Tanzania's Plan for Economic and Social Development 1969–1974, 124.
[44] EAF-UDSM Library: The United Republic of Tanzania, Second Five-Year Plan for Economic and Social Development, 1 July 1969-30 June 1974, Vol. I, (Dar es Salaam: Government Printer, 1965), 123.

BB&Co. identified three possibilities: 1) the construction of a 132-kilovolt transmission line connecting the Pangani system to Moshi and Arusha system; 2) the expansion of the Kikuletwa power plant built during the British colonial period in 1935; and 3) the building of a hydropower dam south of Moshi at *Nyumba ya Mungu* and a 66-kilovolt transmission line to the town of Arusha. TANESCO and the government had to choose one alternative.[45]

The plans to construct a power dam at *Nyumba ya Mungu* were*,* nonetheless, not new and dated back to the 1950s. DARESCO had conducted a study in 1952 in its effort to expand power supply in Moshi.[46] It proposed the *Nyumba ya Mungu* dam site located just a few kilometres downstream of the Kikuletwa power plant. However, during the feasibility survey, they discovered that the area was composed of volcanic sand, making the construction of a "gravity dam" impossible. The geological structure allowed for a rockfill dam, instead. The company considered a rockfill dam unfit claiming that it would be wastage. Alternatively, DARESCO planned to merge the electricity system in Moshi with TANESCO's infrastructure at Pangani Falls in 1957 as the Egerton report proposed in the 1950s.[47] The Tanzanian government abandoned the Kikuletwa option due to poor geological structure which could not yield the required megawatts. It also abandoned the interconnecting line between Pangani and Moshi because it covered considerable distance; hence, it was seen as an expensive option.[48]

To the government of Tanganyika, a rockfill at *Nyumba ya Mungu* dam was compatible with its multipurpose projects, including irrigation schemes in Ruvu downstream of the proposed dam.[49] It quickly commissioned Halcrow and Partners, a British company, to plan a multipurpose dam at *Nyumba ya Mungu*. The project's terms of reference not only required recommendations on the specification and design of a dam and cost estimates, but also on water uses in the basin in general. The final report from Halcrow and Partners' engineers addressed all the engineering and other related problems associated to the construction of a dam and storage reservoir at *Nyumba ya Mungu.* They recommended a hydroelectric dam be

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[45] EAF-UDSM Library: Report by William Halcrow and Partners; Also, First Five-Year Plan for Economic and Social Development, 1 July 1964– 30 June 1969, Vol. I (The Ministry of Planning: Dar es Salaam,1964), 58.
[46] TNA Acc. 5 File No. 31/7: Letter from D. J. Stinger, on behalf of DARESCO's Moshi General Manger to Moshi District Commissioner, dated 24 April 1956.
[47] TNA Acc. 5 File No. 31/7: Stinger to Moshi District Commissioner.
[48] EAF-UDSM Library: Report by William Halcrow and Partners.
[49] EAF-UDSM Library: The First Five-Year Plan for Economic and Social Development, 1st July 1964–30th June 1969, Vol. I, (The Ministry of Planning: Dar es Salaam, 1964), 58.

built to generate 8 megawatts and added that "such a dam could be safely constructed at a reasonable cost."[50]

Despite the urgency of the additional power generation in Moshi and Arusha towns, TANESCO could not finance the project: The government turned to the British once again for assistance.[51] Britain's financing of the *Nyumba ya Mungu* project was not only essential to maintain its influence in the former colonial, but also important to safeguard its vested interests in the Pangani River Basin. During the colonial period, British firms had built the Pangani Falls and, after independence, they financed the Hale power plant, both located in the lower part of the Basin. Financing the *Nyumba ya Mungu* in the upper course of the river would ensure British capital and firms dominated the entire Pangani River Basin, which runs across the north-eastern part of Tanganyika. In October 1963, Tanganyika's Minister of Finance, Paul Bomani, travelled to London to sign the scheme's financial contract. Britain granted a loan of £2 million, of which £0.8 million was to be spent on the dam and the remainder on improving all-weather roads and any imported materials and equipment the government required. The Tanzanian government also funded the project with £0.7 million, and TANESCO contributed £0.53 million from its revenue to complete the project.[52]

The *Nyumba ya Mungu* dam extended British influence and technology transfer to postcolonial Tanzania. The tendering process involved British engineering firms only. One of the clauses in the funding contract was that "the dam should be constructed under the supervision of a reputable British firm or consulting engineers, or an African subsidiary of a British contractor. Furthermore, the contract should be awarded by open competitive tender [to British firms]."[53] Above all, "all imported requirements must be of British origin, and all constructional plant must be British."[54] Whenever second-hand equipment available in East Africa was to be used, it had to be of "United Kingdom manufacture."[55] Seven firms applied, from which Richard

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[50]EAF-UDSM Library: Report by William Halcrow and Partners.
[51] Van der Straeten, *Capital Grids*.
[52] UKNA *DO* 185/35, "U.K. Loan to Help Build New Dam", *The Tanganyika Standard*, 26 October 1963: The United Republic of Tanzania, The First Five-Year Plan for Economic and Social Development, 1 July 1964–30th June 1969, (Ministry of Planning; Dar es Salaam, 1964), p. 58; UKNA *DO* 185/35, "U.K. Loan to Help Build New Dam", *The Tanganyika Standard*, 26 October 1963.
[53] UKNA DO 185/35: Lamarque, East Africa Department, Commonwealth Relations Office, 14 January 1964, as cited in van der Straeten, *Capital Grids*.
[54] *Ibid*., 233.
[55] Van der Straeten, *Capital Grids;* also, letter from F. S. Miles to Paul Bomani, Tanganyika Minister of Finance, dated 19 February 1964, *Nyumba ya Mungu* Dam Project, in UKNA DO 185/35; "U.K. Loan to Help Build New Dam", *The Tanganyika Standard*, 26 October 1963.

Costain Limited won the tender for building, not only because they submitted the lowest bid but also because they had included the training of Tanzanians in the area of hydropower during the building of the dam and installation of generating units.[56] The training component for Tanzanians was in line with Tanzania's self-reliance policy which required training of its citizens. The building of the *Nyumba ya Mungu* dam took four years between 1964 and 1968. The *Nyumba ya Mungu* project added 8 MW to the northern power grid, which totalled 15.4 MW in 1969. Electricity was transmitted on a 66-kilovolt line from the dam to the towns of Moshi and Arusha to ensure reliable power supply and new connections. The line cost 2 million TZS, in a government-to-government loan from Canada.[57]

The completion of this project was another milestone in the expansion of electricity infrastructure in postcolonial Tanganyika. It led to the formation of two electricity grids: the northern system (supplying Moshi and Arusha) and the coastal system (supplying the Tanga, Dar es Salaam and Morogoro regions) as shown in Figure 2.2 below. The rest of the country continued to operate mainly from isolated thermal plants. As in Hale project, *Nyumba ya Mungu* manifested postcolonial politics of progress and development as well as continuity of British influence in Tanzania. The inauguration gathered national and international dignitaries. The Cold War and decolonisation politics also featured at the ceremony. In his opening speech, President Nyerere commended the British commitment to developing Tanzania. He avowed that: "I said, when we became independent, we should need a period of ten years in which to do much more for the development of the country than the British were able to do in their 40 years here. One would have thought that the British would have said: 'Very well, we shall go away, stay away for ten years, and at the end of that time, we shall see if you have fulfilled your promise'. They have not done this. [Instead, they said] 'You have made this promise and we will send you some technicians to help and pay for them. We will also, sometimes, give you loans and grants to help you do in ten years what we failed to do in 40 years.' Nothing could be more generous."[58] Nyerere's words were important and revealed smooth transition from colonial to postcolonial and good diplomacy between Tanzania and Britain in the early 1960s. Nyerere's speech at the inauguration of the *Nyumba ya Mungu* dam was well-received in London. It was

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[56] Van der Straeten, *Capital Grids;* see also, UKNA DO 185/35: The *Nyumba ya Mungu* tender document by Halcrow & Partners, 12 February 1964.
[57] EAF-UDSM Library: TANESCO's Annual Directors' and Account Report, 1966.
[58] Van der Straeten, *Capital Grids*; also, *The East African Standard*, "Work starts on £1 m. dam project", dated 14 September 1964: Nyerere's inauguration speech, in UKNA DO 185/35.

interpreted by the Commonwealth officials as the proper path for those who were against British imperialism in Africa.[59]

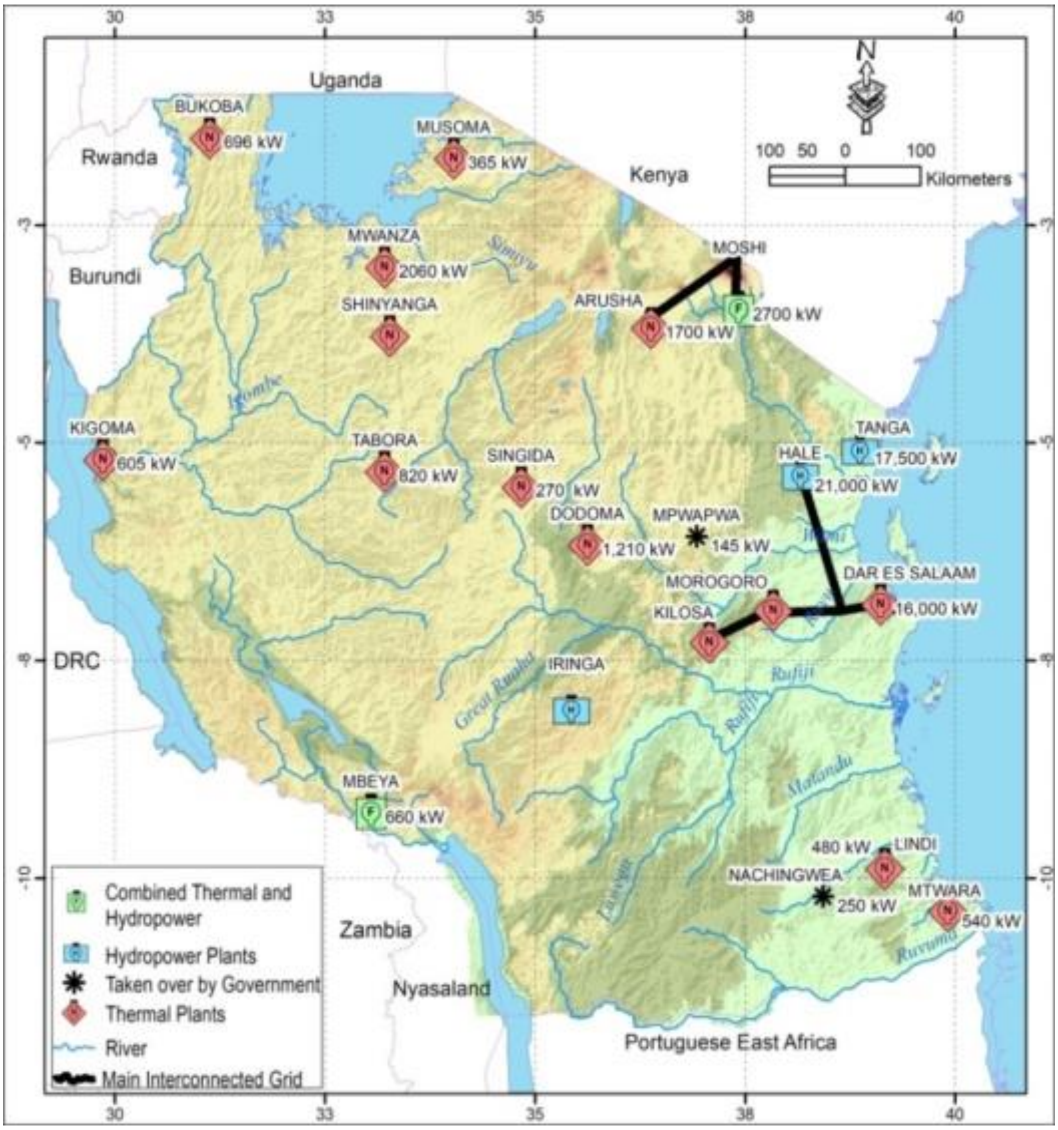

Figure 2.2: The spatial expansion of Tanzania's power grids in the late 1960s
Source: Adopted and modified by the author based on the TANESCO Annual Report, 1966

2.4 Gaining Control over Electricity Undertakings

The second intervention taken by postcolonial state in the early years of independence was institutional one. It involved putting electrical undertakings under strict government control. Despite the continuity of British influence on the development of electrical power systems, there were some changes during this period of change. The Tanzanian government intended to

[59] Van der Straeten, *Capital Grids;* also, UKNA DO 185/35: The Nyumba ya Mungu Dam Project.

closely monitor TANESCO's relations with Western multinational corporations and electrical manufacturing firms. It thus made institutional and policy changes in the 1960s to place the utility on the nation's development path and improve the provision of electricity. The major change was the nationalisation of the electrical power company in 1964. It placed TANESCO under the Ministry of Industries, Mineral Resources, and Power and a managing board consisting of eight members to make it a full-fledged government-owned enterprise. In particular, the chairman of the utility's Board had to be a high-ranking official from the Ministry, and of course, a TANU committed cadre.[60]

The Tanzanian government nationalised TANESCO earlier than any other government enterprise in the country. This also testifies to the perceived criticality of electricity to national building and development. Electricity was a national security, safety, and strategic infrastructure to the state. Nyerere expressed this when explaining why his government nationalised the company saying that, "the recent arrangements, by which the government has taken over ownership of the Electricity supply, and Port handling, have had this objective—the form of control by the people of those sectors of the economy which regulate our advance."[61] These words affirm the perception that electricity was an infrastructure which support critical sectors of national development, thus, it should be placed on the hands of Tanzanians rather than private foreign hands. Before its nationalisation, TANESCO had largely remained in private hands controlled from London's financial market. To the state, this meant placing the country's engine for progress under a colonial system, hindering further access to funds from international donors.[62] It also merged the Ministry of industries and the Ministry of Public Works and Power after its union with Zanzibar in 1964 to for a new Ministry of Industries, Commerce, and Power. This aimed to integrate electricity and industrial development in the country. Measuring this in line with Hempel and others argument that criticality of infrastructure can be defined in terms of strategic socio-technical arrangements and some political decisions,[63] it tells us how electricity was considered critical.

Tanzania took further institutional measures to ensure electricity-driven development in the country. In 1965, it established a new National Electricity Policy in 1965 that made

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[60]Van der Straeten, *Capital Grids.*
[61] Van der Straeten, *Capital Grids*; also, EAF-UDSM Library: The United Republic of Tanzania, The First Five-Year Plan for Economic and Social Development, 1 July 1964–30 June 1969, (Dar es Salaam: Government Press, 1965), p. xiv.
[62] Van der Straeten, *Capital Grids.*
[63] Hempel, *et al*., "Dynamic Interdependencies,"257-258.

TANESCO more of a national agent for socio-political and economic modernisation and development than a commercial electrical utility. The policy stipulated TANESCO's core roles as: (1) provide cheap and abundant uninterrupted power supply whilst remaining economically sound and viable; (2) provide efficient public service on a 24-hour basis; and (3) be a development agent of the government.[64] It required the company to finance a project of about 1.2 million Tanzanian shillings each year from its own internal revenue. This was a strategy to support the state's 'development' initiatives towards independence, and part of a modernisation scheme in rural and small townships. The government intertwined electricity and its socioeconomic development plan. TANESCO's manager, F. S. Batty also highlighted the criticality of electricity to nation's development, saying that:

> Tanesco's commitments are growing. And the impact of the Government's Five-Year Development Plan is placing an increasing demand upon its resources both in terms of manpower and finance. The Company, however, with assistance from its skilled staff engineers and technicians, is determined in playing its part. The basis of development is electricity and Tanesco intends to carry out to the full the obligations the Government has placed upon the Company.[65]

Batty's words endorsed the idea that without electricity there would be no development in the country. The government would not be able to carry out its national development plans and the electric company was such a critical institution for the survival of that nation. The interconnectedness of TANESCO and the national development plans made the utility operate more like a political institution, a 'branch' of the ruling party (TANU), than a profitable electrical company. As the first African Tanzanian TANESCO Manager, Jeremiah Sam Kasambala, in the mid-1970s, the utility had to "implement and execute policies laid down by the Party [TANU] and Government through the Ministry of Water, Energy and Minerals."[66] However, TANESCO succeeded in executing only a few of the government's electrification programmes due to technological and financial limitations. The utility failed to grow both as an economically viable company and as a socioeconomic modernising agent of the state in the 1960s to 1980s.[67]

Moreover, the government embarked on an 'Africanisation' programme as an attempt to reduce dependency on foreign experts. Africanisation programmes involved replacing foreign

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[64] EAF-UDSM Library: TANESCO News Journal, 1st Quarter 1977, *Journal of Tanzania Electric Supply Company Limited*, (1976); Also, TANESCO Annual Directors' and Account Report, 1970, 5.

[65] *The Nationalist*, "Power for the Nation: Electricity Helps Industrialisation", 26 September 1966.

[66] EAF-UDSM Library: TANESCO News Journal of the 1st and 2nd Quarter 1976: *The Journal of Tanzania Electric Supply Company Limited*, (1976), 11.

[67]EAF-UDSM Library: TANESCO Annual Directors' and Account Report, 1970, 5.

(British experts) in different posts with qualified African Tanzanians. Since Tanzania lacked qualified citizens due to late technical education which the British colonial rule established it in Tanganyika in the 1950s,[68] many positions remained under the British. The 1962 workforce survey revealed Tanganyika needed to produce more than 8,000 highly trained African craftsmen, executives, professionals, and technical personnel to fill vacancies in the country. This number was about 86 per cent of all workers in the institutions surveyed in 1962.[69] This was due to the fact that the late technical education in Tanganyika never trained Africans as technical personnel but trained them as wiremen, armature winders, linemen, and motor vehicle electricians.[70]

Despite lack of technically qualified Tanzanians, the Africanisation programme revealed the criticality of electricity infrastructure. While in other non-critical sectors experts were easily replaced by local citizens, Nyerere prohibited such move in critical services, such as health, education, and electricity. Africans' admission to TANESCO's posts were completely based on technological merits. It was only done when it was essential to the country's socioeconomic plans and whether there were qualified, experienced citizens for the job. He emphasised that if a certain job lacked a qualified Tanzanian, the government had to search for loyal, efficient foreign experts while training Tanzanians for such positions.[71] Indeed, the state was committed to the Africanisation programme and the policy of self-reliance. Yet, it was aware that knowledge exchange between the experienced Western experts and local Tanzanians was important for the smooth running of critical sectors. It thus encouraged the use of experienced experts in imparting knowledge to local Africans until they were gradually able to become competent in their area of expertise. For instance, Nyerere saw that it would be not "self-reliant to refuse to carry out the directions of a foreign engineer, a foreign doctor, or a foreign manager" just because he or she is British while the country had no Tanzanian to fill that position.[72] In such a perspective, the Tanzanian government continued to retain British engineers at TANESCO throughout the 1960s. This included the appointment of F. S. Batty, a

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[68]UKNA CO 822/2642: Dar es Salaam Technical College, Tanganyika: letter from B. J. Dubridge to F. D. Webber, Colonial Office, London, dated 4 April 1960; see also, Press Release, Public Relations Department, Dar es Salaam, dated 23 April 1960 and 14 July 1960.

[69] Statistical Abstract 1962, (Dar es Salaam, 1962), 11, in Pratt (1976), 12.

[70] KNA T.1/4/3/ext. 45/3/8: Technical Education Report from Tanganyika Territory; see also, Tanganyika Public Works Department 1950-1962.

[71] Julius K. Nyerere, "After the Arusha Declaration," in Julius K. Nyerere, *Ujamaa: Essays on African Socialism,* (Dar es Salaam: Oxford University Press, 1968), 146–147.

[72] Julius K. Nyerere, *President Nyerere Explains the Arusha Declaration: The Purpose is Man,* (Dar es Salaam: The Mwalimu Nyerere Foundation, 2018), 13.

British expert, as General Manager, TANESCO's top position, in 1964.[73] By the late 1960s, TANESCO had a total of 170 foreign experts holding different middle and top positions.[74]

In the late 1960s, the presence of British engineers and other expertise at TANESCO created tension in the Tanzanian Parliament. Some members claimed that these experts were paid high salaries and their presence at TANESCO increased chances for sabotage of the critical national institutions. Some parliamentarians maintained that hospitals and schools could continue under the administration of foreigners, but electricity was a national security issue, therefore, foreigners had to be removed. In their view, given its strategic role to national development and security, TANESCO needed to be under the leadership of patriotic Tanzania nationals only.[75] They believed that it was dangerous for TANESCO to be managed by external experts. Yet, the Minister for Commerce and Industries responded to their claims by saying: "for now and until that time that we will get adequate Tanzanian engineers, we expect to continue using foreign [electrical]engineers to allow smooth operation at TANESCO."[76] However, it seems to suggest that both sides viewed electricity as a critical service and TANESCO as a critical institution, but they differed on how to deal with the criticality question.

For the government, TANESCO and the country's electricity infrastructure needed qualified expertise; hence, it was dangerous to replace management without ensuring technical and economic efficiencies. The state responded to the shortage of qualified Africans in two major ways. One of the measures aimed to increase the number of qualified Tanzanians by sponsoring them for technical, managerial, and financial studies domestically and abroad in countries such as Canada, West Germany, Japan, Zambia, and England.[77] It also established "on-the-job" training by recruiting and training primary and secondary school leavers to fill supervisory and managerial roles at TANESCO, before TANESCO's establishment of its own training school in Dar es Salaam in 1967.[78]

By the early 1970s, the percentage of African Tanzanians working at TANESCO increased. In senior positions, the proportion rose from 19% in 1964 to 75% in 1970, and in non-

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[73]Van der Straeten, *Capital Grids*; also, EAF-UDSM Library: TANESCO Annual Directors' and Account Report, 1965.
[74] EAF-UDSM Library: Hansard: Jamhuri ya Muungano wa Tanzania, Majadiliano Rasmi ya Bunge, Mkutano wa 12 Tarehe 30 Aprili–10 Mei, 1968-1969, 831–832.
[75] *Ibid*.
[76] *Ibid*. 832.
[77] EAF-UDSM Library: TANESCO Directors' and Account Reports; *Jamhuri ya Muungano wa Tanzania, Hotuba ya Waziri waMajina Nguvu za Umeme katika Bunge la Jamhuri ya Muungano wa Tanzania*, Juni 1974: Parliamentary Records (Hansards), East African Section, University of Dar es Salaam Library.
[78]EAF-UDSM Library: TANESCO Annual Directors' and Account Report, 1965, 6 and TANESCO Annual Directors' and Account Report, 1967 and 1968.

expert jobs, it reached 98% in 1971.[79] The number of Tanzanian experts in TANESCO's middle and senior positions continued to grow in the 1970s. The available sources reveal that while Tanzanian citizens held only 2 of the 11 senior positions and 9 of the 45 middle positions in 1970, they held all 14 senior positions and 46 of the 69 middle positions in 1979.[80] The company obtained its first African Tanzanian General Manager when Jerry S. Kasambala replaced F. S. Batty in the mid-1970s.[81] In 1977, TANESCO also witnessed the departure of the last and the longest-serving British expatriate, A. G. Snell, who had worked for the company for 26 years.[82] The company was exclusively managed by Tanzanian experts by the end of 1970s. Politically, this step symbolised self-rule, handing power into the hands of citizens—and self-reliance.

2.5 The Making of the National Grid: The Great Ruaha Power Project, 1966–1988

We shall see in this section how Tanzania's foreign policy after the Arusha Declaration shaped the building of Tanzania's power infrastructure and grid direction between the 1960s and 1990s. Dar es Salaam continued to grow as Tanzania's economic 'powerhouse' in the 1960s and 1970s. The emergence of new industries, such as the Wazo Hill cement factory, the old Pugu industrial area, the new Ubungo industrial area, and more than 8,000 new houses built by the National Housing Corporation (NHC) in the 1960s, escalated demand from the coastal power system. The demand grew at a rate of 12 – 13 percent per annum between 1961 and 1969.[83] Studies performed by TANESCO during this period estimated that the growth rate would reach 19 per cent in 1972 and that the capacity of the coastal system of 55 megawatts in 1968 would be exceeded by early 1970s.[84] To meet this demand, Tanzania thought to use its many perennial

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[79] EAF-UDSM Library: TANESCO Directors' and Account Report, 1967 and 1969; also, The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania", (The World Bank; Washington, DC, 1970), 12.

[80] See The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania", (The World Bank; Washington, DC, 1970), 12; The World Bank, "Tanzania: Kidatu Hydroelectric Project (First Stage): Project Performance Audit Report," (The World Bank; Washington, DC, 1979), 3.

[81] Rebecca H. Ghanadan, "Public Service or Commodity Goods? Electricity Reforms, Access, and the Politics of Development in Tanzania", (PhD Diss.: University of California Berkeley, 2008).

[82] EAF-UDSM Library: TANESCO News Journal, 1st Quarter 1977*, Journal of Tanzania Electric Supply Company Limited*, (Dar es Salaam), TANESCO, 1976.

[83] James R. Brennan, and Andrew Burton, "The Emerging Metropolis: A History of Dar es Salaam, circa 1862-2000", in *Dar es Salaam: Histories from an African Emerging Metropolis*, edited by James R. Brennan, Andrew Burton and Yusufu Lawi, 13 – 76 (Dar es Salaam: Mkuki na Nyota, 2007), 54-58.

[84] Öhman, "Taming Exotic Beauties," 160; The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania," (The World Bank, Washington, DC, 1970); The URT, "The First-Five Year Plan for Economic and Social Development, 1 July 1964–30 June 1969", (The Ministry of Finance and Planning, Dare es Salaam, 1965); The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania," (The World Bank; Washington, DC, 1970).

rivers for hydroelectricity rather than using expensive imported petroleum products.[85] Tanzania had several options. By the mid-1960s, it had surveyed and estimated hydropower potential at 1343 megawatts in sites including Stiegler's Gorge (400 MW), the Great Ruaha—Kidatu and Mtera rivers (200 MW), and Pongwe on the Wami River (120 MW), among others.[86] Yet, its path to hydropower infrastructure was complex and it was influenced by local and global socio-political and economic forces.

2.5.1 Choosing the Site: Swedish Aid Takeover

Tanzania had divided opinions on which site to build a hydro-dam to expand the coastal system. By the mid-1960s, Tanzania's Ministry of Land, Settlement and Water Development was investigating the possibility of developing the Pongwe site on the Wami River in the eastern part of the country to generate between 80 and 100 million kilowatt-hours.[87] At the same time, TANESCO and its in-house consulting company BB&Co., a British consulting firm, on the other hand was investigating the possibility of building a power dam on the Great Ruaha River. Whilst the Great Ruaha was to TANESCO the best option for expanding the coastal electricity system,[88] the Tanzanian government supported the Wami project because it was a multipurpose project. In fact, Tanzania's First Five-Year Development Plan (1964–1969) had included the construction of a hydropower plant at Wami as a possibility.[89] Wami had an irrigation component for agricultural development and the site was also closer to the towns of Dar es Salaam, Tanga and Morogoro; hence, it needed short-distance transmission infrastructure.[90] But, Tanzania faced several challenges on how to finance the project. It had the UN special fund (which later become the United Nations Development Fund, UNDP) and the river valley development fund from Britain but were insufficient. Moreover, diplomatic problems with Britain had curtailed economic assistance, making it difficult to implement the First Five-Year Development Plan and infrastructure development.[91]

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[85] *Tanganyika News Review,* "Nyumba ya Mungu Dam to Encourage Irrigation," October 1964, as cited in Hoag, *Developing the Rivers of East and West Africa*, 187.
[86] EAF-UDSM Library: Tanzania's Second Five-Year Plan (1969–1974), 122.
[87] Öhman, *Taming Exotic Beauties*, 159-160; also, EAF-UDSM Library: TANESCO Directors' and Accounts Report 1966.
[88] Ibid., 159-160.
[89] EAF-UDSM Library: URT, *First Five-Year Development Plan* (1964-1969), x, 46-48.
[90] EAF-UDSM Library: United Republic of Tanzania, *The Second Five-Year Plan for Economic and Social Development* (1969-1974), 127-128.
[91] Palotti, "Post-colonial Nation-building," 60-84; Bjerk, "Postcolonial Realism,"215-247.

To implement Wami project, Tanzania needed financial assistance from donors other than Britain, USA and West Germany who had experienced diplomatic tensions in the mid-1960s. During this time, plans were underway to employ an international consulting company to prepare an elaborate technical report that Tanzania would use to seek finance in various international agencies particularly the World Bank. With its "sympathetic mission" and its international development authority (SIDA), Sweden was supporting Tanzania's rural water supply infrastructure in the early 1960s and it was interested in extending its development assistance to electrical power industry.[92] The Wami project, as Öhman contends, "fitted very well within the framework of the double-edged Swedish development-assistance policy: the Wami project would be both 'excellent for Swedish technology' and also 'have a great effect on development.'"[93]

During the discussions with Tanzania's authorities about rural water infrastructure in 1965, Petter Narfström, SIDA's representative and a civil engineer who had participated in the building of the Stornorrfors hydroelectric power in Sapmi, Sweden, and a member of the Swedish Power Board, noted about Tanzania's desire to build a multipurpose scheme at Wami. He also noted that Tanzania was seeking an international consultancy company that would prepare the funding proposal. While it was not clear from the archival material whether Tanzania approached Narfström specifically on the Wami project, the Tanzanian government sent in March 1966 an official request for Swedish assistance in the Wami. One month later, TANESCO commissioned the Swedish Consulting Engineers Group (SWECO), to study the Wami and produce a study which would be used for applying fund from international donors.[94]

SWECO completed the study in the last quarter of 1966. In their final report, SWECO had expanded Wami's capacity from 50 MW to 160 MW and included a regulating dam of about 1 billion m^3 at an estimated cost of £29 million. SWECO experts made the Wami project bigger because they were aware that TANESCO and the British BB&Co, Ltd., were interested in the Great Ruaha River. Also, before coming to Tanzania, they "had already been instructed to look at other options, besides the Wami" including the Great Ruaha site.[95] Hence, in their report, they included calculations for the Kidatu and Mtera sites in the Great Ruaha River based on the United Nations Food and Agriculture Organisation's Rufiji River Basin Survey (FAO RBS) of 1961.

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[92] Öhman, *Taming Exotic Beauties*, 142.
[93] *Ibid.*, 160.
[94] *Ibid*.
[95] *Ibid.,* 170.

They concluded their report confirming the government's wishes that the Wami was an appropriate project to meet power demand in the 1970s.[96] But by including Kidatu and Mtera sites, SWECO had identified the Great Ruaha–Kidatu-Mtera project as an alternative to the Wami to secure Swedish development aid in Tanzania's power sector.

The review of Tanzania's plans for socio-economic development unveils that the Great Ruaha project appeared was listed as a favourable government scheme in the Second Five-Year Plan (1969–1974). The plan stated that the government had decided on the thorough study of the hydroelectric potentials in the coastal area and the building of a hydroelectric dam on the Great Ruaha River.[97] This implied that the Tanzanian government had changed its priority regarding the Wami River. Tanzania's shift from the Wami to the Great Ruaha, therefore, reveals several significant issues in the electrical power schemes in the Global South especially in the 1960s–1980s. It is important to mention that, in the early stages of the planning of these sites, President Nyerere had expressed his view to Erik Berg, one of the Swedish experts who had long worked on Tanzania's water infrastructure, that the Wami was his government's favourite project. Berg expressed this view in his letter to Stockholm, saying:

> Regarding the Wami project, the president mentioned that representatives of TANESCO had proposed development of Great Ruaha, but that the government had decided to concentrate all efforts on the Wami. From the UK, Tanzania had inherited a stable administrative system, which was a great advantage, but otherwise the UK had nothing to offer. According to the president, British lethargy had been a problem to many African States.[98]

This quote also reveals Nyerere's perceptions of the former colonial masters and Western capitalist countries. He considered British technological and financial help as a throwback to the colonial past. What factors influenced Tanzania to change its ambitions regarding the Wami? This question is important because it helps to understand how the donors' funding of large-scale hydropower infrastructure in the postcolonial period not only influenced the priorities of leaders but also the sources of electricity and grid direction.

To answer this question better, we need to consider Kjell Havnevik's contention that "large-scale and highly capital-intensive development projects which emerged in Tanzania and elsewhere in Africa during the 1970s can only be properly explained against the background of

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[96] *Ibid*., 160-171.

[97] EAF-UDSM Library: *Tanganyika: Five-Year Plan for Economic and Social Development,* 1964, 75.

[98] Berg's letter to Stockholm in 1966, as cited in Öhman, *Taming Exotic Beauties*, 168-169.

donor self-interest."[99] The World Bank was less interested in funding agricultural projects in the 1960s. The Bank favoured the Great Ruaha Scheme and abandoned the Wami. One of the reasons was that the Wami had the agricultural component since it was a multipurpose scheme. Donors channelled their funds in the projects that had calculable economic benefits. Agricultural schemes could not provide exact profit estimates. In this case, the donors made the money talk. She writes: "Money should be made to talk: [. . .] The important thing is that money should be permitted to talk and to dedicate decisions, and so it does; it talks to TANESCO the way it always talks to power enterprise."[100] Sweden, like the World Bank, it wanted to invest its fund where it was possible to calculate the profit. The agricultural outputs were difficult to estimate when compared to electricity megawatts. Thus, it also twisted its support to Tanzania to follow World Bank's position.

By the mid-1960s, TANESCO had submitted many proposals to the World Bank requesting funding for electricity projects in the mid-1960s. These included the installation of thermal plants in Ubungo, construction of hydropower plants on the Great Ruaha and on the Wami River. In 1966, a World Bank mission visited Tanzania to assess which project to finance among those submitted by TANESCO, and to also investigate the growth of the electrical power industry.[101]

Before the visit, the Bank was aware of the division between TANESCO and Tanzania's government over the Wami and the Great Ruaha. In its final report, the World Bank mission stated: "Preliminary indications are that the sources of power which would provide the lowest cost energy in the early 1970s is a hydropower station at the Great Ruaha River."[102] Despite the World Bank's report, the Tanzanian government did not abandon its intention to build a hydropower plant on the Wami River. Hence, they approached the government of Sweden through SIDA. But, SIDA had included one of its people, John Fletcher, in the World Bank mission to Tanzania. SIDA was, therefore, aware that the World Bank was interested in the Great Ruaha scheme and not the Wami. Besides, the Bank had contacted SIDA to request their assistance if the Tanzanian government agreed on the Great Ruaha project. In this regard, SIDA agreed to

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[99] Kjell J. Havnevik, *Tanzania: The Limits to Development from Above,* (Nordiska Afrikainstitutet; Mkuki na Nyota: Dar es Salaam, 1993), 21.
[100] Öhman, *Taming Exotic Beauties*, 186.
[101] The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania", (The World Bank; Washington, DC, 1970).
[102] Öhman, *Taming Exotic Beauties*, 178.

support Tanzania on the condition that TANESCO had to commission SWECO to conduct a comparative study between the Wami and Great Ruaha schemes.[103]

The need for a comparative study between the two sites was extensively discussed in 1967 by TANESCO and the World Bank.[104] As David Hart stresses in *The Volta River Project* that the building of hydropower dams fused the interests of both African governments and donors, but the wishes of international donors and firms highly overruled many issues, including types of technologies and what projects were to be pursued,[105] the available sources suggest that it was a demand from the donors rather than from the Tanzanian government. Tanzania agreed to the comparative study. In 1968, TANESCO commissioned its in-house consulting company, BB&Co., and SWECO to conduct the comparative study under the supervision of a Swedish engineer, Fletcher.[106] Shortly afterwards, Fletcher submitted the report to TANESCO in July 1968, called "Comparative Study of the Wami River and the Great Ruaha River Development in Tanzania". It identified the Great Ruaha hydroelectric power plant as an economic scheme to expand Tanzania's coastal power grid, contending that the Wami had lower output than what was required.[107]

Tanzania had no more objection to moving to the Great Ruaha and abandoning the Wami project. As the Second Five-Year Plan for Economic and Social Development stated, "the next large-scale project to supply the Coast is the Great Ruaha Project. A comprehensive comparative study on the hydro-electric potentials of the Wami and Great Ruaha Rivers has recently been carried out which indicated definite advantages for a project on the Great Ruaha River."[108] This was a complete turn from the interest of the Tanzanian government's leaders regarding which power site to develop. Tanzania preferred the Wami River multipurpose project but the political tensions with Western donors contributed to that change because Sweden and the World Bank were the only funding options. Like how the old saying goes, he who pays the piper calls the tune, Tanzania fell into the grip of its donors' interests.

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[103]*Ibid*., 178-181.
[104] The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania," (The World Bank; Washington, DC, 1970).
[105] David Hart, *The Volta River Project: A Case Study of Politics and Technology*, (Edinburgh; Edinburgh University Press, 1980); Hoag, *Developing the Rivers of East and West Africa*, 177.
[106] Hoag and Öhman, "Turning Water into Power," 647-648.
[107] The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania," (The World Bank; Washington, DC, 1970).
[108] EAF-UDSM Library: *Tanzania's Second Five-Year Plan for Economic and Social Development*, (Ministry of Finance and Development Planning; Dar es Salaam, 1969), 125.

2.5.2 The Great Ruaha Power Project (GRPP)

The Great Ruaha Power Project is located about 280 kilometres south-west of Dar es Salaam. The scheme involved building a rockfill dam at Kidatu in the Great Ruaha River and a reservoir at Mtera (an area located about 170 kilometres upstream of Kidatu). The Great Ruaha River is in the upper catchment of the Rufiji Basin, and it obtains its waters from the Usangu catchment. Several tributaries such as the Mbarali, Little Ruaha, Kimani, Chimala, Ndembera, and Lukosi Rivers feed the river annually. Initially, the project had to be carried out in two phases. The first phase would involve the construction of a rockfill storage dam about four square kilometres in size, and an underground power station. Hence, it needed construction of a ten-kilometre long, nine-metre wide, and seven-metre-high tunnel for an underground station. The Kidatu water reservoir would consist of a 350-metre long and 55-metre-high dam, as well as 180-metre long and 12-metre-wide tunnels to divert the Ruaha River. The second stage of the Great Ruaha Power Project was expected to start in 1976, immediately after the commissioning of the first 100 megawatts at Kidatu. This phase would involve the building of a concrete dam (45-metres high) at Mtera to regulate water flow to the Kidatu hydropower station located downstream. This would allow TANESCO to expand the generation capacity at Kidatu by installing another two 50-megawatt generators to produce 100 megawatts.[109] The Great Ruaha Power Project was expected to add a total of 200 MW upon the completion of the Mtera reservoir in 1981. Planners anticipated that such amount would meet demand in the coastal system until the mid-1980s.[110]

The question of making power infrastructure more resilient (by ensuring backup systems) and reliable supply was also central in the Great Ruaha Power Project. The first phase involved construction of several thermal plants in Ubungo in the late 1960s and early 1970s by adding 15 megawatts to the existing systems. The World Bank provided a loan of USD 5.2 million for such project. Moreover, TANESCO installed a 15-megawatt gas turbine in August 1973. The turbine unit was provided to TANESCO as part of a loan from the Dutch government.[111] As heralded in Tanzanian newspapers, the turbine was "the largest road-load ever to be

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[109] SNA, SIDA File No.1 TAN 32.1: F13B: 3: Letter from J. S. Kasambala to Electrical Firms, "Great Ruaha Power Project Phase II – Pre-investment study", dated 4th December 1973. see also, correspondence between TANESCO, SIDA, SWECO, and the IBRD in the same file; The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania", (The World Bank: Washington DC, 1970).

[110] *Ibid.*

[111] The World Bank, "Tanzania: Kidatu Hydroelectric Project (First Stage): Project Performance Audit Project", (The World Bank; Washington, DC, 1979).

transported on a Tanzanian road."[112] Tanzania's power system builders (TANESCO, the government, and donors) installed these thermal plants deliberately to avoid breakdowns in Dar es Salaam in the early 1970s.[113] They planned that these plants would not only cover shortfalls in generating capacity before the Kidatu hydroelectric plant was commissioned but would also be used as an emergency power reserve for Dar es Salaam and the costal system at large.[114] Furthermore, TANESCO anticipated that the completion of the first stage of the Kidatu project in 1975 would meet the demand of the coastal grid, which consumed about 80 per cent of the total TANESCO sales in the late 1960s, centred on Dar es Salaam.

The project was extended to a third phase in the late 1970s. TANESCO commissioned Acres International Limited of Canada in 1978 to conduct a study on Tanzania's power sector and recommend the next economic project after the completion of the second phase of the Great Ruaha project.[115] Acres published the results of the study in February 1978 in a document called "Tanzania Power Sector Study". The study showed that Tanzania's national power grid would need additional capacity by the mid-1980s. As such, to avoid persistent power blackouts, Acres recommended the addition of 50 MW to the interconnected national grid by 1986, in a phased construction of a 50 MW coal-fired thermal plant in Ubungo. It also suggested retiring the diesel thermal units in cities and towns such as Dar es Salaam, Arusha, and Moshi, once the Mtera dam was commissioned in 1981. Acres provided other options as well. These included the building of a hydropower plant on the Mtera or Kingengena Rivers (one of the tributaries of the Great Ruaha River). The Acres report also insisted that TANESCO's failure to add such amounts would lead to restricted power supply and blackouts in all the towns connected to the national grid.[116] But the report faced resistance from stakeholders particularly on the proposed electricity-generating technologies.

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[112] *Daily News*, "Work on Kidatu progressing,", 23 March 1973; Also see, *Hotuba ya Waziri wa Maji and Nguvu za Umeme katika Bunge la Jamhuri ya Muungano wa Tanzania, Mwaka* 1973/1974, 15-16.

[113] Swedish National Archives (henceforth, SNA SIDA) File: No. 1 TAN 32.1: A Short Description of The Great Ruaha Project, by Torben Rosendal, SWECO representative in Tanzania, in an integrated meeting held on 27 July 1971, Dar es Salaam. Also, SNA, SIDA F13B: 3: Letter from J. S. Kasambala to Electrical Firms, "Great Ruaha Power Project Phase II – Pre-investment study", dated 4 December 1973.see also, SNA SIDA File No. F13B: 1 and File. No. F13B: 2: Correspondence between TANESCO, SIDA, SWECO and the IBRD.

[114] *Ibid*.

[115] EAF-UDSM Library: Tanzania Power Sector Study, Draft Report, Acres International Ltd, February 1978. see also, SNA, SIDA F13O: 1: letter from S. L. Mosha, on behalf of the TANESCO General Manager to Naarfstrom SIDA, Dar es Salaam, dated 14 June 1978.

[116] SNA, SIDA, File F13B: 9.

The promoters of hydropower technologies and one of the major players in Tanzania's electricity infrastructure such as SIDA and SWECO were the first to comment on the report. Sven Lalandor, Vice-President of the Swedish State Power Board, and Allan Mauritzson, member of the Energy Department of the city of Malmö who commented on behalf of SIDA contended that the report had a "firm belief that the next major extension of power production should be by hydropower. We do not have sufficient data available to make a definite comparison between the available hydropower projects. We believe, however, that the best project for the immediate future is the Mtera hydropower project."[117] In their view, the Acres failed to pay due attention to hydroelectricity. In their turn, SWECO stated that the report was unrealistic with regards to load forecast and that Acres had used historical data rather than actual focus on Tanzania's industrial development plan.[118] Tanzania rejected the Acres report because of its lack of consideration for hydroelectricity, especially the state project at Stiegler's Gorge.[119]

Following negative recommendations, TANESCO funded further studies on how to expand the generation capacity and to avoid intermittent power blackouts in the country. It contracted SWECO to do a Comparative Power Balance Study in Tanzania in which SWECO had to compare various alternatives power generation technologies such as the Stiegler's Gorge, installation of a power plant at Mtera dam, construction of the Kingengenas hydropower plant, and a coal-fired thermal plant at Ubungo in Dar es Salaam.[120] TANESCO required that SWECO should complete the study in a short time, which it did by submitting the report in May 1979. The report's main conclusion was that the installation of a power plant at Mtera would be the most economical alternative.[121]

It is significant to note that studies in the early 1970s had concluded that building of a power plant at Mtera was uneconomical because it would affect power generation downstream at Kidatu as SWECO experts noted in April 1973 that "the development of the full power potential downstream of the dam cannot be economically justified"[122] If at all a plant installed at Mtera dam it should involve a small generation capacity only to feed nearby towns such as

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[117] SNA, SIDA File F13O:1: SIDA's comments on the *Acres Tanzania Power Sector Study, 1978*.
[118] SNA, SIDA File F13O:1: SWECO comments on the *Acres Tanzania Power Sector Study, 1978.*
[119] Havnevik, *Tanzania,* 272.
[120]SNA SIDA File F13B: 7: A letter from J. S. Kasambala to Nordstrom dated 25 January 1979, on the "Power Balance Study Agreement" was a formal instruction to SWECO to proceed with the implementation of the power balance study in accordance with discussions in Stockholm.
[121] SNA SIDA File F13O: 1: Letter from S. L. Mosha to Principal Secretary of the Treasury, dated 15 November 1978.
[122] SNA SIDA materials File No. F13B: 2: A letter from SWECO to the attention of A. W. D. Adama of TANESCO in the Kidatu Hydroelectric Power Plant Technical Data Sheet.

Iringa and Dodoma. But in the late 1970s, SWECO experts came with completely different findings and proposal concerning installing a power plant at Mtera dam. This decision marked the third phase of the Great Ruaha power project which involved the construction of a 200-metre-long headrace and access tunnel, a trail race about 10.5 kilometres long, and two generating units of 42 MW each to produce a total of 84 MW.

The Great Ruaha Power Project transformed Tanzanian power systems. By damming the Great Ruaha River twice, at Kidatu in 1975 and at Mtera in 1981, as well as installing two large electricity generation plants, the project was a crucial scheme to Tanzania's socialist government in the 1960s to 1980s. It was implemented for twenty years from 1966 to 1988, when the last power plant was installed at Mtera dam. It increased the capacity of the national power grid from a few megawatts of hydropower generated at Pangani Falls (17.5), Hale (21), and *Nyumba ya Mungu* (8) in 1935, 1964, and 1969 respectively to 200 MW installed at Kidatu in 1981 and 84 MW installed at Mtera in 1988.[123] The project remains the largest hydropower source of Tanzania's national grid until the completion of the Nyerere (the Stiegler's Gorge) scheme which is under construction which is expected to generate 2115 megawatts.

2.5.3 Tanzania's Foreign Policies and Tendering Politics

Several Western countries competed to extend their social, political, economic, and technological influence on postcolonial Tanzania. Canada and the Nordic countries challenged the influence of Britain and West Germany in electrical firms. This made the tendering of the Great Ruaha's feasibility studies and civil works was not a technical process only but a political one also. The Cold War and decolonisation politics shaped this process as Tanzania aspired to write off the influence of Western colonial powers in its electrical power sector. Postcolonial government leaders used tendering activities to express their discontent in worsened diplomatic relations with Britain and West Germany as well as maintaining its self-reliance policy. Therefore, tendering process became a new area of tension among donors, engineering firms and their experts, and the Tanzanian government and its utility, TANESCO. The controversies emerged particularly over the technical design of the Kidatu dam and the choice of engineers and contractors in performing different project's tasks.[124]

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[123] The World Bank Report, "Project Review from the Bank's Perspective"; Re: Fourth Power Project - United Republic of Tanzania, 29 November 1993, "Project Completion Report", Report No. 12556.
[124] Öhman, *Taming Exotic Beauties*, 137.

Like Sweden and Canada, Britain needed its electrical firms to benefit from the Great Ruaha power project. But the political tensions between Tanzania and Britain were a threat to Britain's broader interests in Tanzania's electrical industry and its prospects in the project. Horace Phillips, the United Kingdom's High Commissioner in Dar es Salaam, in a letter in 1968, informed Eric G. le Tocq, the British Head of the East African Department about the Great Ruaha Hydroelectric Scheme. Phillips explained that SIDA sponsored the comparative and feasibility studies of the Wami-Great Ruaha, but Sweden was unprepared to finance the design and consultancy services.[125] He wanted the British government to finance the project so that British electrical firms would have the opportunity to be considered for consultancy and the main civil works in the GRPP. Balfour Beatty & Company, a British firm, had worked in Tanzania with TANESCO since the colonial period. It had also started negotiations with the World Bank about its position in Tanzania's electrical industry and was seeking to be considered for consultancy on the Great Ruaha power project. But Phillips was sure that unless Britain removed its aid ban in Tanzania, the British electrical firms and expatriates would not survive the competition with other donor countries. He wrote in his letter that:

> In the event they [British Balfour Beatty & Co. Ltd] may well be commissioned on their merits. But from the experience of similar situations in other countries I feel that their chances and in consequence the chance of British contractors for the construction would be enhanced if there were British finance in the project. Such participation would help to secure the future of already long-established British commercial interests in an important sector of the Tanzanian economy.[126]

Phillips believed electrical power was vital to Tanzania's economy and British interests. The long-standing vested interests of the British in the electrical infrastructure in Tanzania was in danger due to diplomatic tensions.[127] Therefore, as the diplomatic conflicts were slowly coming to an end in 1968, British officials in Dar es Salaam persuaded the Commonwealth Development Corporation (CDC) to reconsider its investment in Tanzania, encouraging the injection of funds into the project to pacify their electrical engineering enterprises.[128]

The signing of the financing agreements for the First Phase was established between the World Bank and Tanzania in Washington DC on 14 December 1970,[129] and between Tanzania

[125]UKNA CO 31/454: Letter from Horace Phillips to Eric G. le Tocq, dated 12 December 1968.
[126] *Ibid*.
[127] UKNA CO 31/454: Letter from M. de N. Ensor to B. T. Holmes, dated 28 January 1969.
[128] *Ibid.*
[129] EAF-UDSM Library: TANESCO Annual Directors' and Account report, 1970.

and Sweden in Stockholm on 24 June 1971.[130] This suggests that Britain could not finance the project and the first phase was mainly funded by the World Bank and Sweden. The agreements between Tanzania, Sweden, and the World Bank to fund the project were foreshowed in Tanzania' newspapers as a great step in building infrastructures critical to national development.[131] The project contract was followed by a pre-investment study where SIDA provided TANESCO with 2.7 million Swedish crowns. The aid was on conditions that SWECO should undertake the study to pacify the transfer of Swedish technologies to Tanzania. In the later stage, SIDA also requested the import of Swedish technologies to Tanzania free of import charges. Lars Kalderen, SIDA's director of finance, wrote to the Tanzanian Ministry of Finance that: "we assume that Tanzania will allow the Consultant to import into Tanzania free of duty any equipment for the purpose of the execution of the study as well as grant SIDA and Consultant exemption from all taxes in Tanzania."[132] Thus, there was no official tendering. TANESCO directly invited SWECO to undertake the study. SWECO experts began the study in October 1968 and completed it in November 1969.[133]

Decolonisation and Cold War politics were particularly evident in the tendering for the main civil and electrical works at the Great Ruaha. In 1970, TANESCO announced the tender for the main civil and electrical works which involved building a rockfill dam and installation of two generators to produce 100MW, which was expected to begin in 1971. Like all World Bank-funded projects during that time, the tender had to be internationally competitive among the World Bank member countries. This regulation provided the opportunity to both local and foreign-operated electrical engineering firms, having applied thirty-two firms in total. Because of the rise in construction costs during that time, only six international engineering firms from Holland, Italy, Israel, West Germany, Sweden, Britain, and Yugoslavia had submitted their bids by 25 January 1971.[134]

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130 SNA, SIDA File No. 1 TAN 32.1, F13B: 1: *The Standard*, "460/- Kidatu Dam Contract Signed", 27 August 1971

131 *The Standard,* article dated 9 July 1971, in SNA, SIDA File F13B: 1.

132 SNA SIDA material File No. F13B: 1: L. Kalderen to J. D. Namfua, Principal Secretary of the Treasury, Dar es Salaam, "Kidatu – Terms of Reference for Pre-investment Study", in SRA, F1AB 1389, as cited in Öhman, *Taming Exotic Beauties*, 203. For more on the exemption of Swedish goods import tax in the Great Ruaha project, see also, a letter from Laurence Ostlund, SIDA Programme Officer, to W. M. Mahanyu, Ministry of Communications and Works, Dar es Salaam, dated 11 July 1972; also, Laurence Ostlund to A. H. Msuya, Treasury, Dar es Salaam, dated 3 July 1971.

133 Öhman, *Taming Exotic Beauties,* 203.

134 *The Standard*, "Kidatu power to boost economy", 27 March 1971; The World Bank, "Tanzania: Kidatu Hydroelectric Project (First Stage): Project Performance Audit Report", (The World Bank: Washington, DC, 1979).

The evaluation team submitted the two companies to TANESCO's authorities: Philip Holzmann of West Germany followed by AB Skanska of Sweden. The assessment committee added that Phillip Holzmann was not only the lowest bidder but also the most technically qualified, and therefore, should be the company contracted. The World Bank contested this decision, as it favoured Holzmann. The Bank insisted that the decision of the evaluation committee should be followed. It was apparent that TANESCO and the Tanzanian government exhibited a strong determination to award the tender to the Swedish consortium, AB Skanska. After a long discussion, the Bank agreed that since the difference between the two firms was small, TANESCO should be free to select one of them. Ultimately, TANESCO chose the Swedish AB Skanska instead of West Germany's Philip Holzmann.[135] AB Skanska started the construction of the Kidatu dam and power plant in November 1971, under the supervision of SWECO, adding 100 MW to the coastal power system in 1975.

Undoubtedly, Tanzania's domestic and foreign policy in the 1960s and 1970s contributed to the exclusion of the West German firm and the approval of the Swedish one. In a letter to TANESCO, Sture Jonsson, the Director of AB Skanska, wrote that: "we would like to point out once again—considering our experience in this field—that we have a special interest in the training of local labour and trust that we can make our contribution to Tanzania where social development of lasting value is concerned."[136] Jonsson asserted further that hydropower building sites were an arena for comprehensive training. It involved diverse occupations in the building industry, such as electricians, welders, different mechanics, and operators, among others. Sweden had long taken advantage of this to re-educate and retrain its people. Jonsson, thus, saw the Kidatu plant as an opportunity to provide training to Tanzanians on various theoretical and practical aspects of electrical power technologies.[137] Jonsson had succeeded in showing in his letter that AB Skanska not only knew the needs of the Tanzanian government but also that it was prepared to support the government's policy of self-reliance and Africanisation programme which involved the training of local people in various technical skills during the implementation of different infrastructure schemes. The aim was to create a class of technicians

[135] Öhman*, Taming Exotic Beauties*; The World Bank, "Tanzania: Kidatu Hydroelectric Project (First Stage): Project Performance Audit Report", (The World Bank: Washington, DC, 1979).
[136] SNA SIDA material File: F13B:1: Sture Jonsson to TANESCO: Great Ruaha Power Project, February 25, 1971; also, a letter from F. S. Batty, TANESCO General Manger, to SIDA, DSM, 3 July 1971.
[137] *Ibid.*

who would maintain and repair the networks after the completion of projects or the expiry of the Western experts' contracts.

SIDA was the architect of AB Skanska's training package. Having worked in the country since the early 1960s in rural water supply projects, SIDA knew Tanzania's priorities. Jonsson acknowledged in his letter that SIDA officials created the "lay-out of a training programme."[138] One can thus fairly argue that Tanzanian government and TANESCO preferred AB Skanska because was more suitable to Tanzania's domestic policy of creating self-reliant society, an important tool in the decolonisation struggles. Moreover, Nyerere was aware that Britain and other former Western colonial powers used their technical aid to extend their neo-colonial influence in Africa and Tanzania in particular. In the same way, countries like Britain were sure that Tanzania would not achieve its socio-economic development and self-sufficiency without employing Western technical expertise. This was evident in 1967 when Tanzania nationalised British enterprise in Tanganyika in implementing socialism and self-reliance policy. The British commentators in London viewed Nyerere as the new "Fidel Castro" of Africa who would seize other people's properties and wealth for his own political benefits. They held the view that many British experts would depart, and Tanzania would face an acute shortage of technical expatriates. Nyerere believed this perspective was unhealthy, and that it was a new form of colonialism.[139]

The imperial competitions and decolonisation politics continued in the second phase of the Great Ruaha Power Project between 1976 and 1981. On 4 December 1973, TANESCO invited proposals for a pre-investment study of the second phase, which involved building the Mtera dam intended to store water and add 100 MW to the Kidatu power plant. The invitation came earlier than planned to avoid blackouts which were anticipated in the mid-1980s if delays occurred. Six engineering firms applied. Three applications came from British firms, another two came from Canadian firms, and one from a Swedish firm.[140] When TANESCO's tender evaluation team finished its work, it ranked all the British enterprises in the top three positions. Ken Long,

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[138] *Ibid.*

[139] UKNA Ref. No. T 317/1020: Statist, *Tanzania: An African Castro?* see also, Arusha Declaration, in UKNA Ref. No. T 317/1020.

[140] SNA SIDA, File No. F13B: 3.Letter from J. S. Kasambala to Electrical Firms, "Great Ruaha Power Project Phase II – Pre-investment study", dated 4 December, 1973; see also, letter from GRPP advisor to TANESCO General Manager, dated 21 March 1974, "Great Ruaha Power Project Pre-investment Study, Proposal for Performing Engineering Services"; also, letter from J. S. Kasambala, TANESCO General Manager to International Bank for Reconstruction and Development, dated 22 May 1974; see also, letter from TANESCO to IBRD, "Great Ruaha Power Project Phase II – Pre-investment Study", dated 22 May 1974.

TANESCO's advisor for the Great Ruaha Scheme, recommended in his technical report that the British firm Kennedy and Donkin in association with William Halcrow and Partners were the most suited to the project.[141]

Long's report mentioned that the basis for the selection of the British firms was based on evidence submitted in the proposals and their technical experience. Thus, the second and the third runners, which were all British firms, could also be considered for the study. Long also stipulated why the assessment committee viewed other companies as unsuitable. He clearly stated that the other three companies, the Shawinigan Engineering Company Limited of Montreal, Acres International Limited of Ontario, and SWECO of Stockholm, should not be accepted because of their technical experience and the poor performance they had exhibited in Phase I of the project. Regarding SWECO, Long wrote: "it is not considered advisable to recommend acceptance of SWECO's proposal. [. . .] Furthermore, the degree of frankness accorded TANESCO by this consultant concerning the management of the Phase I Development has been less than satisfactory. Accordingly, their proposal should be not accepted."[142]

The World Bank questioned TANESCO's basis for such a decision. It should be mentioned that, in the First Phase of the GRPP, AB Skanska had encountered a tunnel design problem resulting in disputes between TANESCO and the consulting engineers, SWECO. TANESCO claimed that SWECO was unable to supervise AB Skanska. The conflict was resolved when the World Bank and SIDA provided funds for experts to redesign the tunnel and the overrun costs.[143] Notwithstanding, TANESCO's General Manager, Jeremiah Kasambala, defended SWECO's position in the second stage. In a report to the World Bank, he emphasised that the experience of the British firms, Halcrow and Partners and Kennedy and Donkin, met TANESCO's and that SWECO's performance in Phase I had "left much to be desired" and that TANESCO considered them for the second stage with "serious reservations."[144] He further noted that the "authorities" considered SWECO because of their vast experience and intimate knowledge of the Great Ruaha.[145]

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[141]SNA, SIDA File No. F13B: 3: Letter from GRPP Advisor to TANESCO General Manager, dated 21 March 1974, "Great Ruaha Power Project Pre-investment Study, Proposal for Performing Engineering Services".
[142] *Ibid*.
[143] Öhman, *Taming Exotic Beauties*, 210; Also, SNA SIDA File F13B: 2. R. Korosso, on behalf of Principal Secretary to the Royal Swedish Embassy, Dar es Salaam, dated 14 November 1973; see also, D. J. Bissland, on behalf of TANESCO General Manager to Charles Mozse, Chief Power Division, IBRD, Washington DC, Great Ruaha Power Project Cost Overrun.
[144] SNA, SIDA File No. F13B: 3: TANESCO report to IBRD.
[145] SNA, SIDA File No. F13B: 3: J. S. Kasambala, TANESCO General Manager to International Bank for Reconstruction and Development, dated 22 May 1974.

Kasambala's response to the World Bank left many technical issues unanswered. For instance, concerning the need for a familiar and experienced company, in the report, the evaluation team had noted historical and technical evidence showing that the British Halcrow and Partners and Kennedy and Donkin had done a commendable job on the Kariba Dam, and they had solid experience of African rivers. Besides, they had been involved in different hydropower surveys in Tanganyika since the colonial period and postcolonial period, such as surveying the *Nyumba ya Mungu* dam in the early 1960s. In addition, the British consortium was composed of British experts who had worked with the British Balfour Beatty & Co, Ltd., TANESCO's in-house consulting company in the 1960s.[146] Therefore, Halcrow and Partners and Kennedy and Donkin were also more well-established and mobilised in Tanzania than SWECO, except that they had not participated in Phase I of the Kidatu project. Moreover, Kasambala did not mention the "authorities" he had referred to in his letter, which required an established firm in the country. The pre-investment and feasibility studies during high modernism were conducted under the pressure of donors and political elites, the recommendations by the evaluation team were neither good enough to offer British firms nor to stop their friendly Swedish companies. In the view of the Tanzanian authorities, TANESCO appointed SWECO to the project and excluded the top three British bidder companies. As McCully asserts, the builders just constructed hydro-dams hoping that everything would go well something which resulted to the absence of geological problems in hydropower building an "exception rather than the norm."[147]

SWECO completed the pre-investment study in 1976. Donors decided to fund this phase by signing financial contract in Washington DC, in 1976. The project was jointly funded by the World Bank (a loan of USD 30 million), Sweden (a grant of 80 million Swedish crowns, equivalent to USD 18.6 million), and the Federal Republic of Germany through the *Kreditanstalt für Wiederaufbau* (60 million German Marks, equivalent to USD 21.2 million), while the Tanzanian government contributed USD 20.2 million.[148] Technologies and experts came from a wide range of countries. The contract for the main civil works went to Strade Coop. from Italy, and all mechanical works to Triveni from India. The civil works at the Kidatu dam went to C. G. Jensen from Denmark, penstocks to Steel Linings, and the gates to Hitachi from Japan. J. M.

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[146]SNA, SIDA, File No. F13B: 3: Letter and report from the GRPP Advisor to TANESCO General Manager, dated 21 March 1974, "Report of analysis of the tenders submitted."
[147] McCully, *Silenced Rivers*, 102.
[148] SNA, SIDA, File No. F13B: 3: Kidatu Power Project second stage appraisal document.

Voith of the Federal Republic of Germany supplied all the turbines and pipes; another West German company, BBC, supplied generators, switchgear, control equipment, and local power lighting. ASEA Kabel, a Swedish electrical manufacturing company, supplied 220-kilovolt cables and transformers to the Kidatu project. Yugoslavia's Ingra/Rade Koncar provided generators, and France's COGELEK supplied 220-kilovolt switchyards to connect lines in Morogoro.[149] Building began in 1976 and was completed in 1981, adding 100 MW to Tanzania's national power grid.[150] The grid's capacity rose from 276 MW to 366 MW in 1976.[151]

2.6 Representing Critical Infrastructure

The criticality of electricity was also evident in the way postcolonial Tanzanian leaders portrayed the building and commissioning ceremonies of hydropower dams. Electricity could circulate goods and services and run machines and industries, crucial to the improvement of the people's and country's socioeconomic welfare. The construction of Tanzania's hydropower dams symbolised a tremendous economic and political achievement. System builders portrayed building sites as places of greater commitment to people's development and welfare – critical infrastructure for propelling people's development. To use McCully's words, they represented electrical infrastructure (hydro-dams) "much more than simply machines to generate electricity and store water. They are concrete, rock and earth expressions of dominant ideology of the technical age: icons of economic development and scientific progress to match nuclear bombs and motor cars."[152] Brian Larkin in a similar vein shows that British colonial rulers in Northern Nigeria used the Kano Water and Electric Light Works not only to show how the colonial project turned the area into a modern state, but also the bright future embedded in the colonial technologies. As a result, opening ceremonies consisted of a special military parade, speeches from significant political figures, both from the local government and abroad, and even fireworks.[153] Electrical lights were tools of public display. They were portrayed to have power

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[149] Öhman, *Taming Exotic Beauties*, 212; SNA SIDA File F13B:9: Sten Lööf, "Report: A Survey of Swedish Assistance to the Energy Sector in Tanzania 1967-1980".

[150] Öhman, *Taming Exotic Beauties*, 137; SNA, SIDA File No. F13B: 4 and File No. F13B: 5: *Uhuru*, "*Mwalimu Kufungua Mpango wa Kidatu* Nov. 14," 30 October 1975.

[151] EAF-UDSM Library: *Jamhuri ya Muungano wa Tanzania: Mpango wa Kwanza wa Muungano wa Maendeleo ya Miaka Mitano 1981/82–1985/86*; The World Bank, "Evaluation Summary of the United Republic of Tanzania's Project Completion Report", 29 November 1993, 2.

[152] McCully, *Silenced Rivers*, 3.

[153] Brian Larkin, *Signal and Noise: Media, Infrastructure, and Urban Culture in Nigeria*, (Durham and London: Duke University Press, 2008), 19.

to overcome the darkness of night and turn urban places into broad daylight—progress and a new future brought by the benefits of colonial rule. According to Larkin, these were not only spectacular and political rituals that intertwined colonial rule and technological infrastructure in the colonial world but were also "a new sort of authority located in technology as visible evidence of progress."[154]

Likewise, in postcolonial Tanzania, electricity infrastructure were beyond technical artefacts that produced electrical lights and power. As shown during inauguration, the actual building, and opening ceremonies, hydropower infrastructure represented modernity and legitimised leaders' authority and power. They showcased the disparities between colonial underdevelopment and postcolonial leaders' deliberate development and modernisation initiatives. The of power systems represented deliberate efforts and the ability of the state to promote human advancement. For instance, Miescher highlights how President Kwame Nkrumah used the Volta hydropower project and the building of Akosombo hydro-dam in Ghana in the 1950s and 1960s for representing postcolonial nationhood, modernity, and development. Nkrumah described the Volta hydropower project in these words: "Major projects such as the Volta are the new 'places of Pilgrimage' in this Modern Age of Science and Technology. They serve as monuments to the determination and dedication of a whole people to raise themselves to a fuller and a richer life." Nkrumah urged the Members of the National Assembly to regularly visit the construction site at the Akosombo since it carried the "message of hope and growth" of the nation."[155]

In Tanzania, like elsewhere in postcolonial Africa, inauguration, and commissioning ceremonies of hydropower dams represented political determination and the commitment of leaders to electricity as a critical infrastructure for progress, modernity, and development. The commissioning of the Hale Hydropower Scheme in 1964 represented hydropower dams as a political and technological celebration of postcolonial achievement and its collaboration with former colonial master, Britain. Nyerere said in his inauguration speech:

> Schemes such as this one [Hale hydropower plant] are in fact the bricks and mortar evidence of the revolution which our country is deliberately and purposefully undergoing. It represents the application of science to the needs of the people. And it does this in such a way that our whole country takes further steps out of the poverty which imprisons it. For this hydro-electric

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[154]*Ibid*.

[155] Miescher, Stephan F. "'Nkrumah's Baby'': the Akosombo Dam and the Dream of Development in Ghana, 1952–1966" *Water History* 6 (2014): 341–366, 342.

> station is an example of the combination of brains, scientific knowledge, sweat and discipline which will in practice transform our nation.[156]

Nyerere's words in this quote reveal the high modernism ideology of the post-WWII era when the application of technological and scientific knowledge in transforming human communities was at its peak. The British scientific knowledge used in building the Hale plant was a solution to Tanzania's inherited colonial poverty that the country was determined to alleviate. One of the central points to note in this quote is that Nyerere's words did not only touch on technology and knowledge but also on the essence of building the Hale hydropower plant. The Hale was a critical infrastructure as it could 'transform' the nation and meet the 'needs of the people'—thus, reduce poverty.

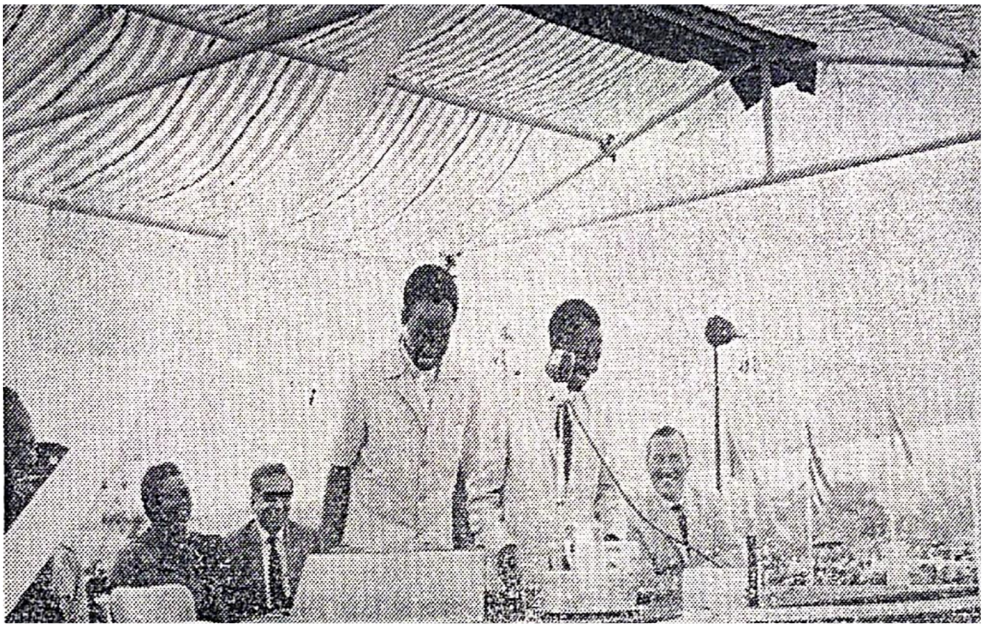

Figure 2.3: President Nyerere (standing left) at the opening of the Hale Hydropower Plant
Source: *The Nationalist*, 26 September 1966

The inauguration and openings ceremonies of the Great Ruaha hydropower project also represented how critical electricity technology was to the postcolonial leaders' envisioned state development. Wilbert Chagula, the Minister for Water Development and Power, inaugurated the main civil works in November 1971 by blasting a 3000-metre cubic rock. Tanzanian newspapers represented this event in various headings such as "Ruaha Project Blasts Off,"[157] and "First moves at Ruaha."[158] The blasting of the rock symbolised the blend of technologies

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[156] Hoag and Öhman, "Turning Water into Power", 632; Hoag, *Developing Rivers in East and West Africa*, 180.
[157] *Sunday News*, "Ruaha Project Blasts Off", 24 November 1971, in SNA, SIDA materials File No. F13B: 1.
[158] *The Standard, "*First Moves at Kidatu", 26 November 1971, in EAF-UDSM Library.

and political motives in addressing Tanzanian postcolonial problems (rocks of underdevelopment). Just as Nkrumah called for people to visit the Akosombo construction site regularly, Chagula also urged TANESCO officials and the Swedish contractors to arrange for President Nyerere to visit the construction sites in the early stage of development. Throughout the building period, Tanzanian government newspapers continued to represent the project as an outstanding achievement of the socialist government. The public display continuously mentioned the costs of construction, the skills, knowledge, and technologies that were used—the application of complex, "intricate and sophisticated" technologies.[159]

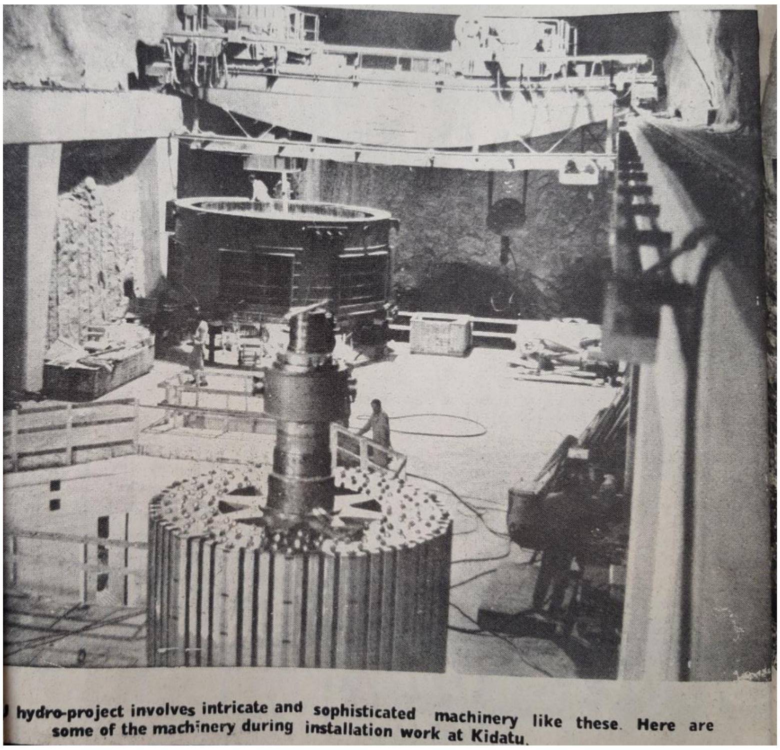

Figure 2.4: The public display of Kidatu as a place of "intricate" technologies in the 1970s.
Source: Daily News, 14.11.1973, in SNA, Sida File No. F13B:1

The construction of the Kidatu dam and installation of electrical machineries took about four years and the builders commissioned it in 1975. The country's president, Julius Nyerere, officiated the ceremony, which was attended by political dignitaries, representatives from different multinational companies, the president of the SWECO board, the main contractor (AB Skanska), and TANESCO top officials. As Öhman describes it, Sweden had a special place as the donor of the project. Its "flag had been placed in the place of honour—closest to the

[159] *The Standard*, "Kidatu power to boost economy", *Maelezo* staff writer, 27 March 1971; *Daily News,* "Kidatu project will take electricity to villages", 19 September 1973, in SNA SIDA material File: F13B: 2.

Tanzanian one,"[160] symbolising Swedish partnership and support to Tanzania's socialist developments. During the ceremony, Tanzanian school children sang that electrical power from the "plant will spread so much light over Tanzania that all opponents of the socialism will be visible!"[161] The Tanzanian government viewed the Kidatu infrastructure as a tool for breaking the 'prisons' of unfreedoms and capitalism.[162] Similarly to the inauguration of the world's first major dam, Dneprostroi, where the chief engineer stated the dam was a foundation for socialism and "what the Bolsheviks can do!",[163] As Winner has aptly asserted that artefacts have politics, Kidatu was a tool for Tanzania's socialism, a departure from former imperial powers.[164]

The representation of large hydropower projects was not just in showcasing the postcolonial leaders' power, commitment, and determination but also the criticality of electricity to development. Taking the postcolonial discourse and the ways system builders displayed electrical schemes, electricity and their vital role in the development process shaped the representation of large power infrastructure. They displayed the schemes because they were vital. They could power and modernise cities, factories, rural communities, improve the provision of social services, and above all power other critical infrastructure in urban and rural areas. For instance, the builders of the Kidatu constantly explained how the project would make the coastal power grid resilient, promote industrial growth in Dar es Salaam, Arusha, Moshi, and the Southern Highlands in Mbeya and Iringa, power socialist villages, and enhance the building of the Tanzania-Zambia Railway in the 1970s.[165] As Larkin argues, we should not be obsessed by political intentions but rather analyse the technical part of technological infrastructures. The political intentions cannot completely change the technical role as he contends that "because technologies have their own material shape and design, they can never fully be reduced to the intentions with which they were constructed."[166] The symbolic representation of large power infrastructure served to display the critical role of electricity in the development process and how the collaboration between international donors' funds, technologies, and political leaders' commitment was vital to achieving the desired ends.

[160] Öhman, *Taming Exotic Beauties,*132.
[161]*Ibid*.
[162] *Ibid.*
[163] McCully, *Silenced Rivers*, 240.
[164] Langdon Winner, "Do Artifacts Have Politics?" *Daedalus*, 109, no. 1 (1980):121-136, 121-24.
[165] *Uhuru Newspaper*, "*Mwalimu Kufungua Mpango wa Kidatu* Nov. 14", dated 30 October 1975, in SNA, SIDA material File No. F13B: 4; see also File No. F13B: 5; Öhman, *Taming Exotic Beauties*.
[166] Larkin, *Signal and Noise*, 20.

2.7 Centralising Systems: Creating a Resilient National Grid

Developing power infrastructure in Tanzania in the 1960s to 1990s did not involve the building of power dams only but also transmission lines. Indeed, transmitting electricity to users is always the ultimate vision of electrical power system builders. It is what defines the technicalities and economics of electrical power schemes. Hughes has shown that power lines are not mere technical monuments, but order how we live every day by embodying complex economic, political, and social "objectives of modern men and women."[167] Hughes argues that it was the inventive and innovative minds, technological problems and engineering solutions, as well as business and entrepreneurial motives that pushed developers of the early power networks to create large, interconnected regional systems.[168] Ronen Shamir also upholds the non-neutrality of electricity lines. He points out that electrical lines shape group formation and play an active role in the performativity of social asymmetries. Whenever constructed, electrical power lines "shape areas and regions and other spatial formations; and actively assemble, sustain, and enable taken-for-granted categories and dichotomies such as the private and the public sphere."[169]

Tanzania's transmission systems were not meant just to transmit electricity from generating plants to users, but to take strategic production to different areas in consonance with plans for socioeconomic development. They involved laying down large systems of towers and wires to serve the flow and circulation of electrical energy and connect various productive activities in the country. We saw above that when the British left the Tanganyika Territory, the existing power infrastructure was small and isolated and that Tanzania had formed two electricity grid systems by the end of the 1960s: the coastal grid built in 1964 to connect the Tanga, Morogoro, and Dar es Salaam regions, and the northern grid built in 1969 to connect the Arusha and Kilimanjaro (Moshi) regions.

Interconnecting these two main power supply systems by building a 220-kilovolt line from Kidatu to Dar es Salam to form a unified national network was one of the components of Phase I of the Great Ruaha Power Project. But the World Bank and Swedish funds for the Kidatu project did not cover the cost of the line; hence, TANESCO and the government turned to the

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[167] Hughes, *Networks of Power*, 1.

[168] Thomas P: Hughes, "The Electrification of America: The System Builders", *Technology and Culture*, 20 no. 1 (1979), 124-161.

[169] Ronen Shamir, *Current Flow: The Electrification of Palestine* (California: Stanford University Press, 2013),3.

Canadian International Development Agency (CIDA) for assistance.[170] Canada had funded and built several electricity transmission infrastructures in Tanzania in the past. They had funded and constructed a 66-kilovolt transmission line from Chalinze to Morogoro and from the *Nyumba ya Mungu* power plant to Arusha in the 1960s.[171] On 31 January 1973, Tanzania and Canada signed a technical and economic funding contract wherein Tanzania's Minister for Finance, Cleopa David Msuya, represented Tanzania, and J. R. Barker, the Canadian High Commissioner, represented the Canadian government. The contract offered a loan of 91 million Tanzanian shillings to cover all imports of electrical materials and services from foreign companies.[172] Canadian engineers from Comstock, Quebec, were the contractors and they were supervised by Shawingan Engineering, another Canadian firm.[173] The building of a 300-kilometre line started in 1973 and reached Dar es Salaam in March 1975.[174]

Before the injection of the Kidatu hydroelectricity to the coastal system, Dar es Salaam faced frequent power outages, affecting industrial production in the country. It was estimated that about 55 per cent of industries in Tanzania were affected by power cuts between 1971 and 1974 due to failure of thermal plants, and lack of oil spare parts.[175] The line improved the resilience of power supply in the coastal power grid.[176] It also added to the capacity of the grid and created backup systems, since the thermal plants operated as emergency reserves and improved supply voltage during peak loads, as well as the grid's capacity to withstand external shocks (breakdowns) and deficiencies. It also replaced poorly operated thermal plants in Ubungo, Dar es Salaam. The shutdown of thermal plants saved the "country's foreign exchange reserves" by reducing diesel consumption, which was estimated at 500,000 litres per month.[177] The World Bank estimated that the line reduced thermal electricity generation from 247

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[170] See also, *Jamhuri ya Muungano wa Tanzania, Hotuba ya Waziri*, 1978/79, 28; SNA, SIDA File No. 1 TAN 32.1: F13B: 2: Press release from the Information Services Division, Ministry of Information and Broadcasting, 31 January 1973.

[171] *The Nationalist*, 27 January 1967; TANESCO Directors' and Account Report, 1965, 5 and 1966, 5; also, Öhman, *Taming Exotic Beauties*, 209.

[172] SNA, SIDA File No. 1 TAN 32.1: F13B: 2: Press Release from the Information Services Division, Ministry of Information and Broadcasting, 31 January 1973, in; *Daily News*, "Tanzania gets 231m/- loan", February 1973.

[173] *Daily News*, "Tanzania gets 231m/- loan", February 1973.

[174] *The Nationalist*, "Tanesco Great Ruaha Power Project", 19 November 1971; *Daily News,* "Work on Kidatu, Dar Power line starts", 7 November 1973; EAF-UDSM Library: The United Republic of Tanzania, *Hotuba ya Waziri wa Majina Nguvu za Umeme*, 1974-75, 16-17.

[175] Samuel Wangwe, (1977: 69) as cited in Coulson, *Tanzania: A Political Economy*, 234.

[176] *Daily News*, "Dar to get Kidatu power next month,"7 March 1975.

[177] *Ibid*.

Gigawatt-hours (GWh) in 174 to 106 GWh in 1977.[178] The second step towards the development of Tanzania's national electricity grid was the building of a 132-kilovolt transmission line from the Hale power plant in the Tanga region to the *Nyumba ya Mungu* hydropower plant in the Kilimanjaro (Moshi) region.[179] Canadian engineers started building the line in 1974 with financial support from the Canadian International Development Agency (CIDA). They installed about 286 electrical towers in about 270 kilometres. The line reached Moshi in 1975. This marked the first move to the integrating electrical systems in six regions, such as Arusha, Dar es Salaam, the Coast, Kilimanjaro, Morogoro, and Tanga, forming the interconnected network (the modern-day national electric grid).[180]

The interconnections of the northern and coastal grids to form Tanzania's national power system, like elsewhere, it was based on the need to enlarge the resilience of the power networks;[181] reduce breakdowns and cost of electricity generation. This was a common strategy which was used in Western cities, nations, and power utilities. For instance, Lagendijk and Erik van der Vleuten expound that, European planners, economists, engineers, and politicians celebrated the interconnections among European power networks in the 1960s and 1970s, believing euphorically that they would become more resilient (reliable) by ensuring "a remarkably high degree of service reliability."[182] In a similar vein, Nye upholds that in the 1920s and 1930s, managers, engineers, and economists of power utilities in Northern America interlinked their systems to form regional networks to solve economic and technical challenges. When one company failed to generate the required amount, other utilities stepped in to make sure that consumer supply is not interrupted, and companies have power reserves.[183] Nye writes: "Before then, a power station that suffered an accident or one that was struck by lightning might stop producing electricity for a long period. For example, the utility company in Hartford lost power on June 5, 1890, and did not restore full service until late autumn. From such experiences, engineers quickly discerned the advantages of linking systems into regional

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[178] The World Bank, "Tanzania: Kidatu Hydroelectric Project (First Stage): Project Performance Audit Report", (The World Bank; Washington, DC, 1979), 3; The World Bank, "Appraisal of the Kidatu Hydroelectric Project of Tanzania Electric Supply Company Ltd. Tanzania," (The World Bank; Washington, DC, 1970).

[179] Tanzania, Second Five-Year Plan for Social and Economic Development, 1969-1974.

[180] *Daily News*, "Power supply to be centralised", 25 October 1974; *Daily News*, "Kidatu Power phase one completed," 14 November 1975.

[181] Hughes, *Networks of Power*, 332.

[182]Vincent Lagendijk, and Erik van der Vleuten, "Inventing Electrical Europe: Interdependencies, Borders, Vulnerabilities", in *The Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities*, edited by Per Högselius, Anique Hommels, Arne Kaijser, and Erik van der Vleuten, (London: Macmillan, 2013), 79.

[183] David Nye, *When the Lights Went Out: A History of Blackouts in America* (Mass: MIT Press, 2010), 16.

networks."[184] Nye highlights further that the welding of different power plants and systems together improved the resilience of power networks in North America, by providing "security against breakdown, both of lights, and traction lines." He notes that "power outages declined sharply," even though they would later lead to huge cascading blackouts.[185] Systems builders held the believe that the merging of Tanzania's isolated electrical plants to form national networks would make generation units benefit each other. Through interconnection, "all reliable thermal plants should be kept in service as reserve plants and to firm the production from hydro plants."[186]

Tanzania's national electricity grid was formed in 1975 and connected all of Tanzania's large hydropower plants, such as the Hale (21 megawatts), Pangani Falls (17.5 megawatts), *Nyumba ya Mungu* (8 megawatts), Kikuletwa (1.2 megawatts), and Kidatu (100 MW), as well as other electricity generation sources, namely thermal plants. The reasoning was that a national grid would enable the implementation of any electrical project anywhere in the country and easily transmit electricity to areas of high demand.[187] Additionally, it would reduce the cost of thermal plants and strengthen power supply. This was particularly important in the 1970s following the world oil crisis which made Tanzania's isolated power systems vulnerable due to the import of insufficient petroleum products to Tanzania. The isolated systems in other regions which depended on thermal diesel and heavy oil fuel suffered from frequent blackouts. In one of the proposals to extend the interconnected network to the north-western regions in Tanzania, the planners noted:

> The possible extension of the coastal [national] grid to the northwest and the southwest would considerably strengthen the Tanzania electricity supply system. Hydropower production in any other regions could be utilized to reduce expensive thermal production in the hitherto isolated systems at the same time the thermal plants already installed in the isolated systems could serve as reserve plants both for draughts [sic!] periods in the hydro-plants and for eventual breakdowns.[188]

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[184] *Ibid*.
[185] *Ibid.,* 17.
[186] EAF-UDSM Library: TANESCO, Tanzania Power Sector Study, by Acres International Limited, Unpublished Draft Report–February 1978. also, SNA, SIDA File F13O:1: Tanzania Power Sector Study: Comments on Acres Draft Final Report–February 1978, by Sven Lalander and Allan Mauritzon, September 1978.
[187] *Jamhuri ya Muungano wa Tanzania, Hotuba ya Wairi wa Maji, Nishati na Madini* katika *Bunge la Jamhuri ya Muungano wa Tanzania akitoa Makadirio ya Matumizi ya Wizara ya Maji, Nishati na Madini 1987/88*.
[188] SNA, SIDA File F13O:1: TANESCO, SIDA, Tanzania Power Sector Study: Comments on Acres Draft Final Report–February 1978, by Sven Lalander and Allan Mauritzon, September 1978.

The Swedish engineering firm which built most of Tanzania's hydropower plants in the 1970s, likewise, believed that the extension of the interconnected grid "will contribute towards reducing the risk of power shortage."[189] Per Ake Nordström and Joran Vedin, SWECO's consulting engineers in Stockholm, explained how interconnecting the coastal and northern grids would improve the reliability of power networks. They explained that interconnecting the grid would:

> . . . ensure the supply even at breakdowns or stand-stills due to maintenance, it is necessary to include a certain amount of space capacity in the system. Throughout the calculations, it has been considered that the capacity shall be sufficient for meeting the maximum load even if the largest hydro unit may be out of operation, and at the same time the available thermal power is reduced to 90 per cent of the installed capacity.[190]

Indeed, improving grid resilience was central to planning and extending electrical transmission lines. As this quote unveils, the expansion of electricity to the north-western regions of the country would not only reduce the cost of running thermal plants but also reduce power outages that were happening due to the shutdown of thermal plants during repair and maintenance. As we will discuss in Chapter 3, repair, and maintenance were one of the main causes of erratic power supply in Tanzania's cities.

As Shamir affirms that grid lines "transcend the boundary they have just established and expand beyond it through outreach to yet unconnected areas or attachment to a neighboring grid,"[191] Tanzania grid after being formed and shaped by different factors expanded to new areas in the 1980s and 1990s. TANESCO extended the interconnected network further to the north-western regions in the 1980s to maximise reliable power supply to consumers.[192] The company also interlinked new regions in the Southern Highlands (Iringa, Mbeya), the central regions (Dodoma and Singida) through a 220-kV transmission line, and the north-western regions in the 1980s (Shinyanga, Mwanza and later Mara and Kagera) through a 132-kV transmission line. These lines were the backbone of the national electricity supply and economic

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[189]Swedish Consulting Group, Consulting Engineers, Architects and Economists, SWECO: Tanzania Power Sector Study: Some Comments on the Draft Final Report Prepared by Acres International Ltd. in SNA, SIDA Materials File F13O:1.

[190] SNA SIDA File F13B: 3: Per Åke Nordström and Joran Vedin, SWECO consulting engineers, Memorandum to Great Stockholm, dated 29 August 1972.

[191] Shamir, *Current Flow,* 1-2.

[192] EAF-UDSM Library: TANESCO, Tanzania Power Sector Study, by Acres International Limited, Unpublished Draft Report, February 1978; Also, SNA, SIDA File F13O:1: Tanzania Power Sector Study: Comments on Acres Draft Final Report–February 1978, by Sven Lalander and Allan Mauritzon, September 1978.

development in the 1970s and 1980s.[193] The extension to these regions was done after the completion of the second stage of the Great Ruaha Power Project, which added 100 MW to the national interconnected grid in 1981. A 132-kilovolt line reached Mwanza in 1988 and was extended to Tabora and Mara after the commissioning of the Mtera power plant in 1988.[194]

The extension of Tanzania's electricity grid connected and splintered different regions and districts in the country because this process was deeply shaped by socio-political concerns such as material configuration, economic production, and ideological and political arrangements. Erik Van der Vleuten and others contend that historians of technology need to embark on a broader investigation of the historical forces which rejected "who they by-passed" and connected "who they thought."[195] Historians need to think about "when, by whom, and for what reasons infrastructure was made to connect and splinter."[196] By and large, the power grid's splintering of regions was intended to facilitate the implementation of the Five-Year Plan for Social and Economic Development, especially the promotion of a basic industrial production policy and Tanzania's socialism. For instance, the government extended the interconnected grid to the Southern Highlands to power the planned new industries such as the Mufindi paper and pulp industries, farm implements, gas containers, oxygen, leather, the SIDO Factory and National Milling Corporation.[197] The extension of the network to this region would also industrialise "the Mbeya Region" which was planned for industries, for instance, cement materials, coal fields, niobium and apatite mines, processing of pulp and timber, wheat mills, electric pumps, etc."[198]

In the 1980s, the Tanzanian government also extended the grid to lake-side towns like, for example, Mwanza and Kagera, because the Tanzanian government planned to establish and expand about 28 industries, among which the aluminium industry, bricklaying, cement plants, and tile manufacturing industries to enlarge construction activities between 1985 and 1990. It also planned to build industries, such as farm implements, textile mills, ginneries, breweries, dairy farms, and meat processing as well as boost production of the primary productive sector, such as livestock, natural resources, mining, and agricultural processing as a corrective measure

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[193] Energy Master Plan and Programme (1990–2005), (The Ministry of Water, Energy and Minerals, 1991, 2).
[194] TANESCO Master Plan 2012: Updated Version, (The URT, Ministry of Energy and Minerals, 2013).
[195] Van der Vleuten, Högselius, Hommels and Kaijser, "Europe's Critical Infrastructure and its Vulnerabilities", 9.
[196] *Ibid*.
[197] See, for instance, TANESCO, Tanzania Power Sector Study by Acres International Limited, January 1981; also, TANESCO, "Power Sector Development Plan 1985 to 2010," Main Report by Acres International Limited, Dec. 1985.
[198] The United Republic of Tanzania, The Second Five-Year Plan for Social and Economic Development, (Dar es Salaam, 1969), 75; 123.

to previous industrial plans that had dominated in the import-substitution industries in urban areas.[199]

Tanzania's national electricity networks portray continuities rather than breaks with colonial electricity provision, as Figure 2.5 reveals. While the postcolonial government wanted to broaden electricity services, it continued to exclude many people and places as the networks followed economic production trajectories much like in the colonial period. As Hasenöhrl points out, transmission lines passed overhead of many rural people to power distant industrial and profitable places, and the grid supplied electricity to those economically lucrative areas while leaving many towns without electricity or dependent on isolated systems.[200] Moreover, urban areas continued to grow more as dominant power users than the rural areas because TANESCO's systems largely followed the previously established colonial power markets and rationale. For instance, Dar es Salaam continued to consume about 50% of all electricity generated in 1989. Collectively, towns and cities connected to the Tanzanian interconnected system, such as Tanga, Moshi, Arusha, Mwanza, Iringa, Shinyanga, and Dar es Salaam consumed about 87 per cent of the electricity generated in the late 1980s.[201]

Generally, the extension of hydroelectricity transmission lines in Tanzania reveals the fusion of strategic attempts to power the postcolonial economy, reduce the costs of electricity generation, and make the grid more resilient. In connection with the national socioeconomic development plans, the interconnected national grid expanded considerably between the mid-1970s and the early 1990s. TANESCO aimed to connect the whole country to the national power grid. By the early 1990s, the interconnected grid was able to generate 261 of the 313 megawatts installed. Hydroelectricity from the Great Ruaha (Kidatu plant 280MW) and the Pangani River (*Nyumba ya Mungu*, Hale, and Pangani Falls) contributed 244 megawatts, about 80 per cent of the whole system.[202] The interconnected national grid had covered many regions in the country. However, the transmission systems remained in the regional and district administrative centres and productive areas rather than in people's homes and rural areas. In 1995, only six regions in Tanzania, Ruvuma, Rukwa, Kagera, Kigoma, Lindi, and Mtwara, were not part of the integrated

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[199] The World Bank, "Staff Appraisal Report: Tanzania Power Rehabilitation Project", (The World Bank; Washington, DC, 1986).

[200] Ute Hasenöhrl, "Rural Electrification in the British Empire," *History of Retailing and Consumption*, 4 no. 1 (2018): 10 – 27, 19.

[201] Björn Kjellström, Maneno Katyega, Henry Kadete, Dolf Noppen, and Abu Mvungi, *Rural Electrification in Tanzania: Past Experiences – New Approaches*, (Stockholm Environment Institute, and Energy, Environment and Development Series No. 15, 1992), 42.

[202] SNA SIDA File F13O: 7: Rufiji Basin Hydropower Master Plan.

national electricity system. It was estimated in the 1990s that interlinking the remained regions would take 13 years from 1993 to 2005.[203]

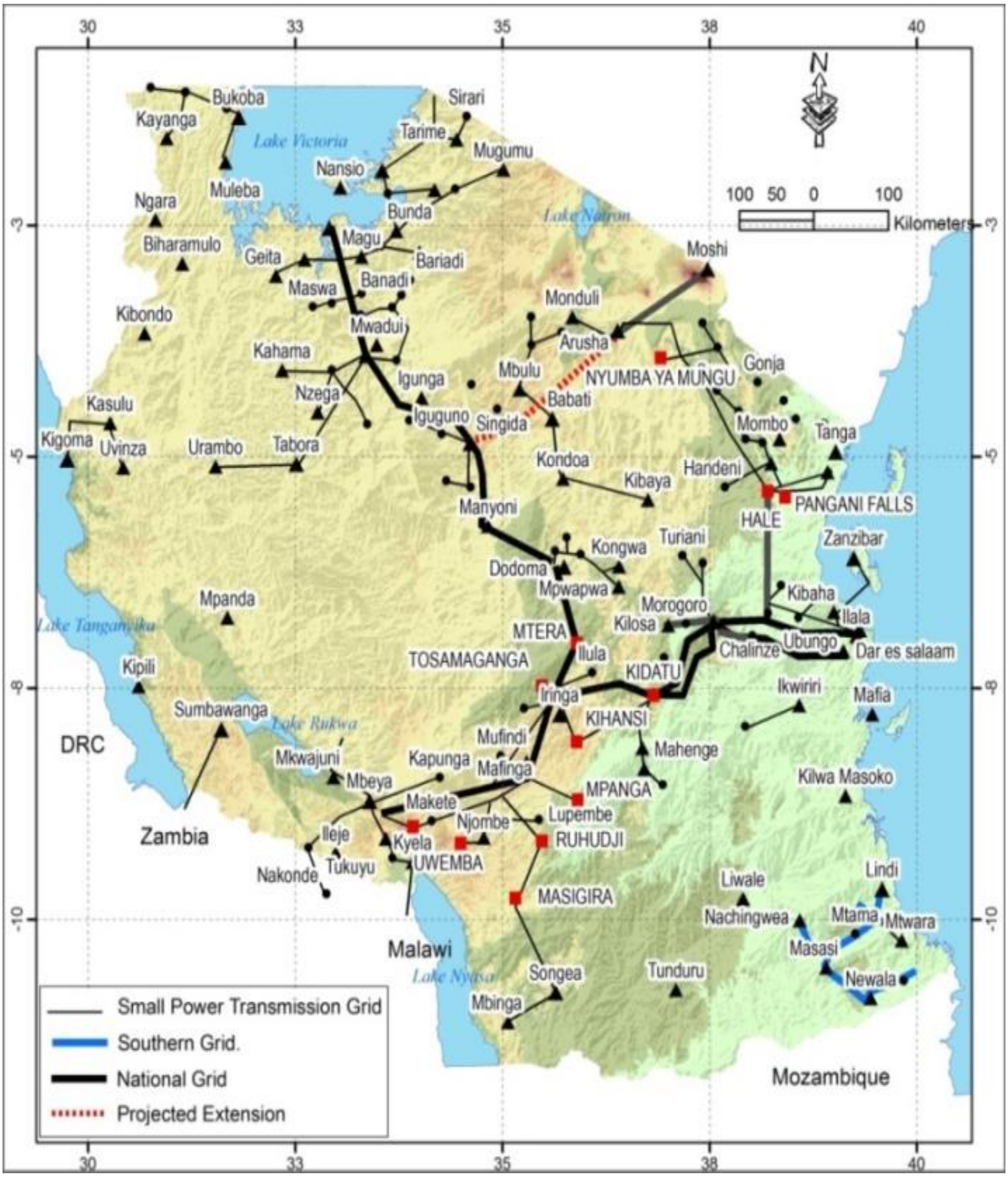

Figure 2.5: The Tanzanian National Power Grid in 1995
S**ource:** Modified from Edward Marandu *et al*., (1999), 68.

[203] Energy Master Plan and Programme (1990–2005), (The Ministry of Water, Energy and Minerals, 1991), 15.

2.8 Conclusion

This chapter has shown the ways electrical power networks developed in the postcolonial period between 1962 and 1995. Both rhetorically and in practice, electricity became the most critical infrastructure for development and the grid reached higher levels of interconnectedness during this period than in the colonial period. Unlike the colonial period, the building of power infrastructure was largely shaped by the Cold War and decolonisation politics, and it involved more bilateral and multilateral donors and agencies. This led to competition among the Western developed states to export capital and technologies to the new postcolonial states. By and large, three actors shaped the process of electrification during this time: the Western donors through their development cooperation agencies, Western experts, and the Tanzanian state politics of development and freedom. The combination of these system builders led to investments from multi-million donors in hydroelectric power schemes that transformed TANESCO from dependence on thermal electricity technologies to dependence on hydropower in the 1990s. Transmission lines expanded considerably in keeping with national social and economic plans. TANESCO, the national electrical power company, became more administratively linked to the national government, rather than a utility with economic and technological independence. These developments reveal how electricity was critical to postcolonial socioeconomic development in the country. Chapter 3 will examine how different political, economic, and technological aspects in the building of hydropower plants in the 1960s – 1980s influenced electricity grid vulnerabilities from the 1980s onward.

CHAPTER THREE
WHAT WENT WRONG? TANESCO's POWER SYSTEM VULNERABILITIES, 1980s–2000s

3.1 Introduction

The preceding two chapters have focused on the building and expansion of power networks in the colonial and postcolonial Tanzania. A few existing studies on the failures of Tanzania's electricity system have explained power failure crisis in Tanzania by focusing on corruption, low government investment in activities such as repair and maintenance, poor utilities management, and the 1990s and 2000s failed electricity reforms.[1] They have not taken a historical approach, hence, they have narrowed recent power failures to the contemporary issues rather than broader national and global socioeconomic and political trajectories since independence. Historians of technology, Per Högselius, Anique Hommels, Arne Kaijser, and Erik van der Vleuten contend that, the vulnerabilities of critical infrastructures "did not fall from the sky, nor did they emerge mysteriously from a vague and abstract process", but they have a "long, very concrete, and traceable history." They note further that we need a "careful and reflective historical examination" of the concerns, choices, priorities, and conflicts of the system builders (their makers) to understand vulnerabilities of technical systems.[2] The present chapter uses the notion of vulnerability to examine forces that influenced breakdowns of TANESCO's systems to contributes to the existing studies that comprehensive understanding of frequent grid breakdowns needs historical approach. Power failures are historical. The concept of critical infrastructure vulnerability which this chapter employs is defined in two levels; the susceptibility to failure of technological systems (system vulnerabilities); and the impact of such failures on societal functions (user vulnerabilities). The current chapter deals with system vulnerabilities ranging from accidental, large, and small-scale blackouts and to day-to-day localised intentional

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[1] For an overview of this perspective, see, for instance, Rebecca H. Ghanadan, "Public Service or Commodity Goods? Electricity Reforms, Access, and the Politics of Development in Tanzania", (PhD Diss.: University of California Berkeley, 2008); S. Karekezi and J. Kimani "Status of power sector reform in Africa: Impact on the poor," *Energy Policy* 30 (2002): 923–945; Degani "Time, Ethics, and Electricity in Postcolonial Tanzania, 177–192; Gray, "The Political Economy of Grand Corruption in Tanzania," 382–403; Godinho and Eberhard, "Power Sector Reform," available at: edi.opml.co.uk/resource/tanzania-institutional-diagnostic-chapter-77, accessed on 27 June 2021; Eberhard and Godinho,"A Review and Exploitation of the Status," available at: https://escholarship.org/uc/item/11k4210h, accessed on 27 June 2021.

[2] Erik van der Vleuten, Per Högselius, Anique Hommels, "Europe's Critical Infrastructure and Its Vulnerabilities – Promises, Problems, Paradoxes", in Per Högselius, Anique Hommels, Erik van der Vleuten and Arne Kaijser, (eds), *The Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities*, (London: Macmillan, 2013),5 - 8.

and unintentional power cuts. The concept vulnerability is applied in this chapter as an analytical too that helps to assess and explain the flaws and weakness of infrastructure systems; it tells why a certain infrastructure fails whether from forces outside (weather and climate catastrophes), forces within (normal accidents and cascading failures), or socio-cultural factors (community actions, terrorist acts, and vandalism).[3] It, thus, examines the extent to which Tanzania's socioeconomic and political history cultivated the vulnerabilities of the power infrastructure experienced in the country since the 1980s. We saw in the preceding chapter that the building of power infrastructure in Tanzania between the 1960s and 1980s was shaped by western donors' competitions to export finance and technologies, as well as by the high modernisation ambitions of postcolonial socialist leaders. This chapter delves into analysing how the imperial and technological decisions of the funders and builders of power networks as well as postcolonial states cultivated the vulnerabilities of Tanzania's power systems.

To a large extent, this chapter builds on May-Britt Öhman's work which shows inappropriateness of technology transfer during the planning and construction of the largest Tanzania's interconnected hydro-dams in the 1960s to 1980s and how it overlooked some scientific procedures, resulting to power failures in the 1990s and 2000s. It extends her work by integrating discussions about Tanzania's economic recession of the late 1970s and 1980s, foreign lobbyist companies, and the economic and technological overdependency. The Chapter illustrates that whilst donors and developmentalists in the high modernism era represented the transfer of technologies from the North and South as a panacea to the perceived as the postcolonial economic and technological backwardness, the transferred technologies turned to become a source of problem. The motives and styles of transfer did not go through strict regulatory scrutiny and the legal framework discouraged adaptation of imported technologies to local contexts. These conditions created financial and technological dependence on Western expertise and equipment in the day-to-day functioning of power systems. The chapter argues that "techno-economic" politics of technologies experienced in the postcolonial development discourse and the ultimate everyday circulation of technologies between the Global North and South, and South to South are significant in understanding the vulnerable condition of

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[3] For an overview of the literature on the vulnerability of 'critical infrastructure', see, for instance, Jens Ivo Engels (ed), *Key Concepts for Critical Infrastructure Research*, (Springer VS, 2018); Gilberto C. Gallopin, "Linkages Between Vulnerability, Resilience and Adaptive Capacity," *Global Environmental Change*, 16 no. 3 (2006), 293–303; Matthew Jude Egan, "Anticipating Future Vulnerability: Defining Characteristics of Increasingly Critical Infrastructure-like Systems," *Journal of Contingencies and Crisis Management* 15, no. 1 (2007): 4–17.

infrastructure in postcolonial Tanzania. Hence, it extends the concept of vulnerabilities from the interconnectedness and interdependencies of technical systems to the circulation of technologies between donors and recipients and the dependency they create.

3.2 A Snapshot of Tanzania Economic Slump and the Grid in the 1970s-1980s

As shown Chapter 2, the Tanzanian government in collaboration with western donors invested heavily in the expansion of electricity infrastructure between the 1960s and 1980s. They built large hydroelectric power dams, high extension lines, and installed thermal power plants in Dar es Salaam to expand electricity provision beyond colonial enclaves and to promote development. Hydropower grew as the dominant electricity generation technology in the 1960s – 1980s, adding about 300 megawatts (MW) in the national grid between 1964 and 1988. Undoubtedly, system builders expected a stable power supply in the country particularly after the completion of the Great Ruaha Power Scheme in the late 1980s. Contrary to their expectations and the heavy investment made in power infrastructure, Tanzania's electrical systems functioned more precariously in the 1980s than at any other time before. The World Bank report on the technical operation of TANESCO's infrastructure noted the utility's poor performance that Dar es Salaam alone experienced about five hundred blackout incidents between 1981 and 1983. It commented further that even though the utility had injected all its emergency power reserves and introduced power shedding of major consumers in Dar es Salaam, power outages and low voltage were still high, and frequency and their duration were expected to grow throughout the 1980s.[4]

Beyond Dar es Salaam, Tanzanian cities and towns connected to the national power grid also remained without electricity for long hours or several days. The situation was alarming and jeopardised utility's equipment, consumers devices, and the national economy at large. Electricity users in industries, business and commercial areas, public offices, and households were affected by frequent power disruptions. The provision of other essential infrastructure services such as water supply and health services were also curtailed especially in major electricity consuming cities such as Dar es Salaam, Moshi, and Arusha.[5] Power failures also

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[4] The World Bank, "Staff Appraisal Report Tanzania Power Rehabilitation Project," (The World Bank: Washington, DC, 1986), 9; The World Bank, "Tanzania Power Loss Reduction Study Volume 1: Transmission and Distribution System Technical Loss Reduction and Network Development," (The World Bank: Washington, DC, 1998), i.

[5] The World Bank, "Tanzania Power Loss Reduction Study Volume 1," 4; Bjorn Kjellstrom *et al*., *Rural Electrification in Tanzania: Past Experiences - New Approaches,* (Report prepared within the research co-operation between the Tanzania Electric Supply Company and, SEI, 1992), 3–11.

constrained the company financially. The utility could not connect new customers and those connected could not get supply without outages leading to substantial economic losses in the 1980s, a time in which the country was also facing a severe economic slump.[6]

The vulnerabilities of the power systems did not fall from the sky but were aggravated by the economic hardship Tanzania experienced since the late 1970s and 1980s. Tanzania's economy followed socialist policies from the mid-1960s to the mid-1980s. In the initial years of independence, its development policy relied on public and foreign industrial investments, leading to economic growth in these early years.[7] In this period, the economy grew at about 4.8 per cent in real terms, and the country had a balance of payments surplus.[8] The adoption of a socialist state in 1967 introduced a new development path which emphasised self-reliance through *ujamaa* villages (cooperative villages in rural areas). By adopting socialist and self-reliance policies, Tanzania denigrated the role of foreign aid and capital as an engine for progress, and it was replaced by domestic resources such as land, people, good leadership, and sound policies.[9] Although socialist policies raised the export of agricultural produce from 1967 to 1973, nationalisation policies, strict control of agricultural prices, imports, and restrictions to stop people from living in urban areas caused economic decline from the mid-1970s. The economy began to show signs of bankruptcy by the mid-1970s. Crop exports fell from 25% in 1966 to 11% in 1979 because some settlers lacked trust in the new socialist state and expatriated their capital.[10] The real wages fell by 65% from 1975 to 1985, the sharpest fall in real income in Africa during this period. The inflation rate hiked from 2.1 per cent between 1961 and 1971 to 22.5 per cent per annum between 1971 and 1977.[11] Tanzania's foreign reserves fell

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[6] World Bank, "Tanzania Power Loss Reduction Study," (1998), i.

[7] David J. Potts, "Policy Reforms and the Economic Development of Tanzania," The University of Bradford, Bradford Centre for International Development (BCID), *Research Paper* No. 14 (2005); David Potts, "Introduction," in *Tanzanian Development: A Comparative Perspective*, ed. David Potts (Boydell and Brewer, 2019).

[8] Andrew Coulson, *Tanzania: A Political Economy*, (Oxford: Oxford University Press, 1979), 183; Rwekaza S. Mukandala, "From Proud Defiance to Beggary: A Recipient's Tale", in Goran Hyden and Rwekaza Mukandala (eds) *Agencies in Foreign Aid Comparing China, Sweden and the United States in Tanzania*, (London: Macmillan Press, Ltd., 1999), 31–36.
The World Bank, "*Accelerated Development in Sub-Saharan Africa: An Agenda for Action,*" also famously known as the Berg Report (The World Bank: Washington D.C, 1981); Michael F. Lofchie, "Reflections on the Tanzanian Trajectory: Decline and Recovery," in David Potts (ed) *Tanzanian Development: A Comparative Perspective*, (Boydell and Brewer, 2019).

[9] Julius K. Nyerere*, Essays on Socialism,* (Oxford: Oxford University Press, 1968).

[10] Samuel Wangwe *et al*., *Transitional Economic Policy and Policy Options in Tanzania,* (Economic and Social Research Foundation, 1998; Mkuki na Nyota; Dar es Salaam, 1998), 1; Coulson, *Tanzania*, 184, 229; Lofchie, "Reflections on the Tanzanian Trajectory"; The World Bank, Berg Report, 26.

[11] Jannik Boesen, Kjell J. Havnevik, Juhani Koponen, and Rie Odgaard, "Introduction," in Jannik Boenik, Kjell J. Havnevik, Juhani Koponen, and Rie Odgaard, *Tanzania: Crisis and Struggle for Survival*, (Scandinavian Institute of African Studies, Uppsala 1986); Aili Mari Tripp, "Defending the Right to Subsist: The State versus the Urban Informal

from US$ 281.8 million in 1977 to US$ 99.9 million in 1978 and experienced a drastic drop to US$ 20 million in 1980.[12]

The International Monetary Fund (IMF) informed the Tanzanian government in 1979 that it had a structural imbalance in the foreign balance of payments, and suggested retrenchment and devaluation measures, which Tanzania refused. Tanzania refused IMF proposal to devalue its currency, cutdown government expenditure and abolish its agricultural crops marketing board as a condition to receive economic assistance. This was followed by mass demonstrations in Dar es Salaam to condemn IMF as a capitalist exploitative institution.[13] The tensions continued in the early 1980s when Tanzania issued many political statements questioning the authority of the IMF to interfere in the internal affairs of the ministries of finance, asking who appointed such an institution to act as a finance minister. Due to its relations with IMF and after following closely the dispute between the two parties, the World Bank also requested Tanzania accept the IMF proposal as a condition to continue its economic support to Tanzania. Top national leaders rejected the proposal and the World Bank ceased financial assistance except those related to the Great Ruaha Power Project.[14] Tanzania tried to endorse its own structural adjustment programmes to revive the economy in the early 1980s, but it failed. Other factors such as world oil shocks, the Uganda-Tanzania war and the collapse of the East African community also fuelled the economic decline.[15] This spread the deficit further to all sectors.[16] The country faced general shortages of basic essential products and services such as petroleum, spare parts, and everyday life staples in the early 1980s.

The financial crisis crippled technical infrastructures due to the unavailability of spare parts, lubricants, and petroleum products in the country. The electrical infrastructure was one of the systems affected by the crisis as the lack of foreign exchange affected TANESCO's

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Economy," (1989); Aili Mari Tripp, "Women and the Changing Urban Household Economy in Tanzania," *The Journal of Modern African Studies* 27, no. 4 (1989): 601-623.

[12] C. S. L. Chachage, "Land Issues and Tanzania's Political Economy", in P. G. Foster and S. Maghimbi, (eds), *Agrarian Economy, State and Society in Contemporary Tanzania*; *The Making of Modern Africa,* (Aldershot: Ashgate Publishing Ltd, 1999), 59.

[13] Werner Biermann and Jumanne Wagao, "The Quest for Adjustment: Tanzania and the IMF, 1980-1986," *African Studies Review*, 29, no. 4 (1986), 89-103; Peter Wobst, *Structural Adjustment and Intersectoral Shifts in Tanzania: A Computable General Equilibrium Analysis*, (International Food Policy Research Institute, Report Number 117; Washington, DC, 2001), 1-2, 7-26

[14] Emily Beth Brownell, "Growing: An Environmental History of Urban Expansion in Dar es Salaam, Tanzania," (PhD Diss.: The University of Texas at Austin, 2012), 52-53.

[15] Wangwe, *Transitional Economic Policy,* 1 – 3.

[16] Andrew Coulson, "The Political Economy of Tanzania 1967–2017: Reimagining the State," in *Tanzanian Development: A Comparative Perspective*, ed. David Potts (Boydell and Brewer, 2019).

operations and its electrical systems seriously. By the 1980s, Tanzania had enormous hydroelectric power resources amounting to 4,800 megawatts but it had only developed 333 MW. This implied that electricity generation continued to depend on oil imports.[17] The day-to-day operations of TANESCO also depended on foreign experts and artefacts, therefore, it affected the generation capacity due to the shortage of petroleum in the country.[18] Tanzania's lack of foreign currency also restricted the import of crucial technologies to TANESCO such as oil for electricity generation and spare parts to maintain its various infrastructures.

A study by TANESCO and Stockholm environment experts on the technical and financial consequences of Tanzania's economic crisis on electricity infrastructure in the early 1990s revealed great consequences. There was critical power load shedding and complete shutdown of many isolated power systems.[19] The report indicated that at substation level, blackouts occurred for about 6 to 15 percent of the total generation time as a result of the lack of consumable spare parts for repair and maintenance.[20] This was because "[m]any of the broken down generator sets had, in reality, been retired and lack of spare parts prevented repair to others."[21] The interconnected grid suffered severe transmission and other technical losses. They escalated from 15 percent from 1970 to 1982 to 25 percent in the mid-1980s.[22] While the centralised system depended on hydropower sources, blackouts were also caused by limited backup systems. Thermal plants built in Dar es Salaam to supplement the system remained unrepaired and lacked oil to operate, frequently leading to unprecedented blackouts.

Tanzania's economic crisis of the 1970s and 1980s also had direct and indirect deleterious consequences on electricity networks. It directly incapacitated the national power utility not only to generate electricity but also to maintain and repair its isolated networks. Indirectly, it affected through the ways urban residents responded to economic difficulties they faced. The main manifestations of the crisis were the unavailability of essential goods and services, low salaries for government workers (many people left the public services and turned to self-employment in other activities) and growing informalities in urban areas. Urban

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[17] Kjellstrom, *Rural Electrification in Tanzania,* 51.

[18]The World Bank, "Tanzania Power Rehabilitation Project"; Kjellstrom *Rural Electrification in Tanzania,* 48; Mark. J. Mwandosya and M. L. P. Luhanga, "Energy Use Patterns in Tanzania," *Energy in Developing Countries,* 14, no. 4/5, (1985), 237; Michael Fergus, "Firewood or Hydropower: A Case Study of Rural Energy Market in Tanzania," *The Geographical Journal* 149, no. 1 (1983): 29, 38.

[19] Kjellstrom *Rural Electrification in Tanzania,* 48.

[20] *Ibid*., 8 – 9.

[21] *Ibid*., 7.

[22] The World Bank, "Tanzania Power rehabilitation project".

historians and other urban infrastructure and environment scholars have often mentioned that the 1970s and 1980s were critical as far as life and infrastructure history in Dar es Salaam is concerned. Town dwellers encountered hardships in meeting their basic needs. Even people who were employed could not support their families—they needed an extra source of income to live in urban Tanzania, especially in Dar es Salaam.[23] Andrew Burton, for instance, shows that Dar es Salaam changed from being a "Haven of peace" (origin meaning of Dar es Salaam) to a "Bongoland" (the land of the brain). This means that, for someone to live in the city, they needed their "brain" (innovativeness to manoeuvre the town's complexities and make a living).[24] The shortage of services prompted tinkering and innovation in the availability of spare parts and petroleum products.

One of the ways residents used their 'brain' was to vandalise electrical power infrastructure to obtain scrap metals for fabricating the spare parts needed to repair other technical artefacts. Before the mid-1980s, the Tanzanian socialist government had managed to exercise strict control over urban spaces by extending the British colonial urban control measures. For instance, in September 1983, President Nyerere pointed out that, "[i]f we don't disturb loiterers, they will disturb us."[25] In this statement, Nyerere showed his provocative standpoint against the unemployed people in urban areas especially Dar es Salaam. The government reinforced its control and the eviction of the so-called "unproductive" urban residents, such as shoe repairmen, tailors, hawkers, and fish sellers among others, because they were viewed as "idle and disorderly persons", loiterers, gamblers, beggars, suspected thieves, rogues, and vagabonds—the economic saboteurs and racketeers.[26] The socialist urban control measures were intended to make urban dwellers and infrastructure safer. The economic crisis crippled police control and doubled the population, which made it harder to patrol and secure inhabitants and facilities in the city.[27]

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[23] See, for instance, Tripp, "Defending the Right to Subsist"; James R. Brennan and Andrew Burton, "The Emerging Metropolis: A History of Dar es Salaam, circa 1862-2000," in Dar es Salaam: Histories from an African Emerging Metropolis, eds. James Brennan, Andrew Burton and Yusufu Lawi (Dar es Salaam: Mkuki na Nyota, 2007), 67; Bernard Calas, *From Dar es Salaam to Bongoland: Urban Mutations in Tanzania*, (Dar es Salaam; Mkuki na Nyota, 2010); Emily Brownell, "Growing hungry: The Politics of Food Distribution and the Shifting Boundaries between Urban and Rural in Dar es Salaam," *Global Environment* 9 (2016): 58–81.

[24] Andrew Burton, "The Haven of Peace Purged: Tackling the Undesirable and Unproductive Poor in Dar es Salaam, ca.1950s-1980s," *The International Journal of African Historical Studies* 40, no. 1, (2007): 120–121.

[25] Aili Mari Tripp, "Defending the Right to Subsist: The State vs the Urban Informal Economy in Tanzania," World Institute for Development Economics Research of the United Nations University, Working Paper, (1989).

[26] Aili Mari Tripp, "Defending the Right to Subsist," 19–25.

[27] Boesen, Havnevik, Koponen, and Odgaard, *Tanzania: Crisis and Struggle for Survival*, 294–304; Tanzania Population Census 1967, 1978, and 1988, as cited in Michael Yhedego "Urban environmental Degradation in

The socialist crackdown and restrictions created a new socioeconomic landscape in the crisis and post-socialist period and in the way, residents lived with infrastructures every day. This reflects, as Brownell claims, how "infrastructures are attempts to rationalize both space and society" and that when services become precarious, people innovate different means of survival—poor services caused by economic crisis and collapse of socialist principles "sparked tinkering and innovation" in the city.[28] Local technologies and 'experts' such as artisans, mechanics, blacksmiths, carpenters, tinsmiths, and repairmen found new space in urban areas where they fabricated local highly needed commodities. The city recreated its material conditions through repair and locally fabricated goods such as hoes, bicycles, domestic utensils, and pull carts. The number of garages and small workshops increased in Dar es Salaam during this period as people decided to create their life possibilities away from the state-crafted socialist development. Scrap metal became an important business as local mechanics created their own rings. Garages and urban scrap metal dealers who sold them to repair shops were able to thrive economically during the 1970s and 1980s, a period of stagnation and decline otherwise. Repair of this type was common and "most-lasting or desirable form of repair, but in the [economic decline and scarcity period in the 1970s and 1980s], it kept lorries on the road."[29] These activities needed materials especially in order to manufacture local spare parts and goods in an attempt to navigate the scarcity of both spare parts and commodities. In *The Second Economy in Tanzania,* T. Maliyamkono and M. Bagachwa demonstrated how Tanzanian cities were run by economic activities beyond the official gaze of government control. They showed that some of the ways residents responded to the economic recession of the 1970s and 1980s was by practicing informal activities such as smuggling, street vending, running private street stalls, carpentry, repair workshops, and so on.[30]

Water and electricity infrastructures were among the technical systems which were affected severely by the crisis as they became the target of vandals in feeding the growing markets of scrap metal and locally made spare parts, among other artefacts. While there had been vandalism of power infrastructure even in the colonial period, Tanzania experienced a new

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Tanzania," *Environment and Urbanization* 3, no. 1 (1991), 147; Interview 5, a shopkeeper, Kinondoni, 20 August 2018; Interview 18, a restaurant owner, Manzese, 24 August 2018.

[28] Emily Brownell, *Gone to Ground: A History of Environment and Infrastructure in Dar es Salaam*, (Pittsburgh: University of Pittsburgh Press, 2020), 111.

[29] Joshua Ryan Grace, "Modernization Bubu: Cars, Roads, and the Politics of Development in Tanzania, 1870s – 1980s," (PhD Diss.: Michigan State University, 2013), 232.

[30] T. L. Maliyamkono and M. S. D. Bagachwa, *The Second Economy in Tanzania*, (Nairobi and Dar es Salaam: ESAURP, I990).

wave in response to the economic slump in the 1980s. Electrical systems became integrated in the political economy of goods, services, and spare parts scarcity. The new socioeconomic and political landscape created insecurity in infrastructures in diverse ways. Innovations by residents became a source of vulnerability and power failures. In 1987, the Minister for Water, Energy and Minerals complained about saboteurs who vandalised water and power systems to obtain scrap metal. He claimed that such activities had increased in areas such as Kinondoni and Ilala in Dar es Salaam. The Minister informed that such removal of infrastructure was not caused by economic hardship and scarcity of spare parts, but due to a few people who did not know the importance of such systems.[31] While the Minister denied the linkage between economic hardship and vandalism of infrastructure, other evidence unveils that lack of spare parts and growing economic hardship made people to uproot infrastructure to obtain scrap metals for spare parts and income generation.

Vandalising electrical power infrastructure, especially distribution networks, cables, wires, and siphoning transformer oil became one of the major issues in Tanzania's print and electronic media since the 1980s. TANESCO's management lamented such situations, which affected it financially. In the early 1990s, for instance, the company had lost six million Tanzanian shillings from stolen electrical aluminium heat conductors in six months alone. The vandals used these wires to make clothes hangers and other domestic utensils which were in turn sold to drycleaners and hawkers in Dar es Salaam. Residents exported smuggled grid components to other countries as industrial raw materials, i.e., scrap metals and copper wires.[32] TANESCO's power infrastructure in different parts of the country and Dar es Salaam experienced a wave of criminality which involved stealing electrical wires and siphoning transformer oil for different purposes. The areas along the Morogoro road, Kimara, Kinondoni and Ilala in Dar es Salaam were the most affected. TANESCO technicians faced severe challenges when trying to repair and rebuild their systems as many electrical power conductors had gone missing in the distribution and transmission lines, leading the power company, industrialists, and domestic users to lose billions of Tanzanian shillings. The company used 200 million Tanzanian shillings to

[31] Hansards, Jamhuri ya Muungano wa Tanzania; Bunge la Tanzania, Mkutano wa 16, Kikao cha 8 Mwaka 1987, uk., 679–81.

[32] *Daily News*, "TANESCO loses 6m/-," 11 January 1994; High cutting of electrical wires and other infrastructure components was also captured in interviews, see for instance: Interview, Kimara, 9 August 2018; Interview, Tabata, 25 August 2018.

replace some vandalised wires and cables between 1979 and 1981, and this amount rose to about 346 million Tanzania shillings between 1983 and 1986.[33]

Electrical power infrastructure vandalism continued in the 1990s when Tanzania's power systems were in critical shortage of generation capacity. One of the incidents occurred on 9th January 1994 where a power pylon of 220 kV carrying electricity from Kidatu to Dar es Salaam was attacked a few kilometres from Dar es Salaam. Unknown vandals unscrewed 18 bolts and nuts and supporting iron bars and attempted to pull down two other towers in the same area by unbolting six nuts in one tower and 12 nuts in another tower. TANESCO stated that iron bars, bolts, and nuts from the towers were highly needed in car repairs and body building of lorries, harrows, and aluminium doors in town garages. The tower which collapsed carried a 130-megawatt transmission line to the national power substation at Ubungo-Dar es Salaam. Hence, the event led to a cascading failure of the Tanzania's entire national grid, leaving the company and all consumers in panic for nine days.[34] The breakdowns cost several million Tanzanian shillings.[35] The destruction and removal of water and electricity infrastructures by unknown people in Dar es Salaam led to restrictions in the circulation of services at alarming rates.[36] While the available sources are scanty in estimating the extent to which this situation affected power networks, it is still safe to posit that a broader economic episode of stagnation and urban insecurities emerged during and after the 1980s economic crisis, led to the crippling of power infrastructure in many ways.

3.3 From a Power Dam to Grazing Land: Blackouts and the High Modernism Rhetoric

While the economic crisis and its associated impact was a dominant narrative about critical power failures in the late 1970s and 1980s, the storyline changed in the 1990s. Of course, financial constraints and vandalism continued to exist side by side, but the decline of the Mtera dam and the installation of power generation plant in 1988 became the centre of the power outages debate. Whenever Tanzanian cities evidenced critical power shedding schemes, the fall in water levels at Kidatu and Mtera was mentioned in print and electronic media and political

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[33] On costs incurred by TANESCO due to infrastructure vandalism, see also, Hansards; Jamhuri ya Muungano wa Tanzania; Bunge la Tanzania; Mkutano wa 12; Kikao cha 18 mwaka 1976 uk., 234 9 234; Also, Hansards, Jamhuri ya Muungano wa Tanzania; Bunge la Tanzania, Mkutano wa 16, Kikao cha 8 Mwaka 1987, uk., 679–81 at: EAF – UDSM Library.

[34] *Daily News* "TANESCO Pylon", 21 January 1994.

[35] *Daily News*, "TANESCO assures people of power," 15 January1994; *Daily News*, "Power may be back to normal today", 19 January 1994.

[36] *Sunday News*, "Sabotage: source of power outages," 15 June 1987.

discourse. Normally, the water levels at Mtera would drop during the dry season between July and December and refill during the wet season from January to June. But the complete drying out of a large section of the dam in 1992 and the socioeconomic and political tensions it brought alarmed system builders (government agencies, TANESCO, electrical firms that had built the dam, and donors), simply because it was not expected. It, thus, attracted international concerns, especially the funders of the Great Ruaha Project, Sweden and the World Bank. The shortage of water affected the Kidatu-Mtera cascade power system which meant that it could not generate electricity to its full capacity of 280 megawatts. This raised concern because since the dams contributed more than 50 percent of Tanzania's national grid and more than 80 percent of its all-hydropower resources. The national electricity power company (TANESCO) embarked on national-wide power load shedding schemes for four consecutive years from 1992 to 1996 as a strategy to avoid the cascading collapse of the whole system. Electricity consumers in towns and cities encountered power outages every day lasting between 8 to 24 hours, halting of industrial and socioeconomic production in the country. As scholars have described the situation, it created environmental and political panic because blackouts hampered grid-connected Tanzanian cities as far as the Island of Zanzibar a few years before Tanzania entered its first multiparty general election in 1995.[37]

This condition was unexpected after Tanzania and its national utility company had invested millions of US dollars to expand its power generation. When writing back to Stockholm in 1982, the Swedish engineering consortium (SWECO) that had built the Kidatu and Mtera dams in the first and second phase of Great Ruaha Power Project, was optimistic about the functioning of the Mtera dam. They described the project as a great success in Tanzania's power sector, and they did not foresee any possibility of problems emerging shortly afterwards. They stated that "[t]he live storage of 3,200 million m^3 is sufficient to safeguard the water supply even during dry years or series of dry years."[38] This phrase implied that upon reaching the highest water levels, the Mtera dam could allow smooth electricity generation at Mtera and Kidatu making

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[37] Martin Walsh, "The not-so-Great Ruaha and Hidden Histories of an Environmental Panic in Tanzania," *Journal of Eastern African Studies*, 6:2 (2012): 306; Charles S. Sokile, Japhet J. Kashaigili and Reuben M. J. Kadigi, "Towards An Integrated Water Resource Management In Tanzania: The Role of Appropriate Institutional Framework in Rufiji Basin," 3rd WATERNET/WARFSA Symposium: Water Demand Management for Sustainable Development, 30-31 October 2002": available at https://assets.publishing.service.gov.uk/media/57a08d3640f0b652dd00181e/R8064-Water; Reuben M. J. Kadigi, Ntengua S. Mdoe, Bruce A. Lankford, and Sylvie Morardet, "The Value of Water for Irrigated Paddy and Hydropower Generation in the Great Ruaha, Tanzania," available at: https://www.researchgate.net/publication/222416147.

[38] SNA, SIDA, File F13B: 25: SWECO Great Ruaha Power Project (Phase II Development); Completion Report, in SNA, SIDA, File F13B: 25.

them yield the required capacity (280 MW) for years, even if, for some reason, there would be no rain in the catchment. Even though the water levels in the dam had exceeded its maximum capacity at the end of the 1980s, the rivers' low water regularities fell below levels in the early 1990s that had never been experienced in its history. The dam could not refill in the early 1990s, contrary to their expectations. Ten years after commissioning of the dam in 1981, and only four years after installing a power plant there in 1988, the Mtera dam changed from an infrastructure made for power generation to grazing land.

Figure 3.1: A dried up Mtera dam in 1992.
Source: Swedish National Archives, SNA SIDA File FB13: 23
The original belongs to Swedish National Archives, Täby (Arninge), photographer unknown.

Although the electricity providers attributed power disruptions in Tanzanian cities to the fall in water levels at the Mtera dam, what caused such a decline in water levels remained tantamount. At least three different accounts emerged. One line of thought upheld by the Tanzanian government and TANESCO's top officials was that the problem was due to human activities upstream, including keeping animals and paddy irrigation. For instance, when informing the public of the extended power rationing in cities connected to the national grid in 1992, TANESCO's managing director said that the load shedding was caused by "dry spells and increased human activities in the dam's feeder streams", which led to a shortage of 120 megawatts out of the 265 megawatts from hydropower.[39] As such, various speeches and reports from the then Minister for Water, Energy and Minerals, and later the President of Tanzania, Jakaya Kikwete, linked the problem to human activities (environmental degradation) and the shortage of rainfall which dried many feeder streams at Mtera. This lowered generation capacity from 330 megawatts to 190 megawatts.[40]

When he came to power as the President of Tanzania in 2005, Kikwete found the country in recurrent power disruptions exacerbated by the drought in 2004 and 2005. Determined to end power outages, Kikwete's government's first intervention was the eviction of a large group of pastoralists in the Usangu catchment, where TANESCO's Kidatu and Mtera infrastructure drew its waters. More than 300,000 cattle were evacuated based on the premise that they drained the water from Mtera through drinking and removal of grass cover. It was the greatest eviction in the history of hydropower technology and the Usangu catchment in Tanzania.[41] With regards to the viewpoints that there had been inadequate rainfall and changes in rainfall patterns which yielded small amounts of water for power generation, they claimed the Usangu catchment had not received enough rainfall in the early 1990s. The third account advocated that changing Mtera from a water storage dam to a power plant in the 1970s had caused the problem. This perception was upheld by the National Environment Management Council of Tanzania (NEMC) and some TANESCO middle and lower ranking experts and officials. There had been no significant shift in rainfall patterns in the area since the 1990s, but the problem was caused by the change of Mtera's usefulness as a storage dam and the breach of the no water abstraction agreement which the Tanzanian government had signed in the 1970s with the donors.[42]

Scholars who studied the Usangu catchment (where Kidatu-Mtera draw their waters) have questioned and refuted the claim held by the authorities that low amounts of rainfall, the change in hydrological patterns, and environmental degradation contributed to the fall in the dam's water levels and the resulting blackouts in cities. They have shown that since the 1970s

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[39] *Daily News*, "TANESCO Power Rationing Schedule for Dar es Salaam and Coast Regions," 10 September 1992.
[40]EAF – UDSM Library: Jakaya Mrisho Kikwete, Hotuba ya Waziri wa Maji, Nishati na Madini Katika Bunge la Jamhuri ya Muungano wa Tanzania, 1992–1994.
[41] Walsh, "The not-so-Great Ruaha," 304–305.
[42] Interview, Ubungo-Dar es Salaam, 13 August 2018; Interview, Ubungo-Dar es Salaam, 9 August 2018; Also *Daily News,* "Mtera Dam drying, farming and other activities in jeopardy", 22 August 1992; See also, Walsh, "The not-so-Great Ruaha," 304–305; Lankford *et al.,* (undated):

there is no evidence of human environmental degradation and changes in rainfall patterns in the Usangu area that would affect electricity generation to such an extent.[43] According to these researchers, the drying of the dam and the power crisis were "hidden stories". Walsh in his well-grounded environmental ethnographic findings has identified three problems which drained the Mtera dam. To a large extent, his observations challenge the long-cherished hydrological and ecological orthodoxies which have placed emphasis on environmental degradation. He explains that paddy irrigation and mismanagement of water flows by TANESCO were the major problems. Although it was recognised since 1978 that development of irrigation upstream of Mtera would deleteriously affect the downstream users, including hydroelectric generation, the Tanzanian government developed food production by establishing large paddy irrigation schemes from the 1970s. Some of the farms were owned by top-ranked politicians in the country, making the problem more complex. Walsh concludes that there were no changes in the area's hydrological patterns and that the meta-narratives on environmental degradation consisted of political and economic interests of various actors which intended to hide the real cause of the problem.[44]

The water use question and massive rice estates were mentioned in numerous sources particularly expressing the sentiment that the government had failed to address the challenge, leading to blackouts in towns and cities.[45] Shadrack Mwakalila, in the same vein, "identified irrigation as the main reason of the reduced flows into the Usangu wetlands and eventually into the Great Ruaha River through the Eastern Wetland."[46] More profoundly, George Katoto Ambindwile, an environmental historian at the University of Dar es Salaam, also refuted the presence of hydrological and rainfall change in the Usangu catchment. He completed his historical environmental change study in 2017, a few months after this dissertation had just taken off. Ambindwile reckons that the Usangu has been receiving adequate rainfall since the 1950s, except for some marginal annual shifts. In his view, the green revolution in the 1970s

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[43] George Katoto Ambindwile, "Rice Farming and Environmental Change in the Usangu Plains, Tanzania, 1920s - 2000", (PhD Diss.: University of Dar es Salam, 2017), 242–323; Matthew P. McCarthy, Brice A. Lankford and Henry Mahoo, "Agricultural Water Management in a Water Stressed Catchment: Lesson from the RIPAWIN Project," (Research Report 116, 2007), 3–4.

[44] Walsh, "The not-so-Great Ruaha," 301–310.

[45] Walsh's and Ambindwile's study also draw their findings from other studies done on the Usangu which have come to the same conclusion, such as Sustainable Management of the Usangu Wetland and its Catchment (SMUWC), a report submitted to IFAD and Government of Tanzania, 2001; McCarthy, Lankford and Mahoo, "Agricultural Water Management in a Water Stressed Catchment," 3–4.

[46] Shadrack Mwakalila, "Assessing the Hydrological Conditions of the Usangu Wetlands in Tanzania," *Journal of Water Resource and Protection,* 3 no. 12 (2012): 376–882, 881.

and the economic reforms of commercialised agriculture in the 1980s promoted state-led rice farming schemes which attracted a large number of farmers in the area but also drained water from power generation. China and the World Bank funded irrigation agriculture in the Great Ruaha catchment which involved improved irrigation techniques that enabled complete drainage of water from rivers. This was contrary to the old traditional irrigation technologies that allowed environmental water flow during dry spells and had a serious impact on TANESCO's power infrastructure located downstream.[47]

Both the Mtera and Kidatu hydroelectricity power dams draw their waters from the Usangu wetlands (Usangu catchment). This is one of the catchments that forms the upper part of the largest river basin in Tanzania, the Rufiji River Basin. The Usangu area has a complex river flow which is characterised by many river tributaries and distributary systems. The water flows largely from the southwest to the northeast part of the catchment where the Mtera dam, the Kidatu River and TANESCO's hydropower dams are located. With its complex river system, water used for irrigation in upstream farms can continue to flow downstream to other rivers. Yet, because of the increased mechanisation of agriculture, most of the water become useless to the downstream users, except for irrigation as they go through a chain of irrigation lands, due to pollution.[48]

This study used land-use and land-cover change images to capture the hydrology and anthropogenic influences in the Usangu catchment and identify the possible causes of the fall in water levels and TANESCO's network vulnerabilities. Four images, one image from each decade since the 1970s when the first hydropower plant was built in the Great Ruaha, was analysed. One of the advantages of using these images is that they assist in indicating the broader physical characteristics of an area, such as the human population, land use, and vegetation details which cannot be easily captured by hydrological and meteorological records over the course of a study like this. The Landsat images helped to capture both the changes and the direction of the change of multiple environmental variables, providing concrete evidence of the socioeconomic, hydrological, and environmental changes in the area.

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[47] Ambindwile, "Rice Farming and Environmental Change in the Usangu Plains," 242–323.
[48] Mwakalila, "The Hydrological Conditions of the Usangu Wetlands in Tanzania," 881.

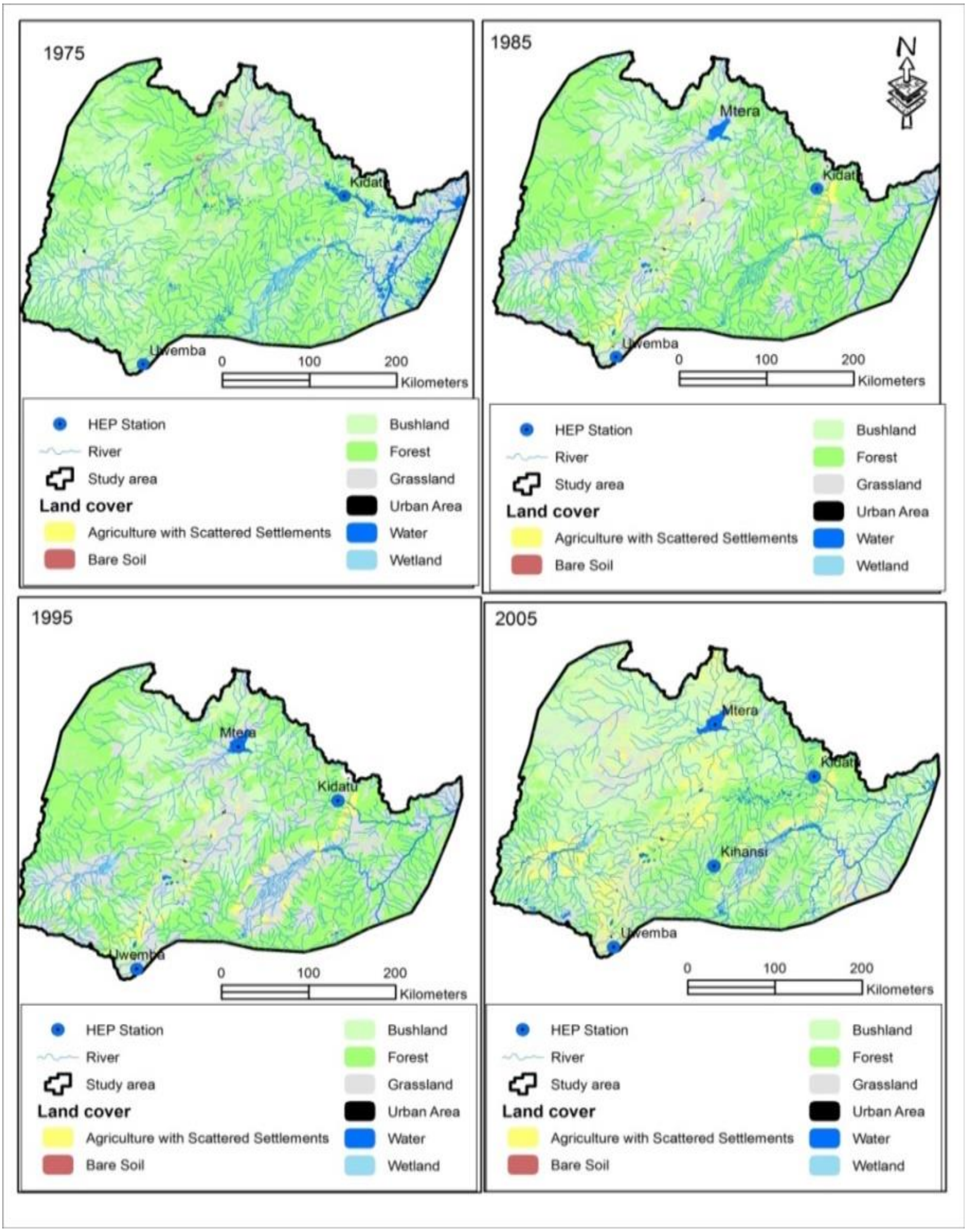

Figure 3.2: Usangu Wetland Landsat Images, 1975 – 2005.
Source: The author in collaboration with GIS officer, IRA, University of Dar es Salaam, Tanzania.

The land-use and land-cover change images of the Usangu Catchment reveal some socioeconomic and environmental changes from the mid-1970s to the mid-2000s which might have contributed to the fall in water levels. One of the general conclusions that can be drawn from the Landsat images in Fig. 4.3 is that there has been an increase in human settlements (population growth) and agricultural activities in the area from the 1980s to the 2000s, as marked in yellow. The trends of these changes are detailed in terms of numbers as shown in Table 4.1, that the area under agriculture and settlement increased from 1 percent in 1975 to 13 percent in 2005. In terms of acreage, it grew from 0.6 million in 1975 to 1.5 million acres in 2005. The table also reveals the reduction in forestland from about 6 million acres in 1975 to 3 million in 2005 and the diminishing wetlands and waters from about 213 thousand acres in 1975 to 98 thousand acres in 2005. Other scholars have affirmed that since 1992–1993 seasons when Mtera dried up completely for the first time in its the living memory, the river tends to dry for at least 100 days per year due to the improvement of small-scale paddy irrigation by donors in the 1980s and 1990s. The projects aimed at improving agricultural productivity but without proper analysis of the environmental impact as well as impact on electricity power generation.[49]

Table 3.1: Land-cover change, 1975–2005

Land Use/ Cover Types			Land Cover						Annual change rate		
	Year: 1975		Year: 1985		Year: 1995		Year: 2005		1975-1985	1985-1995	1995-2005
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	Ha	Ha
Agriculture with scattered settlements	65,883	1	380,069	3	448,588	4	1,518,983	13	31,419	6,852	107,040
Bare Soil	34,382	0	4,208	0	4,206	0	459	0	-3,017	0	-375
Bushland	4,067,396	34	2,448,001	21	2,177,456	18	4,858,503	41	-161,940	-27,055	268,105
Forest	5,845,481	49	6,299,319	53	5,801,787	49	3,389,047	29	45,384	-49,753	-241,274
Grassland	1,587,279	13	2,578,281	22	3,284,376	28	1,949,439	17	99,100	70,610	-133,494
Urban Area	1,058	0	3,351	0	4,169	0	9,352	0	229	82	518
Water and wetland	212,969	2	101,220	0	104,034	1	98,833	1	-11,175	281	-520

Source: The author in collaboration with GIS officer, IRA, University of Dar es Salaam, Tanzania

To recapitulate, one of the central concerns of this chapter is to explain the nature and vulnerabilities of power networks in Tanzania. The proper understanding of what transpired in the Usangu catchment, where Tanzania's largest hydropower plants are located, is significant in grasping the causes of power shedding that has afflicted Tanzanian cities since the 1990s.

[49] Bruce Fox, "An Overview of the Usangu Catchment, Ihefu Wetland, & Great Ruaha River Ecosystem Environmental disaster", http://www.tanzaniasafaris.info/ruaha/Ruaha_River_Disaster.pdf (2004).

Also, as mentioned previously, the drop in water levels at the Kidatu and Mtera hydropower dams (which were built under the Great Ruaha Power Projects I examined in Chapter 2) has dominated the discourse of power failures in Dar es Salaam since the 1990s. This study, therefore, has delved into the question of the fall in water levels and extended it further to shed more light on power system vulnerabilities. By and large, the findings in this study are in line with the studies which link the problem to extensive paddy irrigation upstream. However, it develops this question further to include the politics which shaped the building of these hydropower plants and how such politics ignored development of agriculture in the Great Ruaha area, leading to power shortages in cities in the 1990s and 2010s.

While the technicalities of how Kidatu – Mtera have been silenced and are unavailable in the existing official reports by TANESCO and the government of Tanzania, archival sources obtained in Swedish archives in Stockholm unveil that they were central to this problem. Review of newspaper in Tanzania also illuminated on the 'Mtera question.' Some journalists in Tanzania had touched on these technological issues in the 1990s. Michael Andindilile and Mangengesa Mdimi, environmental journalists, had on different occasions informed the public loudly that the problem at Usangu (Great Ruaha and Mtera dam in particular) was caused by some technical issues which were overlooked during the construction of the Mtera dam. They claimed that high water abstraction for irrigation was the major reason for power outages. In one of their newspaper articles in the *Daily News*, they stated:

> While drought could be the major cause of the low water level in the Great Ruaha, extravagant use of water upstream from the Mtera dam for small-scale and large-scale irrigation projects is responsible. Despite assurances from politicians (understandably) that irrigation projects do not affect the water level at the two dams downstream, the truth of the matter is that they do.[50]

Before these remarks by Mdimi in 1994, Michael Andindilile had already noted in 1992 that the builders of the Kidatu-Mtera dams had overlooked human and environmental side-effects. For him, the halving of the water surface from 600 to 300 kilometres in the early 1990s was due to a poor planning process that disregarded critical ecological and agricultural development issues.[51] Mdimi's and Andindilile's perspective was also shared by TANESCO workers who contended that food has remained Tanzania's top priority in the last four decades and energy generation came in as a fourth or fifth priority. One of the interviewees emphasised that had

[50] *Daily News*, "Mtera, Kidatu water level at the lowest," 28 November 1994.
[51] *Daily News,* "Building of Mtera Dam: experts overlooked some issues", 26 November 1992.

not the water been wasted on irrigation it would have been left to flow to the Mtera dam, and power shedding in cities could have been minimised to a large extent. But this was hard because it was impossible for the government to reduce rice production for the sake of addressing power outages.[52] In that regard, the government allowed the expansion of agriculture (rice irrigation) in the Usangu catchment despite its awareness that such developments had consequences on electricity generation. The findings above unravel the existing water use conflicts in the Great Ruaha catchment as main source of fall of water levels in Mtera dam and resultant electricity shedding in cities connected to the national grid. But as this study observed the Mtera power dam problem was larger than water use conflicts.

The available studies on the Great Ruaha Catchment disclose undisputed correlation between rice farming in the Usangu and breakdowns of electricity in Tanzanian cities. But their conclusions are less situated beyond what transpired in the 1990s. As mentioned, previously, the vulnerabilities of large infrastructures are a product of decisions by its builders. Historians need to trace vulnerabilities through long-term historical processes. They need to consider "the timely development of vulnerability factors" because vulnerabilities in technical systems are a result of human-induced technical and social parameters in time and space.[53] The fall in water levels at the Mtera and Kidatu dams transcended human degradation, shifts in hydrological patterns (drought) and water mismanagement meta-narratives; it was a product of historical time—high modernism, reverberated in the twenty-two years of building the Kidatu-Mtera dams. It was also political and technological challenge. But as Walsh aptly contends, these observations have remained "hidden stories" while the actors' reports continued to identify droughts and changes in "God's" hydrological cycles as the main cause of low water levels and power shedding in the country.

3.3.1 The Planning and Building of the Mtera Dam and Power Plant

We saw in the previous chapter that the Mtera dam and power plant were built as part of the Great Ruaha Power Project which started in the mid-1960s and finished in 1988. While the dam was built in the second stage as a storage dam for power plants installed downstream at Kidatu, the installation of a power plant in 1988 was an extension of the project to a third phase that

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[52] Interview, Ubungo, 10 August 2018; this was also mentioned in some interviews with other TANESCO staff.

[53] Stephanie Eifert, Allice Knauf and Nadja Thiessen, "Vulnerability," in *Key Concepts for Critical Infrastructure Research,* ed. Jens Ivo Engels (Springer VS, 2018), 21–29; Van der Vleuten *et al*., "Europe's Critical Infrastructure and Its Vulnerabilities," 5–7.

had not been planned from the start. The plans to build hydropower dams at the Great Ruaha (Kidatu and Mtera dams) started as early as the 1950s when the British colonial government began to plan and develop the Rufiji waters. The planning gained momentum in the 1950s due to the collapse of the British groundnuts' schemes in Tanganyika. The government wanted to develop successful agricultural projects in the Rufiji Basin. Because of the vastness of the basin (estimated at one-fifth of Tanganyika), and the inadequacy of the experts, E. Smith, the Director of the Department, asked for external assistance for proper planning of the basin. Consequently, Sir Edward Francis Twining, the British governor in Tanganyika, approached the United Nations Food and Agriculture Organization (FAO) in 1952 for assistance. FAO appointed Nicholas Simansky, who had worked successfully on the Gezira scheme,[54] to lead a team of experts to investigate the Rufiji waters in research famously known as the FAO Rufiji Basin Survey of 1961.

The terms of reference were: 1) to assess the irrigation potential in the basin. To this end, irrigable areas were rationally defined, and their relative merits ascertained to determine possible ways of developing them. 2) To investigate water storage sites and their estimated building costs. 3) To outline soils and topographical characteristics.[55] Electrical power was not mentioned anywhere in the terms of reference. Nevertheless, in the post-WWII period, dam building was associated with multipurpose projects as the norm of the day. The water control project engineer, M. Freimann, noted that although electricity was beyond the scope of the FAO RBS report, "the generation of hydropower is complementary to the reservoir studies; as water passing from a higher to a lower elevation always represents a potential source of hydro-electrical energy."[56] Therefore, electricity generation was not part of the project, and it became just a by-product of the FAO RBS.[57]

Before the FAO RBS, Clement Gillman (one of the experienced engineers and a pioneer geographer who had worked in German East Africa and later British Tanganyika), had warned

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[54] The Gezira scheme was an agricultural irrigation programme established by the British in colonial Sudan in 1925 to expand cotton production. See for instance, Victoria Bernal, "Colonial Moral Economy and the Discipline of Development: The Gezira Scheme and "Modern" Sudan," *Cultural Anthropology* 12, no. 4 (1997): 447-479; Arthur Gaitskell, "The Gezira Scheme," *Journal of the Royal Society of Arts* 104, no. 4966 (1955): 67-86.
[55] FAO, Rufiji Basin, Tanganyika, (Report to the Government of Tanganyika); see also Preliminary Survey of the Rufiji Basin, Vol. 1, General Report, Part 1, Rome 1961, 4. Cited in Simon R. Nkonoki in collaboration with Johan Skutle, "Planning for Hydropower Development and Industrialization: The Case of Stiegler's Gorge Hydropower and Flood Control Project in the Rufiji River Basin, Tanzania", University of Dar es Salaam's Institute of Resource Assessment Library; Also reproduced in K. J. Havnevik, "The Stiegler's Gorge Multipurpose Project: 1961–1978), DERAP Working Paper, NO. A 131.Che Michelsen Institute, Bergen, December 1978, 5–6.
[56] *Ibid*., 259
[57] *Ibid*.

that human activities in the Rufiji Basin would have dangerous effects on river flows.[58] The FAO RBS also identified several power sites and their potential in gigawatt hours (Gwh) per year. In the upper catchment, it identified the Great Ruaha (28) and the Mtera dam (186), and in the lower catchment, it listed the Kingengenas dam (338), the Nyangasi dam (2677), and Stigler's Gorge (3533).[59] What was apparent in these findings was that the power sites in the upper catchment (Great Ruaha and Mtera) had a lower generation potential than the sites in the lower catchment. For the Mtera site, Friemann cautioned further that it was a "rising interesting problem" in that the dam had a wide area but shallow depth. This would lead to high evaporation, which made developing about 20 and 30 megawatts possible but only with strict control of evaporation.[60] Prior to the late 1960s, therefore, the Kidatu-Mtera dams were not conducive sites for electricity generation when compared to other sites in the lower part of the Rufiji Basin. But the decision to build large power plants, as we have seen in the previous chapter, primarily arose from the World Bank and SIDA's influence. The Tanzanian government wished to develop Stiegler's Gorge in the Rufiji River and the Wami River.

But we saw in the previous chapter that rivers and river basins were vital centres for human development and economic growth as they could promote agriculture and electricity generation. Tested in the Global North and proved to be successful, river basin development was transferred to the South. The actors involved considered western scientific knowledge and technologies accompanied by massive finance and expertise as a panacea to Africa's postcolonial underdevelopment challenges. Large technical projects were also welcome on the receiving end by postcolonial African leaders who appropriated development schemes for their own political agenda of progress, development, and decolonisation. Different parts of postcolonial Africa witnessed the building of large technical dams for flood control, irrigation, water supply, and electricity generation. Many dams cropped up during this period, including the Cahora Bassa Dam in modern-day Mozambique, the Kariba Dam in the Zambezi, the Akosombo Dam in Ghana's Volta River, and the Kidatu and Mtera Dams in Tanzania, to mention but a few.

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[58] For an expanded biography and the works of Clement Gillman, see for instance, B. S. Boyle, "Gillman of Tanganyika, 1882–1946: Pioneer Geographer," *The Geographical Journal*, 152 (1986): 354–366; See also Havnevik *Tanzania,* 263–266.
[59] FAO, Rufiji Basin Survey, Tanganyika.
[60] May-Britt Öhman, *Taming Exotic Beauties: Swedish Hydropower constructions in Tanzania in the Era of Development Assistance, 1960s – 1990s* (PhD Diss.: Stockholm, 2007), 257–61.

However, as Akala has emphasised, the actors perceived technology transfer to the South as a "passive process flowing seamlessly from the upper echelons to jumpstart lower cadre societies"; hence, they failed to contextualise the local technological, political, and environmental conditions.[61] William Jobin stated with regard to dam building in the past, "[p]olitical power has often operated at the front end of a gun barrel, or the smooth blade of a bulldozer, or the sharp teeth of a chain saw."[62] Politicians' decisions overruled several technical aspects of dam building. Patrick McCully suggests that a good number of dams that were built in the post-WWII period of high modernism remained inoperative or caused socio-environmental challenges and blackouts to communities because engineering and political biases had shaped their planning and construction. Engineers and politicians claimed that these dams had large advantages but based on insufficient geological data. He claims further that sometimes data were "collected but unfavourable findings are either ignored or are interpreted in as optimistic a light as possible."[63] This political and engineering bias dominated planning and construction of hydro-dams in the South and their subsequent failures, and it was evident in many power dams in Africa by the 1980s.

The building of large hydropower dams in postcolonial Africa was a matter of political gambling. For instance, Stephan Miescher, in his brilliant article "Nkrumah's Baby", accounts that he modernist president Kwame Nkrumah adopted tyrannical decisions and pushed the building of the Akosombo dam even when it was apparent that it would not yield the expected benefits and affect the local population at the same time.[64] Terri Hathaway and Lari Pottinger in "The great hydro-rush" sustain the same plight that the builders of the Cahora Bassa hydropower dam in Mozambique ignored recommendations from Dr Richard Beilfuss (a 'local' hydrologist who worked with the International Crane Foundation) and Dr Bryan (a South African river ecologist). These experts warned the builders that the dam would suffer many negative impacts (like Kariba Dam, which was constructed in the same River Basin).[65]As Hathaway and Pottinger show, things happened as Beilfuss and Bryan anticipated. Ten years later, "deleterious

[61] Jethron Ayumba Akala, *In the Technological Footprints of Urbanity: A Socio-political History of Water and Sanitation in Nairobi, 1899- 2015*, (PhD Diss.: TU Darmstadt, 2018), 178.

[62] William Robin, *Dams and Disease: Ecological Design and Health Impacts of Large Dams, Canals and Irrigation Systems*, (Taylor & Francis Ltd,1999), 3.

[63] Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams: Enlarged and Updated Edition,* (London: Zed books, Limited, 2001), 101.

[64] Stephan F. Miescher, "'Nkrumah's Baby'': the Akosombo Dam and the Dream of Development in Ghana, 1952-1966," *Water History* 6, (2014): 341-366, 355–356.

[65] Hathaway and Pottinger, "The great hydro-rush: The privatisation of Africa's rivers," in *Electric Capitalism: Recolonising Africa on the Power Grid*, ed. David A. McDonald, (London and Sterling: Earth Scan, 2009), 153–154.

changes to the Zambezi's riverine, wetland, deltaic and coastal ecosystem were already apparent." Shortly, this affected operation of the power plants as "all but one of Cahora Bassa's turbines remained idle and it led to the sabotage of power lines by people" and blackouts.[66] The failure of the Mtera dam and vulnerabilities of TANESCO power systems were not accidental or a result of interconnection and interdependence, but a noteworthy feature of the large technical infrastructural building between the 1960s and 1980s—what McCully has termed "engineering bias." On the one hand, engineers'/experts' decisions were dictated by the choices, decisions and wishes of politicians and donors and, on the other hand, political decisions were also influenced by the engineers'/experts' economic calculations and estimations.

In a similar vein, high modernism engineering biases dominated the planning and construction of hydropower infrastructure at Kidatu and Mtera in the 1960s to 1980s. They were built without adequate essential water flow and discharge data. The inadequate scientific data started with John Fletcher, a water resource engineer, and a senior member of the Swedish hydropower community, who was appointed by SIDA in 1966 to comment on the SWECO report on the Wami and Great Ruaha (Kidatu-Mtera) River project, as discussed in the preceding chapter. Fletcher visited Tanzania once, where he spent four weeks in Dar es Salaam. He did not visit the Ruaha-Mtera site; instead, he worked from Stockholm most of the time.[67] Fletcher realised in his analysis that data collected by SWECO consisted of a series of Kidatu discharges for 12 years only; hence, they were insufficient. He commented in the report to SIDA that the data were "of course, really too short for the purpose."[68] He also noted that the Ruaha Rivers (Kidatu and Mtera) had high variation between the dry and wet spells. In comparison to Wami, the Kidatu and Mtera sites were more problematic. He found, moreover, that the Great Ruaha had a sharp variation between dry and wet spells; and thus, they were not potential sites compared to Wami.[69] Like how McCully upholds that builders of high modern power dams built infrastructure without sufficient data while hoping for the "hydrological best", Fletcher ended up estimating and smoothing some data on the difference between high and low water discharge in the Great Ruaha River and hoped that no problem will crop up in future. He commented that the variation was significant but "a 12-month drought period of such an

[66] *Ibid.*
[67] Öhman, *Taming Exotic Beauties*, 267.
[68] *Ibid.*
[69] *Ibid.*

outstanding nature" could "hardly be expected to occur again within the degree of probability assumed."[70] In this way, he not only normalised the discharge of the Great Ruaha (Kidatu and Mtera) rivers but also predicted the atmospheric conditions of the Rufiji Basin throughout the (fifty year) life span of hydropower plants, by dismissing the possibility of droughts in the future. To use Öhman's words, Fletcher created an artificial Ruaha and Klar Rivers to make Great Ruaha a complex Great Ruaha power mega-project.[71]

The pre-investment study for Phase I of the Great Ruaha Power Project was another unscientific study which explains the fall of water levels at Mtera and the vulnerabilities of Tanzania's grid. The pre-investment was an essential study as it would provide detailed aspects of the project for negotiation with the World Bank on financing. But TANESCO contacted only one engineering firm, SWECO, to undertake this study. SWECO started the study in October 1968 and took one year to complete, as shown in the previous chapter. However, SWECO studied the Great Ruaha catchment quickly to reduce costs and hasten the completion of the project. It did only some site investigations in the project area instead of the whole catchment. In a memo to TANESCO on the question of building the Mtera dam as a reservoir for the Kidatu power plants, Erling Reinius and Per Åke Nordström, SWECO consultant engineers in Stockholm, commented that it left many things unanswered. They revealed further that in the whole year of the pre-investment study, SWECO did not comprehensively cover the Mtera upstream, but their data were based on FAO RBS and Balfour, Beatty & Co. Ltd. Reinius and Nordström explained that "SWECO Pre-investment Study (1969) of the Great Ruaha Power Project is partially based on earlier studies. SWECO has not made any site investigations in the upper part of the river, upstream of Mtera", but it based its studies on the "FAO Report on map and hydrological studies."[72] They further commented that it "is true that the evaporation losses are very great", and it would need the dam to be highly regulated to avoid low power generation.[73]

The successful building of a dam needs collection and evaluation of adequate data on water discharge and rivers flows. Dams' builders had to wait for an extended period before they could obtain meaningful data because many African rivers lacked hydrological and discharge

[70] Fletcher, Klarälven, Wami and Great Ruaha: SRA, F1AB 1388, cited in Öhman, *Taming Exotic Beauties*, 270–271.
[71] Öhman, *Taming Exotic Beauties*, 270.
[72] SNA, SIDA File No. 1 TAN 32.1, F13B 1: Memorandum by Erling Reinius and Per Åke Nordström to TANESCO, "Some views of the Mtera Reservoir," dated 2 May 1972.
[73] *Ibid.*

data. This process was both time-consuming and costly and system builders were not prepared or ready to wait. [74] This study argues in line with McCully idea in *Silenced Rivers* that:

> Just as dam builders often skimp on geological surveys, so they have shown themselves willing to build based on seriously inadequate hydrological data. When there is not enough water to turn a dam's turbines of filling its canals, or so much water that the dam is threatened with breaching, an 'Act of God' – drought or flood – will invariably be blamed for the ensuing electricity shortages or inundation. However, an act of dam builders – construction without sufficient data to predict how much water is likely to be an available or deliberate disregard of unfavourable data – is more likely to be where the blame should be laid.[75]

This was evident in Tanzania's case. The Great Ruaha system builders, as can be seen above, attached priorities to the completion of projects which would allow for the export of technology and finance from the donors, which ended up overestimating data on annual flows and underestimating peak floods, while hoping for the hydrological best.[76] Even though SWECO did not conduct field studies in the Great Ruaha, this engineering consortium recommended the project go ahead because it was the cheapest and most economical site when compared to others.[77] Their study did not have sufficient data on future socioeconomic developments upstream of the Great Ruaha and Mtera rivers. Yet, they submitted the report in November 1969, and the World Bank and Sweden funded the project after a feasibility study in 1970.[78]

Beyond insufficient data, system builders also ignored opposing ideas especially from local experts and knowledge. As shown above, agricultural activities and water management upstream were the major cause for the fall in water levels, and the blackouts experienced in the 1990s onwards were also due to neglect of integrated water use, and potential water use conflicts in the future during the planning of the infrastructure. Following the growing socio-environmental impacts of large dam projects and environmental campaigns in Western Europe and Northern America in the 1970s, the World Bank required dam builders to conduct ecological studies to reduce their impact. Subsequently, SIDA funded TANESCO to tender the ecological study for the project. TANESCO tendered SWECO to undertake the study. Since the ecological study came late and as a new requirement when the project was about to take off, SWECO could

[74] McCully, *Silenced Rivers*, 105.
[75] *Ibid*., 104.
[76] *Ibid*., 105.
[77] *Ibid.*
[78] Öhman, *Taming Exotic Beauties*, 204–205.

not undertake it. Instead, Olov Hedberg, an assistant professor of systematic botany at the University of Uppsala, was contracted to conduct the study.[79]

Hedberg began the study in 1969, and the reports were due in September 1970 (for Phase I) and in 1971 (for Phase II) of the Great Ruaha Power Project. Besides, the project could not wait for the results of the ecological studies, if Hedberg would find "[n]o insurmountable ecological problems".[80] When Hedberg's first report was published on 1st September 1970, it identified some positive and negative impacts of the project, but it did not fail funders as it stated that the negative aspects would not have any notable effect. It eliminated the chance of agriculture upstream by pointing that "the possibility for agriculture was at the lower part of Kidatu and not at the upper catchment of Mtera."[81] He also recommended further studies on soil erosion, vegetation changes (implanting), resettlement, and the need for integrated planning of the basin.[82]

TANESCO organised and conducted a series of multipurpose planning meetings with different water users and stakeholders in the early 1970s in response to Hedberg's proposal. The main agenda in the integrated meetings was to determine how power infrastructures could be built and exist harmoniously with other water users. Each department was required to submit its observations on the project to the Ministry of Development and Planning (Devplan).[83] However, there were delayed responses and collaborations in the integrated planning meetings. Only a few departments responded to these meetings. Some staff members of the Water Development and Irrigation Department (WDID) in the Ministry of Water and Energy, during the integrated planning meeting in 1972, resisted the building of the reservoir at Mtera. They claimed that the area had a high evaporation rate which would dry the dam and become wastage.

A senior expert water and irrigation engineer from the Water Development and Planning Department, A. Buchanan, warned the members of the high rate of evaporation at Mtera and possibility of agricultural development upstream of Mtera. In his viewpoint, building

[79] SNA, SIDA materials, File No. 1 TAN 32.1, F13B 1: TANESCO Great Ruaha Power Project Tanzania; Report on Phase IA: Ecological Study, September 1970.

[80] SRA, F1AB 1391, IBRD, Public Utilities Project Division, Green cover, Report No. PU-48, confidential, Tanzania: Appraisal of the Kidatu hydroelectric project of Tanzania electric supply company, Ltd, 31 July 1970, 8 as cited in *Öhman, Taming Exotic Beauties*, 205.

[81] SNA, SIDA File No. 1 TAN 32.1, F13B 1: The TANESCO Great Ruaha Power Project Tanzania; Report on Phase IA of Ecological Study, September 1970.

[82] *Ibid*.

[83] SNA, SIDA File F13B: 1: Torben Rosendal, SWECO's country representative, Minutes of the Multipurpose Meeting. 21 July 1971 and F. Sechambo, "Great Ruaha Power Project Ecological Study", Confidential, dated 20 July 1971.

the Mtera reservoir as a storage dam for the Kidatu power plants would be an economic loss.[84] Buchanan was a long-time experienced British water and irrigation engineer who had worked with the British colonial government; hence, he had extensive know-how on water inflow and water use in the basin. In 1972, Buchanan sent a letter to Devplan, as a secret memo, explaining the uncertainties of the Kidatu-Mtera hydroelectric project. He backed his compilation with data on the Mtera reservoir. He advanced that:

> From the surface area of Mtera reservoir, full and spreading over 600 km squares, the annual evaporation is estimated at 1350 mil. m^3. The estimated average annual evaporation at 940 mil.m^3 will be a total yearly loss to the Great Ruaha Valley, and also probably to Tanzania, of water resources sufficient to irrigate 400 km^2 (or 100,000 acres). The Balfour Beatty Report of May 1967 had allowance in their calculations for Mtera dam for 300,000 ac, ft. for irrigation upstream but SWECO design seems to make no such allowance. Indeed, if Mtera is to go ahead as planned it will be necessary to restrict all new water usage in the basin – an area extending from Itigi in the North to Njombe in the South, West to Mbeya and East to Iringa in order to feed this wasteful Mtera reservoir.[85]

TANESCO received this memo from the Devplan two days later and the company sent it to different actors for comments. Erling Reinius and Per Åke Nordström were the first to comment. As stated above, they agreed that SWECO did not investigate the Mtera upstream and that Mtera had high evaporation rates. Thus, SWECO's choice of Mtera was based on the Article 5.02 of the Joint Financing Agreement of 4 December 1970 between Tanzania, Sweden and the World Bank, in which the Tanzanian government committed to no water abstraction upstream.[86] The agreement said: "Tanzania shall not permit any abstraction of water from the Great Ruaha or its tributaries upstream of Kidatu that will in any way reduce the potential output of the Kidatu generation Station."[87] Hence, different actors of the Kidatu-Mtera power project considered future water abstraction upstream as a permanent impossibility. They commented that no major development of irrigation schemes along the upper Great Ruaha River and its tributaries was anticipated in 20 years from the mid-1970s. Reinius and Nordström

[84] SNA, SIDA material, file F13B:1: Minutes of the meeting on "Ecological Study" held on 17 January 1972 at Devplan's conference room.
[85] SNA, SIDA material, file F13B:1: A. Buchanan "Confidential Memorandum to Devplan on Proposed Mtera Dam," dated 22 February 1972.
[86] SNA, SIDA File F13B:1: Erling Reinius and Per Åke Nordström, "Memorandum called 'Some views of the Mtera Reservoir'," dated 2 May 1972.
[87] SNA, SIDA Material, 1 TAN 32.1, F13B 5: Report by the World Bank (IDA) on Tanzania loan for Mtera in which section 5.03 of the Joint Financing Agreement and Letter from F. S. Batty to F. K. Lwegarulila dated 5th September 1971; Letter from F. K. Lwegarulila to TANESCO.

insisted that for economic reasons Mtera could be developed as a storage reservoir for the Kidatu power station despite its shallowness. But in their final statement, they called for a further review of Buchanan's concerns.[88]

Their comments reached TANESCO on 15 May 1972. Three days later, TANESCO replied to Buchanan that it was aware that Mtera "would have repercussions", but it was confident that the measures that were being proposed and taken would limit them to an acceptable level since the project's pros outweigh the cons.[89] The economic profitability of the Mtera was not doubtful to Buchanan. In his earlier report, he had pointed out that although Mtera was the cheapest economic option, it should be abandoned for the future good of Tanzanians. He espoused that it would be better to go for expensive alternatives that would allow both sustainable agriculture and electricity. He informed that at the "cost of Shs.34 million, Mtera dam may be the most economical means of ensuring that Kidatu develops it full 200 MW capacity but this surely does not take into account the long-term development of the upper Great Ruaha basin which is dependant largely on adequate water supplies."[90] He further said: "altogether Mtera dam will be wasteful of water resources and wasteful of good fertile land, 600 km^2 – an area the size of Bahi swamp and just as wasteful."[91] Hence, he suggested that TANESCO should find other alternative sites such as the Lukosi River, or Little Ruaha, which is the principal tributary of the Great Ruaha, the Ngerengere, and the Iyovi rivers.[92]

After TANESCO claimed that it could deal with the environmental effects, Buchanan questioned the utility's absolute authority over the Rufiji Basin waters because he was sure that Tanzania would breach the water rights agreement in the future. R. K. Jain, another senior irrigation engineer at WDID, also believed that "whenever irrigation will come into the picture, even 30 years in the future, it should be the priority over the power project."[93] TANESCO should leave the Mtera upstream to farmers because agriculture would always take precedence over other water uses. Buchanan wrote:

> TANESCO has no authority for deciding whether or not allowance should be made for irrigation water upstream of Mtera. Tanzania will break the Agreement on water something which will lead to abstraction of 900 million

[88]SNA, SIDA File F13B: 1: SWECO Great Ruaha Power Project – Tanzania: Summary of recommendations of ecological study.
[89]SNA, SIDA File F13B:1: Letter from TANESCO to A. Buchanan, dated 13 May 1972.
[90] SNA, SIDA File F13B:1: A. Buchanan "Confidential Memorandum to Devplan," *ibid*.
[91] *Ibid.*
[92] *Ibid.*
[93] *Ibid.*

> cubic metres of water, by evaporation. Purely from the shillings-per-kilowatt point of view Mtera dam provides the most economical but from broader view of development – of Tanzania - Mtera reservoir 'will clearly be wasteful of resources and most uneconomical so that obviously some more expensive solution must be found in the economic interests of the country.' The development of the main agricultural sector of our economy depends primarily on abstraction of water for people and livestock and later for irrigation. By attempting to stop further abstraction of water from an area of 26,000 square miles, TANESCO is proposing to freeze all development in this huge fertile block, 1/12th of Tanzania's land area. This is impossible to contemplate in the best interests of the country; it is not even in the long-term interest of TANESCO who need more development to sell more megawatts."[94]

Notwithstanding challenges from officials of the Water Development and Irrigation Department, TANESCO and other system builders went ahead with the Mtera dam project. They hoped that Tanzania would not contravene the agreement on water abstraction upstream and that there would be no development of agriculture upstream. As McCully contends, the discovery of problems in the construction sites would not stop the projects in the high modernism dam-building era. The so-called experts built the dams even when it was evident that the scheme would face critical problems in the future. [95] For instance, he shows that in the early 1970s, the consortium of German-Swiss-US LAMI engineers discovered that the geological structure of the sites would affect the dams but pushed for the project regardless. Ultimately, the cost of their building, repair, and maintenance raised and continued to be a burden to the Guatemalan electricity power utility.[96]

At the time when the Kidatu and Mtera power plants were built, there was trust in western-based experts and their studies while ignoring the views of local experts and local communities. Despite findings that ignored local knowledge and contexts, donors endorsed them only because western experts had elaborated the studies. Öhman uses "scientific alibi" metaphorically to characterise the building of power infrastructures at Great Ruaha in the 1960s to 1980s. She contends that, in this process, postcolonial leaders favoured western experts and engineers, and they accepted their reports based on their western institutional affiliations rather than on their findings.[97]

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[94] SNA, SIDA F13B:1. Letter from A. Buchanan to TANESCO dated 8 June 1972.
[95] McCully, *Silenced Rivers,* 103–104.
[96] *Ibid.*
[97] Öhman, *Taming Exotic Beauties*, 234–235.

When sharing his experience on donor-funded electrical infrastructure projects in Tanzania during a conference on Nordic dam-building in the South in Stockholm in 1994, Claude Mung'ong'o, (a sociologist and professor of environmental resources and climate change at the University of Dar es Salaam) reports that those studies lacked comprehensive coverage. He stated that the terms of reference given by donors "were too restrictive that our operation had to be confined within the project area. We had no mandate to go beyond that, even if we wanted to follow up any issue upstream, we could not do it. Our terms of reference were based on the site of the dam. That is why the final report that was produced was a report on the dam site and not on the catchment."[98] Mung'ong'o claimed further that 'local' experts when employed in feasibility studies were used as "rubber stamps."[99] Western consulting firms used 'local' experts as a reference point that the research involved "several local scientists who agreed that this project was safe."[100] However, the final reports remained secret and unquestionable even if they failed to capture important aspects that might affect the project.

Moreover, Vijay Paranjpye, an Indian environmental economy professor, labelled dam-building in the Global South between the 1960s and 1980s a non-participatory, undemocratic, and confidential endeavour. He claims that the so-called 'experts' from the Global North described technologies and projects they transferred to the South in terms of positive results to get acceptance, while taking for granted the quality of technology they transferred and their environmental assessments. Unfortunately, the Global South's political leaders concerned never questioned these projects because they were overwhelmed by decolonisation and the desire to modernise. They thus trusted foreign experts and engineers, and whenever local people raised their voices against such infrastructures, the leaders commented that experts would take the necessary precautions.[101] He contends that:

> When you have planners [of a large infrastructure project] coming from the World Bank or the Nordic countries, saying 'we have the technology and we have the money to do it', our governments tend to accept it immediately, and give less attention to cost/benefit ratios, internal rates of return on investment, social and ecological impacts. [. . .]. Dams are not discussed in the parliament as much as they should, the argument being that the experts are handling this.

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[98] Claude Mungo'ngó, "Realities of Environmental Impact Assessment for the Pangani Falls Dam", in Nordic Dam-Building in the South: Proceedings of an International Conference in Stockholm, 3–4 August 1994, 33.
[99] *Ibid*.
[100] *Ibid.*
[101] Paranjpye, "History of the Large Dam Controversy", in Nordic Dam-Building in the South: Proceedings of an International Conference in Stockholm, 3–4 August 1994, 9.

> We lay-persons have nothing relevant to say about a high technology being exported by a post-industrial society. [102]

Paranjpye's concerns in this quote were evident in the way TANESCO and the Tanzanian government handled the ecological studies of the Kidatu-Mtera hydroelectric power. TANESCO and western electrical firms pushed the project while discarding views of the WDID officials. Later, paddy irrigation expanded upstream of the Mtera dam leading to the drying of the dam.

Furthermore, the vulnerability of TANESCO's power systems in the 1970s to the present day can also be better explained in terms of the '(in)appropriateness' of the technologies transferred to Tanzania in the building of the Mtera power plant in the 1980s, rather than derived from the interconnectedness and interdependence of infrastructure systems. Chapter 2 of this dissertation has shown that TANESCO installed a power plant at the Mtera dam, contrary to its initial plans. The plant added 80 megawatts to the TANESCO system setting the Kidatu-Mtera interlinked infrastructure's total capacity at 280 megawatts. However, the construction of this plant became a source of vulnerability in the interconnected Tanzanian system. A technical problem happened during the building of the plant. The available archival sources show that the turbine supplier failed to comply with technical specifications and engineers at reconstruction sites tried to redress the error without success. Therefore, one of the turbines installed at the Mtera dam was below the required technical standards, and it led to poor performance in electrical generation. The World Bank report on the completion of Mtera proclaimed that the fault would "significantly reduce functioning technical efficiency even after all feasible remedies have been applied."[103] It stated further that the defected power turbine would have an impact on power generation because it would generate below the required standards.[104]

Nevertheless, despite these identified technological defects, system builders installed the turbine and celebrated the commissioning of the Mtera plant as a political and technical milestone. The decision to install a turbine which had insufficient specifications raises some questions regarding the appropriateness of the technologies. Willoughby defines inappropriate technology on the basis of the severity of unforeseen side effects. He contends that the

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[102] *Ibid.*

[103] The World Bank, "Memorandum to the Executive Directors and the President of the World Bank, Re: Fourth Power Project - United Republic of Tanzania: Project Completion Report", (A cover letter, no page number), *The World Bank Report No. 12556*, 29 November 1993.

[104] *Ibid.*

"inappropriateness of technology might stem from its being deployed in a context quite different to that for which it was designed, or it might be manifested in the harmful effects of technology upon one class of people."[105] To him, technology might also become inappropriate to the specific purposes it was designed to do. Willoughby also notes that technical incompetence of the designer or the inability to relate technical parameters to the real world of practice can also make a particular technology inappropriate.[106]

In conjunction with this conception, the turbine installed at the Mtera dam was inappropriate technology. Its "technical parameters" were substandard, and it impacted the performance of TANESCO's interconnected national system in the 1990s. For instance, within only two years after the installation of this turbine, the Tanzanian Minister for Water, Energy, and Minerals mentioned it as one of the major reasons for frequent blackouts in Dar es Salaam. The minister testified: "low power generation at Mtera and resultant repetitive power outages in the country was because one of the turbines has failed to generate power since its installation."[107] It was apparent to system builders that the installed turbine was substandard. Yet they continued with the project. Paranjpye characterises dam-building in the high modernism period saying that the quality of technologies shifted to the South dwindled and collapsed because of inadequate environmental impact assessment and that the technical appraisal committees had done a bad job, "technical flaws emerged, and incidents of dam failures rose enormously."[108] This reveals that tolerating technical flaws was part of high modernism dam-building in the 1970s and 1980s.

Last but by no means least, the decision to increase the Great Ruaha Power project in 1979 from 200 MW to 280 MW by installing a power plant at the Mtera dam in 1988 aggravated the vulnerabilities of the TANESCO system. First, it increased overreliance on hydropower sources which are more prone to changes in rainfall patterns in the tropics than the coal technology proposed by Acres. If coal had been installed, it could have bolstered power capacity during droughts and dry seasons. But the overdependence on hydropower reduced the resilience of the power system and increased vulnerability, as TANESCO had to reduce power generation during the dry seasons causing power outages in towns and cities. Moreover,

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[105] Willoughby (1990), 18-19 as cited in Akala, "In the Technological Footprint", 184
[106] *Ibid*., 184.
[107] See Jamhuri ya Muungano wa Tanzania, Hotuba ya Waziri wa Maji, Nishati na Madini, Luteni Kanali Jakaya Mrisho Kikwete, Mbunge, akiwasilisha katika Bunge Makadirio ya Matumizi ya Wizara ya Maji, Nishati na Madini kwa Mwaka 1990/91, 18.
[108] Panjapye, "History of Large Dam Controversy," 9.

installing the plant at Mtera, instead of building it at another river tributary, meant the fall in water levels affected not only the 200 MW at Kidatu but also the 80 MW at Mtera.

The installation of 80 MW in the late 1980s in the same river system led to cascading failures of the power generation infrastructure in the 1990s onwards. One of the interviewees at TANESCO emphasised that the Mtera dam dried because pertinent viewpoints from experts who opposed the project were ignored. She stated that some TANESCO staff members had warned about the possibility of abating water flow to Kidatu, but these views were overshadowed by 'appropriate international' appraisals.[109] She insisted that if the plant installed at Mtera dam would have been built in another Great Ruaha tributary, the fall in Mtera water levels would not have affected the entire power system.[110] Despite the concerns raised by opposers to the Mtera power project, the responsible actors built the plant and created a cascading power system that depended on a single-river system. This meant that the fall in water levels at the Mtera dam in the 1990s had deleterious consequences on the entire interconnected national network.

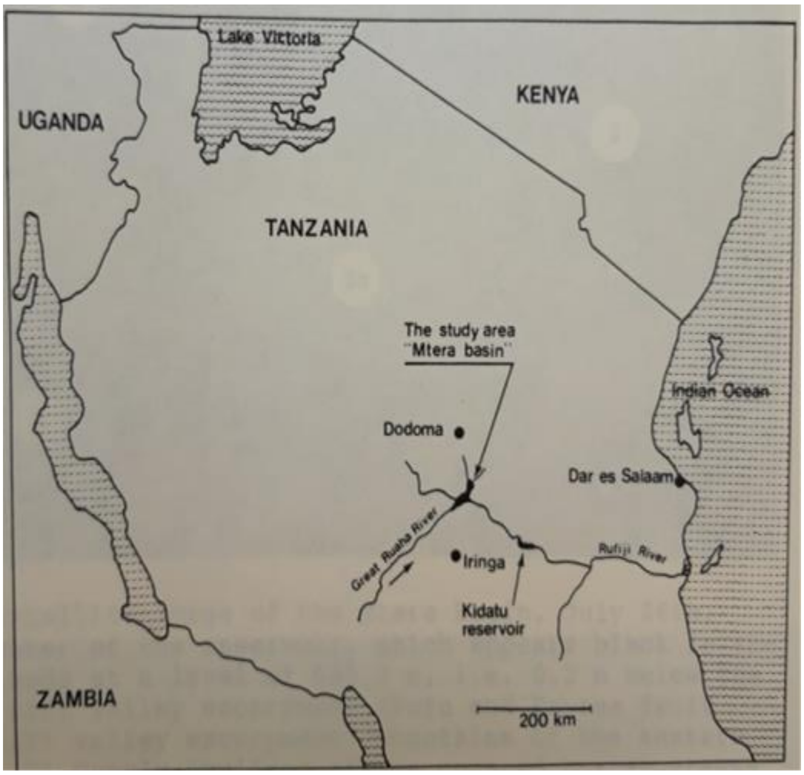

Figure 3.3: *The Position of the Mtera and Kidatu Hydropower Cascade System.*
Source: SWECO Report, in Swedish National Archives, SIDA File F13B: 23

[109] Interview, Ubungo – Dar es Salaam, 9 August 2018.

[110] Interview, Ubungo – Dar es Salaam, 9 August 2018; this claim was repeatedly noted by other informants, but in different ways, for instance: Interview, Ubungo – Dar es Salaam, 10 August 2018; and, Interview, Ubungo-Dar es Salaam, 15 August 2018.

Generally speaking, this section has shown that vulnerabilities in the power systems since the 1990s were caused by the fall in water levels of the largest hydropower infrastructure in Tanzania: Mtera and Kidatu. The declining Kidatu-Mtera water levels went beyond the narratives of seasonal rainfall shortages or human environmental degradation, mainly due to neglect of the ecological and environmental impact of upstream agricultural development which system builders had been warned about since the 1970s. While TANESCO's top leaders and the government of Tanzania have continued to link the vulnerabilities of power networks with changes in hydrological patterns and environmental degradation, this section claims that it was caused by the high modernism technological inefficiencies between the 1960s and 1980s. Consequently, the vulnerabilities in these systems need to take into account their building history and inappropriate planning rather than the more recent manifestations of the problem, such as expansion of rice irrigation or the adoption of Independent Power Producers (IPPs).

3.4 Maintenance Works, Technopolitics, and Blackouts

There is undisputable insight that in many sub-Saharan African cities, maintenance works have bearing on electricity disruptions. But most scholars have argued that infrastructure fail due to lack of maintenance and repair activities. Unrepaired and poorly maintained power systems lead to frequent breakdowns. For instance, Jevgenijs Steinbucks and Vivien Foster start their article "When do firms generate?" with the phrase that: "Most of the continents' power companies are unreliable sources of supply, inefficient users of generating capacity, deficient in maintenance, erratic in the procurement of spare parts,"[111] and other managerial disorders. Steinbucks' and Foster's article focuses on how electricity consumers in Africa generate their own electricity by using off-grid artefacts like diesel- or petrol-powered generators and solar home systems in response to critical power outages. Hence, they do not go into any details on the existing state of inadequate repair and maintenance. However, their idea that erratic power supplies in this region are also caused by deficiencies in repair and maintenance as well as procurement of spare parts is important, especially in the case of TANESCO. In TANESCO, maintenance and repair works were not lacking – they were done regularly as preventive measures against power outages and as directed by manufacturers of various electrical

[111] Jevgenijs Steinbuks and Vivien Foster, "When do firms generate? Evidence on in-house electricity supply in Africa," *Journal Energy Economics* 32, no. 3 (2010): 505-514, 505.

equipment. The presence of such maintenance works, as this section will argue, has contributed to long periods of blackouts because of overdependence on electrical experts, materials, and equipment from developed countries.

Maintenance, as a concept, has been defined widely by scholars as the practice, science, art and philosophy of making technical artefacts or systems operate correctly, based on repair, lubrication, visual inspection, investigation, non-destructive testing, and replacement of parts and components.[112] Graham and Thrift uphold that sometimes there is no clear demarcation between maintenance and repair because what can start as repair can become maintenance, improvement, innovation, and even growth.[113] Maintenance and repair encompass all activities that aim to make the grid perform in "near pristine condition."[114] Electrical power systems, like other technical artefacts, need maintenance to reduce their vulnerabilities (susceptibility to failures). Electrical engineers categorise maintenance into preventive, reactive, and predictive. There is no established guideline or timeframe for electrical network maintenance. Hence, electrical utility managers must decide when, what, and how their power infrastructure must be maintained by following recommendations from manufacturers, and accumulated experience in using certain components, as well as observable technical and health concerns such as tears, faults, and breakdowns.[115] Historians of technology agree that maintenance and repair works make technical systems resilient (the ability to absorb shocks, adapt, and transform). When these works are lacking, infrastructures become vulnerable—susceptible to failures.[116]

Extensive maintenance and repair became TANESCO's central focus in the 1980s to the 2000s. This is not to say that before this period there were no repair and maintenance works. The company has been conducting all predictive maintenance to identify weaknesses in the system and to restore the supply when the systems broke down, or as recommended by

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[112] *Ibid.*

[113] Stephen Graham and Nigel Thrift, "Out of Order: Understanding Repair and Maintenance," *Theory, Culture & Society* 24 no.3 (2007): 1–25, 6.

[114] *Ibid*.

[115] Keith Harker, "Power System Commissioning and Maintenance Practice", *Institute of Engineering and Technology* (2008); R. Keith Mobley, *An Introduction to Predictive Maintenance (2nd edition*), Butterworth, Heinemann: London, 2002); R. Keith Mobley, Lindley R. Higgins and Darrin J. Wikoff, *Maintenance Engineering Handbook (7th edition)* (New York, Chicago: McGraw Hill, 2008).

[116] For an overview of the literature on the significance of maintenance and repair in technical devices, see, for instance, Andrew L. Russell and Lee Vinsel, "After Innovation, Turn to Maintenance", *Technology and Culture*, 59 no. 1 (2018): 17; Graham and Thrift, "Out of Order,"; David Edgerton, *The Shock of the Old: Technology and global History since 1900*, (London; Profile Books Limited, 2006), 75–102.

manufacturers. It conducted maintenance activities such as inspections, repair, guarding and protecting the network through tree clearance, oiling, and changing some parts to allow the grid to operate without many disorders. But from the 1980s, repair became more urgent due to poor performance as described in section 4.2 above. The government and international donors realised that the breakdowns of the power systems, if not checked, would amplify the crisis, and affect the realisation of structural adjustment policies (SAPs).[117] Consequently, Tanzania's power systems experienced clinical maintenance activities for three decades from the mid-1980s to improve the reliability of the existing electricity generation capability, transmission lines, and distribution systems.[118]

Between 1985 and 1995, TANESCO conducted extensive repair and maintenance of distribution infrastructure in Dar es Salaam, Moshi, and Arusha cities, the major load towns, under the scheme known as the 'Tanzania Rehabilitation Project.' In Dar es Salaam, it started in 1985 and was earmarked 'Dar es Salaam Rehabilitation of Power Distribution Infrastructure.' The World Bank financed this project and the Japanese International Cooperation Agency (JICA) provided TANESCO with a loan of about 3 billion Japanese Yen (equivalent to US$ 4.65 million during that time).[119] Like many other projects, those who financed also provided the technologies and expertise. Most of electrical material and equipment as well as experts used in this project were imported from Japan. Japanese engineers worked with TANESCO experts and trained more technicians during the eight years it took to repair the power systems in Dar es Salaam. TANESCO House Journal commented in 1991 that "all linesmen and even labourers who participated in the upgrading and repair works learned to use new technologies."[120]

The scheme repaired distribution infrastructure in essential areas such as the city centre, Oyster Bay, Msasani, and Upanga area, Kariakoo, Regent estate, Kinondoni, Ilala, Sinza, and Magomeni. Power networks in these areas were installed during the British colonial and early postcolonial periods. These networks were old, weak, overloaded, and faced widespread breakdowns. TANESCO also expanded the scheme to low-income consumers in areas such as

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[117] EAF-UDSM Library: Tanzania's Five-Years Plan for the Union Development, 1986/1987–1990/1991, Vol.1: General Perspectives," (The Minister of Planning, Tanzania Mainland and Zanzibar, Government Printers; Dar es Salaam, 1986), 91–92.

[118] TANESCO Archives: Power Sector Development Plan 1985 to 2010: The Main Report, December 1985 by Acres International Limited.

[119] EAF–UDSM Library: TANESCO News Journal: House Journal of Tanzania Electric Supply Company Limited, November–December 1990; See also *Hotuba ya Waziri wa Maji, Nishati na Madini,* Al Noor Kassum*, Bungeni, Mwaka*1984/85, 18.

[120] TANESCO News Journal, November–December 1990.

Manzese and Kimara. These areas also encountered low voltage at about 80 volts; hence, the company saw that, if not repaired, they would deteriorate further and affect the supply in surrounding rehabilitated areas such as Sinza, Msasani and Oyster Bay.[121] The project involved repair of the Ubungo thermal plants built in the late 1960s and early 1970s to enhance the national grid during the building of the Kidatu hydroelectric plant in the 1970s.

The plants became essential backups after the completion of the Kidatu project as it was used to boost electricity voltage in Dar es Salaam. It lacked proper repair in the 1970s and 1980s and, as a result, its generation dropped from the installed capacity of 61 MW to 6 MW in 1985, making the interconnected system operate without a necessary voltage backup.[122] This scheme improved the functioning of power supply in Dar es Salaam by reducing power fluctuations and interruptions, as well as mitigating damage to domestic appliances.[123] The repair also "managed to eliminate most of the power outages and voltage fluctuations, thus making the life of the residents in these areas, occupied people in high-income groups, very comfortable."[124] The phrase that electricity consumers in repaired areas were "comfortable" seems, however, an overstatement of the advantages of repair schemes, as power outages continued, not least those caused by technical weaknesses but also intentional power rationing to allow repair to progress and electricity generation shortage in the 1990s.

TANESCO's grid repair programmes continued until the 1990s. But during this time, they focused on the transmission networks rather than the distribution systems. The maintenance scheme emerged as a proposal of the World Bank's group of experts (ESMAP) in 1992. The ESMAP study unveiled that despite the repair works done in the 1980s and the early 1990s, the increase in electricity demand and limited financial and technological capabilities of TANESCO in the 1980s had reverted the network to disruptions and required extensive repair.[125] Electricity power cuts escalated and the system had extremely low and fluctuating voltage in Dar es Salaam, caused also by poor engineering of the transmission lines from the Kidatu hydroelectric power plant to Dar es Salaam and Moshi. These vulnerabilities damaged

[121] *Ibid*.
[122] *Ibid*., 34–36.
[123] *Daily News,* "TANESCO seeks Japanese aid", 10 August 1990; The World Bank, Staff-Appraisal Report for Tanzania Power Rehabilitation Project (Washington DC, 1994); *Daily News,* "TANESCO asks for more aid from Japan", 10 April 1991.
[124] TANESCO News Journal: House Journal of Tanzania Electric Supply Company Limited, November–December 1990.
[125] The World Bank, "Tanzania Power Loss Reduction Study Volume 1", i.; The World Bank; Tanzania Power VI, 4.

consumers' equipment and appliances prompting critical maintenance and rebuilding of power generation, transmission, and supply infrastructures.

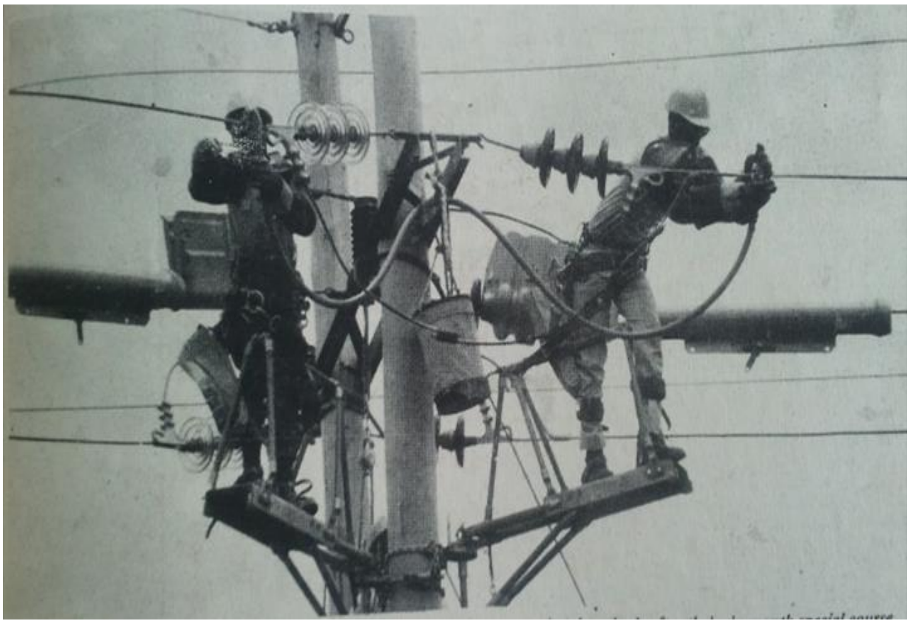

Figure 3.4: TANESCO engineers repairing power lines in Dar es Salaam
Source: *TANESCO News House Journal* (November to December 1990), 17.

TANESCO implemented several maintenance and repair projects during this time including the building a second 220-kilovolt transmission line from Kidatu to Dar es Salaam and a 220-kilovolt transmission line from Singida to Arusha to improve electricity voltage in the north-eastern cities in 1995 and 1996, respectively.[126] The repair works during this time also involved the rebuilding of the Pangani hydropower plant to increase its generation capacity from 17.5 megawatts installed by the British companies in the early 1950s to 66 megawatts in 1995 to reduce power rationing. TANESCO also received financial assistance from Nordic countries (Finland, Sweden, and Norway) estimated at 820 million Swedish crowns to rebuild the Pangani hydropower plant and the Kidatu-Dar es Salaam transmission line to reduce power disruptions in 1992–1995.Tanzania signed a contract with these donor states, which established that all the electrical materials, equipment and experts had to come from these countries, especially from Norway and Sweden.[127] TANESCO technicians would participate in this project

[126] *Daily News*, "Second Kidatu power line construction ready", 29 March 1993.
[127] SNA SIDA Material, File F13 X: 1: Idar Johansen, Terms of Reference: Pangani Redevelopment Project, dated 9 March 1993; See also: The Document of the Agreement between the Government of the Kingdom of Norway (on behalf of donors) and the United Republic of Tanzania signed on 12.11.1991, Dar es Salaam, in the same file. See also, SNA SIDA Materials File 13X: 1, Terms of Reference Pangani Redevelopment Project; Daniel Mshana, "Pangani

largely as trainees, to observe how to operate and inspect the plant. Besides donor-funded repair and maintenance schemes, everyday maintenance activities such as tree cutting, inspection, and fixing done by the utility's technicians to prevent breakdowns or restore power supply were also part and parcel of the repair and power outage landscape in the city.

Even though TANESCO and its collaborators initiated electrical power maintenance and repair schemes to reduce grid vulnerability and improve supply, these activities turned out to be a source of frequent power outages. They took very long to complete, they had become part of the company's daily activities, and they prolonged power blackouts due to restricted supply to users so the repair works could be conducted. Repair activities became a new source of electricity users' complaints since 1980s. In 1991, the *Daily News* reported on the power failures in Magomeni (one of the most densely populated residential and commercial areas in Dar es Salaam) specifying that notwithstanding "the much-publicised current electricity rehabilitation programme which has already gone through several phases,"[128] Magomeni experienced at least three day-long or overnight power failures. The newspaper reporter pinpointed that the inhabitants' felt their expectations were exceedingly frustrated, because instead of improving supply, the repair projects had done the opposite, escalating power cuts.[129]

In 2000, a dispute emerged between Dar es Salaam's residents and TANESCO over the maintenance works which increased their vulnerabilities. The activities involved repairing infrastructures, cutting tree branches, and installing various components in Dar es Salaam. When the tension reached the Dar es Salaam Regional Administrative Secretary, Wilfred Ngirwa, he intervened by stopping the company from repairs particularly during weekends so that Dar es Salaam's residents could enjoy reliable electricity.[130] The concerns that repair works deprived people's supply also crossed streets to the Tanzanian Parliament because whenever TANESCO implemented maintenance schemes or any routine repair works, it involved cutting electricity supply to consumers. In 2013, John Mnyika, the then Tanzanian Shadow Minister for Energy and Minerals, made the same claim. He condemned the frequent power outages in Dar es Salaam

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Falls Re-development Project*", Daily News,* 10 August 1992*;* See also "Power Supply in Tanga to improve", Daily News, 11 May 1993: Also *"Pangani Project to double power output";* SNA SIDA Materials File 13X: 1, Terms of Reference Pangani Redevelopment Project; And also, SNA SIDA materials, File No. F13X: 2: Norplan A/S Report on Pangani power plant; The Document of the Agreement between the Government of the Kingdom of Norway (on behalf of donors) and the United Republic of Tanzania signed on 12 November 1991, Dar es Salaam, in the same file.

[128] *Daily News*, "Erratic power supply," 21 May 1991.

[129] *Ibid.*

[130] *Daily News* "TANESCO assures smooth power supply," 28 October 2000.

caused mainly by maintenance programmes. In his speech at the Tanzania National Assembly, Mnyika commented that repair and maintenance of electrical supply lines had become a stooge for unannounced power shedding in the city making inhabitants vulnerable. His statement came after the Tanzanian government had proclaimed that TANESCO had completed all repair schemes; but still, the city experienced critical power failures because of on-going and unannounced repair works.[131]

The interviews conducted in this study also emphasised this situation by pinpointing that the main task of TANESCO's technicians was to cut and restore power. While the main point they wanted to make was the poor provision of electricity and the company's high degree of negligence when it came to power cuts, their narratives shed light on repair works and power failures. One of them put it this way: *"*whenever one sees TANESCO technicians in the streets, he/she has to know that power will go off soon or it has already been cut."[132] These accounts corroborate the documental review of various TANESCO programmes and reports and prove that repair and maintenance activities were among the major sources of power unreliability. For instance, TANESCO's records of unserved energy between 1992 and 2012 show that maintenance activities were one of the top three sources of blackouts in the country. The company also estimated that it had lost about 3 billion kilowatt-hours of energy through power shedding, faults, and maintenance between 2001 and 2011. About 16 per cent of the lost amount was due to maintenance and repair works.[133] TANESCO shut down its several power plants alternatively for 30 weeks in 2012 to conduct repair works. The company's Power Master Plan estimated that such repair works would contribute about 40 per cent to the forced outages in the country, excluding the planned repairs of transmission lines and all unplanned repairs.[134]

The circulation of technologies in the form of materials and knowledge required for maintenance works was one of the major problems that contributed to escalating power network vulnerabilities in Tanzanian cities. We have seen previously in this section that the most comprehensive maintenance schemes since the 1980s were in the form of development projects supported financially and technically by donors, such as the Nordic countries, Japan,

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[131] John J. Mnyika, Waziri Kivuli wa Nishati na Madini: Hotubakatika Bunge la Tanzania May 2013, 43. He claimed that TANESCO delayed repair works and extended power cuts in the city. In his speech, Mnyika expounded that the government and its electrical power utility, by importing electrical materials and equipment, were noted to be the main cause of extended repair works and blackouts.
[132] Interview 18, restaurant owner, Manzese-Dar es Salaam, 24 August 2018.
[133] TANESCO, Grid Control Department Data Sheet, 2018.
[134] TANESCO Power System Master Plan (2012), 55.

the United States, and other members of the World Bank. For instance, in the 1990s, Tanzania obtained 40 million USD from the World Bank and 3 billion Japanese Yen from Japan under the *Tanzania Power Sector Rehabilitation Project* to repair and upgrade its distribution and transmission lines in Arusha, Moshi and Dar es Salaam, as shown above.[135]

Financial and technical support became one of the major hindrances at the root of prolonged power outages in the country. They created overdependence on skills and spare parts. As Jan Af Geijerstam argues in *Landscapes of Technology Transfer*, the lifeline of transferred technologies in the form of development projects remains more closely linked to the inventors' environment rather than the local context to which they are transferred.[136] Technologies can "operate for decades as alien enclaves, linked to distinct suppliers and customers with little or no local articulation."[137] The donors who funded TANESCO's infrastructure, both construction and repair projects, enabled the geographical relocation of technologies rather than the diffusion of skills to the recipient end, i.e., TANESCO.

The way technologies were transferred created more dependence on the donor states, thus prolonging the problem of spare parts and expertise. Technology transfer was a vital component in these schemes. It was done through the training of TANESCO technicians to expand their technical knowledge of how to operate and perform various maintenance activities after the project was concluded. Foreign experts were paid by project funds to train TANESCO technicians through handiwork or sponsoring for seminars, short and long courses in-country and abroad in countries such as Germany, Japan, Sweden, etc., depending on the project funding agencies. The technical training was done through practical learning from foreign experts during the implementation of projects. Some foreign experts were stationed in Tanzania after the end of a project to extend the training programmes.

The sources consulted show that on-site training received mixed perceptions among the actors and the trainees themselves. On the one hand, some actors perceived them as successful despite their shortcomings. On the other hand, interviews emphasised that the

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[135] The World Bank Online Archive: Report No. 6026 – TA: Staff appraisal report Tanzania Power Rehabilitation Project, 9th April 1986, iii; EAF-UDSM Library: *Hotuba ya Waziri wa Maji, Nishati na Madini*, 1989, 7. See also SNA SIDA File No. F13B: 16: On Evaluation of Tenders repair of Kidatu Power Plant and Improvements of Grid System voltage; also, Terms of Reference for Urgent Repair of Kidatu Power Plant and Improvement of Grid System Voltage in the same file.

[136] Jan Af Geijerstam, *Landscapes of Technology Transfer: Swedish Ironmakers in India 1860–1864,* (Jernkontorets Bersghistoriska Steriftseries 42).

[137] Daniel R. Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940*, (New York and Oxford: Oxford University Press, 1988), 12.

foreign experts controlled the training programmes strictly to the extent that the trainees had little opportunity to learn beyond the trainers' instructions. TANESCO's technicians ended up becoming assistants to the foreign experts instead of being trainees.[138] One TANESCO worker who participated in the project to repair Dar es Salaam's distribution systems funded by the JICA in the 1990s commented that: "training took quite a long period of almost five years. But we ended up working as helpers of the Japanese engineers. The mastery level was below standard but helpful to our everyday repair practices. When it comes to something critical the company has to arrange for Japanese experts to come."[139] The observation from interviews corroborate one of the Norpower local training reports, which insisted that the training was inefficient and had improper monitoring. It restricted TANESCO engineers from acquiring full transfer of the expected knowledge.[140] While they were considered a part of the technology transfer, the on-site training gave TANESCO technicians simple skills such as how to oil or clean machines but not how to conduct intensive repairs. In other words, the skills obtained and experienced in power infrastructure projects were less satisfactory because trainees were limited to a lower level of repair skills, hence, a deeper repair knowledge of these technologies remained "black boxes" to TANESCO's trained technicians.

To function properly, technological artefacts need sufficient skills to adapt, modify, alter, and repair them. David Edgerton terms this process as creolisation—that is, how technologies invented somewhere else mix with new settings and users' skills to offer the required services efficiently. Edgerton contends that as technologies move from a place of origin (rich world) and find new areas (mainly in the poor world), they fuse with local technologies through remodelling to adapt them to local environments in hybrid form—a mixture of foreign and local designs.[141] In his study of Nairobi's urban water infrastructure, for instance, Akala shows that while the extensive, technically centralised water supply system experienced significant shortcomings, Kenyans were able to navigate through by infusing their local expertise into making imported technologies more useful to them. It was only through co-engineering and co-existence of foreign and domestic knowledge that Kenyans were able to meet their

[138] Interview 14, an engineer, Ubungo, 18 August 2018*;* Interview 2, an engineer, Ubungo, 9 August 2018; Interview, engineer, Kimara, 10 August 2018.
[139] Interview, an engineer, Ubungo, 18 August 2018.
[140] SNA SIDA File F13X: 2: United Republic of Tanzania, Ministry of Water, Energy and Minerals, Pangani Falls Redevelopment Project 8th Semi-Annual Meeting Status Report for the period January–June 1995.
[141] Edgerton, *The Shock of the Old,* 101; Edgerton, "Creole Technologies and Global Histories," 75-112.

water supply needs.[142] In the same vein, Amit Prasad shows the importance of tinkering with black-boxed technologies when he explained that MRN and MRI machines were once imported in India as black-boxed technologies.[143] For so long, they operated in black boxes, and the Indians failed to use them to achieve higher results until Indian scientists altered them innovatively, obtaining henceforth far-reaching scientific results.[144] The main take from these scholars is that for transferred technologies to fit and run properly in new environments, they need to be altered and modified through local skills.

While these scholars generally agree that opening the 'black box' helps users to become conversant in the daily use of technologies, electrical technologies from various countries to TANESCO were transferred in black boxes and largely remained so. Manufacturing firms and suppliers used technology transfer contracts to ensure that the maintenance of most of the infrastructure they had transferred to TANESCO remained under their control. The technologies TANESCO received travelled with foreign experts to install, operate, and repair them. The TANESCO workers I interviewed testified to the existing restrictions in repairing some electrical power infrastructure, especially generating equipment. One of the officials commented during an interview that: "although [TANESCO] has qualified experts, we are not allowed to repair some of the equipment. We repair them to certain levels only; not intensive repair."[145] She insisted that this has remained the fundamental problem facing the everyday stability of power networks. These aspects lie beyond the company's decision-making ability because the foreign suppliers and manufacturing firms required the equipment, they supplied to TANESCO be repaired by their experts.[146]

One of the restrictions the company faced was not owning all the infrastructure it used for power generation. Despite operating in Tanzania, they were still under the control of western manufacturing firms. When they experienced failures or breakdowns, the company had to wait for repair experts to arrive from the manufacturers and suppliers. The main task of TANESCO technicians was to operate and inspect power infrastructure rather than repair them. "Our main work has been to watch over electrical networks and document what we see and

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[142] Akala, "In the Technological Footprint".
[143] Black-boxed technology is the opposite of appropriate technology. For a detailed study on appropriate technology and the ways it works in local conditions, see for instance, Peter D. Dunn "Appropriate Technology: Technology with Human Face," (London, 1978).
[144] Amit Prasad, "Burdens of the Scientific Revolution: Euro/West-Centrism, Black Boxed Machines, and the (Post)Colonial Present," *Technology and Culture* 60, no. 4 (2019): 1059–1082.
[145] Interview 4, an engineer, Ubungo-TANESCO, 13 August 2018.
[146] *Ibid*.

how they function. After that, we report to suppliers and manufacturers, if we observe any abnormalities," one staff member said.[147] Only the foreign experts had the legal rights to conduct intensive repairs. One of the interviewees recounted:

> The terms of purchase of most electric generating plants do not allow us [TANESCO engineers] to do comprehensive repair and maintenance until a certain number of years. Purchase agreements, in most cases, give the supplier the mandate to do repair and maintenance of the main machines for a long period, almost half of the plants' life span. [. . .]. TANESCO gets permission only to make simple maintenance and repairs. And nowadays the machines [power plants] are becoming more sophisticated, the suppliers' experts use a password so that no one can do repair work except legally contracted engineers from abroad. In thermal plants, for instance, the terms of purchase restrict us [TANESCO] to repair for about five years, which is almost a quarter of the plants' life span, if well maintained. [. . .] This makes it difficult because whenever faults or breakdowns occur, TANESCO must contact the supplier to bring experts to inspect and initiate the repair process. Normally, this takes a couple of weeks for experts to arrive, and during that time, the Company had to shed power.[148]

This quote ponders on the dependency created by the politics involved in the transfer of technical artefacts and knowledge, particularly in the form of development projects. The transfer agreements restricted tinkering and adaptation of the technology to a local context; hence, they prolonged maintenance works and blackouts. It also alludes to the 'technopolitics' expounded by Timothy Mitchell and Gabrielle Hecht. 'Technopolitics' delve into the political economy and politics of technological artefacts as they circulate and are traded from one part of the globe to another.[149] 'Technopolitics' as a concept is used by these scholars to argue that technologies are not neutral or mere monuments, but they are economic commodities carrying national identities and are used to achieve political goals. It illustrates the complexities that influence design, flow (transfer), usage, control, and power of technologies in attaining economic and political objectives of the contemporary world. It refers to politically strategic technological design that influences symbolic meaning, distribution and circulation of materials and artefacts across the globe.[150]

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[147] Interview 2, an engineer, Ubungo, 9 August 2018.

[148] Interview 2, an engineer, Ubungo, 9 August 2018; This idea was also evident in Interview 4, an engineer, Ubungo, 13 August 2018; Interview 6, an engineer, Ubungo, 15 August 2018.

[149] Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity,* (California: University of California Press, 2002); Gabrielle Hecht, "Introduction" in *Entangled Geographies: Empire and Technopolitics in the Global Cold War*, ed. Gabrielle Hecht (Cambridge, Mass.: The MIT Press, 2011), 3.

[150] Gabrielle Hecht, "The Power of Nuclear Things," *Technology and Culture* 51 (2010): 1–30.

Technopolitics can make technologies limiting or liberating because the marketing of technical things never circulates autonomously.[151] Designers of technologies, who Hecht calls the 'technologists', normally design technologies in such a way that they are able to extend their influence on the users in the future period.[152] They are influenced by a designed economic and political power that perpetuates the inclusion and exclusion of people and places. In this process, experts become powerful agents in the design, flow, and control of technologies and their intended political and economic goals.[153]

Many sophisticated components in TANESCO's systems were shaped by such technopolitics. Technology transfer contracts restricted localisation or creolisation of electrical equipment. They continued to operate in Tanzanian cities, but their repair continued to depend on foreign experts. For instance, in October 2005, when the Tanzanian general election campaigns were coming to an end, a large part of Dar es Salaam experienced a blackout due to the collapse of a transformer in the Ilala substation. Electricity consumers in much of the city remained without power for a couple of days because TANESCO's experts could not fix it. When consumer tensions grew, Ibrahim Msabaha, the then Minister for Water, Energy and Minerals, explained in an attempt to calm the population that the damage required a technical procedure. He said that the problem would be fixed when "JICA experts, who installed the transformers in 1988, come and repair them. The Tanzania electric company (TANESCO) has informed experts from Japan, to come and do the repair works. They are now arranging for the Tanzanian visa."[154] The Minister did not, however, give any details as to why JICA experts had to come for the repair and not TANESCO technicians. While this transformer existed physically in Dar es Salaam, it operated as an alien enclave of their western or Asian Tiger manufacturers and experts. The company estimated that while they waited for Japanese expertise, such a breakdown and the consequent power shedding caused a loss of more than 100 million Tanzanian shillings, besides the economic and social damages to electricity users.[155]

TANESCO's networks had become large technical systems by the 1990s, as shown in the preceding chapter. They were composed of large hydropower generating plants at Kidatu

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[151] Gabrielle Hecht, "Hopes for the Radiated Body: Uranium Miners and Transnational Technopolitics in Namibia," *The Journal of African History* 51, (2010): 213-234, 216.
[152] Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity After World War II* (The MIT Press, 1999), 5, 91–95.
[153] Hecht, *Being Nuclear: Africans and the Global Uranium Trade*, (Cambridge, and London: The MIT Press, 2012), 57, 320; Hecht, *The Radiance of France*, 5 also 91–95.
[154] *Majira*, "Mgao wa Umeme kwa Ilala," 21 October 2005.
[155] *Ibid.*

and Mtera and of transmission networks in the southern highland regions of Mbeya and Iringa, central regions of Dodoma, Singida to Shinyanga, and Mwanza, and in the eastern and northern high load cities of Dar es Salaam, Tanga, Moshi, and Arusha. To coin Hughes' metaphor, the systems had gained technological momentum—a period in which the technical systems take a certain foundation in terms of the technologies used in generation, transmission, and supply, to the extent that the decisions made previously on these aspects become difficult to alter. For instance, large hydropower infrastructure which had been constructed earlier become difficult to alter even when water shortages occur. The momentum phase is when engineers and utilities invest heavily in manufacturing of electrical artefacts to sustain the system. They also use their experience and competence to solve the "critical problems" that the systems may encounter.[156]

Unfortunately, the planning and construction of power infrastructure in the 1960s to 1980s and repair and maintenance projects in the 1980s to 2000s meant TANESCO experienced what Nit Chantramonlasri has called "the supply-side phenomenon." That is, the dependence on western aid in building Global South infrastructures rendered technology recipients like TANESCO helpless when their systems required repairs, limited only to making the 'right technical choice' from the shelves of the supplier companies.[157] When electricity generating infrastructure encountered serious technical problems, technology transfer agreements left TANESCO with no choice other than to contact the manufacturers and suppliers, who had to send technical expertise from Europe, America or Japan to investigate the problems and recommend the way forward. This kind of technical and financial dependency on western expertise and the problems it created in obtaining spare parts, extending the blackouts, were evident in TANESCO's operation on many levels. For instance, the repair of the Kidatu hydropower plant in the late 1980s and early 1990s provides a broader picture on the interconnection between maintenance schemes, black-boxed technologies, and blackouts due to the unavailability of readymade spare parts.

In October 1989, the first-generation unit with the capacity to produce 50 megawatts installed in 1974 at Kidatu failed. The breakdown caused a loss of about 15 per cent of the hydropower in Tanzania's national grid. Towns and cities connected to the national

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[156] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880 -1930* (Baltimore and London: The Johns Hopkins University Press, 1983), 140–160.

[157] Nit Chantramonlasri, "The Development of Technological Change and Managerial Capability in the Developing Countries", in *Technology Transfer in the Developing Countries*, ed. Manas Chatterji (Palgrave MacMillan, NY, 1990), 36–37.

interconnected networks, including the city of Dar es Salaam, faced critical blackouts. TANESCO estimated a loss of about US$ 3.8 million and the government lost US$ 70 million due to disruption in industrial production.[158] The utility commissioned Norpower to examine the other three generators at Kidatu to avoid another accident. This was because the other three generating units were also supplied by the same manufacturers and installed in the 1970s. Norpower recommended urgent repairs of all four units.[159]

But on 1 July 1986, Tanzania and Sweden had signed a bilateral agreement that any renovation project financed by Sweden should involve international firms, and equipment should come from Sweden. In this respect, all bids should be approved by SIDA. Repair of the Kidatu plant was funded by SIDA in collaboration with the World Bank; hence, it was also subject to international tenders and a traditional contracting model of technology transfer. In this model, different manufacturers and companies competed for consultancy, electrical works, and the supply of electrical materials and spare parts.[160] After these international financial, technological, and bidding conditions, three months elapsed before the breakdown of this unit was examined in detailed to initiate repair. It was not until January 1990 that M/S Rade Koncar, a Yugoslavian company that had manufactured and supplied the damaged generator, arrived in Tanzania to establish the root cause of the damage, its scope and assess repair parts required and their costs.

The technical analysis by Rade Koncar found that the 'excitor' and two main rotor poles were destroyed, and new ones had to be manufactured. TANESCO tendered M/S Rade Koncar to manufacture the new spare parts and it was anticipated that the spares would be ready by August 1990. In May 1990, TANESCO discovered that the Rade Koncar wanted to produce a rotating excitor, which was identical to the defective one, while TANESCO wanted a static excitor, which was a new model. The utility requested the firm manufacture the static model instead. This change extended the validity period for another seven months from August 1990 to 31 March 1991. In a letter to SIDA requesting funds to manufacture the spare parts, TANESCO noted the delay, saying: "We had requested the shortest delivery periods, but it seems the best they could come up with was six months. TANESCO will have no other option except to carry

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[158] SNA, SIDA F13B: 16: S. J. Kimaryo to Per Persson, Chief Engineer – Swedish Embassy, Development Cooperation Office) on improvements in the Grid System voltage dated 24 May 1991.

[159] SNA SIDA, File F13B: 16: Report on evaluation of tenders on urgent repairs of Kidatu Power Plant and improvement of the grid voltage system; also, see also TANESCO Archives: Report by Norpower, May 1990 on Kidatu Hydropower Plant, Rehabilitation Study.

[160] *Ibid*.

out massive load shedding. Bearing in mind the criticality and urgency of the matter, SIDA is requested to release the necessary funds so that the contractor can start the work immediately."[161] The letter informed further that a possible source of delay could be the scheduling of materials and equipment flows from suppliers and would force the company to shed power. But TANESCO's manager stated in the letter that "care will have to be taken that, interruptions of power supply to users are kept at a minimum."[162]

By December 1990, TANESCO had completed the terms of reference and tender documents for the larger Kidatu repair project and submitted them to SIDA for formal approval, and all formal technical documents were ready for further plans by April 1991.[163] Swedish Companies, a family of ABB and Kvaerner Turbin AB, won the tender to supply the required electrical equipment and materials for the other three power generation units at Kidatu, and TANESCO signed an official civil works contract with these firms on 5th September 1991.[164] However, the quick beginning of the works was interrupted when important repair parts were damaged during off-loading at the port in Dar es Salaam. The arrival of new spare parts took another three months until April 1992. The actual repair works started in May 1992 under Swedish technicians and TANESCO repairmen as trainees.[165] In short, since the collapse of the Kidatu power generating unit in 1989, it took four years for the plant to be fully repaired. In this entire period, electricity users of Tanzania's national grid lived under power rationing schemes which curtailed power supply regularly. TANESCO had to wait all this time to complete the repair of its Kidatu infrastructure.

The long and protracted economic and technical maintenance and repair procedures of the Kidatu power plant aggravated the blackouts in the form of power shedding in Tanzanian cities. When explaining the reasons for repeated power outages in November 1993, TANESCO's management pointed out that there were delays during repair works at Kidatu caused by the long time it took the company to order and receive new spare parts. Each of the generating units which were under repair had an installed capacity of 50 megawatts. Therefore, shutting

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[161]SNA, SIDA File F13B: 16: S. L. Mosha to Per Persson SIDA – CDO, Swedish Embassy - Tanzania on Repair of Unit one at Kidatu, dated 25 January 1991.
[162] *Ibid.*
[163] SNA, SIDA File F13B: 16: S. J. Kimaryo, to Per Persson dated 24 May 1991; TANESCO: Tanzania – Consulting Services for urgent repairs of Kidatu Power Plant and Improvements of Grid System voltage Evaluation of Tenders; see also: Terms of reference for urgent repairs of Kidatu Power Plant and improvement of Grid System voltage.
[164] SNA, SIDA File F13B: 16: Kimaryo to Per Persson, "Document of the Urgent Repairs of Kidatu Power Plan Tanzania: Contract for Rehabilitation Works of Turbines, TANESCO and Kvaerner Turbin AB".
[165] SNA, SIDA File F13B: 16: A Telefax from SIDA infrastructure division, Stockholm from Anders Hagwall to Per Persson, dated 26 August 1991; See also, "TANESCO to lift rationing," *Sunday News*, 7 November 1993.

them down one by one from May 1992, when the repairs started, to December 1993, when the experts completed the job, meant the ejection of 50 MW from the interconnected system.[166] Correspondence between the company and the international donors reveals that the utility increased its load shedding from 62.7 Gigawatt-hours (GWh) in 1991 to 264.2 GWh in 1993, and the cost of unserved energy due to repair works rose from the US$ 70 million in 1991 to the US$ 290 million in 1994.[167] This meant that the cities remained without power as it was supplied intermittently, affecting the socioeconomic lives of the consumers.

The technopolitics involved in the transfer of electrical technologies as an issue of industrial competitiveness and the need to secure long-term foreign markets to benefit domestic electrical firms and nations was also evident in the sources consulted. Through exported technologies in the form of equipment, experts, and trainings, Sweden became the largest donor in Tanzania's electrical power industry after independence.[168] The archival sources reveal that some Nordic experts were retained in Tanzania or travelled regularly to Tanzania for repair works. Selling of experts, training, and equipment was a profitable business for these electrical firms and the nations they come from. One of the internal memos from SWECO (Swedish engineering consulting firm) to the Swedish International Development Agency (SIDA) in the 1980s illustrates this point:

> I have decided to do a write-up on the project and the financing in order to clarify the situation. I have chosen to do this as a memo, as this is one of the few things which can be done individually in public administration. [. . .] Sweden's assistance to the Power Sector in Tanzania began in 1967 [. . .] The assistance continued during the seventies with alternate contributions within Energy Sector i.e. various studies, projects such as Kidatu I and II, Mtera Dam, personnel for operational staff, training etc. [. . .] One of the interesting aspects in Sweden's untied assistance to the Power Sector in Tanzania during the last decades is the return of not less than SEK 205 million to Sweden in respect of services and goods, which is considerably more than the SEK 180 million contributed by Sweden. The return has probably been higher considering Swedish goods purchased by other contractors.[169]

The memo came as SWECO realised that SIDA had refused to fund phase III of the Great Ruaha Power Project because TANESCO awarded the main civil works tender to an Italian electrical firm as described in Chapter Three of this dissertation. This quote, among other things, portrays

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[166] *Sunday News*, "TANESCO to lift rationing," 7 November 1993.
[167] SNA SIDA File No. F13B: 17: Approved Project Document: Urgent Repairs to the Kidatu Power Plant Tanzania.
[168] SNA, SIDA File F13B: 12: A telefax from NORAD to SIDA, and the World Bank dated 22 December 1983.
[169] SNA SIDA File F13B: 10: A Memorandum from SWECO called "Financing of Mtera Power Plant in Tanzania."

how, besides the supply of technologies in the form of machines, Sweden also benefited from the selling of expertise, conducting technical studies, training, and everyday operations of TANESCO. It also reveals that technologies are transferred because they also entail future markets by providing skill-based services.

Figure 3.5: *SwedPower experts working in Dar es Salaam after the Dar Gas Turbine project, 1994–1997.*
Source: SNA, SIDA File F13O: 10.

Berit Aasem and others argue that technology transfers from the North to the South consist of strong, long-term political and economic motives. She argues that while manufacturers and suppliers get certain short-term profits from the export of technologies, their main interests lie in the long-term trade on goods, skills, and services through purchase agreements rather than the immediate profits.[170] Most Global North engineering firms, therefore, attempt to retain control over the use of the technology transferred, the dissemination of knowledge, and sales.[171] Purchase contracts and transfer of knowledge and skills are restricted in several ways to avoid jeopardising the future intended benefits of the

[170] Berit Aasen *et al*. "Analytical Perspectives on Technology Transfer," in *Technology Transfer in the Developing Countries*, ed. Manas Chatterji (Palgrave MacMillan, New York, 1990), 8.
[171]*Ibid*. 28.

transferred technologies. Black-boxing technologies and prohibiting recipients from tinkering or modifying (in this case, repair and maintain) the exported technology derived not from a fear of creating competition but because they would reduce future trade relations. Scholars have found that most of the Nordic funding to postcolonial states between the 1960s and 1980s had huge commercial interests. The interest of these companies is not only in selling machines, but in spare parts and expertise as well.[172] These economic and political goals were evident in TANESCO's electrical projects in the 1960s to 1990s.

David McDonald in *Electric Capitalism* maintains that electrical technology, particularly the grid, grew in the twentieth century to become a global enterprise, a product of socio-cultural and technical contestation. Like the subtitle he crafted in his edited volume "Recolonising Africa on the Power Grid", McDonald upholds that electricity is not only central to industrial capitalism as a powerful motive, but it is also a lucrative industry characterised by "state politics" and imperialistic competition. Western countries, through their development agencies and electrical engineering firms, scrambled to expand power infrastructures in postcolonial regions because these systems were still missing. He contends "[i]n many ways the rush to build electricity capacity today is akin to the 19th-century "Scramble for Africa", with electricity grid lines replacing the colonial railway lines of yesteryear."[173] Electrical engineering firms from Europe, America, and Asia competed to build large power grids in Africa to export capital in the form of finance and experts, operating on pure capitalistic market dynamics, and recolonisation through electrical infrastructures. Their technologies were transferred together with the engineers to install and operate them, and they ensured that regular visits were required for repair and maintenance works.

While there is nothing wrong with the creation of profit through technology transfer, in line with Hecht's idiomatic term "technopolitics", the flow of electrical technologies (experts, materials and equipment) from the developed countries to TANESCO and other electrical utilities in the Global South was not provided for free. It consisted of designed political and economic motives that prohibited TANESCO's experts from tinkering and repairing the systems intensively. The export of black-boxed electrical technologies to Tanzania was a "technopolitics" that secured intensive imperialist benefits by ensuring long-term employment and selling of

[172] *Ibid*.
[173] David A. McDonald, "The importance of being electric," in *Electric Capitalism: Recolonising Africa on the Power Grid*, ed. David A. McDonald (Earth Scan, 2009), xvi.

expertise and spare parts, but it also extended blackouts in cities. In turn, these hybrid forms of political and technological power based on engineering practices (transfer of technologies, construction, and repair works) between the global electrical industry and the electrical system in Tanzania affected TANESCO's day-to-day grid operations.

3.5 Conclusion

There is no single theory that captures appropriately the vulnerabilities of Tanzania's power networks since the 1980s. As this chapter has shown, power failures and breakdowns were caused by multiple historical forces and in different periods. While the crash of the economy made power networks vulnerable in the 1980s; the failed high modernist engineering of the 1960s to 1980s, and the global circulation of electrical technologies dominated from the 1990s onwards. These were major historical sources of vulnerabilities in the electricity infrastructure since the 1980s and the demarcation between them is blurred. For instance, although vandalism escalated due to socioeconomic changes in the towns in the 1980s, it has affected the system until today. Likewise, the acute shortage of spare parts felt in the 1980s persists today, not because of an economic crisis but because of politics and the political economy in the circulation of electrical technologies. The circulation of technologies in the form of machines and experts for construction and maintenance projects has created overreliance on external experts and technologies. This prolongs or delays maintenance and repair activities and increases power load shedding. Moreover, the fall in the water levels at the Mtera and Kidatu hydropower dams due to local environmental conditions and global political and economic interests between the 1960s and 1980s was apparent from 1992 to recent past. These forces did not fall from the sky but were rather the outcome of how Tanzania and its donors handled planning and construction of power infrastructures between the 1960s and 1980s. Not only did they underestimate or overlook some environmental and technical factors, but they also created technological and financial dependence on donors even in solving simple critical problems in its networks. In this sense, the vulnerabilities of TANESCO's systems cannot be understood only in terms of the failed electricity reforms of the 1990s and 2000s or the interconnectedness of infrastructures to form large technical systems. It needs to consider also these historical and continued dependence on western economic aid and experts, and the politics and economics of technology transfer largely contributed to the vulnerabilities of TANESCO's technological power systems in the postcolonial period.

CHAPTER FOUR
POWERING HOUSEHOLDS: THE SOCIO-CULTURAL HISTORY OF VULNERABLE HOMES, 1920s-2010s

4.1 Introduction

This chapter discusses the usage of electrical technologies in homes and users' vulnerabilities. The question of how Tanzanians use electricity in their domestic space has not been examined by electrification scholars except urban geographer, Rebecca Ghanadan. She studied the impact of the 1990s economic and electricity reforms in Tanzanian household energy use in 2008. She showed that while many Tanzanians had started to acquire different electrical items in their homes by the late 2000s, high electricity tariffs and frequent power outages hindered their full usage. Although residents possessed some electrical items, they used them occasionally to cope with high power tariffs and unreliability.[1] By using a few archival sources available, oral interviews, published and unpublished literature, this chapter seeks to fill this knowledge gap by tracing the historical forces which shaped household electricity usage in colonial and postcolonial Dar es Salaam. The chapter demonstrates that lighting has for a very long time been the dominant household electricity usage in Tanzania until recently when people adopted non-lighting of electrical devices. 'Powering homes', as this chapter is called, captures the expansion in electrical devices in homes which made electricity not only a tool for lighting but also as a source of power. People appropriate technologies with a certain level of vulnerabilities. Therefore, a better insight on the notion of vulnerability requires scholars to consider users of critical infrastructures rather than concentrating of technical systems only.[2] User vulnerabilities is underscored in this chapter as the impact an infrastructure has on the users when it is interrupted.[3] The Chapter aims to broaden our understanding of the sociocultural and economic vulnerabilities associated with the appropriation and use of domestic electrical technologies since most inhabitants in Dar es Salaam interact daily with electricity through domestic electrical devices than through other technical services. It explores factors which shaped the

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[1] Rebecca H. Ghanadan, "Public Service or Commodity Goods? Electricity Reforms, Access, and the Politics of Development in Tanzania", (PhD Diss.: University of California Berkeley, 2008).
[2] Eifert, Stephanie, Allice Knauf and Nadja Thiessen, "Vulnerability" in Jens Ivo Engels (ed), *Key Concepts for Critical Infrastructure Research*, (Wiesbaden: Springer VS, 2018), 26.
[3] For the concept of user vulnerabilities, see, for instance, Per Högselius, Anique Hommels, Erik van der Vleuten and Arne Kaijser, (eds), *The Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities*, (London: Macmillan, 2013), 9; Engels, *et al*., "Relations Between the Concepts," in Jens Ivo Engels (ed), *Key Concepts in Critical Infrastructure Research* (Springer SV, 2018), 46.

appropriation of electrical technologies, and it traces the vulnerabilities of users by looking at how electrical devices and domestic activities were affected by power outages. It argues that to understand users' vulnerabilities better, it is important to look at how electricity consumers appropriated and used both electricity and electrical devices and the threats they faced and experienced.

4.2 Domestic Electricity in the Colonial Period

As we saw in Chapter 1, Dar es Salaam evidenced the expansion of power supply in the period after the Second World War. In the interwar period, the Electricity Department was still repairing and maintaining the networks caused by the impact of the First World War. The technical reports on how electrical systems operated reveal that electricity consumers could not make full use of electrical appliances in their homes. It was not possible even to use electric ring cookers due to weak and frequently breaking grid.[4] The government works consumed 50 per cent of the electricity generated and 15 per cent was used for lighting European property. Other residential and commercial users consumed 10 per cent for lighting and power, Indians used 15 per cent and Greeks consumed 10 per cent.[5] Electricity consumers outside the government circle only began their "fullest use of the supply for lighting and power at a suitable rate" including plugging in the "modern electric ring" when the Department completed a round of repairs on power networks in the early 1920s.[6] This state of affair changed after the Second World War. The British Colonial &Welfare policies which aimed to promote people's wellbeing not only made electricity finds its to more homes. But the adoption and use of common electrical items as we know them today was limited both in African and non-Africans homes.

The report by L. H. King, the chief government electrical engineer and manager of the Electricity Department, stated in 1924 that the chances of the Department making a profit was low because living standards were low and domestic electrical technologies were largely unaffordable to the community. Private consumers were inadequate and "in fact it is only among the commercial community that anything approaching an Eastern standard of living exists."[7] King tried to compare the lives of Asians, then, Indians living in Dar es Salaam with Eastern Europeans. In the 1920s, Eastern Europe had low level usage of electricity than Western

[4] *Dar es Salaam Times,* 10 June 1922.
[5]UKNA T161/1049: Letter from H. A. Byatt to Principal Secretary for the Colonies.
[6] *Dar es Salaam Times,* 10 June 1922.
[7] UKNA T161/1049: L. H. King, Report on the first year of the new plant, Dar es Salaam.

Europe. King's report shows first that residential houses including Europeans lacked a 'modern kitchen'—one equipped with electrical appliances during this time. This observation has several implications in the history of electrification in colonial Dar es Salaam and colonial world at large. While the existing narratives underscored revealed Europeans as main users of electricity in the colonial times, the Dar es Salaam case was different. Indians, who were also majority in the town centre, were the main consumers who enabled the electricity department to gain some profit. This is evident in King's statement because the commercial class was largely composed of people from the Indian sub-continent—who according to the racial history of Dar es Salaam, had occupied the commercial zone (Zone II, as highlighted in Chapter 1).

Electricity providers in Colonial Dar es Salaam took some measures to promote residential usage of electricity including the use of electrical appliances was a way to ensure economic load and profit generation. As mentioned briefly in Chapter 1, the first British administrator in Tanganyika, Sir Byatt and his successor, Sir Cameron, wanted to bring change to the provision and use of electricity in the Territory. They sought to make electrical undertakings a profitable business. They thus put efforts not only at improving electricity reliability and expanding supply but also intervened to make electrical appliances available to electricity users. For instance, Cameron informed the Colonial Office in November 1929 about his plan to import 40 electric refrigerators for government houses in Dar es Salaam.[8] The American Frigidaire, as archival correspondence shows, was among the best refrigerators by then. They had successfully been tested in Dar es Salaam's environment, and Frigidaire had promised Cameron that they would supply refrigerators, spare parts, and a stationed repair expert in Dar es Salaam.[9] Before the 1940s, the British companies had not started to engage seriously with electrical appliances business in the overseas colonies and Tanganyika as a Mandate Territory was more disadvantage since many electrical trading companies that operated in the East African colonies had established themselves in Kenya and Zanzibar. Only a few representatives of these companies operated in Dar es Salaam. For instance, the town had no stationed repair experts and spare parts for many electrical appliances, especially refrigerators.[10] Therefore, Frigidaire's offer to Tanganyika was a lucrative one.

[8] UKNA CO 691/118/1: J. B. Williams to G. Seel, "Refrigerators in Government House," dated 28 March 1931.
[9] UKNA CO 691/109/1: C. C. for Crown Agents to the Colonial Office in London, dated 24 January 1930 and from from Managing Director of J. G. Walsh & Co. Ltd to the Chief Secretary, Dar es Salaam, dated 5 April 1930.
[10] *Ibid.*

The British Colonial Development Policy in the interwar period, which was geared toward promoting overseas trade and solving domestic problems, caused by the World War I. As a rule, British colonial territories in Africa, the Far East, West Indies, and the Caribbean in the 1920s were not allowed to purchase commodities directly from manufacturers or from local merchants abroad. All products which were not manufactured in the colonies or nearby British colonial territories were to be purchased from Britain through the Crown Agents for the Colonies.[11] To purchase government refrigerators for Tanganyika, Cameron informed the Colonial Office in London and the Crown Agents for the Colonies. The Crown Agents for the Colonies and the Colonial Office held the view that the "installation of foreign-made apparatuses on such a large scale would be disastrous to the reputation of British refrigerators overseas."[12] They dismissed Cameron's request and advised him to install refrigerators from a British manufacturing company, instead.[13] Still, the government of Tanganyika was hesitant to install other kinds of refrigerators in Dar es Salaam.

After several correspondences with colonial officials in London, they agreed that a comparative analysis between different refrigerators is made by the Government's electrical engineers. His report showed that based on technical and economic parameters such as running costs, simplicity, availability of spare parts, repair experts, and suitability to the environmental conditions of Dar es Salaam the Frigidaire were suitable refrigerators.[14] But the Crown Agents were against this choice because accepting the massive installation in government houses would interfere with the reputation of British manufacturers.[15] They wanted the Governor to consider the British firm, Automatic Refrigerators, but they were aware that they should not press the "British refrigerators on a reluctant Governor in preference to American refrigerators of superior quality, since such an action would obviously be very difficult to defend in the circumstances of Tanganyika."[16]

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[11] David Sunderland, *Managing British Colonial and Post-Colonial Development: The Crown Agents, 1914–74,* (Woodbridge: Boydell & Brewer Press, 2007), 115.
[12] UKNA CO 691/109/1: From Crown Agents to Tanganyika Territory, dated 24.01.1930.
[13] UKNA CO 691/118/1: J. B. Williams to G. Seel "Refrigerators in Government House," dated 28 March 1931.
[14]UKNA CO 691/109/1: From D. J. Jawine, Deputy Governor, to Lord Passfield, P C., 6 September 1930 and from Cameron to Lord Passfield, dated 10 May 1930 and from Colonial Office to Tanganyika Territory, "Domestic Refrigerators for Dar es Salaam," dated 18.08.1930 and from Donald Cameron to Lord Passfield, dated 27.06.1930.
[15] UKNA CO 691/109/1: C. C. from Crown Agents to the Colonial Office, dated 24 January 1930; from Crown Agents to the Colonial Office, dated 18 August 1930: see also, from Crown Agents to the Tanganyika Territory, dated 24.01.1930.
[16] UKNA CO 691/109/1: Correspondence between Crown Agents and Green on 18-23 August 1930.

However, the great economic depression which started in 1929 created a drop in prices of agricultural crops in Tanganyika and affected the government's revenue. The government redirect the fund to other government works. In a letter to the Colonial Office, the Deputy Governor of Tanganyika wrote:

> As a prospective inhabitant of one of the Government houses in Dar-es-Salaam, I am sorry that the Government does not feel able to go on with this scheme… While I am still of the opinion that the installation of refrigerators in the residences of officials in Dar es Salaam is a very desirable project, I have now reluctantly come to the conclusion that the financial situation has developed so unfavourably, that this Government would no longer be justified in locking up the sum required for the installation of some forty refrigerators, especially at a time when it has been found necessary to postpone important public works.[17]

Electrical technologies, although viewed as significant, were not a priority of the British officials in London and in the colonies, when compared to other services such as water supply, sanitation, roads, and housings. Electrification and domestic electrical technologies were purchased only when financial situations allowed. Additionally, it reveals technological reasoning cannot be separated from economic and political reasoning. Politics were always at the centre of deploying various technical artefacts in the colony. Like in Langdon Winner, artefacts have politics.[18] Until when Cameron left Tanganyika as Governor, the installation of electrical refrigerators in administrators houses, something which could help electricity providers to increase the required electrical load, was not implemented due to British colonial politics. The challenge in installing refrigerators is but one case that reveals difficulties and limited usage of electrical items in colonial Dar es Salaam and especially in colonial administrators' homes.

Other essential electrical appliances such as electrical fans, refrigerators, cookers, and irons were also lacking or used in low quantities. For instance, when DARESCO took over supply from the Electricity Department in 1931, identified low levels of electrical devices in colonial administrators' homes as pressing problem. British administrators continued to use electricity mainly for lighting because they lacked essential electrical appliances in their homes. The company was not happy with the situation because it derailed efforts to make profit and expand electricity supply in Tanganyika. In the late 1930s, DARESCO approached the British colonial

[17] UKNA CO 691/109/1: From Douglas J. Jardine, Deputy Governor of Tanganyika, to Lord Passfield, P. C, Secretary of State for the Colonies, 6 September 1930.
[18] Langdon Winner, "Do Artifacts Have Politics?" *Daedalus* 109, no. 1 (1980): 121–123.

government in Tanganyika about this issue in the late 1930s. In a dispatch dated 8 May 1939, DARESCO's manager, J. D. Marr informed the Chief Secretary of the Tanganyika government, G. R. Sandford, that the low use of electrical devices by Europeans was derailing the company's success.

The letter came as a response after government dissatisfaction with the low pace of electrification in the Territory. In the government's view, DARESCO had failed to expand power infrastructure in the Territory. The company listed several challenges it faced in supplying power including that that while most electrified residents were found in European residential area, electricity was mainly used for lighting. DARESCO was suffering from low economic load because there were insufficient electrical appliances in European homes.[19] Marr's letter referred to this issue in these words:

> Another important branch of our business is giving us concern; that is domestic supply. In ordinary circumstances in a community this load can be built up and developed by normal business propaganda but conditions here are unique in so far as the European communities which we have to serve are, for the most part, officials living in furnished Government quarters. […] Despite the number of years this service has been maintained to these quarters, the results are most disappointing for, in the majority of cases, the available supply of electricity has only been used for lighting.[20]

In his letter, the manager tried to compare uses of electrical items in Tanganyika and other British East African Territories. One example is Uganda, where electricity had been installed and electrical devices were working in the 1930s, whereas hospitals in Dar es Salaam operated without proper lighting facilities and electrical devices.[21] As Edward and Hård have shown, by the late 1920s and early 1930s, the British government in Tanganyika faced critical budgetary constraints. In the early 1930s, it refused to install an electrical light in the Indian hospital in Dar es Salaam based on monetary restraints. A public uproar ensued.[22] To DARESCO, the fact that the British government had failed to subsidise electrical appliances was a weakness they needed to address. They started to find some ways to boost domestic electrical technologies in the town.

[19] UKNA CO 691/175/2: Letter from DARESCO Manager, J. D. Marr, to the Chief Secretary of Tanganyika, 8 May 1939.
[20] *Ibid*.
[21] *Ibid*.
[22] Frank Edward and Mikael Hård, "Maintaining the Local Empire: The Public Works Department in Dar es Salaam, 1920–60," *The Journal of Transport History* 41, no.1 (2019): 1-20.

The low-level use of electrical devices posed economic challenges to the electricity providers. They failed to attain optimal load factor. The electricity they generated was used mainly for lighting. For electricity providers to flourish, they needed maximum load factor which the domestic supply and usage in colonial Dar es Salaam could not offer. Electricity providers in Dar es Salaam were not unique in the low profit and difficulties of obtaining profitable load they experienced due to low level of domestic consumption in the early time of electricity development. Animesh Chatterjee unveils the situation in India by showing that electrical companies and promoters in Calcutta also struggled consistently to expand the electricity markets to households. They advertised various electrically powered devices, especially fans and bells, to attract the Indian middle-class householders, their target electricity consumers.[23] Electrical utilities battled with insufficient usage of electricity to offer enough load through pushing electricity lighting to municipalities and people's homes. Power companies did so through the promotion of electricity over the existing energy sources particularly gas lighting.[24] Moses Chikowero asserts that the Town Council in Bulawayo, which also owned the electrical power supply not only subsidised electricity tariffs for Europeans but also welcomed trading companies and subsidised electrical devices to ensure maximum economic load.[25]

DARESCO as well, struggled to negotiate, advertise, and motivate British administrators to acquire and use electrical devices in the interwar period as a way of attaining economic power load. Like how Chikowero affirms that promotion of electrical items "constituted an important part of the twin gospels of public health and economics"[26] promoters of residential electricity usage in colonial Dar es Salaam represented electrical technologies as having the ability to overcome domestic health and economic challenges. The electricity utilities in Dar es Salaam coded electrical items in a language that motivated users to acquire them. They linked them with public health and efficiency, the major public challenges in infrastructure provision in Dar es Salaam. For instance, in a letter to the colonial administration, the DARESCO manager said that the "advantages and cleanliness of bath water heaters are well known, while the economy of food by using a refrigerator, and its aid to reduce living costs is now proved." He contended

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[23] Animesh Chatterjee, "'New Wine in New Bottles': Class Politics and the 'Uneven Electrification' of Colonial India", *History of Retailing and Consumption* (2018): 6–10, 4-5.
[24] Sunila S. Kale, "Structures of Power: Electrification in Colonial India" *Comparative Studies of South Asia, Africa, and the Middle East,* 34 (2015): 455 – 58.
[25] Moses Chikowero, "Subalternating Currents: Electrification and Power Politics in Bulawayo, Colonial Zimbabwe, 1894-1939," *Journal of Southern African Studies* 33, no. 2 (2007): 291.
[26] *Ibid.*

that in other commercial firms such as commercial banks and industries, the staff's houses were provided with "complete electrical domestic appliances as it is now recognised that these facilities are definite aids to good health and resulting efficiency. […] The firms, in some cases, provide the facilities free and in other cases hire them to their staff at nominal rentals. These items would be electric bath water heaters, refrigerators, ceiling fans and cookers."[27] Electricity, like the *cordon sanitaire*, would improve health through the preparation and preservation of food in Dar es Salaam. Electrical sterilisers, bathwater heaters, refrigerators, fans, cookers, and air conditioners would foster greater cleanliness, and remove dust, dirt, and smoke; as a result, the living standards of colonial administrators' and Indian women would be improved.[28]

DARESCO propagated that the health and efficiency would increase if the government ensured that European officials possessed electrical items in homes such as refrigerators, heaters, and electric cookers. DARESCO intended to convince the British colonial government in Tanganyika that: "with a refrigerator and electric cooker, meals can be made much more digestible and wholesome in the tropics" and electric cookers would reduce darkness on house walls caused by wood smoke. Electricity would also enable "the replacement of kitchen stoves and their attendant disadvantages of dirt and refuse and altogether unpleasant and unhealthy condition for the housewife."[29] Beyond these social advantages, the utility propagated that electricity and appliances also had economic benefits. They would serve to reduce the costs DARESCO charged for electric lighting. Lower electricity tariffs would stimulate trade and commerce in general.[30] Therefore, based on such health, convenience, and economic benefits of electrical appliances, the company requested the government provide a loan to its officials so that they could purchase basic electrical appliances, such as electrical fans, refrigerators, and electric cookers.[31]

The London-based manager of the East African Power & Lighting Company, A. Brook, took DARESCO's concern on expanding use of electrical devices to London on 31 May 1939. Sir B. Boyd of the Colonial Office responded positively giving an example of the British colonial territory of Fiji, where electrical power appliances such as refrigerators and electric cookers

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[27] UKNA CO 691/175/2: From DARESCO Manager, J. D. Marr, to the Chief Secretary of the Tanganyika Government," dated 8 May 1939.

[28] *Ibid*.

[29] *Ibid*.

[30] TNA File. 25874: Minutes of the 46th DARESCO Board of Director's Meeting held on 2 November 1938.

[31] UKNA CO 691/109/1: Letter from DARESCO Manager, J. D. Marr, to the Chief Secretary of the Tanganyika Government.

were “comparatively not known in the Government circles some three or four years ago.”[32] But, according to Boyd, when the government issued a circular in the early 1930s, nearly all government officers in Suva and all District Commissioners had refrigerators by the late 1930s. The Colonial Office was, therefore, optimistic that since the Tanganyika government was aware of the significance of electricity both as “a necessity and a luxury,” it would take all possible measures “to ensure that the domestic and public supplies available are made full use of”[33] by subsidising officials in obtaining electrical appliances. Nonetheless, the outbreak of WWII in 1939 affected government plans severely and all efforts were directed to the war.

The rate of electrical technologies grew in the post-World War II period because the question of power supply was central to the implementation of the Colonial Development & Welfare (CD&W) schemes as we saw in Chapter 1. Domestic electricity usage was one of the recommendations of the Westlake report. The report saw that supply of electricity in homes was very limited, which threatened survival of forest resources. According to Westlake, greater use of domestic electrical technologies would help to conserve forests and increase cleanliness and convenience in homes. Yet, it was an area which the East African British colonial government had until the 1940s failed to consider or develop. He wrote that:

> I am satisfied that there exists an almost untouched field of demand in the domestic sphere. As referred to in paragraph 8 the position regarding the supply of wood is likely to become critical and it therefore follows that at no distant date there may be a considerable demand for electricity for both cooking and water heating. Even apart from this consideration I was frequently told that householders would prefer to have electricity to serve these purposes on grounds of convenience and cleanliness.[34]

In the post-WWII period, DARESCO took some initiatives to expand domestic electrical technologies in the area under its supply licence. First, it changed its electricity tariffs to encourage people to use different appliances. For instance, it introduced all-in domestic tariffs. Before 1948, it metered and charged domestic electricity consumers in two separate tariffs: lighting and power tariffs. For the lighting tariff, electricity users paid 3 shillings monthly, including electrical meter charges. As for the power tariff, mainly for electric fans, it charged 50 cents for each electricity unit consumed. However, by introducing an all-in domestic tariff, consumers were allowed to use other appliances such as an electric iron and radio at a flat rate

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[32] UKNA CO 691/175/2: Letter from E. B. Boyd to A. Brook, dated 7 June 1939.

[33] *Ibid*.

[34] KNA File EP 15/15 and UKNA and File CO 822/143/3: Preliminary Report on Electricity Supply in East Africa by Charles R. Westlake.

of 15 shillings monthly. As the report by DARESCO's secretary to the Tanganyika Board of Finance, Trade and Economics noted, the "transfer from ordinary Lighting to All-Domestic rate Consumers continued day by day as people realise that by the installation of an electric iron and/or radio, apart from fans, they are entitled to enjoy this All-In tariff as against the Ordinary Electricity Lighting tariff."[35] This indicates that the use of domestic appliances increased as more consumers became part of the all-in domestic tariff.

The Board's Secretary was sure that electricity supply would become more profitable as changes in the tariffs applied would make consumers buy some domestic appliances and hence reduce the challenge of economic load. Furthermore, the company also hired different demonstrators to convince and educate both government and electricity consumers about acquiring electrical cooking systems, irons, and refrigerators. It brought some of the demonstrators and exhibitors from Nairobi on how to use domestic electrical devices while keeping their monthly electricity bills low.[36] DARESCO's efforts to motivate electricity consumers to acquire appliances confirm Nye's and Gooday's proposition that the advent of electrical technologies in the domestic sphere was not an automated process. Utility companies struggled to advertise and design appliances in such a way that they were acceptable to users. And in some instances, they employed people to go door-to-door to advertise and sell electrical objects. Households' usage of electrical appliances in colonial Dar es Salaam never grew to become critical infrastructure—they did not shape the household routines of the public at large and people's lives continued to depend less on electrical power infrastructure.

4.3 The Socialist State and Domestic Electricity, 1962 to 1985

The colonial provision of electricity in Tanganyika generally privileged Europeans and Asians than Africans. But after independence, the grid began to penetrate wider areas in the colonial African villages.[37] TANESCO supplied electricity using economic rationalities. It largely extended the grid to new areas where there were enough consumers. In 1966, the General Manager, F. S. Batty, stated, the main goal of the utility was to develop as an economic enterprise. Its policy and intentions were to "play a dynamic role in the electrical development of the country" by

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[35] TNA File No. 30107: DARESCO secretary to the Minister for Finance, Trade and Economics: DARESCO Tariffs revision of Rates Due to increased Cost of Fuel.

[36] TNA File No. 25874: Minutes of the 46th DARESCO Board of Director's Meeting held on 21 November 1938 and letter from DARESCO manager, J. D. Marr, to the Chief Secretary of the Tanganyika Government, dated 8 May 1939, in UKNA File No. 42258 CO 691/175/2, Electricity Development.

[37] Ghanadan, "Public Service or Commodity Goods?,"58-59.

making sure that "more and more people" enjoy the "many advantages of having electricity in their homes."[38] The company not only set goals but also established some measures to improve electricity provision.

To a large extent, the expansion of electricity distribution networks also symbolised the progress the national state was making to bring about development. TANESCO's activities were perceived as central to postcolonial development strategies. The reporting of what was going on in the city regarding electrification intended to inform the public about the efforts made by the government to bring about national development. As *The Nationalist* newspaper reported on the electrification process in the city in the mid-1960s, the company workers worked around the clock to make sure that electricity reaches all parts of the city. Engineers installed new electrical poles and transformers, which in addition to decreasing electricity voltages, "will help the city to look clean and more beautiful." Within few years after independence, TANESCO installed thousands of electric lights in modern-day Msimbazi, Kariakoo and Lumumba which were African premises in the colonial period to mark new era of political independence and national state modernisation. [39]

When Tanzania became independent in 1961, about 27 per cent of generated electricity was used to power and light homes while more than 60 per cent was used in industries.[40] TANESCO encouraged residents to electrify their homes and acquire electrical appliances. As scholars have noted, technical objects evoke discourse and imagery of users who are affected by their presence and use, TANESCO advertised electricity to promote its usage in the city.[41] The company represented electricity as a clean and efficient energy for domestic cooking and lighting. They represented electrified homes as comfortable inhabited ones – they were "sparky" homes, as opposed to those that used firewood, charcoal, and kerosene energy. The Company exhibited electrical technologies at the annual Dar es Salaam Trade Fair, *Saba Saba*, every year to showcase its main duties and responsibilities in modernising and developing the country through electricity generation, transmission, and supply. The exhibitions also aimed to teach the community about the advantages of electrifying homes and using different electrical devices. It, therefore, exhibited different uses of electricity and the advantage of using it in

[38] *The Nationalist*, "Increase in Demand," 26 September 1966.
[39] *The Nationalist*, "Power for the Nation: Electricity Helps Industrialisation," 26 September 1966.
[40] The Government of Tanganyika: Tanganyika Development Plan 1961/62 – 163/64, (Dar es Salaam, 1962), 52.
[41] Aant Elzinga, "Theoretical Perspectives: Culture as a Resource for Technological Change," in Mikael *Hård* and Andrew Jamison (eds), *The Intellectual Appropriation of Technology: Discourse on Modernity*, *1990–1939*, (London and Cambridge: The MIT Press, 1998), 23-24.

homes. The company portrayed electricity as 'modern', 'safe', and 'clean' for urban socioeconomic transformations. It advertised different electrical products such as electrical lamps and domestic appliances (Figure 4.1). It portrayed the use of electric cookers and kettles and other appliances as symbols of modernity, simplification, convenience, and comfort. Being a government-owned parastatal and the main vehicle for national socioeconomic development, TANESCO's invited government leaders to visit, open, and close its annual exhibitions.

Figure 4.1: President Nyerere (is in the middle) viewing electric meters and cookers at the Dar es Salaam Trade Fair in 1972.
Source: TANESCO Directors' Account Report, 1972, in EAF–UDSM Library.

The domestic electrical technologies evidenced both continuities and changes in the socialist period. There was no radical shift in the use of domestic electrical technologies between the colonial and socialist period. The most notable change was the growth of electricity services and consumption beyond the narrow and racialised colonial scope. One of the changes was that electricity services in Dar es Salaam and other towns in postcolonial Tanzania expanded in the 1970s and 1980s when compared to the colonial period. It rose from about 11,000 connections in 1950 to 156,000 in 1990.[42] But as TANESCO noted, enterprises such as the Wazo Cement Factory, the East African Railway and Harbour, Aluminium Africa, and the Kilimanjaro Hotel continued to be their main electricity consumers in the mid-1960s than residential

[42] Jonas van der Straeten, "Legacies of a Past Modernism: Discourses of Development and the Shaping of Centralized Electricity Infrastructures in Late- and Postcolonial Tanzania," in *Proceedings of the International Symposium Next Generation Infrastructures*, 30 September–1 October 2014, 277.

electricity users.[43] Like in colonial period, high power infrastructure followed potential markets and where would ensure quick economic returns. The Tanzanian government avoided the use of taxpayer funds to supply new areas which could take a longer time to bring higher national benefits.[44] The growth in number of residential consumers, however, can be attributed to the fact that the economic and technological parameters. Since electrical utilities have always been concerned with profit-making,[45] TANESCO connected homes to obtain revenue and not because the government promoted electricity as a vital electrical technology in the domestic setting.

The Tanzanian socialist government policies between 1967 and 1985 hindered usage of electricity in the urban domestic space. Tanzania maintained economic rationales in its social services provision in the first five years after independence, but this changed in 1967 after the adoption of socialism. Socialist policies were indigenised to make the country self-sufficient in production and consumption, based on the use of internal resources, such as land, people, good politics, and ethical leadership. Rural-based socialism emerged from Julius Nyerere's realisation that urban-based industrial, capitalistic development were threats to the country's sovereignty. They enlarged dependency on financial and technological support from the former colonial masters and other developed countries. Socialist policies viewed urban development, including provision of different infrastructures such as roads, railways, water, and electricity among others as an obstacle to socialism and rural development. Nyerere expressed this by saying that the "mistake we are making is to think that development begins with industries. It is a mistake because we do not have […] necessary finances or the technical know-how."[46] The government evicted informally employed people from towns and cities, including Dar es Salaam, and forced them to live in socialist (Ujamaa communal) villages.[47]

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[43] Tanganyika Development Plan 1961/62 – 163/64, (Dar es Salaam, 1962), 52.

[44] EAF–UDSM Library: Hansard: Tanganyika National Assembly, Official Report, Thirty-Sixth Session, 4th Meeting from 16 May 1961–6 June 1961, 16; Hansard: National Assembly Official Report, First Session, 2nd Meeting, Sittings from 10 June 1966 to July 1966, 463. See also, Hansard: Parliamentary Debates, Official Report, Second Session, 17th Meeting from 26 June – 17 July 1969, 2342; Hansard: *Jamhuri ya Muungano wa Tanzania, Majadiliano ya Bunge*, Mkutano wa *17, Sehemu ya 2, Tarehe 16 Julai, 1969,* 2342; Hansard: Tanganyika National Assembly, Official Report, Thirty-Sixth Session, Fourth Meeting, from 16 May–6 June 1961, 423, 973-74.

[45] Donald MacKenzie and Judy Wajcman, *The Social Shaping of Technology* (Milton Keynes, Open University Press, 1985); 13-23; David E. Nye, *Electrifying America: Social Meanings of a New Technology* (Mass: MIT Press, 1990), 27-28.

[46] Julius Nyerere, "Ujamaa; The Basis of African Socialism published as a TANU Pamphlet in April 1962," in Julius K. Nyerere, *Ujamaa: Essays on Socialism,* (Dar es Salaam: Oxford University Press, 1968), 26.

[47] Goran Hyden, "Ujamaa, Villagisation and Rural Development in Tanzania", *Development Policy Review* 8, no. 1, (1975), 53-57; P. L. Raikes, "Ujamaa and Rural Socialism," *Review of African Political Economy* 2, no. 3, (2007).

The government believed that the electrification of industries was the only path to development. Without electricity there would be no industrial growth and the country would continue to remain stagnant. Electricity could change the country's "economy from a peasant activity to a modern and highly developed one."[48] TANESCO was, in this case, not only power utility but also a vital entity in Tanzania's road to economic development.[49] However, socialist development approach based on rural areas created a constant battle between rural and urban areas, especially regarding infrastructure provision. As the government blatantly explained, to prioritise rural communities had implications for the urban areas. Nyerere said such rural development programmes meant that "there is less money and less manpower which can be devoted to improving conditions in the urban areas."[50]

By the late 1960s, only about 4 per cent of the population resided in towns but had better infrastructure than all rural areas combined. Rural areas produced most of exportable cash crops which accounted for a large percentage of Tanzania's foreign exchange in the 1960s and 1970s. Yet, foreign exchange obtained from exported crops was reinvested in building socioeconomic and technological infrastructure in urban areas rather than in rural areas where the crops were produced. This urban bias was for Nyerere an exploitation of rural dwellers and had to be changed. The socialist government regarded urban areas and their socio-technical infrastructure as perpetuators of global capitalism, imperialism, potential exploiters of rural communities, and opposers of socialist principles. This perspective was evident in Nyerere's speeches where he repeatedly pronounced that:

> All our big hospitals are in towns, and they benefit only a small section of the people of Tanzania. […] Tarmac roads, too, are mostly found in towns and are of special value to the motor-car owners. […] Again, electric lights, water pipes, hotels and other aspects of modern development are mostly in towns. […] If we are not careful, we might get to the position where the real exploitation in Tanzania is that of the town dwellers exploiting the peasants.[51]

Whereas in other postcolonial world the promotion of electricity as a tool for postcolonial state-led developments involved electrifying homes as an emblem of 'modern' living standards, good life and an "escape from the drudgery of manual labour, and provision of

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[48] *The Nationalist*, "Power for the Nation: Electricity Helps Industrialisation," 26 September 1966.
[49] *Ibid*.
[50] Julius K. Nyerere, *Freedom and Socialism: Uhuru na Ujamaa: A Selection from Writings and Speeches, 1965-1967,* (Dar es Salaam: Oxford University Press, 1968), 96.
[51] Nyerere, "Ujamaa," 27-28.

service which colonised populations had been denied by colonial masters in the first half of the twentieth century,”[52] in Nyerere’s view, provision of electricity in urban homes would continue to perpetuate colonial cultural dominance. Urban households would become a place for conspicuous consumption rather than a place of basic economic production. Nyerere considered the expansion of electricity in these areas would be a sabotage to the economy.[53] His socialist policies made urban communities to live like their rural counterparts to reduce income and other socioeconomic differentiations. Consequently, electricity remained a tool to modernise production and a distant hope for many Tanzanians throughout the 1960s and 1980s. They paid little attention to individual household electricity usage. Hence, although “electric power was a crucial service”, the government targeted economic sectors, small townships, and some populated rural areas rather than urban households.[54]

Oral testimonies paint the picture of how the grid that expanded from the city centre at Kurasini toward the modern-day Districts of Temeke, Ilala, Kinondoni, and Ubungo. In these areas, the grid electrified government workshops and workers’ quarters, industries, hospitals, secondary schools, churches, and police barracks, and houses.[55] In the Kinondoni area, for instance, one of our informants said that despite the grid having reached in the area in 1966, many houses remained without connection. He emphasised, “Very few people had electricity in their homes. If one needed to enjoy, he/she had to go to a relative who lived in government quarters or national housing. People had no money to electrify homes except those who had businesses or were employed by Indians or the government.”[56] Another inhabitant gave an interesting account on the direction power supply took. He claimed that along the Morogoro road, the electricity grid ended at the national corporation housing in Ubungo. The entire areas of the modern-day Kimara area in the eastern part of the city and beyond had no electricity in the 1970s. Along the Bagamoyo road, electricity had reached Sinza, Mwenge, and Kawe,

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[52] James H. Williams and Navroz K. Dubash, “Asian Electricity Reform in Historical Perspective,” *Pacific Affairs* 77, no. 3 (2004): 412.

[53] Emily Brownell, *Gone to Ground: A History of Environment and Infrastructure in Dar es Salaam*, (Pittsburgh: University of Pittsburgh Press, 2020); Richard E. Stren, “Underdevelopment, Urban Squatting, and the State Bureaucracy: A Case Study of Tanzania,” *Canadian Journal of African Studies* 16, no. 1 (1982): 67-91; Larry Sawers, “Urban Primacy in Tanzania”, *Economic Development and Cultural Change* 37, no. 4 (1989): 841-859.

[54] The United Republic of Tanzania, *Tanzania Second Five-Year Plan for Social and Economic Development 1969–1974 Vol. I*, (Ministry of Planning: Dar es Salaam, 1969), 121.

[55] Interview 22, a retired government worker, Tabata, 28 August 2018; also Interview 18, a restaurant owner, Manzese, 24 August 2018.

[56] Interview 26, a retired military officer, Mbezi Beach, 10 October 2018.

supplying also the Wazo Hill cement factory. The area beyond Mwenge was less populated and only a few homes had electricity connections by the 1970s. He said further that:

> The main problem was that people had no capacity to electrify. Electricity was expensive. It was only very few people were able to connect and benefit from electricity. Those who electrified their homes also used it mainly for lighting, ironing, and electric fans. We just got stories about refrigerators, washing machines, and electric cooking ranges from European and Indian housemaids who used those devices… There were grim living conditions, and people were concerned in obtaining food and clothes and not electricity. Kerosene, firewood, and charcoal were enough, and many people were less confident in electricity.[57]

One can conclude from this quote that households' income in Dar es Salaam in the 1970s was still low to afford electrical technologies. The inhabitants were just struggling to meet the most basic life needs. This impeded many homes from domesticating electrical technologies because even in those places where TANESCO had expanded power system, people could not connect.

The Tanzanian government had stipulated in its plan for socioeconomic development in 1969 that TANESCO's "modernisation programme" which involved the extension of electricity to new areas was to enable industrialisation and electrification of some rural areas to support the socialist programmes rather than promoting domestic electricity usage in urban areas.[58] Electricity was largely a tool for socio-engineering communities, modernising rural communities to produce more agricultural outputs and act as a market for urban industrial commodities.[59] The experiences of people who inhabited the city in the 1960s and 1970s reveal that the possession of 'luxurious' and modern devices in homes such as televisions or cars was considered as non-conformist to socialist principles. One resident in Dar es Salaam mentioned that under the socialist regime, "it was like a 'sin' to have items such as a car or television in homes. The government considered them as luxury goods that perpetuated social difference. Those who possessed them, especially government workers, had to justify where they obtained the money to buy luxurious household items."[60] Such items symbolised conspicuous capitalist consumption, exploitation, black-marketeering, and other illegal businesses.

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[57] Interview 26, a retired military officer Mbezi Beach, 10 October 2018.

[58] United Republic of Tanzania, *Tanzania Second Five-Year Plan for Social and Economic Development 1969–1974, Vol. II*, (Ministry of Planning: Dar es Salaam, 1969), 75.

[59] James C. Scott, *Seeing Like a State: How Certain Schemes to improve the Human Condition Have Failed* (New Haven/London: Yale University Press, 1998).

[60] Interview 20, a welder, Msewe, 24 August 2018.

As Lewinson describes the socialist life linked African Tanzanians' household modernity to the possession of other non-electrical things, such as locally made couches, beds, stools, tables, chairs, and coffee tables. People decorated their homes by hanging their companies' and institutions' calendars rather than with electrical devices. Household modernity in Dar es Salaam was defined in terms of neatness and ability to accommodate people rather than possession of technological things. Houses in even in government premises, companies and institutions had a small kitchen, and water and sanitation facilities only. In large flats, "the kitchen had an oven stove, often an extra electric hotplate, and maybe a refrigerator; in smaller ones, the residents cooked on hotplates or kerosene stoves."[61] She contends that even though some government workers were economically able to purchase a few electrical appliances, they avoided doing so because it went against socialist doctrine. While electrical appliances such as radios were common, only a few low-level professionals had televisions, since Nyerere had banned them as an unnecessary luxury.[62]

Tanzania's indigenised socialist state regulated the economy and restricted imports of electrical devices by setting high import tariffs. It set high tariffs on imported technologies to protect its import substitution industrial policies and to cultivate nationalist, patriotic, and rhetorical nation-building based on internal resources and technologies. Furthermore, TANESCO never manufactured electrical gadgets. Its role was to generate, transmit, supply, and sell electricity. The manufacture of electrical appliances particularly electric cookers was done by a small electrical industry in the town of Arusha in the north-eastern part of the country. Furthermore, trading companies such as the National Matsushita Electric Company based in Nairobi, Kenya, the Equipment Limited, Eastern Trading Company Limited, the Wigglesworth and Company (Africa) Limited, and the Hagemeyer Trading Company Limited, imported appliances manufactured by General Electric and the Westinghouse to Tanzania. Contrary to Europe and North America, where national governments collaborated with electrical utility companies and manufacturing companies to subsidise electrical appliances, the Tanzanian government took no robust measures to make electrical items affordable. This made both imported and domestically manufactured appliances unaffordable to many African Tanzanian families. For instance, the retail shop price for a double-plated electric cooker manufactured in

[61] Anne S. Lewinson, "Domestic Realms, Social Bonds, and Class: Ideologies and Indigenizing Modernity in Dar es Salaam, Tanzania," *Canadian Journal of African Studies* 40, no. 3 (2006): 475-476.
[62] *Ibid*.

Tanzania was sold at 4,000 Tanzanian shillings (equivalent to USD 220 in the 1980s), much too high for middle- and low-income households.[63]

As Langdon Winner claims, technical things such as automobiles, televisions, radios, factory systems, nuclear power, telephones, and even industrial systems consist of political motives. To avoid huge gap between rural and urban communities, the government banned television broadcasting until such a time when Tanzania could "have a satellite that would make it possible to cover the whole country."[64] The ban was mainly because Nyerere perceived television as expensive and a tool for widening rural and urban socio-economic disparities,[65] was enforced through a high import duty of 600 per cent in 1983, which affected both the availability and affordability of televisions in Tanzanian cities until the mid-1990s.[66]

A review of local newspapers confirms that Europeans and Indians continued to be the main consumers of domestic electrical technologies in socialist Dar es Salaam. We also found that battery-powered radios and torches were the common household devices advertised in Kiswahili newspapers while English newspapers advertised electrical appliances, such as bread toasters, refrigerators, and cooking ranges. The advertisements of these companies portrayed how these appliances were attached to Western modernity or Indian lifestyles which started in the colonial period. In addition, the use of either Indian or European women in these advertisements did not only reflect the "westernised modernity" attached to these gadgets, but also seems to suggest that they were the targeted consumers and users. Other consumers were large business owners, politicians, the elite class, and government workers who lived in government or company quarters.[67] It is fair to say that, although the spatial grid and connections had grown beyond the colonial enclave, the everyday routines, practices, and culture of African Tanzanian households made little use of electricity from the 1960s to 1980s, much like in the colonial period.

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[63] SNA, SIDA, File No F13O: 8, "Tanzania Economic Research Bureau", as cited in Mari Anderson and Helen Holm, "The Energy Market in Dar es Salaam, Tanzania: A Minor Field Study", Working Paper 127, (Swedish University of Agriculture Science, Upsalla, 1990); The World Bank Report, Tanzania Rehabilitation Project, Report No. 6026, 10 April 1986, 17.

[64] Konde (1984), 47, as cited in Martin Sturmer, "The Media History of Tanzania", (1998), available at: https://www.researchgate.net/publication/35020286_The-Media-History-of-Tanzania.pdf, (1998), 191.

[65] Interview 11, a retired government worker, Mbezi-Beach, 8 August 2018; Interview 20, a welder, Msewe, 24 August 2018; Interview 8, no occupation, Ubungo, 1 August 2018.

[66] Sturmer, "The Media History of Tanzania", 191; Interview 9, no occupation, Tabata, 6 August 2018; Interview 20, a welder, Msewe, 24 August 2018; Interview 5, shopkeeper, Kinondoni, 20 August 2018.

[67] Lewinson, "Domestic Realms, Social Bonds, and Class", 462-495; Jonas van der Straeten, "Measuring Progress in Megawatt: Colonialism, Development, and the 'Unseeing' Electricity Grid in East Africa," *Centaurus* 63, no 4, (2021): 651 – 674.

Figure 4.2: Electrical devices advertisements portraying Western modernity, simplicity, and comfort in homes.
Source: *The Standard*, 13.03.1969 and *The Tanganyika Standard*, 16.01.1964

The available archival evidence also unveils that many Tanzanian households in Dar es Salaam remained unelectrified between the early 1960s and the mid-1980s. Even the electrified households used electricity mainly for lighting rather than powering devices. For instance, the Household Energy Surveys in the 1980s estimated that only 1 percent of the population cooked with electricity and electric cookers were unaffordable. homes used electricity for lighting only and over 95 percent cooked with charcoal, firewood, and kerosene.[68] High import tariffs imposed on electric cookers and other electrical technologies made them unaffordable. In addition to those who lived in rented government houses, only the Indian and European communities in Upanga, Kariakoo, and Oyster Bay could afford electrical appliances. Those who cooked with electricity, as Mari Anderson's and Helen Holm's report on energy market in *in Dar es Salaam* in the 1980s indicates those Tanzanians who, "lived in rented government-owned apartments, which were already equipped with electric stoves" were the ones who largely used electricity for cooking.[69] A large portion of the population depended more on traditional energy

[68] SNA SIDA File No. F13O: 8: "Proceedings of the Seminar on the National Energy Policy for Tanzania, 10-14 September 1990, edited by M. J. Mwandosya and M. L. Luhanga, published by the Stockholm Environment Institute, (1991), 23.
[69] SNA SIDA, File No. F13O: 8: "The Energy Market in Dar es Salaam, Tanzania", working paper 127, Swedish University of Agricultural Science, Uppsala 1990.

sources than on electricity up to the 1980s. The household conditions and lifestyle of many African Tanzanians resembled the colonial period. Poverty levels continued to be high and urban policies remained unfavourable to many African Tanzanians, both employed and unemployed. Kerosene lamps were the major lighting technology and cooking depended on biomass and kerosene.[70]

4.4 Post-socialist Reforms and Electrical Technologies in Homes, 1990-2010s

Tanzanian homes saw the expansion of electrical power technologies from the late 1990s when compared to the socialist period. Electricity usage in people's homes has shown tremendous growth over the last decade. It rose countrywide from 16 per cent of the generated electricity in 1974 to 40 per cent in 2005.[71] The annual domestic electricity consumption also escalated from 1861 gigawatt-hours in 2000 to about 4419 gigawatt-hours in 2012. Household connections doubled from 0.8 million customers in 2010 to 1.7 million in 2015.[72] In Dar es Salaam, the percentage of connected households in Dar es Salaam reached 59 in 2000.[73] This level of household connectedness grew even more in the 2000s and 2010s. TANESCO's reports demonstrates that household electricity users consumed more than half of the generated electricity in 2016 surpassing industrial users who were the main electricity consumers in the colonial and socialist periods.[74] The recent household energy surveys show, the percentage of connected households in Dar es Salaam grew from 75 in 2016 to 86 in 2020.[75]

As figure 4.3 illustrates, from the 1960s to 1980s, electricity usage in homes followed a flattened curve during the socialist period, but from the 1990s the curve rose sharply indicating the increase in connections per year. It also indicates, electricity sales increased sharply from the 1990s in line with increases in residential users' connections. However, looking at the sales curve might be misleading because, in some instances, sales changed with changes in electricity tariffs. Yet, the growth of household connections and electricity sales indicate enlarged appropriation and use of domestic electrical appliances which penetrated Tanzania's markets

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[70] Interview 9, no occupation, Tabata, 6 August 2018; Interview 26, a retired military officer, Mbezi Beach, 10 October 2018; Interview 5, shopkeeper, Kinondoni, 20 August 2018.

[71] T. L. Maliyamkono and H. Mason, *The Promise* (Tema Publishers, 2006).

[72] Lugano Wilson, "Tanzania Energy Sector as the Key Driver to Ongoing Industrialisation", *Energy-Forum*, Dresden Technology Centre, 2017.

[73] Ghanadan, "Public Service or Commodity Goods?," 61.

[74] Donna Peng and Rahmatallah Poudineh, "Sustainable Electricity pricing for Tanzania: E-40305-TZA-1," Tanzania Country Programme of the International Growth Centre, 2016, 37.

[75] Tanzania National Bureau of Statistics, Energy Access, and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings, (The United Republic of Tanzania, 2020), 9, 16-18.

since the 2000s. Rebecca Ghanadan observed such growth in the 2000s, noting that radios and irons were the basic devices in Dar es Salaam homes (domesticated by 79 and 77 per cent of electrified homes, respectively), followed by appliances of high social value such as televisions, mobile phones, and fans, and then what she calls the ‘deepening choices’ appliances, such as stereos, small and large refrigerators, DVD/CD players, blenders, kettles, computers, rice cookers, microwaves, and deep freezers. It is thus possible to suggest that electricity sales from the 1990s-2000s indicate expansion in the number of consumers as well as changes in consumption patterns in homes rather than growth in tariffs.

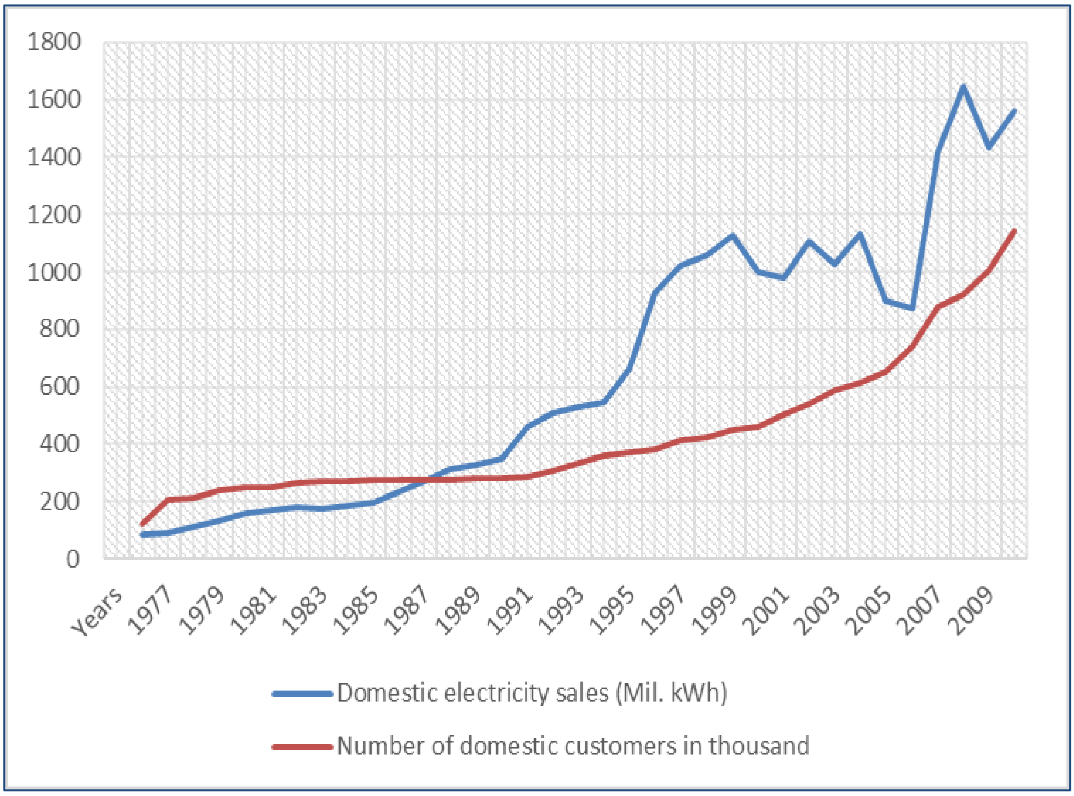

Figure 4.3: Growth of residential electricity customers 1976-2010.
Source: Combined by the author from TANESCO & EWURA, (2018) and Diu (2011).

Historians of technology have contended that acquiring technologies is influenced by the broader socio-cultural and economic historical underpinnings in a society. David Edgerton claims technologies are not domesticated to transform culture, but to serve the needs of a particular socio-cultural setting. He says that historians must engage not only with the technology but also with the society in which that technology is put into use. When we seek to understand how and why users’ appropriate certain technologies, we must be “concerned primarily with asking questions not about technology, but about technology in history—asking questions about the place of technology within wider historical processes."[76] Chatterjee operationalises this claim in his study of electricity and electrical technologies in Bengal when he argues that the supply and use of electrical power technologies did not occur independently of other socio-political, economic, and technical forces in colonial India. Instead, they were part of the larger historical contexts of which Bengal also participated. Chatterjee suggests that rather than looking at electrification as an independent historical force, scholars must consider it in line with the underlying political, economic, and cultural urban experiences.[77] As such, the expansion of domestic electrical technologies in post socialist Dar es Salaam was not independent of wider urban conditions developed during this period.

The liberal economic reforms were the overarching socioeconomic and political ideological drivers that expanded electrical technologies in Dar es Salaam from the late 1990s. In the late 1970s and early 1980s, the socialist government under the leadership of Julius Nyerere had protested the International Financial Institutions (IFIs) liberal reforms in Tanzania.[78] The growing economic crisis in the 1980s and the failure of Tanzania's internal structural policies, however, forced the country into economic reforms. This was marked by Nyerere's stepping down from power as Tanzanian President in 1985 and the signing of a structural adjustment policies (SAPs) package by his successor, President Ali Hassan Mwinyi in 1986.[79] Nicknamed *Mzee Ruksa* (*a father who allowed everything*), Mwinyi jettisoned the socialist restrictions in material possessions, liberalised and globalised the economy, and reduced import taxes on many commodities.[80] SAPs reforms not only ended the socialist market doctrine but also brought a new wave of goods that were circulated, sold, and cherished by inhabitants as vital domestic items in Tanzania.[81] Dar es Salaam, as a metropolitan city, grew as an exhibition zone for global manufactured electrical goods for urban and rural development including

[76] David Edgerton, *The Shock of the Old: Technology and Global History Since 1900*, (Profile Books, 2008), 211.
[77] Chatterjee, "Conflict and Identity," 15-17.
[78] Werner Biermann and Jumanne Wagao, "The Quest for Adjustment: Tanzania and the IMF, 1980-1986," *African Studies Review* 29, no. 4 (1986): 89-103.
[79] Haidari K. R. Amani *et al.*, "Understanding Economic and Political Reforms in Tanzania: A Report Submitted to GDN Understanding Reform, Economic and Social Research Foundation (ESRF), 2004; Peter Wobst, "Structural Adjustment and Intersectoral Shifts in Tanzania: A Computable General Equilibrium Analysis," *International Food Policy Research Institute*, Report Number 117; Washington, DC, 2001), 1-2, 7-26.
[80] Peter Wobst, Structural *Adjustment and Intersectoral Shifts in Tanzania: A Computable General Equilibrium Analysis*, (International Food Policy Research Institute, Report Number 117; Washington, DC, 2001), 22; Mosha, "Electricity Use an Alternative Fuel in Households," 112.
[81] Sean Hilhorst, "Remmy Ongala: Capitalist transition and popular music in Tanzania, 1979-2002," *Journal of African Cultural Studies* 21, no. 2 (2009): 105-126.

modern communication devices such as televisions, mobile phones, computers, and other electrical domestic goods.[82]

The first ways in which economic reforms deepened domestic electrical technologies and people's dependence on electricity was through the question of energy efficiency and environmental concerns. Tanzania experienced an urban energy crisis in the 1980s which was manifested through an increase in the price of petroleum products, charcoal, and firewood. Households consumed about 80 per cent of Tanzania's energy at that time. Hence, environmentalists claimed that the devaluation of the Tanzanian shilling by 80 per cent in 1982 and 1984 and in 1986 from 16 shillings per US dollar to 40 shillings in 1986 to stimulate exports and reduce the shortage of goods,[83] would force urban dwellers especially in the metropolitan city of Dar es Salaam to increase their reliance on forest-based energy resources both for income generation and cheap domestic fuel.[84] To prevent another energy crisis, new modern and ecologically sound household energy sources among which kerosene, liquified petroleum gas (LPG), and electricity, had to be found and promoted.[85]

When Tanzania was preparing its first National Energy Policy in the 1980s, the need for efficient domestic energy became paramount. Studies done before this time had shown that electricity was the cheapest source of energy, but "those in rural and urban areas who have not installed electricity yet, will never be able to do so in the foreseeable future" because of high electricity connection charges.[86] They also identified the high prices of electrical devices, particularly electric cookers, as an obstacle. Despite the reduction in import taxes on electric cookers which the government had introduced in the late 1980s, the "prices [were still] way out of reach of common people."[87] Many residents were ready to appropriate electrical appliances to modernise and to simplify their lives. But high prices of electrical appliances and installation fee were an obstacle. One of the reports explained that:

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[82] Nasibu Mramba, Mikko Apiola, Emmanuel Awuni Kolog, and Erkki Sutinen, "Technology for Street Traders in Tanzania: A design Science Research Approach," *African Journal of Science, Technology, Innovation and Development* 8, no.1 (2016): 121-133.

[83] Biermann and Wagao, "The Quest for Adjustment," 99.

[84] Sunseri Thaddeus Sunseri, "'Something Else to Burn': Forest Squatters, Conservationists, and the State in Modern Tanzania," *The Journal of Modern African Studies* 43, no. 4 (2005): 631.

[85] *Daily News,* "TANESCO efforts frustrated," 15 August 1990; Godfrey Mhando, "*Matumizi ya nishati inayofaa yahimizwa*" *Gazeti la Uhuru*, 26 Januari 1990; Gazeti la Majira, "*TANESCO kuweni wazi*", 29 Januari 2000.

[86] SNA SIDA File No. F13O: 8: "Some Policy Aspects of Energy Development in Tanzania", in Proceedings of the Seminar on the National Energy Policy for Tanzania, 10-14 September 1990, Arusha, published by Stockholm Environment Institute, (1992).

[87] Mosha, "Electricity Use an Alternative Fuel in Household," 113.

> Many women would thus prefer to use electric stoves to charcoal, gas or kerosene because stoves are convenient and electricity [monthly bills when compared on what is spent on other forms of energy] is cheap. Many households use the electricity only for lighting. This is because of the low income of the people who cannot afford to purchase electrical appliances or pay for the high installation charges. In order to contribute to the conservation of forests, the electricity tariff for domestic use should be such that it motivates people to switch into the use of electricity. Local firms should be encouraged to design and manufacture simple, cheap, and robust electric stoves and other electric appliances.[88]

For this reason, in its First National Energy Policy formed in 1992, Tanzania promoted domestic electricity connections and usage of electrical devices. The policy identified electricity as a critical "service and a necessary resource for economic development" and as "a deliberate tool to effect social equity and growth."[89] For the country to move forward economically and avoid depletion of forest resources, the benefits of electricity had to be extended to the wider community by reducing tariffs, since "only a small percentage of the entire population has access to electricity."[90] As the report emphasised, electrifying homes had to go together with "manufacture and dissemination of simple and cheap electric cookers to enable households to substitute electricity for fuelwood and charcoal."[91]

The post-socialist energy actors in Tanzania promoted electrification and electric cookers not to shape people's practices and routines but to promote environmental conservation. But in the 1990s, the focus was not on the economic feasibility of the company but on its environmental sustainability. We saw in Chapter 2 that in the socialist period, the government considered TANESCO as its industrial and rural modernising agent for promoting production. One of the observable changes during this time was that the government began to view TANESCO as an agent for environmental conservation—a promoter of efficient domestic energy technologies. The question of efficient cooking energy dominated the Tanzanian urban landscape and policymaking in the 1990s and 2000s. They viewed electricity as a more environmentally friendly energy technology than biomass.

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[88] SNA SIDA File No. F13O: 8, Proceedings of the Seminar on the National Energy Policy for Tanzania, 10-14 September 1990, edited by M. J. Mwandosya and M. L. Luhanga, published by the Stockholm Environment Institute, (1991).
[89] SNA SIDA File No. F13O: 8: "The First Tanzania National Energy Policy," 20.
[90] *Ibid*.
[91] *Ibid*., 15.

Before this period, TANESCO had planned to import electric cookers in collaboration with the World Bank to increase its financial position in the mid-1980s. The economic crisis had affected many industries, which meant electricity generation lacked adequate markets. Because industries were main consumers of electricity between the 1960s and 1970s, their collapse due to the 1980s economic crisis drove the company into a financial stall. The utility learnt that residential consumers were important. But the World Bank survey in the early 1980s had discovered a low level of electricity domestication since TANESCO's supply networks covered only a small part of urban areas, there was a lack of electrical material prevented new connections, and the absence of consumer credit facilities to electrify and acquire appliances. These aspects made many houses fail to domesticate electrical appliances.[92] TANESCO, the Tanzanian government, and other stakeholders in Tanzania's electrical industry, planned to import and distribute about 35,000-50,000 cheap two-burner electric cookers to promote electricity consumption in electrified homes as a strategy to raise household electricity consumption.[93] Nevertheless, sharp devaluation of Tanzania's currency in the late 1980s which raised the cost of imported electric cookers failed the project.[94] These financial and technical inadequacies compelled the company to shift its focus not only to domestic users but also to more business-oriented management including privatisation.

We failed to find statistical evidence on the number of homes that acquired electrical cookers, or the number of cookers imported or manufactured in Tanzania during this period. However, some of the existing evidence indicates that people had integrated some more appliances in urban homes as a response to these policies. For instance, TANESCO's report to the World Bank also declared that residential electricity usage grew from 19 per cent in 1978 to 31 per cent in 1990 due to deliberate measures taken by the company to broaden household consumption in connection with economic reforms.[95] Residential consumers and electricity consumption doubled within five years in the early 1990s, "due to: (i) greater purchasing power resulting from improved economic conditions in the latter part of the decade; (ii) expanded availability of electricity appliances; and (iii) the low tariff that applies to this group of

[92] The World Bank, "Staff Appraisal Report Tanzania Power Rehabilitation Project", (The World Bank: Washington, DC, 1986); The World Bank, "Project Completion Report United Republic of Tanzania Power Rehabilitation Project", (The World Bank: Washington, DC, 1993), 7.
[93] *Ibid*.
[94] *Ibid*.
[95] The World Bank, "Staff Appraisal Report Tanzania Power VI Project", (The World Bank: Washington, DC, 1993).

consumers."[96] TANESCO was not the only one who had noted that some households were using electric cookers more efficiently than in the 1970s and 1980s. The study by R. Hosier and W. Kipondya on household energy consumption in Dar es Salaam also offers insights into the growth of electricity usage in homes. Hosier and Kipondya found that, in the early 1990s, grid-connected households began "to cook with electricity with greater frequency" because of "relative shifts in energy prices, the gradual acquisition of electric cooking devices, the abolition of the import duty on electric cookers, and the continued subsidy of electricity."[97]Moreover, the question of environmental conservation and electricity for cooking continued to be the object of public debate in the 2000s in Dar es Salaam, showing the role played by environmental propaganda. Evidence suggests that people began using electric stoves more in the 2000s because of forest conservation. Electricity users' complaints regarding power outages and how they prevented cooking with electricity was one of the main public criticisms of Tanzania's electrical power company. While consumers had taken initiatives to domesticate electric cookers, blackouts during cooking time derailed one of their goals—saving the environment. For instance, a letter to the newspaper editor from a Dar es Salaam resident reads:

> We have been experiencing power cuts [annually] since 1992 due to water level problem at Mtera Dam. The question arises: 'What has the government done since then?' The answer is obvious – nothing. This year, the power cuts initially lasted for 16 hours until when the vice-president asked TANESCO to reduce the time to 8 hours. Why do we have power cuts from 2 p.m. – 10 p.m. [. . .]. More questions even arise: How would residents switch to electricity for cooking if TANESCO cuts power at times most needed for such a purpose? How would this help to protect our forests? [. . .] It is early to gauge TANESCO's seriousness in curbing the on-going environmental degradation. But it indicates that, its power supply fosters deforestations.[98]

This resident was not the only one concerned with the fact that power outages hindered the use of electricity for cooking. Another resident also complained in a letter to the editor of *Majira*, one of the daily Kiswahili newspapers, using the following words: "For several years now, Tanzanians have been urged to cook with electricity to curb deforestation and desertification. The citizens have responded positively by acquiring electric cookers and other appliances. But most people have abandoned their electric cookers and switched back to charcoal and firewood because of unreliable power supply."[99]Even though the concerns are

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[96] *Ibid*., 27

[97] R. H. Hosier and W. Kipondya, "Urban Household Energy Use in Tanzania," *Energy Policy,* (1993): 454-473,465.

[98] Letter to the editor from a concerned citizen, "Power rationing disturbing us," *Sunday News*, 24 December 2000.

[99] *Barua kwa mhariri, "TANESCO kuweni wazi", Gazeti la Majira, 29 Januari 2000.*

about electricity users' vulnerabilities, they reveal how the adoption of electricity and electric cookers was a question of efficiency in forest conservation, indicating also that people had begun to domesticate electric cookers even if they were not cooking with electricity or depended on it always.

The second way is that economic reforms and later electricity reforms made TANESCO more business-minded and expanded electricity generation in the country. TANESCO operated relatively well between the 1960s and 1980s, but from the mid-1980s the situation deteriorated, as I detailed in Chapter 3. The company could not repair and maintain its networks leading to high transmission and distribution losses which made its consumers more vulnerable. During this time, the World Bank had initiated the privatisation of public utilities in different countries in the world. The need to commercialise electrical companies was even greater in Africa where poor states had not only failed to sustain financial operations, but also had critical technical conditions. Since the World Bank had invested in TANESCO's infrastructures since the 1960s, as we saw in Chapters 2 and 3, it intervened by introducing electricity reforms, which began with technological assistance in the 1980s. It sponsored repair and maintenance of TANESCO's electrical systems and the training of manpower. It further called for the commercialisation and privatisation of the utility. To execute this proposal, the WB changed its lending policies in 1993 making electricity reforms a compulsory condition for obtaining economic assistance.[100]

Tanzania was reluctant to privatise TANESCO despite the First National Energy Policy in 1992 having welcomed private investors in electricity generation in the country. But when the interconnected national grid became more vulnerable in the early 1990s, following the collapse of the Kidatu and Mtera hydropower dams, as discussed in Chapter 3, the Tanzanian government began to accept the bundling of TANESCO into generation, transmission, and distribution. The power outages increased in the 1990s and the whole grid ran the serious risk of shutting down due to the shortage of rainfall. The repair and maintenance work which were accomplished by the World Bank and other donors had deteriorated and malfunctioned. TANESCO signed its first power purchase agreement with the Independent Power Tanzania

[100] The World Bank, The World Bank's Role in the Electric Power Sector; Policies for Effective Institutional Regulatory and Financial Reforms, A World Bank Policy Paper, (The World Bank: Washington, DC, 1993), 69. See also, the World Bank Public and Private Sector Roles in the Supply of Electricity Services, (The World Bank: Washington, DC, 2004); R.W. Bacon and J. Besant-Jones, "Global Electric Power Reform, Privatisation and Liberalisation of the Electric Power Industry in Developing Countries", *Energy & Mining Sector Board Discussion Paper*, Series Paper no. 2, (The World Bank: Washington, DC, 2002)

Limited (IPTL) in 1995 and later with Songas. The government placed the company under the Parastatal Sector Reform Commission (PSRC), formed in 1994 to oversee privatisation of government parastatals. In 1997, it sent the WB a letter of intent to restructure TANESCO. This was followed by a cabinet decision in 1999 which outlined the electricity industry policy and a restructuring framework for privatising TANESCO.[101]

Although, the Tanzanian government failed to privatise TANESCO, and it was once again placed under the Ministry of Energy and Minerals in 2004, TANESCO became more commercial, no longer operating as an agent of economic modernisation as had been the case under the socialist government from the 1960s to 1980s. In 2002, the Tanzanian government contracted a South African company, NetGroup Solutions, to manage TANESCO from May 2002 to 2006. The private management of TANESCO was intended to improve the financial and technical conditions of TANESCO, make the company business minded, and to operate a dramatic financial breakthrough and preparation for its privatising.[102] Despite NetGroup's high running cost, [103] TANESCO's ability to connect new consumers increased from 36,000 consumers per year in 2000 to about 100,000 in the 2004,[104] new consumers rose from 0.4 million in 2001 to 0.6 million in 2006, a growth of 37 per cent.[105]

While the electricity reforms in Tanzania were not a success story, this period fostered the connection of more households due to expansion in grid generation capacity. It was through the private electricity producers, both long-term and short-term IPPs, that Tanzania sustained its power systems over the 2000s following poor operation of its hydropower plants. Table 4.1 below shows that in 1995, the generation capacity of the national grid stood at 390.4 megawatts. It grew to 1683 megawatts between 2000 and 2015, a growth of 432 per cent.[106] The number of electricity consumers doubled in five years, from 0.8 million in 2010 to 1.6 million

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[101] Ghanadan, "Public Service or Commodity Goods?", 65-68; Katharine Nawaal Gratwick and Anton Eberhard, "Demise of the Standard Model for Power Sector Reform and the Emergence of Hybrid Power Markets," *Energy Policy* 36, (2008): 3948-3960; The United Republic of Tanzania, Electricity Supply Industry Reform Strategy and Roadmap 2014-2025, (The Ministry of Energy and Minerals, 2014); James B. Diu, "Determinants of Residential Demand for Electricity in Tanzania (1974-2009)," (MA Diss.: The Open University of Tanzania, 2011).

[102] Rebecca Ghanadan and Anton Eberhard, "Electricity Utility Management Contracts in Africa: Lessons and Experience from the TANESCO-NETGroup Solutions Management Contract in Tanzania, 2002-2006", MIR Working Paper, (March 2007), 21.

[103] Ghanadan and Eberhard, "Electricity Utility Management Contracts in Africa," 21; Hansard, "Bunge la Tanzania, Mjadala Kuhusu NetGroup Solutions," Mkutano 16, Kikao 25, Tarehe 14 Julai 2004.

[104] Hansard, "Bunge la Tanzania, Mjadala Kuhusu NetGroup Solutions", Mkutano 16, Kikao 25, Tarehe 14 Julai 2004.

[105] Ghanadan and Eberhard, "Electricity Utility Management Contracts in Africa", 21.

[106] Anton Eberhard, Katharine Gratwick, and Laban Kariuki, "A review of private investment in Tanzania's power generation sector," *Journal of Energy in Southern Africa* 29, no. 2 (2018): 5-6.

users in 2015.[107] Consumers increased four times in 15 years from 0.4 million in 2001 to 1.6 million in 2015.

Table 4.1: TANESCO's grid expansion in the postcolonial period, 1964–2015.

No.	Name	Owner	Installed	Fuel	MW
1	Hale	Tanesco	1964	Hydro	21
2	Nyumba ya Mungu	Tanesco	1968	Hydro	8
3	Kidatu	Tanesco	1975	Hydro	204
4	Zuzu	Tanesco	1980	Diesel	7.4
5	Mtera	Tanesco	1988	Hydro	80
6	Tanwat	SPP/IPP	1995	Biomass	2
7	Pangani Falls	Tanesco	1995	Hydro	68
8	Kihansi	Tanesco	2000	Hydro	180
9	Tegeta IPTL	IPP unit	2002	HFO	103
10	Songas 1 -4	IPP unit	2004	NGS	38
11	Songas 5	IPP unit	2004	NGS	114
12	Songas 6	IPP unit	2006	NGS	37
13	Ubungo I	Tanesco	2008	NGS	45
14	Tegeta GT	Tanesco	2009	NGS	17
15	TPC	SPP/IPP	2010	Biomass	102
16	Aggreko Tegeta	Aggreko rental	2011	Gas oil	50
17	Aggreko Ubungo	Aggreko rental	2011	Gas oil	50
18	Symbion Ubungo	Symbion rental	2011	NGS/Jet	126
19	Mwenga	SPP/IPP	2012	Hydro	4
20	Symbion Arusha	Symbion rental	2012	HFO	50
21	Symbion Dodoma	Symbion rental	2012	Diesel	55
22	Ubungo II	Tanesco	2012	Diesel	105
23	Nyakato	Tanesco	2013	HFO	63
24	Kinyerezi I	Tanesco	2015	NGS	150
	Total grid capacity in megawatts				**1683**

Note: *HFO = Heavy Fuel Oil; NGS = Natural Gas; IPP = Independent Power Producer; SPP = Small Power Producer.*
Source: Compiled by the author from TANESCO's 2012 Master Plan, and TANESCO's 2014 Road Map.

The third way is that the economic reforms increased people's income and improved living conditions. Structural policies were designed to resolve macro-economic imbalances, but they also affected individuals' income. As Bert Meertens upheld in the early 2000s, they had

[107] Wilson, "Tanzania Energy Sector," 2021.

deep socioeconomic impacts which affected every aspect of Tanzanians' lives.[108] When conducting interviews, I asked residents in Dar es Salaam what their life in the city looked like in the 1960s and 1970s. The common response was not only about the hurdles they faced, but how life changed after President Mwinyi to the present day. They used the Kiswahili phrase, *maisha yamebadilika sana* ('life has changed so much') to differentiate the socialist and liberal periods with regards to access to infrastructure and the availability of life necessities, such as food, shelter, communication, and clothing. In their accounts, they claimed that Dar es Salaam has progressed faster in communication technologies, clothing, eating habits, access to infrastructure including water and electricity, and geographical growth of the city, as well as the expansion of 'modern' houses. Indeed, Dar es Salaam evidenced changes in living conditions since the 1990s following national efforts to reduce absolute poverty. The national efforts for poverty alleviation in the 2000s aimed to increase household income by boosting access to electricity and information and communication technologies.[109] It is estimated that the household poverty level dropped from 28 per cent in 1992 to about 14 per cent in 2007, before it reached 4 per cent in 2012.[110]

One of the indicators of decline in household poverty and increase in people's income was ownership of houses and access to modern electrical technologies. For instance, whereby 20 per cent of households owned televisions in the city in 2001, this figure rose to 40 per cent in 2007, and mobile phones grew from 9.6 per cent to 67 per cent in the same period.[111] Tanzania's Household Energy Surveys of 2016 and 2020 reveal that homes domesticated more appliances when compared to the years prior. The common electrical devices were mobile phones that were owned by 78 per cent of households, radios and radio cassettes owned by 57 per cent, televisions by 24 per cent, irons by 12, refrigerators and freezers by 9 per cent, fans

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[108] Bert Meertens, "Agricultural performance in Tanzania under structural adjustment programs: Is it really so positive?", *Agriculture and Human Values*, 17, (2000), 334.

[109] For government poverty reduction efforts, see, for instance, the National Strategy for Growth and Poverty Reduction in Jamhuri ya Muungano wa Tanzania, *Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania* (MKUKUTA I), (Ofisi ya Makamu wa Rais, 2005); Jamhuri ya Muungano wa Tanzania, *Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania* (MKUKUTA II), (Wizara ya Fedha and Mipango, 2010); Maliyamkono and Mason, 244.

[110] URT, Poverty and Human Development Report (PHDR), 2009: Brief 4: An Analysis of Household Income and Expenditure in Tanzania Produced by the Research and Analysis Working Group of the MKUKUTA Monitoring System, Ministry of Finance and Economic Affairs: available at https://media.africaportal.org/documents/brief_4_lr, accessed on 30 September 2021.

[111] The World Bank, "Tanzania Mainland Poverty Assessment: Executive Summery", available at: https://www.nbs.go.tz/nbs/takwimu/hbs/Tanzania_Mainland_Poverty_Assessment_Report, accessed on 30 September 2021.

by 7.4 per cent, and electric cookers, 1 per cent.[112] Dar es Salaam also increased cooking with electricity from 1 per cent in 2016 to 3 per cent in 2020.[113]

The city also experienced great sprawling growth from small enclaves to new peri-urban areas which were small villages in the 1960s to 1980s. Such expansion went hand-in-hand with building of permanent and modern houses in places which are considered informal, slums, or unplanned. Whereas in the 1960s the distance from the centre to the peripheries of Dar es Salaam was between 5 to 10 kilometres in different directions, it reached 30 to 60 kilometres in the 1990s, and about 60 kilometres in some directions.[114] Modern houses increased in the country from 42 per cent in 2002 to 65 per cent in 2012.[115] The inhabitants in Dar es Salaam considered three aspects to define a modern house: construction materials, separation of functions, and furniture (including electrical gadgets). In materials, modern houses were those built with concrete blocks, roofed with iron sheets, and floored with non-earth materials, mainly ceramic tiles, and cement. In terms of separation of functions, a modern house had a separate sitting room, kitchen, and sleeping rooms depending on how big the house was. This is differentiated in the Swahili type of house where cooking, sleeping and other activities could take place in a single room. Last, in terms of interior decoration and material possessions, a modern house was furnished with sofas or couches to welcome guests, coffee tables, dining tables, refrigerators, electric cookers, television, and other electrical appliances.

The demise of Tanzania's socialist regime was not an economic and socio-political ideological shift only but was also a change in how people lived every day in their homes and interacted with technologies. Liberal reforms ended the socialist restrictions on importing technologies and citizens' material possession rose conspicuously in consumption and non-conformist to Ujamaa policies. The shift increased housing ownership, which in turn created a space for people to incorporate electrical technologies as essential tools in making their lives more comfortable and meeting households needs. In their own houses, inhabitants became

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[112] Tanzania Bureau of Statistics, "Energy Access Situation Report, 2016: Tanzania Mainland," (The United Republic of Tanzania, 2017).

[113] Tanzania National Bureau of Statistics, "Energy Access and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings", (The United Republic of Tanzania, 2020).

[114] John Briggs and Davis Mwamfupe, "Peri-urban Development in an Era of Structural Adjustment in Africa: The city of Dar es Salaam, Tanzania," *Urban Studies* 37, no. 4 (2000): 797–809; Camillus J. Sawio, "Perception and conceptualisation of urban environmental change: Dar es Salaam City," *The Geographical Journal* 174 (2008): 164–168; Manja Hoppe Andreasen and Jytte Agergaard, "Residential Mobility and Homeownership in Dar es Salaam," *Population and Development Review* 42, no. 1 (2016): 95–110.

[115] United Republic of Tanzania, Basic Demographic and Socio-Economic Profile: Key Findings of the 2012 Population and Housing Census, (URT, 2014), 5-6.

freer to furnish them with modern electrical appliances, which were by and large absent before the 1990s. As people's ability to build their own modern houses increased, they domesticated more electrical technologies.

Residents in Dar es Salaam struggled to build their own houses not only to escape from the burden of paying rent but also to increase their freedom in using electrical devices. It should be said that paying electricity has for decades been one of the major sources of conflict because of differentiated income and appliance usage. Some landlords and landladies restrict the use of appliances that consume more electricity, such as heaters, kettles, refrigerators, freezers, cooking stoves, and rice cookers in order to reduce conflicts in paying electricity bills. When one electric meter is shared by several households, it becomes a question of how to measure consumption and what each household has to pay fairly.

To avoid such conflicts, they normally prohibit the use of those appliances they consider unnecessary or those which consume more power. Before renting a room, a shared apartment, or a house in Dar es Salaam, tenants must negotiate which items they can purchase and use in a shared house to avoid conflicts in paying and buying electricity tokens. In this regard, owning a house means emancipation from conflicts over electricity bills and increased freedom to use more electrical gadgets. as one of the interviewees emphasised: "someone is free to use whatever kind of electricity appliances when he/she owns a house. As I'm owning my two-room house, even if I decide to stay the whole week with my refrigerator on, no one will ask me, as far as it's my own house and I'm able to pay the electricity bill."[116] Since it can take a lifetime for low-income families to build a house, residents are forced to move and electrify their own houses even before the construction is over. Possessing a single-room house or a house with several rooms means not only freedom from renting but also a chance to domesticate electrical appliances, a rare possibility in shared/rented houses. But life in partially built households increased owners' freedom to use electrical items and to avoid billing conflicts in rented homes.

Modern houses have motivated people to domesticate electrical technologies to make them safer and more comfortable. A resident recounted on this view that: "many well-off families see lighting with kerosene or candles as to welcome hazards in their health and houses. Imagine someone can take 20 years to build a family house and get fire accidents. Those who

[116] Interview, Kwembe, 28 July 2018

possess their own houses do not like to hear about kerosene or candles in their homes."[117] In addition, to look more modern, a house needs to be illuminated by electricity and not by kerosene lamps and candles. In houses with many rooms or a big sitting room, kerosene lamps and candles cannot light them properly. Having a modern house with no electrical light and devices could become a burden, as one inhabitant commented.

> When you build a well-ventilated bungalow house, you need electricity to light it and other items to furnish it. It is not attractive to have a big house and then light it using kerosene lamps. Similarly, a big sitting room needs a television and music system. A sitting room becomes unpleasant when it misses electricity and television. That is why electricity is very important. Nowadays people need to live more comfortably, having houses with space, good light, and modern electrical things.[118]

This excerpt suggests that separation of functions in homes forces people to acquire electrical technologies to make their homes more attractive. A kitchen needs kitchen appliances such as a refrigerator, cooker, rice cooker and so on, and a sitting room needs a television, radio, DVD-CD player, etc. A home with separated functions tempts owners to furnish them with electrical devices based on their designed functions. As Huba Nguluma shows on improved settlement in Dar es Salaam that cooking with electricity increased from 4 per cent to 10 per cent when people upgraded their homes to have separate functions in Hanna Nassif–Kinodoni. Some dwellers owned electric cookers "just as a status symbol" as they could not use them in cooking due to high electricity costs.[119] The improved household conditions and ownership due to the rise in individuals' income leads people to domesticate more electrical technologies. Modern homes go hand-in-hand with electricity connection and electronic possessions.

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[117] Interview 28, small business, Kimara, 12 October 2018. However, this was noted by most interviewees. Those who built their own houses and moved in claimed that limitation and conflicts in renting, including about electricity usage and bills, compelled them to build their own houses.
[118] Interview 9, no occupation, Tabata, 6 August 2018.
[119] Huba A. Nguluma, "Housing Themselves: Transformations, Modernisation and Spatial Qualities in Informal Settlements in Dar es Salaam, Tanzania," (PhD Diss.: Roya Institute of Technology, 2003), 151.

Figure 4.4: Common domestic electrical appliances in Tanzanian homes.
Source: Taken by the author in February 2021 in Dar es Salaam.

The fourth way is that economic liberalism changed the informal urban economy and household needs. It required the mobilisation of resources to meet urgent material needs of the Tanzanian society. Opening the door for foreign investors and foreign trade, exports and imports of manufactured goods became the national strategy. Domestically, the country opened space for informal economies through small entrepreneurship, retailing services, hawking and many other activities which had been under scrutiny in the socialist period. In homes, while government workers and the political class were discouraged to invest and live more modern life when compared to the rest of community during the socialist period, as discussed in section 5.3 above, liberal reforms provided room for greater domestic material consumption and lavish lifestyles. The new political economy developed in cities promoted the availability of manufactured goods, improved services, and income generation to the urban poor. It encouraged informal businesses, and made homes places for income-generating activities, which were largely discouraged in the socialist period.[120] Dar es Salaam experienced growth of 'informal' activities, such as hairdressing salons, and barber saloons, retail shops, mobile money shops, television kiosks, food vending, stationery, milling machines, and tailoring shops.[121]

[120] Lewinson, "Domestic Realms, Social Bonds, and Class," 486.
[121] United Republic of Tanzania National Strategy for Growth and Poverty Reduction (2005); See also URT, Ministry of Energy and Minerals, Power System Master Plan 2012; Updated (May 2013).

Tanzania's post-socialist economy transformed urban homes into income generating spaces. This idea contrasts with Catharina Landström's observation that the coming of technologies to homes sought to transform activities which were done at home into medium-size enterprises outside domestic premises and make homes more modern— "a place exclusively for consumption and rest than production."[122] In Dar es Salaam homes became sites for economic activities because these activities lacked well-defined premises. The government failed to integrate them in the larger economic sectors. Moreover, the establishment of these enterprises did not follow business formalities such as registration, account keeping, and tax paying since they were part of the hand to mouth, a general livelihood style for the larger percentage of the city's population. They were part of the everyday household activities. Residents established household activities in homes for "survival rather than longer-term economic growth."[123] The distinction between domestic tasks, such as cooking, refrigeration, washing, laundry, cleaning, etc., and income-generating activities done in homes was generally blurred.

As Elizabeth Ilskog observed in her study of seven electrified areas in Eastern and Southern Africa, by 2000, some forty-two per cent of households in Tanzania had small income-generating activities around their premises. Electricity was used to power various appliances and tools used in meeting different purposes. The fact most of these productive works were located in the vicinity of households made the separation between commercial and domestic use of electricity cumbersome.[124] People electrified their homes to perform economic activities in response to growing post-socialist household and societal needs in Dar es Salaam.[125] When asked why they electrified their homes, the interviewed residents explained how electricity is an important household asset for economic development. One of them recounted:

> Electricity usage in people's households and businesses increased in the 1990s and 2000s. People used it for different productive and household activities. They use it for light and devices such as irons, refrigerators, kettles, radio, television, and so on. These devices are being used in producing economic goods. The coming of new technologies and people's

[122] Catharina Landstrom, "National Strategies: The Gendered Appropriation of Household Technology", in Mikael Hård, and Andrew Jamison (eds) *The Intellectual Appropriation of Technology: Discourse on Modernity, 1990 – 1939*, (London and Cambridge: The MIT Press, 1998), 167.

[123] Alban D. Mchopa, Isaac Kazungu and John Moshi, "Power Rationing Dilemma: A Blow to Small and Medium Enterprises (SMEs) Performance in Moshi Municipality, Tanzania," *International Journal of Economics, Commerce and Management* 2, no. 7 (2014): 1–14.

[124] Elizabeth Ilskog, "And Then They Lived Sustainably Ever After? Experiences from Rural Electrification in Tanzania, Zambia, and Kenya", (PhD Diss.: KTH Stockholm, 2008).

[125] Interview 23, an entrepreneur, Tabata, 28 August; Interview 18, restaurant owner, Manzese, 24 August 2018.

> knowledge that electricity is development as it can be used in many ways, made people electrify to make their homes more comfortable and productive to meet life needs.[126]

Domestic electrical technologies grew as vital tools for household (re)production to reduce hardship. For instance, in the 1990s and 2000s, television sets grew as one of the artefacts for increasing leisure in homes replacing the cinemas of the socialist period. They became socio-cultural tools and the main form of entertainment in bars, restaurants, and homes.[127] But, televisions also developed as livelihood assets for a good number of families. One of our interviewees who owned a television kiosk in Dar es Salaam commented that he self-employed by establishing a video kiosk (a place where people could gather in the evening and weekend to watch televised dramas, football matches, and films) since the 1990s. He moved to Dar es Salaam in 1992 as a carpenter in Mwananyamala. After he had accumulated some amount of money, he purchased a television and started a video kiosk in 1998. People came every evening to watch television and during weekends, he opened his kiosk the whole day. His main customers are male youths, men, and children who watch football and films. He charged them 20 Tanzanian shillings in the late 1990s and increased to 200 shillings as the economy changed. The kiosk became a successful business, so he left carpentry in 2005. By 2018, he had three television kiosks in different parts of the city. They enabled him to meet the needs of his family and he built a three-bedroom house in Kibamba, (one of the suburbs in Dar es Salaam), and paid school fees for his children.[128]

One of the Kiswahili newspaper columnists recapitulated the critical role of electricity and television and how people used them to earn income in the late 1990s. Going by the name Hamisi Kibari, the columnist explained how television and electricity were critical technologies to low-income homes. He wrote:

> I am so sorry for Sultani Masoud and other friends who live in '*Uswahilini*' [low-income residential areas/slums]. Mr Masoud who recently won a coloured television in the competition of the ugliest person. [. . .] In the recent interview he said that he would use the television to generate income by opening a video kiosk to show video records, dramas, and football matches. To him, and so to many people in '*Uswahilini*', the TV that he won, is a big economic enterprise. TVs and videos records, and films are still scarce commodities in '*Uswahilini*',

[126] Interview 1, a professor, and a former environmental journalist, Survey-Mwenge, 31 July 2018.
[127] James Brennan, "Democratizing Cinema and Censorship in Tanzania, 1920-1980," *The International Journal of African Historical Studies* 38, no. 3 (2005): 481-511
[128] The use of television for income generation was noted in many interviews in the city. For instance, another interviewee at Ubungo-Dar es Salaam contended that he earned between 2,000 and 10,000 Tanzanian shillings per day.

> and therefore they are big economic projects for many people. [. . .] Furthermore, one of my neighbours is an older woman whose family depends on the ice cream she sells to school children. She was selling three cool boxes a day in the past several weeks, but she is now selling a half cool box a day. TANESCO's power cuts, which are customarily restored at the mid-night, have affected her business severely. [. . .] Ooohh! Before I forget, there is that water retailer in the market. Yesterday, he was strolling throughout finding ice to cool his water, without success. He asked residents to demur TANESCO's power cuts… I just chuckled at him because of his idea.[129]

This quote reveals how electricity and domestic electrical devices were economic items rather than for entertaining and modernising homes. In informal settlements called shantytowns, or *uswahilini*, some people employed themselves through television kiosks. Even in well-off areas, televisions serve to attract customers in restaurants and bars and many businesspeople also use them as economic assets. The culture of using television as an income generating asset that began in the 1990s when televisions were only a few has continued to the present day, despite the expansion of television in people's homes. The quote, however, goes beyond to show the criticality of electricity in people's livelihoods and the vulnerabilities its users faced (this aspect is expanded in section 5.5 which follows).

The domestication of the television was a socio-cultural process as much as it was technical and economical. Its introduction into people's homes also brought new socio-cultural tensions. It influenced the ways in which people lived every day. Electrical devices changed socio-cultural roles and daily routines in homes as well as transforming household interior designs and social relations. When televisions and television kiosks increased in Dar es Salaam, new socio-cultural tensions emerged. Children spent most of their time in television kiosks and electrified neighbours' homes, which had television sets. In low-income households, this brought new social tensions between parents and children. Parents wanted children to spend their time at home while children wanted to watch television in kiosks or neighbours' homes. This forced some parents to electrify their homes and acquire televisions to keep their children indoors. One resident quipped saying, "I felt so bad because my children turned to become a problem in the street, going to watch television in neighbours' homes or video kiosks. For that reason, [she insisted], I worked day and night to get money to electrify my house and buy a television set for them."[130] The adoption of electrical gadgets also resulted from socio-cultural

[129] Hamisi Kibari, "*Kasheshe la Mgao wa umeme Uswahilini*," *Nipashe*, 14 September 1997.
[130] Interview 15, a tailor and small business owner, Ubungo, 20 August 2018.

changes that have taken place over the last three decades including dealing with parenting challenges, making homes more comfortable, and marching with modernity.

By and large, it was also stimulated by economic gains. Petty traders produced different local goods in their homes and worked as hawkers in different parts of the city to sell them. People depended on electricity for the reproduction of everyday life especially because Dar es Salaam developed as a centre for informal business. For many residents particularly in low-income families, electricity became an economic asset. It facilitated their small businesses daily in the city. One entrepreneurial woman who owned a *genge* (kiosk for selling food items such as vegetables and cooking ingredients) at Magomeni, reproduced similar monetary advantages gained through electrifying her home and acquiring electrical appliances. She contended that as a productive woman, her refrigerator was "critical to her daily income generation" saying that "truly, my refrigerator is a chief source of my income even more than this kiosk [her *genge*]. My family is largely depending on selling cold drinks, ice, and ice cream. [. . .]. We purposely bought a refrigerator to expand our small business at home."[131] She also stressed the crucial role of electricity and her fridge by recalling that she was a vegetable seller in the 1990s and could not switch to another small business because she lived in a rented, un-electrified house. When "we built our own house in 2006, we quickly electrified it and bought a refrigerator to do small business."[132]

In a similar vein, another woman who owned a tailoring stall attested to how she uses her refrigerator in making ice cream and ice to raise her household income. She emphasised, *"*…for sure, electricity is crucial because it powers devices which employ people like me."[133] Moreover, a tailor at Ubungo-Msewe used electricity to run her sewing machines and a refrigerator for making ice and ice cream. She insisted that "TANESCO's frequent power cuts have been affecting my businesses and income. [. . .] I cannot produce ice creams for sale and work appropriately during power outages."[134] As Ruth Schwatz Cowan notes, although the domestication of electrical power technologies was perceived as reducing women's burden of domestic tasks, on the contrary, it increased their workload in the home.[135] Liberal reforms motivated people to electrify their homes and acquire appliances to engage with more income

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[131] Interview 29, small business dealer, Magomeni, 11 August 2018.
[132] *Ibid*.
[133] Interview 23, a tailor, and entrepreneur, Tabata, 28 August 2018.
[134] Interview 19, a tailor, Ubungo-Msewe, 24 August 2018.
[135] Ruth Schwartz Cowan, "The "Industrial Revolution" in the Home: Household Technology and Social Change in the 20th Century," *Technology and Culture* 17, no. 1, (1976): 1-23.

generation activities in homes to meet household and societal material needs. The case of Dar es Salaam, though, does not fit Cowan's interpretation neatly in that the increase in what people could do at home in Global North cities was not always regarded as a good thing. It meant an increased burden on women who were struggling to free themselves from domestic tasks and increase their time in economic activities far from domestic work. Nevertheless, the increase in what people could do at home, especially women, is more about making homes economic production spaces than a place for consumption. Instead of becoming a comfortable, modern place for entertainment, domestic electrical technologies played a significant role in meeting inhabitants' socioeconomic needs. They created opportunities for women food vendors to store and cool their groceries, simplified tailoring works, and helped ice and ice-cream makers.

Figure 4.5: *The use of refrigerators in making cylindrical ice-cubes and ice creams for income generation.*
Source: Photo was taken by the author in Ubungo, Dar es Salaam in August 2018.

The socioeconomic changes brought by the 1980s and 1990s economic reforms expanded electricity and appliance usage in homes. New economic opportunities brought by liberal reforms forced people to electrify their homes and acquire different electricity services. As such, the expansion of power systems in terms of electricity generation, which in turn, expanded transmission and supply networks to connect many households, contributed to the growth of electricity usage in homes. Liberal policies escalated the availability of old and new invented domestic artefacts which were largely missing during the socialist period in many homes, such as televisions, mobile phones, computers, radios, CD and DVD players, stereo systems, and other tools for home entertainment. Both electricity and electrical appliances gained socio-cultural meanings as markers of modernity, created comfort, and were above all essential economic assets in the domestic space.[136]

4.5 Domestic Electrical Technologies and Users' Vulnerabilities

Residential electricity consumers in Dar es Salaam can be categorised into three groups according to electricity and appliance uses. The first group consists of the well-off consumers who possess high-social status appliances, such as microwaves, electric cookers, refrigerators, washing machines, vacuum cleaners, and air conditioners. They mainly acquired them to simplify work at home, increase leisure, and make homes more modern. The second group includes those moderate users largely from middle-income families who possess almost all basic electric devices, such as mobile phones, televisions, irons, fans, and refrigerators. They appropriated and used them to be more modern, to simplify work, and to generate income. The third on the list are low-income users who have only one or two essential appliances domesticated purposely for income generation or other compulsory uses.

The domestication of electrical technologies made electricity users in Dar es Salaam view electricity as critical technology in their lives, but they also became more vulnerable. Technologies are never neutral but influence the routines of their users. Studies on Science and Technology Studies (STS) have delved deeply into the empirical and theoretical analysis of the non-neutrality of technologies. Hård and Jamison posit in *Hubris and Hybrids* that domesticated technologies affect human life diversely from language, gaining new vocabulary for the ways people's everyday lives are organised. According to these authors, technologies including mechanisation, electrification, automobilisation, computerisation, genetic engineering, and so on, affect how we talk, think, and do things. Societal interaction and organisation change "as technologies impose their systemic and infrastructural requirements on the social order."[137] Technologies are appropriated and accepted in a society or household because they perform

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[136] Jeffrey James and Mila Versteeg, "Mobile phones in Africa: How much do we really know?", *Suc. Indic. Res* 84, (2007): 117-126; Hamis Mfaume, "Awareness and use of a mobile phone as potential pedagogical tools among secondary school teachers in Tanzania," *International Journal of Education and Development using Information and Communication Technology* 15, no. 15, (2019): 154-170; Joel Rumanyika, *et al*., "Mobile Technology for Street Traders' Market search in Dodoma – Urban Tanzania: An exploratory Study", *The African Journal of Information System* 11, no. 4 (2019): 249-278.

[137] Hård and Jamison, *Hubris and Hybrids*, 15.

crucial functions and roles. With time, they grow to become not new artefacts but part of society's thinking, perceptions, and attitudes in doing things—at household level, they become part of family life. Sociologists of technology observe that users decide to appropriate a particular technology, but after finding its place in their socio-cultural lives, that technology never remains neutral, it "becomes, like our economy or our political system, an aspect of the way we live socially. It becomes something whose changes are part of wider changes in the way we live."[138] Technologies shape people's daily lives, essentially if they are also used in daily contexts.

The interdependence between technology and users that develops as people decide to domesticate technology and as technology routinises users' socio-cultural life makes technology users vulnerable. STS scholars such as Anique Hommels, Jesica Mesman and Wiebe Bijker in *Vulnerability in Technological Cultures* have gone far to show the ways societies and technologies shape each other and produce vulnerabilities. According to these authors, user vulnerabilities are an outcome of excessive reliance on technological artefacts, procedures, and or ideas in daily life. They have employed the 'technological cultures' metaphor to explain the complex interactions between human societies—people, governments, and households—and technologies. The concept 'technological cultures' depicts how 'modern societies' appropriate technologies to meet numerous critical functions. But in the process of harnessing such opportunities, technologies transform the ways people perceive, think, and do things. In other words, the appropriation and usage of certain technologies create a new worldview that determines how people live every day—in vulnerable technological cultures. They contend, "scientific and technological developments do not only support and straighten societies; they also make societies vulnerable at the same time."[139] The integration of electricity and electrical power gadgets in inhabitants' houses in Dar es Salaam was never neutral, it brought new vulnerable technological cultures into households.

The inhabitants electrified their homes to enjoy electricity end-services such as cooking, lighting, cooling, and powering different electrical gadgets. As different appliances reached the domestic sphere their perceptions on the criticality of electricity increased. They viewed electricity as more critical because its role in daily socio-cultural and economic activities in the

[138] MacKenzie and Wajcman, *The Social Shaping of Technology*, 3.
[139] Wiebe Bijker, Anique Hommels, and Jessica Mesman, "Studying Vulnerability in Technological Cultures," in Anique Hommels, Jessica Mesman, and Wiebe Bijker, *Vulnerability in Technological Cultures: New Directions in Research and Governance*, (Cambridge, Mass., London: The MIT Press, 2014),1 – 2.

domestic sphere increased. As Degani phrased it, electric fans created "spaces to rest and cool down. [. . .] They are small, democratic breeze machines, redistributing the air—as long as the power supply holds."[140] In other words, electricity users viewed the criticality of electricity in connection with increased usage of these devices in homes for everyday life. As one interviewee noted, "in the past electricity went off but we were not thinking about it so much. But everything needs electricity today." He testified further that, "we lived without mobile phones or electricity in the past, but it is difficult to do so today. Mobile phones connect people; they have become tools of entertainment, a source of income, and small banks, for storing and transferring money. […] Everyone needs it to simplify life."[141] Mobile phones have become more than technical objects. They are socio-cultural and economic artefacts of everyday life. They are a "source of income; the whole family depend on it [. . .] Without it my family will stay without food."[142] While in the 1960s to 1980s electricity was largely a technology used to light homes, it grew to become a vital source of power.

People's perceptions of vulnerability arose not only because of the rapid penetration of electrical things into everyday life, but also because households appropriated electrical technologies for income generation activities. Electricity users connected their lives with electricity and considered it to be "everything"—something that everyone needs for daily activities. When it is available, electricity makes life better and when it goes off life becomes much worse.[143] Like blood in the body, "electricity is needed by everyone to survive and when it is missing, life [people's livelihoods] goes astray."[144] The conception of electricity as 'life blood' for everyday living appeared both directly and indirectly among electricity users in Dar es Salaam.

Lukitsch and others have defined the criticality of infrastructure as a technical thing that is "needed to keep running other major technical and/or social systems or which is needed to provide goods or services that are considered vital to the functioning of modern society."[145] Electricity has become critical infrastructure for Dar es Salaam's residents in the terms

[140]Michael Degani, Debra Spitulnik Vidali, and Martin Webb, 2017, "Our Electric Air", Theorising the Contemporary, Field sights, 19 December, available at https://culanth.org/fieldsights/our-electric-air.

[141] Interview 5, a shopkeeper, Kinondoni, 20 August 2018; The modernity perspective was also raised by residents in interview 26, retired military officer, Mbezi Beach, 10 October 2018 ; Interview 9, no occupation, Tabata, 6 August 2018, and Interview 15, a tailor and small business owner, Ubungo, 20 August 2018.

[142] Interview 16, businessman, Kariakoo, 21 August 2018.

[143] Interview 29, Magomeni, 11 October 2018.

[144] Interview 12, electrician, Mwenge, 10 August 2018.

[145] Kristof Lukitsch, Marcel Müller, and Chris Stahlhut. "Criticality" in Jens Ivo Engels (ed) *Key Concepts for Critical Infrastructure Research*, (Wiesbaden: Springer SV, 2018), 11-20, 12.

described. As access and usage expanded, people have come to depend more and more on the grid. They also claim that despite electricity being a technological tool for development and life support, it also has the capacity to ruin people's lives.[146] One informant pointed out that, "If you need to remain poor, play with TANESCO's electricity. It damaged my refrigerator and television last year. I bought new ones and it has damaged them again. You cannot live happily with your appliances without automated backups or other protective gears. Truly, it is pulling back our development efforts."[147] These oral testimonies and life experiences in Dar es Salaam show that as people became more dependent on appliances in meeting different electricity end-services they became more vulnerable.

Jethron Akallah and Mikael Hård had observed the linkage between dependence on technical systems and inhabitants' vulnerabilities in the urban South. They studied local water supply practices in colonial and postcolonial Nairobi and showed that residents became more vulnerable after their homes were connected to the centralised water network, because they abandoned their traditional water supply methods. They show that inhabitants of the so-called 'informal' settlements remained resilient until they became connected to centralised water systems. The connection to centralised water supply and the residents' dependence on these systems has increased their vulnerability, because they abandoned their traditional methods of water collection.[148] One of Akallah's and Hård's significant points is that user vulnerabilities are historically created and increase with dependence on a single source of supply of a given service. They contend that although access to large technical systems might aim to "increase our level of comfort but it may also, simultaneously, make us more vulnerable."[149] The case of Dar es Salaam is different in that people became more vulnerable to the grid not because they abandoned their traditional energy sources but because electrification made them adopt more appliances and, hence, increase their dependence on the grid. As in Akallah's and Hård's study of water infrastructure in Nairobi, vulnerabilities grow when people increase their dependence on the centralised electricity supply. Whenever the grid is turned off or broken down, people's lives are put on hold and even public security are at risk.[150]

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[146] Interview 10, a local government leader, Ilala-Buza, 7 August 2018.
[147] Interview 1, a professor, and a former environmental journalist, Survey-Mwenge, 31 July 2018.
[148] Jethron Ayumbah Akallah and Mikael Hård, "Under the Historian's Radar: Local Water Supply Practices in Nairobi, 1940-1980," *Water Alternatives*, 13:3, (2020): 886-901.
[149] *Ibid*., 887.
[150] The editor, "A more sincere approach needed to absolve us from latest power blues," 20 October 2009.

While inhabitants connected their homes and appropriated various items to generate income, raise productivity, simplify work, entertain, and increase domestic comfort, the growing dependency on the grid has made them more vulnerable. Gabby Mgaya's letter to the editor of the *Daily News* captures how this level of criticality and user vulnerability was achieved in Dar es Salaam as people became more dependent on electricity. He wrote in a long letter about the unpredictable nature of electricity breakdowns and the havoc caused to everyday life. Mgaya lamented about a 38-hour blackout in Upanga Seaview area. As he described the incident, people had walked out from barber shops half shaved. Electricity consumers, both those who had backups and those who had none, lost their groceries in freezers and refrigerators, and faced inconveniences. A part of his letter reads:

> In the absence of air-cooling systems including electric fans, nights in Dar es Salaam could turn into one terrible nightmare. It was at 9 pm when power was finally restored. [. . .] I believe that by that time the fresh milk, sausages, meat, and fish for both domestic and commercial purposes had all gone bad. [. . .] Power disruption for whatever reason is an inconvenience. Electricity runs most essential gadgets in the house. Hence, power cuts cause users to suffer heavy financial loss due to the resultant inactivity and damage to normal life, especially to folks who do not possess those gadgets called generators. And even for those who have generators, the noise is just too terrible.[151]

This excerpt portrays electricity as an enabler of everyday living—a critical infrastructure. Its disruption has deleterious consequences as it curtails the functioning of life-sustaining electrical appliances. As a result, although some people possess back-up tools (generators), they also assume a certain level of vulnerability. As Mgaya's letter described, power interruptions increase the negative effects on households as the domestic technological culture cannot support life without electricity.

In addition to inconveniences, electricity users also explain electricity vulnerability in Dar es Salaam in terms of how power failure ruined their appliances. The destruction of people's electrical power devices emerged as one of most debated matters in electricity provision in Tanzania in the post-1990s. One of the questions was the economic losses caused by damaging electrical items in homes, and thus the public wanted to include a special clause in the policy that would make TANESCO compensate consumers in the event of damaged appliances. Some of the delegates in the National Energy Policy seminar made a scathing attack on TANESCO, claiming that frequent power blackouts cost customers dearly as they lost expensive household

[151]Gabby Mgaya, letter to the editor, "How Disgusting! TANESCO owes Upanga Seaview residents an explanation," *Daily News*, 20 December 2004.

appliances through frequent power cuts.[152] Hindu Lilla was one of them as she narrated her encounter with power outages saying, "I've lost two refrigerators, and several electric irons are now useless. I am now left with one refrigerator which could join the two others lying idle in the store at any time. […] Are there any procedures of taking legal action against TANESCO?"[153] Even though the destruction of people's appliances was debated as a matter of public concern in the 1980s, it continues to be a severe burden to power consumers in Dar es Salaam.

The review of Tanzanian newspapers unveils how users of electrical appliances were vulnerable. Ikamba Ikoshi, an electricity user, expressed her feelings in the following words, "every day from 7 pm TANESCO starts the game of switching power 'on and off'. This has continued for a while now." She went on to say that "those who use electrical appliances such as radios, electric cookers, and refrigerators are worried by uncompensated damages which are being caused." This electricity user's concern came after power failures had damaged her "radio on 20 November 1989 and electric cooker on 2 January 1990."[154] The major concern, however, was not only that the appliances were damaged but also a demand for TANESCO to stop the frequent switching on and off electricity and compensate for the huge losses she incurred. Ikamba was not alone. Another resident explained the extent to which power outages increasing her hardships and vulnerability by damaging domestic electrical devices. She said "power rationing is so critical. It makes the living condition so tough." Yet this was not the main challenge since many people in Dar es Salaam tolerate staying without power for some hours. The damage to electrical appliances was the worst consequence, as she lamented, "I did not expect that my life would return to zero. But that happened when my refrigerator and my husband's computer was damaged. Truly, it is a big loss."[155]

The frequent and widened power outages have made electricity users consider their appliances as meaningless and liabilities. They have curtailed the intended end services as one inhabitant asked, "if I cannot watch my television on, use my refrigerator or electric fan, then, what is the point of having these things in my house?"[156] The long periods of blackouts compromise the essence of electrification and having domestic electrical appliances. Despite meeting critical role in homes, as one resident commented in a letter to one of the Kiswahili

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[152] Lucas Liganga, "Seminar attacks TANESCO," *Daily News*, 12 September 1990.
[153] *Ibid*.
[154] Ikamba Ikoshi's letter to the editor, "TANESCO ichukue hatua," *Gazeti la Uhuru*, 26 Januari 1990.
[155] Adam Fungamwango, "Balaa la mgawo hiloo laanza Dar," *Gazeti la Alasiri,* 3 Agosti 2006.
[156] Interview 5, a shopkeeper, Kinondoni, 20 August 2021.

newspapers, they created frustrations. He wrote: "I am sorrowful that my refrigerator has turned out to be the spoiler of food remains, instead of preserving them like in the beginning."[157] The refrigerators spoiled food items instead of preserving them and improving people's socioeconomic well-being.[158]

Power disruptions reproduced cascading socioeconomic impacts on electricity consumers when they involved damaging electrical devices. First, it causes economic losses as people need extra money to purchase new gadgets or repair the damaged ones. Second, consumers could not make use of their appliances as they remain inoperative even after TANESCO restores power. Some users have claimed that while it takes about 4 to 12 hours for TANESCO to restore power, it would take them several months to replace damaged appliances, affecting their well-being especially if the damaged item was used in generating income.[159] While consumers in Dar es Salaam have standby alternatives for lighting and power when the electricity is turned off, they lack immediate alternatives when their devices are damaged. A large segment of residents in Dar es Salaam is self-employed in an 'informal' subsistence economy—consuming what they produce daily, earning about 5,000 to 15,000 Tanzanian shillings (about USD 2 to 5) per day.

Because of the cost they incur when such outages ruin electrical items, many people prefer to repair their devices as a survival strategy rather than purchasing new ones (as explained in Chapter 5. But when damage is too big to repair, other people have undomesticated their appliances. During the fieldwork, I observed people who lived with unworking televisions, radios, refrigerators, and electric cookers in their homes which they claimed to have been ruined by power cuts. Electricity users view electricity as costly not only because of high tariffs but also erratic supply which makes their appliances a liability instead of an asset. One electricity consumer complained in a letter to a newspaper editor that while people had increased their use of domesticate electric cookers to rescue depletion of forest resources, TANESCO's frequent power cuts forced people to abandon their electric cookers and switched back to biomass.[160] A caricature depicted this scenario, showing that instead of being

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[157] *Barua kwa mhariri, 'Huduma ya Umeme inapokuwa anasa,"* Nipashe, 14 Septemba 1997

[158] Edwin G. Nelson and Erik J. De Bruijn, "The Voluntary Formalization of Enterprises in a Developing Economy – The Case of Tanzania," *Journal of International Development*, 17, (2005), 575-593; Alban Mchopa, Kazungu, and Moshi, "Power Rationing Dilemma," 1-14.

[159] A letter from Dar es Salaam resident to the editor "Kuna nini TANESCO? *Gazeti la Majira*, 14.11.2005; See also, Tuma Abdallah, "Power Rationing: Commodity prices hike", *Daily News*, 18 October 1998.

[160] *Barua kwa mhariri, "TANESCO kuweni wazi," Gazeti la Majira, 29 Januari 2000.*

domesticated to serve different critical services in homes, electric appliances deserved to be in a museum. The caricature suggests that since there are “power blues”, domestic devices were useless. It also indicates that power outages damaged these appliances, and since they cannot function anymore, museum was a good place for them. As Thomas Berker and others remind us, when technologies fail to meet the intended goals for some reasons, they become undomesticated.[161]

Figure 4.6: Frustrations of domestic electrical technologies caused by grid breakdowns.
Source: The Guardian, 28 October 2006.

4.6 Conclusion

This chapter has examined the introduction and use of electrical technologies in households (a neglected topic in the existing historical scholarship on electrification) in the urban South. It has also shown how vulnerability is context-specific and that the concept in the southern cities contexts captures a plethora of socioeconomic and political aspects of everyday life of electricity consumers than the analysis of technical system vulnerabilities. The chapter has shown that while the colonial and early postcolonial socioeconomic and political atmosphere of Dar es Salaam derailed electrification of homes and the acquisition of electrical appliances for most

[161] Thomas Berker, Maren Hartmann, Yves Punie, and Katie Ward, *Domestication of Media & Technology,* (New York: Open University Press, 2006), 1-5.

Tanzanians, the economic reforms of the mid-1980s changed this situation. Trade and economic liberalisation fostered the availability of multiple types of affordable domestic electrical items due to liberal policies which facilitated the importation of cheap goods from China, Japan, and used items from the Global North. Such post socialist policies fostered appropriation of electrical items in homes in line with the growing informal urban economic environments which improved living standard and compelled people to adopt various appliances to increase comforts as well as doing small business in their households. Unlike the Global North where utility companies used advertisements, exhibitions, campaigns, and even door-to-door supply to expand adoption of electrical appliances in homes in the early twentieth century, the coming of electrical devices to Tanzanian homes was largely influenced by the urban and political socioeconomic conditions than TANESCO's deliberate initiatives. The appropriation of electrical technologies and the escalation of power outages made consumers vulnerable. Power disruption created a cascade effect to people's homes. They not only interrupted socio-cultural and economic activities but also damaged electrical items something which increased cost of electricity usage, halted household income, and access to other critical services such as medical, education, and food in everyday context. This portrays a greater difference between power disruption in the Global North and Global South cities. While the cascade effects in the Global North is concerned about short-lived failure of one system and how it causes failure to another interconnected system, this concept in the South entails everyday and persisting effects of power infrastructure failure on socio-cultural and economic lives of people. Thus, the chapter suggests that vulnerability in the Global South should be traced from the wider socio-cultural and economic contexts in which electrical technologies are appropriated and put into use in homes. How did inhabitants in Dar es Salaam cope with vulnerability caused by power infrastructure failures is the subject of Chapter 5 in this dissertation.

CHAPTER FIVE
ELECTRICITY DISRUPTIONS AND THE MAKING OF RESILIENCE FROM BELOW 1980s–2010s

5.1 Introduction

Scholars have shown how electricity users in the Global South cities react to power outages to protect their homes, businesses, and other socioeconomic activities.[162] In Tanzania, some non-historical studies have examined how electricity users such as industrial owners, small businesses, and entrepreneurs deal with power disruptions.[163] Despite the fact that most Tanzanians interact with electricity in the domestic sphere, the question of how residents handle frequent outages in homes has remained inadequately examined. This chapter advances the discussions which started in Chapters 3 and 4 on power disruptions and their impact on household users, to examine innovative strategies in adapting to power failures. It uses the concept resilience from critical infrastructure studies that has so far been analysed on two levels: technical resilience, which focuses on the robustness of networked systems to resist, adapt, and transform into new states after facing perturbation[164]; and social resilience, which entails users' measures to countercheck effects of infrastructure breakdowns.[165] The core of urban functions and resilience in Dar es Salaam and additional Global South cities depends on the resourcefulness and preparedness of the ordinary people.[166] In that connection, this chapter focuses on household consumers' resilience than infrastructure resilience. It underscores resilience as adaptation methods employed by inhabitants to mitigate the impact of power interruptions as their daily routines increasingly become dependent of electricity. It uses the notion of 'technological landscape' coined by Svante Lindqvist to analyse people's practices and

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[162] See, for instance, Ayodeji Olukoju, "'Never Expect Power Always': Electricity Consumers' Response to Monopoly, Corruption and Inefficient Services in Nigeria," *African Affairs,* 103, no. 410, (2004): 51-71; Jonathan Silver, "Disrupted Infrastructures": An Urban Political Ecology and Interrupted Electricity in Accra," *International Journal of Urban and Regional Research*, 39 no. 5 (2016) 984-1003.
[163] Theodora E. Kavishe, "Coping with Power Interruptions in Tanzania: An industrial Perspective: A Case study of one small scale Animal Food Processing Industry in Moshi Municipality" (MPhil., Diss.: University of Oslo, 2015); Alban D. Mchopa, Isaac Kazungu and John Moshi, "Power Rationing Dilemma: A Blow to Small and Medium Enterprises (SMEs) Performance in Moshi Municipality, Tanzania," *International Journal of Economics, Commerce and Management*, 2, no. 7, (2014): 1 – 14.
[164] Ivonne Elsner, Andreas Huck, and Manas Marathe, "Resilience" in Jens Ivo Engels (ed) *Key Concepts for Critical Infrastructure Research,* (Wiesbaden: Springer VS, 2018), 31-38.
[165] Thomas J. Campanella, "Urban Resilience and the Recovery of New Orleans," *Journal of the American Planning Association*, 72:2 (2016), 141-146.
[166] *Ibid*., 141.

skills, and how different local and global artefacts interact and co-exist in Dar es Salaam, to create a socio-technical environment that enables residents to live with frequent power failures. It analyses the old and new energy technologies, people's skills and knowledge, and their experiences and practices in grappling with power outages. The chapter is built on the argument that Dar es Salaam's residents are not passive to or entirely vulnerable of power failures, but they have developed better coping strategies that enhance their resilience to power outages—they have been able to minimise the impact of short- and long-term blackouts.[167]

5.2 Imagining the Technological Landscape

Swedish scholar and historian of technology, Svante Lindqvist, coined the term 'technological landscape' in 2010 to explain how the technological world is constantly composed of superimposed layers of emerging, existing, and declining technologies.[168] In his work, Lindqvist criticises historians of technology for being obsessed with rapid technological changes, new technologies, and growth rather than dealing with the complex terrains of coexisting technologies over long periods of time. He writes that while the wider "technological structures recede into the background, that distant part of the landscape whose only purpose is to serve as exactly that: a backcloth against which the action takes place", historians of technology are on the other hand "fascinated by swift action in the foreground rather than by the technological landscape which provides an apparently constant background to individual actions."[169] The obsession with new technologies in the foreground, as Lindqvist contends, distorts the reality of how technologies develop and exist in communities because scholars tend to forget the significance of those technologies which recede to the background but continue to influence people's actions and the larger landscape. He argues that new technologies do not completely replace the old ones, but they co-exist.

Lindqvist highlights three causes for this phenomenon. First, there has been growing focus on the progressive history of engineering owing to the influence of funding sources, whereby technological studies over the past few decades have been funded by the engineering and business world. Second, writing the history of technology has become an economic project

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[167] For this argument, see also, Sophie Schramm, "On-demand Connections, Formalization and Multiplications: Dis/ordering Water Supply in Kimara Mwisho, Dar es Salaam," in Ulf Engel, Marc Boeckler and Detlev Müller-Mahnleiden (eds) *Spatial Practices: Territory, Border and Infrastructure in Africa,* (Leiden and Boston: Brill, 2015), 173-189.

[168] Svante Lindqvist, *Changes in the Technological Landscape: Essays in the History of Science and Technology*, (Watson Publishing International LLC, 2010), 4.

[169] *Ibid.*

in which historians pay attention to the profitability of their publications. Hence, they have published findings that are attractive to economists, particularly narratives about inventions and innovations rather than imitation, tinkering, and the everyday life of technologies. Third, the history of technology has evolved from the history of science and innovation, which by nature changes more rapidly than the actual material world. Contrary to his argument that technologies co-exist rather than replaced, some technologies still fade away and do completely disappear due to national policies that discard or abolish some technologies when they consider them dangerous. Technologies can also disappear when to users become uninterested or find them useless. Yet, Lindqvist proposition that historians of technology must not forget to pay attention to the continuous and complex technological landscape of co-existing material worlds that support daily lives in societies, which he considers the main objects of the history of technology studies, remains vital to studying everyday life technologies.[170]

Since Lindqvist's work, the concept of technological landscape has been applied in other disciplines and contexts. For instance, Francesca Bray in "Flows and Matrices" gives the concept an anthropological taste when she combines the notions of 'technological landscape' and 'technological culture' to shed light on the vitality of material culture, knowledge, skills, and technical artefacts in the everyday (re)production of a society. While Lindqvist's use of the concept was mainly in connection with large technical systems, Bray extends it to social practices, material things of all kinds, and perceptions that enable a given society to function. Bray defines technological landscape as "the repertoire and distribution of skilled material practices and technical artefacts that a society draws upon to function."[171] This phrase implies that she envisions technological landscape as all elements that encompass the daily functioning of a society, such as tools, technical skills, and material things, which produce certain lifestyles and social, technical, and symbolic practices. The point to note is that the technological landscape, as defined by Bray, is not confined to technical systems but encompasses the skills, knowledge, experiences, and practices on which societies depend for survival. This chapter, thus, adapts the concept of technological landscape in line with Bray's emphasis on material culture, that is, technological landscape does not only involve the co-existence of new, emerging, and declining technologies but also the skills, knowledge, experiences, and routinised practices which form the basis for human socioeconomic and cultural lives.

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[170] *Ibid*., 6, 13.

[171] Francesca Bray, "Flows and Matrices, Landscapes and Cultures," *ICON*, 22, (2016): 8-19, 8.

The notion of technological landscape is crucial in studying Global South infrastructure and urban contexts. In fact, the existing Southern cities infrastructure studies have described the urban terrain by using concepts and terms which resemble what technological landscape entails. The central claim is that Global South urban spaces consist of old and new layers of different infrastructure systems such as transport networks, electrical grids, communications networks, energy, and water supply, among others–the technologies that make up the urban landscape. The coming of new technology does not make the old one automatically fade away. For instance, Stephen Graham and Simon Marvin in *Telecommunications and the City* reveal how the emergence of new telecommunication technologies in cities does not involve the complete substitution of the old forms of communications. The invention of the telephone did not replace the telegraph and the television did not substitute radio transmission, but they co-existed to create the wider telecommunication landscape, which indeed improved the efficiency of the existing technologies.[172] The combination of various technical artefacts means cities experience "successive technological revolutions" and urban areas are continuously composed of "historical layering of networks" which wrap together old and new forms of technologies.[173]

Scholars have studied such continuities and co-existence of different technologies by using notions such as infrastructure 'heterogeneity' and 'hybridity.' Heterogeneity and hybridity as defined by these scholars refer to the co-existence of different modalities of infrastructure provision as complementary or alternative to the networked infrastructures in a certain urban setting. The main argument connecting scholars is that Global South cities have different modalities of provision of water, energy, transport, and sanitation services, which work as complementary and alternative to constantly failing or unavailable centralised infrastructure systems. The multi-layered old and new technologies or heterogeneity and hybridity do not exist as mere monuments of discovery and innovation, but they influence the socioeconomic and cultural meanings and practices of how people live daily. They form basic structures on which people inhabit a particular urban space. They tend to decrease the inhabitants' dependence on networked services, which in turn, reduces the impact when networked systems are disrupted.[174] In this way, they define Global South cities as places which consists of different co-

[172] Stephen Graham and Simon Marvin, *Telecommunications and the City: Electronic Spaces, Urban Places*, (London and New York: Routledge, 1996), 283-285, 332-333.
[173] Brian Larkin, *Signal and Noise: Media, Infrastructure, and Urban Culture in Nigeria*, (Durham and London: Duke University Press, 2008), 6.
[174] See for instance, Sarah L. Smiley, "Heterogeneous water provision in Dar es Salaam: The role of networked infrastructures and alternative systems in informal areas," *Environment and Planning E: Nature and Space* 3, no 4

produced, hybrid, and heterogeneous technologies—technological landscape—that shapes people's resilience to frequent failure of centralised infrastructures.

The technological landscape is a useful tool in studying and understanding residents' resilience to power failures in Global South cities and Dar es Salaam in particular. It provides a 'big picture' of changes and continuities in power and lighting technologies, skills, and knowledge, as well as socio-cultural practices and experiences. It views urban areas as places of distinct technologies, both old and new, traditional, and modern, those in the foreground and those running in the background, which are usually taken for granted, but continue to influence the consumers' decisions. The notion, thus, helps us to avoid being captivated or distracted by new and large technologies, but also captures small, indigenous, energy technologies that recede into the background due to coming of new, modern energy technologies, but continue to shape how people perform different activities and live their lives. It also enables to avoid reproducing deficiency narratives that has characterised Global South cities as vulnerable and non-resilient. By examining the broader landscape of energy technologies in Dar es Salaam and illustrating how it boosted residents' resilience against regular yet inconsistent power interruptions, the notion help in portraying Global South cities as complex, innovative, lively, and resilient—not entirely vulnerable.

The chapter applies the technological landscape in analysing three aspects which have bolstered electricity consumers' resilience against power outages in Dar es Salaam. First, it studies the complementary domestic energy sources and electrical backups, and how they have provided continuity in electricity end-services, such as lighting, cooking, cooling, and recharging mobile phones. Second, it examines how the skills and knowledge landscape influences users' adaptation to power outages. It highlights how the innovative skills employed in the repair and maintenance of electrical devices and the grid promote electricity users' resilience. Lastly, it examines the landscape of routinised socio-cultural practices and the way they have made people resistant to the impact of power failures.

(2020): 1215–1231; Jaglin, "Regulating Service Delivery in Southern Cities: Rethinking Urban Heterogeneity", in Susan Parnell and Sophie Oldfield (eds), *The Routledge Handbook on Cities of the Global South,* (London & New York: Routledge, 2014), 434-447, 434 Shaun Smith, "Hybrid networks, everyday life and social control: Electricity access in urban Kenya," *Urban Studies*, 00:0 (2018): 1 – 17; Mathias Koepke, Jochen Monstadt, Francesca Pilo' and Kei Otsuki. "Rethinking Energy Transitions in Southern cities: Urban and Infrastructural Heterogeneity in Dar es Salaam," *Energy Research & Social Science* 74 (2021): 1 – 12.

5.3 The Landscape of Domestic Energy Technologies, 1980s–2010s

5.3.1 The Co-existence of Old and New Cooking and Lighting Technologies

Energy is a cultural need of every society. Thus, the urban landscape in many parts of the world consists of different energy options. David Nye in *Consuming Power* describes the nineteenth- and twentieth-century American energy landscape—how society used different energy technologies over time. He shows that American society experienced transitions in energy that revolutionised people's socioeconomic, technical, and cultural needs. Energy like many other technologies and material culture is non-neutral. The invention or introduction of new energy resources lead to a new cultural energy use. But as Nye claims, the past decisions in energy systems in America were difficult to change even when invention of new energy technologies was attained. He uses Thomas Hughes's 'technological momentum' concept to put forward his point on the persistence and co-existence of different energy sources in American societies for centuries. Nye's position fits in what Lindqvist has called technological landscape, as he claims that modern American society has passed through various technological energy regimes, ranging from waterpower, steam power, electricity, internal combustion power, to atomic power. Each of these regimes attained technological momentum at a specific period and their momentum declined and receded into the background when another new technology was invented. Yet, although different technologies gained 'momentum' at specific time in the past, the new, emerging, modern energy sources did not entirely replace older forms of energy. They continued to create path dependence that influenced new energy technologies.

Nye's observation is important in analysing electricity users' resilience to power disruptions in African cities particularly Dar es Salaam. It sheds light on how society integrates distinct energy sources and how their co-existence has shaped societies' perceptions, routines, and practices. Both traditional and modern energy technologies in societies are not suddenly transformed by new, emerging energy technologies but because such technologies are social constructions, their significance and usage tend to vary from one time to another. Dar es Salaam's household energy landscape has been shaped by different energy sources that gained technological momentum in a certain period and declined later but continued to influence the socio-cultural lives of inhabitants in some ways.

The household energy landscape in Dar es Salaam intertwined complex layers of traditional and modern energy resources since the 1980s, which enabled its inhabitants to grapple with ailing power infrastructure. For instance, in the 1980s, homes had different levels of dependence on five energy sources for cooking, lighting, and powering devices: firewood, charcoal, kerosene, electricity, and liquefied petroleum gas (LPG). Charcoal was the dominant energy for cooking used by about 90 per cent of the population, kerosene by 50 per cent, firewood by 10 per cent, electricity by 5 per cent, and LPG was used by an insignificant number of homes.[175] These percentages illustrate how households mixed and depended on different cooking energy sources. In terms of lighting, 50 per cent of households in Dar es Salaam used electricity and 50 per cent used kerosene.[176] Unlike other forms of energy, electricity was also used in powering domestic appliances, such as refrigerators, televisions, cookers, kettles, fans, irons, and radios. While electricity was said to be the cheapest source of energy in Dar es Salaam in the 1980s, electrified homes preferred cooking with charcoal because of power unreliability and difficulties in obtaining electrical appliances, as outlined in the previous chapter.[177]

This energy landscape was never static. It experienced transitions in the 1990s and 2000s. The structural adjustment programmes and liberalisation of the economy in the 1980s and 1990s increased the availability and affordability of kerosene and electricity. The government of Tanzania established lifeline tariffs in electricity that aimed to connect more homes for lighting purposes and subsidised kerosene. The measures were responses to the impact of the oil crisis of the 1970s and the biomass energy crisis in Tanzania in the 1980s, as well as state efforts to improve the quality of life.[178] Poor families in the city obtained kerosene for cooking, lighting, and charcoal stoves, and abandoned firewood, which increasingly become expensive and unavailable due to growth and expansion of the city. The adoption and increased use of modern sources, such as kerosene and electricity led to the decline in firewood as one of the dominant sources of energy in the city since the 1990s. Although LPG was considered cheaper than charcoal, its usage remained low during this period due to unavailability and infrequent bottle refilling. Charcoal continued to be the dominant cooking energy in homes in the 1990s and 2000s like in the 1980s due to the low income needed for buying charcoal stove and nature of housing in Dar es Salaam.

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[175] SNA SIDA File No. F13O: 8: "The Energy Market in Dar es Salaam, Tanzania", working paper 127, Swedish University of Agricultural Science, Uppsala, 1990, by Andersson and Holm.
[176] *Ibid*.
[177] *Ibid*.
[178] Richard H. Hosier, Mark J. Mwandosya and Matthew L. Luhanga, "Future Energy Development in Tanzania: The Energy Costs of Urbanization," *Energy Policy*, (1993): 526-542.

However, no single source of energy was completely reliable in terms of availability and prices. Richard Hosier and Kipondya emphasise in this point that because of "the unavailability of supply of all fuels, except charcoal," the number of "households dependent only upon a single fuel—for example, electricity or kerosene was very rare in urban Tanzania."[179] The inhabitants possessed alternative energy sources for cooking and lighting against unreliable supply. But in powering domestic electrical devices such as refrigerators, televisions, electric cookers, fans, kettles, and irons, they exclusively depended on electricity. For this reason, whenever the grid failed, electrical appliances were put on hold rather than the critical household activities, such as cooking and lighting. Households use a different energy mix for various reasons including that some cooking activities cannot sufficiently be met through a single energy source Thus, multiple energy systems coexist to meet heterogeneous uses.

The transition to modern energy sources in Dar es Salaam intensified in the last two decades. The landscape has two major observable dynamics when compared to the 1980s and 1990s. First, there was growth of LPG as the prime domestic cooking energy and decline of kerosene usage in all income-level families in the 2010s For instance, the percentage of households using LPG was 3.9 in 2012 and rose to 27 per cent in 2020, whereas kerosene declined to 8 per cent in 2016.[180] While kerosene was mainly used for quick heating activities, such as boiling tea and cooking in low-income families in the 1980s-1990s, LPG was taking over that role as one resident observed that, "kerosene stoves have nowadays disappeared in shops because people prefer to use LPG and charcoal for cooking rather than kerosene due to its reliability and simplicity."[181] Households preferred LPG to kerosene and electricity for cooking because of its reliability and simplicity. He said, "I rarely saw gas (LPG) bottles in the 1970s and 1980s even in the city centre. It was not like these modern days where every street and kiosk/shop have gas bottles. When one needs a gas bottle, they don't need to go far. Even where a gas dealer is not available in a nearby shop, a *bodaboda* (motor cyclist) can deliver it within a minute."[182] This excerpt testifies on the reliability and convenience of off-grid domestic energy sources. The significant point to note is that users perceived the grid-based energy, basically

[179] *Ibid*., 457.

[180] Tanzania National Bureau of Statistics, Energy Access and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings, (United Republic of Tanzania, 2020), 16-17.

[181] Interview 5, a shopkeeper, Kinondoni, 19 August 2018: The decline and disappearing of kerosene stoves was also noted in the Interview 6, an engineer, Ubungo, 15 August 2018, and Interview 20, a tailor, Msewe-Golani, 24 August 2018.

[182] Interview 5, a shopkeeper, Kinondoni, 19 August 2018.

TANESCO's electricity, as vulnerable and inconvenient when compared to energy supplied through local market chains especially LPG. Whereas LPG was in the background of the household energy landscape in the 1980s and 1990s, it has moved to the foreground. It now competes with charcoal and electricity. When asked which energy sources they use, one resident said, "charcoal and gas are my best cooking energies because they are cheap and always available. Gas also helps to cook faster like electricity, and it has no risk of power outage. I used electricity before, but I found it too risk and nowadays many people prefer gas because even low-income families can afford the smallest bottle. They use it for quick heating or when one lacks money for charcoal."[183] LPG grew as an important domestic energy technology in the 2010s complementing charcoal and electricity as cooking energies.

Second, there was expansion in electricity connections and usage in homes since the 1990s as discussed in Chapter 4. The percentage of electrified homes in Dar es Salaam increased from 75 in 2016 to 88 in 2020.[184] Such expansion made electricity the dominant lighting source when compared to the 1980s. Bye and large, grid electricity and different electrical lighting gadgets such as electric or solar rechargeable torches, lamps and bulbs are increasingly replacing kerosene as a household lighting technology. Since the 1980s, many households have depended on off-grid energy for cooking. They consider off-grid energy sources such as kerosene, charcoal, and LPG supplied through local market chains not only cheap but also reliable and convenient. This implies that residents also electrify their homes mainly to power electrical devices and for lighting rather than for cooking activities. This has been also due to other factors such as high prices and unreliability of electricity. Nonetheless, this does not mean that electricity continued to play insignificant role in cooking activities. City dwellers integrated electricity in cooking and eating cultures more than ever before but not by acquiring electric cookers but by using other electrical devices such as electric kettles, blenders, electric deep fryers, microwaves, and rice cookers. Even in homes that had no electric cookers, they used electricity in cooking using other devices.

Despite the recent growth of new energy technologies such as LPG and electricity, Dar es Salaam's household energy landscape also witnessed some continuities. By and large, charcoal has remained dominant domestic cooking energy in the city. For example, about 73

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[183] Interview 15, a tailor, and small business owner, Ubungo, 20 August 2018.
[184] Tanzania National Bureau of Statistics, Energy Access and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings, (United Republic of Tanzania, 2020), 16-18.

per cent of households used charcoal in 2012. This percentage grew to 88 in 2020.[185] Similarly, although usage of kerosene in cooking declined dramatically in the recent years due to high prices and the coming of cheap and convenient LPG, it did not disappear from shops and homes. Residents use it for igniting charcoal stoves, cooking in low-income families, and insignificant number of homes use it for lighting during power outages. Such continuities corroborate Nye's claims in his social history of energy successions in America that technologies are not deterministically pushed into the lives of people, but they are social constructions. The energy employed in societies is more of a socioeconomic and cultural process than a technological issue. Instead of being completely replaced by new and modern technologies, the old energy technologies tended to be superimposed in the wider landscape of energy usage where they might not necessarily play an economic and technical role, but rather a social-cultural role.[186] Nye's idea that some energy sources are used for socio-cultural rather than economic and technical purposes is evident in Dar es Salaam. For instance, despite residents viewing electricity and LPG as modern energy, they continue to cook with charcoal, not necessarily because of the cost of these energy sources but because charcoal is socio-culturally acceptable in cooking some kinds of food, such as beans and rice. Even electrified homes with electric cookers or rice cookers claim to use these technologies only when they want to cook faster, but they prefer to cook rice and beans using charcoal.[187] The socio-cultural perspective that charcoal fits some cultural foods better means it continues to exist as an important domestic cooking energy that co-exists with modern electricity and convenient LPG.

While the co-existence of modern and traditional energy sources in cooking is for various socio-cultural and economic reasons, it bolstered residents' resilience against frequent grid failures. Electricity consumers have emphasised that they prefer charcoal in cooking because it is cheaply available and more reliable than electricity. One resident insisted that even though she could afford the cost of cooking with electricity, her usage of charcoal or the gas stove was vital in securing her home from blackout blues. She uttered:

> To over-rely on electricity is to keep the family at risk of going to bed without dinner. I am always relaxed when a bag of charcoal is lying at home because it assures me that my children will eat at any time I want. Even when the

[185] Tanzania National Bureau of Statistics, Energy Access and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings, (The United Republic of Tanzania, 2020), 16-17.
[186] David Nye, *Consuming Power: A Social History of American Energies* (Cambridge, Mass: MIT Press, 1999), 5 – 6.
[187] Interview 26, a retired military officer, Mbezi-Beach, 10 October 2018; Interview 4, an engineer, Kimara, 12 August 2018; and Interview 15, a tailor and small business owner, Ubungo, 20 August 2018.

> electricity goes off, I can quickly switch to gas or charcoal, depending on the situation.[188]

These words unveil the security and insecurity or what this study calls vulnerability and resilience question between centralised infrastructure (electricity) and off-grid technologies. They also confirm Shaun Smith's observation on heterogeneous urban energy sources in Maputo, Mozambique, when he says that households use complementary energy sources, such as charcoal, gas, firewood, and electricity to maintain security, autonomy, and their livelihoods.[189] The insecurity (vulnerability) of electricity in Dar es Salaam and maintaining the use of traditional energy such as charcoal to improve household resilience in the face of power outages emerged neatly when an interviewee confirmed that charcoal was for her the best cooking technology than electricity because it is reliable and convenient. She cooks whenever she wants something which is not possible when someone depends on frequently failing power grid. She contended that: "those who use electricity cook easily but they do not have assurance because of intermittent power cuts. Cooking with charcoal takes time, but it is more convenient and reliable when compared to electricity."[190]

It should be noted, however, that the residents in Dar es Salaam use other sources of energy, such as charcoal, gas, and kerosene, not primarily as alternative or backup measures when electricity fails. In other words, the household cooking energy mix in Dar es Salaam is not directly linked to power outages because consumers have never been exclusively dependent on electricity for cooking before. Electricity and electrical cooking appliances have remained expensive and unaffordable to many users, but in the last two decades, charcoal, kerosene, and gas have become affordable and convenient to most residents in the city. Therefore, the usage of multiple forms of energy depends on socio-cultural and economic factors rather than on technical ones. Such factors include the nature of the food cooked, the costs of energy, household conditions, and simplicity required in cooking. For instance, while kerosene, gas, and electricity are used for fast-cooking foods like boiling tea or warming food, charcoal is used particularly for food that requires more time to cook.[191] As a result, the old and new and traditional and modern energy technologies have played complementary roles rather than

[188] Interview 26, a retired military officer, Mbezi Beach, 10 October 2018.
[189] Shaun Smith, "Mobilizing Heterogeneity: Understanding the Dynamic Qualities and Diversity of Energy Access in Maputo", *Urban Geography*, (2021): 1-22.
[190] Interview 2, an engineer, Ubungo, 9 August 2018.
[191] Interview 7, a small entrepreneur, Kwembe, 28 July 2018; Interview 28, small business owner, Kimara, 12 October 2018; Interview 18, a restaurant owner, Manzese, 24 August 2018.

alternative ones. Nevertheless, this is not to say that blackouts and unreliability of electricity has no influence on household energy mix or that the use of different energy sources has helped homes to be more resilient against power cuts. When asked if they would prefer using electricity for cooking if TANESCO lowered its tariffs, electricity consumers in Dar es Salaam claimed that it would be better to go for LPG than electricity. Electricity is, to them, the most insecure cooking energy. Power cuts damage electric stoves, spoil food, and create inconveniences. People could not rely on it to cook. Although residents in Dar es Salaam do not have multiple cooking energies as alternative measures to power failures, the existence of different energy technologies has been helping them to live with regular and inconsistent power outages.

Figure 5.1: The co-existence of multiple cooking technologies in middle income homes in Dar es Salaam.
Source: Photo taken by the author in Dar es Salaam in August 2018.

Nye asserts that as different energy technologies become superimposed in a society, the energy choices of the past "provide a measure of flexibility in response to changing conditions."[192] The availability and usage of multiple and convenient energy technologies has

[192] Nye, *Consuming Power*, 256.

made people less dependent on electricity for cooking activities especially in high-income families where electricity is used as the basic cooking energy. Despite that in low- and middle-income households' electricity is not a dominant cooking technology because of its high cost and unreliability, the availability and usage of other off-grid based sources-maintained residents resilience against power failures. It is not that non-electrical cooking technologies have made cooking more flexible, but they have prevented homes from completely dependent on vulnerable TANESCO's power infrastructure.

When electricity fails, they use gas or charcoal for cooking making their homes more resilient. The case of cooking energies in Dar es Salaam offers a contrasting view to the case Akallah and Hård examined regarding water infrastructure in Nairobi. They observed that as residents became connected to the centralised water system, they abandoned their traditional water sources, a situation which ultimately increased their vulnerability.[193] In contrast, by maintaining and combining their traditional and modern household energy technologies, inhabitants in Dar es Salaam have remained resilient against power outages despite increased household connections in the last two decades. Inhabitants did not abandon off-grid cooking technologies something which made them less dependent on vulnerable power systems.

5.3.2 New and Emerging Light and Power Technologies

The energy landscape in Dar es Salaam is not only about the heterogeneity of household lighting and cooking energy sources, but also about the availability of electricity lighting and power backup facilities. In the 1980s and 1990s, generators were the common electricity power and lighting backup technology. When the grid failed, most people were able to continue with household or urban activities that used other forms of energy, mainly kerosene and charcoal. Grid failure made people more vulnerable because they were unable to perform those activities that demanded electricity.[194] Generators were the only form of backup for those activities that required electrical power. The use of generators in Dar es Salaam has increased as a response to frequent power failures. Such usage, however, has since the 1990s been subject to contestation in the city, not only due to the cost of fuel but also to the noise pollution caused by power generators. Residents who own generators mainly complain of the cost of the fuel

[193]Jethron Ayumbah Akallah and Mikael Hård, "Under the Historian's Radar: Local Water Supply Practices in Nairobi, 1940-1980," *Water Alternatives* 13, no. 3 (2020): 886-901.
[194] See detailed discussion on users' vulnerability in Chapter 4 of this dissertation.

they need to meet power and lighting demands during power outages, whereas other inhabitants complain about the noise produced by generators.[195] For these reasons, only a few households are able to use generators as electricity backup because of the high costs of purchasing generators and fuel. Generators are largely used by small, medium, and large enterprises rather than in people's homes.[196]

The emergence of solar power technologies in the 1980s and their expansion in the 2010s in Dar es Salaam, however, increased the availability of electrical power backup technologies in homes. The global discussion for renewable energy technologies, particularly solar power, gained momentum in the 1980s.[197] The government of Tanzania participated in the discussion as a government response to the 1970s and 1980s oil embargoes,[198] and global collaborations in developing environmentally friendly energy.[199] However, the development of solar technologies and other renewable sources did not grow in the 1980s and 1990s. In 1986, Tanzania had only 66 solar energy units for domestic water heating, pumping, refrigeration, entertainment, and lighting. The number grew to 256 units countrywide in the 1990s and Dar es Salaam had 83 units in 1993.[200] However, solar technologies during this time largely focused on solar heating and drying rather than electricity generation through photovoltaic technologies.[201] The situation changed from the mid-2000 onwards, whereby the city saw a boom in electrical solar installations in the form of individual solar home systems (SHS). These consist of a solar panel(s), battery, inverter, and other accessories capable of powering a few devices, such as radios, televisions, recharging mobile phones, and several electric bulbs in high-

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[195] A letter to the editor, "Huduma ya umeme inapokuwa anasa," *Nipashe*, 14 Septemba 1997.

[196] Koepke, et al. "Rethinking Energy Transitions"; also, Interview 20, aa welder, Msewe-Golani, 24 August 2018; Interview 28, small business owner, Kimara, 12 October 2018; A letter to the editor, "Huduma ya umeme inapokuwa anasa," *Gazeti la Nipashe*, 14 Septemba 1997.

[197] SNA SIDA File F13O: 7: Royal Swedish Embassy Report on Indigenous Resources; See also File No. F13O:7; Tanzania Energy Master Plan and Programme (1990–2005), Draft of the Ministry of Water, Energy and Minerals, January 1991.

[198] Janosch Ondraczek, "The Sun Rises in the East (of Africa): A Comparison of the Development and Status of Solar Energy Markets in Kenya and Tanzania," *Energy Policy* 56, (2013): 407-417

[199] For global and Tanzanian debates on solar and other renewable technologies, see, for instance, SNA, SIDA, File No. FB13O:1: Facts: The United Nations Conferences on New and Renewable Sources of Energy; See also, United Nations Symposium on Energy Planning in Developing Countries, 28th September-3 October 1981, in Stockholm, Sweden, organised by the United Nations in collaboration with the Government of Sweden in the same file; See also, Karin Wohlin of SIDA to Principal Secretary MAJI Dar es Salaam on UN Seminar on Energy Planning, dated 26.0September 1981; see also, from G. B. Andersson, Svensk Dar es Salaam to Cabinet FVB – SIDA 'Preparation for the UN-Conference on Energy' dated 06.04.1980, same file.

[200] Mohammed S. Sheya and Salvatory J. S. Mushi, "The State of Renewable Energy Harnessing Tanzania," *Applied Energy* 65, (2000): 257-271.

[201] SNA SIDA File No. F13O: 9, "Issues in New and Renewable Sources of Energy (NRSE) – National Energy Policy of Tanzania", by Estomih E. Sawe.

and middle-income homes and stand-alone solar devices, as well as rechargeable lanterns, torches, and bulbs across households' income levels.

The recent expansion of solar usage is largely due to the global expansion manufacturing of solar photovoltaic technologies (PV). The global mass production in countries like Germany, the United States, and later in China has increased the availability of affordable solar PV gadgets in Tanzanian markets ranging from about 40 to 200 watts for households and small businesses, lighting devices, mobile phone charging devices, and solar electrical power appliances.[202] For instance, in 2009 the price of a solar home system (solar panels and lamps) was about USD 991 and it dropped by 64 per cent in 2014, reaching USD 354.[203] Solar technologies have expanded not only in terms of quantity but also in quality. For instance, an 8-watt Pico solar system introduced in the 2010s costs less than USD 20 but performs better than a 50-watt traditional solar home system introduced in the 1980s to 2000s.[204] In addition, improved marketing systems have encouraged households at all income levels to install SHS or acquire small lighting and mobile phone recharging solar devices.[205] It should be noted that while solar technologies began to penetrate Tanzanian markets as a solution for non-electrified rural areas, urban homes domesticated them as an alternative electricity source for lighting and powering technology.

These global and local developments have motivated residents in Dar es Salaam to adopt solar technologies and made solar photovoltaic technologies add another layer to the household energy landscape which serve as electrical lighting and power back-up. In 2012, for instance, about 0.7 per cent of homes had a small household solar system (SHS) and this percentage rose to 1.3 in 2016. Likewise, those homes that possessed small solar lighting devices such as lanterns, torches, and lamps increased from 4 per cent in 2012 to 26 per cent in

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[202] Smart Solar Tanzania, "Solar Companies in Tanzania", http://www.smartsolar-tanzania.com/solar-sector-information/solar-companies-in-tanzania/, accessed on 5 February 2021; IFC/World Bank Group, Solar Off Grid Market Research in Tanzania Market Insights Report", Ipsos Tanzania, 2017; Power Africa, "Off-Grid Solar Market Assessment: Tanzania", 6.

[203] Itamar Orlandi, Nico Tyabji and Jenny Chase, *Off-grid Solar Market Trends Report 2016*, (Bloomberg New Energy Finance, World Bank, IFC and Global Off-grid Lighting Association, 2016), available at https://www.lightingglobal.org/resource/off-grid-solar-market-trends-report-2016/, accessed on 13 September 2021; Nygaard, I., Hansen, U.E. and Larsen, T.H. (2016); "The Emerging Market for Pico-scale Solar PV Systems in Sub-Saharan Africa: From Donor-supported Niches Toward Market-based Rural Electrification. UNEP DTU Partnership," available at https://www.gogla.org/sites/default/files/recource_docs/market-pico-solar_web, access on 12 September 2021; David Bauner, Melinda Sundell, Jacqueline Senyagwa and Jeremy Doyle, "Sustainable Energy Markets in Tanzania Report I: Background", Stockholm Environment Institute and RENETECH, 2012.

[204] *Ibid*.

[205] *Ibid*.

2016.[206] This percentage rose further in 2020 to reach 30 per cent for different solar power and lighting artefacts and 23 per cent of those possessed solar lighting devices only. Solar technology has become the second household lighting energy of choice and the leading alternative measure against power outages used by about 27 per cent of urban residents in Tanzania.[207]

The availability of solar devices at prices ranging between 2,000 and 15,000 shillings (USD 1-7), depending on the quality and functions, motivated the adoption of solar power and lighting artefacts in homes. As one resident claimed, "solar electricity has nowadays become cheap to use because panels and lighting devices (*visola*) are available everywhere. Some distributors allow people to install and pay slowly."[208] The competition of solar technology marketing systems has improved in the last 10 years in Tanzania. More competitive companies have increased not only the quantity and quality of solar power and lighting but also instituted marketing systems that have made their products penetrate every street through hawkers and street traders. Different electrical solar lighting gadgets (figure 5.2) are among the remarkable products sold by street vendors and hawkers (*machinga*) in Dar es Salaam.

Solar photovoltaic technologies enable households to cope with power outages more efficiently when compared to petroleum-based technologies in three major ways. First, the expansion of solar photovoltaics as a domestic alternative power and lighting technology from the 2000s reduced fuel-based technologies from 23 per cent in 2016 to 6 per cent in 2020.[209] It reduced the cost of blackout adaptation in households. Before the 2000s, only a few homes were able to acquire small diesel/petrol-powered generators as a power backup. They used fuel-powered generators to ensure lighting and most importantly to power domestic electrical appliances.[210] Those families who did not have the purchasing ability to buy fuel-powered generators were not able to use their appliances during electricity outages. Most homes had lighting backups but not power backups. The services that required electricity waited for TANESCO to restore the grid.

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[206] Tanzania National Bureau of Statistics, "Energy Access Situation Report, 2016: Tanzania Mainland, (The United Republic of Tanzania, 2017), xvi.
[207] Tanzania National Bureau of Statistics, Energy Access and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings, (United Republic of Tanzania, 2020), 16-17.
[208] Interview 28, small business, Kimara, 12 October 2018.
[209] Tanzania National Bureau of Statistics, Energy Access and Use Situation Survey II in Tanzania Mainland 2019/20: Summary of Key Findings, (United Republic of Tanzania, 2020), 16-17.
[210] Barua kwa Mhariri, "Huduma ya umeme inapokuwa anasa," *Nipashe*, 14.09.1997; Adam Fungamoyo, "Balaa la mgawo hiloo laanza Dar," *Alasiri,* 31.08.2006.

Figure 5.2*:* Some of the household solar and electrical rechargeable lighting devices used in Dar es Salaam.
Source: Photo taken by the author in Dar es Salaam in October 2018.

By and large, enterprises such as hotels, restaurants, bars, and barber shops and hairdressing salons were the ones that possessed electricity power backups in the 1980s and 1990s rather than homes because the purchasing and running of fuel-powered generators is more expensive than solar power technologies. But the recent expansion of solar technologies in the 2010s means people can electrically back-up their power their homes more cheaply. The inhabitants who were unable to use diesel-fired generators have acquired low-cost solar panels.[211] Solar devices have relieved homes from the everyday costs of buying kerosene. One consumer testified that:

> Everyone is doing whatever they can so as to get alternative light and power sources. [. . .]. I started using generators in 1993 and I decided to install a solar power last year because it is efficient. It is cost effective. I spent 30,000 and 40,000 shillings [US $15 - 18] on fuel monthly. The second good thing with solar is that is noiseless. With the generator I had to shut it down immediately after 9pm to avoid disturbing my neighbours. With solar we can recharge mobile phones and stay connected even if power outages take a long time.[212]

[211] Interview 5, a shopkeeper, Kinondoni, 19 August 2018; Interview 6, an engineer, Ubungo, 15 August 2018; Interview 1, a professor, and a former environmental journalist, Survey-Mwenge, 31 July 2018; Interview 20, a welder, Msewe-Ubungo, 24 August 2018.

[212] Interview 5, a shopkeeper, Kinondoni, 20 August 2018. Many of the electricity users interviewed claimed that solar technologies were the best power and lighting sources in their homes, unlike fuel-based options such as generators and kerosene lamps which made them incur monthly fuel costs. Solar power involves only installation costs and simple maintenance and repair when compared to other technologies.

The recent expansion of cost-effective solar technologies and options has reduced the cost of electricity generation. The availability of many options and the nominal cost of generation devices have extended people's ability to acquire backup devices. The development of solar technologies in the last two decades has pushed kerosene lamps and candles to the background of the household lighting technologies and enabled householders to obtain light during power outages at the flip of the switch, like with grid electricity.[213]

Solar technologies have other advantages. They are simple and cheap to install. In some homes, their installation involves simple, separate wiring systems from that of the TANESCO grid. However, in some homes, it involves installation of wiring which enables both grid and solar power electricity to operate. Moreover, solar technologies are available in different-sized panels that do not need any technical installation. They also have rechargeable options, such as torches and lamps that can be easily bought and are affordable across all household income levels. Consumers recharge their lanterns and torches from electricity or from direct sunlight. When sunlight is low, they use the TANESCO system and during power outages, they recharge them with sunlight. Solar photovoltaics are also simple to use and enable homes to restore light more quickly after grid disruptions than candles and kerosene lamps. They offer automated (quick) backup systems unlike the traditional kerosene lamps, generators, and candles which take time to light. "Even when TANESCO cuts power, people do not eat or sleep in darkness because there is *visola* (solar lamps). We just switch them on like we do with grid electricity," one of the interviewees commented.[214] In addition, they produce electric light, unlike the smoky, smelly kerosene lamps— they produce electric light that supports domestic activities in the evening without much difficulty. They also have many functions in addition to lighting. For instance, some of the good-quality and high-priced solar lighting devices also function as radios or mobile chargers. The advent of solar power has not only increased resilience in terms of reducing costs and improving efficient but also enables quicker restoration of light and power when the TANESCO power grid collapses.

The coexistence of complementary cooking energy and electricity backup in homes has pushed blackouts to the background of the urban landscape. They have enabled the continuity of electricity end-services during power outages. As observed in many parts of the city, when

[213] Interview 23, a tailor and small business owner, Tabata, 28 August 2018; Interview 15, a tailor and small business owner, Ubungo, 20 August 2018; Interview 26, a retired military officer, Mbezi Beach, 10 October 2018; Interview 16, businessman, Kariakoo, 21 August 2018; Interview 22, a retired government worker, Tabata, 25 August 2018.
[214] Interview 28, small businessman, Kimara, 12 October 2018.

the TANESCO grid fails, people gather in different urban spots and homes that have power backups to watch football matches and other vital televised programmes. They also recharge their mobile phones in mobile charging and repair kiosks.

As AbdouMalique Simone contends, socio-cultural relationships in the Global South cities are not just social descriptors, but "they are materials themselves to be articulated in various forms" in navigating life constraints and making new possibilities,[215] such as residents who had no electrical power backups now enjoy mobile recharging services from their neighbours who have generators or solar power. Others obtain them from small enterprises which provide mobile charging services at costs between 200 and 500 shillings.[216] In line with Lindqvist's concept of technological landscape, when power fails, backup power and lighting alternatives have moved to the foreground of the urban technological landscape and blackouts have receded into the background. Based on Marjolein Spaans' and Bas Waterhout's definition that resilience is the ability of communities to continue services when infrastructure systems are in disruption,[217] the presence of electricity backups has improved people's resilience in Dar es Salaam. They have allowed the continuity of electricity services such as lighting, mobile recharging, watching television, among other services, even if the conventional grid fails. Such maintenance of electricity end-services during blackouts has made solar power devices important tools in bolstering people's resilience.

5.4 The Landscape of Restoration and Innovation: Technical Knowledge and Skills

Resilience is associated with the ability of technical systems, societies, and communities to restore or recover from the effects of a crisis or infrastructure breakdown in an efficient manner. It is the way technical artefacts and people "may continue to fulfil their function" after a crisis or breakdown—how the running and operation of technical things and societies are restored.[218] The innovative repair works rather than inventions of new technologies are the key resilience strategies in Dar es Salaam's households. They help in attaining and maintaining household

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[215] AbdouMaliq Simone, "Relational Infrastructures in Postcolonial Urban World", in Stephen Graham and Colin McFarlane (eds), *Infrastructural Lives: Urban Infrastructure in Context*, (London & New York: Taylor and Francis, 2014), 18.

[216] I observed mobile phones being recharged in repair shops in my survey in neighbourhoods such as Ilala, Magomeni, Manzese and Tabata in Dar es Salaam in 2018; Tanzania National Bureau of Statistics, "Energy Access Situation Report: Tanzania Mainland", (The United Republic of Tanzania, 2017), 124. This survey indicated that about sixteen percent of people recharged their mobile phones in charging shops, neighbours, and friends.

[217] Marjolein Spaans and Bas Waterhout, "Building up Resilience in Cities Worldwide – Rotterdam as Participant in the 100 Resilient Cities Programme", *Cities*, (2016), 1-8.

[218] Elsner *et al*., "Resilience," 37

resilience. As Steven Jackson notes, it is through repair that "rich and robust lives are sustained against the weight of centrifugal odds, and how sociotechnical forms of infrastructures, large and small, get not only broken but *restored*, one not-so-metaphoric brick at a time. On this road [of repair] we travel the path from disrepair to admiration, even reverence, and are confronted above all by the remarkable *resilience*" (my emphasis).[219]

The social, technical, and material world that forms urban technical infrastructure and sustains people (making them resilient) does not function only due to high-tech designers and constructors but also to the daily work of fixers and repairers.[220] The skilled electrical and electronic technicians locally knowns as *mafundi* play a critical role in making households deal with power disruptions. They mediate electricity users' everyday life as they negotiate with erratic power supply and its consequences.[221] Kevin Borg studied auto mechanics and automobile repair in the United States. He uses the concept of 'middle ground' to explain the significance of repair activities and repairpersons in the everyday usage of technical things. He shows that repair mechanics ('homo-fixer') are the middle ground or the mediators between car producers and users.[222] Borg contends that, "the repair shop is where the weaknesses of technology are laid bare; where progress is stalled, repaired, and sent back on the road; where technological failure is the stock-in-trade and the ideal of the well-oiled machine meets the reality of our entropic world."[223] To use Ruth Oldenziel's and Mikael Hård's notion of mediation in *Consumers, Tinkers and Rebels*, technicians in Dar es Salaam are intermediaries between the impact of maddening power outages and electricity users.[224] They have tinkered and tweaked

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[219] Steven J. Jackson, "Rethinking Repair", in Tarleton Gillespie, Pablo J. Boczkowski, and Kirsten A. Foot (eds) *Media Technologies Essays on Communication, Materiality, and Society*, (Cambridge& MA: The MIT Press, 2014), 222.
[220] Stephen J. Jackson, "Repair as Transition: Time, Materiality, and Hope," in Ignaz Strebel, Alain Bovet, Philippe Sormani (eds), *Repair Work Ethnographies: Revisiting Breakdown, Relocating Materiality*, (Singapore: Palgrave Macmillan, 2019), 337-347.
[221] For more scholarly works on how technicians contribute to the making of the material world and socio-technical sustainability (resilience) in Global South cities, see, for instance, Lara Houston, "Mobile Phone Repair Knowledge in Downtown Kampala: Local and Trans-Local Circulations", in Ignaz Strebel, Alain Bovet, Philippe Sormani (eds), *Repair Work Ethnographies: Revisiting Breakdown, Relocating Materiality*, (Singapore: Palgrave Macmillan, 2019), 129-160.
[222] Kevin L. Borg, *Auto Mechanics: Technology and Expertise in Twentieth Century America,* (Baltimore: The Johns Hopkins University Press; 2007), 2, 4.
[223] *Ibid*.
[224] For the notion of mediation, see, for instance, Ruth Oldenziel and Mikael Hård, *Consumers, Tinkerers, Rebels: The People Who Shaped Europe*, (Palgrave Macmillan, 2013) Ruth Oldenziel and Adri Albert de la Bruhèze, "Theorizing the Mediation Junction for Technology and Consumption", in Adri Albert de la Bruhèze and Ruth Oldenziel (eds), *Manufacturing Technology, Manufacturing Consumers: The Making of Dutch Consumer Society*, (Amsterdam: Aksant, 2009), 11-39; Ruth Oldenziel, Adri Albert de la Bruhèze, and Onno de Wit, "Europe's Mediation Junction: Technology and Consumer Society in the 20th Century," *History and Technology* 21, no. 1 (2005): 111-121.

electrical appliances, backup facilities, and the grid to minimise the costs of breakdowns to users. They are renovators who help inhabitants adapt to power failures.

Repair activities became more critical in Tanzania's urban landscape since the 1970s. Tanzania's economic recession of the 1970s and 1980s created scarcity of goods and services which "sparked tinkering and innovation" among residents.[225] Local technicians fabricated spare parts and fixed different artefacts such as cars, domestic appliances, and other tools of daily life in Tanzanian cities. *Mafundi* obtained their technical skills and experiences formally by going to technical colleges and universities and informally through everyday handiwork in friends' and relatives' repair shops or garages. The most fundamental way the technicians' skills have enhanced household resilience is through the repair of damaged electrical power appliances. As discussed in Chapter 4, people's domestic electrical devices are damaged by the collapse and restoration of electricity. TANESCO hardly compensates for such damages when they occur, hence, they leave the burden to consumers. Electricity users incur extra costs to repair or replace the damaged devices. Nevertheless, residents in Dar es Salaam prefer mending their appliances in repair shops than purchasing new ones because repair is not only the cheapest way to restore and extend the life of their appliances but also because there are skilled repair technicians. One resident remarked, "only a few houses in Dar es Salaam would be using electric gadgets were it not for the good job of the *mafundi*."[226]

The repair costs are still challenging to most low-income households, but they are manageable. Another consumer puts it as follows: "frequent power outages damaged my television twice and *fundi* repaired it and changed its power supply system cheaply. It is four years now since I repaired it and it is still working. The cost of *fundi* repair cannot be compared with the cost and time taken to demand compensation from TANESCO, which is hard to get."[227] Normally, *mafundi* charge electricity consumers between 2,000 and 15,000 shillings (USD 1-10) as a service charge. The total cost of repair, however, will depend on the cost of spare parts for the damaged device. Skilled local technicians are a vital node in the urban electricity infrastructure landscape and in how residents use electricity daily in their homes. They restore the electricity end-services offered by appliances and extend the life of domestic electrical

[225] T. L. Maliyamkono and M. S. D. Bagachwa, *The Second Economy in Tanzania*, (Nairobi and Dar es Salaam: ESAURP, I990); see also Emily Brownell, *Gone to Ground: A History of Environment and Infrastructure in Dar es Salaam*, (Pittsburgh: University of Pittsburgh Press, 2020), 111.
[226] Interview 27, a repairman, Magomeni, 22 August 2018.
[227] Interview 5, a shopkeeper, Kinondoni, 20 August 2018.

devices. Together, repair work has reduced the socioeconomic effects of power outages in homes but also performed the resilience function of restoration of services after breakdowns.

The *mafundi*'s repair work is also innovation. It involves fixing new industrial and locally fabricated components to adapt domestic electrical appliances to the local socio-technical environment of blackouts in Dar es Salaam. They tinker with power supply systems in appliances such as radios, televisions, sub-woofers, DVD players, electric irons, and cookers to make them compatible and resistant to voltage fluctuations and power disruptions. My personal experience illustrates this innovation and re-adaptation process of electrical devices. In 2018, I bought an electric iron at Saturn shop in Darmstadt. I took the iron with me during my final fieldwork in Dar es Salaam in 2020. I used the iron for one month in Dar es Salaam when it stopped working. When I took it to a *fundi*, he looked at the head of the plugging cable and asked where I bought the iron. When I informed that it was from Germany, he immediately replied "this is the problem."[228] At a cost of 10,000 shillings (USD 4), he repaired it, cut off the original plug and replaced it with a new 'fused' plug. The iron functioned properly with a tinkered plug and cables.

Like in my personal encounter with the electrician described above, the domestic electrical appliances used by many residents in Dar es Salaam come from second-hand markets. The electricity voltage level in the countries of first usage differ in many ways from that of Tanzania. For instance, TANESCO supplies residential electricity at 230 voltage (v) and a frequency of 50 hertz (Hz). But traders in Tanzania import second-hand electrical appliances from countries such as China (supplied at 220v/50Hz), the United States (supplied at 120v/60Hz), Canada (supplied at 110/120v and 60Hz), and Japan (supplied at 100v/200v and 50/60Hz.[229] The second-hand domestic electrical appliances from these countries, among many others, are not designed for TANESCO's residential supply of 230v/50Hz, yet consumers have been putting them into use without any voltage converters. As the technicians claim, this has increasingly become a source of damage especially due to the critical fluctuation of TANESCO's grid voltages. When they are imported into the country, such appliances require modification to suit local conditions.[230]

[228] My personal encounter and conversation with an electrical technician at Mbezi-Mwisho in Dar es Salaam in December 2020.
[229] See "Mains electricity by Country", available at: https://en.wikipedia.org/wiki/Mains_electricity.
[230] Interview 13, an electricians/repairman, Mwenge, 14 August 2018; Interview 24, repairman, Tabata, 28 August 2018; Interview 27, electricians/repairman, Magomeni, 22 August 2018.

A common technical adaptation of electrical gadgets that technicians have made is fixing the new power supply system in domestic electrical appliances. They use both locally- and industrially made spare parts to fix new power supply systems in electrical devices.[231] They have engaged in what Edgerton calls "creolisation". The term refers to the ways in which the technologies invented, manufactured, and first used in the developed Western countries travel and find new uses in foreign environments. He observed that most of the technologies in use in the Global South megacities are 'creole technologies.' They have been imported, transformed, and readapted using local skills and knowledge to suit local needs and contexts beyond the primary intentions of their manufacturers.[232] They function in a hybrid form— 'creolisation'.[233] Similarly, Arnold in *Everyday Technologies* expounds that when transferred to the Global South, Western technologies are assimilated and adapted to fit local socio-technical landscapes. He uses the case of sewing machines, bicycles, and typewriters in India to argue that, although socio-technical adaptation of artefacts does not necessarily involve the modification of the physical appearance of technical artefacts, imported technologies "might in time undergo significant modification."[234]

The repair landscape of domestic electrical technologies involves interaction between technicians and users. Users are not passive agents, but they participate in the process of negotiation between the repairers, users, and material artefacts. This is evident in an interview with one of the technicians who explained how they have been educating users on repairing their devices. He said that "we have been advising our customers on the need to replace high volt capacitors, but only a few accepted this idea in the past. Many of them have been changing the capacitors of their televisions [and other devices] before they were damaged. This indicates that people have started to understand and act to protect their appliances against fluctuating power voltages."[235] The *mafundi* possess more knowledge on the ways electrical artefacts work than ordinary users, and thus, their repair kiosks have become training grounds for consumers on how to handle their appliances better. Electricity consumers have a certain level of

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[231] Interview 27, electricians/repairman, Magomeni, 22 August 2018.
[232] David Edgerton, "Creole technologies and global histories: rethinking how things travel in space and time", *History of Science and Technology*, 1, (2007), 101; Cf. David Edgerton, *The Shock of the Old: Technology and Global History since 1900*, (Profile Books, 2008).
[233] Edgerton, "Creole technologies and global histories," 76, 101.
[234] David Arnold, *Everyday Technology: Machines and the Making of India's Modernity,* (The University of Chicago Press; Chicago, 2013), 7-8.
[235] Interview 13, electrician/repairman, Mwenge, 14 August 2018; Interview 27, electrician/repairman, Magomeni, 22 August 2018.

knowledge on how their electrical appliances work. This is fundamental in their negotiation with technicians regarding which spare parts to use and what they can afford to pay. The interaction between technicians and users makes repair kiosks not only places where domestic appliances are fixed, but also where skills, efficiency, and robustness (resilience) are reinforced.

Figure 5.3: *A fundi checking and modifying a television power-supply system at Magomeni Dar es Salaam.*
Source: Photo taken by the author in Dar es Salaam in February 2021.

Mafundi also make 'creole' backups. They fabricate local electricity backup systems such as solar inverters and power storage batteries. Such backups are made up of a few wires and a car battery or solar battery to restore electrical power. They recharge these backups when TANESCO electricity is available, and they use the stored power during power outages.[236] While many *mafundi* make these backups to ensure the continuity of their electronic repair works during power outages, they use them mostly to recharge people's mobile phones. One of the technicians I interviewed in Tabata proclaimed: "I use this small inverter during power outages. Many people come to recharge their mobile phones here, and others are also purchasing

[236] Interview 24, repairman, Tabata-Segerea, 28 August 2018.

inverters that I make."[237] The *mafundi* kiosks are not only repair places but also mobile phone recharging places that thus ensure the continuity of mobile communications and mobile money transactions even during power failures. Street technical skills have created a wide range of backup gadgets beyond generators and solar photovoltaics in the city, increasing people's adaptation capacity.

Mafundi have also reinforced household resilience from below by making, installing, and repairing different lighting and power backups. Like other urban dwellers in Sub-Saharan cities,[238] residents in Dar es Salaam use backup facilities as explained above. Most significantly, street technicians have made people in Dar es Salaam resilient by encouraging the use of backup systems. Technicians provide installation, repair, and maintenance services to ensure the proper running of backups. "We install, repair, and boost the capacity of solar panels and inverters as per our customers' requirements. We have been doing this in many households in Dar es Salaam and all regions. Nothing is difficult nowadays and everything can be done", one of the technicians emphasised.[239] The *mafundi* readapt electrical devices with new parts, some fabricated locally, to make the appliances more resistant to electricity brownouts. The adaptation through repair done by the *mafundi* in Dar es Salaam confirms Jackson's idea that repair works should not be regarded as completely backward looking, aimed only at restoring what is broken. They are also forward looking toward the future— that is, renovating things in such a way that they make technologies more durable[240]—they become more resistant to shocks and future breakdowns (increasing resilience). Similarly, resilience studies have shown that resilience has a temporal dimension which not only considers looking backward to restore the lost functionality of technological services, but also forward looking when making artefacts more robust and able to withstand future shocks and stresses.[241] Repair and new compatible practices in Dar es Salaam do not only restore the functioning of devices but also make them resilient to TANESCO grid brownouts.

The second category of street electricians in Dar es Salaam are commonly known as *vishoka* (hatchets, freelance electricians), singular, *kishoka.* Unlike those *mafundi* who repair appliances, *vishoka* tinker with TANESCO's electrical systems and household wiring to resolve

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[237] *Ibid*.
[238] Silver, "Disrupted Infrastructure," 996-999; Olukoju, "Never Expect Power Always," 59.
[239] Interview, Ubungo, 15 August 2018.
[240] Jackson, "Repair as Transition," 343.
[241] Elsner, *et al*., "Resilience," 31-38.

different technical inadequacies. Many *vishoka* have gained their technical skills from attending technical trainings and through everyday work with TANESCO. They entered the company through day-to-day, part-time, and short contract jobs, and often became formal TANESCO employees, but many returned to the streets to grab any electrical work to earn an extra living. By working with TANESCO, the *vishoka* have not only obtained training "ordinarily taught to regular street electricians" but also gained experience to work as TANESCO technicians.[242] The skills they acquire include how to rectify electrical poles, fix loose connections, install electrical poles, balance transformer loads, and connect and disconnect electricity consumers. Although TANESCO considers the *vishoka*'s work as informal and illegal, they deliver technical advice and solutions regarding household wiring, installation of domestic electrical devices, expedite household electricity connections, repair broken cables and electric meters, and fix electrical shocks for small charges from consumers.[243]

The *vishoka*'s activities are limited to small areas, which can range from a single household to too little households. They restore electricity service quickly, when the grid, electrical lines, or meters have failed and when response from TANESCO technicians is delayed.[244] They tinker with the grid using TANESCO's electrical materials and equipment that they acquire through friends within TANESCO. They have "provided the useful but not-quite-licenced service of climbing up utility poles and balancing loads on transformers", while preserving the core logic of power network performance.[245] When the electricity utility has failed to provide the required technical services within the required time, the *vishoka* take the opportunity at a reasonable pay from consumers. Degani describes the role played by the *vishoka* in increasing electricity users' resilience or reducing the grid's vulnerabilities in the following words:

> TANESCO consumers similarly are cut off when their local utility poles fall over, their wires strip, or their meters are ripped off the wall. They must endure service delays [blackouts] that are long, economically damaging and often dangerous. In such moments, the structural vulnerability of the 'last mile' becomes clear. It is simultaneously too localised (warped by specific conditions) and not localised enough (dependent on logistical coordination from the centre). In response, residents develop contingency plans around

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[242] Michael Degani, "Modal Reasoning in Dar es Salaam's Power Network," *Journal of the American Ethnological Society* 44, no. 2 (2017): 5.
[243] *Ibid*.
[244] *Ibid*.
[245] Michael Degani, "'Shock of Humor': Zaniness and the Freedom of Permanent Improvisation in Urban Tanzania," *Cultural Anthropology* 33, no. 3 (2018): 485.

> the service line. They purchase solar-powered backup systems and generators, solicit unofficial repairs by *vishoka*–a mixture of moonlighting TANESCO employees and freelance 'street electricians' – and offer bribes to expedite maintenance.[246] [my emphasis].

The expansion of the *vishoka's* activities in Dar es Salaam is linked to the changes in the broader socioeconomic and technological landscape in post-socialist Tanzania. The structural adjustment policies and electricity reforms of the 1980s and 1990s, which were intended to reduce government expenditure, led to the dismissal of workers in government parastatals including TANESCO. Workers were forced or encouraged to retire. In the post-socialist Dar es Salaam's constellation marked by a life of hardship and trickery (*ujanja*), some retired workers became street electricians in collaboration with their friends in the company and off pocketed the money.[247] In addition, the increased number of consumers and poor electricity services in the post-socialist period meant the *vishoka* provided essential technical skills and services that improved electricity supply to users. As observed during interviews, liberal policies made urban dwellers more aware of their right to electricity services, as expounded in Chapter 4.

Whereas domestic electricity was considered as privilege in the socialist period, in the post-socialist period and in the context of electricity reform, it became a right and a necessity. TANESCO operates through public taxpayers' money, therefore, it had to improve electricity services.[248] But instead of improving services, the provision of electricity became more impoverished making consumers turn to the services of the *vishoka*. Electricity consumers negotiated with *vishoka* when faced with some simple technical issues. They report to TANESCO when the problem is too complicated for the *vishoka* to fix. The inhabitants employ street electrical technicians to solve electrical power supply problems when TANESCO becomes unresponsive.[249] The consumers believe that the *vishoka* respond promptly and that the use of "formal procedures 'leads nowhere at all.'"[250]

The *vishoka* have increasingly become "people as infrastructure", to use AbdouMalique Simone's notion. Drawing on his example from Johannesburg, Simone states that the survival of people in cities depend on the "ability of residents to engage in complex combinations of

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[246] Michael Degani, "Disservice Lines"' *Limn,* 10, (2018): 67.
[247] Degani, "Emergency Power," 177-192; Degani, "Shock Humor," 485; Rebecca H. Ghanadan, "Public Service or Commodity Goods? Electricity Reforms, Access, and the Politics of Development in Tanzania," (PhD Diss.: University of California Berkeley, 2008), 110.
[248] Interview 20, a welder, Msewe-Golani, 24 August 2018.
[249] Michael Degani, "Modal reasoning," 1–15.
[250] Ghanadan, "Public Service or Commodity Goods?,"110-111.

objects, spaces, persons, and practices."[251] He extends the notion of infrastructure from technical systems to people's socio-cultural networks, practices, and intersections. He shows how social practices and infrastructure coproduce each other to produce flexibilities and improvisations in technical infrastructure in the Global South, where technologies are inefficient, and urbanity is unregulated. The "intersection" of street technicians and electricity users and electricity users' "networks" with the *vishoka* have offered socio-technical material and space in which households gained resilience.

The *vishoka* intersect the technological, material, social, and institutional spheres of power infrastructure. They provide residents with crucial alternatives in handling power outages. They enable them to "restore technical functionality at the edges of the network and thus, retroactively, TANESCO's monopoly on it (since that monopoly is itself reciprocally predicated on technical functionality). They eventually realign the edges of the networks back into a feedback loop, and this makes them different from official repair only in degree, not kind."[252] Degani concludes on the technical role of the *vishoka* and especially in handling various technical breakdowns in TANESCO's power supply networks that "residents understand that while *having* to pay *vishoka* can amount to a risky or burdensome proposition, it is legitimate to be *able* to pay those same *vishoka* when TANESCO is not responding."[253] Whilst Degani's work analyses how informal practices by vishoka make TANESCO's network more vulnerable, I contend in this chapter that the collaboration between *vishoka* and electricity users were not mere "informal" tinkering but portrays the historical agency of users and bottom-up approaches that have made consumers resilient to power outages. In other words, *vishoka* increased to become electricity users' alternative when faced by minor technical problems and when TANESCO becomes unresponsive.

Oral narratives given by a welder in Msewe reveal how his area faced a problem of loose connections that caused sparks in the electric pole, power outages, and voltage fluctuations, which not only left them without electricity but also ruined people's domestic items several times. As he claimed, despite having informed TANESCO of such technical inefficiencies, the company could neither repair nor change the pole for several months. The pole continued to

[251] AbdouMaliq Simone, "People as infrastructure: intersecting fragments in Johannesburg," *Public Culture* 24, (2004): 407-429; Andrea Protschky *et al.,* People as infrastructure: translating a metaphor for infrastructure research, KRITIS (ed), "Concepts of Infrastructure," Whitepaper of an internal workshop, (2021), 12-14**.**
[252] Degani, "Modal reasoning in Dar es Salaam's power network," 6.
[253] *Ibid*.

affect them especially during windy or heavy rains. He organised for a *kishoka* who fixed the problem after several months of TANESCO's unresponsiveness.[254] He summed up his account, saying, "if one completely relies on TANESCO, one might stay without power for several weeks."[255] In a similar line, another interviewee said, "it takes a century for TANESCO to respond to customers' calls. It claims that it has no material and people, even if it is for a small problem like sparks on a pole or loose connections. If someone else can fix the problem, one cannot stay without power for three weeks while waiting for TANESCO."[256]

In their study on the power infrastructure in different localities in Dar es Salaam, Koepke and others have noted an interesting point on why consumers hire informal technicians. They say that the "[d]emand for illegal connections is big. These technicians exist because, first of all, they're trusted by customers. They're faster, they can move faster than TANESCO."[257] These narratives are important in rethinking the temporality of resilience. How quick restoration of infrastructure service is done is a measure of infrastructure/society resilience. The consumers are willing to pay for quicker restoration when faced with technical breakdowns that have curtailed electricity end-use services and the *vishoka* help to restore supply quickly. Hence, the consumers' ability and readiness to pay for the *vishoka*'s technical ability to provide quicker electricity restoration services illustrates the role of both users and *vishoka* in making residents resilient, as well as temporality as a critical aspect of resilience.

5.5 Infrastructure 'Visibility' and the Landscape of Routinised Practices

To what extent does the visibility of infrastructure enhance electricity users' resilience against power disruptions? Scholars have maintained that stabilised technological networks increase vulnerabilities because they tend to escape the notice of users.[258] They become visible when they face a breakdown. Geoffrey Bowker and Susan Leigh Star use the notion of "infrastructure inversion" to explain that infrastructure becomes visible when there is a power blackout, a bridge washes out, or a server is down, as well as when individuals and institutions adopt backup

[254] Interview 20, a welder, Msewe-Golani, 24 August 2018.
[255] *Ibid.*
[256] Interview 15, a tailor and small business owner, Ubungo, 22 August 2018.
[257] Interview with Consumer Protection Organization as cited in Koepke *et al*., "Rethinking energy transitions in Southern cities," 7.
[258] See, for instance, Stephen Graham, "When Infrastructures Fail," in Stephen Graham (ed) *Disrupted Cities: When Infrastructure Fails* (New York and London: Routledge, 2010), 26; Stephan Eifert, *et al*., "Vulnerability," in Jens Ivo Engels (ed) *Key Concepts in Critical Infrastructure Research*, (Springer SV, 2018), 24.

mechanisms.[259] Nigel Thrift uses the concept of "technological unconsciousness" to point out that users in the Global North cities are more vulnerable due to invisible infrastructures. The infrastructures on which people's lives depend become "black-boxes" to their users.[260] Similarly, Nye provides an empirical case in American blackouts. When Americans faced cascading failures in 1965 for the first time, the public panicked and suffered disastrous effects, but when rolling blackouts became common in the 1980s, people became more prepared.[261] They kept their freezers and refrigerators closed to preserve groceries, stored water in advance, listened to battery-powered radios instead of watching television, used a grill instead of electric stoves, and lit with candles because they were aware that power would be restored after a short time.[262] Unlike most Western cities, infrastructures in the South are highly visible given their everyday disruptions and improvisations. As Graham contends, when breakdowns are more common, they become normalised in society because people tend to accept them as normal everyday occurrences rather than the exception. Therefore, they do not only prepare for them but also put in place backup mechanisms to cope with the anticipated disruptions. This makes infrastructure users more resilient even if they depend on vulnerable technical systems.[263]

Like in many other Global South cities, power systems in Dar es Salaam are visible to their users. As shown throughout this thesis, the visibility of power infrastructure is historical and distinct socio-technical forces have shaped everyday realities over time. They were visible throughout the economic crisis in the 1980s and in the debates about the drying-up of the largest, interconnected hydropower system in the country, Kidatu and Mtera, in the 1990s.[264] In addition, the World Bank engineered electricity reforms in the 1990s and 2000s that were geared towards revenue collection and turned the city into a landscape of power disconnections for people who failed to pay their electricity bills under the NetGroup Solutions.[265] In the 2000s and 2010s, electricity infrastructure became more visible through the corruption scandals involving the Independent Power Producers (IPPs), such as IPTL and Richmond LLC, which hit the media and the National Assembly. The corruption allegations sparked nation-wide debates

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[259] Geoffrey Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences,* (Cambridge, MA: The MIT Press, 2000), 35.
[260] Nigel Thrift, "Remembering the Technological Unconscious by Foregrounding Knowledge of Position," *Environment and Planning D. Society and Space* 22, (2004): 175-190.
[261] *When the Lights Went Out: A History of Blackouts in America* (Mass: MIT Press, 2010).
[262] *Ibid.,* 138
[263] Graham, *Disrupted Cities,* 19.
[264] For a detailed discussion on the historicity of power outages during this period, see Chapter 3 of this dissertation.
[265] See the discussion in Chapter 4 of this dissertation.

in the media and the National Assembly on the connection between power failures and corruption in the management of TANESCO.[266]

Moreover, the introduction of prepaid meters since the mid-1990s has increased the visibility of electrical power infrastructures in Dar es Salaam. The inhabitants buy electricity tokens monthly, weekly and others daily. The process of recharging prepaid meters also has some technical limitations like forgetting to recharge at household level, leading to frequent power outages, but also at national level, like failure of the electricity token systems or meters not responding. For instance, a critical situation happened in May 2015 and in May 2021 when the prepaid meters' mobile payment system failed and left many homes in darkness, creating long queues at electricity token vending shops.[267] These challenges have made people interact with power systems daily and made them more visible. The visibility of power infrastructure through frequent breakdowns has improved people's resilience, as detailed in this section. It has enabled people to normalise power outages and develop not only preparedness measures (outlined in section 5.3 above) but also socio-cultural adjustments in their daily lives.

Figure 5.4: Visibility of infrastructure: Consumers queuing for electricity token in 2015 and 2021.
Source: See the link below.[268]

[266] See, for instance, Gratwick, Ghanadan and Eberhard, "Generating Power and Controversy,";; Zitto Kabwe, "How Pan Africa Power Ltd acquired Independent Power Tanzania Ltd for almost nothing and looted USD124m from the Bank of Tanzania", Briefing Paper (2014); Gray, "The Political Economy of Grand Corruption in Tanzania," 382-403; EAF-UDSM Library: Majadiliano ya Bunge (Hansard), Bunge la Tanzania, Taarifa ya Kamati Teule ya Bunge iliyochunguza Mchakato wa Zabuni ya kuzalish Umeme wa Dharura Ulioipa Ushindi Richmond Development Company LLC ya Houston, Texas Maekani, Mwaka 2006 (Mkutano wa Kumi; Kikao cha Saba Tarehe, 6 Februari, 2008).

[267] By Saumu Mwalimu and Bernard Lugongo, "Frustration as Dar hit by 'Luku' crisis", *The Citizen,* 2 May 2015; *The Citizen*, "LUKU Drama: Long queues as hundreds struggle to purchase electricity", 19 May 2021.

[268] Sources of these photos, see: https://hakipensheni.blogspot.com/2015/05/frustration-as-dar-hit-by-luku-crisis.html, accessed on 10 August 2021 (left), and *The Citizen* Newspaper, 19 May 2021 (right).

Power outages are part of the daily life discussions of residents in Dar es Salaam. Because they have persisted for decades and TANESCO's investments have failed to address them, the residents view blackouts as a technological and management challenge that is beyond TANESCO's ability to handle. One inhabitant questioned in a letter to a newspaper editor as to why there was no headway: "Why is it taking so long? How do we come to terms with the fact that there may never be a guaranteed, reliable power supply in this country?"[269] For another electricity consumer, it was a great misfortune that Tanzania suffered from power disruptions in the twenty-first century, a century of science and technology in which electricity is a critical infrastructure, and that Tanzania's authorities consider this situation normal. He wrote:

> The Tanzanians lack an important service: electricity. Even in a big city like Dar es Salaam, load shedding is rampant every year. The interruptions have been here for so many years to the extent that the situation becomes normalised. The authorities have normalised it and point fingers to the 'Act of God:' inadequate rain. Why is it persisting for years now? Is there no other way out? How long will we continue with blackouts?[270]

This excerpt indicates the visibility and normalisation of power outages in Dar es Salaam. It also shows the electricity users' perception that strategies followed by the electrical company to reduce power failures have failed to address the problem making its infrastructure more visible to consumers. Representing the community's awareness and normalisation of blackouts, one of the Kiswahili newspapers, *Nipashe,* printed a caricature on 21 December 2006 that illustrated the culture of blackout preparedness (Figure 5.6). Putting it into context, TANESCO's acute power shedding normally occurs in December before the beginning of the long rainy seasons in the southern highlands to refill the Kidatu and Mtera dams. As the caricature shows, instead of preparing for Christmas celebrations, people are preparing for blackouts by ensuring that they have kerosene oil and lamps, torches, and matches. Generally speaking, the cartoon reveals the resilience measures adopted by electricity users but also their awareness and how they have routinised their activities.

The visibility of power infrastructure in Dar es Salaam has led residents to develop routinised socio-cultural practices that has increased their resilience against power interruptions. Paul Edwards in "Infrastructuration" contends that the visibility or invisibility of

[269] A letter to the editor, "A more sincere approach needed to absolve us from latest power blues," *THISDAY*, 20 October 2009.
[270] Tom Kilumbi, Barua kwa Mhariri, "Huduma ya Umeme inapokuwa anasa," *Nipashe* newspaper, 14 September 1997.

infrastructure leads users to develop certain habits, skills, and norms, which he terms 'routines'.[271] The transparency (visibility) of infrastructure in the Global South cities where electricity "comes on and off randomly, or is only available at specified hours,"[272] is not mere technical weakness, it shapes users' minds, decisions, and actions. It formulates new routines, a lifeworld in which its users inhabit, constantly rehearse, and act upon, as an integral part of how people live every day.[273] The significance of socio-cultural routines is well noted in infrastructure resilience studies, which have also shown that societal and cultural practices and contexts have the potential to reduce or increase vulnerabilities. For instance, Stephanie Eifert and others emphasise that, in contrast to societies where blackouts are occasional, people sit in the darkness and their comestibles perish in freezers and refrigerators because the reliability of supply and the invisibility of infrastructure does not create any incentives to take preparedness measures. However, in "a society facing energy blackouts every day, people develop strategies like buying power generators or candles, so that they include these blackouts into their daily routines."[274] The perceptions, experiences, and socio-cultural routines developed by electricity users in Dar es Salaam from the decades of power outages have made them innovate blackout preparedness and adaptation measures.

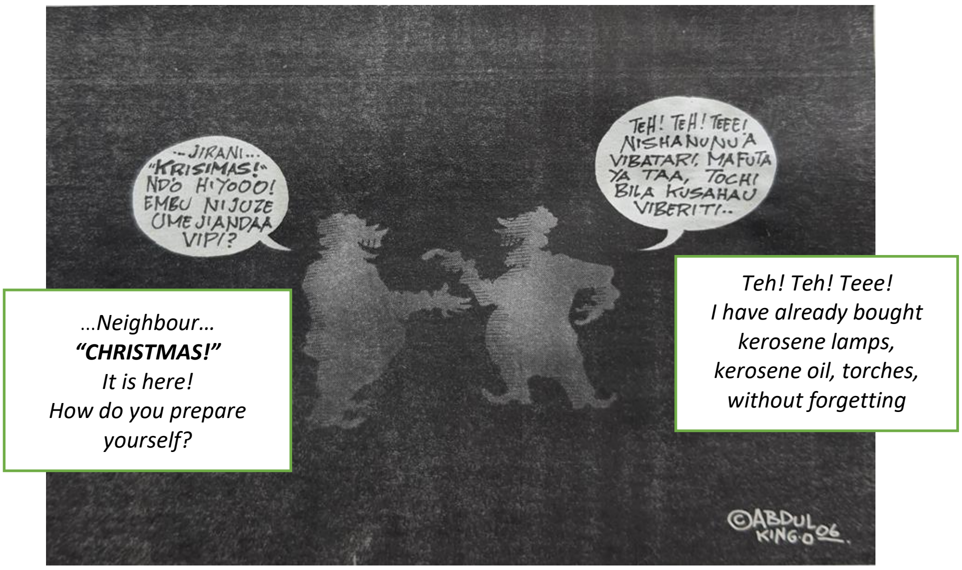

Figure 5.5: A cartoon representing electricity users' blackout preparedness measures.
Source: *Nipashe*, 21 December 2016

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[271] Paul N. Edwards, "Infrastructuration: on habits, norms and routines as elements of infrastructure", in Martin Kornberger, Godfrey Bowker, Donald Bren, Julia Elyachar, Mennicken Andrea, Peter Miller, Joanne Nucho, Joanne Randa, and Neil Pollock (eds.), *Thinking Infrastructures*, (Bingley, 2019), 355-366.
[272] Edwards, "Infrastructuration," 356.
[273] *Ibid*. 359.
[274] Eifert, *et al*., "Vulnerability," 24.

Oral testimonies illustrate these sociocultural adjustments and the way they have enhanced resilience against power breakdowns. People have developed individualised and innovative blackout preparedness to reduce the impact of power failures on their lives. One interviewee who also owns a food-vending kiosk commented, "we do things on our own. Because I am not sure that electricity will be available the whole day, I always prepare some ice bars to cool my drinks and keep groceries fresh."[275] She insisted further that without ice and cool boxes that worked as an alternative to the refrigerator, the power cuts would completely damage her business.[276] Frank Trentmann, in what he calls the "elasticity" of blackouts in everyday life, claims that blackouts are not inherently bad, but they unveil the flexible side of practices so often considered as stable and tenacious.[277] He notes further that while we cannot romanticise blackouts and people's creativity in building resilience, we must also not consider blackouts as a completely bad thing. "Breakdowns are a systematic part of everyday life" and electricity users are not mere victims, they "play an active role in absorbing and coordinating them, in some cases even generating them."[278] When blackouts are normalised, argues Trentmann, they create a "high degree of elasticity in people's response" and make power breakdowns a constitutive landscape of lived normality. We, therefore, need to understand blackouts in a more balanced way, by recognising them "as a creative as well as destructive part of normality."[279]

Trentmann's observation is crucial in understanding blackouts in Dar es Salaam. The electricity users have recreated their socio-cultural practices and routines to reduce the effect of power failures. The life experiences of electricity consumers reveal a high degree of the customisation of routines to inconsistent power outages. For instance, a resident claimed, "TANESCO cuts power so frequently. If it takes three or four days without an electricity outage, one must ask oneself what has happened because it is not normal for TANESCO to supply power reliably."[280] In a similar note, another inhabitant declared, "power outages are boring but are

[275] Interview 15, a tailor, and small businesswoman, Ubungo, 20 August 2021.
[276] *Ibid*.
[277] Frank Trentmann, "Disruption is Normal: Blackouts, Breakdowns and the Elasticity of Everyday Life," in Elizabeth Shove and Frank Trentmann (eds) *Time Consumption and Everyday Life Practice, Materiality and Culture,* (UK. Berg, 2009), 67-84, 70.
[278] *Ibid.,* 80-81.
[279] *Ibid.*
[280] Interview 17, a retired technician, Ubungo, 22 August 2018. This was noted also by several other informants, see, for instance, interview 19, a tailor, Msewe, 24 August 2018.

not surprising. They have become part of our daily lives. I do most of my essential work when electricity is available. I make sure that my mobile phones and lighting gadgets are well charged every time. We know that a day will not pass before TANESCO cuts power in our street."[281] This was also reaffirmed in another interview: "Before I go to work daily, I always ask colleagues if there is electricity in our office. I do the same before I return home. If there is no electricity at home, I must do all my work in the office before I go home. I also make sure that my laptop, mobile phones, and power bank are fully charged because I am not expecting electricity all the time."[282] Such consciousness that power will fail exhibited by residents in Dar es Salaam and how it made them develop resilience measures affirm Arjen Boin and Allen McConnell point that for individuals or society to develop infrastructure resilience measures "there must be a general awareness that a catastrophe may strike."[283] The fear of power failure has galvanised and pushed Dar es Salaam's residents to develop adaptive strategies.

When TANESCO grid fail, people in Dar es Salaam do not panic when power goes off but wait in the hope that TANESCO will restore it quickly. As Jackson contends, hope is not a sign of defeat, but "grounding and productive, a source of individual and collective agency rather than resignation,"[284] thus, waiting and hoping that TANESCO will restore electricity after a short period of time is one of people's socio-cultural responses to power failures. People in Dar es Salaam considered all blackouts as ordinary power disruptions and patiently waited for TANESCO to restore power. As a tailor commented, "I might wait the whole day because I know electricity will be restored and when TANESCO restores it, I go back to work, even if it is midnight."[285] Waiting has been a long-time invented strategies for Dar es Salaam's inhabitants when faced by infrastructure service shortage. Brownell contends the scarcity of infrastructures and commodities in the 1970s and 1980s developed waiting attitudes among inhabitants in Dar es Salaam. Waiting not only became "the moral constitution of Tanzanians" but it also became a contested rhythm of how the urban landscape and infrastructure were lived daily.[286] Since power failures are largely caused by load shedding and repair activities; they take short periods between 30 minutes to 8 hours. When a disruption happens, therefore, people tend to wait

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[281] Interview 30, charcoal dealer, Msewe, 24 August 2018; The ideas on how people are prepared for blackouts emerged also in other interviews. For instance, interview 5, a shopkeeper, Kinondoni, 19 August 2018.

[282] Interview 25, a typist, and a personal secretary, Majengo, 13 September 2018.

[283] Arjen Boin and Allen McConnell, "Preparing for Critical Infrastructure Breakdowns: The Limits of Crisis Management and Need for Resilience," *Journal of Contingencies and Crisis Management* 15, no. 1 (2007): 54.

[284] Jackson, "Repair as Transition;" 344-345.

[285] Interview 19, a tailor and small businesswoman, Ubungo-Msewe, 24 August 2018.

[286] Brownell, *Gone to Ground*, 92.

rather than panic or revolt even if they are not informed about the cause of the breakdowns or how long it will take TANESCO to restore power.

Wiebe Bijker and others have noted that those people who face frequent power outages become "better able to cope with even bigger blackouts."[287] The inhabitants in Dar es Salaam have been experiencing frequent power outages which improved their adaptive capacities.[288] While power outages create panic and fear among electricity users in developed world cities,[289] in Dar es Salaam people switch to other activities which do not require electricity, when TANESCO grid fail. This is not to romanticise the socio-cultural adjustments, preparedness, and resilience measures of electricity users in Dar es Salaam. Rather it is in line with Gabrielle Hecht caution that STS scholars should not simply valorise people and cities in the Global South as resilient but engage with the poor state of infrastructures in this region. In her view, it is scarcity that forces people to make do "with what they have at hand."[290] Indeed, it was the ailing condition of TANESCO's infrastructure that motivated electricity users in Dar es Salaam to learn from and adapt to electrical power scarcities and vulnerabilities (frequent power failures) which, in turn, have increased their resilience. They maintained and acquired alternative technologies (as discussed in section 5.3 above) that enable them to survive periods of disruptions/scarcities but also readjusted some socio-cultural and economic routines to cope with regular and yet inconsistent power disruptions.

5.6 Conclusion

This Chapter has unpacked the dysfunctions, vulnerability, and non-resilience narratives that traditional studies have been associated to the state of the Global South cities. It has explored Wiebe Bijker's and other scholars' claim that a certain level of vulnerably is needed for a society to build resilience. Vulnerability creates room for users to develop flexible alternatives. They

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[287] Wiebe Bijker, Anique Hommels, and Jessica Mesman, "Studying Vulnerability in Technological Cultures," Anique Hommels, Jessica Mesman, and Wiebe Bijker (eds) *Vulnerability in Technological Cultures: New Directions in Research and Governance*, (Cambridge, MA, London: The MIT Press, 2014), 1-2.

[288] On everyday practices and household resilience against blackouts, see, for instance, Alasdair Neilson, "The Socio-Political Importance of Blackouts in South Africa," *Social Space*, (2017): 2, 7; on the importance of blackouts in resilience building, see also, Hugh Byrd and Steve Matthewman, "Exergy and the City: The Technology and Sociology of Power (Failure)," *Journal of Urban Technology* 21, no. 3 (2014): 85-102; Nina Heidenstrom and Anders Rhiger Hansen, "Embodied Competence in Preparedness for Blackouts: Mixed Methods Insights from Rural and Urban Norwegian Households", *Energy Research and Social Science* 66, (2020): 1-11; see also, Nina Heidenstrom and Harald Throne-Holst, "'Someone Will Take Care of It'. Households' Understanding of their Responsibility to Prepare for and Cope with Electricity and ICT Infrastructure Breakdowns," *Energy Policy* 144, (2020): 1-11.

[289] Nye, *When the Light Went Out*, 1-5.

[290] David Serlin, "Confronting African Histories of Technology: A Conversation with Keith Breckenridge and Gabrielle Hecht," Rethinking Postcolonial Science and Technology, *Radical History Review* 127, (2017): 97.

uphold that, sites facing constant power failures are resilient to large, prolonged, and cascading blackouts.[291] The Chapter has shown that vulnerable power infrastructure has compelled consumers to maintain their traditional energy technologies, domesticate new off-grid lighting and powering devices, renovate their appliances, and develop socio-cultural routines to minimise the impact of power outages in their lives. People's everyday lives in Dar es Salaam have been mediated through superimposed layers of energy technologies both old and new, traditional and modern, networked and off-grid. They have also involved the use of technical skills and socio-cultural experiences in an urban landscape. The blackout preparedness measures in Dar es Salaam have become mundane, everyday life practices. Power consumers are active agents in handling power outages. They use their accumulated experiences and the innovated technical material resources surrounding them rather than wait for institutions (actors in the electricity industry) to create robust technical systems.

While the debates on infrastructure and urban resilience have concentrated on technical inventions and innovations and the capacities of institutions to provide quick responses, this chapter has shown that resilience is more than that. It has explored the infrastructure users' perceptions, attitudes, and understanding of the socio-technical contexts of how infrastructure operates in each urban context. The chapter maintains that studying people's resilience against power disruptions in the urban South needs to consider the wider technological landscape, as it unveils broader, complementary, and alternative measures that improve flexibility during breakdowns. It challenges the tendency of measuring resilience in the urban South by looking at the large, centralised networks not only because they have malfunctioned, but because they lack universality. Through the lens of the technological landscape as employed by Lindqvist and Bray, it is evident that electricity consumers in Dar es Salaam are socially and materially resourceful, skilful, and resilient despite their dependence on vulnerable power systems. Generally, the chapter upholds that the heterogeneity and the many-sidedness of the technological landscape (multiple energy sources, skills, practices, and experiences) has enabled electricity users in Dar es Salaam to innovatively minimise the impact of power outages.

[291] Bijker, Hommels and Mesman, "Studying Vulnerability in Technological Culture," 1 – 26.

CONCLUSION

VULNERABLE NETWORKS, USERS RESILIENCE, AND USABLE PAST

This dissertation investigated the socio-cultural history of electrical technologies in colonial British and postcolonial Dar es Salaam from 1920 to 2020. Its aim was to understand the socioeconomic, political, and technological factors that influenced the growth of electrical power networks and electricity usage in order to explain their perpetual breakdowns and people's responses by using the critical infrastructure concepts of vulnerability and resilience. In five substantive chapters, it has used Tanzania's electrical power infrastructure to detail and unpack the meanings and the applicability of vulnerability and resilience concepts in technological systems in the Global South in a historical perspective. The dissertation has covered a wide range of topics and themes in the history of technology, from system building (invention and innovation) and technology transfer to household technologies or what David Arnold calls 'everyday technology.' It has shown how electrical infrastructure grew from small firewood-driven plants at Kurasini in 1920 to a large technical system in 2020 covering almost the whole city, making almost all its inhabitants interact with or depend on power infrastructure in one way or another. The study has argued that, rather than being caused by the interconnectedness and interdependencies of infrastructures, power network vulnerabilities in Tanzania can be better understood only when defined in relation to historical, economic, and technological dependence on foreign capital and technologies which intensified in postcolonial times. It argues further that although electricity users since the late 1990became increasingly more dependent on electricity, they also became more resilient due to the innovative and adaptive strategies they developed to deal with grid failures. This study provides insights not only into how modern-day Tanzania's grid came into existence, how it operates, and how people have lived with constant disruptions, but also contributes to the history of technology and urban studies in the South on multiple levels.

I began this dissertation by questioning Daniel Headrick's 'tools of empire' perspective which maintains that Western technologies were imported and used in the colonies as a measure to elevate colonisers and subordinate the colonised majority.[1] I showed in Chapter 1 that although this perspective offers significant light in understanding infrastructure building in

[1] Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (Oxford: Oxford University Press, 1981).

colonial world, electricity provision in colonial Dar es Salaam was not simply an emblem of colonisers modernity and a tool of exploitation. But it was a new technology in a new context and environment that struggled to find its way to the existing colonial socio-economic and political landscape. The coming of electrical technologies to the streets and into people's homes was not completely a top-down process as the tools of empire idea assumes. But it was a complex and contested process in which the local environments and people played a vital role.[2] The Colonial Office in London and Colonial State in Tanganyika did not view electricity as they did other technical systems. Colonial officials considered electricity a non-profitable business that lacked direct benefits to colonial exploitation.[3] Therefore, whilst the building and everyday repair and maintenance of technical systems such as roads, harbours, telegraphs, railways, and water and sanitation were strictly funded by the public coffers, electrical power infrastructure was left to private entrepreneurs from 1931. This thesis does not entirely refute that colonial government used electricity for multiple colonial ends. But it insists that the tool of empire thesis is theoretically insufficient regarding electricity technologies in colonial Dar es Salaam.

To some scholars in the Global North, it is no longer state-of-the-art to criticise Headrick's tools of empire concept from four decades ago. While it is correct that Headrick' notion has received considerable analysis, application, and criticism, I find it still relevant to discuss especially in the context of emerging material culture, technology, and postcolonial histories in Africa. As I have shown in Chapter 1, many additional non-colonial, and non-racial factors such as economic (budget deficits, Africans' inability to pay electricity connection fees and monthly bills) and technological challenges (low generation capacity, small grid coverage, and colonial electrical power legal, safety and security measures) restricted the expansion of power grid to the colonised African premises. To remit our energy to only new and emerging theories and concepts will obscure many untapped issues in the continent's history of technology and material culture. To use David Edgerton's phrase, tools of empire is the "shock of the old" concept that can still enable us to better reposition this left-behind continent on the global map of history of technology and material culture. In other words, the teaching, learning, researching, and writing of African history of technology and material cultures requires

[2] Srinivasa Rao and John Lourdusamy, "Colonialism and the Development of Electricity: The Case of Madras Presidency, 1900 – 47," *Science, Technology, Society* 15 no.1 (2010): 27-54; Sunila S. Kale, "Structures of Power: Electrification in Colonial India," *Comparative Studies of South Asia, Africa, and the Middle East* 34, (2015): 455-58

[3] Jonas van der Straeten, *Capital Grids: A Global History of Electricity in East* Africa (New York: Palgrave Macmillan, forthcoming).

historians to not become obsessed by new emerging concepts but requires testing or applying both seemingly 'old' and 'new' theories. This will broaden the angle from which African material culture, skills, and knowledge can be captured – both local and foreign and colonial and postcolonial technologies. When carefully studied through the tools of empire lens, these socioeconomic and technical issues can unearth rich historical narratives of electricity technologies in Africa and of African material culture in the colonial context.

Although I did not intend to take Thomas Hughes' evolutionary model of 19th- and 20th-century Western electrification as my framework, I found it indispensable to engage with his work. The model assumes that after being invented and developed, electrical technologies are transferred to new environments where they are adapted, grow, and gain 'technological momentum'—they become large technical systems with millions of consumers, develop strong socio-technical and managerial structures, and potentially produce the experts and materials needed for daily operations of the networks.[4] I concur with scholars who have criticised Hughes' work, arguing that the growth of electrical power systems in colonial contexts was shaped by multiple local factors, and that the models does not fit since electrification in the colonies started with transfer of technologies rather than inventions.[5] Likewise, the evolution of Tanzanian power networks was not a replica of what Hughes described in London, Berlin, and Chicago. In fact, Tanzanian power networks never reached what Hughes calls 'technological momentum', that is the system's ability to attain economic and spatial expansion continuously. This requires electrical companies have the capacity to produce technologies, materials, equipment, and expertise needed for the day-to-day operation of the system.

What is indispensable in Hughes' model, particularly regarding the vulnerabilities of Tanzania's power systems, is the idea that growth from small, isolated networks to large technical systems involves a complex web of actors in the form of institutions, people, technologies, and material objects.[6] These aspects form what Hughes calls the internal and external environment in the development of large technical system (LTS). The technologies and expertise required for everyday operations of the Tanzanian power systems studied in this work were invented and manufactured in other countries and were transferred to TANESCO via

[4] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880 -1930* (Baltimore and London: The Johns Hopkins University Press, 1983).
[5] Rao and Lourdusamy, "Colonialism and the Development of Electricity,"; Van der Straeten, *Capital Girds;* Ronen Shamir, *Current Flow: The Electrification of Palestine,* (California: Stanford University Press, 2013).
[6] Hughes, *Networks of Power*.

complex networks of actors, such as donor countries, development cooperation agencies, manufacturers, and suppliers as well as Western electrical consulting companies under certain legal, economic, political, and technical restrictions. TANESCO failed to develop sufficient indigenous capacity in terms of the local manufacturing of vital components and the required technical skills, hence, they continued to depend on Western technologies and expertise for the everyday operation of the power networks.[7] Tanzania's power system lacks this technical independence which thus perpetuates vulnerabilities.

Urban infrastructure and technology scholars have already hinted about the connection between Western technological infrastructure models and vulnerabilities of critical infrastructure in Global South cities. For instance, in his study on water infrastructure in Kampala and Nairobi, historian of technology, David Nilsson, addresses a fundamental question as to why African actors such as governments, city managers and municipal companies have failed to derive solutions to failing infrastructure after decolonisation.[8] He highlights that technologies from developed countries are "signed, sealed, and delivered" to African environments to operate the way they do in the Western context, making them experience a kind of a "technological closure."[9] For him, infrastructure breakdowns (vulnerabilities) are rooted in the conservatism of postcolonial leaders. They continued to uphold high modernity ideologies of the 1960s and 1980s instead of innovating and adapting Western technologies and infrastructure models to fit the local contexts.[10] Jochen Monstadt and Sophie Schramm also noted the lack of adaptation of transferred Western technological infrastructure to the South. In what they call 'translation' of technological ideals, Monstadt and Schramm maintain that infrastructure ideals that operate in Global South cities were copied from the Global North cities and applied directly without being 'translated.' That is, they were not assessed, modified, and adapted to suit local environments.[11]

Truly, African leaders' failure to innovate and adapt Western technologies to local contexts can serve as our point of departure in understanding the vulnerabilities of

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[7] Mark J. Mwandosya, "Some Policy Aspects of Energy Development in Tanzania," in: SNA, SIDA no. F13O: 8. Proceedings of the Seminar on the National Energy Policy for Tanzania, (SEI; Stockholm, 1992).
[8] David Nilsson, "The Unseeing State: How Ideals of Modernity Have Undermined Innovation in Africa's Urban Water Systems," *N.T.M* 24, (2016): 481-510, 500.
[9] *Ibid.,* 488.
[10] *Ibid.,* 482-485.
[11] Jochen Monstadt and Sophie Schramm, "Towards the Networked City? Translating Technological Ideals and Planning Models in Water and Sanitation Systems in Dar es Salaam," *International Journal of Urban and Regional Research*, 41, no. 1 (2017): 104 – 125.

technological infrastructures in the Global South–the failed translation which hinders these systems from attaining 'technological momentum.' But the idea that African actors have failed to adapt Western technologies because of their obsession with high modernity ideologies even after more than fifty years of independence is one-sided and requires further investigation. This calls for the need for caution, as Walter Rodney, a prominent African scholar and revolutionary, contends, things which Western 'experts' and 'scholars' tend to consider as a source of African underdevelopment are the consequences of underdevelopment rather than its cause. Rodney continues by saying that Africa's lack of engineers and technically skilled personnel to build its own roads, bridges, and hydroelectric stations does not cause underdevelopment, but the problem rests on what Western actors, experts, technologies, and engineers do *to* and *in* Africa. For him, to find the real cause of Africans problems, one needs to look outside Africa rather than within.[12] The inability of TANESCO and Tanzanian institutions and actors to invent, innovate and adapt Western technologies to local environments was not due to high modernism only. It also was also due to global capitalist restrictions—the contested and negotiated techno-politics and economics of technology and technology transfer.

Power infrastructure vulnerabilities in the Global South need to be defined not in the conventional Western terms of interconnectedness and interdependence of technological systems only, but also in terms of the techno-politics and economics of technology transfer and financial and technological dependency that develop between donor and recipient states. In doing so, however, is not to paint Tanzania or the Global South as victims of Western technologies. It is also not to trace the transfer of Western technologies to the South, as Mavhunga warns, the "task of doing STS in non-western contexts need not be one of simply tracing the mobility of western artefacts and practitioners".[13] But it does take seriously how western technologies operate in the Global South's local socio-political, economic, and technological environments and their associated consequences. This is essential in grasping the vulnerabilities which Southern infrastructure systems face.

Mavhunga contends moreover that the history of technology transfer to the South does not only help us understand Western technical artefacts, expertise, or ideas, but it is a significant lens that "we cannot do without." It helps Africans to "better understand how the inbound

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[12] Walter Rodney, *How Europe Underdeveloped Africa*, (Baltimore: Black Classic Press, 1981), 21 – 22.
[13] Clapperton Chakanesta Mavhunga, *What Do Science, Technology, and Innovation Mean from Africa? (*Mass.: MIT Press, 2017), 4.

forces that complicate our lives operate, from where they derive their motivations, and the ends to which resources were extracted and freedoms and prosperities enjoyed at our expense are deployed."[14] Chapters 2 and 3 of this dissertation examined how Western electrical firms undertook all the required technical and economic feasibility studies, as well as the actual construction of electrical infrastructure. The electrical materials and equipment used also came from donor states. Hence, the technical and financial dependence rendered TANESCO incapable of performing repair and maintenance.[15] Repair and maintenance depended on Western expertise and technologies, which made networks more vulnerable by prolonged repair works and power shedding. Because power systems in Africa are largely imported technologies, the proper grasping of how they operate in Africa and the vulnerabilities they experience cannot be fully understood without examining how electrical technologies were transferred. As Mavhunga upholds, histories in the non-Western world which focus on technology transfer to the South can constructively enable us to identify the shortfalls and are "opportunities for us to come into the conversation" of science, technology and innovation "from a different optic."[16] Looking at how transferred technologies work in the South and their associated restrictions gives us another lens to understand Western technologies in the South and a new form of infrastructure vulnerabilities they create.

Technologies are not artefacts that are open to simple modification and readaptation to new environments. They are, rather, invented, manufactured, and exported to new lands to provide tangible national identities, prestige, recognition, and above all economic gains. Nathan Rosenberg's *Inside the Black Box: Technology and Economics,* blatantly maintains that technologies are economic assets in which nations invest hugely for profit making. To become fully profitable for manufacturers and users, inventors negotiate vigorously and subject technologies to economic and political scrutiny. As Rosenberg argues, one of the ways in which developers and manufacturers of technologies ensure huge profit is by transferring them in 'black boxes' to reduce the costs of regular innovation and cut down competition among developers and users.[17]

[14] *Ibid*., 7.
[15] For technology and technical dependence follow the discussion in Chapters 2 and 3 of this dissertation.
[16] Mavhunga, *What Do Science*, 7.
[17] Nathan Rosenberg, *Inside the Black Box: Technology and Economics,* (Cambridge: Cambridge University Press, 1982).

In postcolonial Tanzania, donor countries transferred technologies through foreign aid, and in so doing, they were directly or indirectly doing business.[18] But African leaders were fascinated with high modernity ideologies, economic and political environments of the 1960s and 1970s. They embraced imported technologies without adequate regulatory scrutiny and compromised the quality of technologies imported to the continent, like in the case of Great Ruaha Power Project, where Western experts imported and installed a hydropower turbine that was below technical specifications.[19] Moreover, African leaders also accepted and signed one-sided agreements that reserved "the right to build, operate, and maintain the manufacturing plants" to experts from Western multinational corporations (MNCs).[20] MNCs transferred 'hard' technologies to African countries while retaining control of their sophisticated components, meaning Africans lacked "technological autonomy', a situation whereby technologies operate in Africa but users have no legal authority or technical capacity to organise, modify, reproduce, manage, and control them.[21] Edward Beatty called this state of affairs a "gap between *adopting* new technologies and *assimilating* new knowledge and expertise."[22] Such economic and technological restrictions limited the development and growth of the indigenous technological capacity of their users, created financial and technological dependency, and perpetuated power system vulnerabilities in the South.

This dissertation is not about the vulnerabilities of large technical systems only. It is also about consumer resilience. As Mikael Hård and Andrew Jamison have argued, the history of science and technology needs new theorisation which goes beyond standard narratives of 'romance' and 'tragedy.' Historians must avoid writing histories that take extreme positions because the real world is complex and consists of both challenges and opportunities. They emphasise the need to explore the "ambiguous and diverse lifeworlds of technoscience" from different vantage points that recognise both risks and challenges, as well as appreciate the

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[18] Van der Straeten, *Capital Grids;* David A. McDonald, "Electric Capitalism: Conceptualising Electricity and Capital Accumulation in (South) Africa," in *Electric Capitalism: Recolonising Africa on the Power Grid*, ed. David A. McDonald, (New York: Routledge, 2008).

[19] Gussai Sheikheldin, *Liberation and Technology: Development possibilities in pursuing technological autonomy,* (Dar es Salaam: Mkuki na Nyota, 2018); Öhman, *Taming Exotic Beauties*, 321.

[20] David M. Haug, "The International Transfer of Technology: Lessons that East Europe Can Learn from the Failed Third World Experience," *Harvard Journal of Law and Technology* 5, (1992): 218.

[21] Sheikheldin, *Liberation and Technology*, 6. This idea corroborates Daniel R. Headrick position regarding the transfer of equipment and diffusion of knowledge in, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940*", (New York and Oxford; Oxford University Press, 1988), 9-11.

[22] Edward Beatty, *Technology and the Search of Progress in Modern Mexico* (California: University of California Press, 2015), 2.

innovations that help us to keep up with "the dangers that surround us."[23] Putting it in context, they call for the need to bring a balanced analysis that singles out not only the deficiency and vulnerabilities of transferred and diffused Western electrical technologies in the South and how they unfolded in the hands of foreign experts, generating power, prestige, domination, and wealth at the expense of Africans. We should also trace and analyse the agency of local Africans as thinkers, doers, and creators of the everyday technologies and environments on which their lives depend.[24] Such an analysis brings us closer to the question I asked in the Introduction of this dissertation; how can we apply or understand the resilience concept in connection with Global South electricity infrastructure? This question helps us also to reflect on Mavhunga's concerns when he asks: "Where are laughter, joy, happiness, creativity, means-making, **and resilience** in the African story? We have invested in showing how cruel others have been and forgotten **how resilient**, resourceful, and creative we have been in spite of it all" [bold mine].[25] In this assertation, Mavhunga perceives and insists that Africans are creative and innovative in daily grappling with various socioeconomic and technological challenges that surround them, and, thus, historians of technology should employ a proper lens in studying technology and peoples' practices in Africa.

Despite technology transfer challenges that made power networks vulnerable, the strategies employed by electricity consumers to compensate power failures in Dar es Salaam vividly proves that they are innovative and creators of their own domestic and urban spaces, which made them resilient in their *own* way. The broader technological landscape consists of rich, multi-layered lighting and energy technologies, local technical knowledge, experiences, and the skilled practices which electricity consumers use to cope with everyday power interruptions. Contrary to the traditional Western view of resilience (which defines it in relations to robustness and the ability of infrastructures to absorb, withstand, or bounce back to their original state after facing perturbations as well as strong institutional frameworks for prevention and preparedness to breakdowns and catastrophes), the case of Dar es Salaam redefines resilience as individualised bottom-up action bolstered by everyday consumer experiences, practices, and localised innovations, modifications, and tinkering. This endorses

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[23] Mikael Hård and Andrew Jamison, *Hubris and Hybrids: A Cultural History of Technology and Science*, (New York and London: Routledge, 2005), 7.
[24] Mavhunga, *What Do Science*, 7.
[25] *Ibid*., 5-6.

Thomas Campanella claim that the actual resilience in cities "comes down to people."[26] Therefore, one of the modifications in the concept of resilience which this thesis suggests is shifting the concept from institutional and technical capacities (nuts and bolts engineering) to lived everyday experience and practices.

When defined in terms of Global North's top-down institutional and technological capacities, resilience in Southern cities becomes myopic. First, utilities that provide various technological infrastructure in the South do not have huge financial investments for high technological inventions and innovations such as smart grids and smart cities. In African cities, residents are the ones who co-produce spaces in coping with infrastructure disruptions.[27] Paying greater attention to institutional and technical capacities, thus, reproduces vulnerability narratives and renders the residents' ingenuity and resilient practices invisible.[28] Second, the proper distinction between technical systems and people's practices in African cities is missing. As Abdou-Malique Simone reminds us, in African cities people are or function as infrastructures. The residents' everyday lives depend upon their ability to calibrate and engage in complex intersections with technical artefacts, practices, persons, and spaces. Such intersections create the socio-technical networks of alternatives, flexibilities, and improvisations on which societies draw. This means residents in cities are not social descriptors but technical materials to be articulated in numerous forms.[29]

Despite many decades of the provision of the so-called modern infrastructure systems such as water and sewage, railways, roads, telegraphs, and electricity, the lives of people in African cities have continued to depend on off-grid alternative ways to supplement existing LTS. For example, despite electrifying their homes, people still cook with charcoal and light their homes with candles, kerosene, and other off-grid electrical solar lights when the TANESCO grid

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[26] Thomas J. Campanella, "Urban Resilience and the Recovery of New Orleans," *Journal of the American Planning Association*, 72 no. 2, (2006): 141-146, 142.

[27] See, for instance, Sylvy Jaglin, "Regulating Service Delivery in Southern Cities: Rethinking Urban Heterogeneity", in Susan Parnell and Sophie Oldfield (eds), *The Routledge Handbook on Cities of the Global South,* (London & New York: Routledge, 2014), 434-447, 434; Sarah L. Smiley, "Heterogeneous Water Provision in Dar es Salaam: The Role of Networked Infrastructures and Alternative Systems in Informal Areas," *Environment and Planning E: Nature and Space* 3 no. 4 (2020): 1215–1231; Kathryn Furlong, "STS Beyond the "Modern Infrastructure Ideal": Extending Theory by Engaging with Infrastructure Challenges in the South," *Technology in Society* 38 (2014): 139-147; Monstadt and Schramm, "Toward The Networked City?," 104–125; Colin McFarlane, "Infrastructure, Interruption, and Inequality: Urban Life in the Global South", in *Disrupted Cities: When Infrastructure Fails*, ed. Stephen Graham, New York and London: Routledge, 2010), 131-146.

[28] Andreas Huck and Jochen Monstadt, "Urban and Infrastructure Resilience: Diverging Concepts and the Need for Cross-boundary Learning", *Environmental Science and Policy* 100, (2019): 2011-220, 214.

[29] Abdou-Maliq Simone, "People as Infrastructure: Intersecting Fragments in Johannesburg," *Public Culture* 24, (2004): 407-429.

is down. They also recharge their mobile phones in kiosks or at neighbours who possess backups. Residents in Dar es Salaam can still obtain different electrical end services in the absence of TANESCO electricity, as shown in Chapter 5. Users are also knowledgeable about the vulnerability of the TANESCO system and the alternatives that surround them as electricity users. Such knowledge guides their daily decisions, actions, and practices. Grasping resilience in these cities, therefore, requires transcending Western standard notions of resilience to seriously consider local peoples' meanings, knowledge, and practices. Resilience should be defined in terms of how societies communicate, transport, travel, transact, prepare meals, wash, produce, and so forth, at times of breakdowns rather than how technical systems do not fail (how reliable the networks are) or how institutions are prepared to address failures.

The bottom-up approach to resilience which this study proposes not only helps to escape the direct application of derived Western concepts to Global South contexts as Mavhunga has cautioned against, but also modifies the conventional canon on which urban studies have viewed cities, infrastructure, and people in this part of the globe. For so long, African urban scholars have privileged Global North cities and treated Southern cities as "sites of underdevelopment", disrepair, deficiency, non-resilience and vulnerability that exist "on the margins of the map of global capitalism".[30] Among the reasons for this characterisation is that scholars employed Western theories, concepts, and methodologies without taking local contexts into account. That is, they failed to examine how inhabitants managed and calibrated survival measures which bolstered their lives against weak and vulnerable infrastructures. As Bijker and others uphold, scholars and actors should not view vulnerabilities always in a catastrophic light because "people living in cities that are vulnerable to frequent power failures have developed flexible ways of coping with such electricity shutdowns."[31] The existing infrastructure inadequacies, as David Serlin argues, have forced Africans to innovate different alternatives to bolster their everyday lives and the resilience of Africans needs to be contextualised along with the scarcities (vulnerabilities) that surround them.[32] In a similar vein,

[30] See, for instance, Roy Ananya, "Worlding the South: Towards a Postcolonial Urban Theory," in *The Routledge Handbook on Cities of the Global South,* (eds) Susan Parnell and Sophie Oldfield (London and New York: Routledge, 2014), 9-21, 13; Garth Myers, "Why Africa's Cities Matter," *African Geographical Review* 30 no.1, (2011): 101-106; see also, Garth Myers, *African Cities: Alternative Visions of Urban Theory and Practice*, (London: Zed Books, 2011).
[31] Wiebe Bijker, Anique Hommels, and Jessica Mesman, "Studying Vulnerability in Technological Cultures," in *Vulnerability in Technological Cultures: New Directions in Research and Governance*, (eds) Anique Hommels, Jessica Mesman, and Wiebe Bijker (Cambridge, Mass., and London: MIT Press, 2014), 1-2.
[32] David Serlin, "Confronting African Histories of Technology: A Conversation with Keith Breckenridge and Gabrielle Hecht," *Rethinking Postcolonial Science and Technology: Radial History Review* 127, (2017): 87-102, 97.

the case of Dar es Salaam unveils that the frequent disruptions of the TANESCO grid are not equal to consumer vulnerabilities. But the interruptions and their consequences have compelled consumers to develop preparedness measures, which, in turn, broadened their adaptive capacity and resilience.

Historians of technology have recently shown that research findings are not only essential to understanding our past but also useful to our future technology usage. In what they call *usable past*, historians of technology contend that the history of technology has potential to respond or contribute to debates on current societal issues and future technology use options.[33] Timothy Moss, for instance, upholds that although its illogical to think how historians looking at the past can help or broaden our view of the future, history of technology can perfectly do that because it is closely associated with innovation, progress and the future, and it can serve to contextualise technological futures in time.[34] But as Marcus Popplow aptly noted, despite the usefulness of historical knowledge to the present and future societal technology use, there is substantial deficit of historical knowledge among policy and decision makers and in the public discourse.[35] Thus, while writing a *usable* history of electrical power technology was not envisioned from the beginning of this study, it was clear at the end that a critical reflection on the findings of this study can contribute to the notion of *usable past*. For instance, the last decade was characterised by confusion among Tanzanian energy policy makers on suitable future energy technology or energy transitions. The major concern was whether large hydropower technologies were the best technology for the country's future electricity generation.

This study opens new paths to further inquiries into Tanzania's historical pasts and futures of electrical technologies, which if understood and employed by policy makers and practitioners, might be helpful to the future of Tanzanian energy technologies. The review of energy policies, power infrastructure planning, building contracts, and construction reports made the history of Tanzania's grid (its success and limitations) become so clear. It seeks to suggest that Tanzanian system builders can learn from previous limitations of large hydropower dams. Overreliance on large hydropower technology limits the attainment of resilient systems.

[33] See, for instance, Timothy Moss und Heike Weber, "*Einleitung: Technik- und Umweltgeschichte als Usable Pasts. Potenziale und Risiken einer angewandten Geschichtswissenschaft*", *Technikgeschichte* 88, no. 4 (2022): 367-378.
[34] Timothy Moss, "*Technikgeschichte für heute: Formate der Vermittlung*", *Technikgeschichte* 88, no. 4 (2022): 385-390, 385.
[35] Marcus Popplow, "*Technikgeschichte in Zukunftsdebatten. Zur Brückenfunktion historischer Technikzukünfte*", *Technikgeschichte* 88, vol.4 (2022): 408-414, 411.

By learning from the vulnerabilities that face old hydropower dams, Tanzania has looked to diversify its energy technologies by shifting to and prioritising natural gas, followed by coal, water and then renewable sources when compared to the priorities given to hydropower technologies in the 1960s to 2000s. But as I hinted in the Introduction to this dissertation, in 2017, Tanzania revived its Stiegler's project to generate 2115 megawatts to increase the capacity of the grid and reduce frequent power outages.

The ongoing construction of the Nyerere dam reveals greater parallels and legacies of the high modernity development discourse in the building of the Kidatu and Mtera dams witnessed in the 1970s and 1980s. Like the previous hydropower dams in postcolonial Tanzania and sub-Saharan Africa, builders overlooked serious ecological and technical issues. As the recent report by Tanzania's Controller and Auditor General (CAG) unveiled in 2021, TANESCO failed to review the economic and technical feasibility of the project and it built the dam based on the feasibility studies produced by Norwegian companies in the 1970s and 1980s. The building started without sufficient recent technical, economic, and ecological data.[36] The critics of the dam have also mentioned that the bidding and tendering process of the Egyptian companies Elsewedy Electric Co. (consultant) and Arab Contractors (contractor) was highly politicised and hastily done without internationally accepted procedures. The consultant and contractor are incompetent for large hydropower dams, let alone a mega-dam, but they were selected under an ambitious state project which crushed and disregarded opposing views.[37]

The scheme's planned completion date is 2022. But some critical design and financial problems have already started to emerge that will make the project take nine years to complete instead of the previously estimated four years, as well as a cost overrun of 10 billion US dollars instead of 3.6 billion US dollars estimated during the beginning of the project.[38] Like how the major power dam building actors disregarded local and foreign experts whose views opposed the implementation of various power schemes in the 1960s and 1980s, ignoring opposing views is still going on regarding mega hydropower projects in Tanzania and beyond. In the Stiegler's Gorge case, those who opposed its construction were not simply ignored but had to be jailed

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[36] Elias Msuya, "Julius Nyerere Hydroelectric Power Project using 1970 Feasibility Study," *The Citizen*, 8 April 2021. Available at:<https://www.thecitizen.co.tz/tanzania/news/national/julius-nyerere-hydroelectric-power-project-using-1970-feasibility-study-3354208 >(20.04.2022).

[37] Barnaby Joseph Dye, "Unpacking Authoritarian Governance in Electricity Policy: Understanding Progress, Inconsistency and Stagnation in Tanzania," *Energy Research & Social Science* 80 (2021): 9.

[38] George Obulutsa, "Tanzania Hydropower Dam to Cost More than Double Government estimate-study," *Reuters*, 14.02.2019. <https://www.reuters.com/article/us-tanzania-dam-idUSKCN1Q324G> (15.05.2022).

under huge resource nationalism, modernism, and state interests.[39] Moreover, Tanzania's plans to build large hydropower dams at Rumakali and Ruhuji under the World Bank's initiatives for "Sustainable Energy for All" are underway.[40] But the extent to which these large power projects will be successful surely depends on how decision makers will truly learn from and correct past successes and failures, as expounded in the pages of this thesis.

Experience from the past reveals that technological limitations such as the lack of spare parts and in-country repair and maintenance personnel caused by the incomplete transfer of technology and knowledge during the infrastructure planning and construction phase were among the major sources of power network vulnerabilities. In the 1960s – 1980s, postcolonial governments in Africa struggled to make power supply reliable by building large hydropower dams, which in turn became the source of grid vulnerabilities due to overdependency on Western technologies, funding, and expertise. TANESCO and other global South utilities and their governments require intense scrutiny and the proprietorship of the technologies they use in electricity generation, transmission, and supply. Tanzanian decision makers can learn that the reliability (resilience) of the system does not only depend on its capacity to generate or how huge generation is but on the availability of technologies and skilled personnel to watch over the day-to-day operation of the system. This is the major understanding of vulnerability of power networks this dissertation expounds. This understanding is significant specifically now, the time in which Global South countries are currently exploring new initiatives (resilience measures) to expand electrical power technologies by adopting Western smart technologies including wind and solar power. They can learn that they need to first address the previous limitations to full transfer of technology. This is indeed one *usable past* which Global South governments and electricity providers can benefit from this study. This makes this study not about the accounts of the past historical events that have shaped the present power networks only, but it is also useful for future electrical technology use in Tanzania. As Popplow emphasises, this is *public history*—a history that offers *public* knowledge and alternatives about present and future technology use.[41]

[39] A. Masara, "Anyone Against Stiegler's Gorge Project will be Jailed, says Minister," *The Citizen*, 22.05.2018. <https://www.thecitizen.co.tz/News/Anyone-against-Stiegler-s-Gorge-project-w/1840340-4575212-12u8n4f/index.html> (20.05.2022).
[40] Barnaby, "Unpacking Authoritarian", 8.
[41] Popplow, "Technikgeschichte in Zukunftsdebatten," 411.

Lastly, Kathryn Furlong in "STS beyond the 'modern infrastructure ideal'" argues that science and technology studies (STS) approaches to cities and networked infrastructures have failed to reflect on the diversities which exist in the Global South because they are derived from the circumstances and experiences in the North. She proposes that Global South infrastructures need their own theorisation connected to their local contexts beyond the Western modern infrastructure standard.[42] In this regard, Furlong corroborates Mavhunga's proposition that scholars who study Global South societies and technologies need to come up with new theories and perspectives which are not derived from the North but which suit realities in the South.[43] Indeed, the case of TANESCO's networks examined in this thesis offers an opportunity on how vulnerabilities and resilience of critical infrastructure in the South can be theorised or understood. The Western perspective that the interconnectedness of systems makes them vulnerable is insufficient in analysing the vulnerabilities of infrastructures in the South. Therefore, this study proposes that a better understanding of Global South infrastructure requires going beyond the interconnectedness narratives to seriously engage with the way technical artefacts, skills, and knowledge required in maintaining system resilience are circulated between North and South. Regarding resilience, this thesis maintains that the history of technology and critical infrastructure resilience studies should take the material components that residents in the Southern cities use to meet different electricity end-use services, such as cooking, lighting, cooling, communicating, and entertaining domestic and urban spaces rather than concentrate on networked infrastructures and the ways they operate. The study on how the co-existence of grid and off-grid technologies influence the social and material culture is crucial not only in understanding the socio-cultural resilience of electricity users but also the growing history of technology and material culture research in the South.

[42] Furlong, "STS Beyond the "Modern Infrastructure Ideal," 140.
[43] Mavhunga, *What do Science*, 1 – 15.

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18.	"Kidatu project will take electricity to villages"	*Daily News*	19 Sept. 1973
19.	"Kuna nini TANESCO?"	*Majira*,	14 *Nov*. 2005
20.	"LUKU Drama: Long queues as hundreds struggle to purchase electricity"	*The Citizen*,	19 May 2021
21.	"Matumizi ya nishati inayofaa yahimizwa"	*Uhuru*,	26 Jan. 1990
22.	"Mgao wa Umeme kwa Ilala"	*Majira*	21 Oct. 2005
23.	"Mtera Dam drying, farming and other activities in jeopardy"	*Daily News*	22 Aug. 1992
24.	"Mtera, Kidatu water level at the lowest"	*Daily News*	28 Nov. 1994
25.	"Mtikila aisusia TANESCO televisheni: Kisa? Adai uzembe wao umeifanya iungue"	*Alasiri*	28 Nov. 1997

26.	"Mwalimu Kufungua Mpango wa Kidatu Nov. 14"	*Uhuru*	30 Okt. 1975
27.	"Pangani Project to double power output"	*Daily News*	*11 May* 1993
28.	"Power for the Nation: Electricity Helps Industrialisation"	The Nationalist	26 Sept. 1966
29.	"Power may be back to normal today"	*Daily News*	19 Jan. 1994
30.	"Power rationing disturbing us"	*Sunday News*	24 Dec. 2000
31.	"Power Rationing: Commodity prices hike"	*Daily News*	18 Oct. 1998
32.	"Power Supply in Tanga to improve"	*Daily News*	10 Aug. 1992
33.	"Power supply to be centralised"	*Daily News*	25 Oct. 1974
34.	"Ruaha Project Blasts Off"	*Sunday News*	24 Nov. 1971
35.	"Sabotage: source of power outages"	*Sunday News*,	15 June 1987.
36.	"Second Kidatu power line construction ready"	*Daily News*,	29 Mar. 1993.
37.	"Seminar attacks TANESCO"	*Daily News*,	12 Sept. 1990.
38.	"TANESCO asks for more aid from Japan"	*Daily News*,	10 April 1991.
39.	"TANESCO assures people of power"	*Daily News*,	15 Jan. 1994.
40.	"TANESCO assures smooth power supply"	*Daily News*,	28 Oct. 2000.
41.	"TANESCO efforts frustrated"	*Daily News*,	15 Aug. 1990.
42.	"TANESCO Great Ruaha Power Project"	*The Nationalist*,	*19 Nov. 1971.*
43.	"TANESCO ichukue hatua"	*Uhuru*,	26 Jan. 1990
44.	"TANESCO kuweni wazi"	*Majira*,	29 Jan. 2000.
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46.	"TANESCO Power Rationing Schedule for Dar es Salaam and Coast Regions"	*Daily News*	10 Sept. 1992
47.	"TANESCO Preparing Dar es Salaam for Hydro-Electric Power"	*TanganyikaStandard*	12 Mar. 1963
48.	"TANESCO Pylon"	*Daily News*	21 Jan. 1994.
49.	"TANESCO seeks Japanese aid"	*Daily News*	10 Aug. 1990.
50.	"TANESCO to lift rationing"	*Sunday News*,	7 Nov. 1993.
51.	"TANESCO: Brief History"	*The Nationalist*,	26 Sept. 1966
52.	"U.K. Loan to Help Build New Dam"	*Tanganyika Standard*	26 Oct. 1963
53.	"Work on Kidatu, Dar Power line starts"	*Daily News*	7 Nov. 1973
54.	"Work starts on £1 m. dam project"	*E. A. Standard*	14 ept. 1964

4. Interviews

Interview No.	Date (s)	Interviewee (s)	Place of Interview	Gender	Age	Occupation	Nickname
Interv. 1	31.07.2018	1	Survey-Mwenge	M	60	Former journalist	Litijo
Interv. 2	09.08.2018	1	Ubungo	M	58	Engineer	Johnes
Interv. 3	10.08.2018	1	Kimara	F	49	Engineer	Magdala
Interv. 4	13,26.08.2018	1	Ubungo - TANESCO	M	46	Engineer	Jose Jose
Interv. 5	19,20.8.2018	1	Kinondoni	M	73	Shopkeeper	Rolf B.
Interv. 6	15.08.2018	1	Ubungo - TANESCO	M	51	Engineer	Piere
Interv. 7	28.07.2018	1	Kwembe	F	76	Small entrepreneur	*Ma* Njeteni
Interv. 8	01.08.2018	1	Ubungo	F	85	No occupation	Babu Jose
Interv. 9	06.08.2018	1	Tabata	F	90	No occupation	*Bibi* Tabata

Interv. 10	07.08.2018	1	Ilala	M	86	Local gov. leader	Alhaji
Interv. 11	08.08.2018	1	Mbezi-Beach	M	88	A retired gov. worker	Mbezi Juu
Interv. 12	10.08.2018	1	Mwenge	M	52	Repairman or Fundi	Fundi1
Interv. 13	14.08.2018	1	Mwenge	M	59	Repairman or Fundi	Fundi2
Interv. 14	18.08.2018	1	Kimara/TANESCO	F	51	Engineer	Mabundala
Interv. 15	20.08.2018	1	Ubungo	F	50	Tailor/small business	Maria
Interv. 16	21.08.2018	1	Kariakoo	M	64	Businessman	Abubakar
Interv. 17	22.08.2018	1	Ubungo-Kimara	F	78	Retired technician	Domina
Interv. 18	24.08.2018	1	Manzese	M	50	Restaurant owner	Mparee
Interv. 19	24.08.2018	1	Ubungo-Msewe	F	50	Tailor	Mishono
Interv. 20	24.08.2018	1	Msewe-Golani	M	54	A welder	Mchomeaji
Interv. 21	25.08.2018	1	Magomeni	M	60	Small business dealer	Kiondo
Interv. 22	25.08.2018	1	Tabata	M	86	Retired gov. worker	Maghembe
Interv. 23	28.08.2018	1	Tabata	F	52	Tailor/entepreneur	Mshonaji
Interv. 24	28.08.2018	1	Tabata	M	53	Repairman or Fundi	Fundi3
Interv. 25	13.09.2018	1	Ilala-Majengo	F	58	Typist	Mkutubi
Interv. 26	10.10.2018	1	Mbezi-Beach	M	70	Retired mil. officer	Kamanda
Interv. 27	22.08.2018	1	Magomeni	M	57	Repairman or Fundi	Fundi4
Interv. 28	12.10.2018	1	Kimara	M	72	Small business	Mzee Jongo
Interv. 29	11.08.2018	1	Magomeni	F	52	Small business	Ma Genge
Interv. 30	25.08.2018	1	Ubungo-Msewe	F	55	Charc./food vendor	Wakitaa H.

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