Energy dependency, the potential supply of renewable energies and the political responses in Turkey in the decades since the oil-crisis

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ABSTRACT

The transition to post-fossil future and widespread utilization of renewable energy technologies have become inevitable across the globe, not only due to limited amount of fossil energy sources, but also the impacts of human-dominated activities on the planet Earth. Turkey, is one of the countries, having scant amount of fossil energy, but rich in various renewable sources with the sufficient capacity to contribute Turkey's primary energy goals; such as diminishing energy dependency, increasing supply security and diversification of energy sources. Nevertheless, the country is still highly dependent on natural gas and crude-oil imports to meet its growing energy hunger as a result of economic and demographic expansion as well as the insufficient implementation of the energy efficiency technologies. The rising energy imports and therewith the current account deficit put a big burden on country's vulnerable economy. Turkish government plans to raise the share of renewable energy sources in electricity production to at least 30% by 2023. The calculations show that geothermal power and biomass-based energy production will achieve the 2023 targets, while solar energy installations remain insufficient in number. Wind- and hydropower with their high potential and adequate number of proposed facilities will contribute to the total electricity generation in considerable amount. The public awareness and social acceptance of utilization renewable energy plants have positive impacts to the gradual development of these plants.

PREFACE

The thesis „Energy dependency, the potential supply of renewable energies and the political responses in Turkey in the decades since the oil-crisis" is made up as a completion of the doctoral studies in political science between 2012-2018. The research interest in the field of Energy Politics of Turkey has initially emerged during my master studies in Turkey and Germany. After my graduation in Master of Arts in European Studies in the field of Turkey and the European Union Energy Politics, I decided to put more emphasis on the role and potential of renewable energies for diminishing the external energy dependency of Turkey, and herewith started my doctoral studies. With its unique geographical situation and abundant amount of renewable energy sources, Turkey has a very special geostrategic position between East and West. Therefore, energy plays a major role for the country in accomplishing its foreign policy goals. From the time I started my research until I finished it, no major changes have been taken place in country's energy policy goals and strategies. The country is still highly dependent on fossil fuel energy sources, ultimately energy imports, and has scant capacity of using its renewable energy sources such as wind, hydro, geothermal and biomass. In its foreign policy, there had been significant changes, which dramatically influenced country's relationships with its neighbour countries as well as its energy cooperation and pipeline agreements. Not only externally, the country experience significant internal political challenges and serious economic instabilities. During these vicissitudes concerning internal and external affairs of Turkey, analysing their impacts on country's energy policy have been interesting as well as quite challenging.

In this context, it would have not been possible to write this thesis without the guidance and invaluable contributions of my previous advisor Prof. Dr. Elmar Altvater. I feel indebted for his generosity in sharing his time, as well as his continued support and patience in each stage of my thesis.

Furthermore, I am very thankful to my current advisor, Prof. Dr. Michèle Knodt, for her gracious support and time, her supervision and to review my thesis.

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LIST OF ABBREVIATIONS

AKP	Justice and Development Party
ARI	Resources International, Inc.
bbpd	billion barrels per day
bcm	billion cubic meters
bmt	billion metric tons
bmp	biochemical methane potential
bob	billion of barrels
BOTAS	Petroleum Pipeline Corporation
BTC	Baku-Tbilisi-Ceyhan Crude Oil Pipeline
°C	Degree Celsius
CED	Environmental Impact Assessment
CHP	Combined Heat and Power
CO_2	Carbon-dioxide
EIA	U.S. Energy Information Administration
ENTSO-E	European Network of Transmission System Operators for Electricity
EPDK	Energy Market Regulatory Authority
ERoEI	Energy Return on Energy Investment
EU	European Union
EÜAS	Turkish Electricity Generation Company
GAP	South-eastern Anatolian Project
GDP	Gross Domestic Product
gt	gigatons
GW	Gigawatts
h	hectare
IS	Islamic State
km	kilometre
km^2	square kilometre
kV	kilovolt
kwh	kilowatt-hour
LNG	Liquefied Natural Gas
m	meter
mcum	million cubic meters

MENR	Republic of Turkey Ministry of Energy and Natural Resources
MFA	Republic of Turkey Ministry of Foreign Affairs
mmt	methylcyclopentadienyl manganese tricarbonyl
MTA	Mineral Research and Exploration of Turkey
mtoe	million tons of oil equivalent
MVA	Mega Volt Amp
MW	Megawatt
OECD	Organization for Economic Co-operation and Development
PKK	Kurdistan Workers' Party
RMP	Realistic Methane Potential
TEIAS	Turkish Electricity Transmission Company
TETAS	Turkish Electricity Contracting and Trading Company
tcm	trillion cubic meters
tones	t
TWEA	Turkish Wind Energy Association
twh	terawatt-hour
U.S.A.	The United States of America

1. INTRODUCTION

1.1. Research framework

Despite the vast quantities of energy coming from the Sun, humans have always been compelled to explore other sources. As Elmar Altvater stated, "*in terms of energy supply, we help ourselves to the solar energy stored in fossilized form in coal seams, reservoirs of natural gas, instead of using the endless flow of beams from the sun*." (Altvater, 2014). In today's world, our ability to access these energy sources shapes the way we communicate, live and travel. The relationship between humans and energy is getting stronger, and therefore, the issues; namely, cost, sustainability and reliability of sources, become universal. In many regions and provinces across the world, communities have limited or no access to reliable and secure energy supplies. This lack of access to modern energy sources hinders socio-economic development; which is a major part of sustainable development.

The predictions tell us that the Earth does not have unlimited amounts of those resources, which are essential for the life span of human beings and other living creatures. Defining the boundaries of the Earth, to act as a proverbial guardrail and keep us from going over the edge, is essential in order to avoid disastrous outcomes for humanity. These *planetary boundaries* will neither hinder growth and development nor slow down the progress of drivers. They are there to prevent a catastrophe (Rockström, et al., 2015 S. 59). We can no longer exploit minerals, fish, living species, freshwater, land, oil, coal and natural, without threatening the survival of life of the Planet Earth. In 'Dialectics of Nature' Friedrich Engels argues that the power of nature conquers every living creature and that we, the human beings, as a part of nature, will never "win" or rule over it:

> "*Let us not, however, flatter ourselves overmuch on account of our human victories over nature. For each such triumph, nature takes its revenge on us. Thus at every step we are reminded that we by no means rule over nature like a conqueror over a foreign people, like someone standing outside nature — but that we, with flesh, blood, and brain, belong to nature, and exist in its midst, and that all our mastery of it consists in the fact that we have the advantage over all other beings of being able to learn its laws and apply them correctly*" (eds. Cohen et. al., 2010).

We no longer need to question whether ecological and social catastrophes are approaching, as we are already experiencing this change in various facets of life. Instead, the question is to ask how strong they will be (Rockström, et al., 2015). We are missing a developmental framework that simultaneously respects the true functioning of Earth's climatic, geophysical, atmospheric and ecological processes. As it is propounded by Henri Lefebvre, a famous French Marxist philosopher and sociologist: the (physical) natural space is disappearing. While there is a universal wish to protect and save nature; nobody is willing to allow nature to retrieve its authenticity (Lefebvre, et al., 1991) and, in the meantime, the Earth is becoming hotter than was ever before experienced by humans. James Lovelock, an influential scientist and creator of Gaia theory, considers that "*the planet Earth has reached a state now that it is profoundly dangerous to us and our civilization*." (Lovelock, 2005). Lovelock argues that the governments across the globe are already too late to apply green and sustainable concepts, such as the development of environmentally friendly energy technologies and utilization of renewable energies. Therefore, in order to meet the rapidly growing global energy need, Lovelock perceives only the only reasonable, secure and reliable alternative is nuclear energy (Lovelock, 2005). The question that remains is: what can be done to maintain the Holocene-like conditions on the Planet Earth when we are already living in Anthropocene?

Today, with the Anthropocene era in which we are living, the "man-made fingerprint of global warming" is not the only problem; every major ecosystem in the planet is in decline. Up until now, Earth has managed to absorb disturbances, hiding away 90% of the heat from greenhouse gas emissions in the ocean, and soaking up more than 50% of our CO_2 emissions in natural ecosystems. So long as nature is in good shape, the Earth's resilience is high, however, as Earth's resilience declines, the critical systems are likely to cross thresholds which change the Earth from friend to foe (Rockström, et al., 2015). With this in mind, humans need to respect *planetary boundaries*; a term which was coined by Johan Rockström and his colleagues in 2009 and updated in 2014. The assessment shows that there are nine planetary boundaries: 1) Climate change, 2) Stratospheric ozone depletion, 3) Rate of biodiversity loss, 4) Chemical pollution, 5) Ocean acidification, 6) Freshwater consumption, 7) Land-use change, 8) Nitrogen and phosphorus pollution and 9) Air pollution or aerosol loading

These planetary boundaries can be divided into three groups relative to their volume of risk: The first group includes processes with sharply defined thresholds, such as the risk of melting in the Greenland and Antarctic ice sheets; namely, climate change, stratospheric ozone depletion and ocean acidification (Rockström, et al., 2015 S. 69). The second group includes boundaries based on slow planetary variables that contribute to the underlying resilience of the Earth. These “slow boundaries” are land-use change, freshwater use, biodiversity loss and nitrogen and phosphorus pollution (Rockström, et al., 2015 S. 69). The third group of boundaries consists of two human-made threats: air pollution/aerosol loading and chemical pollutions, such as heavy metals and organic pollutants (Rockström, et al., 2015 S. 69).

The man-made, ecological degradation we are facing is not only threatening us, but all living creatures existing within the ecosystem. Foster (Foster, 2009) emphasizes the significance of harmony by highlighting Marx’s “metabolic rift” theory between nature and society, which uses the example of the 19th century soil crisis. Marx clarified the fact that "*soil nutrients (nitrogen, phosphorus, and potassium) were removed from the land and shipped hundreds and thousands of miles to the cities where they ended up polluting the water and the air and contributing to the poor health of the workers*" (Foster, 2009 S. 49). According to Marx, this symbolised a rip in the metabolic cycle between nature and society, which must be "restored" for the continuity of "successive generations". Which, he argued, would only be possible by creating a harmony between nature and society. This raises the issue of ‘ecological sustainability’, not only in relation to the scale of the economy, but also in the form and intensity of the interaction between nature and society under capitalism (Foster, 2009 S. 49).

In reference to these challenges, my thesis utilises Turkey as a case country. Current studies in sustainability and the environment show that Turkish social and business cultures have traditionally possessed a harmony in working with environmental awareness. However, the lack of future orientation, a paternalist way of management and the survival concerns of the individuals and businesses cause a certain lack of environmental initiative (Cakar, et al., 2014). In addition, the country is geographically situated between fossil-energy-poor European and fossil-energy-rich Middle-Eastern and Caspian regions and therefore plays a significant role, as a natural energy hub particularly for the EU energy markets. Except for coal, Turkey itself is deficient in domestic fossil energy sources. The country requires high amounts of fossil fuel imports to meet its domestic energy demands, which are delivered through crude oil and natural gas pipelines. This high dependency on fossil imports decreases the capacity for energy supply security and the possibility to diversify energy sources or manoeuvre between various energy supply options. In the past few decades these issues have substantially increased the country's debt, which burdens Turkey's already fragile and volatile economy.

In Turkey, the industrial sector is the major energy consumer contributing 3.1% (or 30.9 mtoe) of the total energy consumption in 2014 and representing the primary reason for the country's growing demand for energy. The energy use of the industry sector has increased by 20.3% since 2004, followed by the transport sector with 24% (or 20.6 mtoe). Additionally, households contribute 22.3% (or 19.1 mtoe) and commercial and public services (including agriculture) account for 17.6% (or 15.1 mtoe) of the total energy consumption (IEA 2016). While the energy demand in households has shown a slight increase of 5.8% since 2004, the demand in the commercial sector grew by the extreme amount of 105.4%, more than in any other sector (IEA 2016). In order to meet this rising energy demand in various sectors, Turkey is in urgent need of implementing sustainable and efficient energy policies, which aim at substantial elimination of fossil energy usage, diversification of energy sources and routes towards the wider utilisation of renewable energy sources.

In the global energy market, the cost of energy is an important factor for a country to exist and act competitively. Due to the high prices attached to energy, the competitive power of Turkey in a global context remains weak. It is therefore fundamental for Turkey to redefine its energy policies and reshape its energy strategy in order to be more competitive in the global market.

Since the Justice and Development Party (AKP) came into force in 2002, Turkey has been following a multi-dimensional energy strategy, which has integrated the following energy goals: 1) the diversification of energy supply sources and routes, 2) the contribution to domestic and European energy security by acting as a reliable energy hub, and 3) an increase of renewables in country's total energy production. Predictions show that the potential of renewable sources in Turkey, including hydro, wind, solar, geothermal and biomass, are sufficient to establish Turkey as an energy-independent country. The substantial increase of renewable energy sources in the total energy mix would also contribute to the sustainable development of Turkey, by decreasing its energy dependency on natural gas and crude oil imports.

1.2. Hypothesis

Civilisation has witnessed many disasters caused by man-made interference with the natural foundations of life and the subsequent destabilization of the earth's climate. Regardless of the era of human development, society has always required energy to live, to be nourished, to cook, to heat and to work. In light of this background, we may trichotomize those past, current and upcoming eras which world energy has, does and will face, in correlation with Marx's classifications of the development of humanity and production: Pre-fossil-, fossil- and the post-fossil energy eras (Altvater, 2014). The emergence of energy eras and the transformation to new energy regimes cause not only vicissitude in the interaction of human being with nature and climate, but also reveal economic and political novelties between the actors in global sense. As Turkey has only negligible amount of fossil resources, the transition from pre-fossil to a fossil energy regime in response to the economic expansion and population growth, has engendered external energy dependency .

In the pre-fossil or pre-industrial era, humans and their activities have not played a major force in the dynamics of the Earth System. In this period, the energy resources came primarily in the form of human and animal muscle as well as biomass. The population growth and the limited land availability, combined with restrictions upon further expansion and economic growth, dictated a transition towards a fossil energy regime. The transformation from pre-fossil to fossil era was not solely an energy transformation, but also an economic and societal change. The energy transition from pre-fossil to fossil era accelerated after the collapse of the Ottoman Empire and the foundation of new Republic in Turkey, in parallel to industrialisation efforts, demographical and economic growth. As Turkey's economic growth model is import rather than export-oriented, the energy transition from pre-fossil to fossil era caused a substantial increase in Turkey's energy dependency and long-lasting budget deficit. In light of this, Turkey should not construct a fossil fuel future for its energy policy. Rather, Turkey needs to realise its energy transition to a post-fossil energy regime. On the one hand the country possesses a sufficient amount of renewable energy sources and on the other hand, there is also a commitment to reduce the amount of energy consumed per unit gross domestic product (GDP) by the year 2023, by at least 20% (regarding energy intensity) compared to 2011 (MENR, 2015). It is therefore important to evaluate each energy era in order to better understand the current situation and challenges Turkey is faced with, while also demonstrating the future prospects of the country's energy potential.

Today, as we are still living in a fossil era, the Earth is very much dominated by human activities. Responsibility lies with a rising energy demand resulting from the rapid increase in population, the positive demographic trends and industrialisation in the 20th century. According to the projections of the United States Energy Information Administration's (EIA) *International Energy Outlook 2016* report, the world energy consumption will grow by 48% between 2012 and 2040. It is expected that most of this growth will come from countries that are not in the Organisation for Economic Cooperation and Development (OECD). Over the projection period, non-OECD Asia, including China and India, will contribute more than half of the world's total increase in energy consumption (EIA, 2016).

During the last century, the world population has increased more than three times, while the corresponding fossil fuel consumption has risen twenty times higher than previous records. Many geologists estimate that the global oil supplies will run out and eventually the world will reach peak oil or its highest production level by 2050. It is expected that, in pursuit of reaching peak oil, the petroleum production will decrease, which also indicates a rise in costs for the remaining supply.

In parallel to the growing population and economic expansion, Turkey has also become one of the fastest growing countries in the world over the last two decades. The economic and demographic widening of country has brought with it rising energy demands. The growing energy demand has also brought growing energy dependence on external imports due to an insufficient amount of domestic energy production.

In regard to **energy demand**, in 2015 Turkey met 35% of its total primary energy demand from natural gas, 28.5% from coal, 27% from oil, 7% from hydro and only 2.5% from other renewables. The country imports around 99% of the natural gas and 89% of its oil supplies. Regarding **energy supply**, the country's total primary energy supply has significantly risen over the past 40 years from 24.4 mtoe in 1973 to 129.7 mtoe in 2015. Accordingly, the amount of natural gas and crude oil imports in Turkey's total primary energy supply, have gradually increased each year up until 2018. The remaining amount of energy supply was derived from indigenous energy sources, such as domestic coal and renewable energies, as well as imported coal (MENR, 2015).

As a result of raising natural gas and crude oil imports, the external energy dependency of Turkey has also been increasing incrementally since 1990. The energy dependence reached 75% at the end of 2014, from 51.6% in 1990. This heavy reliance combined with inaccurate monetary exchange rate policies, have deepened Turkey's current economic deficit. So long as Turkey remains a larger consumer than producer and resists the inclusion of a considerable amount of renewable energy sources, the current deficit problem will continue. In this regard, it is identified that the energy dependence and current economic budget deficit are interrelated and directly proportional with each other.

Despite country's immense potential for renewable energy, Turkey has only a modest plan to increase the share of renewable energies up to 30% of the total electricity generation mix. It is also planned for renewable energies to meet 10% of the energy requirements in the transportation sector by the year 2030. Turkey also possesses a high potential for unconventional hydrocarbon sources. Based on the estimations of the US EIA, exploration activities conducted by Turkish Petroleum (*Türk Petrol Anonim Ortakligi - TP*), Shell and other international corporations, Turkey has a considerable amount of shale gas, especially in the Thrace Basin and south-eastern Anatolia region. Nevertheless, there are environmental, geographical, technological, legal and economical obstacles hinder the shale gas extractions in both regions.

In addition to its renewable and shale gas resources, Turkey forms a natural energy bridge, by hosting important crude oil and natural gas pipelines between the energy-rich Caspian Basin, Middle East, and energy-scarce European region. Therefore, an uninterrupted flow of the conventional energy sources to Turkey and to Europe is essential. Nonetheless, due to the long-lasting conflicts in the south-eastern parts of Turkey and its neighbouring countries, the crude oil and natural gas flow exists under constant domestic, political and security challenges. Particularly, the ongoing terrorist attacks of the Kurdistan Workers' Party (PKK) and wars in bordering countries have been major threats to the energy security of Turkey. The presence of these challenges undermines the development of further planned energy pipeline projects and highlight the urgency of energy independence and the transformation from fossil to post-fossil through the increased use of renewable energies. To confront these challenges, the policy recommendations are explained in the conclusions chapter of this thesis.

Turkey displays the highest growth energy demand of all OECD countries and its domestic energy production only meets around one-quarter of its total energy use. It is therefore not foreseeable that the renewables could subrogate fossil fuels to meet the energy hunger in Turkey. As 'reducing import dependence' is one of the short- and long term national energy strategies of Turkey, the government canalises its investments on nuclear power and coal. The abundance of domestic coal reserves and the significance of the coal extraction industry, which is connected to the construction industry, is vital for Turkey. Coal is the backbone of the domestic-led growth strategy in Turkey. However, Turkish coal has a low quality, consisting primarily of lignite and possessing a low hear capacity and high level of pollution. Instead of promoting renewable energies, Turkey has turned to nuclear energy. Much like coal plants, nuclear power plants can only survive with government support and subsidies. Furthermore, the construction of nuclear power plants contradicts the country's national energy strategy. In addition, the fuel for the Akkuyu Nuclear Power Plant will be produced in and delivered from Russia. These are primary factors which hinder the development of renewable energy sources in Turkey. In addition to these, Turkey has the strictest local content requirements for renewables of any country in the world. Another challenge is country's steep domestic content requirements regarding the development of a domestic capacity for renewables manufacturing.

In this context, this thesis intends to analyse and answer the following research question: **Why Turkey does not have a high share of renewable energy in its total energy mix despite the potential and sufficient capacity of renewable energy sources?**

With regard to this research question, the outcomes propound that Turkey is possesses a substantial amount of renewable energy sources. The significant reduction and even elimination of fossil energy sources can only be possible through substantially increasing multiple sources of renewable energy for the purposes of electricity generation. In this way, the power production from renewable energy sources will play a fundamental role, in contributing to sustainable development, in the pursuit of an incremental reduction in external energy dependence and thus in country's long-term current economic debt. The energy liberalisation process (which has already begun) and the private sector investments, play a crucial role in the widespread usage of renewable energies. Nonetheless, dependence on foreign technology for hydroelectric and wind power equipment poses a challenge, regarding the development of renewable energy. In order to accomplish a post-fossil future with a global renewable energy vision four things must happen: 1) the competitive financial power of renewable energy resources must be improved, 2) the implementation and exploitation of the renewable energy resources must be increased, 3) the administrative processes to integrate the renewable energy resources into a national grid must be eased and 4) the technical barriers in front of the electrical grid connections must be removed. In addition to these economic, technical and administrative improvements in the field of renewable energy, the social level also needs to be taken into the consideration. The significance of renewable energy sources must be communicated to the public and the construction of the renewable plants must be accepted by the inhabitants. In this regard, social awareness and public acceptance play a major role in Turkey for the faster establishment of renewable power plants on local and national levels.

The extension of renewable energies in the total energy production does not only correspond to the main energy strategies of Turkish government, it also contributes to the country's national and international climate strategies; i.e. fulfilling the greenhouse gas emission targets within the framework of Paris agreement. Up until now, the energy related acts of Turkish government remain inconsistent with its energy and climate goals, as the government continues with its fossil-energy-oriented strategies. For example; by the year 2023, the country aims to add nuclear power to add more than 10,000 MW to its total energy mix and achieve full utilisation of domestic coal in electricity generation, regardless that burning coal predominantly responsible for the country's greenhouse gas emissions, contributing to 167.2 million tons of the 259.8 million tons of emission increase between 1990 and 2014. These targets are neither compatible with country's national climate nor its energy (*milli enerji*) strategies. Moreover, the current renewable energy strategy has two major deficiencies: First, Turkey's energy targets were drafted when renewable energy was still relatively expensive, therefore, these targets fail to reflect the actual achievable potential. Second, the targets - along with Turkey's energy and climate policy – are only set for the short term, focusing on 2023.

1.3. Methodology

The research method of this doctoral thesis relies mainly on a detailed literature review as well as empirical and statistical analyses. Therefore, mostly qualitative, but also quantitative methods are used. The aim of the thesis is to provide a broader understanding of Turkey's current energy and climate challenges, including energy supply security and energy dependency problems by explaining the theoretical background of the pre-fossil, fossil and emerging post-fossil energy eras. In order to analyse each energy scenario and to provide a clear credible body of research, the following resources are frequently used:

- Regarding the former utilisation, current situation, developments and future forecasts of the hydrocarbon and renewable energy sources in Turkey, the official documents, annual reports, strategy papers, graphics and maps of the Turkish Ministry of Energy and Natural Resources (MENR), Turkish Ministry of Foreign Affairs (MFA), Energy Market Regulatory Authority of Turkey (EMRA), General Directorate of Renewable Energy (YEGM), Turkish Petroleum Corporation (TPAO), International Energy Agency (IEA), the United States Energy Information Administration (EIA), Organization of Economic Cooperation and Development (OECD);
- Statistical data from the Turkish Statistical Institute and European Commission's Eurostat;
- Legal framework documents and amendments of Turkey's Environment Law.

These resources have contributed to propound Turkey's geopolitical situation and energy dependence and identify Turkey's energy mix. In addition to these, several expert interviews were conducted to understand the legal framework and installation capacity of renewable energy sources.

1.4. Content overview

The first chapter gives a general introduction to the aims of this thesis based on the research questions, hypothesis and desired outcomes. The research challenges are also discussed.

The second chapter propounds the theoretical background of the research question, which is based on three energy eras: Pre-fossil, fossil and post-fossil energy eras. The characteristics of these energy areas and inevitable energy transformation from fossil to post-fossil energy era will be discussed.

The third chapter examines the production, utilisation and electricity generation of conventional energy sources in Turkey; which include, oil, natural gas, coal and nuclear energy. This chapter examines the crude oil and gas imports to Turkey, the pipelines that facilitate the transportation of such fossil fuels through Turkey and the corresponding increase of dependence on such fossil fuels between Turkey and its neighbouring countries. Primary sources of information were derived from the Turkish

Ministry of Energy and Natural Resources, the Turkish Energy Regulatory Authority, and the Turkish Petroleum Pipeline Corporation (BOTAS).

The fourth chapter provides background information about the pre-history (Ottoman Empire), early history and the current situation of Turkey as well as the detailed economic and political analysis of Turkey's foreign and energy policies concerning energy supply security and energy dependency issues. Not only energy, but also economic and political aspects of the country which have a correlative relationship with Turkey's energy dependency problem will be elucidated.

The fifth chapter analyses the potential contribution of non-conventional (renewable) energy sources to Turkey's energy infrastructure. The chapter demonstrates that Turkey has a vast amount of renewable energy sources; including, hydro, wind, and geothermal, biomass and solar, that may reduce energy dependence and increase the energy security of Turkey. Nevertheless, Turkey has not adequately exploited this potential, primarily due to the of absence of renewable energy regulations and incentives and the continued use of energy policies dependant on the wide range utilisation of fossil fuels.

The sixth chapter explains the potential of unconventional energy sources (shale gas) in Turkey, based on the data of the U.S. EIA.

The seventh chapter analyses the energy forecasts at a global level as well as peak oil and challenges regarding the future of energy resources. It is important to analyse global challenges in order to better understand their implications on Turkey's energy problem

The eighth chapter concludes this thesis, which aggregates the addressed points of the whole chapters, major outcomes and policy recommendations.

2. THEORETICAL BACKGROUND AND THE ENERGY ERAS

2.1. Pre-fossil Energy Era

Around 4.6 billion years ago, as the first signs of life appeared during the Archaean age, the living conditions were far less hospitable than they are today. During this era, for more than two billion years, the Earth remained almost unchanged. Human beings have lived the majority of their time on the Earth as simple hunter-gatherers and have faced several crises as the Earth shifted back and forth between ice ages and lush warm periods; for example, during the Palaeolithic period (Rockström, et al., 2015 S.

31). The population was between a few million and 10 million and people used a combination of physical strength and simple tools to sharpen the stones for the procuring food by hunting, fishing or by gathering seeds, berries and roots. During the Mesolithic period, the agricultural development contributed to the rise of permanent settlements by the water's edge. Around 75,000 years ago, in a critical cold period, the entire human population might have dwindled down to 15,000 fertile adults, located in the high plateau in northern Ethiopia (Rockström, et al., 2015 S. 31). This period was a critical period for human beings, as it came close to signalling the extinction of our species. However, around 11,700 years ago, the Earth's stormy climate became milder, as the Earth left the ice age and entered the period referred to as "Holocene". During the Holocene period, around 10,200 years ago, the Neolithic era had begun and people processed trees to create essential tools to begin agricultural activities. They started to tame and train animals for their personal use and set them to work. In the course of history, humankind has also benefited from wind- and hydropower. The civilizations expanded and villages, towns and eventually cities, came into existence. As crops and animals could be raised to meet the demand, a global population explosion occurred. Cattle, goats, sheep, and pigs all have their origins as farmed animals in the so-called Fertile Crescent, a region covering eastern Turkey, Iraq, and southwestern Iran (The Genographic Project 2016), which triggered the Neolithic Revolution.

Looking back to the historical process of human beings on the Earth, even 160,000 years earlier than today, survival was no easy task. The world's climate kept alternating between cold episodes of expanding ice sheets, water scarcity, low sea levels, and food shortages; and warm episodes of abundant water, high seas, and lush biomass resources (Rockström, et al., 2015 S. 31). The needs of humankind have undergone a change in the course of time. It has only been during the past 10,000 years that the conditions necessary for human societies to develop have been reliably present (Rockström, et al., 2015 S. 31).

In the pre-fossil era, the (economic) growth was dependent on population growth, which, in turn, depended on the supply of goods and services for sustenance and reproduction (Altvater, 2001). In this era, energy was produced by the agricultural and forestry sectors, using land as an input. The primary energy sources were physical labour, animal labour, and biomass. The energy systems were designed to produce the most output with the least amount of human input, in order to generate energy. Animal power was utilised in the form of horse mills, wind power in the form of windmills and hydropower with the utilisation of a water wheel for industrial purposes (CMU, 2003 S. 1-5). Wood and coal were the primary fuels for cooking, heating, and other domestic uses. Most of the energy generated from biomass sources (primarily wood and peat) was drawn up into chimneys rather than into the room or cooking pots. Wood combustion to generate heat throughout the centuries caused deforestation, which is still observable in the regional and global environment on a large scale (CMU, 2003 S. 1-5).

The technologies from the pre-fossil energy era may give us some clues regarding how we can utilise nature without destroying it; the three-field crop rotation system, timber-frame construction, windmills, and sailing ships all have a similar logic that humans must first learn to fit in with natural flows before they can harness and manage them for their benefit (Unmuessig, et al., 2012 S. 1-52).

In addition to energy, population and economic growth aspects, the pre-fossil era and the Holocene period witnessed the birth of different human cultures and civilizations. This included the Longshan Neolithic agrarian cultures of the Yellow River Valley in China; the ancient Egyptian irrigation societies along the Nile; the Mesopotamian irrigation societies along the Tigris and Euphrates rivers; the Greek, Roman and Ottoman empires; the Islamic civilizations in a large part of Africa and Central Asia; the agricultural societies of the Maya civilization in Central America (Rockström et. al., 2009 S. 32).

The Ottoman Empire represents the history of the Turkish Republic during the pre-fossil energy era. In a pre-fossil society without steam engines, trucks, or other mechanised forms of technology, animals served as the heavy lifters, stores of energy, and long distance transporters needed to power the economy of the Ottoman Empire (Mikhail, 2017). During the pre-fossil energy era, the Ottomans took their primary energy needs from traditional biomass sources. Until the early 1800s, virtually all of the energy used and produced in the Ottoman Empire came from wood biomass. The Ottoman territory was rich with dense forests. Nonetheless, the demographic development of the population and the constant aspiration for survival, led to the maximum exploitation of nature. The woods were constantly being harvested to use as firewood to heat the Ottoman Palace, trees were also cut down to use for building material, i.e. timber for the navy shipyards, an energy source in the army for the arms production or for their leaves which were used to feed domestic animals. One of the main reasons for cutting down woods and thus causing intensive deforestation was the cultivation of areas for pastures. Production of wood charcoal used for heating baths and residences of the Sultan, masters and beggars during the wintertime, were also prominent purposes. There was no official registration system identifying the quantity of timber obtained from the natural forests.

Not only the Ottoman Empire, but the wellbeing of all societies around the world are derived from the Holocene era, which provided us with fresh water, productive soils, quality of air, fish, stable equilibrium of forests and a stable climate. Nevertheless, it did not take too much time until the world was pushed out of the Holocene into another epoch, due to the increased technological potency of human activities. These activities have consistently influenced and even dominated many aspects of the Earth's environment, and its functioning. Since the beginning of the fossil-fuel era and the *great acceleration* of the human enterprise in the 1950s, humanity's wide-ranging impacts – including climate change, chemical pollution, air pollution, land and water degradation, nutrient overload, and the massive loss of species and habitats (Rockström, et al., 2015 S. 33), Earth's major systems and tipping points were put under pressure. Consequently, we have introduced our own geological epoch, the "Anthropocene".

2.2. Fossil Energy Era

Before industrialisation, humans had already begun to extract and use some fossil sources. Between the 11th and 14th centuries, medieval Europe experienced rapid population growth, leading to new settlements throughout central and eastern Europe (Moore, 2002 S. 303). In the early 13th century, coal mining began and energy from coal was used mainly for the forcing and melting of metals (CMU, 2003). There was significant growth of manufacturing output and cash-crop agriculture, as part of a generalised wave of commercial expansion throughout Afro-Eurasia (Moore, 2002 S. 303). In the 14th century the feudal system in Europe was faced with a crisis. By the end of the 15th century, the feudalism in Europe came close to its demise when "proto-capitalist" development especially in Poland, eastern Germany, Czech, the Balkans and parts of northern Italy came into existence. In the 16th century, feudalism's demise and capitalism's ascent had begun. At the beginning of the 17th century, the need for large quantities of accessible, dependable, transportable and powerful energy, encouraged the exploration of more energy sources. Great Britain experienced an energy crisis due to a shortage of wood and began using coal as a substitute fuel source for domestic purposes

(Nef, 1977 S. 140). In the 18th century the transition from feudalism to capitalism brought about the inevitable emergence of the classless socialist society. Feudalism led to a class struggle between the feudal ruling class and the emerging capitalist class, which also highlights to the transition point from pre-fossil to fossil energy. The inventions and discoveries generated the Industrial Revolution, which began in Great Britain and spread to Western Europe and the United States within a few decades.

The beginning of the fossil energy era dates back to the middle of the 18th century together with the industrial revolution, as the people learned how to exploit fossil fuels as a new, cheap and efficient energy source. Within the fossil energy era, nature, humanity, politics and the economy became interconnected. The relationships of humankind within the web of life became denser, fully connected and every link of the chain mattered (Rockström, et al., 2015). The foundations of capitalism were established during the fossil energy era. The transformation from pre-fossil to the fossil era was not solely an energy transformation, but also an economic and societal change. As *Karl Polanyi* explains, up until the 19th century, the human economy was always embedded in society. The term "embeddedness" expresses the idea that the economy is not autonomous, as it must be in economic theory, but subordinated to politics, religion and social relations (Polanyi, 2001 S. xxiv). Polanyi argues that creating a fully self-regulating market economy requires that human beings and the natural environment be turned into pure commodities, which assures the destruction of both society and the natural environment (Polanyi, 2001 S. xxv). There are two levels to Polanyi's argument: The first is a moral argument, that it is wrong to treat nature and human beings as objects whose price will be determined entirely by the market (Polanyi, 2001 S. xxv). Otherwise, such concepts would violate the principle, which has always persisted, that humans and nature have always been recognised as important dimensions and not as the subordinated objects of the market. The second level of Polanyi's argument propounds that, despite the economy's apparent self-regulating nature, the state must play the ongoing role of adjusting the supply of money and credit to avoid the twin dangers of inflation and deflation (Polanyi, 2001 S. xxvi).

According to Polanyi, in all societies there are a number of institutions that regulate economy, ensure the livelihood and survival of people; for example, state and state-like institutions are one of them. The family is of course very important at all times. Moreover, communities and tribes were very important to the old societies that Polanyi researched and ethnic and religious communities still have very important functions. Market is an important institution, which determines the livelihood of people and coordinates economic life. But Polanyi says, “the market is different”, because, unlike the state and the family, the only function of the market is economic function. Therefore, if the concept of humanity is reduced to an economic institution, which only has economic meaning, then human life become an accessory of the economy. The idea of society becoming an accessory of the market is particularly important today, as we can currently observe it taking place. Privatisations, the elimination of rules regulating the labour market and the attack on all regulatory institutions up to the minimum wage, can be identified as attempts to make human society an accessory of the market. According to Polanyi, this does not occur naturally. He further explains that the emergence of the market, which operates according to its own rules, exists not by itself but through intervention.

Based on Polanyi’s assumptions, we can assert that through the societal and economic transformation to the fossil era from pre-fossil society, nature and human were seen as objects to be subordinated under the market and the state has a vital economic role to supply money, as well as to guide the avoidance of inflation and deflation. The social relationships, the nature and human are embedded in the economic system. On the contrary, in pre-industrial societies, social relationships are deeply embedded in all economic activities and institutions. While humans work to earn their living (economic activities), they are involved in their communities and act in ways that ensure the community’s well-being, to protect the social harmony and foster social cohesion (social relationships). The community members also maintain social ties through mutual reciprocity and the redistribution of resources. These reciprocal acts hold communities together as they support each other in meeting the demands of daily living; in this way, the community maintains social cohesion.

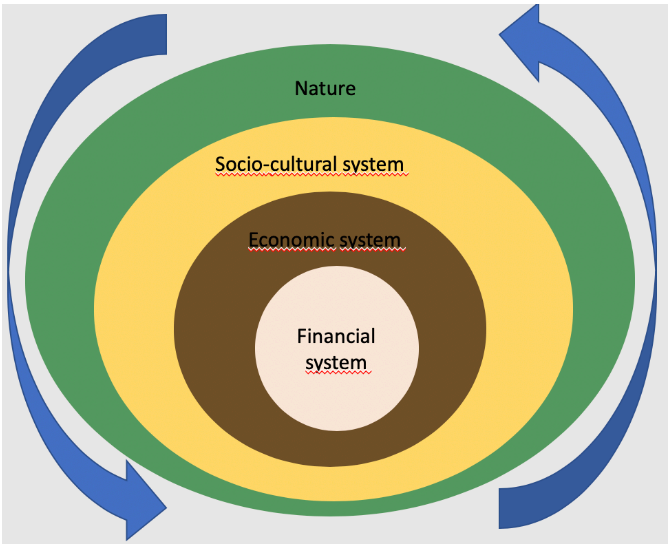
As the transformation of pre-industrial societies into industrial societies took place, the economic activities became removed from the community. The USA, which was the instrument of the new capitalist elites, created markets to allow the owners of capital to produce and sell products, treating land, labour, and capital as if they were commodities. Furthermore, they placed constraints on community rights, limited community access to common property and removed traditional barriers to trade and finance (Rice, et al., 2013). Since land, labour and capital are not 'natural' commodities, the governments had to enforce this fiction through the mechanisms of contracts and laws. The most damaging part of this system was that it undermined the cooperative aspects of civil society, maintained the separation of civil society from the economy and consequently, business interests and governments underestimated both the cooperation of community members and the importance of reciprocity and redistribution (Rice, et al., 2013). The governments dignified the notion of private property and reinforced the idea that people actually should take care of themselves and become vying individuals who would willingly relinquish their commodities to find work in the new industrialising societies (Rice, et al., 2013).

The capitalist system in the fossil epoch developed the subrogation of fossil fuels instead of workers. Polanyi propounds the results of such a system as the following:

> "*To allow the market mechanism to be sole director of the fate of human beings and their natural environment indeed, even of the amount and use of purchasing power, would result in the demolition of society...Robbed of the protective covering of cultural institutions, human beings would perish from the effects of social exposure; they would die as the victims of acute social dislocation through vice, perversion, crime, and starvation. Nature would be reduced to its elements, neighbourhoods and landscapes de- filed, rivers polluted, military safety jeopardized, the power to produce food and raw materials destroyed...Undoubtedly, labour, land, and money markets are essential to a market economy. But no society could stand the effects of such a system of crude fictions even for the shortest stretch of time unless its human and natural substance as well as its business organization was protected against the ravages of this satanic mill."* (Polanyi, 2001 S. 76)

Polanyi analysed how, as a result of the Industrial Revolution, the production factors, i.e. labour, land and capital – and with them, people too – had lost their embeddedness in a broader cultural context and were exposed to the forces of supply and demand. With their livelihoods and survival at risk, many people reacted by calling for a strong state – such as in the communist countries and in National Socialist Germany. The present situation in many affected countries is equally challenging, the economic and food-shortage crises have made people into pawns of the market. The way out of current situation is undecided, however, it can be managed successfully. Now, it's all about re-embedding: The financial system into the economic system; the economic system into the socio-cultural system; and the socio-cultural system into the natural environment (Figure 1). No doubt about it – it's a major challenge for our own and the upcoming generations.

Figure 1. Embeddedness vs. Re-Embeddedness



Polanyi observed that the road to the free market was opened and kept open by an enormous increase in continuous, centrally organised and controlled interventionism (Onder, 2015 S. 140). Since the 1980s Turkey has demonstrated the paradox of the opening of markets going hand in hand with the strengthening of the state's iron grip. The reforms that opened up the Turkish economy to international forces after the 1980 coup were pushed by an oppressive, nationalistic military junta and later eagerly followed by civilian governments. According to Nilgün Önder, an associate Professor at the University of Regina, in the 1980s Turkish state intervention in the economy did not actually decline; rather, its direction changed. Through a systematic centralisation of policy powers, there was a "reinforcement and expansion of [the state's] coercive powers over society (Armstrong, 2010). Forty years later, the situation in Turkey shows that an open economy and a liberal state are far from inevitable counterpoints (Armstrong, 2010).

The economic globalisation of the late 20th century brought about a world-wide expansion of markets to areas which were previously outside the orbit of market relations. Societies throughout the world have been affected by the challenges of globalisation (Bugra, 2020). Although welfare state institutions and policies have undergone important changes and transformations, social policy has not lost its importance in advanced capitalist countries and it has acquired a novel significance in the late industrialising countries of the periphery, where public social spending has increased and new instruments of social policy have been introduced (Bugra, 2020). In both late-industrialising and advanced industrialised countries, the new developments in social policy have been situated in the context of the new global capitalism. These changes in policies and institutions constitute a response to the challenges of a new, market-dominated economic order (Bugra, 2020). Capitalism is a system of “cheap nature”, where energy can be obtained at a low cost. Cheap nature is central because every era of high economic development growth of the modern world has been premised on the ‘four cheaps’. Every era of capitalism carries with it ‘new imperialism’, ‘new extractivism’, ‘new colonialism’, ‘new ways to getting cheap labour’, ‘new industrial revolutions’, ‘new agricultural revolutions’ or ‘new scientific revolutions’. As the relationship of human beings with the web of life has become denser, the limits of nature have become much more visible. According to Jason Moore these limits which elicit capital accumulation can be called the “limits of the frontiers”: labour power, food, energy and raw materials (Moore, 2016). As labour, food, energy and raw materials are made cheaply – through the appropriation of the unpaid work of “women, nature and colonies” – they become what Jason Moore identifies as the “Four Cheaps” (Moore, 2014). According to Moore, as the Four Cheaps are restored, new opportunities for capital accumulation appear; for instance, the railroad revolution of the 19th century or the automobile revolution of the 20th century. Over time, the Four Cheaps stopped being cheap, “because the squeezing out of unpaid work in the upswing of an accumulation cycle exhausts the resilience of uncommodified relations of reproduction” (Moore, 2014). Accordingly, labour costs have risen along with the costs of food, energy and raw material prices. The opportunities for accumulation in the zone of material production then stagnate and begin to contract. Financial expansions tend to begin when the Big Four inputs become more expensive. The value composition of the labour, food, energy and raw materials then rises rather than falls (Moore, 2014).

The ability to access cheap energy sources and raw materials has become a very crucial factor in the fossil energy era. If there is no possibility to attain abundant and inexpensive raw materials, the labour productivity stagnates in the presence of rising energy prices. In a capitalist production system, the growth of labour productivity requires the substitution of labour for fossil energy and its technical and social conversion system. In the course of capitalist streamlining, the exploitation of energy sources is not rational. During the fossil industrial revolution, the energy basis is radically converted from biotic to non-biotic (mainly fossil) sources (Altvater, 2001).

The capitalist streamlining begins with the restraining of the wind and hydro power, which, like stationary, are grounded energy sources, and are incapable of supporting the spatial mobility, urban-industrial agglomeration and temporal acceleration that the capitalist accumulation requires (Altvater, 2001). Renewable energy sources are not always available where and when they are needed. Along with the industrial revolution, the machine power began to replace human labour in the production of goods for the first time in history. It was with the use of fossil energy sources since the 18th century, that the limits presented by time and space and their physical energy came to an end (Altvater, 2001). In 1763, the steam engine was designed and built by James Watt. In 1767, the first solar thermal collector was developed by the Swiss scientist Horace de Saussure (CMU, 2003) and used in America as an energy source for cooking purposes until oil and gas became more frequent and reliable ways to generate power. Coal and wood were, for the first time, available as the primary fuel sources for the steam engine, particularly after the 1800s in regard to locomotives (CMU, 2003). In 1816, natural gas was piped into cities for domestic uses such as cooking, home illumination and street lighting (CMU, 2003). In 1859, for the first time, petroleum was drilled in Titusville, Pennsylvania and it began to replace coal as a plentiful energy source. Petroleum was easy to obtain and transport; it emitted less particulate pollution than coal, and it replaced scarce whale oil as a fuel for lamps (CMU, 2003). In 1861, crude oil was used as the liquid fuel for the internal combustion engine. Thus, coal became gradually unfavourable for consumers due to the labour issues surrounding the mining industry. Miners had started to strike for safer working conditions and more money, which subsequently affected the amount of coal available to the consumer.

In the 1900s photoelectricity, which is the basis of the photovoltaic cells, was discovered. Nevertheless, the development of the material technology for photovoltaic panels occurred slowly and thus, the photovoltaic did not become a primary source of electricity. In the 1950s the large-scale use of photovoltaic solar energy became prevalent. Contrary to sluggish developments in the photovoltaic area, wind power was developed on a large scale in the USA as a source of energy for farms and railroad stations, using tall windmills to pump water from underground wells (CMU, 2003). The 20th century process was defined by Eric Hobsbawm as "the death of the peasantry", as the most dramatic change of the century (Hobsbawm, 1994). Hobsbawm ascertains the disappearance of this truly world-historical anachronism in the 'revolution of global society' or ‘global transformation' from the 1950s, that extended industrial capitalism beyond its historic heartlands of Western and Central Europe, as well as North America. All culture which is stemmed from agriculture, must now be derived from industry and must be concentrated in cities (Altvater, 2001).

From Moore's perspective, in the fossil energy era, capitalism tends toward ecosystem simplification: accessing the resources as fast, easily and cheaply as possible without considering potential environmental impacts. As coal and other fossil fuels were easier to use and available in abundance and required little effort, research and investment went into photovoltaic research. Capitalism is not an economic system, but a way of organising nature to commit to an endless cycle of capital accumulation and an infinite economic growth. From its emergence in the 16th century, it has been premised on endless capital accumulation. The idea of “continuous” accumulation proceeds through a strange crystallisation of wealth: “labour productivity” in commodity production. The accumulation of wealth entails a geometrically rising demand for ‘Cheap Natures’. The major line of thinking surrounds continuously taking from nature for free or at a low cost. Within this transition, new diseases occurred through biological transformations (Moore, 2016).

In the late 19th and 20th centuries, the steam turbine was developed as a cheap source to generate electricity, by using coal as a fuel source (CMU, 2003). The beginning of the enormous use of fossil fuels coincides with the establishment of the 60-acre Highland Park automotive plant, complete with a moving assembly line, opened by Henry Ford in 1910 (CMU, 2003). In the Middle East crude oils were already known from natural seepage and pools, but they were used rather as protective coatings than as fuels (Vaclav, 2000). Those years foreshadowed that the Middle East would become one of the world's biggest oil producers and one of the global powers in the oil industry in the future.

Energy technologies developed rapidly and by the 20th century crude oil and its products had become an indispensable part of the industrial economy (CMU, 2003). Consequently, in 1960, countries with plenty of oil reserves came together to establish an international organization and economic cartel, called Organization of the Petroleum Exporting Countries (OPEC), to control the flow of oil as well as to coordinate the policies of the oil-producing countries. The Islamic Republic of Iran, Iraq, Kuwait, Saudi Arabia and Venezuela are the founding countries of the OPEC. With the participation of Qatar, Indonesia, Libya, the United Arab Emirates, Algeria, Nigeria, Ecuador, Gabon, Angola, Equatorial Guinea and Congo the organisation totals 15 member-countries (OPEC, 2018). In 1973, six Persian Gulf oil producers voted to raise their benchmark oil price by 70%. In the same year OPEC cut production and stopped oil shipments to the U.S. and other countries. By the time the embargo was lifted in March 1974, the oil prices had soared to US $12 per barrel, almost four times the pre-crisis price. While OPEC states enjoyed new geopolitical influence, the U.S. and other oil importer countries suffered from unprecedented fuel costs and recessions. This oil shock caused an energy crisis and the energy crisis brought energy shortage concerning all nations, especially the U.S., which was highly dependent on imported oil. This crisis brought sweeping changes to global energy policies in the 1970s and 1980s and led to energy conservation and investment policies that aimed at massive reductions in global carbon emissions. Thereby, the emerging interest to explore renewable energy sources for large scale generation of electricity and other energy needs was born (CMU, 2003).

In pursuit of an acute need of alternative energy sources in the 19th century, the social analysts became aware of the negative relation of capitalism to the environment, the issue of revolutionary changes taking place in the mode of production and how this was transforming the human relationship to nature. Consequently, environmental sociologists in the USA drew predominantly on three interrelated ideas derived from Marx and the critique of the capitalist political economy: (1) the treadmill of production; (2) the second contradiction of capitalism; and (3) the metabolic rift (Foster, 2009 S. 48).

The treadmill of production describes capitalism as an inexpungable, accelerating treadmill that constantly increases the scale of the throughput of energy and raw materials as part of its quest for profit and accumulation. This, inevitably pressing on the earth's absorptive capacity (Foster, 2009 S. 48).

The second contradiction of capitalism refers to the idea that capitalism, in addition to its primary economic contradiction arising from class inequalities in production and distribution, also devastates the human and environmental conditions of production, on which its economic progress eventually rests. In this conception, once the ecological damage turned into an economic crisis of capitalism, a feedback mechanism was set into play (Foster, 2002). Nevertheless, it is speculative that the notion of "Second Contradiction" exists. According to John Bellamy Foster and some other social scientists, there is no such convenient feedback mechanism for capitalism as a whole. Because capitalism never runs out of new ways to extract surplus value, even in the worst social and environmental disasters (White 2016), like the aftermath of Hurricane Katrina in 2005, the 2010 Haiti earthquake or the Deepwater Horizon oil spill in the Gulf of Mexico in 2010. It is what Naomi Klein, a Canadian author and a social activist, calls "the rise of disaster capitalism". As the public becomes disoriented in situations following massive collective shocks; such as, wars, terrorist attacks, or natural disasters, there are new opportunities to make profits and achieve control, by imposing 'economic shock therapy'. (Klein, 2007).

According to Foster, capitalism's intention to swap over environmental problems, implies that the earth remains, far and wide, a "gift to capital". Capitalism, in essence, uses the whole biosphere as a huge garbage can, and runs from one ecosystem to another, damaging them respectively (Foster, 2009). Foster emphasises in his book, *the Ecological Revolution*:

> "*We should not underestimate capitalism's capacity to accumulate in the midst of the most blatant ecological destruction, to profit from environmental degradation (for example through the growth of the waste management industry), and to continue to destroy the earth to the point of no return – both for human society and for most of the world's living species. In other words, the dangers of a deepening ecological problem are all the more severe because the system does not have an internal (or external) regulatory mechanism that causes it to recognize*." (Foster, 2009)

The third notion, *the metabolic rift*, refers to the logic of capital accumulation that creates a harsh rift in the metabolism between society and nature, severing fundamental processes of natural reproduction (Foster, 2009 S. 49). By articulating the concept of metabolism, Justus von Liebig, and his analysis of the ecological contradictions of industrialised capitalist agriculture greatly influenced Marx in his time. According to this notion, all life derives from metabolic processes between organisms and their environment. All living creatures carry out an exchange of energy with their surroundings, which is then integrated into their internal life processes. Thus, Marx defined the labour process as a "metabolic interaction between nature and man" (Foster, 2013). The metabolic rift between nature and man, (or soil and worker in the example of the big crisis of capitalist agriculture in the nineteenth century in England) (Foster, 2007), pointed out the necessity of the restoration of nature through sustainable production. According to Marx, the metabolic rift represented a problem of sustainability. He remarked that capitalism undermined the vitality of the everlasting sources of wealth – the soil and the worker – and pointed out the necessity of a much more sustainable relation of human beings to harmonious production with ecological systems, rather than merely economic notions (Foster 2009).

Regarding the Ottoman Empire, we may assert that the Ottomans did not 'successfully' achieve their transition to capitalism, as their "Western" counterparts did. According to Polanyi, in non-capitalist class societies, the 'economy' or the 'market' is instituted as networks of patronage and thereby, organised through the hierarchical allocation of political rights and privileges (Polanyi, 1977). It is almost unanimously accepted that the Ottoman Empire radically diverged from Western Europe, as its "provisionist" and "fiscalist" economic policies sharply contrasted with European "mercantilist" practices (Düzgün, 2017 S. 25). It is contended that a particular set of economic policies, which involved price regulations, export restrictions, and military/urban subsidies, remained in place throughout the early modern period, thereby preventing the growth of 'merchant capitalism' in the Ottoman Empire (Genc, 2009 S. 53). Although the Ottomans built a world empire, they were not part of the core of the emerging capitalist system in the late 16th century, which eventually steered the Empire toward the periphery. The marginalisation of the Empire started in the 16th century and was completed by the end of the 19th century. Accordingly, the Empire was victimised by the emergence of the capitalist system (Evrensel, et al., 2017).

The Era which saw the utilisation of conventional energy and fossil energy first began with the extraction of coal in the Ottoman Empire between 1829 and 1858. Sultan Mahmud II with his decree of July 29, 1843 (in Turkish: *Sadaret Tezkeresi*) made, for the first time, coal production in the Eregli and Amasya provinces possible and called for it to put on the market in Istanbul to make a valuable contribution to the Ottoman treasury. The aim was to build domestic steamships and to power them with domestic coal. Nevertheless, domestic coal was not sufficient enough to realise the intentions of the Sultan (Ediger, et al., 2010). In 1848, the number of Ottoman steamships had risen to 18, and the mines in Zonguldak began producing around 40,000 tons of coal per year. During the 1877-1878 Ottoman-Russian Wartime, the mine production considerably increased and reached 181,000 tons. The wartime had a significant impact, not only on coal production, but also largely on petroleum. During this period, Russia became the first major competitor in the oil market, particularly in the Black Sea region, due to the disruption of the transportation of American oil. Russia then became a major oil supplier to the Ottoman Empire. The 1905 petroleum crisis in Russia caused a decline in production, which adversely affected the oil supply of the Ottoman Empire despite the oil consumption level being relatively low (Ediger, et al., 2010).

The first electrification efforts in the Ottoman Empire had first begun during the reign of Sultan Abdulhamid II. (1876-1909). Izmir and Thessaloniki were the first Ottoman cities met with electricity. Abdulhamid II abstained from electricity and therefore, during his reign, electricity was used only in the palace and hotels of Istanbul, rather than in the whole city (Geyikdagi, 2011). In 1902, Tarsus, a province in the south of Turkey, Italian and Swiss companies initiated the first electrification process, with an installed capacity of 120-horse power (1 horsepower = 0.7 kW) hydropower plant (Gürbüz, et al., 2007). The plan was to connect 2 kW dynamo to the mill and the power plant (Geyikdagi, 2011). Therefore, the necessary equipment including dynamo, line, and other electrical materials were sourced externally and imported. After the installation of the hardware and dynamo, the power plant was able to produce electricity – however, it only provided electricity to some of the private dwellings (Geyikdagi, 2011). A similar system continued to operate in the early years of the Turkish Republic until 1938, when all power plants were nationalised (Gürbüz, et al., 2007).

After the deposition of Abdulhamid II, the production, and utilisation of electricity became widespread in Istanbul (Geyikdagi, 2011). Due to the absence of any steam powerful enough to operate a hydraulic plant in the vicinity of Istanbul, the construction of a steam plant had been considered as a solution (Kirac, et al., 2003). *Halic* (English: Golden Horn), a horn-shaped inlet of the Bosporus was determined as the best place for the plants. *Halic* is a natural, sheltered harbour, which had sufficient supply of fresh water, facilitated coal transportation and enabled the efficient distribution of power to the whole city (Kirac, et al., 2003). In electrification of the European and Asian sides of Istanbul, a transmission cable crossed the Bosporus under the Marmara Sea. The construction of the essential plant and power distribution network was completed in 1914. The power plant, which was the first power plant of the Ottoman Empire, had been established in an area of 120,000 m^2 on the European side of Istanbul. It was the Silahtaraga Power Station, a coal-fired generating station with a capacity of storage for around 40,000 tons of coal and remained in use from 1914 to 1983 (Kirac, et al., 2003). The electricity sector was mostly contingent on foreign investments. In 1923, the total installed power capacity was 33 MW and the total electricity production was 45 million kwh. The power activities were under the direction of foreign companies from Belgium, Germany, Italy and Hungary, which also held a certain degree of independence in management.

The plant continued to produce electricity in its original capacity until 1920. Due to the increasing need of power, the construction of additional new boilers and engine rooms took place in the upcoming years. The plant was nationalised in 1937 and operated under the direction of the Municipality of Istanbul until 1970. The Turkish Electricity Administration took over the management of the plant from the Municipality in the 1970s (Kirac, et al., 2003). With four engines and four boiling rooms, the total producing capacity reached 100,000 kW. The Silahtarağa power station was shut down in 1983 due to the lack of the cooling water in the stream. After its closure, the plant was converted into a university campus for the Istanbul Bilgi University and now houses two museums and several other facilities.

The Ottoman Empire managed to maintain its own power generation until the late 17th century. Thereafter, the Ottomans became progressively weaker in comparison to their Western rivals. Since the industrial revolution, the energy sources like coal, petroleum, steam, and electricity have been a driving force for the modern civilisation development. The Ottomans, however, were lagging behind the industrial and technological development of the West, and hence became even more dependent on Europe.

Towards the end of the 19th century, the first petroleum exploration activities by drilling took place in Iskenderun and the Thrace region within the boundaries of Ottoman Empire. Nevertheless, very minor oil and gas discoveries were made. There were no serious exploration activities until the establishment of "Petroleum Exploration and Operation Management" by the Law Number 2189 on May 20, 1933. The establishment of the Law saw geological investigations conducted of all regions which had the potential of petroleum discovery and was led by two American geologists and one Swiss palaeontologist. Following the geological investigation and drilling activities conducted once more in the Iskenderun region, no positive results were achieved. In the Thrace region, a strong gas flow was discovered, but completely dried out at the end of the second month of drilling activities. The first and economic commercial oil discovery in Turkey was made in the Raman province in the Southeast Anatolian region. In 1940, petroleum was discovered at Raman-1 well and production started from the 1,052 m depth. The daily production capacity of the Raman-1 well was 10 tons of petroleum. Until 1954, 84 million Turkish liras, (around 21 million Euros), were spent for the petroleum exploration activities in Turkey. During this period 37 explorations, 13 productions and 19 geological investigation activities were performed. The total production of petroleum was 95,881 tons.

During very first years of the newly founded Republic of Turkey (1925-1937), 64% of total wood production was utilised as firewood. Wood biomass met 60% of the country's primary energy consumption. Correspondingly, in 1926, the biggest lumbermill of Europe began operation in Ayancik province in the Black Sea region of Turkey. The goal of the factory was to set up a simple system to generate electricity from the timber residue. Nevertheless, the designing company disregarded some of the contractual obligations, which led to excessive deforestation in Ayancik. The factory continued its activities until the end of 1994 under the direction of the Ayancik Government (Akyol, 2014).

The combined demands of industrialisation and urbanisation in Turkey almost tripled the energy consumption in the 1960s and 1970s (Chapin Metz, 1995). In 1960, more than half of the primary energy consumed came from non-commercial sources. This was primarily firewood, however it was also comprised of manure and agricultural waste. These non-commercial energy, domestic coal, and lignite sources accounted for more than 80% of all primary energy consumption, whereas oil supplied only 18% of the energy used (Chapin Metz, 1995). During the 1970s, the demand for electricity began to exceed the supply, and by late 1979 the power gap began to restrain industry. After 1977, the constant power blackouts affected industrial, commercial and residential consumers (Chapin Metz, 1995). By 1979, the restricted imports of crude oil meant that fuel for cars, trucks, and tractors had to be rationed (Chapin Metz, 1995). In the mid-1980s Turkish government, under the presidency of Turgut Özal, launched the “build, operate and transfer - BOT” system. The primary goal of the BOT system was to open the floodgates for foreign investors, who would provide the capital and the technology to build plants, operate them for several years with guaranteed revenues and finally transfer the units to the government when the investment had been entirely returned (Chapin Metz, 1995). Thereafter, through the setup of hydroelectric dams and coal-run thermal power plants, the share of wood-biomass in total energy production decreased to 14%. By 1980, oil supplied about 47% of the primary energy consumed, coal and lignite about 2%, hydroelectric power 8% and non-commercial sources only 23%. By 1992, 43.5% of final energy consumption came from crude oil, 31.1% from lignite and hard coal, 4.1% from hydroelectric power, 6.9% from natural gas and 14.4% from other sources like solid fuels, geothermal, solar and wind power (Chapin Metz, 1995).

The energy transition from pre-fossil to fossil era had taken place much faster after the collapse of the Ottoman Empire and the foundation of the new republic in Turkey was established in parallel to industrialisation efforts, demographical and economic growth. While the use of traditional biomass and coal saw the country meeting almost 80% of its energy needs, the economic and demographic consumption pushed the energy demand ratio higher, which brought with it a dependency on external energy. As Turkey's economic growth model is import rather than export-oriented, the energy transition from pre-fossil to fossil era and the subsequent energy dependency created a long-lasting economic budget deficit for the country.

In the 20th century, access to energy resources had become a determining factor in winning wars, influencing neighbours and challenging enemies, thus gaining a geopolitical power over other countries. The connection between energy security and the military had been established, focusing on the "defence of international oil tanker chokepoints and the free flow of oil through these trade routes" (Nuttall and Manz 2008). Not withstanding this, towards the end of the 20th century, a new energy approach began to emanate, driven by technological developments, environmental concerns, resource constraints and socioeconomic demands. This new energy paradigm led to the shift from fossil energy to renewables – which are abundant, as long as the planet Earth exists.

Even though it seems like the transition from fossil energy era to post-fossil energy era might deemphasise territorial applications of geopolitics, the significance of oil and natural gas will remain until the transition period to post-fossil energy regime is fully realised. In this context, despite its external dependency on the energy-rich Middle East, Central Asian regions and the "energy-scarce" Europe, Turkey sits in a unique geographical position. Eastern Thrace of Turkey in the Marmara region, which is geographically part of South-eastern Europe, constitutes 3% of the territory of the country; whereas 97% of Turkish land lies in the Anatolia (Asia) region. Bosporus (*Bogazici*) and Dardanelles (*Canakkale*) divide and connect the European and Asian continents. Turkey plays a pivotal role in the region as a transit corridor for energy resources, which flow from the producer states to the consumers and consequently, give Turkey the chance to benefit the 'strategic regional power' of its location (Aribogan, et al., 2009). In this current fossil energy era, the energy-superpower countries enjoy the benefits of holding a high amount of hydrocarbon reserves. Turkey is not a superpower in the region, but an influential player on the world stage and can therefore be considered as an emerging regional energy player. As a natural hub between energy rich and energy scarce countries, Turkey could benefit from its geographical position by implementing well-designed, comprehensive and coherent long-term energy policies. By doing this, the country could achieve a gradual transition to post-fossil ere and develop its economic expansion concepts in parallel to its energy transition strategy.

The beginning of the fossil energy epoch in Turkey dates back to the time before industrialisation. The negative impacts of this era on the environment, climate and fauna have more than doubled since the transition from a feudal to a capitalist system. The immense use of fossil energy resources during the past 50 years has caused a doubling in global CO_2 emissions. Due to the capacity of CO_2 to stay in the atmosphere for up to 1,000 years, one would expect that the entire amount of CO_2 emitted has contributed to the 1°C increase in warming observed during this period. Nevertheless, in reality, ocean and land ecosystems of the biosphere each absorb roughly 25% of our emissions, leaving only half of the total in the atmosphere (Rockström, et al., 2015 S. 70). This means that in the past half century, the amount of CO_2 absorbed by nature has increased from 2 billion tons to 4 billion tons (Rockström, et al., 2015 S. 70). The human-dominated fossil era has pushed the planet out of the Holocene to the Anthropocene Era. The transition from fossil to post fossil era is not only necessary due to the limited resources of the Planet Earth, but rather, it is essential in order to prevent the Planet from becoming a 'Hothouse Earth' (Saplakoglu, et al., 2018).

2.3. Post-fossil Energy Era

The planet Earth has limited sources of fossil and nuclear energy. Additionally, it has a limited capacity to absorb polluting gasses, to adapt to climate change and to deal with the increasing greenhouse gas emissions in the atmosphere. Contrary to nuclear and conventional sources, solar energy existed prior to the industrial history of human beings and will still be available in the post-industrial future, as long as the Sun exists. The utilisation of renewable energy sources can be applied to all areas of usage in society, such as mobilisation, alimentation, communication, social and political regulations and participations. However, even renewable energy and resources do not exist without certain limitations; most notably, there is little scope for expanding the total land available for bioenergy and biomass production without putting food production and nature conservation at risk (Unmuessig, et al., 2012).

From the year 1750 to the mid-1950s, humans and human activities had a limited impact on the Earth's ecosystem. After the 1950s, the observations show that the significant changes in the Earth system are very much directly linked to the variations in the global economic system. Therefore, humanity had a new and cumbersome responsibility for the planet. The Planet Earth was being pushed out of the Holocene Era by human-dominated, large-scale, economic activities. The beginning of this new era, called *Anthropocene* started in the mid-1950s with 'the Great Acceleration'. *Anthropocene* is derived from the word "*anthropogenic*" or "*anthropos*," meaning made from human activity. The primary reasons causing the Earth system to undergo radical change are listed below (Steffen, et al., 2004):

- *In the last 150 years, humankind has exhausted 40% of the known oil reserves that took several hundred million years to generate.*
- *Nearly 50% of the land surface has been transformed by direct human action, with significant consequences for biodiversity, nutrient cycling, soil structure, soil biology, and climate.*
- *More nitrogen is now fixed synthetically for fertilisers and through fossil fuel combustion than is fixed naturally in all terrestrial ecosystems.*
- *More than half of all accessible freshwater is appropriated for human purposes, and under- ground water resources are being depleted rapidly in many areas.*
- *The concentrations of several climatically significant greenhouse gasses, in addition to carbon dioxide and methane, have substantially increased in the atmosphere.*
- *Coastal and marine habitats are undergoing a change; 50% of mangroves have died out, and wetlands have shrunk by one-half.*
- *About 22% of recognised marine fisheries are overexploited or already depleted, and 44% more are at their limit of exploitation.*
- *Extinction rates are increasing sharply in aquatic and terrestrial ecosystems around the world; the Earth is now in the midst of its first great extinction event caused by the activities of a single biological species (humankind).*

The empirical observations of certain parameters from 1750 until today show us how the drivers of change have shifted. At the global scale, the pattern of the curve between this timeframe increases for the twelve indicators that depict human activity. For example: primary energy use, world population, urban population, real GDP growth, foreign direct investments, large dams, water extractions, paper production, fertiliser consumption, transportation, telecommunications and international tourism. These indicators have impacts on significant environmental components of the Earth system. Carbon dioxide, methane release from agriculture, nitrous oxide from air pollution, surface temperatures, stratospheric ozone layer depletion, overfishing in the oceans, ocean acidification, nitrogen overload, shrimp aquaculture crisis, deforestation, land expansion and terrestrial biosphere degradation are all examples of this.

As humankind is confronted with social, natural, financial and ecological limitations, it is becoming clearer that we are close to exceeding the "limits of the nature". Since 2003, the four cheap nature elements (labour, food, energy, raw materials) have become more expensive. The gradual depletion of cheap natural elements was underpinned by a long cycle of world economic expansion and "new extractivism", in its varied forms. Rather than perceiving the end of cheap nature as the reassertion of external limits to growth, Moore argues that capitalism, in our time, has exhausted the historical relation that produced cheap nature (Moore, 2014), i.e. labour costs are increasing and will continue to increase in the future. As a consequence of climate change, suppression on yield productivity of many crops like alfalfa, beans, peanuts, potatoes, rice, soy, and wheat, along with the continuing failure of the genetically modified organisms "revolution" to revive yield productivity growth, the world is coming to the end of the era of cheap food. Moreover, the world has "new" problems with capitalism that are currently emerging, which cannot be fixed by the old technological regimes, such as new diseases, superbugs or superweeds.

The post-fossil energy regime, which is the world's new energy paradigm, is based on the physics and economics of renewables and is being reflected in the landscape as distributed, decentralised and diversified patterns of power generation. However, the transition from fossil to post-fossil energy regime has been a slow process. The transition to renewable energy requires even more appropriate social institutions and economic forms (Altvater, 2010 S. 54). Such a 'renewable revolution' refers to involving a radical transformation of the patterns of production and consumption, life and work, gender relations and the spatial and temporal organisation of social life (Altvater, 2010 S. 54). There are some essential factors, which make the whole practice even more difficult. First, the existence of big players in the energy arena. The global giant energy companies have a powerful share and influence in power generation (electricity supply companies) and energy distribution (grids and pipelines) (Altvater, 2010). Furthermore, the transition of the production patterns (including technologies) of the fossil fuel era and the primary components (production plants, infrastructures), along with main drivers (profit seeking, global and market competitiveness, mental support), efficiency and consistency of energy consumption and the corresponding consumption patterns (including petrifying and concreting infrastructures), transport, municipal planning, and sufficiency, is performed. In the post-fossil era, the renewable energy scheme will become dominant and "residual". The integration of the fossil energy system into the renewable regime will occur as a result of this.

3. CONVENTIONAL ENERGY SOURCES OF TURKEY

3.1. Oil

Turkey's economy is one of the fastest growing economies in the world. Although the Turkish economy was scaled down during the global economic crisis of 2009, the country achieved a 12.4% increase in annual growth in 2010. In 2012, the Turkish economy slowed down. After growing 4.2% in 2013, the economy again slowed to 2.9% in 2014 (The World Bank, 2017). The election-related uncertainties, geopolitical developments and concerns over the Turkish Government's handling of corruption allegations, tarnished confidence and weakened private demand. Despite distrusting consumers and long-winded election uncertainty, Turkey achieved a 4.2% economic growth in 2015. (The World Bank, 2017). According to the economic outlook data of *Focus Economics*, economic growth in Turkey will likely weaken in the coming quarters, due to tighter financial conditions, shaky investor sentiment and a high oil import bill as a result of growing crude oil imports. The economic growth is expected to total 3.5% in 2019 (Focus Economics, 2018).

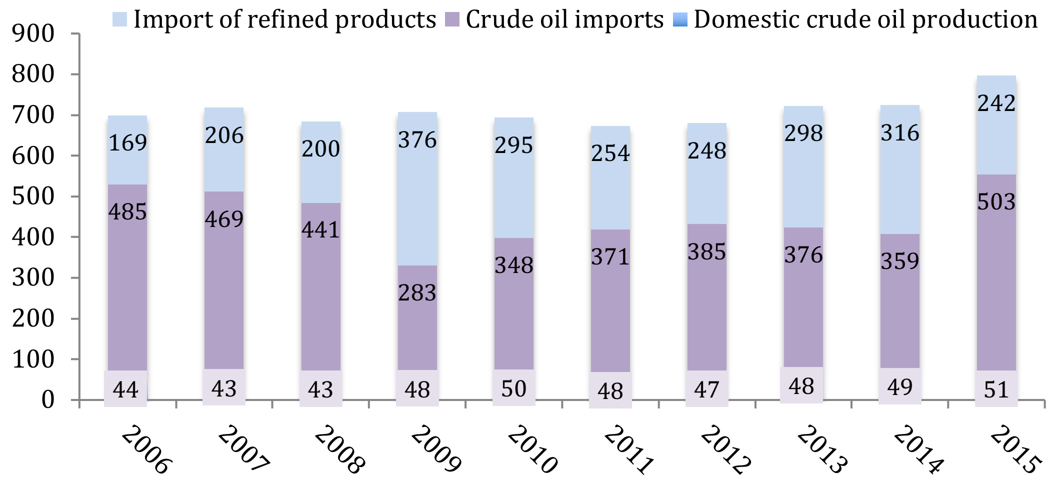
As a fossil-energy-dependent country, Turkey, with its scant amount of conventional resources, is not able to meet its rising energy demand with domestic crude oil. The estimations and exploration activities of the U.S. Geological Survey, TP, Shell Oil and Mobil have shown that Turkey has neither the sufficient amount of crude oil resources, nor the necessary infrastructure and technological competence to perform oil drilling activities. The U.S. Geological Survey estimated that there are around 438 million barrels of oil, yet undiscovered, in the South-eastern onshore part of Turkey, in the Batman and Adiyaman provinces. Further deposits are located in Thrace in the Northwestern region. Shell Oil have determined that the oil located at Paleozoic levels would be recoverable and further investigations proved significant deposits in central Anatolia under the salt flats in the plain north of Konya (Chapin Metz, 1995). To expedite the exploration process, in 1983 the Turkish government facilitated the easing of regulations on exploration activities, allowing foreign companies to export 35% of production from fields discovered in Anatolia and 45% from offshore fields. The explorations showed that the oil deposits of Turkey are at very deep levels. However, it was not possible to discover how large the oil deposits might be.

TP, Shell Oil and Mobil controlled most of the petroleum output, which had climbed gradually to a peak of 3.6 million tonnes in 1969 but declined to about 2.1 million tonnes in 1985 as deposits depleted. By the early 1990s, output had increased once again to nearly 4.4 million tonnes. The main petroleum project during the 1980s was an attempt at secondary recovery at the Bati Raman fields in the south-eastern Anatolia, which were expected to produce roughly 1.5 million tonnes a year over a twenty-year period (Chapin Metz, 1995).

After the liberalisation package came into force in 1984, several foreign firms started their exploration activities. Until the mid-1990s no major findings had been reported. Only TP pushed up their oil exploration efforts at home and in the offshore areas, in expectation of raising output. However, the escalating conflict with Kurdish rebels in the south-eastern part of Turkey jeopardised their prospects. After several attacks and bombardments on oil installations by the PKK, the western operators in the area became concerned with the safety of their operations. Mobil, one of the major operators in the area, restricted their operations to 3,200 barrels of oil per day in Selmo field and at other smaller sites, after terrorist attacks on their staff. Shell Oil's 25,000 barrels of oil per day capacity rig, near the Batman refinery, was also attacked by terrorists several times.

In 1991, British Petroleum began its exploration activities in offshore areas of the Black Sea. However, hopes for finding reserves offshore were shattered as BP's oil exploration failed to locate any reserves in the marine regions of Turkey's northern coastline, despite this, the explorations in the Black Sea coastline continue (OGIB Research Team, 2013). Projections that the Aegean shelf contains substantial petroleum deposits, also exist. However, due to tense relationships between Greece and Turkey, the exploration prospects in the Aegean Sea continue to be on standby. Turkey's domestic oil production has remained almost the same over the years and has only a slight contribution to the country's total energy mix (Figure 2). As a consequence, Turkey remains heavily dependent on oil imports and will do so as long as diversification of the primary energy sources remain unimplemented. The gradual integration of renewable energy sources to the primary energy production is necessary for further progress in this area.

Figure 2. Turkey's domestic crude oil production, imports of crude oil and other products (in bbpd)



Data source: Own illustration based on the data from (Turkish Petroleum, 2016).

The rapid economic boost caused an expansion in Turkey's oil consumption. In 2015, Turkey's crude oil consumption reached over 710 thousand bpd (EIA 2015c). The country produced 2.5 million tonnes of crude oil, less than half the peak production of 4.4 million tonnes in 1991 (IEA, 2016). This was produced from 1,334 crude oil wells in 134 different production areas, mainly in the Batman and Adiyaman provinces in the south-east Anatolian region. Turkish Petroleum, the country's dominant oil and gas exploration and production company, produced around 75% of this total amount of crude oil. Onshore oil production achieved around 17.5 million barrels and offshore oil production amounted 12.9 million barrels.

Over the past decade, net crude oil imports have increased by 7.2%, while net imports of oil products have grown by 260% (IEA, 2016). Because Turkey produces only a small amount of crude oil, to meet its huge rate of oil consumption, the country imported 89% of its oil supplies, which is around 25.1 million tons of crude oil. The major crude oil imports were 45.6% from Iraq, followed by Iran with 22.4%, Russia with 12.4% and Saudi Arabia with 9.6%. Other countries holding smaller shares in Turkey's crude oil imports are Columbia with 3.5%, Kazakhstan with 2.6% and Nigeria with 2.1%

(MFA, 2017). In 2016, the country exported 14.6 million tonnes of petroleum products and imported 10.8 million tonnes (MFA, 2017).

Oil imports have seen volatility for decades in accordance with economic growth and regional production curves. Iran, Iraq and Saudi Arabia have been representing the largest shares in Turkey's oil imports. The share of Russian crude oil in total imports has declined sharply from 37.9% in 2007 to 12.4% in 2015 (IEA, 2016). The crude oil imports from Egypt and Libya have almost run out.

The Turkish MENR, General Directory of Petroleum (PIGM), TP and EPDK are the primary entities involved in the oil sector. MENR is responsible for the definition of targets and implementation of energy policies in coordination with public and private entities. The PIGM is the principal policy-making body within the MENR. It executes energy policies and conducts studies on energy markets, energy policy, efficiency and environment. EPDK is the regulatory agency for the downstream market in Turkey, which monitors actual pump prices, issues licenses to oil companies and retailers and defines and supervises quality standards. TP, founded in 1954, is a state-owned national oil company, involved in hydrocarbon exploration, drilling, production, refinery and marketing activities. It also actively conducts production and exploration projects in Azerbaijan, Kazakhstan, Iraq and Libya. The corporation is one of the biggest investors in the Caspian region and has been carrying out activities in the area for more than twenty years.

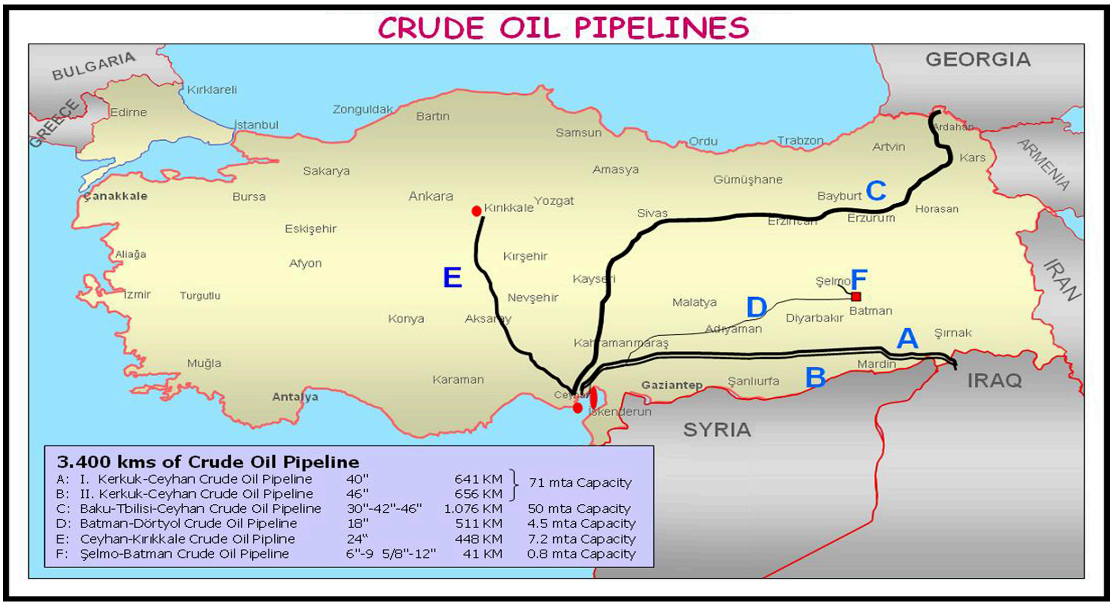
Turkey restructured its upstream regime to attract investment in local production. The new Turkish Petroleum Law No. 6491, enacted on June 11, 2013, is streamlining the liberalisation of the oil and gas exploration and production activities and guaranteeing a more transparent investment environment for the industry (IEA, 2016).

In Turkey, the downstream market is open, and pricing is liberal (GIZ International Fuel Price database, 2014). Petroleum downstream activities are governed by the Petroleum Market Law No. 5015. EPDK carries out the regulatory oversight of the activities and monitors the nearest-accessible global free market prices and Turkish petroleum market prices (IEA, 2016). Nevertheless, prices for gasoline and diesel fuel are among the highest in the world because of high excise taxes on fuel (OECD, 2016). This is due to the huge domestic debts and budget deficits, which Turkey has always encountered. Accordingly, the country is benefiting from the high motor fuel taxes to raise revenue to bridge its financial gap. According to Erkan Erdogdu, former senior energy market specialist at the EPDK, "the main reason for relative high fuel taxes in Turkey has mostly been purely fiscal; that is, revenues are needed for fiscal consolidation, and fuel taxes are relatively difficult to evade compared with Turkey's income tax system" (Erdogdu, 2014).

3.1.1. Oil Pipelines

In the domestic network of Turkey, there are 28 active transmission companies. The main crude oil pipelines in operation to transport domestically produced crude oil are: Batman-Dörtyol, Şelmo-Batman and Ceyhan-Kırıkkale. There are also two international crude oil pipelines running through the country, which are: Baku-Tbilisi Ceyhan (BTC) and Iraq-Turkey (Map 1 and Table 1). The total length of the three crude oil pipelines reaches to 3.374 km. In 2012, the annual handling capacity was 2,8 million bpd (IEA, 2013). BOTAS is responsible for the operation of these pipelines.

Map 1. Domestic and international crude oil pipelines of Turkey



Data source: (BOTAS, 2018).

Table 1. Currently Operating Crude Oil Pipelines (COP) of Turkey

Pipeline	Capacity (Mt/year)	Start of operation	Length (km)			Supply origin
Baku-Tbilisi-Ceyhan COP	50	2006		Turkey	Total	Caspian region (Azerbaijan and Kazakhstan)
				1,076	1,776	
Iraq-Turkey COP	70.9	1977/1987		Turkey	Total	Iraq
			I. Line	641	986	
			II. Line	656	890	
			Total	1,297	1,876	
Ceyhan-Kirikkale COP	7.2	1986		448		Connecting Ceyhan port and oil refinery
Batman-Dörtyol COP	4.5	1967		511		Transport of oil produced in southeast Anatolia to Dörtyol terminal

Data source: Own illustration based on the data from (BOTAS, 2018).

The 511km long **Batman-Dörtyol** Crude Oil Pipeline, began operation in 1967 under Turkish Petroleum, before being transferred to BOTAS in 1984. The annual capacity of this pipeline is 4.5 million tonnes. The pipeline transports crude oil produced in south-eastern Anatolia region to the Dörtyol Marine Terminal (IEA, 2013). In 2014, the transport of 2.5 million tonnes (17.7 million barrels) of crude oil took place through this line (BOTAS, 2014). The 42km long **Şelmo-Batman** Crude Oil Pipeline has an annual capacity to transfer 5.7 million barrels of crude oils produced in the Şelmo area to the Batman Terminal. This pipeline, however, has not been active since 2007. **Ceyhan-Kırıkkale** Crude Oil Pipeline is 448km long and has an annual capacity to transfer 5 million tonnes (TÜPRAS, 2018).

Two major international crude oil pipelines are running through the country: Kirkuk-Ceyhan (Iraq-Turkey) and Baku-Tbilisi-Ceyhan. Additionally, to prevent possible maritime accidents and to enhance the security for the straits, Turkey signed a protocol with the Russian government for another oil pipeline: Samsun-Ceyhan by-pass oil pipeline. Thanks to the proximity of Samsun to the oil outlets on the Eastern Black Sea, the seaborne transportation of oil in the Black Sea was minimised. Despite having better environmental conditions, this pipeline project fell into abeyance, as it was not economically competitive enough.

3.1.1.1. Baku-Tbilisi-Ceyhan Crude Oil Pipeline

Baku-Tbilisi-Ceyhan (BTC) is the largest component of the East-West Energy Corridor and carries the crude oil from Azeri-Chirag-Güneşli field through Azerbaijan and Georgia to Ceyhan on the Mediterranean coast of Turkey, bypassing the environmentally-critical Black Sea and the Turkish Straits (MFA, 2017). The idea of constructing a new oil pipeline on the East-West route had emerged in the early 1990s in Turkey. There were several reasons for the new oil pipeline project: Firstly, following the Gulf War, the Kirkuk-Yumurtalik pipeline that had been transporting Iraqi oil to the Turkish Mediterranean port Ceyhan, was closed under the United Nations Security Council resolution 661 in 1990. The resolution had a heavy, negative economic impact on Turkey. Secondly, the potential value of Central Asian and Caspian oil reserves were considered on the condition that they were accessible to western customers. Therefore, the need for a safe and secure route out of the Caspian Sea emerged. Thirdly, as a NATO member and strategic partner of the U.S. and Western Europe, Turkey believed that it was possible to gain leverage in the region with the construction of the new pipeline. As opposed to their competing major suppliers; Iran and Russia, a Turkish partnership with Azerbaijan was formed, which helped to reinforce future integration into regional and international institutions of this newly-independent state. It also increased Turkey's strategic importance. Turkey was not the only country whose decision primarily stemmed from geopolitics. Azerbaijan also believed that shipping its oil to markets through an oil-scarce, NATO member country would bring long-term energy security, compared to shipping via countries that had huge local amounts of oil sources. Ultimately, the Azerbaijani International Operating Company (AIOC) consortium preferred BTC pipeline as the cheapest and most secure option for exporting oil to the world markets. The U.S. was widely engaged and supported the BTC pipeline project (Baran, 2005).

The Turkish Foreign Ministry strongly promoted the BTC pipeline, asserting that the logistical, environmental and security related problems, resulting from the substantial increase in traffic through the Turkish Straits, would diminish when the BTC began to operate. In this context, the Turkish policy was primarily focused on ensuring the environmental health and security of the Turkish Straits and particularly those of Istanbul. On the contrary, the oil companies considered the Straits to be the cheapest option commercially, compared to the pipelines for the transportation of Caspian oil (Baran, 2005). It took some time for the companies to recognise that the BTC pipeline was a more sustainable and commercially beneficial option for transportation of crude oil in the long term.

BTC is a major part of the "east-west energy corridor" project, which was initially created by the US government to transport rich oil and gas sources in the Caspian Sea and the Middle East, securely to the West. It also facilitated Turkey's aim to become a major energy player in the region. Turkey's close relations with the U.S. from the mid-1990s until 2000 played a significant role in the development of BTC and the overall east-west energy corridor projects. One of the main reasons behind the US support for BTC was to ensure the transportation of Caspian oil to market, via a stable NATO ally, rather than through Iran or Russia (Baran, 2005). Another driving force for the project was Turkey's environmental and security concerns regarding the maritime route passing via the Turkish Straits.

The BTC began operation in 2006 by BOTAS in Turkish territory. BP p.l.c. owns 30% of BTC, while Azeri company Azerbaijan SOCAR holds 25%. Other major shareholders are US Chevron (8.9%), Norway's StatoilHydro (8.7%), Turkish Petroleum (6.5%), Italy's Eni (5%) and France's TOTAL (5%) (SOCAR, 2016). In 2011, this pipeline brought 257.2 million barrels of crude oil from the Caspian Sea to Turkey (IEA, 2013).

3.1.1.2. Kirkuk-Ceyhan (Iraq-Turkey) Crude Oil Pipeline

The operation of this pipeline started in 1976, transporting oil produced in Kirkuk and other locations in Iraq to Ceyhan (Yumurtalık) Marine Terminal (MFA, 2017). Through the implementation of various projects, the annual capacity of the line reached 70.9 million tonnes in 1987. In September 2012, Iraq and Turkey agreed to extend Iraqi crude oil import through this pipeline by 15 years (IEA, 2013). The transport of oil from the Kurdish Region occurs through the Kirkuk-Ceyhan pipeline to Turkey. In 2013, the Kurdistan Regional Government (KRG) completed construction of a new pipeline, beginning at Taq field near Erbil in the KRG-controlled portion of northern Iraq and joining the existing pipeline to Ceyhan, Turkey, near the Iraq-Turkey border. The crude oil flows on the KRG line are low, as the Iraqi central government objected to the KRG selling oil without the approval or involvement of the central government. In 2015, 26.1 million tonnes (192.4 million barrels) of crude oil were transported through this line (BOTAS, 2015). Furthermore, exports differ from month to month due to the security issues on both sides of the Turkish-Iraqi border and long-standing dissensus between the KRG and the central Iraqi government regarding the sharing of oil revenues. The pipeline is perpetually under the threat of the PKK terrorist organisation. The PKK has sabotaged pipelines carrying crude oil from the Kurdistan Region's oil fields to Turkey many times in the last decades.

Turkey, benefiting from its geographical advantage, offered a low cost and reliable transit option for exporting oil to the international market. Due to its geopolitical position, Ceyhan (Yumurtalik) Marine Terminal was identified as a major trading and energy hub for crude oil in the region. Since the construction of an oil refinery and an LNG terminal, more than one million barrels of crude oil per day are currently exported from Ceyhan Terminal to the global markets (MFA, 2017).

Both the BTC and Kirkuk-Ceyhan pipelines are transit pipelines. All the crude oil reaching the Port of Ceyhan is delivered to the world market (IEA, 2016). So far, Turkey has not purchased crude oil from the BTC, but is benefiting from all indirect revenue generated within the BTC project. Furthermore, the country will collect $140-200 million in the first 16 years of the project and $200-300 million in the next 17 to 40 years, depending on the amount of oil transported, transit fees and operations services payments. There have been some ongoing discussions regarding Turkey's non-purchasing agreement with the BTC and financial losses for the country's economy. The crude oil delivered through the Kirkuk-Ceyhan pipeline is occasionally supplied to the Turkish market. Both the BTC and the Kirkuk-Ceyhan oil pipelines are important for the oil supply security of external countries rather than Turkey's own energy supply security (IEA, 2016).

Turkey aims towards an uninterrupted and dependable gas and oil flow from Caspian Basin and Middle East resources to Turkey and Europe via Turkish territory. In 2015 Turkey imported 503 billion bpd of crude oil and some 242 billion bpd refined products. Regarding crude oil import sources, Iraq amounted the biggest supply source with 29% of the total. The other important supplier countries were Russia (18%), Iran (14%), India (8%) and Saudi Arabia (6.5%). The imported crude oil pipelines are delivered to the refineries by tankers and pipelines. Turkey has many major oil ports, which are oriented mostly towards oil products, particularly diesel oil: Antalya, Mersin-Ataş, Trabzon, Hopa, Izmir-Aliağa, Gemlik, Tekirdağ, Izmit, Iskenderun, Zonguldak, and Istanbul. Among these, the Samsun, Mersin- Ataş, Izmir-Aliağa, Izmit and Istanbul ports also have the capacity to unload other petroleum products, such as jet fuel and gasoline

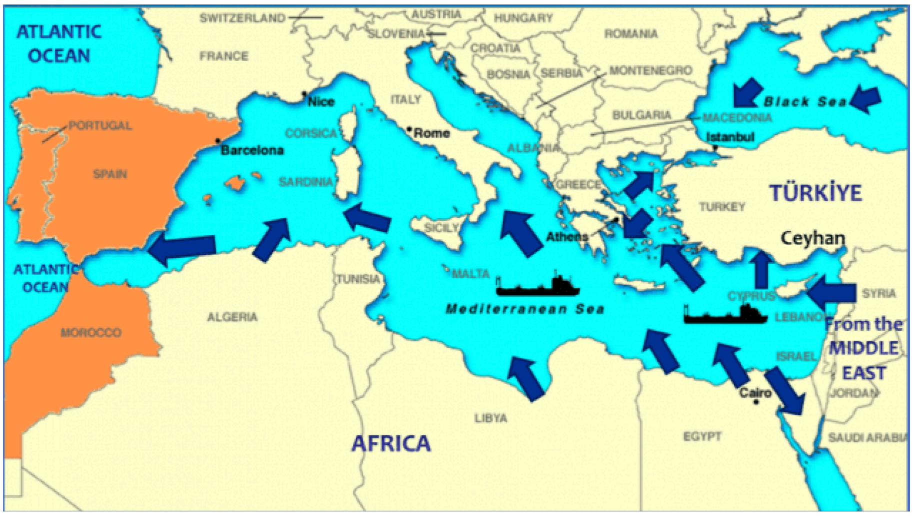
(IEA, 2013). TÜPRAS is Turkey's sole oil refiner, operating four refineries, located in Izmit, Izmir Kirikkale and Batman, with a total annual crude oil processing capacity of 28.1 million tonnes. While Izmit and Izmir refineries import crude oil by tankers, Kirikkale and Batman refineries deliver crude oil by pipelines. Izmit and Izmir refineries each have an annual processing capacity of 11 million tonnes crude oil. Kirikkale Refinery has the capacity for 5 million tonnes crude oil processing per year, and its crude oil supply is delivered via Ceyhan Terminal of BOTAS and Ceyhan-Kirikkale Pipeline. Batman Refinery, as the first founded refinery of Turkey, processes 1.1 million tonnes crude oil annually (TÜPRAS, 2018).

Turkey is a significant energy corridor bringing oil exports from energy-rich Eurasian and Middle East countries to energy-deficient Europe and other global markets. Concerning its geopolitical position, Turkey is one of the safest routes for the direct transmission of energy fuels via pipelines. The country's ambition to become a key energy and trade hub dates back to 1990s. The idea is to increase the interdependency between countries and to maintain stability. In this respect, major pipeline projects, realised and proposed, will contribute to Europe's energy supply security and will also enhance Turkey's role as a reliable transit country on the East-West as well as North-South energy axis (MFA, 2017).

3.1.2. Political Conflicts and Turkey-Cyprus-Israel Energy Triangle

The Eastern Mediterranean region is the gateway to the Middle East, the Mediterranean, the Aegean, the Black Sea, the Red Sea and the Atlantic Ocean. The region is a gateway for Africa to the aforementioned seas. The estimations show that 47% of world's proven oil reserves and 43% of world's proven natural gas is located in the Eastern Mediterranean. Due to these facts, Cyprus, with its strategic location and its status as one of Turkey's most sensitive political issues, is also a strategically crucial land for the United Kingdom, Russia, China, Israel, the United States, the European Union and, of course, for Greece (Pamir, 2018).

Map 2. World trade transit routes via Mediterranean Sea



Data source: (Pamir, 2018).

Almost 30% of world trade transits travel via the Mediterranean basin (Map 2). Approximately 4,000 cargo and commercial vessels travel through the Mediterranean on a daily basis, with 40,000 Russian vessels alone passing through the Turkish Straits annually. The geopolitical landscape of Mediterranean, particularly Cyprus, is crucial as it is also close to the Suez Canal, which is one of only three gateways to oil and natural gas reserves and the Mediterranean itself. The island is also home to the American tracking and early response station, as well as an intervention point both for the United Kingdom and the USA (Pamir, 2018).

According to the estimations of the U.S. Geological Survey, about 438 million barrels of oil are as yet undiscovered in the southern onshore part of Turkey, near Cyprus (USGS, 2012). Despite the ambiguity surrounding whether these resources will be economically viable to develop, in 2012 Turkish Petroleum began drilling for oil and gas onshore, at 3,000 meters deep, near the town of Trikomo. They did this in collaboration with the Turkish Republic of Northern Cyprus government (BBC News, 2012). This initiative from Turkey created some geopolitical tangles in the area. The Republic of Cyprus protested against Turkey and the Turkish-Cypriot leadership, claiming their drilling was illegal and in contravention of United Nations resolutions on the island and violation of the sovereignty, independence and territorial integrity of Cyprus (BBC News, 2012). In response to this argument of the Republic of Cyprus, Turkey propounded that no government has the right to negotiate over the territorial waters of Cyprus, until the territorial situation of the island is clarified.

This problematic issue with Cyprus stemmed from the division of the Cyprus Island between the Greek Cypriots in the South and the Turkish Cypriots in the North, which took place following a 1974-military coup that resulted in Turkey's military intervention as a peacekeeping measure. Since the "Treaty of Guarantee" in 1960, the United Kingdom, Greece, and Turkey are the three postcolonial guarantor powers of Cyprus. Officially, Turkey does not recognise the Republic of Cyprus and entitles the country as "Greek Cypriot Administration of Southern Cyprus." Furthermore, Turkey and Northern Cyprus have no diplomatic relations with the Republic of Cyprus. Turkey also refuses to open its port and airports to the Republic of Cyprus, claiming that the EU has fallen short of its commitment to trade with Northern Cyprus (Gotev, 2016).

The main issues on which Turkey and Greece disagree are the: "re-sharing of the island's soil to Turkish and Greek sides, the guarantor system and property issues" (Daily Sabah, 2017). According to Mustafa Akinci, President of Northern Cyprus, the "requests from the Turkish side are clear: an egalitarian solution is the only possible option, with a two-sided federal system" (Daily Sabah, 2017). A referendum on the Annan Plan in 2004 saw the majority of Turkish Cypriots back reunification, while more than three-quarters of Greek Cypriots rejected it. A possible reunification of Cyprus remains improbable.

In the second half of 2012, the Modiin Energy and Adira Energy Corporations announced that they had discovered 232.2 million barrels of oil and 1.8 trillion cubic feet of natural gas at their offshore Gabrielle and Yitzhak Licenses, which are 24 kilometres northwest of Tel Aviv (Oster, 2012). More than a year later, after Turkish Petroleum had started its drilling activities, Italian Eni signed exploration and production-sharing contracts, in partnership with South Korean company Kogas, for three deep-water blocks in offshore Cyprus. The contract included blocks 2, 3 and 9 in the Cypriot deep offshore portion of the Levantine basin, which encompasses an area of around 12,530 km^2. In September 2014, 'Saipem 10000' drillship began its drilling activities in the Cypriot waters, on behalf of the joint Eni/Kogas venture (Offshore Energy Today, 2014).

Turkey does not lean toward to any oil or gas company that works with Cyprus for exploring activities. Therefore, the Turkish government strongly protested the energy exploration of the Republic of Cyprus in the Mediterranean, claiming that the company's drilling activities in the Turkish-Northern Cyprus area were illegal. Accordingly, in March 2013, Turkey decided to suspend its energy projects with Italian energy group Eni due to the company's involvement in oil and gas exploration activities in the coast of southern Cyprus. Furthermore, the Turkish government declared that companies could be precluded from future Turkish energy investments if they became involved in Greek Cypriot energy exploration work (Hürriyet Daily News, 2013).

In the latter half of 2013, Turkey's Barbaros Hayrettin Paşa seismic vessel, which had been drilling oil and gas exploration tests off the coast of the Mersin-Iskenderun-Antalya region in the eastern Mediterranean, wanted to enter 'exclusive economic zones' of the Republic of Cyprus, in order to continue its exploration activities (Hürriyet Daily News, 2013). Greek Cypriot authorities declared the exploration activity of Turkey as the "most serious escalation of a dispute that has long simmered since the declaration of a breakaway Turkish Cypriot state in north Cyprus in 1983" (Kambas, 2014). The European Parliament also condemned the actions taken by the Turkey, called on Turkey to remove the vessels operating in Cyprus' exclusive economic zone and to stop its "provocative actions" and "threats" against the Republic of Cyprus (European Parliament, 2014). The Northern Cyprus government described the European Parliament's resolution as unrealistic and called on the Greek Cypriot government to "cease blame-games and return to the negotiation table so that a lasting and comprehensive settlement to the Cyprus problem can be found at once" (Offshore Energy Today, 2015).

Currently, a total of 2,000 bcm offshore gas have been discovered in the exclusive economic zones of Cyprus, Israel, and Egypt. In comparison, the annual consumption of natural gas in the EU was 426 bcm in 2015. In this case, the discovered reserves in the exclusive economic zones need to be enough to meet the annual energy requirements of the EU. In the Cypriot exclusive economic zones, there is already a significant discovery, the "Aphrodite" field (Gotev, 2016). In 2015, the Eni/Kogas joint venture drilling ship located gas in the Zohr prospect in Egyptian waters. It is recorded as the largest gas discovery ever made in the Mediterranean. The location of Zohr is about six km from the boundaries of Cyprus' block 11 and about 90 km from the Aphrodite reservoir in block 12 (Offshore, 2016).

A possible resolution for the Turkish-Cypriot energy conflict made headway in the beginning of 2014. The Turkish- and Greek-Cypriot leaders met to relaunch negotiations to end the island's division, after a nearly two-year break. According to experts, changing dynamics in the region, created by the island's undrilled offshore gas and oil riches and a huge natural gas basin found in waters of Israel, triggered this breakthrough (Charalambous, 2014). According to the U.S. Geological Survey estimations, Israel and Cyprus discovered an estimated 3,450 bcm gas reserve in the Levant Basin, which was worth around US700 billion dollars and could meet the gas supply needs of the entire world for a year (EurActiv.com with Reuters 2016). Assoc. Prof. Dr. Hubert Faustmann from the Nicosia University argued that "Turkey and Israel's energy cooperation has triggered an American intervention and forced both sides to agree on a joint statement leading to a resumption of talks (…) Israel is looking to diversify by gas pipeline through the sea of Cyprus and Turkey and invest in an LNG plant on the island, but Israel will not give its gas to Cyprus unless there is a solution" (Charalambous, 2014). The discovery of new natural gas and oil reserves in the Eastern Mediterranean brought a new catalyst for harmonisation, peace and possible cooperation in the region.

Turkey and Israel have had volatile relations both in political and energy terms over the years. Both countries centre upon the discovery of enormous reserves of natural gas, worth hundreds of billions of dollars, under the waters of Israel and Cyprus. To utilise these reserves, Israel requires the cooperation of Turkey (EURACTIV.com with Reuters, 2016). On top of high drilling costs, another fundamental concern for Israel has been to find a route for gas delivery to potential customers. Jordan, which has a peace treaty with Israel, was an option, as they were long-term buyers of Israeli gas. A possible gas delivery route through Lebanon and Syria, both neighbouring countries of Israel, was inconceivable, due to the conflict between the countries. Instead of these, Turkey and Egypt, both having a big market, with 80 million and 93 million people respectively, ultimately fit much better as potential long-term consumers (EURACTIV.com with Reuters, 2016). Historically, Italian Eni found one of the world's largest natural gas fields off the coast of Egypt, resulting in Egyptian President Abdel Fattah al-Sisi declaring that Egypt would focus on developing its energy resources. Consequently, the Turkish route became a more convenient and reasonable option for Israel, leading to Turkey playing a significant connection hub role between East and West, Asia, Middle East and Europe (EURACTIV.com with Reuters, 2016).

Diversifying energy imports and energy supply routes is one of the major targets and energy strategies of Turkey. Turkey imports almost 60% of its gas –around 27 bcm gas annually- from Russia. Due to the country's high dependency on Russian gas, Israeli gas could be an alternative to decrease natural gas import dependency on one supplier. Major energy companies of Turkey, such as Zorlu Enerji and a consortium of Turcas and

Enerjisa have already begun negotiations with Israel over gas prices and potential pipeline routes. The companies stated that there is a potential of around 30 bcm of gas annually in Levantan Basin, of which Turkey could buy 8-10 bcm per year. This amount of gas delivery would support Turkey to reduce almost 37% of its gas dependency from Russia. The estimations show that there are significant amounts of gas in the territorial waters of the Republic of Cyprus (EURACTIV.com with Reuters, 2016). If Israel intends to use the Turkish route, at least a part of the planned pipeline would have to pass through Cypriot territorial waters first.

3.2. Natural Gas

According to the International Energy Statistics of the EIA and Oil and Gas Journal, over the past 20 years the world's proved natural gas reserves have grown by about 40% to a total of 196.8 tcm as of January 1, 2016 (EIA, 2016). Furthermore, during the same period, proven reserves in the non-OECD region as a whole have grown by 43% (54.1 tcm), while proven reserves in the OECD region increased by 21% (2.9 tcm). As a result, the share of world proven natural gas reserves located in OECD countries has declined from 10% to 9% over the past 20 years (EIA, 2016).

When considering the top ten countries, holding the largest natural gas reserves in the world, Russia is holding the biggest share of the global reserves with 24.2% (47.8 tcm) followed by Iran with 17.1% (33.8 tcm), Qatar with 12.6% (25.1 tcm), U.S. with 4.8% (9.5 tcm), Saudi Arabia with 4.1% (8.2 tcm), Turkmenistan with 3.8% (7.5 tcm), the United Arab Emirates with 3% (6.1 tcm), Venezuela with 2.8% (5.5 tcm), Nigeria with 2.5% (5.1 tcm), and Algeria with 2.2% (4.5 tcm) (EIA 2015a). Azerbaijan does not rank among the top 20 countries. Under these circumstances, it is unlikely that Azerbaijan will be a reliable gas supplier to Europe in the future. It is, however, expected that Azerbaijan's future in natural gas production will come from the Shah Deniz gas field. Industry analysts assert that Shah Deniz is one of the world's largest natural gas field discoveries in the last 20 years and therefore can meet Europe's energy demand (EURACTIV.com, 2012).

Natural gas has been one of Turkey's most strategically important industrial sectors, due to its direct and indirect impact on economic development and growth (Rzayeva, 2014). In Turkey, the first natural gas reserve was discovered in the Hamitabat and Kumrular areas by the TP and was used for the first time in the

Pinarhisar Cement Factory in 1976. Due to the rapid population growth, the wave of industrialisation, and the search for a solution to the substantial air pollution, Turkey decided to increase its share of natural gas, as an alternative energy resource. For this purpose, Turkey and the Union of Soviet Socialist Republics (USSR) signed an agreement for the first import of natural gas in 1984. In 1986, BOTAS (Turkey) signed a natural gas purchase-sale agreement with Soyuzgaz Export (USSR) lasting 25 years, with a plateau value of 6 bcm (EPDK, 2016).

In pursuit of this purchase and sale agreement with Russia, construction of the 842km long Russia-Turkey natural gas pipeline began in October 1986. The pipeline entered Turkey in Malkoclar, on Turkey-Bulgaria border, reached Hamitabat and then followed the route of Ambarli, Istanbul, Izmit, Bursa, Eskisehir, finally reaching Ankara in August 1988 (EPDK, 2015). As the first natural gas discovery and generation only happened in 1987, from the year 1976, as the first natural gas import took place, a limited amount of 747 mcum gas for generation and consumption was achieved (EPDK, 2015).

Natural gas was used by the residential and commercial sectors for the first time in Ankara in October 1988, Istanbul in January 1992, Bursa in December 1992, Izmit in September 1996 and in Eskisehir only a month later in October 1996 (EPDK, 2015). In 2001 "Natural Gas Market Law No. 4646" entered into force to liberalise and create a transparent and competitive natural gas market and to replace the previously monopolistic structure of the market. The law and its accompanying regulations brought significant liberalisation targets to the Turkish natural gas market over the preceding decade. Nevertheless, the government's position and long-standing aspirations for the liberalisation of the market were not in accord with that of BOTAS. Most of these targets were still remaining unmet and the ineffective domestic gas regulation was still existent. The following is an overview of the biggest obstacles, preventing Turkey from becoming a sustainable gas hub in the global energy arena:

- There is still a lack of competition in the natural gas market.
- BOTAS, as a dominant market player, has a monopoly over the gas transmission network.
- The Natural Gas Market Law intended at limiting gas imports of BOTAS from 80% to 20% of total consumption by the end of 2009. Nevertheless, on May 2013, the Law was revised and changed to a 50% reduction of BOTAS' imports by an unspecified date (The revised version of the Law has not yet approved by the

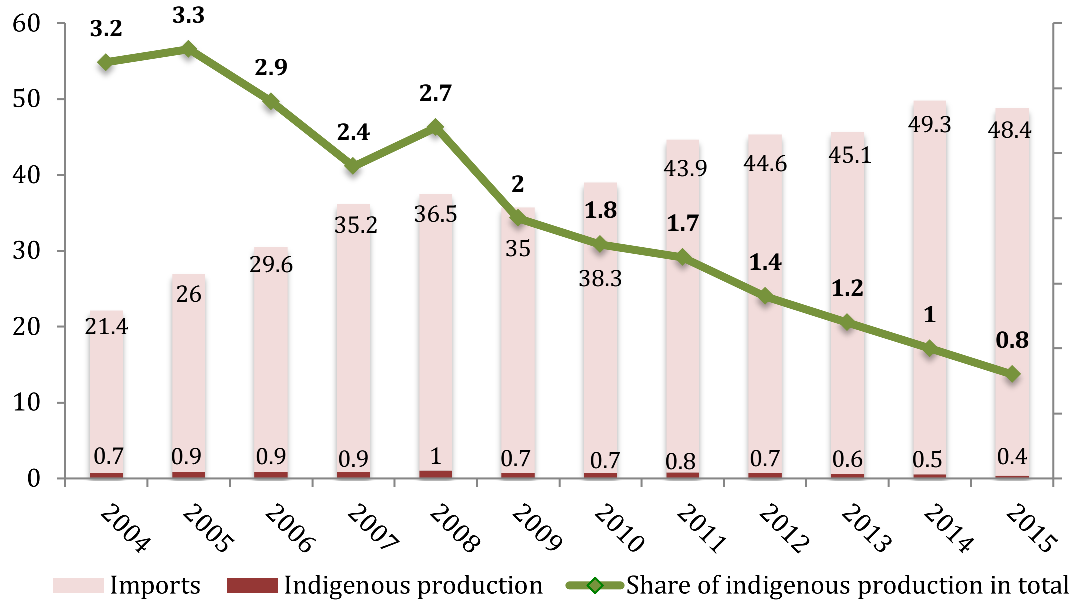
National Parliament of Turkey). In 2015, BOTAS still managed almost 75% of all gas imports and 80% of domestic gas sales.

- BOTAS subsidises domestic natural gas prices between 15-20% because of the high price of imported gas, especially from Iran (whose price is the highest). The Turkish government reimburses BOTAS through state subsidies. The enforcement of the cost-based pricing system and unbundling BOTAS into four different corporate bodies (import, transmission, storage, sales) would provide a competitive market for the private players, but BOTAS resists implementing this system. As a result, both the state and BOTAS itself suffer financially from the contractually binding oil indexation of the gas price formula in the contracts (Rzayeva, 2014).
- It is a vital element for the countries like Turkey, which highly depends on natural gas imports, to have a storage capacity equivalent at least between 20% to 30% of consumption. Nevertheless, Turkey has a severe shortage of gas storage facilities, which equate to only 6% of consumption. Having limited storage capacity is a significant obstacle in establishing supply security.
- None of the sectors (industry, household, power generation) are capable of using an alternative product other than gas by any possible gas disruption.

3.2.1. The Proportion of Natural Gas Imports in Turkey's Energy Dependency

Turkey imports almost 99% of the natural gas it consumes. Regarding natural gas demand growth, Turkey has ranked second to China in the last decade. Since 2005, Turkey's natural gas net imports have grown by almost 80%, driven by higher gas consumption in the residential sector, following large-scale gasification, rising private investments in gas-fired power plants and growing consumption in the industry sector (IEA, 2016). Domestic natural gas production experienced a sharp decline since 2008, from 1.0 bcm to 0.4 bcm in 2015, representing less than 1% of domestic gas demand (see Figure 3)

Figure 3. Turkey's indigenous natural gas production and natural gas imports (in bcm) and the share of domestic production in total gas supply



Data source: Own illustration based on the data from (Turkish Petroleum, 2016).

According to the estimations of BOTAS, Turkey's gas demand will almost double to 81 bcm by 2030 from 47.2 bcm in 2015 (MFA, 2017). The first and main driver of this rapid growth will be gas-fired electricity generation, where demand, according to BOTAS' forecasts, will most likely grow up to 45 bcm per year by 2030 (Rzayeva, 2014). The natural gas demand is very high, despite the government's energy target to reduce the share of natural gas in the electricity generation sector from the current 45% to 30% or below and their aims to replace it with domestically-produced coal, lignite, renewable energy and nuclear (Rzayeva, 2014). The second driver is the household sector, where estimated demand will grow from 9.3 bcm in 2014 to 22.7 bcm in 2030. The primary driver is the industrial sector, where estimated demand will rise from 12.4 bcm in 2014 to 14.2 bcm in 2030 (EPDK, 2015).

Based on the 2014 data of the EPDK, the energy conversion sector was the largest consumer of natural gas in Turkey, amounting 23.4 bcm and representing about 48% of the country's total gas consumption. This sector includes electricity, heat, auto producer heat and/or electric power plants. The industry and residential sector consumed 12.4 bcm and 9.3 bcm natural gas, which represented 25% and 19%, respectively. Service, transportation, and other areas consumed only small amounts of natural gas (EPDK, 2015). The substantial natural gas demand growth in the residential sector occurred as a result of the gasification of the south-eastern part of the country and the vast construction of new housing and apartment blocks. The gas distribution system in Turkey covers all provinces, except for Artvin in the north-east and Şirnak and Hakkari in the south-eastern part of Turkey. For these areas, it is asserted that the investment would not be economically feasible. The construction work for the gas transmission lines to Tunceli, a province in the eastern part of Turkey, is currently underway.

Table 2. Natural gas import agreements of Turkey

Agreement	Date of signature	Date of gas delivery	Duration (years)	Quantity (bcm³/year)	Date of termination
Russia (Westward)	Feb 1986	Jun 1987	25	6	2011 (*)
Algeria (LNG)	Apr 1988	Aug 1994	20	4	2014 (**)
Nigeria (LNG)	Nov 1995	Nov 1999	22	1.2	2021
Iran	Aug 1996	Dec 2001	25	10	2026
Russia (Blue Stream)	Dec 1997	Feb 2003	25	16	2028
Russia (Westward)	Feb 1998	Mar 1998	23	8	2021
Turkmenistan	May 1999	-	30	16	-
Azerbaijan	Mar 2001	Jul 2007	15	6.6	2022

(*) The contract has terminated at the end of December 2011.
(**) Turkey renewed its LNG agreement with Algeria in 2014. The new contract will run for 10 years and Turkey will import 4.4 bcm of LNG annually from Algeria.
Data source: Own illustration based on the data from (EPDK, 2015).

In 2015 Turkey imported in total approximately 48,4 bcm natural gas from the above indicated (Table 2) supplier countries. 40.8 bcm natural gas of this total amount came through the pipelines. The major natural gas suppliers as follows: 55% (26.8 bcm) came from Russia, followed by Iran with 16% (7.8 bcm), and Azerbaijan with 13% (6.2 bcm) (see Table 3). Due to insufficient storage capacity, a heavy dependency on regular natural gas by the business sector and supply chain diversification strategy (Kilic 2016), Turkey also imported a total of 7.6 bcm LNG. More than half of the LNG imports (3.9 bcm) came from Algeria. The rest of the LNG imports were supplied by Qatar with 1.7 bcm and Nigeria with 1.2 bcm.

Table 3. Distribution of Turkey's gas imports resources between 2005 and 2015 (bcm)

Countries - Years	Russia	Iran	Azerbaijan	Algeria (LNG)	Nigeria (LNG)	Others (Spot LNG)	**Total**
2005	17.5	4.2	0	3.8	1.0	0	**26.5**
2006	19.3	5.6	0	4.1	1.1	0.1	**30.2**
2007	22.8	6.0	1.2	4.2	1.4	0.2	**35.8**
2008	23.2	4.1	4.6	4.1	1.0	0.3	**37.3**
2009	19.5	5.2	5.0	4.5	0.9	0.7	**35.8**
2010	17.6	7.7	4.5	3.9	1.2	3.1	**38.0**
2011	25.4	8.2	3.8	4.1	1.2	1.1	**43.8**
2012	26.5	8.2	3.3	4.1	1.3	2.5	**45.9**
2013	26.2	8.7	4.2	3.9	1.3	0.9	**45.2**
2014	27.0	8.9	6.0	4.2	1.4	1.7	**49.2**
2015	26.8	7.8	6.2	3.9	1.2	2.5	**48.4**

Data source: Own illustration based on the data from (EPDK, 2016).

After Germany, Turkey is the second largest consumer of Russian gas and paid Gazprom $10 billion in 2014 (Clemente, 2016). For Turkey, a reduction in external imports would signify less dependence on one supplier country and one supply route, as well as less current account deficit. Turkey needs to coordinate its energy imports, gain more negotiation powers over Russia and ensure more protection against any possible delivery disruptions.

Due to the tense regional political situations and disputes with the Iraqi Central Government, Turkey did not see the Kurdistan Regional Government's gas as a viable option until recently. Nevertheless, the country seeks to diversify its natural gas imports, particularly following the breakdown of ties with Russia and now maintains a cordial relationship with its south-eastern neighbour, the Kurdistan Region, for a possible gas delivery agreement. An interdependent energy relationship between the Kurdistan Region and Turkey may help Turkey to abandon its strong opposition against the self-determination of Iraq's Kurds, in their drive to achieve independence and statehood (Iddon, 2016).

The Kurdistan Region may hold around 5.6 tcm of natural gas reserves, around 3% of the world's total reserves. The exploration activities are continuing, and the expectation is that more gas reserves will be located. By the year 2019 or 2020, large volumes of gas are expected to flow through a Kurdistan Regional export pipeline to Turkey, at the Fish Khabur border (Kurdistan Regional Government, 2013).

While the talks concerning a possible natural gas agreement between Turkey and the Kurdistan Regional Government go on, the Group of Communities in Kurdistan (KCK) announced their strong opposition to any agreement which would bolster Turkey's economy. The KCK is an organisation founded by the PKK to put into practice the political ideology of jailed instigator Abdullah Öcalan. Under these circumstances, pipeline construction would be under the constant threat of sabotage, which has the potential not only to generate devastating results in various aspects of the region, but also to claim lives.

An agreement between Turkey and Kurdistan on hydrocarbon resources would also assist the Kurdish Regional Government in overcoming the economic crisis which it has suffered over the past years. Similar to other hydrocarbon-rich countries, the Kurdish Regional Government also depends mainly on hydrocarbon revenues to create stability and security within the country, since this, high dependency prevents the country's ability to diversify in other sectors.

3.2.2. Transmission and Pricing System of Natural Gas in Turkey

Based on the Natural Gas Market Law No. 4646, private companies are authorised to invest in and build their transmission and distribution lines. Nevertheless, currently all the transmission lines are owned by the state pipeline company BOTAS and no other companies have applied for a license to build a pipeline.

In Turkey, BOTAS is responsible for the operation of the transmission of natural gas countrywide. The length of natural gas transmission and distribution lines reached over 118,000km in 2015 from 4,510km in 2002. 12,964km of this structure is natural gas transmission line (MENR, 2015). The country has, in total, nine entry points: four through international pipelines, two LNG terminals, two national production areas and one storage facility (International Energy Agency 2013). BOTAS natural gas transport system has nine main entry and exit points (EPDK, 2016):

1) from Azerbaijan through Türkgözü,
2) from Iran through Dogubeyazit-Gürbulak
3) from Russia through Malkoclar (Balkan)
4) from Russia through Durusu (Blue Stream),
5) through LNG terminals at Marmara Ereglisi

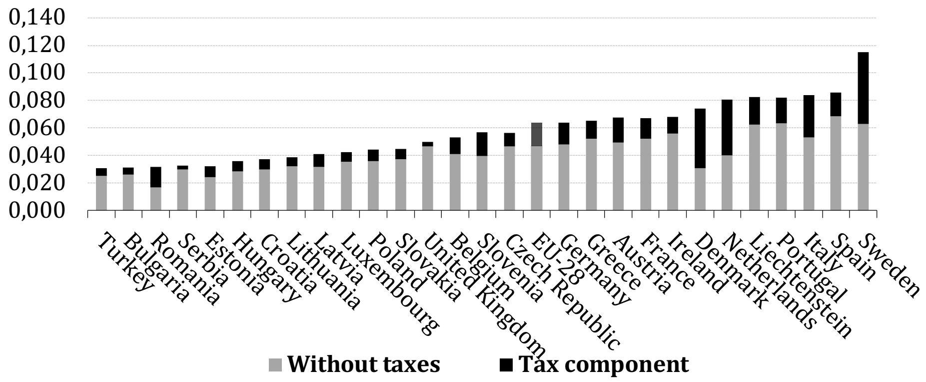
6) through LNG terminals at Egegas Aliaga,
7) from the Turkish Petroleum underground store at Silivri/Degirmenköy,
8) from two production sites in Turkey: Turkish Petroleum Akcakoca Cayagzi Production and,
9) TEMI Edirne Production

In 2015, approximately 50.2 bcm of natural gas entered Turkey from these main access points. 84.2% of these natural gas entries were distributed by BOTAS, and 15.8% was carried out by other private import and wholesale companies. 49.9 bcm of this total natural gas delivery was domestically consumed through the transmission network (EPDK, 2016).

A total of 14 gas basins can be found in Turkey. The largest of these is Marmara Kuzey, an offshore field in the Sea of Marmara in the Thrace-Gallipoli Basin. Predominantly, three companies carry out the gas production: Turkish Petroleum, BP P.L.C., and Shell. Some natural gas fields have been brought onstream in the Black Sea; including, the Akçakoca, East Ayazlı, Akkaya and Ayazlı fields. The largest supply for Turkey's natural gas demand came from Russia via the Blue Stream pipeline. Moreover, a remarkable volume of gas is distributed to the larger populated cities like Istanbul and the Marmara region via the Bulgaria-Turkey line. By the end of 2015, Turkey imported 733 mcf gas via the Tabriz-Dogubayazit pipeline.

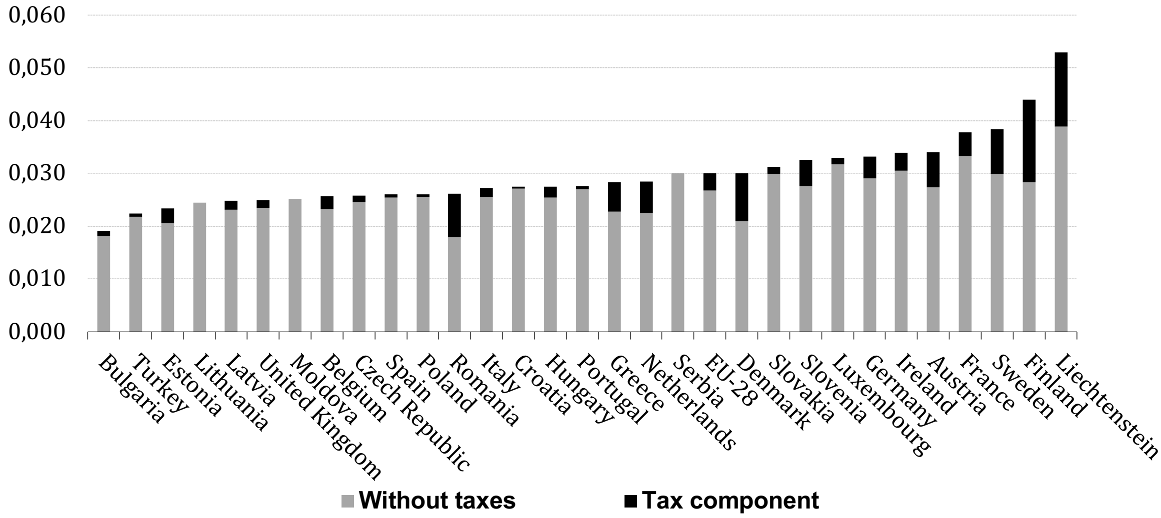
Up until now, Turkey's high domestic natural gas prices and ever-growing energy demands have aroused the interest of foreign investors. By international comparison, despite the price increases each year, natural gas prices, for both the industrial and household customers in Turkey, tend to be lower than many other countries in Europe (see Figure 4 and Figure 5).

Figure 4. Natural gas prices and tax components for household consumers in Turkey and EU member states in 2016 (EUR/kwh)



Data source: Own illustration based on the data from (eurostat, 2017).

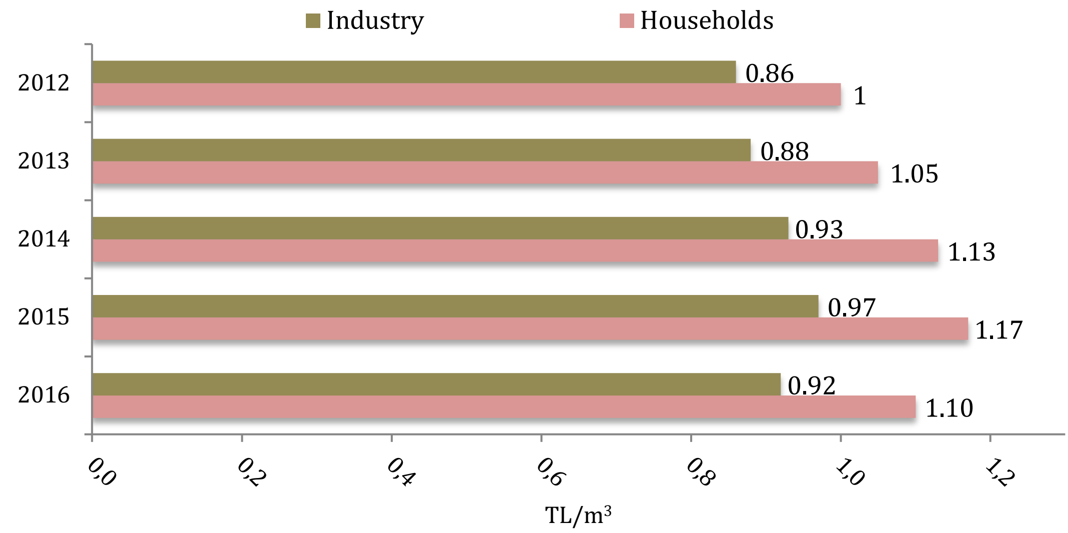
Figure 5. Natural gas prices and tax components for industrial consumers in Turkey and EU member states in 2016 (EUR/kwh)



Data source: Own illustration based on the data from (eurostat, 2017).

In 2016, the natural gas for industrial consumers in Turkey, in relation to the EU-28, had the lowest cost, with an average of 96.9 kurus ($0.30) per cubic meters. Turkey's household customers, after Hungary and Romania, also paid the smallest price for natural gas consumption in the EU, with an average of 1.2 Turkish Lira ($.40) per m³ (see Figure 6).

Figure 6. Natural gas prices in Turkey for households and industry between 2012-2016



Data source: Own illustration based on the data from (TUIK, 2016).

For a country like Turkey with scant natural gas sources, it is important to control the market by setting a pricing strategy. Therefore, the market opening is in force for wholesale, but does not apply to the household and larger retail consumers. The natural gas prices for households are set by the government, which gives the government crucial leverage to govern the market, without a direct involvement (Rzayeva, 2014). Households still benefit from very low prices, given that distribution companies are obliged to provide the cheapest offer, subsequently making no margins (IEA, 2016). Each year, EPDK determines the threshold to enable all consumers to freely choose their supplier. Wholesale prices are determined by the sellers and buyers in the market, and not by the EPDK. Retail prices vary according to the retail group and the distribution regions (IEA, 2016). The government has also leverage in the industry, particularly in the power generation sector, through its subsidy activities (Rzayeva, 2014).

Generally, power generation and prices are the main determinants of natural gas demand growth or decline in Turkey's energy profile. On the one hand, BOTAS sells natural gas, at subsidised prices, to companies for power generation; On the other hand, the government subsidises natural gas for households which makes it extremely burdensome, as both sides buy natural gas for a high price and sell it for low prices (Rzayeva, 2014). Therefore, in case of high prices, if the proposed plant is installed, Turkey will try to meet the demand mainly with domestically produced hard coal and lignite and driving towards nuclear in the future. Nevertheless, even the full utilisation of coal and lignite resources for power generation are not enough to meet the rising energy demands of Turkey. Instead, the renewables have abundant potential to bridge the energy gap. Furthermore, in the case of a global decline in gas prices, Turkey would have the edge to reduce its single supplier dependence, build a competitive gas market, and further implement its plans to operate as a regional gas hub.

3.2.3. Natural Gas Pipeline Network in Turkey

Turkey produces only a small amount of natural gas. In 2015, Turkey produced 398.7 mcum natural gas, from 240 gas wells in 78 production areas, while consuming around 47.5 bcm natural gas (MENR, 2015). Therefore, in order to function as a gas transit country, adequate amounts of gas need to be pumped from gas supplier countries to Turkey, both to meet country’s domestic energy demand and to provide gas transportation via pipelines to Europe. Primarily during the heating season months (from November until March), Turkey's natural gas demand is quite high. Moreover, Turkey has faced several supply disruptions and power cuts due to terrorist attacks on pipelines, in critical regions like East- and South-eastern of Turkey. The PKK has threatened the security of pipelines and the entire Turkish territory for over thirty years. The Tabriz-Dogubayazit Pipeline and Baku-Tbilisi-Erzurum Pipeline have previously been hit by the Kurdish rebel militants by a series of explosions (Table 4).

Table 4. Turkey's currently available natural gas import pipelines and capacities

Pipeline	Origin	Operated by	Approximate Capacity (in mcf)
Blue Stream	Russia	Gazprom	1,550
South Caucasus (Baku-Tbilisi-Erzurum)	Azerbaijan	South Caucasus Pipeline Consortium	820
Tabriz-Doğubayazıt	Iran	BOTAS	1,930
Bulgaria-Turkey	Bulgaria	Gazprom	2,000

Apart from the above illustrated pipelines, Turkey, as a significant transit country in the region, also participates in other international pipeline projects:

- Arab Gas Pipeline Project, which is intended to transport Egyptian gas to Turkey and Europe via Jordan, Lebanon, and Syria.
- Turkmenistan-Turkey-Europe Natural Gas Pipeline Project, which aims to transport total amount of 30 bcm Turkmen gas to Turkey (16 bcm) and Europe (14 bcm) (IEA, 2013).
- Iraq-Turkey Natural Gas Pipeline Project, which is in the planning stage to be constructed in parallel to the existing Kirkuk-Ceyhan Crude Oil Pipeline (IEA, 2013).

3.2.3.1. South Caucasus Pipeline

Since the discovery of the Shah Deniz gas field in 1999, over 40 bcm of gas have been supplied to Azerbaijani, Georgian and Turkish consumers. Shah Deniz is one of the world's largest gas-condensate fields, holding over 1 trillion m^3 of gas. This gas field can produce around 10 bcm of gas annually and approximately 50,000 barrels a day of condensate (BP Georgia, 2017). The operations of Shah Deniz Phase I began in 2006, suppling gas for the South Caucasus (also known as Baku-Tbilisi-Erzurum) Natural Gas Pipeline.

The South Caucasus is a 692 km-long pipeline, which has been designed to transport natural gas from the Shah Deniz Phase I gas field in the Azerbaijani sector of the Caspian Sea, via Georgia, to Turkey (MFA, 2017). The South Caucasus Pipeline Company, a consortium of seven national and international energy companies, owns the pipeline. The companies of the consortium include BP P.L.C. (United Kingdom, also the technical operator) with a 25.5% share, Statoil (Norway, also the commercial operator) with a 25.5% share, SOCAR (Azerbaijan) with a 10% share, Lukoil (Russia) with a 10% share, NICO (Switzerland) with a 10% share, Total (France) with a 10% share and TP (Turkey) with a 9% share (Hydrocarbons Technology, 2016). Since 2007, 6.6 bcm of gas has been shipped to Turkey annually, through the Shah Deniz Phase I project.

At full capacity, after the newly planned stages of development, it is envisaged that the pipeline will export up to 25 bcm of gas annually. The expanded South Caucasus Pipeline system will tie into the Trans-Anatolian Natural Gas Pipeline (TANAP) at the Eastern Turkey border, which will connect with the Trans Adriatic Pipeline at the Western Turkey border, some 1,900 kilometres away (BP Georgia, 2017).

3.2.3.2. Trans-Anatolian Natural Gas Pipeline (TANAP) and the Caspian Dispute

All pipelines, which transport Caspian gas to Europe, need to pass through Turkish territory. With this in mind, Turkey aims to offer a safe, consistent and reliable transit system. TANAP is perceived as the backbone of the Southern Gas Corridor, which, in the medium term, is expected to transport Shah Deniz II gas to Europe (Rzayeva, 2014). A concrete step was made on June 26, 2012, in Istanbul, Turkey, as the Azerbaijani and Turkish governments signed the "Intergovernmental Agreement" and the "Host Government Agreement" to implement the TANAP, which was proposed to create a stable and secure route for gas transport, across Turkey, to the border with Greece. The ground-breaking ceremony of the TANAP project was held on March 17, 2015, in Kars, Turkey. The TANAP project is part of a program of gas development in Azerbaijan and gas transmission from Azerbaijan through Georgia, Turkey, Greece and Albania to Italy. Turkey is the host country of this project, which is the first realisation of the Southern Gas Corridor (Nyman, et al., 2016).

The term Southern Gas Corridor is used to describe infrastructure projects aimed at improving the security and diversity of the energy supply of the EU, by bringing natural gas from the Caspian region to Europe (Nyman, et al., 2016). TANAP Dogalgaz

Iletim A.S. (TANAP Natural Gas Pipeline Company), is a company established under Turkish company law, to implement the TANAP project and own and operate the pipeline system upon project completion (Nyman, et al., 2016). The TANAP project can be propounded as a rather plausible alternative, in economic terms, to the partially eliminated EU flagship project Nabucco. TANAP is managed and operated by a consortium of energy companies, along with SOCAR (Azerbaijani State Oil Company), which holds a 58% share in the principal company. The other shareholders of the TANAP project are: BOTAS with 30% and BP P.L.C. with 12% (MFA, 2017). There are two alternatives to be considered with this project: The possibility of upgrading the current BOTAS pipeline network and/or construction of a new standalone pipeline across Turkey, to facilitate shipping of Azerbaijan's natural gas from the Shah Deniz II field.

The Shah Deniz gas field is operated by the BP P.L.C., which has a share of 28.8%. TP has the second largest share in Shah Deniz Field with 19%. The other co-ventures and their shares are as follows: SOCAR (Azerbaijan) 16.7%, Petronas (Malaysia) 15.5%, Lukoil (Russia) 10% and NICO (Iran) 10% (MFA, 2017). The first substantial amount of gas delivered via a route from Azerbaijan to Eskisehir, Turkey and from there to Europe through TANAP, is expected in June 2018 – with 2 bcm, initially. Saltuk Düzyol, the General Director of TANAP in Turkey, has claimed that this volume will reach 6 bcm over three years. The sale of gas in Turkey will be carried out by BOTAS.

The upstream project Shah Deniz Phase II is expected to provide 16 bcm per annum gas to millions of consumers in Georgia, Turkey, Greece, Bulgaria, and Italy. 6 bcm per annum gas will be sold to Turkey and the remaining 10 bcm per annum gas will be supplied to Europe. The initial capacity of 16 bcm of gas per annum (first stage), is expected to expand to 24 bcm per annum by 2023 (second stage) and to 31 bcm per annum by 2026 (third stage). This will take place upon construction of the required additional compressor stations (TANAP Dogalgaz Iletim A.S., 2016). The estimated initial investment cost of the 1,850 kilometres-long-pipeline will be $11.2 billion (Abbasova, 2016).

TANAP will start from the Turkish border with Georgia, beginning in the Turkish village of Türkgözü, in the Posof district of Ardahan. It will run through 20 provinces (from east to west): Kars, Erzurum, Erzincan, Bayburt, Gümüshane, Giresun, Sivas, Yozgat, Kirsehir, Kirikkale, Ankara, Eskisehir, Bilecik, Kütahya, Bursa, Balikesir, Canakkale, Tekirdag, Edirne and will end at the Greek border in the Ipsala district of

Edirne. From this point, the Trans Adriatic Pipeline will connect the natural gas to the European gas markets (Nyman, et al., 2016). The pipeline will be able to transport approximately 73% of annual Turkish natural gas consumption. This amount of gas exceeds the annual imports from Russia and will affect Russia's future market shares, not only in Turkey, but also in its traditional European market (Rzayeva 2014). The pipeline's capacity will be 30 bcm per year. Azerbaijan expects to double its current gas production to 50-65 bcm annually, between 2025 and 2030 (Rzayeva, 2014).

The political advantages of TANAP for Turkey are certainly quite important. The project may contribute significantly to growing political leverage of Turkey in the broader context of Europe, the Black Sea, the Caspian Sea, the Middle East and Mediterranean regions, by enhancing the country's strategic position as a reliable partner and an important transit country (Rzayeva, 2014). Turkey will thus realise its long-term strategic goal, to become a major energy hub between Eastern suppliers, rich with hydrocarbon sources and European markets, in need of energy imports. Moreover, the Turkish and Azerbaijani governments have decided that the TANAP project will be managed under the Turkish Law. This ordinance gives Turkey the additional benefit of not only controlling the legal processes, but also managing financial issues. Thereby, all the revenues of the TANAP project will be regulated by Turkish law, including various taxes, duties and other payments (Rzayeva, 2014).

There are, however, different arguments as to whether the operation of TANAP will allow Turkey to diversify away from Russian gas and import cheaper gas from Azerbaijan. On the one side, TANAP is very much welcomed and supported by the EU. Through the TANAP project, Turkey gains not only economic gains from transit fees, but also political leverage over its partners in Brussels and Baku. On the other side, some Turkish observers argue that due to high transmission tariffs, the gas through TANAP will be more expensive than Russian gas. Moreover, it remains unclear whether there will be sufficient gas for both the TANAP and, eventually, for the planned Southern Gas Corridor from Shah Deniz field.

In the light of these uncertainties, Azerbaijan has taken the initiative to begin negotiations with Turkmenistan, to allow Turkmenistan to supply gas to TANAP, in the second phase. According to the estimations, between 10 bcm and 30 bcm of Turkmen gas could reach Azerbaijan annually, through the Trans-Caspian Pipeline, if Turkmenistan agrees to a long-term agreement with European customers. Up until now, Turkmenistan has preferred to sell its gas at its border, and, so far, not ventured downstream (Shaban, 2016).

More crucially, there are still disputes about the legal status of the Caspian Sea, which must be determined before the construction of any pipeline infrastructure. For much of the twentieth century, the Caspian Sea was the exclusive domain of Iran and the Union of Soviet Socialist Republics, with the latter enjoying naval dominance (Janusz, 2005). With the collapse of the Soviet Union, the geopolitical situation in the region changed significantly. Instead of two, there are now five littoral states, which share the natural heritage of the Caspian Sea: Kazakhstan (30.8%), Turkmenistan (16.8%), Iran (18.7%), Azerbaijan (15.2%) and Russia (18.5%). For the last 25 years, Russia has simply blocked negotiations to define the legal status of the Caspian and, in one sense, hampered any pipeline developments between Europe and the littoral states of the Caspian.

The Caspian Sea is rich with vast amounts of oil and gas reserves, along with important transportation routes connecting Europe and Central Asia. In this sense, the Caspian has the potential to supply the world energy market. Nevertheless, the dispute over the legal regime of the Caspian Sea, raises many problems in the fields of international law (law of treaties, the law of the sea, environmental law) (Janusz, 2005). The legal status of the Caspian Sea largely depends on whether the Caspian Sea is a 'lake' or 'sea' regarding both geography and law (Siradze and Suleimanov 2013). If the Caspian is classified as a 'sea,' according to the United Nations Convention on the Law of the Sea provisions, each littoral state would have a 'territorial sea', with a breadth not exceeding twelve miles, an exclusive economic zone not exceeding 200 miles and a continental shelf (Janusz, 2005). If the Caspian is considered as a 'lake,' then the seabed will be divided evenly between all littoral states. Under this scenario, the crucial issue being that all countries would have to agree before a pipeline could be constructed across the Caspian (Coffey, 2015). Recognising the Caspian as an (international) lake also requires the use of the waters to be regulated by the international agreements of border states, which determine the lines of state borders, rights of navigation and terms of use of waters for non-navigational purposes (Janusz, 2005). Each littoral state has different claims regarding the demarcation of the Caspian seabed. Iran, with the shortest Caspian coastline, considers the Caspian to be a lake and demands to divide up the Caspian's resources equally five ways (Fitzpatrick, 2014). The three former Soviet states –Azerbaijan, Turkmenistan, and Kazakhstan- consider the Caspian to be a sea and, therefore, claim to divide the Caspian seabed along existing national borders (Coffey, 2015). On the other hand, Russia's position on the Caspian seabed ownership, is more complicated. Russia wants to remain strong in the area, in order to prevent other members from superseding it. Different ministries are pursuing different policies concerning the Caspian dispute. The Russian Ministry of Foreign Affairs considers Caspian to be a lake, believing that it will preserve Russia's dominant geopolitical role in the region. On the other hand, the fuel and power ministries and the oil and gas lobby consider the Caspian to be a sea, asserting that would create more opportunities for Russian companies to compete for more lucrative contracts (Coffey, 2015).

Through its cooperation and close diplomatic relations with Azerbaijan, Turkey aims to become a critical gateway for energy corridors between east and west, by offering diversification of routes and supplies to Europe, which will contribute to both the EU and Turkey's energy security policies. In order to accomplish its target, the conflict over the disputed offshore energy fields in the Caspian Sea must be resolved, in order to achieve an unhindered flow of gas and oil.

3.2.3.3. Trans Adriatic Pipeline

The Trans Adriatic Pipeline is the European leg of the Southern Gas Corridor, which aims to connect the EU market to new gas sources. The pipeline is designed to bring gas from Caspian region and potentially the Middle East, to the EU, thereby contributing to the further diversification of the European energy supply sources and routes. On June 2013, the Shah Deniz Consortium announced the implementation of the Trans Adriatic Pipeline, instead of the Nabucco West project. With a capacity of 10 bcm of gas per annum, the pipeline will transport gas from the Shah Deniz Phase II field in Azerbaijan to the EU market, as of 2020. Connecting with the TANAP at the Greek-Turkish border, the Trans Adriatic Pipeline will cross Northern Greece, Albania and the Adriatic Sea before coming ashore in Southern Italy, to connect with the Italian natural gas network. The builder and operator of the Trans Adriatic Pipeline is a joint venture consortium, including several energy companies: BP P.L.C. (United Kingdom, 20%), SOCAR (Azerbaijan, 20%), Snam (Italy, 20%), Fluxys (Belgium, 19%), Enagás (Spain, 16%) and Axpo (Switzerland, 5%) (Trans Adriatic Pipeline, 2016).

3.2.3.4. The Southern Gas Corridor

The Southern Corridor, a term used by the European Commission, was planned to contribute to energy diversification by opening up access to vast new gas supplies from the Caspian and the Middle East, whilst also bringing an end to Russian dominance in Central and South-Eastern Europe, which has been disproportionately dependent on Gazprom (Loskot-Strachota, et al., 2013).

Azerbaijan, Turkey and the EU are promoting, as partners, the development of the Southern Gas Corridor and cooperating to implement the TANAP project (Nyman, et al., 2016). The significance of the project was already stated in the European Commission's 2008 *Second Strategic Energy Review – An EU Energy Security and Solidarity Action Plan*: "A southern gas corridor must be developed for the supply of gas from Caspian and Middle Eastern sources, which could potentially supply a significant part of the EU's future needs. This is one of the EU's highest energy security priorities" (Nyman, et al., 2016).

Turkey has been a candidate country to the EU since the Helsinki Summit in 1999. The negotiations have since continued, from October 2005 (Nyman, et al., 2016). According to the data of the Turkish Ministry of Foreign Affairs, in the accession process, 13 chapters ("4-Free Movement of Capital", "6-Company Law", "7-Intellectual Property Law", "10-Information Society and Media", "12-Food Safety, Veterinary and Phytosanitary Policy", "16-Taxation", "18-Statistics", "20-Enterprise and Industrial Policy", "21-Trans-European Networks", "25-Science and Research", "27-Environment", "28-Consumer and Health Protection", "32-Financial Control") have been opened to negotiations so far, while one of them ("25-Science and Research") has been provisionally closed. The negotiations on eight chapters cannot be opened at present ("1-Free Movement of Goods", "3-Right of Establishment and Freedom to Provide Services", "9-Financial Services", "11-Agriculture and Rural Development", "13-Fisheries", "14-Transport Policy", "29-Customs Union" and "30-External Relations"), as a result of the decision of the European Council on December 2006. According to this declaration, no chapters can be provisionally closed because Turkey does not undertake its obligations stemming from the Additional Protocol to Ankara Agreement in its entirety (Turkey's position concerning Greek Cypriot Administration) (MFA, 2016).

The European Commission, in its Enlargement Strategy published on 12 October 2011, proposed to develop a "Positive Agenda" between Turkey and the EU. The

Commission mentioned a broad range of areas as the main elements of the Agenda, such as "intensified dialogue and cooperation on political reforms", "visas", "mobility and migration", "energy", "fight against terrorism", "further participation of Turkey in Community programs", "town twinning", "trade and the Customs Union" and "supporting efforts to align with the acquis, including on chapters where accession negotiations cannot be opened for the time being". Turkey has accepted the proposal on the condition that it serves as a supportive and complementary tool for negotiation process with the EU (MFA, 2016).

Although the energy chapter has not been opened for negotiations, energy is a topic of key interest in Turkey-EU relations and enhanced cooperation is an integral part of the Turkey-EU agenda (Nyman, et al., 2016). In Turkey, a range of reform measures helped attract private sector capital, to meet the rapid growth in energy demand. These actions include electricity, gas, renewable energy and energy efficiency legislation, the establishment of an energy sector regulatory authority (EPDK), energy price reform, the creation of a functional electricity market and large-scale introduction of natural gas, restructuring of state-owned energy enterprises and large-scale private sector participation through privatisation, including the entire power distribution and new investment with over 30,000 megawatts of electricity generation capacity (Nyman, et al., 2016). Nevertheless, due to its heavy dependence on hydrocarbon imports, the country appears to be heading towards a macroeconomic bottleneck soon.

Turkey supports all the Southern Gas Corridor projects passing through the Turkish territory (MFA, 2017). A total investment of approximately $45 billion and 3,500-kilometer-long Southern Gas Corridor crosses seven countries, involves more than a dozen major energy companies and comprises several separate energy projects. The components of the Southern Gas Corridor are (Trans Adriatic Pipeline, 2016):

- The Shah Deniz 2 development; drilling wells and producing gas offshore in the Caspian Sea.
- The expansion of the natural gas processing plant at the Sangachal Terminal on the Caspian coast of Azerbaijan.
- Three pipeline projects: South Caucasus Pipeline in Azerbaijan/Georgia, Trans-Anatolian Pipeline in Turkey and Trans Adriatic Pipeline in Greece, Albania, and Italy.
- The expansion of the Italian gas transmission network.

- The possibilities for further connection to gas networks in South-eastern, Central and Western Europe.

The current cost of Southern Gas Corridor, including upstream work on Shah Deniz Phase II, is now estimated at around $40 billion, including $9.3 billion for the Trans-Anatolian Gas Pipeline, $6 billion for the Trans Adriatic pipeline and $23.8 billion for developing Shah Deniz Phase II, as well as the expansion of the South Caucasus line (Shaban, 2016).

3.2.3.5. Turkey-Greece-Italy Interconnector

The overall Interconnector system is comprised of the Turkey-Greece Interconnector and Greece-Italy Interconnector onshore and offshore (Socor, 2016). The project includes three segments: expansion of the Turkish national grid for transmitting natural gas to Italy and Turkey, building a pipeline between Turkey and Greece and the building of a further pipeline between Greece and Italy (Hydrocarbons Technology 2015a). The 296km long Turkey-Greece Interconnector (Karacabey-Komotini) section, became operational in 2007. The annual capacity of the pipeline is 11.5 bcm. The investment cost of the pipeline was 165 million euros for the Turkish and 118 million euros for the Greek section (Hydrocarbons Technology, 2016).

The construction of the 807km long proposed Interconnector Greece-Italy segment, will take place in two sections: 207km underwater crossing the Ionian Sea and 600km ground section (Hydrocarbons Technology 2015a). The 207km section, known as the Poseidon pipeline, requires an estimated investment of 500 million euros. The 600km section, also known as IGI Onshore, is an onshore pipeline and was built by DESFA (Hydrocarbons Technology, 2016).

The Interconnector Greece-Bulgaria bypass line will be 181km long (150km in Bulgaria and 31km in Greece) and will connect the Greek gas network in Komotini with the Bulgarian gas network. This pipeline project and the Trans-Adriatic Pipeline (which also transports natural gas from the Caspian Sea, from Greece-Albania-Adriatic Sea-Italy and further to Western Europe), have the potential to turn Greece into an energy hub in southern Europe (Reuters, 2016).

3.2.3.6. TurkStream Natural Gas Pipeline

Turkey and Russia are interdependent, particularly in economic and energy terms. Russia, as Turkey's largest trading partner, supplies more than half of Turkey's natural gas consumption and one-fifth of its domestic oil needs. The share of natural gas in electricity generation is 48%, which is a clear indication of the country's high dependency on natural gas, to generate electricity. 70% of Turkey's gas imports from Russia come through the Trans-Balkan pipeline, which travels via Ukraine, through Moldova, Romania, and Bulgaria (Gurbanov, 2015). In winter alone, Turkey imports 48 mcum through Blue Stream and 42 mcum natural gas from Russia daily, through the West Stream. In the case of an energy crisis between both countries, Turkey does not have the manoeuvrability to diversify its energy sources in a short time and receive adequate amounts of gas from other suppliers, compared to Blue Stream and West Stream pipeline. Furthermore, the country is still very much behind on meeting its energy deficit with renewable energy sources, despite its great potential, particularly in wind, hydropower and geothermal energy. Turkey’s heavy dependence on Russian energy obligates the country to play this energy game by Russian rules. Turkey has many bilateral trade and infrastructure deals with Russia, which would be affected by any conflict, including the proposed construction of TurkStream pipeline and Akkuyu nuclear power plant projects. Considering the energy targets of the Energy Ministry of Turkey, gaining energy independence is of greatest importance. In order to reach this target, the country is planning to operate a nuclear powerplant, which, nevertheless, will be built by Russia. Turkey is thereby opening a new energy dependency chapter with the same country. Ultimately, Turkey’s energy policies do not seem parallel with its primary targets. The policies are ensuring further energy dependency and that engenders the strange irony that: Turkey needs Russia, to gain its energy independence from Russia.

Nabucco has emerged as the key project of the East-West energy corridor, in the supply of energy to Europe from the Caucasus and to give the Middle East a gas hub in Austria, via Turkey, Bulgaria, and Romania, South Stream. Simultaneously, a Russian-led project to side-line Nabucco and compete with the construction of an alternative pipeline to Europe, has also emerged. The construction of Nabucco was expected to start in 2013, with the first gas scheduled to flow in 2017. It was planned that the pipeline would carry 31 bcm gas per year (Gotev, 2015). Nevertheless, the Nabucco project is suspended and now only three smaller projects are available, to compete for the supply right to the EU, through the Turkish-EU border (Gotev, 2015):

- Nabucco West – via Bulgaria and Romania to Austria
- South East Europe Pipeline – via Bulgaria and Romania to Hungary

- Trans-Adriatic Pipeline – via Greece to Italy

Initially, South Stream was planned to start from the Russian coasts of the Black Sea, travel through Ukrainian waters in the Black Sea to Bulgaria, Serbia, Hungary, Bosnia and Herzegovina, Croatia, Austria and Italy, pumping 63 bcm of gas annually. However, due to political conflicts in Ukraine, Russia agreed with Turkey to re-route South Stream through Turkish seashores (Gurbanov, 2015).

On 1st December 2014, the Presidents of Russia and Turkey, Vladimir Putin and Recep Tayyip Erdogan, met in Turkey, where Putin announced significant issues like "the suspension of South Stream pipeline", "increasing gas supply for Turkey", "expansion of Blue Stream pipeline's capacity" and "6% gas discount for Turkey". On the same day, Turkish BOTAS and Russian Gazprom, signed a memorandum of understanding, to construct a new, offshore natural gas pipeline across the Black Sea to Turkey, named "TurkStream." A year later, Greece joined this joint enterprise, for the construction of a pipeline across Greek territory. As planned, the offshore part of the pipeline will cross the Black seabed. The length of the offshore section will be around 910km (Gazprom Export, 2017).

The new gas route also means a third gas link between Turkey and Russia, which increases the gas dependence of Turkey from 58% to 70%. The pipeline will surface on the shore of the European part of Turkey, near Kiyiköy, with a gas delivery point at Lüleburgaz, for the Turkish customers and as the distribution point for the European customers at Ipsala, the border crossing between Turkey and Greece (Map 3) (Gazprom Export, 2017).

Map 3. The planned route of the TurkStream Pipeline

Data source: Russia Business Today 2018.

The length of the Turkish onshore section will be 180km. The annual capacity of the pipeline will be 63 bcm. About 16 bcm gas will be supplied to Turkey, and the remaining 47 bcm gas is contemplated for the new gas hub, designed to be constructed on the Turkish-Greek border, which will then be further transported to Europe (Gurbanov, 2015).

In reality, a memorandum of understanding is non-binding for both parties, meaning many negotiations are needed to realise the TurkStream project. The experts hold different opinions concerning Turkey's pipeline agreement with Russia. Erdal Tanas Karagöl, an Economist from the SETA Foundation and a presumptive nominee of parliament from the AKP, sees the pipeline project as a positive decision. He discusses that Turkey's efforts regarding new energy pipelines, have now come into fruition. Moreover, he interprets the placing of Turkey at the centre of energy pipelines, makes Ankara an important agent in the decision-making process concerning energy subjects. On the other side, Cüneyt Kazokoglu, an energy market expert, assumes that natural gas and nuclear power agreements with Russia will only increase Turkey's energy dependence on Russia. He explains:

> "*Between 2003 and 2013 our natural gas imports from Russia are doubled: 13 bcm natural gas we imported in 2003, had increased to 27 bcm in 2013. Now with Turkey Stream, our energy dependency on Russia will even multiply. Therefore, Russia has the word and power again on the pipeline politics, not the Turkey*".

The construction of Akkuyu Nuclear Power Plant in Turkey will be carried out in collaboration with Russian Rosatom. Through this nuclear partnership, Russia hands over the operational control of the power plant, as well as the selling price of nuclear-powered electricity on the market. Besides this, Russian employees will work in the engineering department of this nuclear power plant. The necessary materials for the power plant will also come through the imports from Russia. Ultimately, Turkey will be dependent on Russia both in natural gas and nuclear energy.

Consequently, Turkey, by putting all eggs in one basket, will possess no space to bargain over import prices. The current data from EPDK shows that Turkey imported 49.2 bcm of natural gas in 2015. Russia has the highest share of 54.7% (26.9 bcm) in Turkey's gas imports (Anonym, 2015). To diminish the amount of natural gas imports, it is essential for Turkey to modernise its energy infrastructure and diversify its import supplies as much as possible. Diversification of gas imports will help the country to decrease the focus of its energy dependence being placed solely on one country. It will also reduce risks in the case of gas disputes between the supplier countries, such as the frequent gas conflicts between Russia and Ukraine.

Ensuring supply security is one of the fundamental elements required to achieve a sustainable economic growth. In this regard, transportation of natural gas to Europe via Turkey, with the TurkeyStream pipeline, will be one of the key determinants of providing energy supply security. Moreover, AKP has maintained its "axis expansion policy" since 2002, by improving its trade relations and partnerships with Russia in the energy field (BBC, 2014).

From the very beginning, South Stream was a project based on politics and not economic rationale. The project was terminated due to the EU's opposition to the pipeline, which it did not comply with the "Third Energy Package". The third energy package of the EU endeavours to introduce more competition by breaking up energy monopolies. In essence, this means that the supplying company cannot also own the pipeline. The pipeline must be held by a third-party in order to foster competition – a requirement that neither Gazprom nor the consortium members appreciated (Dempsey, 2014). From a legal point of view, since neither Russia nor Turkey is a member of the EU, they are therefore not bound by Third Energy Package rules, which makes the eventual construction of TurkStream much easier (Gurbanov, 2015).

3.2.3.7. Turkey – Qatar Pipeline

The construction of a proposed Turkey-Qatar Pipeline essentially dates back to the end of 1990s, as the "Greater Middle East Initiative" took shape. Prior to the September 11, 2001 terror attacks and the U.S. invasion and occupation of Iraq in March 2003, some of the neo-conservatives in the George W. Bush Administration declared that the U.S. policy of appeasement of authoritarian regimes in the Middle East had failed and that the US must move quickly to remove those regimes and establish democracy across the region (Girdner, 2005). Nevertheless, there is a lot of scepticism surrounding whether the Iraq war was launched upon the rationale of the establishment of democracy or not. The Middle East has moved towards more uncertainty in the wake of Iraq War and the Arab world remains further than ever from democratic norms and governance.

In the aftermath of September 11 events and the 2003 Iraq war, the U.S. and the EU have come to define terrorism as a common and global security threat. In early 2004, the Bush Administration launched the Greater Middle East Initiative, as "a forward strategy of freedom in the Middle East". However, the idea of Greater Middle East Initiative, developed by the US State Department, was to be another tool of imperialist control which could be used to secure the resources, labour and markets of the region, to beef up US global hegemony and secure corporate profits in the area. Theoretically, simultaneously ending any incentives for terrorism (Girdner, 2005).

As a result of raising objections from Europe, especially from the French government and under pressure of Arab countries like Egypt and Saudi Arabia, the initiative was laid aside in 2008. The initiative, which has once again, recently re-emerged, includes roughly three major components:

1) Swift regime changes: Restructuring the economic and political geography of the region and integrating it into the world economy as investment and cheap labour, which accordingly restores US hegemony.
2) Energy Security: The Middle East produces nearly 36.7% of the global crude oil and 15.7% of world natural gas. The region includes four of the top eight oil-producing countries in the world. U.S., China, Japan, India and four EU countries (Germany, Italy, France, Netherlands) import almost 60% of the total crude oil production from these countries. Regarding natural gas, Qatar is the only country, which exports natural gas from the region. The share of Qatar's total worldwide natural gas export is 14% (Russia has 21.4% share in comparison to Qatar). Five EU member countries (Germany, Italy, Slovakia, United Kingdom, France) alone import 30% of global natural gas production. Access to oil and gas sources in the Middle East, has become essential for China, the U.S. and Europe, as the region offers alternative energy routes and thus plays a major role in reducing European dependence on Russian gas.
3) The security of Israel: Although the first component of the initiative ended in failure, it served Israeli interests, enhancing their safety.

In 2009, Qatar brought the "Turkey-Qatar Pipeline" project to the table, which proposed the construction of a $10 billion, 1,500km natural gas pipeline starting in the Iranian-Qatari South Pars/North Dome Gas-Condensate field and travelling to Europe via Saudi Arabia, Jordan and Syria and Turkey. Through the immense pressure of the U.S. and Qatar's powerful lobbies in main European countries, the pipeline project, led by Qatar Petroleum, awakened the interest of several European companies (Escobar, 2015).

In this pipeline project, Turkey plays the role of being a key energy crossroad, which corresponds with Ankara's aim to set Turkey as the major energy transfer line for the whole of the EU. Moreover, if the project was realised, it could diminish Europe's dependence on Russian and Iranian gas resources and thereby Russia's strategic advantage over the EU. Nevertheless, Syrian President Bashar al-Assad refused to give permission for the pipeline to go through his territory and announced that he would not allow the pipeline to run through Syria in order "to protect the interests of their Russian ally" (Kennedy, 2016). According to Foreign Affairs, Russia put intense pressure on Assad to reject the pipeline, to safeguard its own business and prevent its position in European gas markets being undermined (Orenstein, et al., 2015). It is important to keep in mind that the proposed pipeline route of Qatar is not obliged to pass through the territories of Turkey and Syria. It could also easily cross Saudi Arabia, the Red Sea, Egypt and reach the Eastern Mediterranean (Escobar, 2015).

On this matter, in the Daily Star Robert F. Kennedy Jr. wrote, "…that the moment Assad rejected the Qatari pipeline, Saudi, Israel and the US military and intelligence planners quickly arrived at the consensus that fomenting a Sunni uprising in Syria to overthrow the uncooperative Bashar al-Assad was a feasible path to achieving the shared objective of completing the Qatar/Turkey gas link" (Jamal, 2016). General Wesley Clark, former European Supreme Allied Commander of the North Atlantic Treaty Organisation, stated in a 2007 interview with Amy Goodman on "Democracy Now", that soon after the 9/11 events, he had received a memo from the office of US Secretary of Defence Donald Rumsfeld: "This is a memo that describes how we're going to take out seven countries in five years, starting with Iraq, and then Syria, Lebanon, Libya, Somalia, Sudan and, finishing off, Iran" (Clark, 2007). Within the so-called ‘endgame regime changes program', Syria was the next country planned, after Iraq. There is a similar assumption in some quarters that the AKP decided to join the "swift regime changes" project, after Turkey's attempts failed to persuade Bashar al-Assad to give the green light for the pipeline.

In the meantime, Iran, which shares the world's richest gas repository – the South Pars/North Dome – with Qatar, decided to lodge its $10 billion rival pipeline project the Iran-Iraq-Syria Pipeline (Islamic Pipeline), to pump Iranian gas to Europe via Iraq, Syrian ports such as Latakia and under the Mediterranean Sea. The official contract between Iran, Iraq, and Syria was signed in July 2011, when the tragedies and civil war already had begun in Syria.

Until then, Syria was geo-strategically ignored as, compared to the Gulf Cooperation Council Petrodollar Club, it did not possess much oil and gas. The insiders, however, had already recognised the significance of Syria as a regional energy corridor (Escobar, 2015). Since the discovery of vast amounts of offshore oil and gas potential, its importance has grown.

It is clear that most of the foreign belligerents in the war in Syria are gas-exporting countries, with interests in one of the two competing pipeline projects that seek to cross Syrian territory, to deliver either Qatari or Iranian gas to Europe (Orenstein, et al., 2015). Because Russia has a vital interest in controlling gas supplies to Europe, where Gazprom sells 80% of its gas, the dual pipelines would be a disaster for the 'Kremlin.' These new proposed pipelines from Qatar and Iran could take away market share from Russia and bring the prices down, below what the Russian state budget needs to survive (Orenstein, et al., 2015).

Iran is an energy giant in the region, with the world's largest reserves of gas and fourth largest reserve of oil. Nonetheless, its economy was heavily hit by dramatic oil price decline since mid-2014 and nuclear-related sanctions by the U.S. and the EU. On 14th July 2015, a group of EU and non-EU countries (China, France, Germany, Russia, the United Kingdom and the U.S., with the EU) reached an agreement with Iran on the Joint Comprehensive Plan of Action (JCPOA). The Joint Comprehensive Plan of Action dictates limitations to Iran's nuclear program as well as increased monitoring and transparency, in exchange for the relief of existing international sanctions, including on trade. In response to the Joint Comprehensive Plan of Action and following confirmation from the International Agency for Atomic Energy, which stated that Iran had fulfilled its nuclear obligations under JCPOA, all EU economic and financial sanctions taken in connection with the Iranian nuclear program were lifted in January 2016 (EC, 2018).

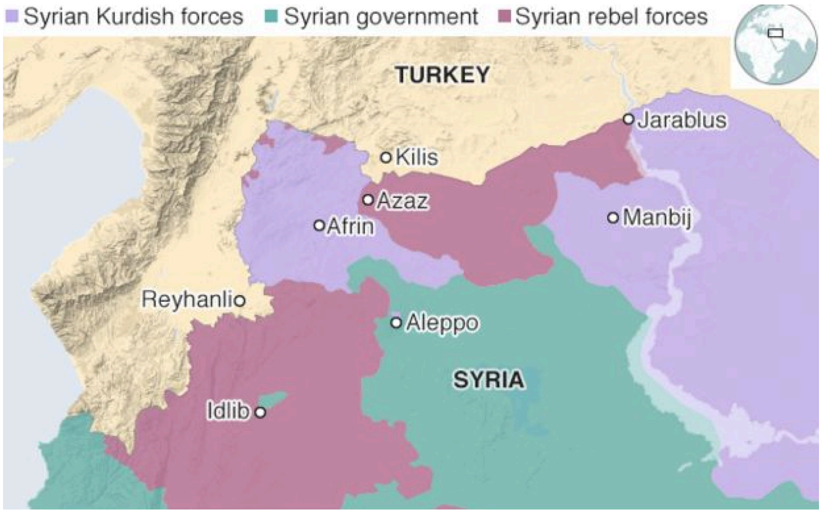
The current U.S. administration supports the 'Turkey-Qatar pipeline', "as a way to balance Iran" and at the same time "diversify Europe's gas supplies away from Russia" (Orenstein, et al., 2015). The Qatar/Turkey pipeline would have given the Sunni Kingdoms of the Persian Gulf absolute domination of the world's natural gas markets and strengthen Qatar, America's closest ally in the Arab world. Qatar hosts two massive American military bases and the U.S. Central Command's Mid-East headquarters (Kennedy, 2016).

TurkStream and Iran-Iraq-Syria Pipeline projects, are known as the major rival projects to the proposed Qatar pipeline project. As AKP-Turkey's Syria policy has reached a strategic impasse, the country launched a dual reconciliation with Israel and Russia and made friendly overtures to Turkey's long-lasting regional rival, Iran. According to Ergin Yildizoglu, a journalist from the Turkish, left-oriented, daily newspaper Cumhuriyet, Turkey's burgeoning alliance with Russia, especially after the July 15-16 coup d'état attempt in Turkey, was eventually rebuffed by the US and EU (Yildizoglu 2016). Turkey's efforts to reconcile with Russia was actually more for the benefit of Russia, as Russia stands to benefit from Turkey's membership of the North Atlantic Treaty Organisation membership and alignment with the US, making it appear as though the U.S. is the 'lone irrational outlier' in Syria.

On August 24th 2016, Turkey launched its largest military cross-border operation, called 'Euphrates Shield', in the Syrian Civil War. As the former Turkish Prime Minister, Binali Yildirim stated, the main desire of this military intervention was to cleanse the Turkish border from the IS and other militants, thereby defending Turkey's territorial integrity. Yildirim further declared, "Turkey is also defending Syria's territorial integrity. The aim of these terrorist organisations is to form a state in these countries. They will never succeed" (Tattersall and Pamuk 2016). However, there is a widespread consensus that Turkey entered Syria only under the pretence of 'the fight against the IS' (Dicle 2016). Additionally, according to Reuters' report, an alliance of 23 Kurdish parties in Syria declared, in a joint statement, that they accuse Ankara of trying to occupy Syria under the pretence of fighting terrorism (Tattersall and Pamuk 2016).

In 2016, Turkey experienced many deadly bomb attacks blamed on the radical Islamists and Kurdish terrorist groups, particularly the PKK (Kurdish Workers Party) and YPG (Yekîneyên Parastina Gel). Due to this, Turkey's main concern is the threat that Kurdish militants in Syria will seize a swath of border territory and instigate Kurdish insurgents on its soil. Therefore, Turkey refuses to tolerate an autonomous Kurdish zone on their southern frontier (Map 4).

Map 4. The South-eastern border of Turkey (June 2018)



Data source: (IHS Conflict Monitor, 2018).

Given these circumstances, on 20th January 2018, Turkey launched a cross-border military operation "Olive Branch", targeting the Kurdish-majority district of Afrin in the Aleppo province, northwest Syria. Afrin is controlled by the YPG, which has strong ties with the PKK. For Turkey, the elimination of Kurdish autonomist ambitions in northern Syria, both in Afrin and further east, between the border towns of Kobanê and Hasakah, is an extension of its campaign against the PKK (Seckin, 2018). The potential conflicts in Turkey's Olive Branch Operation are between Turkey, Russia and the USA. As all airspace of Syria is controlled by Russia, Turkey needs to have acquired tacit acquiescence from Russia prior to the operation (Seckin, 2018). Russia's acquiescence will likely drive a deeper wedge between the two NATO allies, USA and Turkey, in light of the latter's support for the YPG, under the Syrian Democratic Forces, which is the USA's key Syrian proxy (Seckin, 2018). Moreover, facing the threat of being pervaded by Turkey and its Free Syrian Army allies, Russia calculates that the YPG will be a better option to return Afrin to the Syrian government (Seckin, 2018).

3.2.4. The Contribution of Liquefied Natural Gas

With the purpose of diversifying natural gas resources, increased security and flexibility of gas supply, Turkey imports LNG mainly from Algeria, Nigeria, and Qatar (to some extent also from Egypt). BOTAS has conducted and imported LNG from Algeria since 1994 and from Nigeria since 1999. Turkey currently has two LNG storage terminals: Marmara Ereglisi LNG Import Terminal and Izmir Aliaga Terminal.

Turkey has suffered greatly from supply deficits in the past; as a consequence of the reductions in the natural gas supply via the Western Line, during the gas dispute between Russia and Ukraine in 2006 and 2009, cutbacks in natural gas exports from Iran during the winter due to technical problems and Iran's policy to compensate own domestic consumption, as well as the lack of sufficient storage capacity in Turkey itself (EPDK, 2016).

In 2015, 94.8% of total natural gas imports were distributed from countries through pipeline agreements, or as LNG within the scope of long-term import license agreements. The remaining 5.2% of gas was imported from other countries as spot LNG (EPDK, 2016). Turkey's overall LNG (spot and long-term) import in 2015 was 7.6 bcm. 453.4 mcum of LNG was consumed directly by the consumers, without using the national transmission network (EPDK, 2016). This amount represents 1.1% LNG of total national natural gas consumption. 5.1 bcm, around 67.1% of total LNG imports (having long-term import agreements of BOTAS) came from Algeria, while the remaining 1.9 bcm, around 32.9% LNG, came from Nigeria. The remaining amount of LNG was imported as spot from seven countries. Within these countries, Qatar represents the biggest share in terms of spot LNG imports with 68.5%, followed by Nigeria with 7.3%, Norway with 7.2%, Trinidad and Tobago with 6.7%, France with 3.6%, Spain with 3.4% and Belgium with 3.3% (EPDK, 2016).

According to Article 5 of the "Natural Gas Market Law," Law No. 4646, to enable private companies to import gas as LNG or via pipeline, BOTAS cannot sign a new contract with countries where it already has a contract. Nevertheless, based on the "Amendment of the Electricity Market Law and other Laws", Law No. 5784, introduced on July 9th 2008, BOTAS has the right to enter into a new contract for LNG imports and other private companies are allowed to import spot LNG (EPDK, 2016).

BOTAS owns the Marmara Ereglisi LNG Import Terminal, which is utilised as a base load plant and when necessary, a means of peak shaving for the gas purchased during LNG import operations. The company currently has two buying and selling contracts signed with Algeria for 4.4 bcm gas per annum and Nigeria for 1.3 bcm gas per annum, with a total capacity of 5.7 bcm gas per annum (BOTAS, 2014). BOTAS operated 234 facilities and reached approximately 40 bcm of natural gas sales in 2014 by presenting the natural gas into Turkish market. The Marmara Ereglisi Terminal has a 685,000 cubic meters per hour gas send-out capacity and three storage tanks (85,000 m^3 capacity for each). Installation of a new 160,000 m^3 storage rank in the Terminal is planned (BOTAS, 2014).

Egegaz operates the Aliaga LNG Terminal, with a daily capacity of 16.4 mcum (International Energy Agency 2013). At the end of the year 2014, around 1.6 mcum spot LNG was imported from international spot LNG market, through the private LNG Terminal in Izmir Aliaga (BOTAS, 2014).

Due to the insufficient development of LNG infrastructure, Marmara Ereglisi and Aliaga LNG terminals are not able to fulfil Turkey's gas deficit. LNG development is chronically limited due to subsidies and weak market competition, which is, in turn, related to the rooted regulatory advantages that BOTAS has accumulated over the years. So long as the storage capacity is not expanded, Turkey's natural gas policy will cave into Russia's rigid gas pipeline contracts. Considering the demand forecast, Turkey may face supply shortages within the next years and also may not be able to meet peak demand during winter days if the imported volume of spot LNG is reduced by price pressures and limited regasification capacity, due to the fact that the LNG import and storage capacity has not yet been expanded (Rzayeva, 2014).

3.2.5. Underground Natural Gas Storage Capacity of Turkey

Turkey is only able to meet less than 1% of its natural gas demand with domestic production. The remaining substantial amount of natural gas comes from imports. For this reason, potential constraints to gas imports or gas disputes with the exporting countries pose a significant threat to Turkey's energy and supply security (Nyman, et al., 2016). Hence, underground natural gas storage projects are crucial for Turkey to regulate its seasonal, daily and hourly needs. However, insufficiency in natural gas storage areas and network capacity adversely affect not only the flow of gas, but also the trading of gas by its prospective competitors (Nyman, et al., 2016). Therefore, technical and economic compliance of new storage investments are crucial. The Natural Gas Market Law No. 4646 Article 4, requires "to store an amount corresponding to 10% of the natural gas to be imported every year, in the national territory for five years" (Laws Turkey, 2001).

Regarding the natural gas storage capacities worldwide, the estimated global storage capacity is over 383 bcm. Based on the 2013 data of BOTAS, the USA has the most gas storage sites and huge capacity for underground storage, followed by Russia (Table 5).

Table 5. Underground natural gas storage capacities of countries

Countries	Storage sites	Storage capacity (bcm)
USA	442	127.2
Russia	28	97.6
Ukraine	13	32.1
Germany	51	20.4
Canada	49	14.8
Italy	10	14.9
France	16	12.7
Turkey	**1**	**2.6**
Others	67	60.7
Total	677	383

Data source: (Nyman, et al., 2016).

Total storage capacity in the EU is approximately 108 bcm. France, Germany, and Italy hold approximately one-third of their annual requirement in stock. In many countries in Europe, the gas storage facilities constitute between 20% and 30% of their annual gas consumption (Nyman, et al., 2016). Ukraine, with 49%, has the largest storage capacity of national demand, followed by Italy (30%), Russia (27%), the USA and Germany with almost 20% respectively. Turkey barely has a total capacity of 2.6 bcm natural gas storage in Silivri, constituting only 5% of the annual gas consumption, which is not able to cover demand spikes.

The shortages in the gas market and infrastructure not only prevent Turkey from achieving gas supply security at a reasonable price, but also threaten supply security of electricity, as natural gas-fired power generation accounts for between 40% and 50% of the total electricity generation (Nyman, et al., 2016). Turkey's very limited underground storage capacity creates additional problems for BOTAS whenever it cannot take all the contracted volume during the summer and May, when there is the lowest demand. It therefore has to pay ‘take or pay' penalties (Rzayeva, 2014). For managing the seasonal imbalances of supply and demand and to avoid the adverse consequences of supply interruptions, it is mandatory to increase storage and daily withdrawal capacities. Currently, Turkey has one natural gas storage facility in operation and one in the construction phase.

3.2.5.1. *Silivri Natural Gas Storage Facility*

The Silivri Natural Gas Storage Facility is the first and the only active underground storage facility in a gas field. It was converted into an underground storage by Turkish Petroleum in 2007, to compensate the seasonal differences in natural gas consumption. In this manner, natural gas can be kept in storage tanks when demand is weak and reproduced when the need is high. It is then possible to meet short-term, excessive gas demand during winter, or extreme need to produce electricity during summer. Total storage capacity of the Silivri facility is 2.6 bcm (about 5% of demand) at two depleted gas fields. The first is the Kuzey Marmara (North Marmara) Field, located in the Marmara Sea and has a depth of 1,200 meters. The second one is the Değirmenköy Field, with a depth of 1,100 meters (Turkish Petroleum, 2016). About 2.1 bcm of this total storage capacity is allocated to BOTAS, while some 561 bcm capacity is open to private firms (IEA, 2013). The reproduction capacity of the Silivri Storage Facility was increased from 14 mcum per day in 2007, to 25 mcum per day in 2014. Turkish Petroleum has planned to further production capacity increase to 50 mcum per day and has agreed to increase the total storage capacity up to 2.8 bcm (Rzayeva, 2014). Moreover, Turkish Petroleum plans to increase the total capacity to 4.3 bcm, the daily withdrawal capacity to 75 mcum and injection capacity to 40 mcum per day, after the completion of the Degirmenköy and Surroundings Natural Gas Storage Project (Phase II) and the Kuzey Marmara Natural Gas Project (Phase III) (Turkish Petroleum, 2017).

3.2.5.2. *Tuz Gölü Underground Natural Gas Storage Facility*

Tuz Gölü Underground Natural Gas Storage Project, which is located about 40 km south of Tuz Gölü (Salt Lake), in the Sultanhani locality of Aksaray Province, aims to meet energy demand by storing and using natural gas underground (BOTAS, 2015). The construction activities of this project remain under the ownership of BOTAS. The aim of the project is to utilise salt domes under the Tuz Gölü (IEA, 2013), as the salt reservoirs are technically the most economical model for storage facilities. The salt layers, which start from 600-700m underground, will burrow approximately 1,100-1,500m deep by pumping fresh water (BOTAS 2014). The water required for dissolution will be supplied by Hirfanli Dam, with a 120km long pipeline (BOTAS, 2014). In this way, the Salt Lake natural gas storage project ensures the storage of 8% of current natural gas consumption.

Once the second largest lake in Turkey and having the official protection status of Special Environmental Protection Area since 2000, Tuz Gölü and its satellite wetlands (Kulu, Terkesan and Bolluk Lakes, Esmekaya Marshes) face the threat of drying up as a result of the dominant water policies. In addition to the impacts of climate change, illegal well drillings for irrigated agriculture activities (especially sugar beet farming), reduced the surface area of Tuz Gölü by 60% between 1987-2005. Each year well drillings go deeper and cause the reduction of underground water, which naturally feeds the basin. Moreover, the soil in the region becomes arid, salinized and uncontrollable desertification loss of landscape/aesthetic degradation in the area occurs (Basak, 2014). The biodiversity loss, groundwater pollution and depletion, reduced ecological/hydrological connectivity and crop damage (partially food insecurity) problems are already very visible in the field.

Within the scope of the Tuz Gölü Natural Gas Storage Project, the plan is to reach a capacity of 500 mcum through the completion of the first phase, and 1 bcm working gas capacity with the conclusion of the second phase. When the project is fully accomplished, a maximum of 40 mcum of natural gas will be able to be distributed to the Turkish natural gas network every day (MENR, 2016).

According to the Turkish Ministry of Public Works and Settlement "Seismic Zoning Map of Turkey," the Tuz Gölü Gas Storage Project routes are included in the 1st, 2nd, 3rd, 4th and 5th-degree earthquake zones. However, the city of Aksaray, where the construction work continues, has not been the epicentre of an earthquake in the past, due to its geographical and seismotectonic position (BOTAS, 2013). Until now, the average magnitude of earthquakes recorded in the province of Aksaray and surroundings are approximately 5.2. All in all, with regards to the ‘environmental impacts assessment' report, the construction of the storage facility has started in the remotest point from the active fault line in Aksaray. The threat of a potential earthquake in the region and possible hazards are , however, far from impossible.

Energy imports are one of the heaviest burdens of Turkey's growth and weak economy. The primary reason for the country's high budget deficit lays upon its high dependency on fossil fuel imports.

The appreciable increase in energy prices in Europe has generated a slight decrease in demand for gas. Instead, the use of renewables has increased to narrow the energy gap. One-quarter of all energy consumed in the EU is gas and 58% of this gas is imported. 42% of this gas comes alone from Russia, and around 80% of EU gas imports pass through Ukraine. The EU member states feared that a new gas supply disruption, similar to the 2006 and 2009 Russia-Ukraine gas disputes, might rise again due to the Crimea crisis. During this time the gas routes of many Western Balkan countries, like Bosnia and Herzegovina, Croatia, Republic of Macedonia and Serbia were disrupted. Some energy experts claimed that the actual winner of this gas dispute was Turkey, as the EU would likely seek alternative gas routes and Turkey would benefit from being a transit country. Europe hoped to benefit from Turkey's geographically advantageous position, to be a bridge for the transportation of Caspian gas to Europe, as a shield against Russia's drastic energy strategies. This assumption reflects the truth, that the EU indeed, after the crisis, recognised the vulnerability of its energy security and therefore launched several projects like diversifying natural gas import routes and increasing the share of LNG in the total gas supply.

Considering the energy scenarios, Ankara's ambition is to make Turkey the major energy crossroad for the whole EU:

i. as a transit hub for gas from Iran, Central Asia and, Russia,
ii. as a hub for major gas discoveries in the Eastern Mediterranean,
iii. and as a hub for gas imported from the Kurdistan Regional Government in northern Iraq (Escobar, 2015).

Turkey, at the crossroads of Asia and Europe, may have the best chance to act as a reliable transit country, ensuring uninterrupted gas flow from Caspian basin to Europe. In order to function as a gas hub, Turkey needs to be able to import sufficient amounts of gas both to meet its own energy demand and any re-export commitments, providing adequate gas via its pipeline capacity across the country. The country's increasing energy needs are jeopardising its surplus capacity to transport enough gas from Middle East and Caspian to Europe. Therefore, the development of energy efficient technologies and an increase in the share of renewable energy sources in its total energy supply, is fundamental for the energy security of both Turkey and Europe.

3.3. Coal

3.3.1. Hard Coal

In contrast to its scant oil and gas reserves, Turkey has large amounts of lignite and some hard coal. According to the latest statistics from the EIA, Turkey has 9,592 million tons of recoverable coal reserves. Anthracite and bituminous (also called recoverable hard coal) constitute for, with 355 million tons, only a small part of the total reserves. The major part of the total reserves consist of the sub-bituminous and recoverable lignite, holding 9,237 million tonnes (EIA, 2017). Coal's share, including lignite, in Turkey's primary energy supply, decreased from 24% in 1970 to 13% in 2014 (Ersoy, 2016). Since 2013, the production of coal has considerably decreased, although it saw a slight increase in 2014. In 2015, Turkey's saleable coal production reached 61.9 million tonnes which is comprised of 58.7 million tonnes lignite, 2 million tonnes hard coal and 0.8 million tonnes asphaltite (Table 6).

Table 6. Coal production in Turkey (unit: ton)

Ore	Producer	2012	2013	2014	2015	2016
Asphaltite		649,830	648,953	336,852	837,112	1,475,101
Bitum. Shale	TKI	394,277	149,828	259,508	288,185	372,028
Coal	EÜAS	24,297,709	16,011,459	18,987,907	10,855,125	13,267,974
	TKI	36,815,592	23,257,009	22,854,114	12,432,171	24,330,886
	Other public sector		11,245,055	1,063,927	399,816	213,501
	Private sector	16,900,893	12,810,342	23,301,062	35,043,058	39,718,241
	Total	78,014,194	63,323,865	66,207,011	58,730,170	77,530,602
Hard coal	TTK and Royalty Holders	3,235,299	2,789,338	1,916,833	2,074,049	1,496,223
Grand total		82,293,600	66,911,984	68,720,204	61,929,516	80,873,954

Data source: Own illustration based on the data from (MENR, 2017).

Coal consumption in Turkey has increased each year between 2002-2015, except in 2013. In 2015, Turkey's total coal consumption reached 97.2 million tonnes. 31.8 million tonnes of this came from domestic and imported hard coal, and the remaining 65.4 million tonnes were lignite and asphaltite. In 2015, Turkey's domestic coal supply was 16.8 mtoe, of which lignite made up 15.3 mtoe, hard coal 1.1 mtoe, and asphaltite counted for 0.4 mtoe. The largest share of the hard coal supply in 2015, around 44.6%, was utilised for generating electricity, while 17.8% was used for heating purposes. Coal imports totalled 19.4 mtoe, of which 19.2 mtoe was anthracite, and 0.2 mtoe was coke. In the same year, the annual increase in domestic coal supply was 15.1%, with imported coal supply totalling 12.8%.

In 2015, the total installed coal-fired power plant capacity increased by 722 MW, compared to previous years, reaching 15,493 MW and representing 21.2% of the total installed power of Turkey. Domestic coal constituted, with its 9,428 MW installed capacity, 12.9% of total installed capacity, whereas imported coal, with its 6,064 MW installed capacity, represented 8.3% of the country's total installed capacity. The share of electricity generation from hard coal in total energy production of Turkey is gradually increasing. 72.1 twh (27.8%) of Turkey's 259.7 twh gross power generation, came from hard coal (15.2%) and lignite (12.5%). In total, by the end of 2015 there were thirty-eight hard coal- and lignite-fired power plants in Turkey, with an installed capacity of approximately 15,200 MW (20.6% of total capacity). The majority of the power plants are lignite-fired plants, using domestic lignite with an installed capacity of 8,700 MW (11.8%) and hard coal-fired power plant with an installed capacity of 6,500 MW (8.8%). The primary plants are the Zonguldak-Eren coal-fired power plant at the port of Black Sea, with an installed capacity of 2,790 MW and both Afsin-Elbistan A and B, which are lignite power plants, located in the southeast of Turkey with a total installed capacity of 2,795 MW. Around 70 new coal power plants are in planning for construction, in line with the country's 2023 energy vision.

The largest hard coal deposits of Turkey are located in the Zonguldak basin on the Black-Sea coast in North-western Turkey, which has a total of 1.3 billion tons of hard coal reserves and the electricity generation potential of 11 billion kwh per annum. Currently, only 21% of this potential has been achieved (MENR, 2017). The production of hard coal, which has shown a downward trend since the 1980s, diminished to 1.9 million tonnes in 2004. From this date on, the saleable hard coal production has been remobilised and has reached 2.3 million tonnes in 2012. From 2012, production of hard coal gradually decreased to 1.9 million tonnes in 2013, 1.8 million tonnes in 2014 and, finally, to 1.4 million tonnes in 2015. One particular reason for this reduction is the geological structure of the basin, which makes mining difficult due to the steep seams, which are disturbed by frequent faults and contain a large amount of methane (IEA, 2016). The contribution of 'Zonguldak Basin' in meeting the energy demand of Turkey has declined to 7-8% in 2015 (TKI, 2015).

Over 90% of total coal production is run by three state-owned enterprises: Turkish Coal Enterprises (TKI), Electricity Generation Company (Elektrik Üretim A.Ş. - EÜAŞ) and Turkish Hard Coal Enterprises (TTK). The state-owned TTK has a de facto monopoly on the production, processing, and distribution of hard coal, though there are no legal restrictions on private sector involvement.

To meet its increasing energy demand, Turkey has been importing hard coal since the 1980s primarily from Russia, Columbia, the U.S., South Africa and Australia. In 2015, a total of 33 million tonnes of imported was imported from these five countries, plus Canada. The largest amount of coal was imported from Columbia with 11.4 million tonnes, followed by Russia with 11.3 million tonnes per year. South Africa with 5 million tonnes, Australia with 2.8 million tonnes, the U.S. with 2 million tonnes and Canada with 500,000 tonnes supplied the remainder (TKI, 2015).

Increasing coal imports puts a high burden on the country's budget. The coal import bills of Turkey exceeded $1 billion for the first time in 2004 and continued to increase annually to a total of $4.6 billion in 2012. Due to the decline in coal prices in the international markets, the import bills of Turkey were also decreased to $3.5 billion in 2013, $3.2 billion in 2014 and $3 billion by the end of 2015.

Another significant coal mine is located in Soma, a town and district of Manisa Province in the Aegean region of Turkey. It is the region's biggest facility and supplies jobs to around 6,000 employees. This former state-run mine was leased to a private company in 2005, ‘Soma Holding,' however, Turkish Coal Enterprises, a government conglomerate, still retained ownership. The holding took over the coal mine, which contains 18 million tonnes of coal reserves, from the Turkish Coal Enterprises in line with the "*rödovans* system." *Rödovans* comes originally from the French word "redevance" and means royalty. The *Rödovans* system was first introduced in Turkey in the 1980s for the purpose of preventing the continuation of illegal and unlicensed mining.

Soma Holding tripled production to what had initially been deemed possible. By May 2014, the company was able to extract a massive 15 million tons of coal, three years ahead of schedule (Munyar, 2012). Nevertheless, while Soma Holdings enforced rapid expansion of the mine underground, it failed to increase and maintain the mine's ventilation systems – vital to providing clean air to miners (Guguen, 2015). On 13 May 2014, a massive explosion at the pit ensued, approximately 2km below the surface. After this explosion, the inadequate ventilation system failed to pump the poisonous carbon monoxide out of the mine creating a death chamber for the miners (Guguen, 2015). According to the official numbers and expert report, 301 miners lost their lives to carbon monoxide poisoning. A further study by the Turkish Association of Chambers of Engineers and Architects stated: "The reason for the carnage (at Soma) is privatisation, marketisation and the outsourcing policies over the past 12 years in the mining sector and also in the area of health and safety” (Guguen, 2015).

The tragedy at Soma is the worst-ever mining disaster in the country's history. There have been strong assertions that, due to the rödovans system, the company glossed over certain mandatory work safety measures, to retrench the costs and thereby endangered hundreds of mining workers' lives. The workers were not educated enough on security rules, the number of rescue chambers in the mine was insufficient and not all the workers had an oxygen mask in tow. Another mining disaster came in October when 18 miners were trapped and died in a mine in the Central Anatolian province of Karaman's Ermenek district, after water flooded into their shaft from a nearby disused mine.

The mining disaster in Soma was evidently the result of privatisation and the negligence of both the government and the mining company. We can identify here, that as long as the mining corporations' pursuit of profit takes precedence over the safety and well-being of miners, safety and fairness of working conditions, ultimately – the lives of the workers, remain under the threat of the capitalist system.

Following these two mining disasters in Soma and Ermenek, the country finally approved ratification of the International Labour Organisation (ILO)'s Convention No. 176 on Health and Safety in Mining. The victory for Turkish miners in approving ratification of ILO's Convention No. 176, came after years of campaigning led by IndustriALL with its Turkish mining affiliates Maden-Is (Mineworkers' Union) and Tes-Is (Energy, Gas and Water Workers' Union), along with the support from labour unions around the world (Construction, Forestry, Mining and European Union/Australia, National Union of Mineworkers/South Africa, United Steelworkers/US, Rosugleprof/Russia, and IG Bergbau, Chemie, Energy, Germany). After the Soma disaster, 60 mines closed down due to economic and safety reasons, as the government promptly increased the frequency and diligence of its inspections (Guguen, 2015).

Turkey's mine fatality track record is a dreary one. According to International Labour Organisation figures, Turkey ranks first in Europe and third in the world for fatal work accidents. The ILO says 18 out of 100,000 insured labourers die every year in work accidents, seven times greater than the EU average of 2.5. More than 10% of workplace accidents in Turkey happen in mines (Senerdem, 2014). Turkey's privatisation drive in the 1980s, has been the predominant driver of the worsening of health and safety standards for the miners. According to the 2013 numbers of Turkey's Statistical Institute, the highest rate of work-related health problems in the last 12 months, was in the mining and quarrying sector, standing at 5.5%. Since 2000, there have been 1,308 fatal accidents in the mining industry and 1,500 deaths in Turkish mines. The employees of the Soma mining company stressed that the safety standards and working conditions deteriorated after the privatisation. The Global Methane Initiative, an international partnership aiming to reduce global methane emissions (Senerdem, 2014), argued in its 2013 report that "uncertainty in privatisation policies, allocation of insufficient resources and absence of legislation in methane control in coal mines and release to atmosphere" are the main challenges for the mining industry in Turkey (Sagir, et al., 2013). Moreover, unions in Turkey face a constant struggle. Turkish metalworkers have recently been banned from striking and union busting is common practice (Guguen, 2015). In its 2014 report, Human Rights Watch criticised the Turkish government for being "increasingly autocratic." A report by the rights organisation said: "In office for three terms since 2002, and enjoying a strong parliamentary majority, the ruling AKP has demonstrated a growing intolerance of political opposition, public protest, and critical media" (Guguen, 2015).

3.3.2. Lignite (brown coal)

Lignite is Turkey's other crucial domestic energy resource. Lignite deposits are spread across the country with proven reserves of 15.6 billion tonnes. Nevertheless, the thermal values of Turkish lignite are mainly very low (TKI, 2015).

After the oil crisis in the 1970s and as a result of investments in lignite enterprises, lignite production increased from 14.5 million tonnes in 1980 to 42 million tonnes in 1986, principally to meet the demand of lignite-fired power plants installed during this period. Production reached a peak of 76.2 million tonnes in 2008 and then started to diminish (Ersoy, 2016). In 2014, 62.6 million tonnes of lignite was produced, which ranked Turkey as the fifth largest lignite producer country in the world. In 2014, the amount of lignite production decreased to 42 million tonnes, as a consequence of the closure of mines, due to the tragic mine accidents and high operating costs(Ersoy, 2016).

The total lignite reserve of the Electricity Generation Company (Elektrik Üretim A.Ş. – EÜAŞ) is 7.8 billion tonnes and the total lignite in Afşin-Elbistan basin is 4.8 billion tonnes. The biggest lignite deposits (around 40%) are located at the Afşin – Elbistan basin of South-eastern Anatolia. In 2011, a landslide occurred at the Çöllolar Coal Field near the Afşin-Elbistan thermal power plant, during which eleven mine workers lost their lives. The second largest lignite basin is in Soma in the Aegean region of Turkey. Other significant deposits are located in the Tunçbilek, Denizli-Civril, Seyitömer, Bursa, Can, Muğla, Beypazarı, Sivas and Konya-Karapınar basins. In January 2013, the MENR announced that Turkey's Mineral Research and Exploration General Directorate (MTA) had discovered 1.8 billion tonnes of lignite reserves in Konya's Karapınar neighbourhood. That amount of reserve is enough to fuel a thermal power station generating 5,000 MW of electricity for 30 to 40 years, in a Central Anatolian province (Anatolia News Agency, 2013). During 2013-2015, a total of ten thermal power plants, with an installed capacity of 5.7 GW, were privatised in accordance with the new Electricity Market Law (IEA, 2016).

3.3.3. Asphaltite

Asphaltite is a solid petroleum fuel with a high softening point, which contains high amounts of sulphur and volatile substances. Its melting point is between 200°C-315°C. Asphaltic materials are usually formed by the migration of petroleum and solidification in cracks during tectonic movements (Kavak, et al., 2010 S. 59). As far as is known, the world's asphaltite reserves are very limited. The known reserves are located in China, Spain, Cuba and Argentina.

Asphaltite is the natural origin of oil and oil residues. It is composed of hydrocarbons and polar compounds, associated with valuable elements such as cadmium, as well as expensive retrievable elements like molybdenum, vanadium, and nickel. The calorific value of Asphaltite varies between 5,500 and 5,800 kcal/kg, which is higher than that of brown coal, but lower than that of hard coal.

The MTA has explored over 79,969 million tonnes of asphaltite reserves in different fields of Turkey. Turkish asphaltite contains high amounts of petroleum and therefore can be used as solid fuel, after the extraction of oil. Turkey does not hold a vast amount of asphaltite reserves. The total known reserve is 81 million tonnes, and 45 million tonnes thereof is visible. The asphaltite in Sirnak contains high amounts of ash and sulphur and their calorific value is high (Kavak, et al., 2010 S. 59). Since asphaltite has always been used for heating purposes by the local community in the East- and Southeast Anatolian regions, it was not possible to derive these trace elements.

Asphaltite mining is crucial for the Southeast region of Turkey and particularly for Sirnak. The asphaltite veins were formed in South-eastern Anatolia as a result of compressive tectonics, where fractures developed longitudinally and were filled with liquid/semi-solid asphaltic matter towards the surface. The twelve significant asphaltite formations within and around the Sirnak region are: Avgamasya, Milli, Anılmış-Karatepe, Seridahli, Nivekara, Ispindoruk, Segürük, Harbul (Aksu), Silip, Üçkardeşler, Rutkekurat and Uludere Ortabag-Ortasu (Kavak, et al., 2010 S. 59). Utilisation of the locally produced asphaltite will make a significant contribution towards meeting Turkey's increasing electricity supply requirements and sustainable reduction of the current budget deficit. For that purpose, a 135 MW single-unit Sirnak-Silopi Thermal Power Plant was built, which uses the asphaltite of Sirnak as a fuel source. The remaining two units, with 135 MW for each total installed capacity, are under construction. The power plant will generate 972 million kwh electrical energy annually. Fluidised bed boiler technology used at the power plant is designed to exploit asphaltite reserves in an environmentally friendly and efficient way. The facility will promote regional industrial development and provide employment opportunities for the residents of Sirnak and the surrounding areas. Moreover, it is also used in the production of dyes, polishes, auto tires, electricity isolation, battery protectors, expanded rubber, floor tiles, water-resistant cables and the like. Additionally, the asphaltite has also recently become important as a synthetic petroleum source.

Due to its combustible sulphur content, asphaltite creates serious environmental pollution problems if burned without any physical cleaning procedures. The asphaltites, inholding dominant carbonate minerals (calcite and dolomite), produce carbon dioxide from the breakdown of carbonate minerals, when burned (Kavak, et al., 2010 S. 60). In order to prevent such hazardous impacts, research and developments in the fields of coal washing, pyrolysis and gasification and the production of coal liquids and gaseous fuels, can be options for municipal authorities to prioritise.

3.3.4. Fuel Production from Biomass and Coal (TRIJEN)

In order to prevent the hazardous environmental impacts of coal production technologies, municipal authorities in these fields and regions need to validate the feasibility of the production of clean coal fuels, such as coal liquids and gases. Injecting, storing and monitoring power station stack gases and carbon dioxide in the subsurface (geologic storage), as an approach to mitigate atmospheric emissions of carbon dioxide, should also be considered (Tosun, 2014 S. 14).

With the purpose of implementing clean coal technologies, the "Fuel Production from Biomass and Coal (TRIJEN) Project" went into effect on June 15th 2009, under the primary supervision of TÜBITAK Marmara Research Centre and Turkish Coal Enterprises. A pilot scale system, with 250 kg/hours fuel feeding and 1.1 megawatts thermal capacity, was built in the Soma-Cenkyeri operation area. The purpose of this project was to develop the technology required to produce a more affordable, efficient and clean liquid fuel from the widespread and national coal and biomass resources. This would aid in Turkey's sustainable development and energy security and was distributed to centralised poly-generation plants, to demonstrate the outcomes in a pilot scale.

Clean coal technologies are critical for Turkey to produce energy efficient and environmentally friendly clean fuels, to reduce the dependency on imported oil and to provide fuel diversity. Within this frame, the objectives of this project were to establish the necessary know-how on the design, construction, installation and operation of a pioneering plant.

In this project, for the production of liquid fuel from coal and biomass blends, the initial aim was to achieve the design, manufacture, installation and test activities on the laboratory scale systems and subsystems and thereafter, to once more carry out the design, manufacture, installation and test activities on a pilot scale system with 250 kg/hours fuel feeding capacity and its subsystems – according to the data and experiences obtained from the initial laboratory studies performed.

In the first stage of project activities, numerical and experimental research and development studies at the laboratory scale level were conducted in the following areas:

- Coal and biomass gasification technologies.
- Gas clean-up technologies.
- Gas conditioning technologies.
- Carbon dioxide capture technologies.
- Developing an iron-based catalyst for syngas conversion to liquid fuels and related reactor technologies.

In light of the data and gains obtained from the laboratory-scale studies, a pilot scale system was built. Within the pilot scale system, technology development activities were performed on the following topics and all outcomes were demonstrated in a pilot-scale integrated system:

- Production of raw synthesis gas via gasification.
- Removal of contaminants from produced syngas.
- Carbon dioxide capture in order to increase the efficiency of liquid fuel production process.
- Development of catalyst for liquid fuel production and production of liquid fuel from conditioned and cleaned syngas.
- Heat generation/recovery at the stage of liquid fuel production in order to increase the system efficiency.

During this period, fuel feeding, gasification, gas clean-up, gas conditioning and separation, liquid fuel production and heat generation systems were integrated as a whole. On August 28th 2015, a first experiment was carried out to obtain a 40% hydrogen-containing synthesis gas. Experiments with regard to the production of liquid fuel are still in progress. In the future, implementation of a thermal plant with 120-130 megawatts thermal capacity is planned (Akgün, 2016).

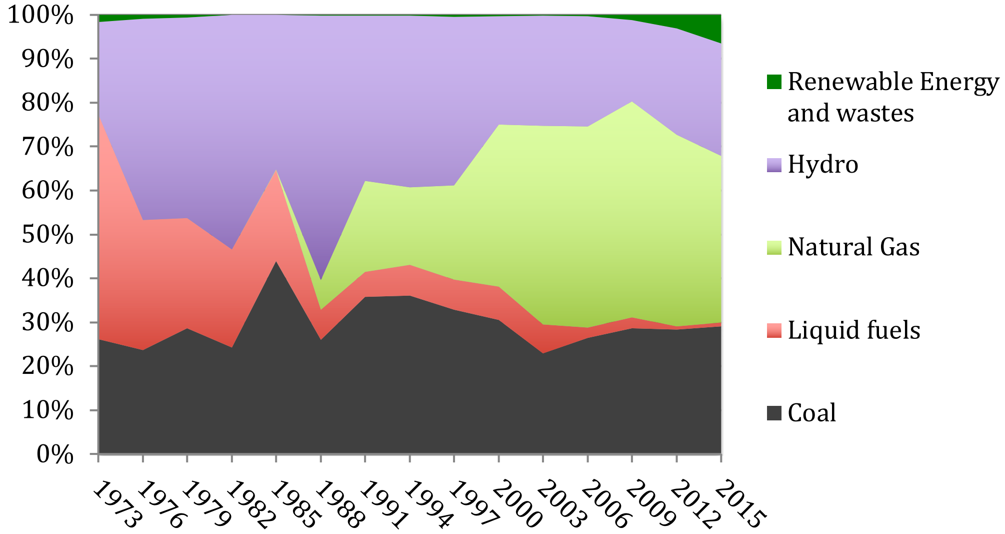
Turkey's persisting energy target is the full utilisation of coal and lignite reserves which would diminish dependency on external energy imports. Government policy in Turkey (for example; incentives to invest in thermal power plants, revocation of environmental penalties, lack of a particular climate target) encourages mines to produce as much coal as possible at the lowest possible price, regardless of the risks regarding working conditions. The government has a vast number of thermal power plant projects to turn the country into a coal "paradise" by 2023.

Nevertheless, Turkey's 'high-carbon policy' has been increasing fossil fuel dependency, as well as energy import dependency. Climate change is not the amount of coal, but the emission amount depending on the energy it provides. When the unit amount of coal possessing a low thermal value is burnt, it provides little energy and hence emits a low emission, if the coal has a high thermal value, more carbon dioxide emission occurs. Therefore, the corresponding thermal and emission values to the aforementioned amounts of coal will be used during the climate change dimension of this study.

3.4. Energy Generation and Energy Supply in Turkey

According to the estimations, Turkey's total primary energy demand will reach 218 mtoe by 2023, from the current level of 125 mtoe. The final electricity demand of Turkey is expected to reach 418 twh in 2023, from the 2015 total of 264 twh. The share of energy sources in total electricity generation between 1973 and 2015 is illustrated in Figure 10. According to the figure, natural gas was included in the total electricity generation after the liberalisation activities of the 1980s, which represents the highest share up until the end of 2015. Other energy sources with a high share of the total electricity generation are coal and hydro. The share of renewable energy sources increased over the years after 2006, nevertheless, this still represents just a small amount of the total electricity generation (Figure 7).

Figure 7. The share of energy resources in total electricity generation



Data source: (MENR, 2015).

As a result of economic growth, the average annual electricity consumption growth has been around 5.5% for many years. In 2015, Turkey's electricity demand increased by 2.6% compared to previous year. **Electricity consumption** has nearly doubled and reached to 263.8 twh in 2015, from 132.6 twh in 2002. Industry sector with 46.2%, had the largest share in total electricity consumption, followed by commercial and public services (30.1%), residential sector (22.3%), transport (0.4%) and energy sector (0.03%) (IEA, 2016). **Electricity production**, on the other, hand has also almost doubled, reaching 261.7 twh by the end of 2015, compared to 129.4 twh in 2002. 37.9% of this total electricity generation is provided from natural gas, 29.1% from coal, 25.6% from hydropower, 6.5% from renewables (4.4% from the wind, 1.3% from geothermal, 0.6% from biofuels and waste, 0.2% from solar energy) and 0.9% from liquid fuels.

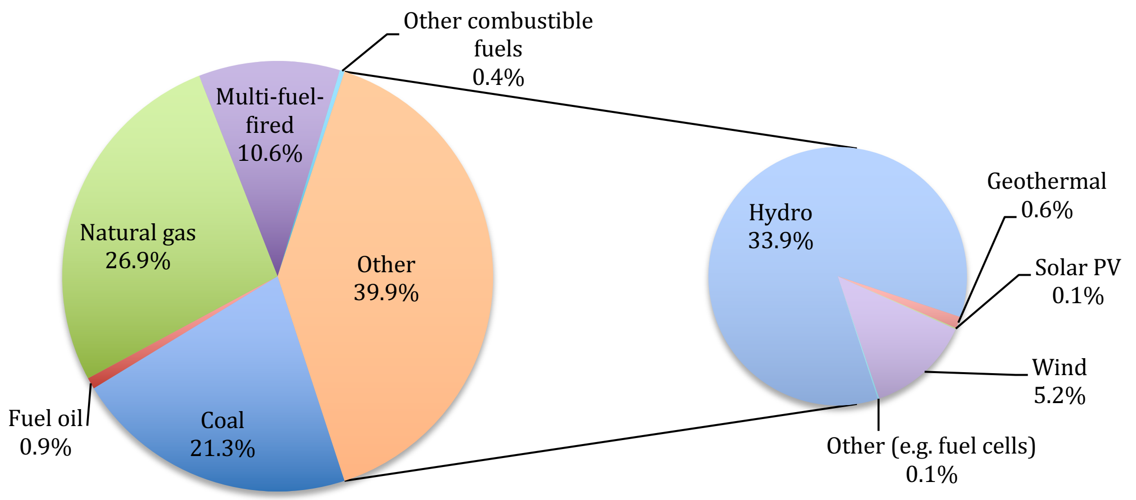
Table 7. Installed generating capacity by fuel between 2007-2014 (in MW)

Turkey	2008	2009	2010	2011	2012	2013	2014
Total capacity	**41,818**	**44,761**	**49,524**	**52,911**	**57,059**	**64,007**	**69,520**
Combustible fuels	27,595	29,339	32,279	33,931	35,027	38,612	41,572
Coal	10,191	10,590	11,950	12,550	12,576	12,606	14,814
Fuel oil	1,819	1,699	1,593	1,300	1,285	616	595
Natural gas	10,657	11,825	13,303	13,144	14,116	17,170	18,724
Multi-fuel-fired	4,868	5,138	5,325	6,811	6,881	8,021	7,370
Other combustible fuels	60	87	108	126	169	199	249
Hydro	13,829	14,553	15,831	17,137	19,609	22,289	23,643
Geothermal	30	77	94	114	162	311	405
Solar photovoltaic	0	0	0	0	0	0	40
Wind	364	792	1,320	1,729	2,261	2,759	3,630
Other (fuel cells)	0	0	0	0	0	36	50

Data source: (IEA, 2016).

Since Turkey has no nuclear power plant, the renewable energies comprise the third pillar in power generation, which are mainly supplied by the hydropower plants (Table 7). By the end of 2014, total installed electric capacity had increased to 69.5 GW from 41.8 GW in 2008. Hydropower contributed 33.9% of this installed capacity, followed by the natural gas with 26.9%, coal with 21.3% and renewable energy sources with 39.9% (Figure 8).

Figure 8. The share of energy sources in Turkey's electricity mix in 2015



Data source: Own illustration based on the data from (IEA, 2016).

The number of electric power generation plants increased to 1.481 by the end of 2015, from 300 in 2002. 560 plants generated electricity from hydropower, 244 from natural gas, 122 from wind, 80 from biomass and waste, 36 from multi-fuel sources (liquid and natural gas), 34 plants from coal, 21 from geothermal, 11 from nominal fuel oil, one from diesel and ultimately one plant from asphaltite. Additionally, there are 369 unlicensed power plants operating in the market since 2010. The principles and conditions of unlicensed power generation have been regulated by the "By-Law on Unlicensed Electricity Generation in the Electricity Market" (*Elektrik Piyasasinda Lisanssiz Elektrik Üretimine Iliskin Yönetmelik)*, which came into force on December 3rd 2010. The main purpose of this legislation was to facilitate the entrance of smaller power plants to the electricity market, provide electrical energy for consumers and reduce the loss in electrical energy (Gozen, 2015). Accordingly, every person or legal entity (like universities, building complexes, shopping centres), which is an electricity subscriber, may establish a power plant without obtaining license from the EPDK and sell the surplus energy to the grid/licensed distribution companies.

The total installed capacity of renewable energy sources increased two and a half times and reached 31.2 GW by the end of 2015, from 12.2 GW in 2002. The electricity generation from renewables reached 82 twh by the end of 2015, with a 142% increase from 34 twh in 2002. Installed capacity of wind energy was 173 times higher in 2014 than in 2004 while geothermal power was 27 times higher (IEA, 2016). Biofuel and waste use increased tenfold, while solar power was first introduced in 2013. Solar power is still at a low level, but its shares have been increasing since 2013 (IEA, 2016). In comparison to other IEA member countries, Turkey's share of fossil fuels in electricity generation was the 9th highest in 2015. The geothermal share ranked 3rd highest behind New Zealand and Italy. The share of hydropower became the 7th highest with a record production in 2015 (IEA, 2016).

3.5. Electricity Networks of Turkey

3.5.1. Electricity Transmission

The energy forecasts of the MENR show that the electricity demands of Turkey will reach 416 twh in 2023. To meet these growing electricity demands, the length of transmission line extended to 57,076km in 2015, from 44,544km in 2002. In the same year, the electricity distribution line reached over 1,100,000km, from 812,399km in 2002 (MENR, 2015). The transmission grid consists of a combination of high-voltage lines of 400 kV and 150 kV and a few lines of 66 kV (Table 8). The transmission network is a state-owned monopoly since 2011, under the ownership and operation of the TEIAS.

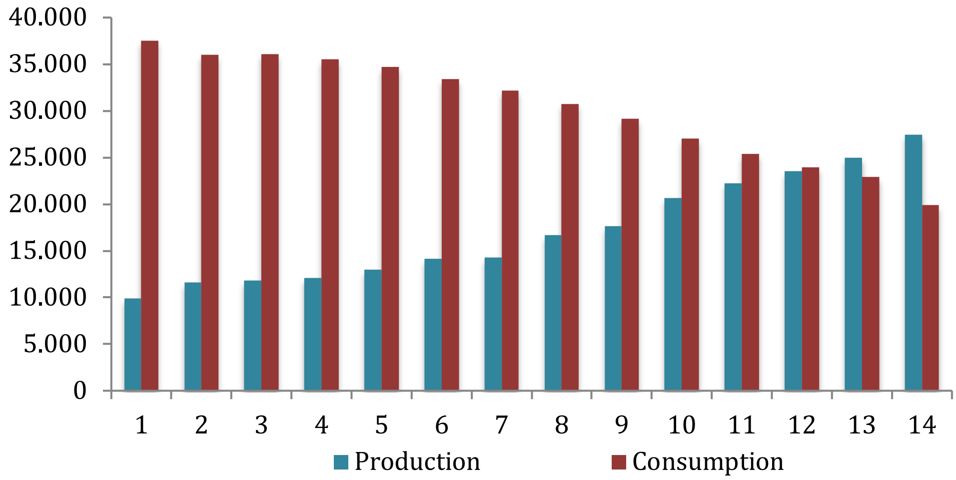
Table 8. Turkey's transmission network by the end of 2015

Base voltage level of transmission lines	Number of substations	Length of transmission lines (in km)
400 kV	100	19,071
220 kV	1	84.5
154 kV	589	37,449
66 kV	11	140
154 and 400 kV and underground (380+154+66 kV) cables	0	331.7
Total	**701**	**57,076**

Data source: Own illustration based on the data from Turkish Electricity Transmission Company - TETC 2015.

The transmission tariff and transmission connection tariff have been regulated by EPDK, in line with the Electricity Market Law No. 6446 and the Tenth Development Plan (2014-18). Accordingly, the transmission tariff prepared by TEIAS consists of use of transmission system price, transmission system operating price, market operating price and the principles and procedures relating to the implementation of the tariff. Based on No. 5398-1 of the EPDK Board decision and its annexes, there are 14 regional tariffs for generation, 14 regional tariffs for load and a unique tariff for system operation. The import is considered as generation while the export is considered as load (EPDK 2015a; IEA 2016).

Figure 9. The regional use of transmission system tariffs for production and consumption (TL/MW-Year)



Data source: Own illustration based on the data from (EPDK, 2017)

According to Figure 9, the use of transmission system tariffs for consumption is high in all regions except 13 and 14, which consist of Aegean and Southern Marmara regions, where the production activities are denser than the consumption. In region 12, the tariffs for consumption and production are almost the same, which is used for import and export activities. In regions 1, 2, 3 and 4 we see a huge gap between the production and consumption tariffs, where the consumption tariffs are very high. These regions consist of North-eastern, Eastern and South-eastern geographical regions where the consumption activities are denser than the production.

The transmission system operating tariff has been determined for the year 2015 as 599.8 Turkish Lira/MW. The system operating tariff is determined each year for production and consumption in all regions, according to the needs for systems operation.

The Turkish transmission network has cross-border connections to the electricity grids of all neighbouring countries, from which it exports and imports electricity. Nevertheless, the capacity and trade volumes of these interconnections are rather limited, with 550 MW from Bulgaria and Greece to Turkey and 400 MW from Turkey to Europe via these countries. Moreover, the Turkish grid system is still not set up for synchronous operations with all other countries (Map 5).

Map 5. Electricity Interconnections of Turkey

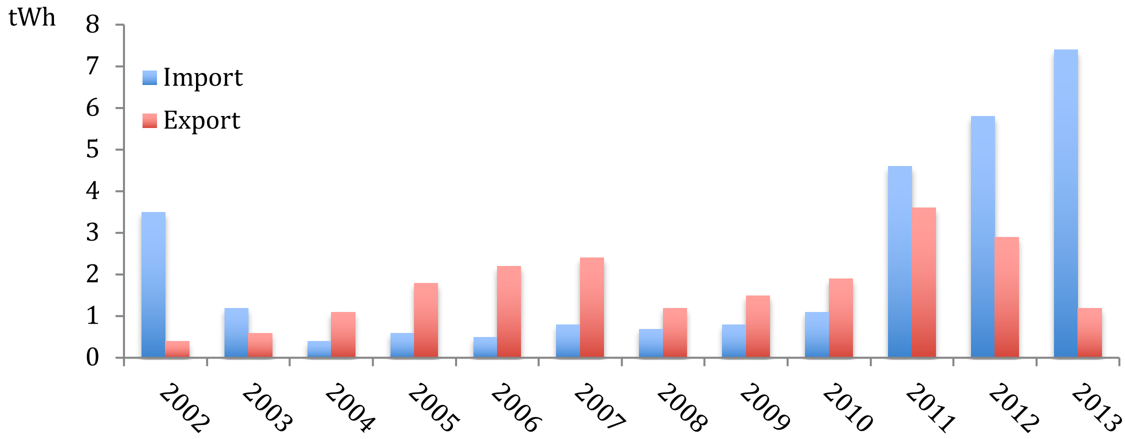
Data source: (Erten, 2015)

Turkey has synchronous connections with Georgia, Armenia, Azerbaijan-Nahcivan, Iran, Iraq and Syria. There are two interconnection lines to Georgia at 220 kilovolts and one to Armenia, which is not in operation. The interconnection lines between Turkey-Syria and Turkey-Iraq were completed and Turkey exported electricity to Syria until October 2012 and to Iraq until June 2015 (IEA 2016). Turkey has two interconnection lines with Iran. One of which, Khoy-Baskale, is 400 kilovolts and has been operating since the beginning of 2015.

At the beginning of the year 2016 Turkey finalised its technical and administrative preparation to work with the ENTSO-E and synchronised its power system with the Continental Europe Power System. The TEIAS became the associate member, as well as the first observer of the ENTSO-E since its creation in 2009. The parallel operation of the Turkish electricity system with the ENTSO-E has led to a decrease of primary frequency control reserve, a more stable frequency, greater harmonisation of the international grid codes in line with EU practices and access to the EU internal energy market (IEA 2016).

In the past, electricity imports and exports were traded through intergovernmental agreements and bilateral contracts between state-owned electricity utilities. Since 2003 EPDK is the responsible authority for approving supplier licenses, including for import and export of electricity, subject to available capacity (TEIAS) and the approval of the MENR (IEA, 2016).

Figure 10. Net electricity of imports to and exports from Turkey



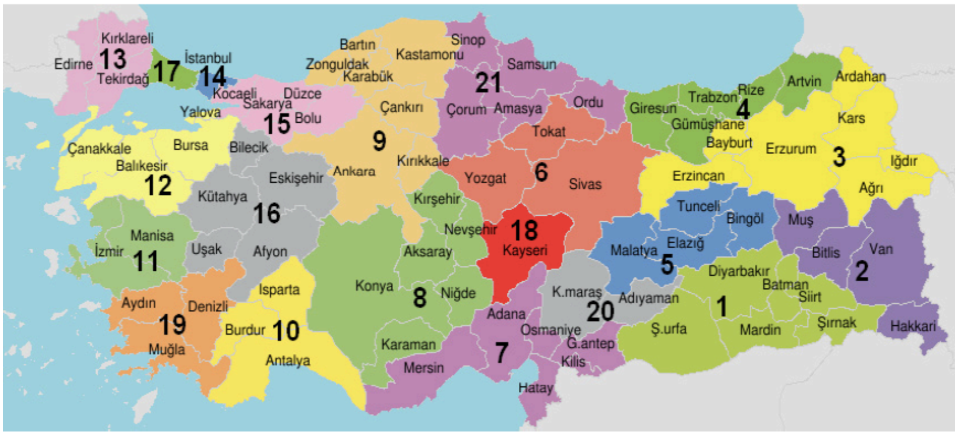
Data source: Own illustration based on the data from (TEIAS, 2016).

In 2015, Turkey's cross-border electricity net imports ranked around 4.4 twh or 2.1% of the total electricity supply of the country (see Figure 10) (IEA, 2016). Over the past decade, both imports and exports have grown, around 66.7% of total imports came from Bulgaria in 2014 and the remainder from Iran (28,3%), Georgia (3.7%), Azerbaijan (1.3%) and Greece (0.05%). Electricity is predominantly exported to Greece (70.8%) and to Iraq (29.1%) (IEA, 2016).

3.5.2. Electricity Distribution and Retail Sale

The Turkish distribution sector has experienced various structural changes throughout history. Since the enactment of the Electricity Market Law No. 4628 and through to 2004, TEDAS was structured as seven subsidiaries and foundations in the provinces, not included in the subsidiaries (EPDK, 2017). After 2004, with the aim of establishing free market conditions and a competitive market environment in the electricity distribution sector, TEDAS privatised publicly owned electricity distribution companies. The Electric Power Sector Reform and Privatisation Strategy Document were declared and the Turkish distribution network was divided into 21 regional monopoly electricity distribution areas (see Map 6).

Map 6. Electricity distribution regions of Turkey



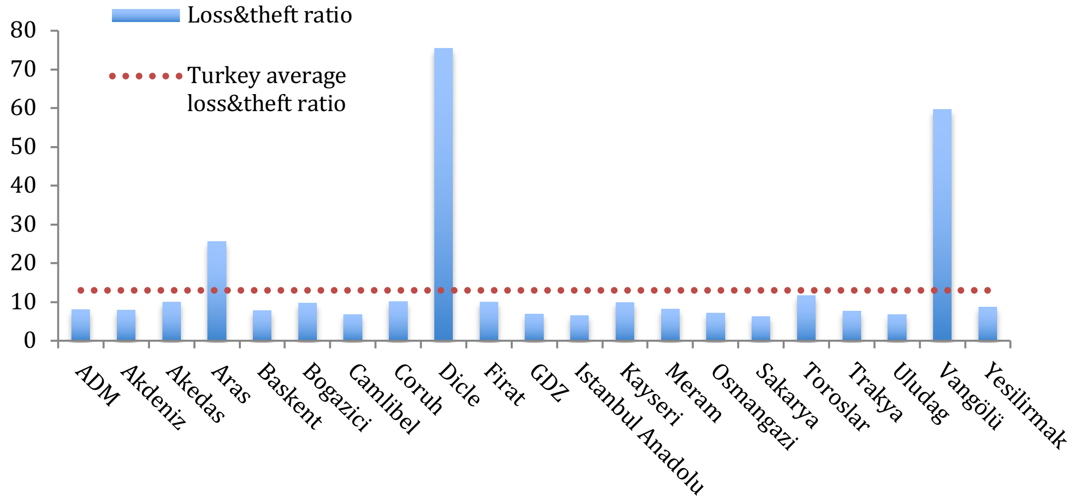
Data source: (EPDK, 2017).

The "transfer of operating rights" was the preferred privatisation method within the framework of No. 4046 "Implementation of Privatisation Law". According to this method, while the property of the distribution of assets remained with TEDAS, all shares of the distribution companies were sold as a whole, depending on the operating rights (EPDK, 2017). The electricity distribution sector of Turkey is fully liberalised after legal unbundling in 2013 (IEA, 2016).

With respect to privatisation in the liberalised market, one of the major targets of all distribution companies is to reduce losses and theft rate. Up until now, a significant reduction has been achieved at the loss and theft ratio. While the ratio for distribution across Turkey was 20.9% in 2002, it was reduced to 14.8%. In 2009, the same ratio increased to 17.7%, but again achieved a reduction by the end of 2014 to 12% (EPDK, 2015).

As indicated in the Figure 11, the highest loss & theft ratio belongs to Dicle (72.5%), Vangölü (59.7%) and Aras (26.6%) provinces in the South-eastern region. All other distribution companies in the remaining regions remain under the average loss & theft ratio of Turkey.

Figure 11. Loss & theft ratios of the distribution companies in 2015 (in%)



Data source: Own illustration based on the data from (EPDK, 2015).

There is a high need for investment in the distribution networks, including for metering and communication infrastructure, which would put pressure on tariffs. Up until now, distribution tariffs are regulated by the EPDK, but the MENR monitors the investment in distribution, which limits the independence of the EPDK.

4. PERCEPTION AND ASSESSMENT OF THE DIFFERENT ENERGY SOURCES

4.1. Global Views and Perceptions of Nuclear Energy

The projections for new nuclear power plant constructions have dwindled in most of the western European countries since nuclear accident in Fukushima. However, some Eastern European and Far Eastern countries are planning to put their construction plans into effect. Although several nuclear power plant projects have been proposed, due to the economic and regulatory constraints, Turkey has so far failed to build a nuclear reactor.

In the nuclear energy sector, many technology providers or reactor vendors are state-owned enterprises, such as in Russia, Korea and France. This means, a clear political and economic relationship is very likely to develop between the country which is providing technology and the country planning for new nuclear energy. The primary strategy of these state-owned companies is to offer lower prices, to gain political leverage through the establishment of an international nuclear energy company (Heffron, et al., 2014).

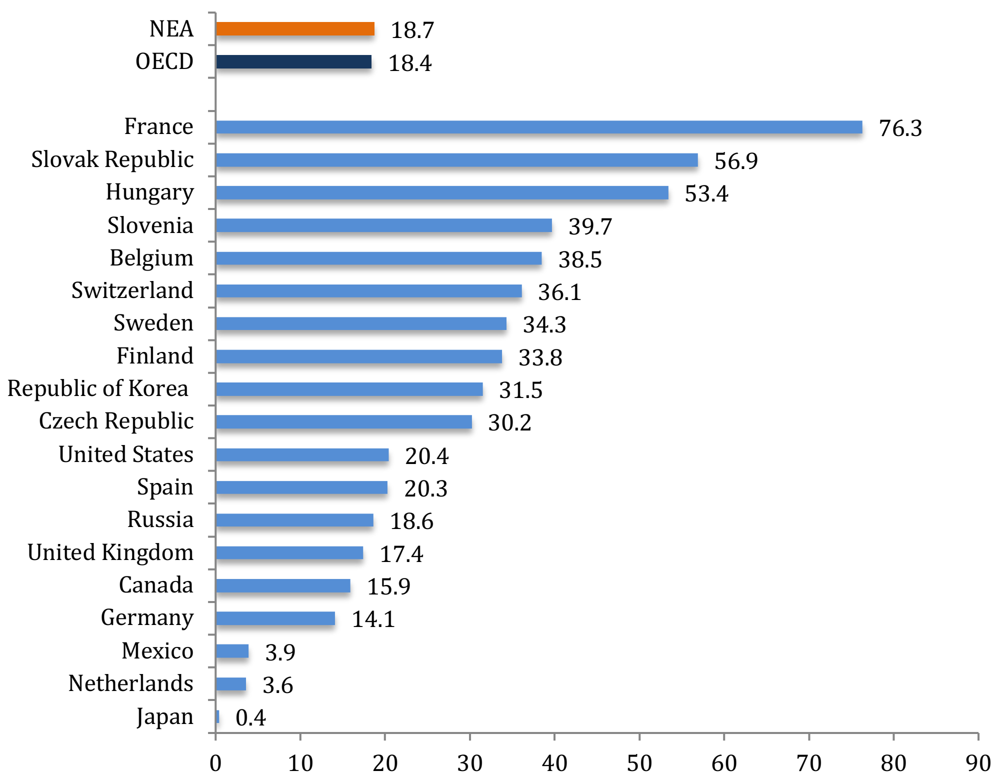
The first nuclear reactor produced electricity in 1951 in the USA, followed by the United Kingdom (1953), Russia (1954), France (1956) and Germany (1961). The oil crisis in the early 1970s incited the construction of nuclear power plants. The world's economic slowdown, which began a decade later, prompted the decline in fossil fuel prices and led to a reduction in the growth of nuclear energy demand. The Three Mile Island nuclear accident in the USA on March 28th 1979, and Chernobyl disaster in Ukraine on April 26th 1986, raised mistrust against the safety and reliability of nuclear power plants across the world. Apart from the appalling social and environmental results of Chernobyl, the disaster had long-term health effects, with over 6,000 thyroid cancer cases and 4,000-25,000 deaths as a result of radiation exposure.

On March 11th 2011, a massive earthquake occurred, measuring 8.9 on the Richter scale, which generated a 15-metre tsunami that crashed the eastern coastline of Japan. This enormous tsunami disabled the power supply and led to the cooling of three Fukushima Daiichi reactors, causing a simultaneous nuclear disaster (World Nuclear Association, 2018). The multiple barriers that were engineered to keep radiation away from the environment and people failed (Greenpeace International, 2012). In less than 24 hours, as a result of the lack of cooling at the first Fukushima reactor, a major hydrogen explosion blew apart the last remaining barrier between massive amounts of radiation and the open air (Greenpeace International, 2012). Even now, more than a few years after the release of massive amounts of radiation from the nuclear accident, hundreds of thousands of people incur the long-term radioactive pollution. The cost of the disaster is estimated to be around $50-$80 billion. Chernobyl and Fukushima prove once again, that there is always the risk – either through human failure, technical error or a natural disaster – that a nuclear catastrophe may occur. As these risks are predominantly unpredictable, we may not debate "nuclear safety" in the 21st Century.

According to the World Nuclear Association's 2018 numbers, most of Western European (Belgium, France, Germany, Netherlands, Switzerland), Scandinavia (Sweden) and some Southern European countries (Italy, Spain) have no future projects to build new nuclear reactors or to enlarge the existing ones (World Nuclear Association, 2018). After the nuclear disaster at the Fukushima Daiichi plant in Japan, Germany adopted a policy of phasing out nuclear energy by 2022 and ensuring that 80% of the country's electricity supply comes from clean energy by 2050. Japan has concluded to review their available and planned nuclear power reactors. Russia has also decided to review their newly installed nuclear power reactors and safety measures, though they will continue to build new reactors regardless of the potential threat. France has committed to abide by the decisions taken by the EU regarding nuclear power reactors and guarantees to increase the share of renewable energy sources in the total energy consumption (see Figure 12).

South Korea demonstrates to improve safety measures and further nuclear power generation from the existing and planned reactors. Although many European and some of the Far Eastern countries retreat from new nuclear reactor constructions, countries like the USA, United Kingdom and Turkey are planning to build new power plants. The United Kingdom already has 16 reactors, generating 18% of its electricity and plans to install an additional eight new reactors by 2025. The USA, as the world's largest nuclear energy producer, accounting more than 20% of global nuclear electricity generation, plans to install 14 new units. Turkey plans to construct 3 nuclear power plants that each generates 1,200 MW electricity by the year 2023. (World Nuclear Association, 2018).

Figure 12. Share of nuclear energy in total electricity production of countries in 2016



Data source: (World Nuclear Association, 2018).

According to Figure 12 France, with 76.3%, has the biggest share of electricity generation from nuclear power plants in its total energy generation; more than four times higher than the OECD and NEA average. The Eastern European countries such as Slovak Republic and Hungary have quite a high share of nuclear energy in their total power generation. Japan has a very small share with 0.4% energy generation from nuclear power reactors, followed by Netherlands with 3.6% and Mexico 3.9%. Turkey is not in the list, as the proposed nuclear power plants are either under construction or in a pending process, which will be clarified in the next subchapter in detail.

4.2. The Future Prospects of Turkey in the field of Nuclear Energy

Turkey's proposal to build a nuclear power plant dates back to the 1950s. Accordingly, in 1956, the General Secretariat of Atomic Energy Commission was established by law No. 6821, as an organisation affiliated with the Prime Ministry. A year later, Turkey became a member of the International Atomic Energy Agency. Following its membership, 'TR-1' research reactor with a 300 MWe installed capacity was constructed and became operational in 1962. In 1967-68, "Decree on Radiation Health" and "Regulation on Radiation Health" entered into force. In 1970 a feasibility study took place regarding a 300 MWe power plant. In 1973 the electricity authority decided to build an 80 MWe demonstration plant, but it did not occur. Afterwards, in 1976, the Akkuyu site on the Eastern Mediterranean coast near the port of Mersin was licensed for a nuclear plant. There were many attempts to build several plants, however, all of them failed due to the lack of financial guarantee from the government (World Nuclear Association, 2018). In 1982 the Turkish Atomic Energy Authority entered into force, which is responsible for determining the basis of national policy, plans and programs regarding the utilisation of nuclear energy for the benefit of the State and to submit them to the Prime Minister for approval. Until 2007 many attempts regarding construction of a nuclear power plant failed due to economic circumstances. In 2007 a new law concerning "Construction and Operation of Nuclear Power Plants and Energy Sale" was approved by the parliament and the President. The law provided TAEK to set the criteria for building plants and for TETAS to buy all the generated power under 15-year contracts. Under this law, the public institutions were permitted to build the plants, if other tenders were unsatisfactory. The law also addressed a waste management and decommissioning, providing for a National Radioactive Waste Account (*Ulusal Radyoaktif Atik Hesabi – URAH*) and a Decommissioning Account (*Isletmeden Cikarma*

Hesabi – ICH), into which generators would progressively pay $0.15 c/kwh (World Nuclear Association, 2018).

Map 7. The location of planned Nuclear Power Plants in Turkey

Data source: (World Nuclear Association, 2018).

Since then, three nuclear power plants are now planned for construction (Map 7): Akkuyu, Sinop and Igneada which are located in the Mediterranean, Black Sea and Marmara regions of Turkey, respectively. Akkuyu will eventually be the first plant, which introduces nuclear energy to Turkey, as the construction of this power plant is expected to begin soon. The feasibility studies for Sinop are continuing. The plans for Igneada were confirmed in 2015, with the nuclear reactor technology coming from China (Table 9).

Table 9. Planned Nuclear Power Reactors of Turkey

Name	MWe	Construction date	Operation date
Akkuyu 1	1,200	2018	2023
Akkuyu 2	1,200	2019	2023
Akkuyu 3	1,200	2020	2024
Akkuyu 4	1,200	2021	2025
Sinop 1	1,150		2024/2025?
Sinop 2	1,150		2025/2026?
Sinop 3	1,150		
Sinop 4	1,150		
Igneada 1-4	2x1,250 2x1,400		

Data source: (World Nuclear Association, 2018).

For the legislation and regulation of a nuclear program, there are also overarching legislative frameworks, set by international codes of conduct and regulations that Turkey has to act upon. These international codes and regulations are categorised, in a broad sense, under the '**United Nations**' and the '**International**

Atomic Energy Agency' (Ozbek, et al., 2016). The framework for nuclear transport security in seas is combined with the '**International Ship and Port Facility Security Code**'. Moreover, the Turkish authority is responsible for the implementation of the '**International Maritime Dangerous Goods Code'**, which includes, on top of the 'Safety of Life at Sea', the authorisation and special transportation of radioactive materials in coordination with Turkish Atomic Energy Authority.

4.2.1. Akkuyu Nuclear Power Plant Project

The Turkish Electricity Trade & Contract Corporation (TETAS) called for tenders in March 2008, inviting bids for the first nuclear power plant at Akkuyu, near the port of Mersin on the eastern Mediterranean coast. In the event, only one bid was received from 14 interested parties, this being from Atomstroyexport, in conjunction with Inter RAO (both from Russia) and Park Teknik (Turkey), for an AES-2006 power plant with four 1200 MWe reactors (World Nuclear Association, 2018). On May 12th 2010 Russian and Turkish heads of state and signed an intergovernmental agreement for Rosatom, called "Agreement on Cooperation in Relation to the Construction and Operation of a Nuclear Power Plant at the Akkuyu Site in the Republic of Turkey". The Akkuyu power plant will be the first project internationally designed in the 'Build-Operate-Own' model of financing. According to this agreement, the Russian energy company Rosatom will build and operate a four-reactor nuclear power plant, targeting a fully operational plant by the 100-year anniversary of the Republic of Turkey in 2023. According to the agreement, Rosatom will build, own and operate the Akkuyu Nuclear Power Plant, which will have four 1,200 MWe AES-2006 units and constitute for a US$20 billion project (World Nuclear Association, 2018). TETAS guarantees to purchase 50% of the total production for fifteen years, at an average price of $12.3 cents/kwh for (Bal, 2015). After 15 years, when the plant is expected to be paid off, the project company will pay 20% of the profits to the Turkish government (World Nuclear Association, 2018). The first of four reactors are expected to begin to operate in 2023. Each year one additional reactor is planned to be added to operation, until approximately 2025, with a total site capacity of 4,800 MWe. The power plant has been estimated to meet 16% of Turkey's energy demands. Consequently, the Russian energy giants Gazprom and Rosatom will dominate around 74% of Turkey's energy market.

There is a high possibility, that there will be delays on the construction of the Akkuyu nuclear facility, due to some licensing obstacles. In 2013 Rosatom applied to the

Ministry of Environment and Urban Planning of the Republic of Turkey to start the *Environmental Impact Assessment (ÇED)* report. The report is a pre-requisite for the evaluation of the viability of the project, which comprises the issues like determination of the environmental conditions and potential ecological consequences of the nuclear power plant in the region (Bal, 2015). The *ÇED Report* of Rosatom was rejected by the Ministry of Environment and Urban Planning due to the uncertainty and lack of information regarding the storage of nuclear waste. After a very short time of the rejection, the report was approved by the Ministry of Environment an Urban Planning, although the report neither provided a credible assessment nor drew a critical attention to the potential risks of the power plant. Moreover, the government downplayed the seismic risks of the project, despite the fact that Akkuyu is located in a seismically unstable area. Some of Turkey's highly regarded earthquake experts are demanding a halt to the construction of this nuclear plant until geodetic research is completed in the area. If an earthquake occurs, it may cause a catastrophic nuclear accident in Akkuyu, which could have destructive consequences not only for Turkey, but for the 165 million people in the Eastern Mediterranean.

There are strong protests from environmental organisations against the construction of this nuclear plant, claiming irremediable environmental and health concerns. One of the most active opponents of the Akkuyu nuclear power plant, the President of 'Mersin's Environment and Nature Association' (*Mersin Cevre ve Doga Dernegi*) Sabahat Aslan and the President of the Chamber of Medical Doctors of Mersin *(Mersin Tabipler Odasi)* Dr. Ful Ugurhan, pointed out that the major risk of construction of the plant, is the close range of the *Ecemis fault line.* In addition to *Ecemis,* there are four other fault lines which have historically influenced the seismic conditions of the region: I) *Kibris subduction zone, II) Ölü Deniz fault, III) South Aegean subduction zone, and IV) Eastern Anatolian*. Sabahat Aslan underlines the predominant gaps in the controversial *ÇED Report* regarding the potential implications of a possible earthquake in the area. Moreover, according to Aslan, the maintenance of heat removal under the new model of Russian power units holds significant environmental risks. The units will consume approximately 20 billion litres of seawater per day for the cooling system and 2.5 tonnes of chlorine will be processed on a daily basis, which all in all will contribute to a drastic climate change in the region , leaving lasting negative impacts on agriculture and the ecosystem (Bal, 2015).

Prof. Dr. Ali Cemal Gücü of the Marine Sciences Institute in the Middle East Technical University, Ankara, highlighted that the ÇED report of Akkuyu calls out the potential threats. If the power plant is built, it will cause degradation of the marine ecosystem as well as the extinction of fish and other marine species (Ercan, 2014). Moreover, the water intake and sea traffic of the plant will pose a real danger to the Mediterranean Monk Seals, which is one of the ten most endangered species in the world, with an estimated population of only 50-100 on the entire Turkish coastline including the Black Sea, Aegean and the Mediterranean.

From the Russian point of view, having the opportunity to construct and operate the first nuclear project outside its borders will boost its competitiveness in the international nuclear energy arena. Turkey, by employing Russia to build, own and operate the project, has put politics over legislative development and the safety and protection of its citizens (Heffron, et al., 2014). Akkuyu nuclear project neither supports technology transfer nor reduces Turkey's reliance on Russian energy imports (Heffron, et al., 2014).

The Turkish Government has no shareholder within the Akkuyu project company and interacts only as regulator. The project company is Russian-owned and subject to the Turkish Law, which is open to private partners, but the public ownership is out of scope. Unlike the Sinop power plant project, which will be explained in the next subchapter, the technology transfer issue is not mentioned in the Akkuyu project. Regarding the fuel, waste management and decommissioning, it is stated in the Article 12.2-4 of the 'Intergovernmental Agreement':

> "*Subject to separate agreement that may be agreed by the Parties, spent nuclear fuel of Russian origin may be reprocessed in Russian Federation… The Project Company is responsible for decommissioning and the waste management of the nuclear power plant. Within this framework, the Project Company will make the necessary payments to relevant funds stipulated by the applicable Turkish laws and regulations*" (Resmi Gazete, 2010).

Additionally, the Akkuyu Company is to contribute $0.15 cents/kwh to a special fund, to be established for the management of nuclear waste. Based on the Article 12.4, it seems like Turkey will not be faced with a spent fuel and radioactive waste management problem in the case of Akkuyu plant (Atiyas, 2015). Nevertheless, there are some undisclosed issues such as where the reprocessing of spent fuel will take place and what will happen if the spent fuel is reprocessed in Russia. While the government has yet to fully articulate a spent fuel policy, it still remains unclear if Turkey included the potential costs of waste management into its nuclear power related financing models (Bilezikci Pekar, 2014).

4.2.2. Sinop Nuclear Power Plant Project

In 2006, the province of Sinop, a port city on the Black Sea coast, was chosen to host a commercial nuclear power plant. In November 2007, a new Law No. 5710 on "*Construction and Operation of Nuclear Power Plants and Energy Sale*" was approved by the Turkish authorities. This law gave a declaration for the Turkish Atomic Energy Authority to set the criteria for building and operating the nuclear power plants. Since February 2008, preparatory work has been under way at Sinop on the Black Sea coast, to build a second nuclear plant, along with a €1.7 billion nuclear technology centre (World Nuclear Association, 2018). In May 2013, the Turkish government acceded the proposal from a consortium led by Mitsubishi Heavy Industries (MHI) and Areva, with involvement from Itochu and Engie, which proposed four Atmea1 reactors with a total capacity of about 4,600 MWe.

The power plant was planned to be constructed by a consortium of Mitsubishi Heavy Industries and the Itochu Corporation from Japan, together with Engie from Germany. EÜAS intended to take a 35% stake in the project company, with the balance shared among Mitsubishi, Itochu and Engie (World Nuclear Association, 2018). In 2018 Itochu Corporation withdrew from the project. EÜAS now intends to take 49% equity. Engie will be the operator based on the build-own-operate agreement.

The Sinop nuclear power project includes the construction and operation of four Atmea-1 reactors with a total capacity of 4,800 MW electricity. The estimated cost of planned 5,000-5,600 MWe capacity Sinop nuclear plant will be between $22 and $25 billion (World Nuclear Association, 2018). The areas of cooperation between Turkey and the consortium partners include conducting a feasibility study, economic impact assessment of the project, design, construction, operation, repair and decommissioning of the nuclear power plant as well as ensuring nuclear safety and supply of the nuclear fuel. The feasibility study for the construction of the first Atmea1 Unit was due for completion in mid-2017, the announced timeline for the construction to start was 2017 and it was planned to be fully operational by 2023 (World Nuclear Association, 2018). Nevertheless, due to the prolonged technical, commercial and feasibility studies of

Mitsubishi heavy Industry in the area, there is, as yet, no certain date regarding the beginning of the plant construction.

Turkey has a considerable amount of ownership stake in the company responsible for the Sinop nuclear power plant. Moreover, the issue of 'technology transfer' is covered in the project plan of Sinop power plant, which includes a human resource development plan in the host country. Additionally, there are also some risks associated with the operation of plant, which must be considered. The major risk of Sinop nuclear plant is that the generated electricity from the plant will eventually be too expensive compared to alternative sources. Nevertheless, this risk is almost eliminated through the 'power purchase agreement', which TETAS will sign with the project company, committing to purchase 100% of the project's output, which eliminates the market risk. The purchase guarantee significantly reduces the market risk for the Sinop project. Through the power purchase agreement, the EÜAS consortium (which includes EÜAS and other public and private entities) will even hold a 49% share.

Another important risk is Turkey's deficient policy regarding the management of spent fuel and radioactive waste. According to the Sinop Agreement the final disposal of the spent fuel and radioactive waste is the responsibility of Turkey. As indicated in the Annex No. 6 "Final disposal of spent fuel and radioactive waste" of the Agreement between Japan and Turkey on Co-operation for the development of nuclear power plants and the nuclear power industry in the Republic of Turkey:

> *"The Government of the Republic of Turkey is to be responsible for the final disposal of spent fuel and radioactive waste in accordance with the laws and regulations of the Republic of Turkey. The Project Company is to pay a contribution of 0.15 US cents/kwh for waste management…"* (MFA Japan, 2013).

The International Atomic Energy Agency defines the "spent fuel" as "*nuclear fuel removed from a reactor following radiation, which is no longer usable in its present form because of depletion of fissile material, poison build-up or radiation damage*" (IAEA, 2007). The project company is only responsible for the management of spent fuel and radioactive waste until they are transferred to the final disposal facilities, whereby responsibility is transferred to Turkish authorities. It is also still unclear how the fuel cycle set-up will be realised and whether the spent fuel from the Sinop plant will be reprocessed. Although Japan has a full fuel cycle set-up, including enrichment and reprocessing of used fuel, most reprocessing of Japan takes place in the United Kingdom or France (Bilezikci Pekar, 2014). Whether Japan will provide a spent nuclear fuel take back provision for Turkey remains ambiguous. Furthermore, Turkey is also yet to determine any policy regarding spent fuel storage. It is still unclear if the costs related to the storage of spent fuel and the eventual construction of an underground repository were included in the Sinop projections (Bilezikci Pekar, 2014). Until 2018 no site was specified for where the power plant would be built. In 2018 the Turkish Ministry for Energy and Natural Resources confirmed the Thrace region had become the definite choice to host Turkey's third nuclear power plant.

4.2.3. Igneada Nuclear Power Plant Project

TAEK has identified Igneada, in the Kirklareli province on the Black Sea, as the site to build a power plant as part of 100 GWe required by 2030. In November 2014, EÜAS signed an agreement with the State Nuclear Power Technology Corporation of China and Westinghouse, to begin negotiations to construct a four-unit nuclear power plant in Turkey (World Nuclear Association, 2018).

Similar to the other proposed nuclear plant projects, there are also certain concerns from the locals, environmentalists and NGO's regarding the construction of Igneada power plant. Igneada is famous for its floodplain forests. The construction works will seriously threaten the pristine habitat and natural life in the region. Igneada has the third greatest floodplain forests in the world. Moreover, some 258 bird varieties of the total 453 that are found in Turkey are in Igneada, with 670 different plant types and 668 species of animals living in the area (Celikkan, 2015).

Beyond the incomparable environmental threats of a possible plant construction in the area, the metropolis of Istanbul and the residents in Bulgaria would also hang by a thread. While Istanbul is located 100km from Igneada, the Bulgarian border is just 12 km away. Yasar Mersin, from the "Igneada Nature Representatives Group", along with the locals living in the villages around Igneada, propound that Bulgaria, as the neighbouring country, must also approve the construction of a power plant so close to its borders (Celikkan, 2015).

The status of the Igneada power plant construction is still pending and currently there is neither a certain construction nor an operation date proposed.

4.2.4. Turkey's Uranium Reserves and Fuel Cycle

Turkey has limited uranium reserves. The main nuclear deposits of Turkey are generated from Uranium und Thorium. The MTA discovered a Temrezli deposit in the central Anatolian region, 220km east of Ankara, in the early 1980s. Measurement of resources at Temrezli indicated a total of 2,351 tonnes of Uranium in the end of 2013 (World Nuclear Association, 2018). Contrary to its scarce uranium deposits, Turkey has a vast amount of thorium reserves, which can be used in nuclear power plants to generate electricity. According to OECD and International Atomic Energy Agency data, Turkey, holding a minimum of 744,000 tonnes, which is around 11% of the total global thorium reserves, has the second largest thorium reserves worldwide after India. The majority of the reserves are discovered in Eskisehir-Sivrihisar, Isparta-Aksu, and Malatya-Hekimhan provinces, located in the Northern Mediterranean, Central- and Eastern Anatolian provinces (Sultansoy, et al., 2015). According to the Turkish Energy Foundation’s 2015 report, if thorium technology could be commercialised, Turkey would produce a substantial amount of added value and transform that into exports, replacing fossil fuels. Compared to the conventional nuclear facilities, thorium plants would have considerably lower carbon emissions, less radioactive waste, and ultimately less environmental damages and risks arising from carbon emission (Sultansoy, et al., 2015). Nevertheless, Turkey’s ability to benefit from this opportunity by developing thorium technology, is still weak due to the following identified challenges (Sultansoy, et al., 2015):

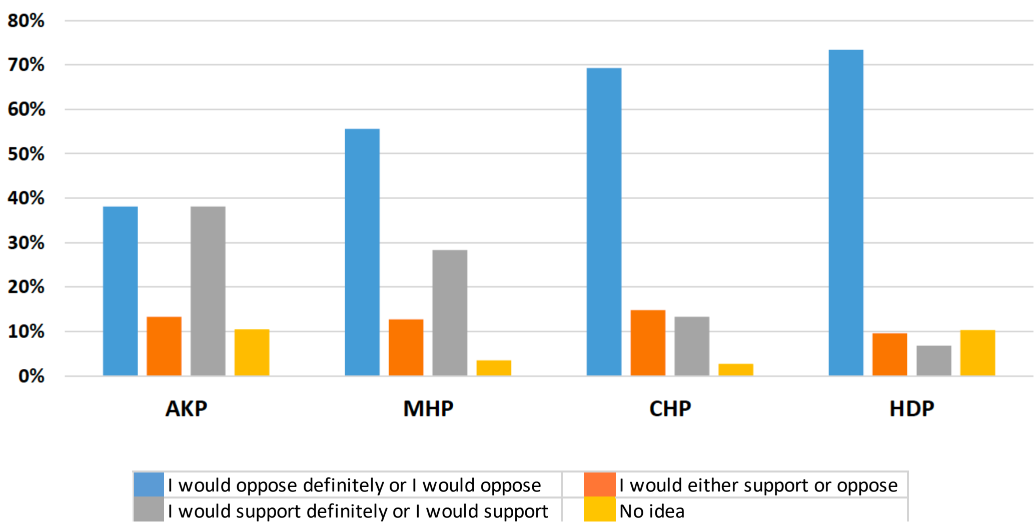
i. Inaccurate public perception arising from the tabloidisation of the issue.
ii. Heavy bureaucratic and administrative mechanisms.
iii. The lack of an effective national research & development policy.

4.2.5. Public Awareness and Social Acceptance

(Ertör Akyazi, et al., 2012) performed a face-to-face survey in 2012 among 2,422 residents from urban Turkey, regarding the citizens’ preferences on nuclear and renewable energy sources. It was the first study in Turkey on energy preferences. The survey took place before the Fukushima nuclear accident, and therefore, the respondents’ answers are free from the influence of the events in Fukushima. Even so, one of the main indications was that the opposition to nuclear energy was relatively strong – only a small number of respondents listed nuclear energy in their top two choices. Supporters of nuclear energy were mostly males who, despite being knowledgeable about climate change and engaged in environmental issues, were unconcerned about the issue. Nuclear opponents were found to be more concerned about the environment and pessimistic about their future, many displaying a generally lower dependency on technology.

Another face-to-face survey, performed by the Kadir Has University in 2016, with 1,204 participants originating from different regions of Turkey, showed that the supporters of the construction a nuclear power plant had actually increased, despite the Fukushima nuclear accident. The numbers showed that 32.5% of respondents would definitely oppose, 17.1% would not support, 14.2% remained neutral, 20.7% supported and 5.9% definitely supported the construction of a nuclear power plant, in the local area where they lived (Ediger, et al., 2016). The survey also showed the political opinions of the respondents, compared to their responses regarding the power plant construction (Figure 13).

Figure 13. Characterisation of the political party supporters with regard to the construction of nuclear power plant in Turkey



Data source: (Ediger, et al., 2016).

Based on the above results, the proponents of the AKP and MHP political parties are also the supporters of nuclear power plants. This comes as no surprise, as the AKP is the leading government party in Turkey, in alliance with MHP. The opposition parties, CHP and HDP, remain strongly opposed to nuclear power plant projects.

Further survey results show some interesting discrepancies within the responses. For example, 23.4% of people support the construction of further nuclear power plants in Turkey, in addition to the Akkuyu and Sinop power plant projects. 28.4% of respondents believe that nuclear energy will decrease the energy dependency in Turkey, as well as energy prices within the country. The results showed that the respondents who were in support of nuclear power plants, were not ignorant of the serious dangers which the nuclear power plants pose for health, habitat and for society. These survey participants simply prioritised the government discourse regarding nuclear energy security (Ediger, et al., 2016).

The survey results, from a holistic point of view, show us that the people primarily concerned by Turkey's increasing energy dependency and energy prices. Although they are partially aware of the environmental, health and security risks of nuclear power plants, almost 30% of people still supported the further construction of power plants in their home regions. Nevertheless, 23.1% of people are still opposed to the construction of further power plants and many of them are active in local and national protests.

4.3. Results and Outcomes

One of the important energy targets of the Turkish government, is to reduce energy imports as well as energy dependency. Turkey has been relying on Russian gas imports, like many other European countries. Nevertheless, signing an agreement for the construction and operation of a nuclear energy plant with a Russian company, stands in full contradiction of Turkey's target to reduce its energy dependency. If the Akkuyu project goes into effect, Turkey's energy reliance on Russia will increase between 58% and 70%. In this context, Turkey is in the position to change the fuel source, but not the supplier. Even if the Akkuyu nuclear power plant begins operation, because of the type of the reactor, the fuel must be produced in Russia and delivered from Russia. Ultimately, Turkey's dependency on Russia will continue to increase. Secondly, construction of a nuclear power plant is not solely enough for the substantial reduction of the dependency on natural gas. So long as the electricity demands increase and energy efficiency measures remain unimplemented, the closure of existing natural gas pipelines is unthinkable.

Turkey's ambitions for nuclear energy to account for 5% of the Turkish electricity production by 2023, have made the country one of the most potentially profitable and active markets in the world. The country's targets, as an emerging nuclear power state, also influence Ankara's position to transfer and adopt sensitive nuclear technologies, including uranium enrichment. The uranium enrichment and spent fuel technologies are necessary for the reprocessing technologies and also for the production of fissile material for nuclear weapons. According to Sinan Ülgen, a well-known scholar on

Turkey and its relations with the EU, the distinction between nuclear energy ambitions and nuclear weapons capability must be revealed. He stated, *"in justifying Turkey's policies, nuclear policy is influenced strongly by the fact that it is a non-nuclear-weapon state seeking to develop an indigenous nuclear energy program"* (Ulgen, 2012). Nonetheless, as mentioned, Turkish authorities have not announced any plans to carry out uranium enrichment or reprocessing. They have, however, left open the possibility to make this addition at a later time.

The statements of the Turkish authorities stipulate that their decision-making process regarding operating a nuclear power plant in Turkey, is virtually without interrogation. Taner Yildiz, the former Minister of Energy and Natural Resources, asserted that building nuclear power plants in Turkey do not cause risk. He supported this by citing that "*celibacy is riskier than nuclear*", referencing the finding that the life expectancy of bachelors is six years shorter than married people in the USA (Günel, 2011).

In a press conference, Turkish President Recep Tayyip Erdoğan declared that the people of Turkey are totally misinformed about nuclear energy. He explained:

> *"There is no investment without risk. If so, then we should not use bottled gas at home, or install a natural gas line for the residencies, or no crude people should cross over the country"* (Own translation from the 15.03.2011 dated press conference of the former Prime Minister Recep Tayyip Erdogan).

There are two plausible policy approaches to structure the way a 'State' deals with the nuclear liability issue. These are utilitarian policies, which correspond to 'regulatory policies designed to maximise general welfare' and rights-based policies, referring to 'moral principles designed to promote social justice' (Heffron, et al., 2014). The "build-own-operate" mechanism of the Akkuyu nuclear power plant creates less incentives for the Turkish government and does not address Turkey's need for an independent regulatory body, with the internal capability to observe Russia's actions on Turkish soil. The mechanism gives the weight of responsibilities in transport safety and security to the Russian side (Ozbek, et al., 2016).

Greenpeace International discussed in a 2013 report, that nuclear liability conventions only protect the industry – this includes operators, suppliers as well as investors – but not the people and victims. According to this report, the core problems of nuclear liability are as follows (Froggatt, 2013):

- The international liability conventions are contradicting.

- The operator of a nuclear power plant is solely responsible for the damages. The nuclear suppliers are exempted from paying any penalties.
- The total amount of compensation as a result of a potential nuclear accident is much lower than the actual cost of a nuclear accident.
- The description of a nuclear damage is not alone enough to address all types of damages caused by a nuclear disaster.

Regarding the nuclear liability issue, a utilitarian approach would view the matter with a result-oriented perspective: The operation of a nuclear power plant comes with significant risks, such as threats to public health, civil liability issues raised by individuals affected by nuclear-related accidents. But the risks may be preponderated by the potential benefits to the nation's economic status (Heffron, et al., 2014). The policy approach of Turkey can be perceived as utilitarian, as Turkey "has put politics over legislative development and the safety and protection of its citizens in the event of a nuclear energy accident" (Heffron, et al., 2014). Even though the serious environmental and public health risks exist, if Turkey still aims to build and operate nuclear reactors within the country, a significant amount of legislative reforms must firstly be implemented. Furthermore, the safety and protection of the citizens must be prioritised (Heffron, et al., 2014).

Turkey is substantially rich in renewable energy resources. Nevertheless, by giving that massive sum to the nuclear industry, the Turkish government is setting up a barrier to a clean, safe and sustainable future (McKeating, 2013). Turkey possesses one of the best renewable energy potentials in Europe, with sufficient capacity to prevent the need for nuclear power. Nevertheless, the Ministry of Energy insists upon nuclear energy, in spite of the fact that "380 billion kwh electricity can be generated by solar photovoltaic" or having a "48 GW wind installed capacity will have no feasibility question (today the installed capacity for wind power plant is around 2 GW)" (Gürbüz, 2016). The fact is, that renewable energy sources are much more feasible for technology transfer as well as to provide more employment opportunities than a nuclear power plant. In conclusion, the lack of a sustainable domestic nuclear infrastructure, unclear planning regarding the management of spent fuel and radioactive waste, potential environmental risks and the continuation of non-transparent statements, are the counter arguments for the facilitation of the planned nuclear power projects.

The question remains, whether the Turkish government will continue with construction plans, as a result of its modernist and growth-seeking ambitions, or whether they will consider the high environmental costs, that nuclear power plants may bring about. Up until 2015, the local and national activists, environmental groups and NGOs had managed to stop proposed nuclear power plant projects. Nevertheless, in spite of the Fukushima disaster, the Turkish government have completely ignored these opponents and pushed ahead with power plant construction. Another problem in Turkey is the lack of public participation in the decision-making processes of such important projects, which have the possibility to directly impact citizens' lives. The societal engagement and the participation of civil society, NGOs and citizens is vital to counter the determination of the authorities.

5. NON-CONVENTIONAL (RENEWABLE) ENERGY SOURCES

The aim of this chapter is to contextualise renewable energy in Turkey, including the role and potential of renewable energy sources in Turkey's climate strategy. Furthermore, the renewable energy policies, legislations and contribution of specific renewable energy sources to Turkish power generation will be analysed. Additionally, the environmental impacts and the social acceptance and public perception of each renewable energy source will be addressed.

The utilisation of renewable energy resources has become inevitable worldwide. This is not only because of the peak oil and termination of fossil fuel era, but also due to the unprecedented pressure of human dominated activities on the planet. The Earth is being battered by humanity from every direction: The extinction of species, rising greenhouse gas emissions, ocean acidification, chemical pollution, land use change and rising freshwater consumption. With regard to these serious planetary changes, the governments and global organisations have started to develop renewable energy policies and implement various support mechanisms, obligations and incentives to implement the energy transition from fossil to post-fossil energy era. The most commonly used renewable energy policies are as follows (Arioglu Akan, et al., 2015 S. 16379–407):

a) Capital subsidy: The subsidy covers a share of the upfront capital cost of an asset (such as solar water heater).

b) Feed-in premium: Producers sell generated electricity from renewable energy sources at market prices and a premium is added to the market price to compensate for the higher costs and financial risks of the production from renewables.

c) Feed-in tariff: A minimum price per unit is guaranteed over a fixed time period when electricity can be sold and fed into the network.

d) Fiscal incentive: An economic incentive, which provides individuals, households or companies with capital subsidy, grants or rebate, as well as reductions, value added taxes or other taxes.

e) Investment tax credit: Allows investments in renewable energy to be either fully or partially deducted from the tax obligations.

f) Mandate/obligation: A measure that requires consumers, suppliers and generators to meet a minimum target for renewable energy, such as a percentage of total supply.

g) Production tax credit: A measure providing the investor or owner of a facility with an annual tax credit based on the amount of generated renewable energy by that facility.

h) Renewable energy certificate: A certificate awarded for the generation of one unit of renewable energy (1 MW hour of electricity).

i) Renewable energy target: A goal set by a government to achieve a certain amount of renewable energy in the future.

j) Renewable portfolio standard: This represents an obligation set by a government on companies or consumers to provide or use a predetermined minimum renewable share of installed capacity or of electricity.

As for Turkey, *renewable energy target, feed-in tariff* and *biofuels obligation/mandate* have been used as regulatory policies and targets (Arioglu Akan, et al., 2015 S. 16379–407). As a member of the OECD and candidate country of the EU, Turkey is one of the developing countries with a substantial potential for wide range of renewable energy sources. The country has one of the highest hydropower, geothermal, solar and wind energy potentials among the EU member states. Nevertheless, current energy policies of Turkey are jeopardising the development and utilisation of renewable energy sources in a sustainable and efficient way. The country is strongly dependent on fossil energy imports. By the end of 2015, renewables contributed 15.7 mtoe of country's total energy production, which represents 12.1% of total energy supply of Turkey, which came from hydro (4.4%), geothermal (3.7%), biofuels and waste (2.5%), wind (0.8%) and solar (0.7%). The electricity production from renewable energy sources reached 83.8 twh, which represented 32.2% of total electricity generation (IEA 2016). The remaining energy supply was came from the fossil energy imports, predominantly natural gas imports from Russia. Moreover, Turkey's energy demand has been increasing rapidly over the last decades, which has had a negative impact on the country's economy as a result of high amount of fossil energy imports. The inefficient and high use of fossil fuels creates air pollution and raises the greenhouse gas emissions of Turkey.

5.1. Renewable Energy Legislation and Regulations in Turkey

Based on the previously stated energy situation of Turkey, energy efficiency has become a crucial issue in the energy agenda of the Turkish MENR. Therefore, on April 5th 2001, the Turkish Government ratified the Energy Charter Treaty and the Protocol on Energy Efficiency and Related Environmental Aspects, as well as committing to formulate and implement policies for improving energy efficiency and reducing the negative environmental impacts of the energy cycle. Turkey's energy efficiency policy is guided by the 'Energy Efficiency Law No. 5627', which came into force in 2007. This specific Law has set "the legal framework for energy efficiency and prevention of the wasteful use of energy in order to reduce the burden of energy costs on the economy and protect the environment" (MFA, 2017). To establish a road map for the implementation, the MENR prepared an 'Energy Efficiency Strategy', approved by the High Planning Council on February 20th 2012. The main goals of this strategy are highlighted as: A reduction of energy density by 20% per GDP until 2023, energy losses in industry and service sectors, decreasing energy demand and carbon emissions of buildings, providing 30% of total electricity production from renewable energy, efficient use of energy in the public sector, strengthening of institutional structures, capacities and cooperation, employing advanced technologies, increasing awareness-raising activities and creating alternate financing sources than public sources (EC, 2016). It is mandatory to coordinate 'Energy Efficiency' measures throughout the country and between the relevant public and private institutions in order to accomplish a strong institutional capacity in the sector.

Currently, Turkey produces 20% of its total electricity supply from renewable energy sources and plans to increase this rate to 30% by 2023 (MFA, 2012). The country's intended nationally determined contribution, adopted in September 2015 ahead of the Paris COP21 Conference, contains decisive targets of 16 GW for wind and 10 GW for solar in 2030. The wind target is below the intentions set out in the 2009 Strategy (20 GW) and the solar target is much lower than the solar potentials in Turkey (IEA, 2016).

Turkey has also made concrete steps regarding the increase of energy efficiency. Through Turkey's Council of Ministers Decree, Number 2014/6058 (*published in the Official Gazette on May 09, 2014 with number 28995*), several amendments have been made to the implementation of the current investment incentive system, also relating to the energy efficiency issue. According to this decree: "investments aimed at energy efficiency i) which are realised in existing manufacturing industry plants having a minimum 500 tons equivalent petroleum energy consumption and provide a minimum 20% power savings per unit, and ii) the investment return of which is a maximum of 5 years" (Pekin & Pekin, 2016) will be benefited from the incentives. According to the European Commission's 2003 and 2005 projects (which were designed for Turkey's Accession Partnership programs), respectively titled "*Improvement of Energy Efficiency in Turkey*" and "*Increasing Public Awareness on Energy Efficiency in Buildings*", a person in Turkey is consuming two or three times more energy (per m^2) for heating, than people in countries such as Germany or France. This situation poses both financial and environmental challenges. Currently, there are ongoing discussions in the Energy Commission of the National Assembly of Turkey regarding a new Draft Energy Efficiency Law and an amendment to National Purchasing Law.

In 2005, Turkey has adopted the basic legal framework for the renewable energy (Law on Utilisation of Renewable Energy Sources for the Purpose of Generating Electrical Energy No. 5346, YEKA Law (in Turkish: *Yenilenebilir Enerji Kaynak Alani)*, which supported hydro, wind, solar, geothermal, biomass, biogas (including landfill gas) and wave, current and tidal energy. As indicated in the Turkey Review 2016 report of the IEA, "the Law provided for the choice between direct sales of renewable electricity into the spot market versus a general feed-in tariff, and included supplier obligations to purchase renewable electricity, priority connection, and exemptions from license obligations for small generators (0.5 MW), as well as reduced fees for land acquisition and project preparation" (IEA, 2016).

In 2011, Turkey enacted its very first Renewable Energy Support Mechanism (Yenilenebilir Enerji Kaynaklari Destekleme Mekanizmasi - YEKDEM). The goal of this mechanism was to increase and diversify the use of renewable energy sources without interrupting free market conditions. Furthermore, a gradual reduction in greenhouse gas emissions, efficient waste utilisation, better environmental protection and development of the necessary manufacturing sectors are targeted (Arioglu Akan et al. 2015). Concordantly, the power plants, which have been in operation since May 18th

2005, or that will come into operation before December 31st 2015, will be eligible to receive the following feed-in-tariffs for the first ten years of their operation. The new law also brought some incentives, such as licensing, land appropriation and purchase guarantee through a constant feed-in tariff (Arioglu Akan et al. 2015).

In December 2004, Turkish government presented the **National Renewable Energy Action Plan for the period 2013-2023**, in line with the methodology of the EU Renewable Energy Directive 2009/28/EC. Based on this directive, the National Renewable Energy Action Plan asserts that "Turkey had a 13.5% share of renewable energy in gross final consumption in 2013 and needs to reach 20.5% by 2023" (IEA, 2016). Other targets, regarding the utilisation of renewable energy sources, set by the Action Plan, are listed as follows (IEA 2016):

- Lifting up installed power to 120,000 MW
- Full utilisation of all economically feasible hydropower potential for generating electricity to reach 34,000 MW
- Increase installed power generation capacity of wind up to 20,000 MW.
- Expansion the use of solar power in electricity generation to utilise Turkey's abundant potential to reach 3,000 MW
- Utilisation all of 600 MW of geothermal electricity potential in Turkey
- Implementation of support mechanisms for biomass use of 1,000 MW
- Achieving a 10% share of renewable energy use in the transport sector.
- Extending the length of transmission lines to 60,717 km
- Extending the use of smart grids
- Reaching a power distribution unit capacity of 158,460 MVA
- Raising the natural gas storage capacity to 5 bcm

In January 2015, Turkish Ministry of Energy and Natural Resources released a 2015-2019 Strategic Plan. The adopted Strategic Plan for the period 2015-2019, targets the expansion of renewable energy sources to 30% of total energy production by 2030. To reach the designated 2023 energy targets set by the Turkish MENR, appropriate support and incentive mechanisms must be formed within Turkey's New Law on Renewable Energy Sources: 1) Feed-in Tariff Mechanism, 2) Unlicensed Generation, and 3) Local Content Support.

1) <u>Feed-in Tariff Mechanism:</u> To use its renewable potential and support the contribution of renewables in total electricity generation, Turkey enacted the

“Amendment Law to Utilisation of Renewable Energy Resources for the Purpose of Generating Electrical Energy No. 6094” in 2011 (IEA, 2016). The law provides feed-in tariffs to renewable energy producers for a maximum term of 10 years from their operation date. Each year the investor may choose between the feed-in tariff and direct sales in the power market. In this context, feed-in prices for hydroelectric and wind power-based generation facilities are fixed up to US$7.3 per kwh, geothermal energy-based generation facility to US$10.5 per kwh, biomass energy-based (including landfill gas) and solar energy-based generation facilities to US$13.3 per kwh (Table 10). Adding local content to the project will bring an additional US$23-92 per MWh per project for five years. Furthermore, there is a spot market, which can function as an alternative sales point for renewable energy generators (Energy Charter Secretariat 2014).

Table 10. Feed-in Tariff Mechanism in Turkey

Type of power plant facility	Feed-in tariff ($/kwh)	Maximum local production premium ($/kwh)	Maximum possible tariff ($/kwh)
Hydroelectric	7.3	2.3	9.6
Wind	7.3	3.7	11
Geothermal	10.5	2.7	13.2
Biomass (including landfill)	13.3	5.6	18.9
Solar photovoltaic	13.3	6.7	19.5
Concentrating solar	13.3	9.2	22.5

Data source: Own illustration based on the data from (pwc, 2012).

2) <u>Unlicensed Generation:</u> Real and legal entities which are generating electricity from renewable energy-based production facilities with a maximum installed capacity of 1 MW, can benefit from the above scheduled feed-in prices in the case that they supplement surplus electricity back into the distribution system. Within this framework, distribution companies, having electrical retail sales licenses, must purchase this energy within the context of Renewable Energy Support Mechanism (Kaplan, 2015).

3) <u>Local Content Support:</u> This support is considered as an extra bonus and shall be added to the feed-in tariff of relevant renewable energy resources to encourage the utilisation of renewables. In the case of usage of local mechanical or electronic equipment in generation facilities, commissioned before 31st December 2020 and subject to the *Renewable Energy Source Support Mechanism*, a local equipment bonus

shall be added to the feed-in tariff, relevant to this renewable energy source (Kaplan, 2015).

4) Biofuels Obligation/Mandate: Within this policy, the designated parties are required to meet a minimum target for renewable energy such as a percentage of total supply, or the stated amount of capacity. Additionally, quotas and mandates may include obligations, which require the installation of renewable heat or power technologies, renewable purchase mandates and requirements for blending biofuels into transportation fuel (pwc, 2012).

In regard to the support and incentive mechanism, the last by-law modification was published by the MENR in the Official Gazette No 28755 on September 4th 2013. Within this regulation, the procedures and principles have been rearranged, which relate to determining, documenting and the auditing of additional prices for components and integrative parts, where the manufacturing process takes place domestically. This regulation features additional support for companies with facilities that use locally produced equipment/components for a maximum possible tariff for each renewable energy source. Furthermore, through this by-law modification, many domestic and foreign investors will be able to establish equipment production facilities in Turkey. Hence, in the foreseeable future, Turkey may become the largest supplier of renewable equipment and spare parts in the region.

Given Turkey's high fossil fuel imports, the main energy policy for securing long-term energy independency, is the efficient use of the country's indigenous sources, particularly the renewable energy potential. Although the existence of the country's adopted National Energy Strategic Plan and the 2023 targets for the 100th anniversary of the Republic of Turkey highlights the promotion of renewable sources, one of the biggest problems hindering widespread use of renewables in Turkey is the lack of a coherent national energy policy plan, in which the specific place and role of renewable energy sources is well defined. As previously clarified, Turkey's wind and hydropower potential is considerably high. Nevertheless, specific policies for each renewable energy source is missing. The estimations propound that, in the next decade, between 22.5 twh and 45.0 twh of electricity must be generated from renewable energy sources (other than hydropower), to fill the energy demand gap (Melikoglu, 2013). In line with this projection, implementation of a stronger policy is needed, to support the deployment of solar, geothermal heat and biofuels for transport in a sustainable and cost-effective way (Arioglu Akan, et al., 2015). Moreover, investing in the advanced renewable energy technologies paves the way both for utilising renewable energy potential more efficiently and providing employment opportunities for citizens. The significance of the participation of single renewable energy sources to the total electricity generation will be analysed in the next subchapters, associated with their environmental impacts and social acceptance issues.

5.2. Wind Power

Wind energy is obtained from differences in solar heat at Earth's surface locations. Around 2% of solar energy is converted into wind power, which means, in a manner of speaking, so long as solar energy is available in the world, there will be wind as well. Wind power is formed naturally in the atmosphere, does not cause environmental pollution and represents a plausible solution to Turkey's energy security and external energy dependency problems. Wind energy is domestic, independent, natural and infinite. The power generation from wind does not cause acid rain or atmospheric heating, carbon dioxide emission and does not harm nature or human health. It provides fossil fuel savings and has no radioactive effect.

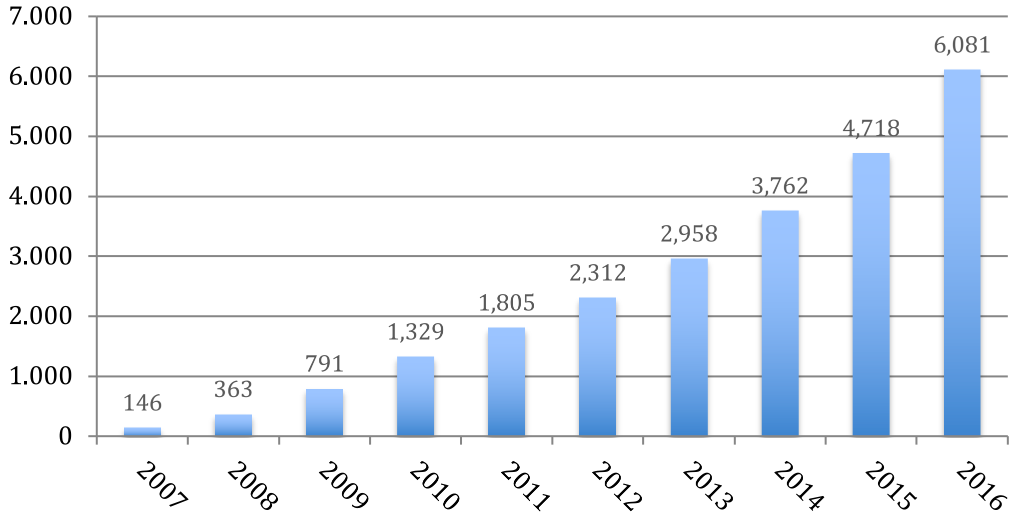
In global terms, wind energy gained particular importance, after the first oil crisis in 1973. Before the 1970s, it was possible to obtain cheaper oil supplies. Following the first oil crisis, a conference was held in Denmark in 1990, where issues like the utilisation of wind turbines, were addressed. Wind turbines convert wind energy into mechanical energy and then turn it into electrical power (Ilkilic, et al., 2011). During this period, many studies related to the development of wind turbines were carried out in Germany and many technical operations were conducted in wind generators in Switzerland, Austria, and Italy.

5.2.1. The Contribution of Wind Power to Global and Turkey's Energy Supply

According to the 2017 data of the Global Wind Energy Council, the global installed wind power capacity had reached 486,749 MW by the end of 2016, growing from 23,900 MW in 2001. Based on the same data, China again became lead the world's wind energy production with 168,690 MW total installed capacity (34.7% global share), followed by the U.S. with 82,184 MW (16.9% global share) and Germany with 50,018 MW (10.3% global share) (GWEC, 2017). In the same year, Europe installed 12,491 MW of gross additional wind capacity. With a total installed capacity of 153,729 MW, wind energy has overtaken coal as the second largest form of power generation in Europe.

Germany maintained, with 50,018 MW, the largest installed wind power capacity, followed by Spain with 23,074 MW, the United Kingdom with 14,543 MW and France with 12,066 MW. With 1,387 MW new wind power installed capacity, Turkey broke a record and has overtaken the Netherlands (0.9 GW), Poland (0.6 GW), Ireland (0.4 GW) and Portugal (0.2 GW). Total installed wind power capacity in Turkey gradually expanded from 146 MW in 2007 to 6,081 MW by the end of 2016 (Figure 14) (GWEC, 2017).

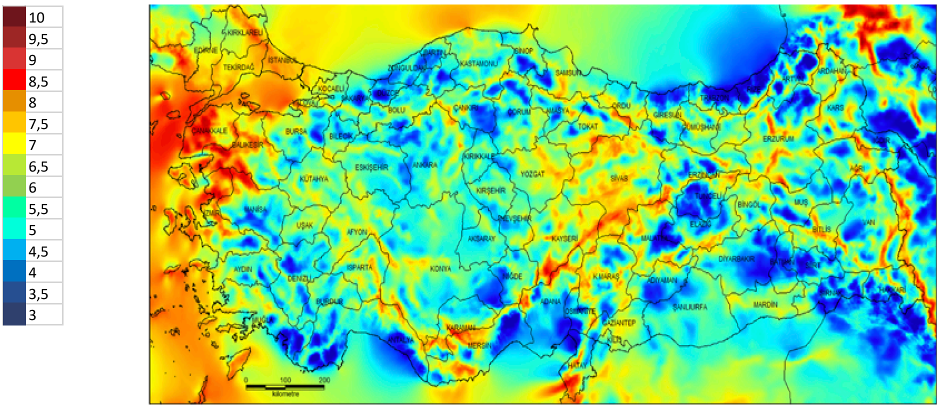
Figure 14. Cumulative Installations for Wind Power Plants in Turkey (in MW)



Data source: Own illustration based on the data from (TWEA, 2017).

Due to its geographic position, Turkey is under the influence of different air masses, which give rise to potential wind energy generation possibilities in different areas. Northern winds over the Balkan Peninsula and Black Sea provide strong airstreams during the winter period (Gencer, et al., 2009) Along the Black Sea coast, locations with flat hinterland coasts are the most suitable locations for wind turbines. Most of the Black Sea coast is composed of sudden hills, escarpments and cliffs in the hinterland that prevent the potential placement of turbines (Durak, et al., 2002). (see Map 8).

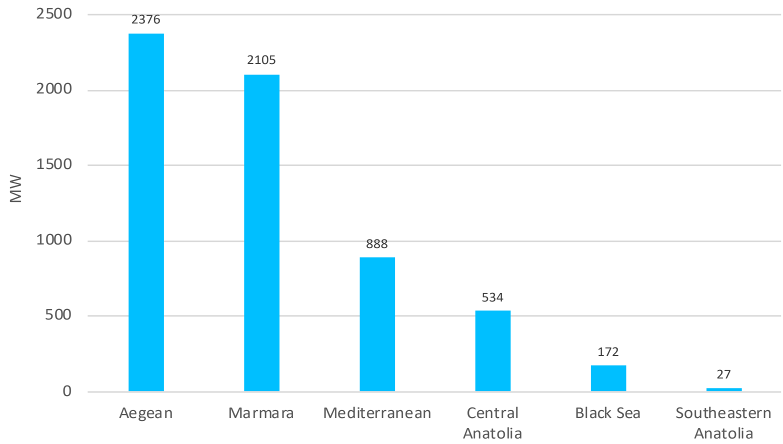
Map 8. Annual Wind Energy Potential – Wind Energy Speed Atlas



Data source: (YEGM, 2018).

Turkey has an enormous potential to produce electricity from wind energy. According to Ilkilic and Nursoy, in Europe Turkey has the biggest wind energy potential, with the capacity to fill its entire energy consumption appetite (Ilkilic, et al., 2010 S. 450-459). Kurban and Hocaoglu reports that Turkey's theoretically available annual potential to be 88,000 MW, of which 10,000 MW is economically feasible (Kurban, et al., 2009 S. 19-28). The statistical data released by the TWEA points out that the wind energy potential of Turkey is primarily focused in the Aegean, Marmara and Mediterranean regions from higher to lower, respectively. This report also shows that the majority of installed wind power plants are located in the west of Turkey: 2,376 MW (39% of the total capacity) in the Aegean region and 2,105 MW (34% of the total capacity) in the Marmara region. Other areas with a share of installed wind power plants are Mediterranean with 888 MW (14% of total capacity), Central Anatolian with 534 MW (8% of total capacity), Black Sea with 172 MW (2% of total capacity) and finally South-eastern Anatolian region with less than 27 MW (0,4% of the total capacity) (Figure 15).

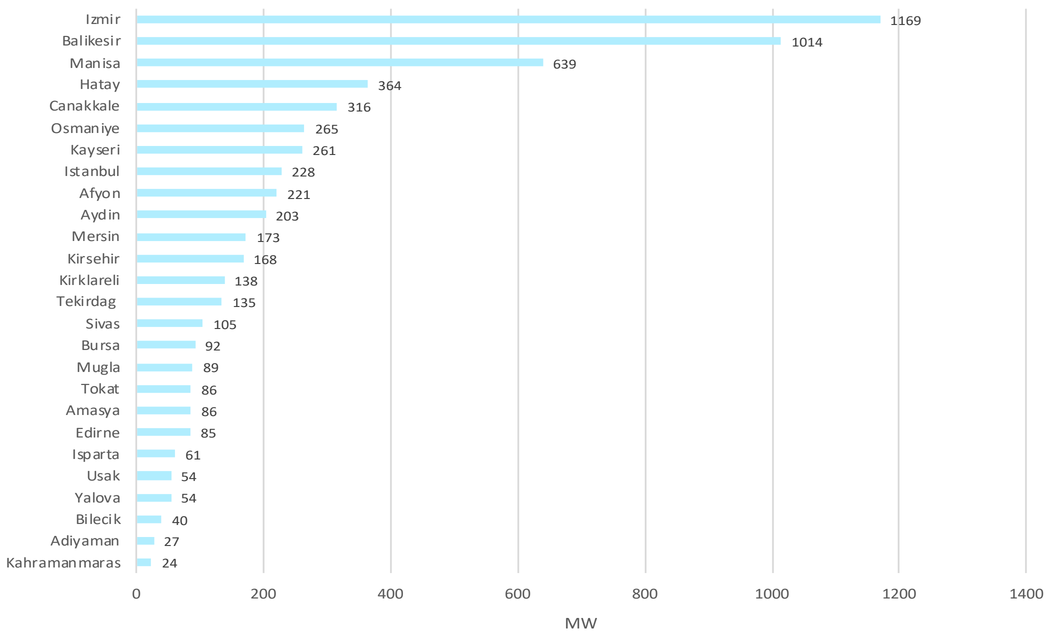
Figure 15. Operational Wind Power Plants According to Regions



Data source: Own illustration based on the data from (TWEA, 2017).

Balikesir, Izmir and Manisa, cities situated respectively in the Marmara and Aegean coasts, are alone responsible for 55% of the country's wind energy potential. Among them, the Strait of Canakkale, which connects the Marmara Sea to the Aegean Sea, has a significant role, possessing a high wind energy potential (Figure 16).

Figure 16. Operational Wind Power Plants According to Cities



Data source: (TWEA, 2017)

Despite having enormous wind power potential, Turkey still lags far behind developed countries when it comes to generating wind energy when compared to the global wind energy leaders: China and the USA. Furthermore, according to Tolga Bilgin, President of the Wind Power and Hydropower Plants Businessmen's Association (RESSIAD), Turkey has a disadvantage of not having a suitable turbine manufacturing industry: "*Countries like Germany, China and India promote their wind tribune industries and exports. Turkey's all-installed power's gain flies abroad (to other countries) because it does not have this industry*" (Hürriyet Daily News, 2013).

In Turkey, the highest annual average wind speed values of 5.8 m/second at 10 m height, are found in Bandirma, a district of Balikesir (Ilkilic, et al., 2011). Canakkale is the second province with the most wind energy potential, having an annual mean wind speed over 7 m/second at 50 m height. Electric generation from wind energy began in Turkey in the 21st century. The first Turkish wind turbine was built in Çeşme, at the Golden Dolphin Hotel in 1985, with a total installed capacity of 1.5 MW. There have been other unsuccessful attempts between 1986 to 1996 (Oner, et al., 2016 S. 117). The development of modern Turkish wind power engineering first started in Alacati, Izmir in 1998, with three Enercon E-40 wind turbines, which had a total power capacity of 1.5 MW. The first "Build-Operate-Transfer" model power plant in Turkey was established as a wind energy power plant, which began operation in Alacati, Cesme in 1998 with 12 turbines and a total installed capacity of 7.2 MW (Ilkilic, et al., 2011). The third wind farm, with 17 turbines and a total power capacity of 10.2 MW, was constructed in Bozburun. The private sector has submitted numerous applications for licensing new wind power plants (Oner, et al., 2016 S. 117). Total installed capacity had reached 18.9 MW and the MENR had evaluated 72 new projects totalling about 2,000 MW in the early 2000s (Demirbas, 2006). After a commissioning of 30 MW capacity, the capacity of Bandirma wind power plant has reached to 50.1 MW (Ozgür, 2008). Nevertheless, the wind market did not achieve a significant growth until the law for the use of renewable energy sources in electricity production (Law No: 5346) was ratified in 2005, which included a series of policy reforms. Despite the law, by the year 2007, Turkey was quite unsuccessful in making use of its rich potential. In the following years, continuously growing, the total installed capacity reached to 791 MW in 2009 and 7,012 MW by the year 2018. If this trend continues, the share of wind energy for generating electricity is expected to be around 4% by the year 2025, which is still far below the country's immense wind energy potential.

Table 11. Top Ten Wind Power Plants in Turkey (Capacity-wise)

Plant Name	Licensed Capacity (MW)	Location
Soma	264	Manisa
Geycek	168	Kirsehir
Balikesir	143	Balikesir
Gökcedag	135	Osmaniye
Bergama	120	Izmir
Karaburun	120	Izmir
Dinar	115	Afyon
Samli	113	Balikesir
Tokat	94	Tokat
Catalca	93	Istanbul

Source: (TWEA, 2018).

5.2.2. Soma Wind Farm

The Soma Wind Power Plant is the largest wind farm in Turkey, which currently operates 169 turbines, with a total installed capacity of 240.1 MW in the Soma and Kirkagac districts of the Province of Balikesir. Soma contributes to a local sustainable development by creating jobs in Turkey and the surrounding region, while procuring available services like subcontractors and equipment manufacturing. On-site operations also increase knowledge regarding the local development of replicable technology to assist in the transfer of similar projects to proximal regions in Turkey (Sustainable, 2019). Soma Phase I, with 88 turbines and a total capacity of 79 MW, began generating electricity in 2009. Phase II (31 turbines, 61 MW) came online in 2012. Soma III (50 turbines, 100 MW) followed in 2015. Phase IV is now being built and will add 12 turbines and 48 MW of capacity, for a total of 181 turbines and 288 MW. Soma wind farm avoids about 167,000 metric tons of CO_2 equivalents (Cloverly, 2019).

Soma is the only wind farm in Turkey, which feeds electricity into grid at 380 kV. Therefore, despite the growing numbers of installed capacity of wind power plants, it makes only a slight contribution of wind power generation to Turkey's total electricity production.

5.2.3. The Environmental Impacts

Despite being a renewable and environmental-friendly energy source, there are some general environmental impacts of wind power plants. Some wildlife researchers and biologists assume that wind turbines in particular have an adverse impact on wildlife, especially on birds and bats. The birds and bats die from collisions with wind turbines due to the changes in air pressure caused by the spinning turbines, as well as from habitat disruption.

Noise and visual impacts are the two most significant public health and community concerns associated with wind turbines. Most of the sound generated by wind turbines occurs due to the movement of turbine blades through the air. In addition to this aerodynamic sound, there is also a mechanical sound emitted from the turbine (Union of Concerned Scientists, 2013).

Since the turbines themselves occupy approximately 2% of the area, most land area can be used for farming purposes such as vegetables, nursery stock and cattle, without the use of heavy equipment between the turbines (Evrendilek, et al., 2003).

As an environmentally friendly form of energy, there are no global warming emissions associated with operating wind turbines. The only warming emissions associated with a wind turbine's life cycle are materials production and transportation, on-site construction and assembly, operation and maintenance, decommissioning and dismantlement (Union of Concerned Scientists, 2013).

5.2.3. Public Awareness and Social Acceptance

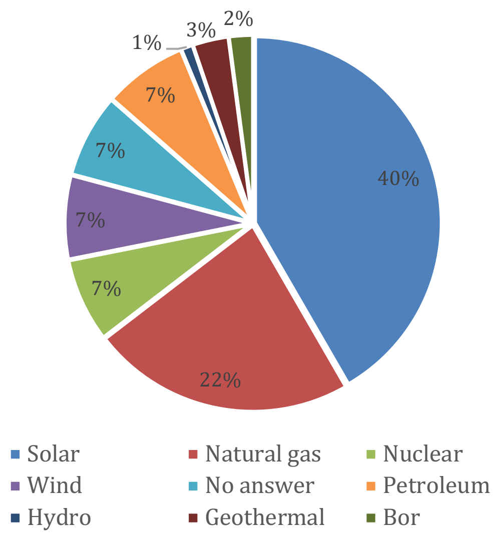
Based on the outcomes from a face-to-face survey of 2,422 residents from urban Turkey (Ertör Akyazi, et al., 2012), almost two-thirds of respondents support the investment of wind power plants in the city where they are living. Only a small minority opposes the further investment to wind power. Nevertheless, there has been local resistance to wind farms in several places, which has often been associated with environment-related problems of renewables – such as noise, visual pollution, and potential harm to migrating birds, as mentioned in the previous subchapter. In such cases, resistance to specific wind farm projects has often been understood in terms of "not-in-my-backyard" attitudes (Ertör Akyazi, et al., 2012). However, recent studies demonstrate that there is not enough relevant empirical evidence to explain these attitudes. Therefore, it is not possible to attribute the oppositions to a single reason.

Another survey from (Ediger, et al., 2016) justifies the above highlighted survey outcomes. 57.3% of 1,204 respondents support the construction of wind power plants in the area they are living. Furthermore, 39.5% of respondents think renewable energy sources such as wind, solar, geothermal must be used for the electricity generation, despite the fact that energy transition from fossil fuels to renewable sources will be a more expensive option. The social acceptance of wind energy as well as renewable energy in general, increased in 2017 compared to 2016.

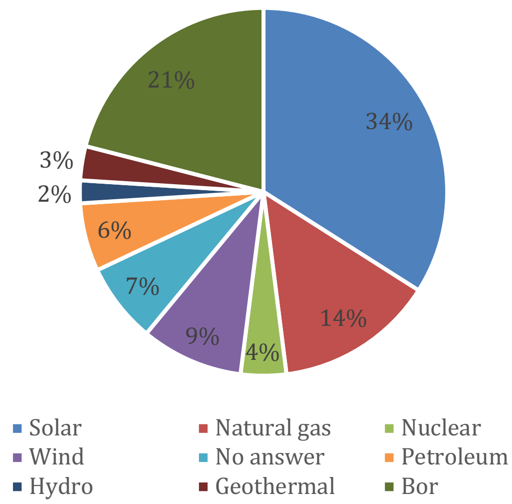
Figure 17 shows the respondents' opinions, regarding which type of energy will be the most important in the world and in Turkey.

Figure 17. Which type of energy will be the most important one in the world and in Turkey in the future?

In the world



In Turkey



Data source: (Ediger, et al., 2016).

5.2.4. Results and Outcomes

There are some obstacles to operating wind power plants in Turkey:

I. The feed-in tariff had been limited to the first ten years of operation. Therefore, Turkey must put in place new feed-in tariffs and incentives. Currently, wind power plants in Turkey benefit from state incentives. For instance, if the 55% of the materials used for plant construction is local, the state increases purchase guarantee by 30%, i.e. from 10 years to 13 years. Nevertheless, the new legislative revision is still not sufficient to encourage the utilisation and installation of new power plants.

II. General Electric, one of the world's leading energy companies, has been in the process of building local wind turbines in Turkey. Doğa Derneği, a non-governmental organisation active in Turkey, points out to the potential threat of building wind farms and photovoltaic facilities in areas inhabited by Eastern Imperial Eagles. The remaining 35 breeding pairs of Imperial Eagles are documented in the Thrace region, and four pairs inhabit Istanbul where the rising wind turbines can make the habitat unsuitable for breeding, hunting, and dispersal (Doga Dernegi 2014).

III. Wind-generated power, similar to solar or hydropower, is variable in nature. By wind-generated power resources, the amount of electricity produced at any given point in time, by a given plant, will depend on wind speeds, air density and turbine characteristics. To avoid voltage fluctuations, some necessary measures associated with the grid circuit connection must be determined. Accordingly, wind power, which will be connected to the network, cannot exceed 5% of short-circuit power of the network. In Turkey, there is an assumed constant circuit angle rate, as a consequence of technical calculations which is valid for the whole country. Nevertheless, in practice, this rate may vary from region to region. It is, therefore, significant to review the connection criteria and rate of the power plants to actualise more wind energy projects.

IV. Constrained or lack of transmission capacity is one of the significant barriers to the development of wind power plants in Turkey, since the most favourable areas for wind power are typically located far from load centres. The transmission lines to those specific areas would have to be planned to deliver power from all potential wind power plants to achieve the goal of installing 20,000 MW of wind power plants by 2023. This requires substantial upfront investment in transmission capacity, which private project developers would be reluctant to finance, placing the burden on public financing.

Turkey has a significant potential for wind power development with its coastal length of 7,200km and high average annual wind velocities, creating the potential for the efficient utilisation of the Mediterranean shores, Aegean Sea coast areas and northern and western parts of the Marmara Sea coast (Arioglu Akan, et al., 2015). Concerning the environmental impacts of wind power plants, the global warming potential of wind power is 88% lower than for geothermal electricity and 11% lower than large hydropower.

To reach its 2023 target of 20,000 MW wind power plants, a total installed capacity of nearly 16,000 MW or (2,000 MW annually) wind power must be constructed and integrated to the grid between 2015-2023. According to the International Renewable Energy Agency's 2015 report on 'renewable power generation costs', the capital investment for wind energy turbines varied from US$1,127/kwh to

US$1,376/kwh in 2014, in developed countries. Ultimately, the calculations show us, in order to fulfil its energy goals, Turkey must spend between $18.0 billion and $22.70 billion in the next eight years for the construction of wind power plants (IRENA, 2015). In addition to that, the wind turbines have a limited lifetime, varying between 20 and 25 years.

5.3. Hydroelectrical Power

Water and energy are intrinsically interrelated and connected: We need energy to extract, transport and distribute clean and fresh water and we need water to produce clean energy. This kind of relationship between water and energy was labelled "water-energy nexus" in 1994 by Peter H. Gleick, an American scientist working on environmental issues. Due to the rising concerns regarding the sustainable use of fresh water sources, Gleick historically drew the attention of scholars, to the physical and environmental constraints in humankind's use of hydro sources, which in the present day are beginning to manifest (Gleick, 1994 S. 267). The conceptualisations of the water-energy nexus are limited by understandings of resource or commodity orientations, scarcity or efficiency driven views and resource supply-demand relations in technical terms (Eren, 2018 S. 22). In addition to its technical peculiarities, the water-energy nexus is inherently under the influence of social, political and economic powers.

Hydropower is considered as a clean, renewable energy source, as it uses the Earth's water cycle to generate electricity. Around one third of the solar radiation reaching the Earth is responsible for the running of hydrologic cycle (Ozis, et al., 2008). Therefore, the cycle is a never-ending system, so long as the Sun exists. The manipulation of water sources by human beings dates back to dawn of civilisation - even outside the realm of energy generation purposes - as the Mesopotamians built dams, irrigation canals and town water supply systems at least 8,000 years ago, from 3,000 BC in Jordan (Erdogdu, 2011 S. 690). The vertical water wheel was created in the Middle East during the first century of BC identified by the earliest textual reference by Greek geographer Strabo (Jones, 1924), describing a water mill in the new palace of Mithridatus VII Eupator, King of Pontus at Cabeira (*Niksar,* north of Turkey) (Viollet, 2017 S. 571). Romans knew about waterwheels, nevertheless, did not extensively use them until the fourteenth century. The initial purposes were graining wheat into flour, sawing wood, powering textile mills and later operating manufacturing plants (Gulliver, et al., 1991 S. 1.2). At the end of the Middle Ages and at the eve of the Industrial

Revolution, the water wheels were the support to many economical pre-industrial activities such as fulling paper mills, treading cane for sugar processing, moving bellows and water hammers for metallurgy (forges) (Viollet, 2017 S. 570). During the nineteenth century, hydropower became, for the first time, a source for electricity generation. Although some forms of hydroelectric turbine development date back to 1750, Benoit Fourneyron, a French engineer, is credited with his contributions to the development of the first modern turbine in 1833 (Gulliver, et al., 1991 S. 1.2).

Today, the most significant share of new hydropower is held by China, which accounts for around one-half of the world hydropower capacity. Other countries with substantial additions in 2015 were Brazil, Turkey, India, Vietnam, Malaysia, Canada and Colombia. In Turkey, hydropower is the most developed renewable energy source among the installed renewable energies. This is predominantly due to the fact that the country has the geographical advantage of suitable water resources, located in seven regions. Additionally, Turkey has historically been host to several different civilisations and these civilisations were engaged in various hydro-works. With respect to this background, next sub-chapter aims to analyse the historical development of water works, the current status of electricity generation from hydro resources, as well as the environmental and societal impacts of hydropower plants in Turkey.

5.3.1. Hydraulic Works in Turkey

Regarding the history of water works, Turkey – particularly ancient Anatolia – can be identified as one of the most important locations in the world. As Turkey has historically hosted many civilisations, there are remains of dams, irrigation canals, water collection and water power structures, dating back over the last 4000 years.

The oldest hydraulic works in Turkey, such as dams, irrigation canals and water collection structures, date back to the second Millennium BC, the **Hittite period** in Central Anatolia. During the **Urartu period** in Eastern Anatolia, in the first half of the first Millennium BC, several small dams, water supply and irrigation canals were constructed. Following this, the number of water and hydropower structures substantially increased during the **Hellenistic, Roman and Byzantine periods**, in the second half of the first Millennium BC and the first half of the first Millennium AD. This period witnessed the construction of long-distance water supply schemes, multiple water conveyance systems, water distribution and wastewater collection systems, tunnel-like twin structures covering water courses, tunnels, river diversion systems, dams, water mills and even hydro-powered stone saws in Western and Southern Turkey. The longest water conveyance systems and aqueducts of ancient times were built during the late Roman Empire and Byzantines, for the capital city Constantinople (Istanbul), which were later used by several ottoman water conveyance systems. During the **Seljukide period,** like the previous periods, dams, irrigation canals, watermills and hydropower structures were built, between the 11th and 14th centuries in Central and Eastern Anatolia. One of the most interesting cases is the Seljukide Haburman masonry bridge, which is the most ancient water power scheme in Anatolia and is still in operation (Ozis, 2015 S. 564). Moreover, the famous Abo-I Iz Al-Jazari, whose names were, afterwards, given to the town "Cizre" in South-eastern Anatolia of Turkey, designed ingenious hydromechanical devices, which are predecessors of present-day hydraulic instruments (Angelakis, et al., 2016).

During the Ottoman Empire era, water supply and conveyance schemes with several aqueducts and tunnel sections, water distribution and wastewater collection systems as well as river diversion systems, gained acceleration thanks to the multiple works of the famous engineer and architect Sinan (known in Turkey as *Mimar* (architect) *Sinan* or *Koca* (the greatest) *Sinan*). During the final years of the Empire, in 1902, the first electricity was generated at the Tarsus hydroelectric scheme (see chapter 4.1.1.), which utilised the elevation difference of the Berdan River at Tarsus falls in the Mediterranean part of Turkey (Ozis, 2015 S. 569).

In Turkey the hydroelectricity infrastructure connects the national context of the water-energy nexus to its local context, as they are planned, developed and approved on the national level, run by the private companies or the state, and operated in the river valleys on the local level (Eren, 2018 S. 23).

5.3.2. The Current Status of Electricity Generation from Hydro Resources

From the foundation of the Republic of Turkey in 1923, until the liberalisation period in 1980, the main target of the Turkish policy makers was to develop the utilisation of primary domestic energy sources, such as hydro and coal, to meet the energy demand. In 1930, the government tried to increase electricity production through the operation of hydropower plants. Except some efforts for hydropower, there were no considerable development in renewable energy sources, including wind, solar, biomass or biofuel. While the installed capacity of the hydroelectric power plant was 3.2 MW in 1932, it had increased nearly 100 folds by 1959 (TEIAS, 2012). The 1980 coup was a milestone in the political economic path toward liberalisation and privatisation, which had a dramatic impact on the social, economic and political dynamics of the country (Eren, 2018 S. 23). Following the 1980 liberal period, some legal regulations were adopted to reduce the public share in the economy and attract potential private investors to the market. By the end of the 1990s, it was determined that the quasi-privatisation policies were not functional and even rapidly damaged the fiscal situation. Turkey made a concrete step to establish a competitive electricity market through the adoption of Electricity Market Law in 2001, to promote private participation and improve the efficiency in electricity supply. As the AKP came to power in 2002, state policies exhibited an obvious inclination toward liberalisation (Eren, 2018 S. 23). Since the AKP came to power in 2002, the state has made a series of changes to open the electricity sector to private investors for capital accumulation and to attract private companies to the hydroelectricity sector (Eren, 2018 S. 24). Between 2011-2015 alone, a total of 50 hydroelectric power plants, with a total installed capacity of 168.5 GW, were privatised through the amendment of the new electricity law (IEA, 2016). The state approved multiple projects along one single river, completely and continuously interrupting the natural hydrological flow (Eren, 2018 S. 24). Hydroelectricity production has become an attractive business option for the profit-seeking entrepreneurs and companies with or without sectoral experience. This hydro-boom (Eren, 2018 S. 24) and rapid hydroelectricity development programme have, therefore, had immense adverse effects on the livelihoods of the local people, fish species, biodiversity and environment.

The gross theoretically viable hydroelectric potential and technically viable potential of Turkey are the highest in Europe, with 433 billion kwh and 216 billion kwh, respectively. The economically feasible potential, however, is only 140 billion kwh (Inlawco law offices, 2017). The cost-effective hydroelectric potential of Turkey is 16% of Europe's economically feasible hydroelectric potential. Nevertheless, in comparison to the other countries possessing hydropower possibilities in Europe, Turkey uses only a small amount of its hydropower potential. By the end of 2015, hydro accounted for 25.8% of total electricity generation of Turkey. The total hydropower installed electricity generating capacity, increased in Turkey by 2.2 GW reaching 23.6 GW. The heavy fluctuations in rainfall affected the hydropower production. Following a dry period and sharp drop out in 2014, production bounded back in 2015, by nearly 66%, to 66.9 twh (REN21, 2016).

As stated in the 2023 energy goals of the Turkish MENR, the installed hydropower capacity is aimed to reach 36 GW until 2023. Referring to IRENA's 2015 "*Renewable Power Generation Costs*" report, the total installed cost for large-scale hydropower plants, typically varies between $1,000 kwh and $3,500 kwh. Nevertheless, it is also possible to find projects with different costs outside this range. For instance, installing hydropower capacity at an existing dam that was built for other purposes (such as flood control or water provision), may have less costs than given range, around $450 kwh. On the other hand, projects at remote sites, located far from existing transmission networks and without sufficient local infrastructure, can cost more than $3,500 kwh due to higher logistical and grid connection costs (IRENA, 2015). Since there is no certain information regarding the exact locations for the new hydropower investments, it is not possible to determine in which range of the calculation costs these hydropower plants will belong. Therefore, using the lowest and highest values of $450 kwh and $3,500 kwh, can provide more coherent results. As indicated before, Turkey's installed hydropower capacity ranks 23,643 MW in 2015. Accordingly, the country needs to add 12,357 MW hydropower installations to reach its target. Therefore, the calculations show that Turkey needs to spend between $5.5 billion and $43.2 in the next eight years for the construction of hydropower plants.

These calculations show the necessity for huge amounts of investments to support the installation of new hydropower plants. For the investors and developers of hydropower plants, Turkey has always been an attractive choice due to the low-cost labour force and large portfolio of civil and mechanical engineers working in the field of hydropower. Furthermore, all the civil works construction materials and goods can be provided from the province where the project is being developed, which decreases shipping costs during the construction phase (Appleyard, et al., 2014). Nonetheless, the uncertainties regarding the location and the investment plans of proposed hydropower plants still need to be clarified.

5.3.3. The Contribution of Major Hydroelectric Power to Turkey's Energy Supply

The characteristic features of Turkey's geographic location make the country unique in the region. The total length of its land borders and coastline is 10,765km. 2,949km from this total represent land borders while 7,816km indicate coastline (DSI, 2006). The average altitude (1,132m) of Turkey is higher than that of Asia (1,050m) and three and a half times greater than that of Europe (330m)(DSI, 2006). Turkey has around 120 natural lakes. The Lake Van with a surface area of 3,712km^2 and an altitude of 1,646m from sea level, is the largest and deepest in the country. The Salt Lake (Tuz Gölü) in central Anatolia, follows the Lake Van as the second place with a height of 925m from sea level and a surface area of 1,500km^2 (DSI, 2006).

According to the data of Turkey's General Directorate of State for Hydraulic Works (DSI), by the end of 2015, the number of hydroelectric plants had risen to 562, which were located in 70 provinces and held a total installed capacity of 26 GW. 12 GW of this total amount was constructed and developed by the State for Hydraulic Works (DSI, 2015). The largest reservoirs, regarding their surface areas, are the Atatürk Dam with 817km^2, Keban Dam with 675km^2, Karakaya Dam with 268km^2, Hirfanlı Dam with 263km^2, Altınkaya Dam with 118km^2 and Kurtboğazı Dam with 6 km^2 (DSI, 2006). The water collected in these dams, is principally used for irrigation facilities, domestic consumption and to generate hydroelectric power. In addition to the high number of natural lakes, Turkey has many streams and rivers. The freshwater reserves of the country have been divided into 25 river basins, whereas more than 95% of the country's hydropower potential is distributed into 14 river basins (Melikoglu, 2013 S. 505). Some of the major rivers, with considerable lengths are: Kızılırmak with 1,355km (empties into the Black Sea), Euphrates (Fırat Nehri) which travels to the Syrian border with 1,263km, Aras travelling to the Armenian border with 548km, Tigris (Dicle Nehri) with 523km (empties into the Persian Gulf), Yeşilırmak with 519km (empties into the Black Sea) and Ceyhan with 509km (empties into the Mediterranean Sea) (DSI, 2006).

Regarding the rivers and streams, the total economically feasible hydropower potential of Turkey's major river basins account for 129.5 twh per year. The Black Sea region, with its steep and rocky mountains which extend along the coastline, has a significant hydropower potential (Melikoglu, 2013 S. 505). The most significant streams, regarding their annual economic potential, are Euphrates (Firat) (37.8 twh), Tigris (Dicle) (16.5 twh), Eastern Black Sea Basin (13.1 twh), Coruh (10 twh), Seyhan (6.9 twh), East Mediterranean Basin (6.7 twh) and Kizilirmak (6.4 twh) (Kücükali 2008). Euphrates-Tigris (Fırat-Dicle) with their 184,918 km^2 drainage area and elevation range between 500-5,000m, are estimated to hold 30% of the country's hydropower potential (Melikoglu, 2013). Around 90% of the Euphrates' flow and 46% of the Tigris' flow originates in Turkey. For this reason, the South-eastern Anatolian Project (*Güneydogu Anadolu Projesi – GAP)* is one of the most important hydropower projects in Turkey, in order to meet local energy needs. This will be further discussed in the following sub-chapter.

5.3.4. The Role of the South-eastern Anatolian Project (GAP)

The GAP plays a significant role in meeting the local energy requirements, as well as in the sustainable development of Turkey's agricultural and rural sector. GAP is one of the largest power generation, irrigation, and regional development projects of its kind in the world, covering 3 million h of agricultural land. This agricultural area represents over 10% of the cultivable land in Turkey. The GAP consists of 22 dams and 19 hydroelectric power plants, with a total generation capacity of around 27 billion kwh of electricity per year and irrigation networks for an area of approximately 1.8 million h. The existence of the dams is essential, not only for irrigation and hydropower, but also for the domestic water supply in the major cities (Yüksel, 2015). At the very outset, the GAP Regional Plan, dating back to 1977, was perceived as a program to develop water and land resources in the region. The idea of utilising water resources in Turkey first emerged during the time of Atatürk, the founder of the Turkish Republic. Initial steps were also taken in 1936, with the establishment of the Administration for Electricity Studies upon the order of Atatürk. The Administration for Electricity Studies started its reconnaissance work on the 'Keban Project', to produce energy from the water resources, Euphrates and Tigris basins (Ministry of Development, 2014).

GAP is a multi-sector, integrated regional development project, aiming to improve the living standards and income levels of people in the South-eastern Anatolian region and to thereby eliminate regional development disparities between the east and west of Turkey, contributing to social stability, economic growth and employment opportunities in the rural sector. The project area covers nine provinces in the Euphrates-Tigris basins and Upper Mesopotamia: Adıyaman, Batman, Diyarbakır, Gaziantep, Kilis, Mardin, Siirt, Şanlıurfa and Şırnak (Ministry of Industry and Technology, 2017). The Euphrates and Tigris rivers represent over 28% of the country's river-based water supply and the economically irrigable areas in the region make up 20% of those for the whole Turkey.

The basic components of sustainable development in the GAP region, were identified as social, agricultural, physical, spatial and environmental sustainability as well as economic viability (Yüksel, 2015). Moreover, energy is a key element of the GAP, as the region's energy production capacity is larger than its consumption. Nevertheless, up until now, the energy consumption of the region is much above its production. Furthermore, the region is still suffering from persistent problems, such as terrorist attacks, unemployment, shortage of qualified labour, poor education infrastructure, low levels of education, insufficient health infrastructure and services, difficulty to access drinking water, poor rural infrastructure, insufficiency of industrial and energy infrastructure and low levels of capital accumulation (Ministry of Development, 2014). The GAP region is still the of the less developed regions in Turkey. Despite these long lasting and persistent problems, 10 hydraulic power plants (HPP) have been completed under the GAP and physical realisation in energy investment has reached 74% (Table 12).

Table 12. Status of GAP Energy Projects in terms of Physical Realisation in 2014

Project	Established power (MW)	Energy production (GWh)	Present status of the project	In operation since
EUPHRATES BASIN	**5.370**	**20.216**		
Karakaya Dam and HPP*	1.800	7.354	In operation	1987
Atatürk Dam and HPP	2.450	8.900	In operation	1993
Birecik Dam and HPP	672	2.516	In operation	2000
Karkamis Dam and HPP	180	652	In operation	1999
Kahta Dam and HPP	75	171	Master plan	
Sanliurfa HPP	50	124	In operation	2005
Kocali Dam and HPP	39	187	Master plan	
Büyükcay Dam and HPP	30	84	Master plan	
Sirimtas Dam and HPP	26	87	U. construction	
Fatopasa HPP	22	47	Master plan	
Cagcag HPP	14	42	In operation	1968
Erkenek	12	52	In operation	2010
TIGRIS BASIN	**2.172**	**7.245**		
Ilisu Dam and HPP	1.200	3.833	U. construction	
Cizre Dam and HPP	240	1.208	Master plan	
Batman Dam and HPP	198	483	In operation	2003
Silvan Dam and HPP	150	623	U. construction	
Dicle Dam and HPP	110	296	In operation	1999
Kralkizi Dam and HPP	94	146	In operation	1998
Kayser Dam and HPP	90	341	Master plan	
Garzan Dam and HPP	90	315	Reconnaissance	
TOTAL	**7.542**	**27.461**		

Data source: (Ministry of Development, 2014)

As shown in Table 13 Turkey's electricity generation from hydro resources has increased during the last two decades reaching 59.3 billion kwh in 2013. Hydroelectric generation from GAP has shown fluctuations and reached almost the same amount of energy in 2013 (16.9 billion kwh) as it held in 1995 (16.1 billion kwh). Therefore, the share of power generation from GAP in Turkey's total electricity production from water sources has gradually decreased.

Table 13. The Comparison of the Energy Production between Turkey and GAP

Years	Turkey Hydraulic (kwh)	GAP Hydraulic (kwh)	GAP/ Turkey Hydraulic (%)
1997	39,8	19,4	48,7
1998	42,2	20,1	47,5
1999	34,6	14,8	42,7
2000	30,9	12,1	39,2
2001	24,0	11,5	47,9
2002	33,7	12,4	36,8
2003	35,3	15,3	43,3
2004	46,1	22,4	48,7
2005	39,6	18,7	47,2
2006	44,2	21,4	48,5
2007	35,8	18,2	51,0
2008	33,3	15,6	47,0
2009	35,9	12,1	33,7
2010	51,5	17,5	34,0
2011	36,7	17,3	44,4
2012	57,9	19,2	33,2
2013	59,3	16,9	28,5

Data source (Ministry of Development, 2014).

This table propounds the fact there are no substantial developments regarding the electricity generation from the GAP, due to not all hydropower plant projects being completed or yet in operation. When all proposed projects are completed, it is assumed that 27 billion kwh of electricity will be generated from the GAP region annually, which alone represents 45% of the total economically exploitable hydroelectric potential in Turkey.

5.3.5. The Environmental Impacts

Despite being a rather clean and environmentally friendly energy source regarding greenhouse gas emission rates, the hydroelectric power plants also have some adverse environmental impacts, which need to be considered. These negative effects will be clarified in general terms, to also address the Turkey-specific impacts:

- Hydropower has a lower climate impact because no fuels are burned. Nevertheless, when associated with the construction of a dam, a large amount of vegetation grows along the riverbed, which can decompose in the lake. This decomposition causes reproduction and release of methane, a potent greenhouse gas.
- Though being clean and efficient, hydropower requires the use of dams, which can cause flooding, the altering of ecosystems and affects the wildlife and people that depend on those rivers. Flooding land for a hydroelectric dam has acute environmental drawbacks: it destroys the forest, wildlife habitat, agricultural land and scenic areas. According to (Baskaya, et al., 2011 S. 3286-88), in nearly all the plants under construction, hardly any precautions are taken to prevent the negative environmental effects of solid and liquid wastes such as glass, nylon, tin, paper, waste water from toilets and kitchen sinks and the oil used in machines and other equipment.
- Although hydropower has no impact on air quality, construction and operation of hydropower dams may cause alteration of ecosystem biogeochemistry, affecting natural river systems, fish, and wildlife populations and emanate loss of agriculturally productive and alluvial bottomland (Melikoglu, 2013). Hydroelectric dams can cause erosion along the riverbed upstream and downstream.
- The initial capital costs for a hydropower plant can be relatively high. However, the project itself has low production costs, and it does not depend on foreign capital and support when considering long-term economic evaluation (Yuksel, 2013).

Despite above listed negative effects, hydropower plants are predominantly environmentally harmless energy production facilities. Hydroelectric power plants release water back into rivers after it passes through the turbines. Modern turbines can convert as much as 90% of the available energy into electricity, whereas the best fossil fuel plants manage only about 50% (Melikoglu, 2013). This way of power generation does not pollute water. The plants do not produce a substantial amount of solid waste.

The emission intensity (in tonnes CO_{2e}/GWh) of hydroelectric plants are substantially lower when compared to the emission rates of natural gas- and coal-generated electricity (Table 14). Large reservoir hydropower plants have high biogenic emissions of methane and their global warming potential is two times higher than the small reservoir and run-of-river plants. This is largely because of the greenhouse gases emitted by the flooded biomass and soil, dependent on the type of plant, reservoir size, water depth and climate (Atilgan and Azapagic 2016). Moreover, large reservoir hydropower has the lowest depletion of elements and fossil resources as well as acidification (Atilgan and Azapagic 2016).

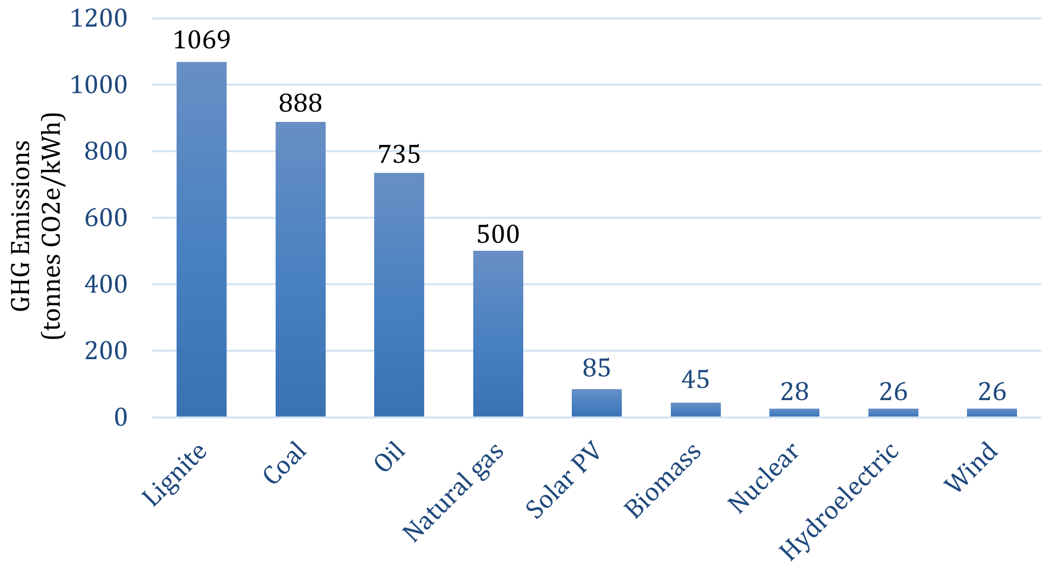
Table 14. Summary of Lifecycle GHG Emission Intensity

Technology	Mean	Low	High
	tons CO_2e/GWh		
Lignite	1,054	790	1,372
Coal	888	756	1,310
Oil	733	547	935
Natural gas	499	362	891
Solar PV	85	13	731
Biomass	45	10	101
Nuclear	29	2	130
Hydroelectric	26	2	237
Wind	26	6	124

Data Source: Own illustration based on the data from (WMA, 2011).

According to Figure 18, coal fired power plants have the highest GHG emission intensities on a lifecycle basis. Although natural gas and to some degree oil, had noticeably lower GHG emissions, biomass, nuclear, hydroelectric, wind and solar photovoltaic, all have lifecycle GHG emission intensities that are significantly lower than fossil fuel based generation (WMA, 2011), therefore they remain environmentally friendlier energy sources.

Figure 18. Lifecycle Average Emissions Intensity of Electricity Generation Methods



Data source: Own illustration based on the data from (WMA, 2011).

5.3.6. The Legal Framework

The construction of hydroelectric power plants in Turkey is regulated by the "Regulation for the Issuance of Water-rights Agreements in order to Commence Production Activities in the Energy Market". This regulation sets the rules and principles in respect to the "Water Rights Agreement" between the General Directorate of State Hydraulic Works and the legal entities, which are operating within the scope of the "Electricity Market Law", for the issuance of production licenses, required to legally install and run hydroelectric power plants (Turkish Water Assembly, 2011). Before construction commences, a *CED Report* to the Ministry of Environment and Forests must be provided. In the case of receiving a "Positive CED", the company works with the General Directorate of Forestry, General Directorate of National Real Estate Properties and third parties, on issues of expropriation and appurtenances. After architectural, static, infrastructural and other technical assessments, the company receives a construction permit. As soon as the construction has been properly completed, the company conducts the hydroelectric power plant and Energy Transmission Lines tests and applies to TEIAS for the registration. The Turkish MENR approves the applications for hydroelectric power plants, while TEIAS approves the applications for Energy Transmission Lines. After receiving successful approvals from both sides, the production of electricity begins. Consequently, the legal process for the construction of hydroelectric power plants is very complex and confusing for private companies.

Instead of preparing a single strategic document to regulate the ways of implementation and thus simplify the bureaucratic procedures for the private investors, the Turkish authorities and procedures have been distributed amongst several different institutions (Turkish Water Assembly, 2011).

5.3.7. The Societal Impacts of Hydropower Plants

The legal constraints and difficulties are not the only challenges concerning the construction of hydroelectric power plants. There are also serious violations regarding human rights and potential threats of damage to flora and fauna, especially in the Black Sea region. The licenses, given by the EPDK and the General Directorate of State Hydraulic Works to the private companies, are granted without any assessment of social and technical problems and without allowing the impacted people or the local organisations a say regarding if or how the projects should run. Alone in 2011, EPDK issued production licenses for 761 hydropower plants, which would be located in national parks, natural parks, natural reserve areas, wildlife improvement zones, specially protected environmental areas and natural protected areas. If these power plants are installed, freshwater ecosystems and biodiversity would dramatically be deteriorated.

Based on the Environmental Law No. 2872, Article 3 (a), (b) and (e), the ministries and local authorities are obliged to create a participant milieu, that allows the involvement of chambers, unions, non-governmental organisations and citizens to govern their environmental rights (e-Mevzuat, 2006). Nevertheless, the current system and situation in Turkey do not allow the local people to be informed, to avoid conflict with the construction of the projects. According to the unofficial statements from Turkish authorities, thousands of dam and hydropower schemes are in planning to be built on almost all of the main rivers in Turkey, in line with the vision 2023 targets to meet the aimed energy aim by 2023. Up until now, there is no certain information concerning the location and size of the proposed hydroelectric power plants. Therefore, it is not possible to carry out a specific environmental and social analysis for the potential impacts of the hydropower plants. In addition, it is known that the local people living in proximity of any dam and/or hydroelectric power plant project areas, often generally receive no regular or substantial income. Their primary source of income is concentrated on farming, animal breeding and fishery. Hence, the river systems are essential for the survival of the local people. Many of the rivers, particularly in the Black

Sea region, are under threat of being destroyed due to currently running or projected hydroelectric power plants. Locals in the areas with the support of many civil society organisations, like *Doga Dernegi*, are continually gathering to resist the construction of these power plants. Some of these demonstrations have resulted in success of the local people, that the proposed projects were cancelled or postponed.

There are two hydroelectric projects, which I would like to discuss in order to demonstrate the importance of public acceptance in the water-energy nexus relationship:

5.3.7.1. The Ikizdere Valley Hydroelectric Project

The Ikizdere River Basin gives a unique opportunity to analyse hydroelectricity sector in relation to the electricity sector for two reasons. First, it has a long history of hydroelectricity production, as the first hydroelectricity plant was constructed in the Valley in 1950. The electricity product ion was started in 1961 by the state. Second, the 'sustainable development', which was launched in 2003, has shaped the valley (Eren, 2018). The Ikizdere Hydroelectric Plant was privatised in 2008 and 24 new private hydroelectricity projects emerged. The boom of emerging projects has mobilised the local people, both collectively and in individual ways. Local opponents voiced their opposition to the hydroelectric development in Ikizdere through press releases, street protests, demonstrations including blocking highway traffic, occupying construction sites for the planned hydroelectric plants and opening court cases to cancel the projects (Eren, 2018).

Under the name of 'sustainable development', the state essentially has promoted small-scale hydroelectricity plants as potential renewable energy producers. The program was based upon the fact that the "run-of-the-river technology" has low environmental impact due to its low capacity. Furthermore, these sorts of power plants divert water, use it to generate electricity and then release it back into the river, without holding. Therefore, they have little effect on downstream users. Nevertheless, the hydroelectric structure of Ikizdere Valley, built in 1950s and early 2000s, demonstrate otherwise (Eren, 2018 S. 25).

According to interview results and outcomes of the personal observations in the study by Aysen Eren, the re-construction of Ikizdere Hydroelectric Plant was premised on increasing the profits of state and energy companies.

First, the Ikizdere Power Plant, in the 1950s, did not have the infrastructure to store water. After privatisation, the private company initiated a revision project to construct a water storage system, claiming that it was necessary due to technical reasons. Nevertheless, the local people who worked for the plant construction claimed that the project actually aimed to increase profits by assuring availability of water for electricity production at peak times, such as in summer (Eren, 2018 S. 26).

Second, the water storing infrastructure of the plant takes control of the river flow, and even regulates it. The quasi-dam of the water storing system blocks the river flow, stores the water and releases only certain amounts of water, defined as the 'minimum water requirement' (MWR). Principally, each hydroelectric plant is required to leave water in the riverbed after diverting the river flow for electricity production. Moreover, filling the regulation pool takes time and varies from season to season. For example, while 24.4 m^3/s average stream flow, filling a pool takes 1.8 h, while by 10 m^3/s average stream flow, it takes 4.5h. The local people claimed that the filling time can even stretch as long as eight hours, also claiming that the water is not only stored during the low flow months. Even in high-flow months, the hydroelectric plant did not always release the flow it had diverted to produce electricity (Eren, 2018 S. 26).

In the Ikizdere Valley Hydroelectric Plant project, the water-energy nexus, has been transformed from local to national level. The aims and principles of producing electricity were determined at a national level. Turning the riverbed into artificial pools in a quasi-dam form to store water, building the water-intake facilities to block the natural flow, installation of surge tanks, and constructing large sized pools are methods to ensure that the infrastructure will have always water available for electricity generation and that the hydroelectricity companies will have the flexibility of using stored water for production, at specific pre-determined times in their production programme (Eren, 2018 S. 27).

The Ikizdere Valley project is an example, in the context of a national transformation in the water-energy nexus, where the liberalised electricity market creates 'structural tensions' in hydroelectricity production, whereby the infrastructures take a specific new role in the electricity market, as the provider of a determined amount of electricity on a predetermined time and date (Eren, 2018 S. 27). Due to the almost constant low-flow in the river bed, local people are much concerned about the future of river and their livelihoods. The water level in the river is essential for tea-cultivation, which is the main source of income for the local community. They hold the opinion that the tea gardens will be affected and, as a consequence, the tea production will sharply drop. The disappearance of some fish species is also observed as a result of alteration in river regime and a lower level of water. Finally, water pollution in the Ikizdere River has become more visible. The local people, who live close to sections with a reduced flow of water, have started to smell a foul odour coming from the river, during summer months (Eren, 2018 S. 29).

The Ikizdere River Basin project is also a good example to compare how the hydroelectric power generation system was before the liberalisation to how it is currently. In the past, when the river flow was sufficient, the hydroelectricity infrastructure was the provider of hydroelectricity. Now, when the market price is high, hydroelectricity infrastructures have become the providers of hydroelectricity (Eren, 2018 S. 30). The observations also show that the 'sustainable development' hydroelectricity programme of the state which demonstrates "take water, use it to generate electricity, and release it back", does not correspond with the Ikizdere Valley Hydroelectricity Power Plant.

5.3.7.2. The Cide Regulator and Hydroelectric Power Plant

The "Cide Regulator and Hydroelectric Power Plant" project, which was cancelled as a result of major demonstrations of the local people, is held up as a success story. The plant was proposed to be built on the Kure Mountains National Park and buffer zone in Kastamonu, a city in the Black Sea region of Turkey, which received legal protection status in 2000 due to its extraordinary natural landforms (canyons, caves, dolines), the natural structure of old-growth forests (best preserved Black Sea Moist Temperate Karstic Forest), unimpaired river ecosystems, rich wildlife habitats and biodiversity (Kraljevic et al. 2013). According to the "National Parks Management Plan", any activities within the buffer zone that may disturb the natural balance and structure of the rivers, forests and coastal zones are strictly forbidden. Nevertheless, plans were made to construct Cide Regulator and Hydroelectric Power Plant on Devrekani River, within the buffer zone, in the National Park. Devrekani River has a length of 147 kilometres. The estimated installed capacity of the hydroelectric power plant was 22 megawatts. If the project was realised, the entire structure, quantity, and quality of Devrekeani River, the main river of the Küre Mountains National Park, would end up with environmental deterioration. The main failures of this project were as follows:

- Building the hydropower dam on the wrong river.

- Overlooking the wildlife and biodiversity.
- Mismanagement of the risks and environmental impacts.
- Failing to procure the social license to operate.

5.3.8. Results and Outcomes

The construction and operation of hydroelectric power plants have not only impact on livelihoods of local residents, they also impact animal species living in those areas. If all rivers in Turkey (which has the total length of almost 10,000 km) were converted to hydroelectric power plants and dams, there would be little space left for the normal functioning of natural ecosystem. According to the 2014 report of *Doga Dernegi* and *Birdlife International,* 55% of the 319 bird species in Turkey, have severely decreased in population over the last decade due to the destruction of their natural habitats, primarily resulting from dam and hydroelectric power plant constructions (Turkish Water Assembly, 2011). The habitat of those extinct bird species were located mostly around the Euphrates and Tigris River, in the South-eastern Anatolian region of Turkey. The location of hydroelectric power plants have been in the exact locations experiencing scarcity of water resources, which has the additional effect of trapping water at higher altitudes, while leaving lower areas waterless. Some lakes in the basins even dried up due to the lack of water flow (Turkish Water Assembly, 2011).

Up until this point, a great number of demonstrations from locals, against the construction of hydroelectric power plants ended negatively, often with the local inhabitants being forced to leave their homes. It is expected that 2 million people will eventually be forced from their homes due to hydroelectric power plant and dam projects (Turkish Water Assembly 2011).

The installation of small-scale (run-of-river) hydropower plants can be more feasible, due to their lower effects on climate, in comparison to large-scale hydropower plants. Small, mini and micro-hydro plants provide not only electricity and water for both irrigation and drinking purposes, but they also create job opportunities in rural areas and can therefore help to prevent disproportional migration to the major cities (Dursun, et al., 2011 S. 1228).

5.4. Geothermal Power

Geothermal resources principally manifest around active fault systems, volcanic and magmatic units. According to (Elvan, et al., 2013), geothermal energy is "*the thermal* *energy obtained by artificial methods from hot water, wet steam and dry steam generated by heat accumulated in rocks in deep layers of earth and carried into reservoirs by fluids as well as from hot, dry rocks"*. There are four different types of geological formations, from which energy can be extracted: hydrothermal, geo-pressurised, hot, dry rock and magma. The energy from these reservoirs can be tapped and used for heating or electricity generation (Elvan, et al., 2013).

Modern geothermal power plants are considered to be a clean energy resource due to their low CO_2, NO, and SO emissions. Low-temperature (20°C-70°C) fields are used mostly for heating purposes, but are also utilised in industry and production of chemicals, whereas intermediate-temperature (70°C-150°C) and high-temperature (above 150°C) fields are used for electricity generation and for integrated heating purposes (Elvan, et al., 2013).

Electricity generation from geothermal resources was first performed at Larderello, Italy, in 1904. Since then, it has been predicted that the use of fossil fuels will diminish in our century. For this reason, geothermal energy as a renewable energy resource has become very attractive in Turkey and globally, for the replacement of fossil energy sources. The benefit of geothermal energy is that it can be utilised directly and indirectly. The drawback of direct utilisation is that it can only be used locally (Serpen, et al., 2010). On the other hand, indirect use of geothermal energy, with its relatively low temperature, seems inefficient in comparison to fossil fuel fired energy sources. Nevertheless, it has an advantage of base-load power generation as compared with the other renewables such as the wind and solar photovoltaic energy (Serpen, et al., 2010).

5.4.1. Geothermal Energy Situation in Turkey

Based on the 2016 data of the World Energy Council, Turkey ranks as the 3rd country, after China and the USA, in terms of geothermal energy generation with 1.28 mtoe per annum (World Energy Council, 2016) and can produce 5% of its electric energy consumption and 30% of its heat energy consumption. In the same year, Turkey accounted for half of the new global capacity additions, followed by the United States, Mexico, Kenya, Japan and Germany (World Energy Council, 2016). According to the latest numbers of the Energy Atlas in November 2017, Turkey's installed geothermal power generation capacity has already reached over 1,000 MW – which has been the 2023 goal of the Turkish MENR. It has also become the 4th country globally, for its installed power capacity, followed by New Zealand with 980 MW and Italy with 944 MW (World Energy Council, 2016).

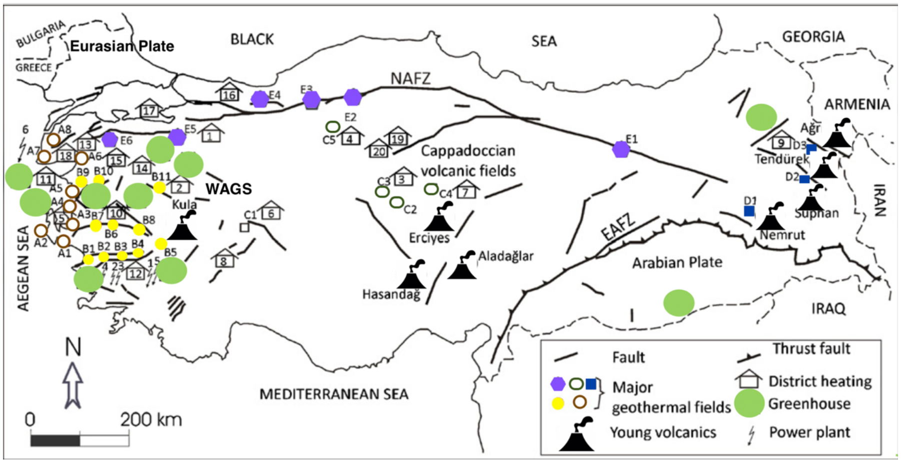
Nonetheless, the country uses only about 4% of its geothermal energy potential efficiently and the electricity generation remains in low levels. Up until now, around 600 geothermal prospects and more than 250 geothermal fields were discovered in Turkey, 170 of which hold a temperature range of 40–242 °C. 95% of these are low to medium enthalpy fields and most are also suitable for direct-use applications (Parlaktuna, et al., 2013).

Turkey is located on the seismically and tectonically active Mediterranean Earthquake Belt (Parlaktuna, et al., 2013). The tectonically active nature of Turkey results from the Alpine-Himalayan Mountain Belt, that began developing after the closing/shrinking of the Tethys Ocean, in the Late Mesozoic Era (Serpen, et al., 2010). High-mountain chains were shaped along the northern and southern belts of Anatolia, while some pre-Cambrian-Palaeozoic metamorphic shields (i.e. the Menderes and Central Anatolian Massifs) remained at the Central Anatolian Belt (Serpen, et al., 2009). The westward movement of the Anatolian Sub-plate through the northward push of the Afro-Arabian Plate, particularly in South-eastern Anatolia, resulted in extensive crustal stresses in Eastern and Central Anatolia. These forces led to the development of vast volcanic fields between the Miocene and more recent periods (Serpen, et al., 2010).

The southern section of Western Anatolian is closer to the subduction zone. Therefore, the heat generated by friction is easily transferred to shallower depths (Map 9).

Map 9. Map of major geothermal fields and neotectonics plates

(NAFZ: North Anatolian Transform Fault, EAFZ: East Anatolian Transform Fault, WAGS: Western Anatolian Graben System)



Data source: Modified from (Serpen, et al., 2009).

In the northern section, the distance in depth to the subduction slab is larger, so the heat transfer decreases from the deeper sections to the surface (Simsek, 2002). The most important geothermal fields discovered in the Aegean region in Büyük Menderes Graben, are as follows: Manisa-Alasehir-Köseali (287 °C), Manisa-Salihli-Caferbey (249 °C), Denizli-Kizildere (242 °C), Aydin-GermencikÖmerbeyli (239 °C), Manisa-Alasehir-Kurudere (214 °C), Aydin-Yilmazköy (192 °C), Aydin-Pamukören (188 °C), Manisa-Alasehir-Kavaklidere (188 °C), Manisa-Salihli-Göbekli (182 °C) and Kütahya-Saphane (181 °C).

5.4.2. Laws and the Regulatory Framework

The governing body in Turkey, responsible for the development of geothermal energy, is the MTA. After 2005, the geothermal applications and electricity generation from geothermal sources were regulated under the Law on Utilisation of Renewable Energy Sources for the Purpose of Generating Electrical Energy (Law No 5346, adopted in 2005) and the Law on Geothermal Resources and Natural Mineral Waters (Law No 5686, adopted in 2007), along with the Geothermal and Mineral Resources Law Implementation Regulation No 26727. The Law No 5346 aims to widespread the use of renewable sources in a sustainable, economical and reliable manner, to increase the diversification of resources and decrease the amount of CO2 emissions. Along with the Law on Amendments on Law No 5346, the new Law No 6094 entered into force in in 2010, in which electricity generation prices as incentives for diverse renewable energy sources were determined. As observed in Table 15, geothermal energy suppliers can sell their electricity at a higher price of US 10.5 cents, higher than hydro- and wind energy suppliers, but lower than biomass (including landfill gas) and solar power.

Table 15. Price of electricity in Turkey from renewable energy sources after the provision of the Law in 2010 and numbered 6094

Type of production facility based on renewable energy resources	Prices Applicable (USD cent/kwh)
a. Hydroelectric production facility	7.3
b. Wind power based production facility	7.3
c. Geothermal power based production facility	10.5
d. Biomass based production facility (including landfill gas)	13.3
e. Solar power based production facility	13.3

Data Source: (Resmi Gazete, 2005).

The laws and the associated regulations give solutions to the problems concerning legislative matters and obligations of the exploration and production concession rights, as well as the technical responsibility, control, and protection of the geothermal areas (Parlaktuna, et al., 2013). Under Article 4 of the Law No 5686, ownership of geothermal sources belongs to the State, rather than private property-owners, where the resources are located. In the case of any planned activity in the geothermal field, Turkish citizens or legal entities, are obliged to apply for a license (Kartal, 2013). There is still no specific law on geothermal energy that regulates the utilisation of geothermal sources of the country in their full potential. Moreover, the existing legislation must be further developed in compliance with European Community directives.

Despite the strong presence of the State in geothermal and other energy fields, since the amendment of Law No 5686, companies which are distributing or producing geothermal resources, are provided with some specific incentives. Under Article 26 of the Regulation No 26727, these companies are regarded as an industrial enterprise and can be granted with a geothermal resource distribution or production certificate. These companies are then able to apply for particular incentives, such as reduced electricity tariffs (Kartal, 2013).

In Turkey, the share of private entities in power generation has increased from 32% in 2002 to 75% by the end of 2015. The private companies are also predominantly operating the geothermal power plants. Since the public sector in Turkey has diminished its share of the power generation sector, the performance of the privatised power plants has increased from 45 to 80% in the same time period.

5.4.3. Electricity Generation from Geothermal Sources

Based on the 2016 data of the Turkish MENR, the geothermal capacity of Turkey is 31,500 MW. 79% of the areas with a potential are situated in Western/Aegean region, 8.5% in Central Anatolia, 7.5% in the Marmara, 4,5% in Eastern Anatolia and 0.5% in other regions. 94% of these geothermal sources are low or medium heat, suitable for direct applications (heating, thermal tourism, the output of minerals), while 6% are medium/high enthalpy fields, located in the Aegean region of the country and convenient for indirect applications, such as electricity generation. Based on the official data of the Turkish MENR, the development in geothermal energy application and electricity generation can be listed as follows (MENR, 2016):

- The number of geothermal fields suitable for electricity production increased from 16 in 2002, to 25 in 2016.
- The number of greenhouses, heated from geothermal energy, increased from 500 square meters in 2002 to 3,931 m^2 in 2016, with a rise of 686%.
- District heating from geothermal energy grew from the equivalent of 30,000 residences in 2002, to the equivalent of 114,567 residences in 2016, a rise of 281%.
- Geothermal heat capacity reached from 3,000 MW to 14,000 MW by the end of 2015, with a growth of 366%.
- Electricity production from geothermal energy reached from 15 MW_e in 2002 to 820 MW_e in 2016, with a rise of 5,366%.

In its planned 2023 targets, the Turkish government aims to generate 1,000% of electricity from geothermal power generation. With respect to the above-indicated data, there is a substantial increase in Turkey both in geothermal applications and in electricity generation from geothermal power. As mentioned, the latest data shows us that Turkey has already achieved its 1,000% target, much earlier than expected. Nevertheless, the future prospects show that the growth in Turkey's energy demand will be between 6% and 8%, adding 50,000 MW to the grid by the year 2020. Indicating that the electricity generation from geothermal sources will only be able to meet a small amount of Turkey's energy demand, due to its small share in renewable sources. In this regard, it would be a much more feasible option to consider geothermal energy as a local energy source, rather than an option for countrywide energy supply.

The electricity generation from geothermal sources needs high temperatures, such as 150°C and over (Canka Kilic, et al., 2013). The most important geothermal fields for power generation can be observed in Table 16. There are three significant geothermal fields with a high capacity of power generation: Denizli-Kizildere (1,2,3), Aydin-Germencik and Manisa-Alasehir geothermal fields.

Table 16. Geothermal fields with highest electricity generation in Turkey

Field	City	Installed capacity (MWe)	Operation capacity (MWe)
Kizildere	Denizli-Sarayköy	15	15
		80	80
		6.85	6.85
Hidirbeyli	Aydin-Germencik	20	20
Bozköy		24	24
		24	24
		24	24
Pamukören	Aydin-Kuyucak	61.72	45.02
Gümüsköy	Aydin-Germencik	13.2	13.2
Alasehir	Manisa-Alasehir	24	24
Salavatli	Aydin-Sultanhisar	8	8
		9.5	9.5
		34	34
Tuzla	Canakkale-Ayvacik	7.5	7.5
Gerali	Denizli-Sarayköy	23	
Total			**452.41**

Data source: (Canka Kilic, et al., 2013).

Alasehir field, with 287 °C, has the hottest geothermal water wells in Turkey. The drilling activities in Manisa-Alasehir geothermal well have increased, particularly following 2011.

The Kizildere geothermal field was the first field discovered by the MTA in 1968, and was utilised for electricity production in 1984, with an installed capacity of 20.4 MW (Parlaktuna, et al., 2013). The field is associated with a major fault line along the northern boundary of the Büyük Menderes Graben (Karamenderesi, 2013). Until now, a total of 20 deep wells, varying in depth from 370 to 1241m have been drilled, with temperatures ranging from 170 to 212 °C (Varinca, 2011). The most significant characteristic of this field is the high amount of non-condensable gases, with a CO_2 content of 96–99%, hydrogen sulphide content of 100–200 ppm and ammonia content of 72 ppm (Varinca 2011). The plant, before its privatisation, was associated with, among other issues, surface water contamination.

Kizildere-I Geothermal Power Plant was run by EÜAS, on behalf of the government, for 24 years. In 2008, the field was privatised and transferred to Zorlu Enerji Company for 30 years (Kindap, et al., 2010). The company acquired the 17.4 MWe capacity of Kizildere-I geothermal power plant and expanded the plant in 2013, with the 80 MWe capacity of Kizildere-II geothermal power plant. In 2017 the construction of Kizildere-III geothermal power project was completed in the same field, which currently generates 99 MWe.

In 1986, a liquid carbon dioxide and dry ice production process, with a capacity of 40,000 tonnes per year, was added to the field. The processing capacity increased to 120,000 tonnes per year in 1999. In addition to electricity and dry ice production, the field has been used for greenhouse heating and space heating (Varinca, 2011). The Kizildere geothermal fluid is also used for bleaching processes in the textile industry, as well as in the drying and washing of textile products. The area is known for its thermal springs and balneology centres with health and spa facilities, which offer therapeutic mud baths and thermal baths, which particularly attract tourists to the region.

Aydin-Germencik geothermal field is the second most economically significant geothermal field for generating electricity. The field was discovered by the MTA and is located in the west of Büyük Menderes Graben, about 40 km from the Aegean Sea. The MTA has drilled ten wells for exploration, with depths varying between 285 and 2.398m. The temperatures of the first and second aquifers were between 203–217 and 216–232 °C. The hot water can be used by industry, in electricity generation, district heating, and in touristic as well as balneology centres (Varinca, 2011).

In addition to power generation, geothermal energy is used in various sectors as direct-use applications, such as district heating and sometimes for individual space heating, domestic hot water supply and greenhouse heating.

5.4.4. Direct-Use Applications of Geothermal Energy: District Heating, Greenhouse Heating, Hot Water and Balneology

The direct-use applications of geothermal energy are widely utilised in Turkey, especially in the Aegean region where the surface temperatures range between 25°C and 150°C. The application areas, which mainly centre upon industry and buildings, are listed as follows: heating and/or cooling homes, businesses, spaces and greenhouses, health care and treatment applications, thermal tourism applications (hot springs, spas, balneological uses of geothermal water, etc.), fish farming (heating water), aquaculture productions, farming (crops, fruit, vegetable raising and drying) and mushroom production (Canka Kilic, et al., 2013). Other fields of geothermal application, where the temperatures vary between 100°C and 250°C, are processed for heat supply, drying, chemical and mineral productions (CO_2, fertilizer, lithium, heavy water, hydrogen, and mineral water, etc.) and geothermal heat pump applications (Canka Kilic, et al., 2013).

Contrary to the world trend in geothermal energy, utilisation of heat pump applications—due to its high capital costs—and other enhanced geothermal systems have not achieved a remarkable progress in Turkey. Only greenhouse heating systems have become popular in Turkey, in recent years. The district heating projects have not yet gained the same acceleration as greenhouse applications, mainly due to the following reasons (Serpen, et al., 2010):

- Currently, no available geothermal resource has been discovered close to the provinces.
- The competition between the geothermal and natural gas industry is inconsiderably low.
- Some of the geothermal district heating systems do not have sufficient heat supply.
- The heating costs are relatively high.

According to data from the International Geothermal Association, Turkey's total thermal installed capacity is 2.0 GW and the direct use of geothermal energy sources is 10.2 GW_{th} per year (IGE, 2014). The direct use applications for geothermal energy include district heating, greenhouse heating, and thermal tourism facilities. 58% of the proven capacity (2.7 GW_{th}) is utilised for geothermal heating, which includes residence heating (805 MW_{th}), greenhouse heating (612 MW_{th}), thermal facilities heating (380 MW_{th}), balneology (870 MWth) and heat pump applications (38 MW_{th}) (Parlaktuna, et al., 2013). Space heating is the predominant type of direct utilisation of geothermal energy in Turkey. In total, 17 provinces (mainly in western and central Anatolia) in Turkey, use geothermal fluid in residential heating. The first geothermal district heating system was established in Gönen in 1987 (Parlaktuna, et al., 2013). As it is illustrated in Table 4, Balcova field in Izmir with 243 MW_t has the largest residential heating capacity.

There are two significant geothermal district heating fields in Turkey, with their high capacity of heating and adoption of new technologies. The first is the Balçova-Narlıdere district heating system (Table 17). This heating field is an exception among other district heating systems in Turkey, due to its adoption of the newest technologies and low operational costs. According to 2013 data, the system could heat in excess of the of 35,000 residences. The second is the Afyon district heating system, which attracts attention with its innovative geothermal projects. Afyon has achieved becoming the first self-sufficient city in Turkey, to meet its own energy needs only through its domestic sources, namely geothermal heating. 15,000 residences, 50 hotels and hundreds of greenhouses are heated through the underground geothermal heating system. As natural gas and coal are not utilised for the energy generation, the city is able to save 210 million TL (around € 45 million) each year, which is re-invested for new geothermal discoveries.

Table 17. Important geothermal district heating systems for households in Turkey

Field	Number of residencies	Temperature (°C)	Capacity (MW_t)	Company
Balcova-Narlidere	35,000	140	243	Governorship and municipality
Afyon	15,000	95	125.5	Predominantly municipality
Sandikli	11,000	75	119	Predominantly municipality
Simav	12,000	125	92	Municipality
Diyadin	570	70	62	Predominantly governorship
Salihli	7,500	94	57	Municipality
Edremit	5,500	60	39	Municipality and private
Kozakli	3,000	90	34	Predominantly municipality
Kizilcahamam	2,500	70	28	Predominantly municipality
Sindirgi	300	98	24	Municipality and private
Kirsehir	1,900	57	20	Predominantly municipality
Gönen	3,400	80	19	Predominantly municipality
Sarayköy	2,500	95	19	Predominantly municipality
Dikili	2,000	125	19	Municipality
Sorgun	1,500	80	19	Municipality
Bigadic	1,500	96	7	Municipality
Bergama	450	70	3	Municipality

Data source: (Turkey Geothermal Association, 2017)

Afyon geothermal energy investments draws world-wide attention with their innovations. The city is specialised in the field of geothermal and solar energy. In addition to having Turkey's second largest thermal heating facility, around 15,000 residences are warmed by the geothermal district heating system at a 60% cheaper cost than equivalent traditional heating systems (e.g. natural gas). This is equivalent to 300,000 tonnes of coal per year. In 2013, the city allocated US$75 million to alternative and renewable projects and accomplished 12 inventions that were tagged with patent and utility model. With recent investments, about 1.5 million m^2 of indoor space has been heated by natural underground water. This includes 50 hotels as well as residences. In addition, the heating of the greenhouse areas is also done with thermal systems (Gecer, 2014).

Besides district heating systems for residences, Turkey also has more than 350 thermal resorts, heated by low temperature geothermal water, which offer balneology and thermal tourism applications. Afyon-Orucoglu Thermal Resort facilities have been heated since 1992 with geothermal water at 48 °C temperature. In addition, the Bolu-Karacasu Thermal Facility has been partially heated to 44 °C since 2001, Rize-Ayder Cure Center at 55 °C, Hatay-Kumlu Thermal Facility at 37 °C with bottom heating, Sivas-Hot Cermic Hot Springs at 46 °C and Samsun-Havza Thermal Facilities are heated by geothermal water at 54 °C temperature. In Haymana, the mosque is heated with 45 °C geothermal water (Turkey Geothermal Association, 2017).

Heating greenhouses through geothermal energy has become very fashionable, especially in recent years. Major greenhouse areas are located in Western Anatolia. The greenhouse heating capacity in Turkey grew to almost 3 million m2 greenhouse heating (612 MW_{th}) in 2015. As a result of market saturation, the greenhouse investments have slowed down in the last 3 years. Greenhouses are heated 1500–2000 h per year, and their main produce is tomatoes and Californian peppers (Serpen, et al., 2010). The major export markets are Russia (60%) and Europe (20%). 10% of the yield is sold countrywide. The major greenhouse applications are located in Dikili-Bergama, in Aegean region, with 1,000,000 m^2 and in Sanliurfa-Karaali in South-eastern Anatolia, with 474,000 m^2.

Geothermal resources with average and excess enthalpy in Turkey have high CO_2 content. This CO_2 gas is used to accelerate the growth of greenhouse production as well. Greenhouses consume 4,000 tons CO_2 per year per hectare. Therefore, it is essential to transmit 1000–2000 parts per million of CO_2 into greenhouse atmosphere. Consequently, the CO_2 gas obtained from geothermal resources is utilised for greenhouses (Serpen, et al., 2010).

5.4.5. The Environmental Impacts

Despite being an environmentally friendly energy source, geothermal power facilities have some adverse impacts on water quality, air emissions and water and land use.

In geothermal power plants, hot water pumped from underground reservoirs predominantly contains high levels of sulphur, salt, and other minerals. Most geothermal plants have closed-loop water systems, whereby the extracted water is pumped back into the geothermal reservoir after it has been used for heat or electricity production. In these systems, water is stored in steel well casings, cemented to the surrounding rock, which may cause water contamination. Geothermal plants may require between 1,700 and 4,000 gallons of water per MWh for cooling and re-injection (Union of Concerned Scientists, 2014). Using geothermal fluids rather than freshwater, which is typical world-wide, reduces the plant's overall water impact.

Regarding their impact on the volume of air emissions, there is a difference between open- and closed-loop geothermal power systems. In closed-loop systems, gasses released from the well are injected back into the ground after giving up their heat (Union of Concerned Scientists, 2014). Therefore, the air emissions remain in minimal levels. In open-loop systems, gasses are exposed to the atmosphere after giving up their heat. Thus, the gasses like hydrogen sulphide, carbon dioxide, ammonia, methane, and boron are released into the air. Hydrogen sulphide, which has a distinctive "rotten egg" smell, is the most common emission (Kagel, et al., 2007). As soon as hydrogen sulphide is released in the atmosphere, it changes into sulphur dioxide (Union of Concerned Scientists, 2014). This contributes to the formation of small acidic particulates, which can be absorbed into the bloodstream and cause heart and lung diseases. Sulphur dioxide has further environmentally hazardous impacts; it causes acid rain, which damages crops, forests, and soils. Nevertheless, the sulphur dioxide emissions released from geothermal plants are approximately thirty times lower per MW hour than those from coal plants (Union of Concerned Scientists, 2014).

Many geothermal sites worldwide are located in more complex and sensitive ecological areas. The removal of water from geothermal reservoirs sometimes causes land subsidence. Many geothermal facilities address this problem by re-injecting wastewater back into geothermal reservoirs after the water's heat has been captured (Union of Concerned Scientists, 2014).

There is also an evidence that hydrothermal plants can lead to an even stronger earthquake frequency. Enhanced geothermal systems (hot, dry rock) may also increase the risk of small earthquakes, the process to pump water at high pressures is to fracture underground hot rock reservoirs. Earthquake risk associated with enhanced geothermal systems can be minimized by siting plants an appropriate distance away from major fault lines (Union of Concerned Scientists, 2014).

Estimated global warming emissions for open-loop systems are approximately 0.1 pounds of CO_2e/kwh (Union of Concerned Scientists, 2014). Around 10% of air emissions are CO_2, a small amount of methane and a more potent global warming gas. In closed-loop systems, there are no gas releases into the atmosphere, but there are still some emissions associated with plant construction and surrounding infrastructure (Union of Concerned Scientists, 2014). Enhanced geothermal systems have global warming emissions of approximately 0.2 pounds of CO_2e/kwh.

Increasing the share of geothermal power in the electricity mix would increase some of the life cycle impacts such as acidification and global warming potential, compared to increasing the share of hydropower and wind. Nevertheless, these impacts would still be much lower than providing electricity from fossil fuels (Atilgan, et al., 2016).

In spite of their contribution to the total electricity production, these resources also have potentially negative environmental impacts on other natural resources such as soil and water in the basin. The resources contain harmful substances, especially high concentration of boron, arsenic, selenium, lead, cadmium, hydrogen, sulphur, mercury, ammonia, radon, carbon dioxide and methane. After its extraction from Kizildere geothermal wells and its utilisation, hot water flows into the Büyük Menderes Stream, which engenders deoxygenation and this threatens the aquatic ecosystem and disturbs the ecologic balance.

5.4.6. Public Awareness and Social Acceptance of Geothermal Energy

The utilisation of geothermal sources is an environmentally friendlier energy option and has more diverse application possibilities than the other renewable sources. Moreover, it does not depend on climate conditions. Nevertheless, the waste produced by the geothermal facilities include toxic metals. Geothermal plants may also smell and produce noise pollution during construction, the drilling of wells and the escape of high-pressure steam during testing. Therefore, it is imperative that the project owners inform the local residents about the benefits and potential adverse effects of living near a geothermal plant

The main economic benefit of a geothermal plant is the creation of short- and long-term employment opportunities for the local residents. Furthermore, the plant owners may purchase some necessary materials and equipment from local sources. Another benefit of a geothermal power plant is providing district heating systems to the close residents or farms. The agricultural crop production can benefit from the heating system.

Cetiner et al. conducted a case study with 3 high school and 101 university students to determine the social acceptance and perception of geothermal energy in the Big Peninsula, Canakkale, Turkey. The results of the research show that geothermal energy sources in the Big Peninsula have significant potential for different areas of use, but the knowledge regarding the environmental effects is insufficient. 73.1% of people were of the opinion that geothermal resources are a form of energy as well as are a natural formation. 71.2 thought that geothermal resources were solely hot water. 76.9% shared the opinion that geothermal resources were unnecessary. Of participants, 52.9% thought geothermal energy was used for tourism, 71.2% thought it was used for treatment and 56.7% thought it was used for central heating. A significant part of respondents (41.3) did not know that one of the uses of geothermal energy was agriculture (Cetiner, et al., 2016).

In terms of environmental impacts of geothermal energy, the survey participants did not have a high level of knowledge. 23% did not know whether geothermal energy affects the environment positively or negatively, whereas 25% shared the idea that they do not have negative effects on the environment. A high majority of respondents (75.9%) shared the opinion that geothermal energy triggers earthquakes.

Regarding the promotion of geothermal energy, 66.4% participants thought visual media were effective and 74% thought it provided significant contributions to the local and cultural tourism. On the other hand, 45.2% of respondents thought that training and seminars to promote geothermal energy were not beneficial. 74% of participants agreed on the same idea that geothermal heating had appropriate costs and 67.3% advocated for state grants to support geothermal energy. Of participants 46.7% thought it was necessary for the state to support geothermal energy by identifying incentive regions. An important survey result showed that universities were the most reliable source of information about geothermal energy (51.6%), whereas energy companies were 18%, local government 17.2% and state information sources 13.1%, respectively.

5.4.7. Results and Outcomes

Geothermal energy is environmentally friendly due to its contributions to the reduction of carbon dioxide. Moreover, it does not depend on climate conditions and can address many forms of energy needs. The efficient utilisation of geothermal energy has environmental benefits in local, regional and even global terms. Geothermal energy can displace power generation from fossil fuel-powered plants and hence help to improve local air quality, mitigate regional impacts such as acid rain and reduce greenhouse gas emissions globally. The geothermal facilities have neither huge piles of ash nor barrels of radioactive waste.

Turkey has an abundant potential of geothermal, but the systematic exploration of these resources is has not yet been accomplished. The drilling activities are still insufficient in number. Heating costs put a heavy burden on the Turkish economy. District heating through the geothermal energy in Turkey is the cheapest way compared to gas-fired combi boilers (which is mostly preferred for residential heating), it has therefore gained wide acceptance among consumers.

Despite having many positive characteristics as a renewable energy, utilisation of geothermal sources can also have adverse impacts on the environment. The wastes produced by geothermal systems include toxic metals. Furthermore, these systems produce a potential air pollutant: hydrogen sulphide. However, this could be processed and removed for use in industry. Geothermal plants also produce noise pollution during construction, through the drilling of wells and the escape of high-pressure steam during testing (Erdogdu, 2009). Finally, geothermal power plants are mostly located in high estate areas, where the external appearance of the plant is important to the surrounding community. Summarised, the environmental costs of geothermal energy seem to be minimal in comparison with fossil fuel sources and facilities.

Geothermal power may help Turkey to move towards a more decentralised form of electricity generation, where the installed plant meets the necessities of local customers, avoids transmission losses and increases flexibility in system use. Thereby the diversification of power generation plants will be ensured which in turn increases competition in electricity generation.

5.5. Biomass energy

This chapter focuses on the main types of available residues for bioenergy production and their geographical distribution in Turkey. The chapter further aims to examine the use of agricultural as well as livestock residues to contribute to achieving the renewable energy targets of Turkey. The chapter discovers the social acceptance and public perception of the energy production from biomass and the knowledge among the community regarding the positive contribution of bio-sources to local energy production. The majority of the available data is provided by the Food and Agriculture Organisation of the United Nations' BEFS Assessment for Turkey, as well as own quantitative and qualitative research in the IZAYDAS biogas plant, which was considered as a case study within the chapter.

5.5.1. Biomass energy production from crop and livestock residues

Turkey is the 7th largest agricultural producer in the world and a top producer as well as exporter of crops such as hazelnuts, chestnuts, apricots, cherries, figs, olives, tobacco and tea (OECD, 2011). Agricultural exports are highly diversified and comprise more than 10% share in total exports in 2016 (Table 18). (Ergocun, 2018).

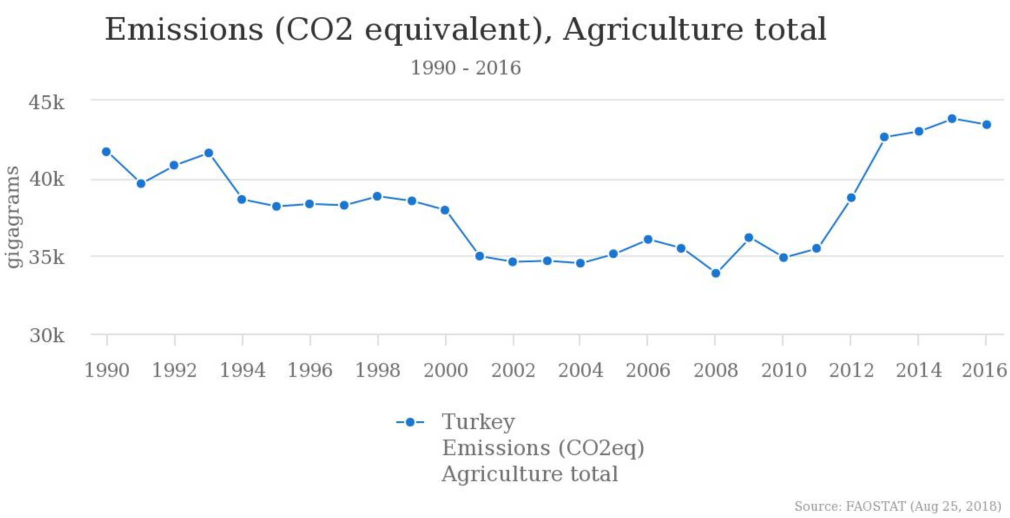
Table 18. Agricultural trade – Key commodities (2016)

Rank	Trade commodity	Export quantity (t)	Export value (1,000 US$)	Share in total value of exports
1	Hazelnuts	133,755	1,161,213	8,1%
2	Nuts, prepared (exc. groundnuts)	97,715	689,008	4,8%
3	Pastry	321,315	648,086	4,5%
4	Raisins	236,068	425,953	2,9%
5	Chocolate	145,077	402,725	2,8%
6	Tobacco (unmanufactured)	50,742	358,206	2,5%
7	Chicken meat	314,695	351,026	2,4%
8	Apricots, dry	78,755	288,793	2%
9	Figs dried	69,683	249,501	1,7%
10	Tomatoes	485,963	239,875	1,6%

Data source: Own illustration based on the data from (FAOSTAT, 2016) and (WITS, 2016).

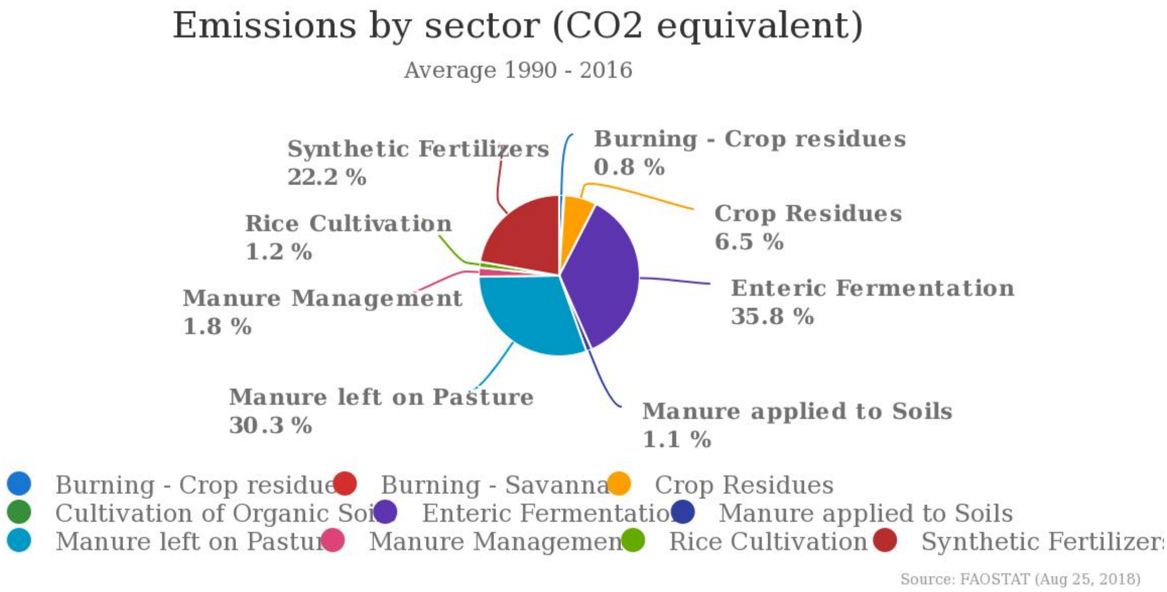
Despite being a significant source for energy generation, the agricultural sector of the country has a substantial contribution to the increase of greenhouse gas emissions within the years. As seen in Figure 21, the greenhouse gas emissions from the agricultural sector started to increase in 2011 from 348,88 gg to 354,88 gg, surpassed the 1990 levels (417,05) in 2016 (434,49) and is demonstrating a tendency to increase over time as a portion of the total emission in Turkey (Figure 19) (FAOSTAT, 2018).

Figure 19. Greenhouse gas emissions (CO_2 equivalent), Agriculture total



Greenhouse gas emissions can be produced from agricultural activities such as production and processing of agricultural products, livestock (enteric fermentation, fertiliser management), rice production, burning agricultural wastes in open areas and agricultural lands. Enteric fermentation is the sub-sector that is responsible for the majority of agricultural emissions (Figure 20).

Figure 20. Greenhouse gas emissions by sector (CO_2 equivalent)



Agricultural activities predominantly cause CH_4 and N_2O emissions. N_2O, CO and NO_x emissions are also released as a result of stubble burning. In order to diminish these gas emissions, the Turkish Ministry of Food, Agriculture and Livestock developed policies, strategic plans and some projects. Furthermore, since 2007 the Turkish Ministry has initiated giving a “Good Agricultural Practices Certificate” to the producers who do not damage environment, human and animal health and ensure translucency and sustainability in agriculture. By 2010, 4,540 producers in 48 provinces have received certificates covering an area of 78,174 ha (with an increase of 1,458% comparing to 2007). Turkey aims to give certificates in 81 provinces by the year 2023. In addition to good agricultural practices, the Turkish Ministry has taken significant steps to implement relevant measures in “Environmentally Based Agricultural Land Protection Program (*in Turkish: CATAK*). The program includes innovative practices in the field of agriculture such as reducing the negative impacts of agriculture on climate change. In this regard, a pilot project as a “best practice” had initially performed between 2006 and 2008 in Seyfe Lake (Kirsehir - Central Anatolia Region), Kovada Lake (Egirdir/Isparta – Mediterranean Region), Eregli Reedfield (Konya – Central Anatolia Region and Sultan Reedfield (Kayseri – Central Anatolian Region). These areas have been defined as “Wetlands of International Importance”. In order to overcome the environmental problems in the areas, land consolidation activities were implemented by the end of 2008 (UNDP, 2013).

In this context, it is significant to implement an efficient bioenergy policy coherent with Turkey's agricultural situation and policies. The utilisation of briquettes and pellets can be considered as efficient technologies that help to extract the energy potential contained in agricultural crop residues in a more efficient way, with no specific chemical transformation of materials (FAO, 2016). Briquetting and pelletising by replacing coal consumption, will bring the country to closer to its renewable energy goals; i.e. increasing the share of renewable energy to 30% in total energy generation by the year of 2023.

5.5.2. Bioethanol and Biodiesel

Sugar beets are the main source of bioethanol production in Turkey, followed by corn and wheat. Bioethanol is produced from molasses, which is a by-product of sugar production from sugar beets (Atalaysun, 2016). When the sugar is extracted from beets, the alcohol remaining in the molasses is converted into ethanol. The remaining molasses is used as feed and as raw material for the pharmaceutical industry, cosmetic, construction, alcoholic beverages and yeast. Annual molasses production in Turkey varies from year to year and is around 670,000 metric tonnes. No additional sugar beets for the purposes of future production of bioethanol are currently planned.

The 2015-2019 Strategic Plan of the Turkish Ministry of Energy and Natural Resources set out the priority to work more closely with the agricultural sector to develop biofuels (biodiesel and bioethanol). The preparatory regulation for this target of the Ministry was issued by the EPDK 2011 for biofuel blending, which was set as mandatory starting from 2013 for bioethanol (2%) and biodiesel (1%), with the target of reducing the oil imports. Since 2016, the blending ratio for bioethanol was increased to 3% (Atalaysun, 2016).

The annual fuel consumption in Turkey in 2015 ranked as 22 MMT, of which 1.9 MMT was gasoline and 20,1 MMT was diesel. Currently there are three plants producing fuel-purpose bioethanol with a total production capacity of 150 million litres. Around 84 million litres of this amount are provided from the Cumra plant of Pankobirlik in Konya province in the Central Anatolian of Turkey. The remaining amount of bioethanol comes from two plants in the cities of Bursa and Adana, where the production utilises locally grown corn.

The EPDK regulation requires bio-ethanol production to be obtained solely from domestically grown agricultural products. In 2017, the blending ratio is expected to rise to 5%, which will necessitate extra bioethanol production. In this respect, Pankobirlik is currently considering a new factory to produce bioethanol from corn, to meet the increased bioethanol needs in 2017 (Atalaysun, 2016).

In order to see the production necessity of crops in biofuel production for given mandatory blending ratios, the bioethanol and biodiesel quantities must firstly be calculated. In the table below these figures are provided, based on the amount of consumption multiply the blending ratio for the year 2013, 2014, 2017 and by a proposed participation to the EU membership (Table 19).

Table 19. Mandatory Blending Application and Biofuel Requirement

Fuel type	Consumption (million tons in 2015)	Blending ratio (%)		Biofuel quantity (thousand tones)
Gasoline	1,9	2	2013	38 (bioethanol)
		3	2014	57 (bioethanol)
		5	2017	95 (bioethanol)
		10	EU Membership	190 (bioethanol)
Diesel	20,1	1	2013	201 (biodiesel)
		3	2014	603 (biodiesel)
		5	2017	1,005 (biodiesel)
		10	EU Membership	2,010 (biodiesel)

Data source: Own illustration based on the data from (Atalaysun, 2016) and (Bölük, et al., 2013).

With respect to the biofuel quantities for each year, the production necessities of certain crops for bioethanol and biodiesel are calculated as shown in Table 20.

Table 20. Agricultural Feedstock Necessity of Mandatory Blending

Biofuel	Biofuel consumption quantity (million litre)			Crop	Harvest yield of biofuel feedstock (kilogram per litre biofuel)	Production necessity (1000 tones)		
	2%	3%	5%			2%	3%	5%
Bioethanol	38	57	95	Corn	2.4	91	137	228
				Wheat	2.9	110	165	275
				Sugar beet	10.5	399	598	997
Biodiesel	201*	603	1,005	Rapeseed	2.2	442	1,326	2,211
				Sunflower	2.5	502	1,507	2,512
				Safflower	3.3	663	1,990	3,316
				Soybean	5.0	1,005	3,015	5,025

* 1% blending rate for biodiesel in 2013.

Data source: Own illustration based on the data from (Atalaysun, 2016) (Bölük, et al., 2013)

According to the calculations, bioethanol production from sugar beets seems more feasible and sustainable for Turkey. Currently, around 500 thousand hectares of sugar beet production area was sufficient to meet the mandatory requirement ratio of 3%. However, concerning higher blending ratio (5%), bioethanol can only be obtained from sugar beets if an additional land area of around 14.8 thousand hectare is allocated for sugar production (Bölük, et al., 2013). In terms of land area capacity, Turkey has enough potential to meet the required blending ratio of EPDK with sugar beet-based bioethanol for gasoline.

Up until now, no extra production from sugar beet or corn was needed to meet the required threshold for bioethanol. Extra production facilities and industrial farming for bioethanol may cause soil erosion, water pollution and increase carbon dioxide emissions due to the use of fossil fuels in biofuels crop growth and production. According to *Friends of the Earth International Organisation*'s fact sheet, water pollution from fertilisers, toxic herbicides and pesticides increases with more core ethanol production caused by the corn farming. Furthermore, due to massive land requirements, bioethanol and biofuel production contribute to global deforestation and ecosystem destruction. Moreover, corn as one of the most prevalent crops for bioethanol production, uses large amounts of oil-based fertilisers, which release high amounts of greenhouse gas pollution.

Regarding the production of biodiesel, the production methods differ from those of bioethanol. Biodiesel is obtained from oilseeds and since the subvention cut offs through an 'agricultural revolution' in 2002, Turkey became a net importer of oilseeds. All the seeds, necessary for the biodiesel production, need to be imported, which increases the burden of import bills on top the current account deficit in Turkey.

Bioenergy systems and biofuels may help to displace foreign petroleum imports in energy-scarce countries, as well as sustain energy security and prevent climate change. Turkey has an installed capacity of more than 1.5 million tonnes regarding biodiesel plants, including 34 biodiesel facilities. Nevertheless, these plants are not fully utilised due to the low oil seed self-sufficiency ratio and increasing trade account deficit. Therefore, biodiesel production based on oilseeds is not sustainable for Turkey in economic terms. In contrast, bioethanol production in Turkey seems to be sustainable and can meet the mandatory blending ratio requirement. Bioethanol production from sugar beets is the more rational choice over corn, due to the sufficient plantation area and potential for utilisation of the remaining molasses as feed and as raw material for the pharmaceutical, cosmetic, construction, alcoholic beverages and yeast industries. Furthermore, sugar beets have less negative environmental impacts such as soil degradation and water pollution in comparison to corn, contributing less to greenhouse gas emissions.

5.5.3. Energy production from biomass and the legal framework

The term biomass (in Greek language bio means life and maza means mass) refers to non-fossilised and biodegradable organic material originating from plants, animals, and microorganisms. The biomass includes products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilised and biodegradable organic fractions of industrial and municipal solid wastes (Demirbas, 2009). It also includes gasses and liquids recovered from the decomposition of non-fossilised and biodegradable organic material (Demirbas, 2009). It is an important renewable energy source, where solar energy is stored as chemical energy through photosynthesis during the growth of plants and trees, which can be released via direct or indirect combustion (Demirbas, 2009).

According to the estimation of the International Energy Agency, 2.7 billion people worldwide are still relying on traditional biomass energy source, like polluting stoves and fuels for cooking by using mainly wood, other biomass and charcoal (IEA, 2016).

Biomass can be generally used in two forms: Traditional biomass and modern biomass which are classified according to the supply sector as follows:

- Forestry sources: Dedicated forestry (short rotation plantations like willow, poplar) and by-products (wood products)
- Agricultural sources: Lignocellulosic energy crops (herbaceous crops), oil, sugar and starchy crops, agricultural residues and livestock wastes
- Industrial sources: Industrial residues
- Waste: Dry lignocellulosic waste (residues from parks and gardens) and contaminated waste (demolition wood, organic fraction of municipal solid waste, biodegradable landfilled waste, landfill gas, sewage sludge) (Isler, et al., 2008)

The estimated biomass potential of Turkey is 4.8 million tonnes, which could be obtained from forests, and over 15.3 million tonnes from agricultural waste. In total, the biomass potential of Turkey is 8.7 mtoe of which 49 MW was operational in 2014 (IEA, 2016). Based on the vision 2023 targets of the Turkish MENR, the government intends to increase use of biomass-based energy generation to 1,000 MW by 2023.

The basic legal framework in Turkey to support electricity generation from biomass-based energy and biogas, was adopted in 2005 as *Law on utilisation of Renewable Energy in Electricity Generation No. 5346*. The Law provided the choice between direct sales of renewable electricity into sport market or a general feed-in-tariff, which includes the requirements for suppliers to purchase their renewable electricity, priority connection and exemptions for small generators (0.5 MW) from license obligations, as well as reduced fees for land acquisition (IEA, 2016). Furthermore, the government in Turkey promotes the use of biomass over fossil fuels and uses the best available agricultural and irrigation techniques to reduce emissions and conserve natural resources in agriculture (Nachmany et. al., 2015). The adopted 'Law on Soil Conservation and the Act on Grassland and Pasture Conservation' as well as the 'Action Plan on Drought Preparedness and Combating Drought' are desired to contribute to carbon sequestration (Nachmany et. al., 2015).

5.5.3.1. Energy production from traditional biomass

Approximately 60% of total biomass worldwide used for energy purposes is traditional biomass like fuel wood (some of them converted to charcoal), sawdust, straw, stalk, combustible residues, wastes and animal dung. These are gathered by hand

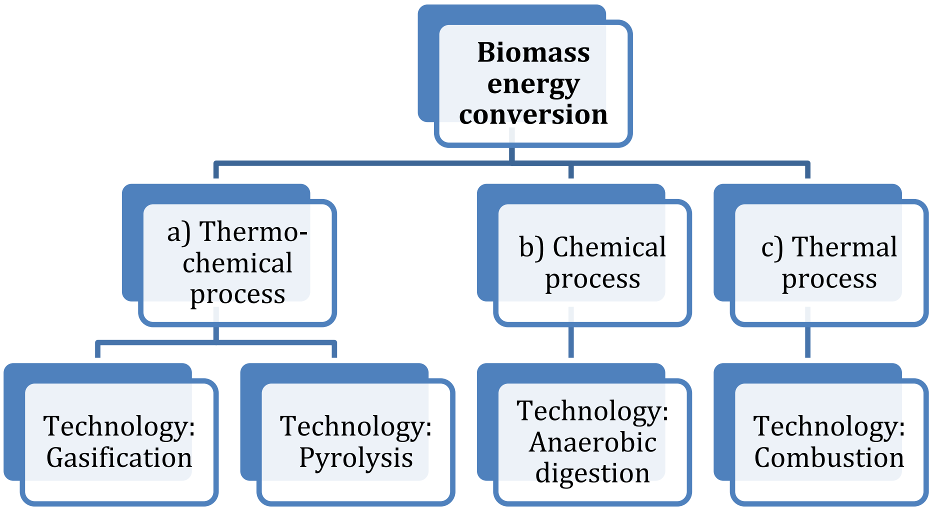
and mostly combusted in open fires or stoves for cooking, heating for dwellings and lighting purposes, especially in the developing countries and in rural areas.

In Turkey, non-commercial energy forms, stoves and ovens using biomass are the main source of energy, especially in the rural areas used both for cooking and heating purposes. The second primarily used fuel is coal. Turkish traditional stoves and ovens, which come from multi-cultural Anatolian and Ottoman Empire cultures, are still used today. Examples for the widely-used stoves and ovens are dung stoves, wood stoves, sawdust stoves, *kuzine* stoves, rock ovens and tandoor ovens (Isler, et al., 2008). The wood stove is a simple stove type, which is widely used in the rural areas where forestry products are abundant for heating and cooking purposes. The sawdust stove is mainly utilised in the countryside for cooking purposes. Sawdust is obtained from cutting, grinding, drilling, sanding, or otherwise pulverizing wood. Dung stoves have a similar system with sawdust stove, however it utilises dung obtained from livestock. The wood, sawdust and the dung stoves all have detrimental impacts on the environment and human health. Lastly, the *kuzine* stoves, which are made of sheet iron and used for heating and cooking purposes, are widely utilised by the households in rural and urban areas (Isler, et al., 2008). Tandoor ovens are one of the old and traditional ovens used in Turkey and used widely for cooking purposes in rural areas. Rock ovens, called *Şamot* in the Ottoman Empire, consist of fire-resistant special rocks. They were principally used for baking and cooking purposes (Isler, et al., 2008).

5.5.3.2. Energy Production from Modern Biomass

Modern biomass is obtained from renewable sources in a sustainable manner. As it is indicated in the previous sub-chapter, wood is used as a major resource for cooking and heating purposes in rural regions, but its use for energy production from modern biomass is rather a new concept in Turkey. In order to obtain energy from modern biomass, there are different technologies, which are illustrated in Figure 21.

Figure 21. Biomass Energy Conversion Technologies



a) Thermo-chemical Process

In the thermochemical process, there are two technologies utilised, which are: *Gasification technology* and *pyrolysis technology.* By using *gasification technology*, energy crops, rice straw, bark, peat, sawdust, municipal solid waste, forest residues, and wood chips are the main energy input for the gasification plants. Biomass gasification means incomplete combustion of biomass taking place at a temperature of about 1,000°C. In this phase, four distinct processes occur: 1) Drying fuel 2) pyrolysis 3) combustion and 4) reduction. The composition of the output depends on the type of gasification agent adopted. The typical composition of released output consists of 85% syngas, 10% char, and 5% liquid. The biggest advantage of this technology is that electricity production by biomass gasification is highly efficient and has low environmental impacts. The disadvantages of gasification are the tar formations, dust production, operating and maintenance costs, sensitiveness of biomass collection, composition and preparation, and the obligation of gas-cleaning (Dilucia La Perna, et al., 2013).

By using *pyrolysis technology*, energy crops, wheat straw, bark, peat, chicken litter, sawdust, forest residues and wood chips are the main energy input for the plants. Pyrolysis is a thermochemical decomposition process in which organic material is converted into a carbon-rich solid and volatile matter by heating in the absence of oxygen (Dilucia La Perna, et al., 2013). The composition of the output from a typical pyrolysis process consists of 35-45% bio-oil, 30-40% biochar, and 20-30% syngas. The advantages of pyrolysis technology are that it enables flexible fuel production, power production and sequestration of carbon in char. The disadvantages of this technology bear a resemblance to the gasification technology. In addition to this, the greatest disadvantage of pyrolysis technology is low electricity generation. The economic viability of this technology also depends on the biochar market (Dilucia La Perna, et al., 2013).

b) Chemical Process – Anaerobic Digestion (Biogas Technology)

In the chemical process, crop residues, dairy cattle, poultry manure, pig manure, beef cattle, corn silage, molasses and sugar beet residues are used as input for the anaerobic digestion. This process is the decomposition of organic matter by bacteria in the absence of oxygen. It is the transformation of organic matter into biogas and a liquefied effluent. The process follows four steps: 1) Hydrolysis 2) acidogenesis 3) acetogenesis and 4) methanogenesis. By the end of anaerobic digestion, biogas (fuel), fibre (soil conditioner) and liquor (liquid fertiliser) are released as output. The biogas composition depends on the type of feedstock. Typical ranges of the composition are 55-70% methane and 30-45% carbon dioxide. The advantages of biogas technology are the high electricity generation, reduction in odour levels, reduction of land and water pollution. The disadvantages of this process are the risks of chemical reaction inhibition, feedstock collection and preparation, the seasonal variance of feedstock and the obligation of gas-cleaning (Dilucia La Perna, et al., 2013).

c) Thermal Process – Combustion

In combustion technology, wood chips, bark, forest residues, waste wood, rice hulls, sugar cane bagasse and switch grass are used as input to the process. Thermal combustion is the most common way of converting solid biomass fuels into energy and generation of high-temperature heat as flue gasses. The combustion technology is robust; biomass combustion for commercial and district heating has a great potential and can be used for large-scale plants. The main disadvantage of the technology is the low electricity generation (Dilucia La Perna, et al., 2013).

The investment cost of a woody biomass-fired plant is between 1.5 – 4 times higher than a conventional fossil-fired plant. These high initial capital costs stem from the necessity of large-scale caldrons and large-scale facilities to produce and store wood residues. Furthermore, the average yield of a natural gas or fuel oil burning engine is around 80%, whereas the yield of a woody biomass burning plant is not expected to be more than 75%. According to the calculations of the Turkish General Directorate of

Forestry, establishing a woody biomass power plant in a public institution is only economic if the electricity generation capacity of the plant is more than 10 MW. In an industrial factory, a power plant with a minimum capacity of 2.2 MW would be economical to operate. All in all, sole electricity generation from biomass is not efficient. Therefore, cogeneration (combined heat and power) systems can be preferred, which simultaneously generate electricity and heat.

Under current policies, which include settings regarding prices, capital investments and tariffs, profitable conditions for the cogeneration of heat and power (CHP) were defined. Nevertheless, based on the 2016 report of *Food and Agriculture Organisation of the United States,* the actual price of heat was not able to be procured, due to the lack of infrastructure for large heat distribution. Only the assessment of the electricity from CHP was possible. According to the analysis, the CHP plants need to operate using high efficiency technologies and utilising high-energy potential feedstock. Two distinct bioenergy pathways were implemented to analyse the electricity from CHP plants:

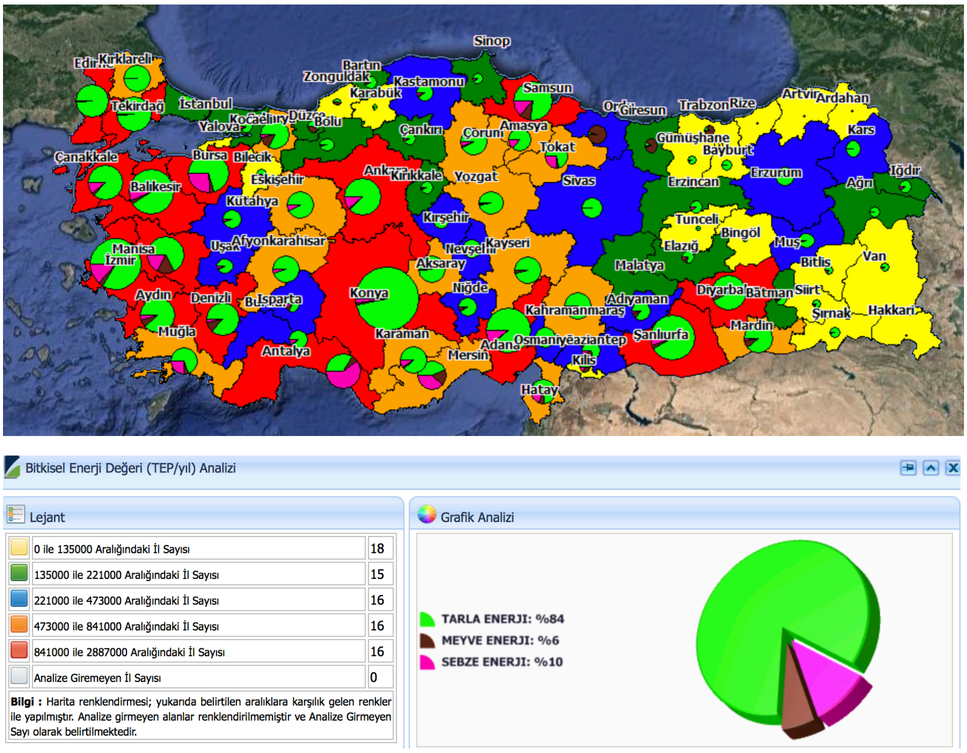
I. Direct residue combustion in CHP plants (crop residues – groundnut husk, pistachio shell, hazelnut husk, rice husk, maize cob, maize husk

II. Residues first converted into biogas (animal manures – cattle manure, poultry manure) and sunflower heads

I. Direct Residue Combustion

The Figure 22 shows the provinces with the potential of energy value from field crop, fruit and vegetable residues. The official data and map are provided by the Turkish Ministry of Energy and Natural Resources – Turkey Bioenergy Potential Atlas. The provinces with the highest amount of bioenergy value is shown in red and again in a larger format on the pie chart. It is possible to see the quantitative energy value of each province on the illustrated interactive map online via http://bepa.yegm.gov.tr. According to this data, the provinces with the largest amount of energy value from field crops are almost evenly distributed to Central, South and West provinces in Turkey such as; Konya (Central Anatolia - 2.8 mtoe), Izmir (Aegean - 2 mtoe), Balikesir (Marmara - 1.5 mtoe), Adana (Mediterranean - 1.4 mtoe), Sanliurfa (South Eastern - 1.4 mtoe), Samsun (Black Sea - 1.3 mtoe) Ankara (Central Analia - 1.2 mtoe) and Diyarbakir (South Eastern - 1 mtoe). Due to their low amount of energy value, the residues from fruits and vegetables are not considered in this analysis.

Figure 22. Electricity capacity generation (MW) from field crop residues



Data source: (YEGM, 2018).
Translation: Grafik Analizi (Graphical Analysis): Green area = Energy from field crops 84%, brown area: Energy from fruits 6%, pink area = Energy from vegetables 10%

Turkey has a wide range of field crops, naturally with different potentials of energy values. Based on the 2016 statistical data of the Food and Agriculture Organisation of the United Nations, the top 10 most promising field crop residues identified as potentially available and profitable are; hazelnut shell and husk, groundnut husk cotton stalk, maize cob and husk, pistachio shell, soybean husk, sunflower heads and rice husk (FAO, 2016). Under a set of specific production conditions and feedstock options, the briquetting and pelleting of these top 10 crop residues could be a promising option and future solution to substitute charcoal and fuelwood for heating and cooking purposes. It is fundamental to take into account the minimum required energy potential and the price ceiling for both briquettes and pellets after considering the region's charcoal and fuelwood consumption, as well as to what extent the competing industry has been established (FAO, 2016).

In order to assess the potential of major crop residues for generating electricity through direct combustion in CHP plants, Table 21 is provided.

Table 21. Energy potentials and collection cost for feedstock identified as available for bioenergy production

Feedstock	Energy potential (metajoule/kg)	Feedstock ($/tons)
Corn stalk	16.4	$276.0
Tobacco stalk	16.2	$201.3
Soybean stalk	16.7	$200.5
Sunflower stalk	13.6	$104.9
Rice straw	14.9	$104.1
Maize husk	17.4	$75.7
Cotton stalk	18.1	$23.6
Corn cob	17.7	$20.9
Rice husk	13.5	$19.0
Almond shell	17.0	$0.0
Groundnut husk	18.6	$0.0
Hazelnut husk	17.0	$0.0
Hazelnut shell	19.9	$0.0
Pistachio shell	17.7	$0.0
Soybean husk	15.5	$0.0
Sunflower head	14.5	$0.0

Data source: (FAO, 2016).

Total electricity output of CHP systems depends on two factors: Energy potential of feedstock and amount of heat converted into electricity (FAO, 2016). With respect to the profitability of crop residues, the most promising crops for the electricity generation are: Hazelnut shell, groundnut husk, cotton stalk, corn cob, pistachio shell, almond shell, hazelnut husk, soybean husk, sunflower head and rice husk. Nevertheless, in Turkey pistachio shell and almond shell, despite their promising profitability, are not available in sufficient quantities to supply minimum profitable sizes due to their energy potentials and cost. In line with this aspect, the most promising feedstock in terms of quantities, energy potential and cost are corn cob and corn husk. Adana, Osmaniye, Sanliurfa and Mardin provinces, located in Mediterranean and South-eastern Anatolian respectively, along with Sakarya province which is located in the Marmara region, would be the best options to establish large plantation areas, due to their adequate agricultural surface areas (see Table 22).

Table 22. Potential electricity generation capacities of CHP direct combustion system in provinces producing most promising residues

	Electricity Capacity									
Province name	Almond shell	Corn cob	Corn husk	Groundnut husk	Pistachio shell	Rise husk	Hazelnut husk	Soybean husk	Hazelnut shell	Total capacity province (MW)
Adana	-	25.8	7.0	0.8	-	-	-	-	-	33.6
Sanliurfa	-	17.2	4.7	-	2.0	-	-	-	-	23.9
Mardin	-	14.2	3.9	-	-	-	-	1.0	-	19.0
Sakarya	-	10.3	2.8	-	-	-	3.7	-	1.3	18.0
Osmaniye	-	10.6	2.9	0.6	-	-	-	-	-	14.1
Manisa	-	9.1	2.5	-	-	-	-	-	-	11.5
Samsun	-	3.0	0.8	-	-	3.0	2.9	-	1.0	10.8
Konya	-	8.2	2.2	-	-	-	-	-	-	10.4
Edirne	-	-	-	-	-	9.0	-	-	-	9.0
Kahramanmaras	-	6.1	1.7	-	-	-	-	-	-	7.8
Mersin	-	5.8	1.6	-	-	-	-	-	-	7.3
Ordu	-	-	-	-	-	-	5.3	-	1.8	7.1
Izmir	-	5.2	1.4	-	-	-	-	-	-	6.6
Aydin	-	5.2	1.4	-	-	-	-	-	-	6.6
Diyarbakir	-	4.5	1.2	-	-	-	-	-	-	5.8
Hatay	-	4.5	1.2	-	-	-	-	-	-	5.7
Bursa	-	4.2	1.1	-	-	-	-	-	-	5.3
Düzce	-	1.0	-	-	-	-	2.5	-	0.9	4.4
Giresun	-	-	-	-	-	-	2.9	-	1.0	3.8
Karaman	-	2.8	0.8	-	-	-	-	-	-	3.6
Gaziantep	-	1.3	-	-	2.3	-	-	-	-	3.6
Balikesir	-	0.7	-	-	-	2.7	-	-	-	3.4
Trabzon	-	0.6	-	-	-	-	1.7	-	0.6	2.9
Canakkale	-	0.7	-	-	-	2.0	-	-	-	2.7
Denizli	-	2.0	0.5	-	-	-	-	-	-	2.6
Kirklareli	-	1.1	-	-	-	0.5	-	-	-	1.6
Antalya	-	1.6	-	-	-	-	-	-	-	1.6
Corum	-	-	-	-	-	1.5	-	-	-	1.5
Kocaeli	-	1.1	-	-	-	-	-	-	-	1.1
Zonguldak	-	-	-	-	-	-	1.0	-	-	1.0
Amasya	-	1.0	-	-	-	-	-	-	-	1.0
Adiyaman	-	0.9	-	-	-	-	-	-	-	0.9
Siirt	-	-	-	-	0.8	-	-	-	-	0.8
Batman	-	0.8	-	-	-	-	-	-	-	0.8
Sinop	-	-	-	-	-	0.7	-	-	-	0.7
Tekirdag	-	-	-	-	-	0.7	-	-	-	0.7
Tokat	-	0.6	-	-	-	-	-	-	-	0.6
Mugla	-	0.6	-	-	-	-	-	-	-	0.6
Igdir	-	0.5	-	-	-	-	-	-	-	0.5
Bartin	-	0.5	-	-	-	-	-	-	-	0.5
Total Capacity Feedstock (MW)	-	151.7	37.7	1.4	5.1	20.1	20.0	1.0	6.6	243,6

Data source: (FAO, 2016).

Based on the given outcomes, it can be asserted that the use of high efficiency technologies producing heat and electricity is fundamental. Furthermore, the crops with high-energy potential should be chosen for generating electricity in the CHP plants. In addition to this, locally produced electromechanical and electrical equipment would be preferable due to cost efficiency and the provided additional premium from the Turkish authorities, which would additionally increase the business profitability (FAO, 2016).

5.5.4. Biogas (Methane)

Biomethane is methane sourced from renewable biomass such as organic waste, sewage, agricultural residues or energy crops. It has the major constituent in common with natural gas: methane. It can also be obtained from woody biomass like forestry residues through the production of synthetic gas (Strauch, et al., 2013).

Biomethane makes a significant contribution to climate protection and carbon dioxide emission reduction, as it is also a flexible energy carrier and can be used as electricity, heat and vehicle fuel (Strauch, et al., 2013). It also meets the main three principles by which Turkey's energy strategy stands: security of supply, sustainability, and competitiveness in energy terms. A legally binding biomethane target will reduce Turkey’s exposure to volatile fossil fuel prices. Hedging against such volatility is crucial as Turkey's import dependence is set to grow to more than 80% of oil and gas by 2035. Because the substrates for biomethane production are homemade or derived from internal processes, they can displace fossil fuel usage proportionate to its production and therefore enhance the security of supply (Strauch, et al., 2013). Locally-produced energy and stimulating technological innovation are the keys to develop competitive energy market and to increase employment opportunities (Strauch, et al., 2013). Similar to natural gas, biomethane can be used for household applications such as cooking and heating (Strauch, et al., 2013). Compared to other renewable heat sources, biomethane is one of the more expensive fuels. Nevertheless, it offers to operate an existing natural gas heating system with green energy. In rural households of Turkey, utilisation of biomethane for cooking and heating purposes could be beneficial as well as more environmentally friendly than direct combustion of biomass.

Biogas is the pre-stage of biomethane, which can be obtained from almost all kinds of wet organic matter with low lignocellulose content, e.g. organic waste, sewage sludge and manure by anaerobic digestion (Strauch, et al., 2013). Anaerobic digestion is

a natural process where bacteria acts upon the humid organic materials and decomposes them into biogas (Strauch, et al., 2013). The obtained biogas is cleaned of its impurities and upgraded, to increase the methane content (Strauch, et al., 2013). Biogas technology is used when there is some feedstock which cannot be directly burned in CHP plants due to their high water contention or high amount of ashes produced during combustion. In these cases, the most technically appropriate solution is the biogas option, to extract the energy potential contained in wet biomass (FAO, 2016).
To assess the profitability zone for the specific plant residues and animal manures, the realistic methane potential (RMP), biochemical methane potential (BMP) and feedstock costs are considered and illustrated in Table 22. According to the table, tea waste, draff, tomato ind., sunflower heads, molasses and beet press cakes are seen as the most profitable sources to be used in electricity production from biogas. The landfill option, which seems less profitable than the mentioned feedstock, is the most commonly used option in Turkey. The landfill has freely available feedstock (municipal solid wastes, organic wastes) and they are paid to dispose of the residues. Hence, they have additional credits which the other feedstock do not have. Notwithstanding this, due to its lower RMP, landfill is not as compatible as the other options like beef press cake or molasses (FAO, 2016).

Based on the further assessments of the Food and Agriculture Organisation of the United Nations' Bioenergy and Food Security Assessment, when the larger feedstock options are considered, it is shown that the traditional residues like sunflower heads and animal manures (such as cattle manure and poultry layer collected at slaughterhouses and dairy plants) give the most promising biogas production numbers for Turkey. Regarding the importance of dairy, poultry and sunflower industries in Turkey, a huge potential to utilise these biomass residues effectively is existent.

Table 23. Standard Biogas Properties and Estimated Collection Costs for Selected Biomass Residues

	RMP	BMP	Feedstock cost ($/tons)
Napier grass	70	274	50
Cattle blood	62	400	14
Beet press cake	59	300	0
Molasses	54	308	0
Cattle stomach	53	485	14
Poultry blood	51	343	14
Typical straw	51	170	50
Cattle-ind.	50	250	14
Catte-farm	50	250	41
Fruit pomace	50	189	35
Tomato field.	48	200	50
Tomato ind.	48	200	0
Draff	43	503	0
Poultry stomach	39	350	14
Tea waste	37	250	0
Landfill	29	206	0
Buffalo-farm.	23	230	55
Poultry layer	57	243	15
Buffalo-Ind.	14	230	14
Food waste	14	571	0
Milk whey	6	1,000	14
Sunflower heads	52	199	0

Data source: Own illustration based on the data from (FAO, 2016).

According to Table 24 Turkish provinces would achieve a total combined production capacity of 768 MW. 243.4 MW production is expected from CHP combustion plants for direct residues. Ultimately, Turkey will reach a total capacity of at least 1,011 MW generated electricity. This amount will be sufficient to meet Turkey's energy target by 2023 from biomass (FAO, 2016).

Table 24. Potential electricity generation capacities of CHP system in producing most promising residues

Province name	Electricity Capacity (MW)			
	Biogas from sunflower heads	**Biogas from cattle manure**	**Biogas from layer manure**	**Total capacity province (MW)**
Konya	32.5	34.1	10.2	76.8
Edirne	39.6	6.0	0.2	45.8
Tekirdag	39.1	5.6	0.7	45.4
Kirklareli	25.6	8.3	0.3	34.2
Balikesir	4.8	19.3	5.8	30.0
Adana	18.3	9.6	0.7	28.6
Ankara	5.5	18.1	3.9	27.5
Afyon	-	11.5	11.7	23.3
Izmir	-	17.7	4.1	21.9
Bursa	4.3	10.5	3.8	18.7
Erzurum	-	17.4	0.2	17.6
Kayseri	0.6	12.7	3.4	16.9
Samsun	4.8	9.7	1.3	16.0
Diyarbakir	-	14.4	0.5	15.1
Denizli	6.2	6.7	1.6	14.5
Kars	-	14.3	0.2	14.5
Aksaray	8.0	6.2	0.3	14.5
Canakkale	7.0	7.1	0.2	14.3
Manisa	-	5.7	8.4	14.1
Aydin	-	13.4	0.6	14.0
Gaziantep	-	12.6	1.3	13.9
Eskisehir	5.1	4.8	1.2	11.1
Amasya	3.6	5.8	1.2	10.7
Corum	5.7	4.6	-	10.3
Mus	-	9.6	0.3	9.9
Istanbul	5.9	2.8	0.9	9.8
Sivas	-	8.4	0.4	8.8
Yozgat	-	8.1	0.6	8.7
Tokat	4.6	3.7	0.2	8.6
Kastamonu	-	8.0	0.2	8.2
Agri	-	7.4	0.1	7.5
Kahramanmaras	2.2	4.7	0.3	7.2
Kirsehir	1.2	5.5	0.4	7.1
Ardahan	-	6.8	0.1	6.9
Mugla	-	5.6	0.5	6.1
Mersin	-	4.1	1.5	5.6
Van	-	5.1	0.3	5.4
Burdur	-	5.1	0.2	5.3
Igdir	-	4.4	0.1	4.5
Hatay	-	4.1	0.4	4.5
Kirikkale	0.7	3.2	0.6	4.5
Usak	-	4.3	0.1	4.4
Isparta	-	4.2	0.2	4.4
Nigde	-	4.0	0.4	4.4
Malatya	-	4.0	0.4	4.3

Electricity Capacity (MW)				
Province name	**Biogas from sunflower heads**	**Biogas from cattle manure**	**Biogas from layer manure**	**Total capacity province (MW)**
Kocaeli	-	3.8	0.6	4.3
Antalya	-	3.9	0.5	4.3
Karaman	0.8	2.4	1.1	4.3
Sakarya	-	3.1	1.2	4.3
Elazig	-	3.6	0.6	4.2
Trabzon	-	3.8	0	3.8
Kütahya	-	2.7	1.1	3.8
Erzincan	-	3.3	0.4	3.7
Cankiri	-	3.7	-	3.7
Sinop	-	2.9	0.1	3.0
Mardin	-	2.6	0.4	3.0
Düzce	-	2.2	0.3	2.6
Adiyaman	-	2.4	0.2	2.6
Bitlis	-	2.4	0.1	2.5
Gümüshane	-	2.4	0.1	2.5
Bolu	-	1.9	0.5	2.4
Bayburt	-	2.3	0.1	2.4
Bingöl	-	2.3	0.1	2.4
Giresun	-	2.1	0	2.1
Batman	-	1.9	0.2	2.0
Artvin	-	2.0	0	2.0
Nevsehir	-	1.3	0.7	2.0
Osmaniye	-	1.8	0.2	2.0
Karabük	-	1.7	0.2	1.9
Zonguldak	-	1.5	0.2	1.7
Ordu	-	1.3	0.2	1.5
Hakkari	-	1.0	0	1.0
Bartin	-	0.8	0.2	1.0
Sanliurfa	-	0.6	0.4	0.9
Tunceli	-	0.9	0	0.9
Siirt	-	0.7	0.1	0.8
Bilecik	-	0.4	0.2	0.6
Yalova	-	0.5	0.1	0.6
Kilis	-	0.5	0.1	0.6
Rize	-	0.4	0	0.4
Sirnak	-	0.3	0.1	0.4
Total Capacity feedstock (MW)	**226.1**	**460.6**	**80,3**	**768**

Data source: Own illustration based on the data from (FAO, 2016).

5.5.5. Case study: IZAYDAS Biogas and Waste Management Facility

As it is indicated, by global comparison, Turkey has one of the greatest livestock and agricultural potentials in the world. The country has the potential of 2,000 biogas plants, which could operate with animal manure. Nevertheless, there are some challenges, which constitute an impediment to biogas potential being realised. First of all, the authorisation process to run an anaerobic digestion facility is complex and includes many steps, such as application, examination, evaluation, approval and licencing. Second, the current situation with respect to the central grid connection applications (electricity, gas, pipeline) of biogas plants is still not clearly addressed in the law. There is also a lack of necessary regulations concerning the properties and methods of use of the solid product (digestate) resulting from biogas plants. Third, the public perception and social acceptance regarding the positive contribution of biogas facilities to energy and climate remains low.

Considering this information, many agricultural wastes in Turkey are still largely underutilised and left to rot or openly burned in the field. Animal manure is utilised directly in the area without undergoing any processing or cumulated in the open field. Both methods and techniques cause serious health problems and increase environmental pollution.

For the purpose of utilising agricultural, animal and agro-industrial residues, a biogas power plant with name “IZAYDAS” was established in the north-western part of Turkey. The facility is a waste and residue treatment, incineration and utilisation company, in operation since May 1996 in Kocaeli, an industrial metropolitan city in the Marmara region. The scope of the IZAYDAS biogas project is to develop biogas production systems suitable to agricultural and animal residues with high efficiency and low cost, to integrate these systems with internal combustion engines and to mainstream the biogas production technologies across the country (IZAYDAS, 2014). The annual input of the biogas plant, fed from agricultural and animal wastes, was 3,025 tonnes in 2015. The input came from the grass residues (29 tonnes), fruit and vegetable market residues (2 tonnes), poultry manure (134 tonnes), waste from inside of tripe (148 tonnes), cattle manure (2,593 tonnes), and other residues (119 tonnes). In addition to 155 cubic meters per hour biogas, 350 kilowatts electric power and 350 kilowatts heat is obtained from a gas motor. Furthermore, 2,023 tonnes of very high quality organic solid fertiliser and liquid fertiliser (2,019 tonnes) have been achieved as an outcome in the facility. For the electricity generation in the facility, a production license was obtained from the EPDK as of 12.01.2012 for a period of ten years. A part of the obtained electric power is used for facility needs and the remainder is given to the national electric distribution grid. In the cogeneration unit, released heat energy is used for heating the reactors and remaining parts are used for the other heating needs of the facility. In 2014, 400 MWh electricity was generated by the biogas plant from the given quantity of wastes in Table 25 (IZAYDAS, 2014).

Table 25. Quantities of the wastes taken to the facility and outgoing fertiliser (Unit=kg)

Waste type	2012	2013	2014	2015	2016
Grass	648,720	760,330	698,960	29,680	3,260
Poultry Manure	260,200	162,820	152,780	134,920	67,630
Cattle Manure	2,972,560	1,783,190	3,865,830	2,593,910	2,808,640
Fruit/Vegetable Market Residue	1,406,670	370,390	157,270	2,200	15,140
Waste from Inside of Tripe	315,510	242,690	224,860	148,680	86,000
Other	132,440	62,910	67,275	119,300	131,000
Total	**5,736,100**	**3,382,330**	**5,166,975**	**3,028,690**	**3,111,670**

Data source: Own illustration based on the data from (IZAYDAS, 2015).

Arzu Ulutas, the responsible person for the recycling department at the IZAYDAS facility, explained that the major problem for the biogas facilities in Turkey is the lack of necessary regulations and frameworks regarding the operation of a biogas plant. IZAYDAS established one of the first biogas facilities in Turkey without any legal regulations, which would explain the obligatory issues surrounding the operation of the biogas facility. There is an ongoing problem regarding transportation of wastes to the facility, for which it is obliged to provide services. Consequently, this causes the waste transportation service operations to become very costly.

The IZAYDAS corporation has facilities in the fields of clinical and hazardous waste incineration and energy production, hazardous waste landfilling, domestic industrial waste landfilling, medical waste sterilisation, domestic landfilling and energy production, marine waste management, excavation wastes storage, biogas and integrated power generation, laboratory services, waste transportation services, and electricity generation from the wind. In the facility, between 1997 and 2015, a total of 382,305 tonnes of hazardous waste were accepted to the incineration plant, and 363,574 tonnes of this were disposed of. During the disposal, 207.3 GWh electricity was produced, and 82.1 GWh of this sum are sold to TEIAS (IZAYDAS, 2015).

Table 26. Produced, Consumed and Sold Electricity in Izaydas Incineration Plant

Izaydas Incineration Plant	Unit	2012	2013	2014	2015	2016
Incoming waste to incinerator	ton	37,209	30,815	31,837	24,499	39,964
Incinerated waste in facility	ton	33,374	32,533	31,289	30,232	35,028
Produced electricity amount	kwh	16,890,700	14,988,900	12,093,500	16,010,500	16,594,500
Received electricity amount	kwh	1,163,020	1,052,250	2,735,187	1,121,810	837,658
Consumed electricity amount	kwh	9,427,860	9,020,200	11,258,447	11,553,163	11,987,638
Sold electricity amount	kwh	8,625,860	7,020,950	3,570,240	5,579,147	5,444,520

Data source: Own illustration based on the data from (IZAYDAS, 2016).

In 2016, 39,964 tonnes of waste were disposed of in the incineration plant and 16,594,500 kwh of electrical energy were generated in return (Table 26)(IZAYDAS, 2016). 11,987,638 kwh electricity were consumed within the facility and 5,444,520 kwh of electric energy were sold to the national grid network – TEIAS.

Waste management systems development has never been a priority policy area in Turkey. The first significant step was made towards a successful waste management after the "by-law on solid waste control" was adapted in 1991. Following this, some other enactments came into force, to set the necessary framework for the waste management in the country. Turkey aims to establish a waste management system in accordance with the related national and EU legislation addressing the establishment of necessary waste treatment facilities (pre-treatment facilities and landfills) and transfer stations, reduction of the amount of waste, ensuring recycling and re-use, and reducing the waste transportation costs (Bakas, et al., 2013).

Turkey still does not have a developed and fully functioning waste-management and waste-disposal system. At least half of the total population of around 73 Million does not have access to any waste disposal/recovery and wastewater treatment services, they are thereby being exposed to serious health threats and environmental damage. Furthermore, 44% of the municipal solid waste is still dumped into open dumping sites of municipalities, therefore allowing the release of the very potent greenhouse gas methane into the atmosphere causing explosion risks.

Besides disposing of combustible plastic wastes, used oils, pharmaceutical and cosmetic wastes, petrochemical wastes, PVC, solvent, dye wastes, glues, adhesives and treatment sludge, the 5,400 kg p/hr capacity of clinical and hazardous waste incineration plants also generates electrical power. A part of the generated power is used by the plant and the remainder is sold to the national electric distribution network. In 2015, 30,232 tonnes of waste was disposed of by incineration, which generated 16.0 gWh electric energy. 11.5 gWh from this generated power were used in the facility. The remaining 4.5 gWh of generated electric power was sold to TEIAS, 1.1 gWh of which were purchased (IZAYDAS, 2015).

In the past, incineration was considered as the most efficient way to get rid of waste. Nevertheless, since the beginning of worldwide industrialisation, the structure of waste management has massively changed. Today, the mass-production of chemicals and plastics make the incineration method a more complex, costly and high polluting disposal method. In contrast to the fallacy that incineration is the most efficient waste disposal method, incineration is transforming the waste problem of Turkey to a mortal threat of pollution.

Incineration facilities release a high amount of dioxin, furan, sulphur, nitrogen oxides, lead and other heavy metals into the environment. Moreover, these plants are becoming an easy way for the industries to cover up their waste product issues and thus clear up their "from the cradle to the grave" responsibilities for their products. The industries are then able to continue their extravagant production process (Greenpeace Akdeniz, 2005).

5.5.6. The Environmental Impacts

Up until now, many studies and policies focused on liquid biofuel production systems and quantifying the greenhouse gas emissions associated with direct and indirect land-use change (REN21, 2014). Currently, the focus of the carbon footprint debate of biomass shifted to the increasing use of solid biomass – forest biomass in particular – in modern applications (for instance, wood chips in district heating for dwellings or co-firing of wood pellets in coal-fired power plants) (REN21, 2014). As indicated in the "Renewables 2014 Global Status Report", there is a general concern among stakeholders that carbon emission through the combustion of biomass will be segregated, if the quantity of biomass used can be associated through the regrowth of a crop or forest in a sustainable biomass management system (REN21, 2014).

According to the World Bioenergy Association's newly published fact sheet on forest sustainability and carbon neutrality, the use of forest biomass is carbon neutral because the carbon contained in wood originates from the atmosphere and is released to the air by wood decay or combustion. Before a tree can be burned, it has to grow by absorbing carbon from the atmosphere (World Bioenergy Association, 2012). However, by burning fossil fuels like coal oil and natural gas, the process is accelerating and thus releases vast amounts of carbon into the air, which is not part of the "natural" carbon cycle (World Bioenergy Association, 2012). Furthermore, future carbon payback times could be shortened by increasing crop yields, changing petroleum sources and improving biofuel technology (Gibbs, et al., 2008). Bioenergy crops can reduce greenhouse gas emissions by removing carbon dioxide from the air and storing it in crop biomass and soil. In addition to biofuels, these crops generate co-products such as protein for animal feed (FAO, 2008).

Regarding energy production, the utilisation of some open-fire traditional stoves is quite inefficient. From the point of health and environmental concerns, it has considerable debilitative impacts, due to the released smoke and carbon emissions.

5.5.7. Public Awareness and Social Acceptance

Energy from biomass represented 3% of the total primary energy consumption in Turkey in the year 2015. In general, it is quite difficult to evaluate how high the knowledge or awareness is regarding bioenergy in Turkey, as there is almost no relative data. Even the representatives from the Directorate General for Renewable Energies in Turkey could not give concrete, quantitative data regarding how the public perception in Turkey is concerning the energy production from the biomass sources. The only available data was the survey, performed by the Kadir Has University, Istanbul, Turkey, regarding the public perception of Turkish citizens regarding the utilisation of renewable energy sources. According to the 2016 survey results, although many of the respondents are not particularly aware of the meaning of bioenergy (20%), they support the construction of a bioenergy power plant as much as they support solar or wind energy power plants close to the area in which they are living (28.3%).

5.5.8. Results and Outcomes

Turkey has a substantial amount of wide range biomass sources for the production of biomass-based energy as well as biofuels. In terms of biomass-based energy production, two main agricultural residue types were considered: **crop residues** (collected or spread) and **livestock residues** (cattle, buffalo and chicken manure). In general, western provinces show a greater availability potential of **crop residues** than the eastern provinces. Due to the lack of data on the current utilisation of livestock residues, the analysis solely estimated the total residues produced at the provinces of Turkey and not their availability. In this context, **cattle manure** seems to be equally distributed among provinces. Notwithstanding this, the Eastern and Central Anatolian regions have the largest share of manure, followed by the Aegean, Black Sea and Marmara regions. Konya (Central Anatolia), Balikesir (Marmara), Erzurum (East Anatolia), Izmir (Aegean) and Kars (East Anatolia) provinces have the largest production of **cattle and buffalo manure**, each with production of more than 4 million tonnes of manure annually. The highest amount of chicken (layer and broiler) residues were found in Manisa (Aegean), Balikesir (Marmara), Bolu (Black Sea), Afyon (Aegean) and Sakarya (Marmara) provinces, whereby each produces more than 600,000 tonnes of manure per annum. Manisa produces the most **chicken manure**, with annual production of 1 million tonnes each year (FAO, 2016).

The energy production from biomass resources remain in exceptionally low levels in Turkey due to the lack of necessary regulation as well as legal framework, government incentives and low public awareness. Even the Directorate General for Renewable Resources (YEGM), the only official responsible authority in Turkey, does not have the relevant information, data or publication regarding future forecasts of biomass energy. Despite the proven potential as explained above, the electricity production from biomass as well as biogas remain idle. In order to tackle this challenge, it is important that the YEGM produces more data about biomass energy in order to increase the social awareness and the number of local biomass power plants. In addition to this, the necessary framework for the electricity generation from biomass resources needs to be prepared by the relevant government authorities.

5.6. Solar Power

The energy from the Sun is the source of all types of energy resources, either directly or indirectly. Solar energy occurs from the fusion process in the Sun, where Hydrogen combines to form Helium. It is the conversion of radiant energy of sunlight, which is used for electricity and heat production. This thesis focuses on the electricity generation from solar energy, and not particularly on the heat generation. For the electricity generation, solar PV is the conversion technology uses solar radiation by photovoltaic cells. Solar thermal power generation systems collect and concentrate sunlight to produce the high temperature needed to generate electricity (EIA, 2018).

There are different methods to utilise energy from solar radiation. The easiest and most direct application of solar energy is the conversion of sunlight into low-temperature heat. In low-temperature heating application, passive and active solar energy conversion technologies can be implemented. Solar collectors are used for the active conversion of solar energy to heat (Benli, 2016). This technology is commonly used in Turkey as flat plate collectors in the domestic hot water systems due to the low cost of operation, such as solar hot water systems (Capik, et al., 2012). Capturing solar energy is the main feature of this method (mostly used in the sunny coastal regions) that can reduce electrical consumption (Capik, et al., 2012).

5.6.1. Solar-Photovoltaic (PV) Power Generation in Turkey

Photovoltaics is the method of obtaining electricity from the sun through silicon crystals. Currently it is the most popular technology among other solar power technologies, which generates electricity with the photo-voltaic effect. Basically, the PV system uses a thin sheet of semiconductor material, which consists of two layers: n-type and p-type layer. These two different types of layers are used to form a junction at the interface of the sheet. An internal electric field at the junction is created, electron hole-pairs are generated by the solar photons in the electric field, which creates negatives charges on one side and positive charges on the other side of the interface. The charge separation creates a voltage and current flows lead to the generation of electricity (Yazici, 2017).

A PV system can be installed either as an off-grid application or as a grid-connected application. If the system is installed as off-grid, so it has no connection to a national power grid. Off-grid applications lead PV systems to be preferable, especially in the non-electrified areas since the size of the system is adjustable for individual consumer applications. The grid connected systems have connection to national grid, whereby the electricity generated can be transmitted to the electricity network. The most popular PV panel installations are roof-top and ground-mounted panels (Yazici, 2017). In Turkey, all regions except for the Eastern Black Sea region is suitable for the electricity generation from Solar PV technology.

The potential of the photovoltaic market in Turkey is colossal, the country has a significant amount of solar radiation and vast areas for solar farms (Capik, et al., 2012). Due to the high installation costs of photovoltaics, the economical usage of them is not available in Turkey (Benli, 2016). Only the Ministry of Environment and Forestry (forestry observation towers), Turkish Telecommunication Companies (transfer stations), the Highway Board Department (emergency calling, traffic management systems), EIE Group (demonstration applications) and various research associations have a common installed photovoltaic capacity of 300 kV (Benli, 2016). Nevertheless, due to the lack of interest of Turkish authorities, Turkey does not have an organised commercial and domestic photovoltaic program, which ultimately hinders the electricity generation of photovoltaic.

5.6.2. Concentrating Solar Power (CSP) Technology

CSP technologies, also known as solar thermal electricity, lead to collect direct-beam solar irradiance and use it to heat a liquid, solid or gas material. The heat energy stored in the semi-conducting material is used in the engine heating process to generate electricity (Yazici, 2017). In Turkey, South-eastern Anatolia (examined on a regional basis) is the most fertile region while the Black Sea is the most inefficient region regarding the use of CSP technologies (Kaplan, 2015).

There are various advantages of using CSP technologies. One of the main advantages is that the system has a wide range capacity, contrary to solar PV systems. They can range from small distributed systems to large centralised power stations. The materials used for the CSP technology are also common and accessible. The expectations show that worldwide, the installation and the investment costs of CSP systems will decrease by 2050.

5.6.3. Solar Thermal Energy Technology

Solar thermal energy can be classified as active solar heating or cooling technologies and thermal storage. In solar heating technologies, solar irradiance is transformed into heat with solar collectors. Afterwards, the heat is transferred with a carrier fluid to a storage tank, which is insulated to store heat (Yazici, 2017). There are two types of solar water heating systems: active and passive. In the passive solar water heating system, the water is heated with and stored inside the collector. Passive solar water heaters are much more environmentally friendly and low cost, however, they are not the ideal technology for the colder seasons. In active solar water heaters, carrier fluid circulation is controlled with electric pumps and controllers (Yazici, 2017).

Solar cooling technologies can be classified under three categories:

In *solar electric refrigeration*, PV panels are used for the power necessity of conventional refrigeration machines.

In *solar thermal refrigeration*, solar thermal energy is used to produce a refrigeration effect with solar mechanical compression, solar absorption or solar absorption refrigeration.

Solar thermal air conditioning is the system fir dehumidification of the air in air-conditioning units (Yazici, 2017).

Thermal storage technologies can also be classified as sensible, latent, sorption and thermochemical.

In *sensible* heat storage systems, a material with a heat capacity is used.

Latent heat storage stores the energy generated from a phase change of a material.

In a *sorption* heat storage system, a sorption material is used for either absorption or adsorption to store heat transferred from water vapour.

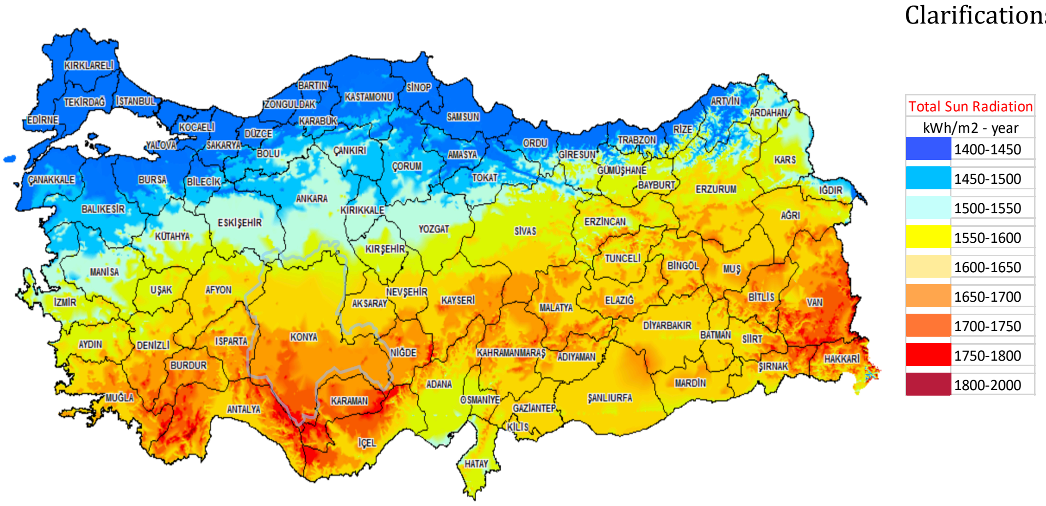
Thermochemical heat storage systems use endothermic chemical reactions to store heat.

5.6.4. Solar Energy Generation in Turkey

Due to its geographical location, Turkey is a lucky country regarding its potential for solar photovoltaic energy (Map 10). The country receives an average sunshine duration of 7.2 hours per day and solar radiation of 3.6 kwh/m^2. The total annual radiation period is around 2,610 hours. With regard to duration of the sunshine (8.2 hours/day) and solar radiation (4 kwh/m^2/day), the South-eastern Anatolia Region has the highest solar energy potential, followed by the Mediterranean Region in second place. Despite having immense potential, the energy generation from solar is only practiced by flat plate solar collectors. Major demand for the utilisation of solar collectors comes from low-income households in particular. Moreover, a growing share is being installed on large apartment buildings, hotels, hospitals and military accommodation places, which are predominantly located in the sunny coastal regions to produce domestic hot water for their facilities (Benli, 2016).

Map 10. The Solar Power Radiation in Turkey

Clarifications:



Data source: (YEGM, 2018).

Solar technology in Turkey has experienced a fast growth rate during recent years. In 2015, energy consumption from solar energy was 0.65 twh, which is 329% higher than 2014 consumption levels (Yazici, 2017). The expectations from a Greenpeace Turkey Report assert that solar power industries will maintain a growth rate of 35% in the renewable energy sector (Greenpeace International, 2015).

In a global comparison, Turkey ranks among the top countries with its solar collector areas and installed capacity. Turkish industry has also a significant experience regarding the production and marketing of the solar water heating system.

Similar to the other renewable sources, the responsible law for solar energy, which provides the basic legal framework for the support of renewable energy, is the *YEKA Law No. 5346 on the Utilisation of Renewable Energy in Electricity Generation*. TEIAS, as the system operator, tenders the grid capacity for solar energy projects and is in charge of the feed-in-tariff collection and distribution. Moreover, regional governments, such as provincial administrations, municipalities and governors, are in charge of granting construction and operation licenses for solar generation facilities (IEA, 2016). Turkish feed-in tariff for photovoltaic currently stands at $13.3 kwh. Nevertheless, the photovoltaic sector in Turkey is still not sufficient enough to provide for a high number of employees. Based on the legislation, the photovoltaic power plant installations cannot be built in the agricultural areas. Furthermore, the land use for photovoltaic plants is limited to 20 acres/MW (Guden Law Firm, 2016).

Solar photovoltaic technology initially gained popularity in Turkey in 2011 and achieved a considerable growth rate in the years following. Still, the developments in solar photovoltaic installations remain low despite its high potential. The technologies used in Turkey are PV solar power, CSP and solar water heating. At the end of 2016, total installed capacity for PV power and CSP were 832.5 MW and 1 MW, respectively (Yazici, 2017). In the global level, Turkey has the second highest solar water heating capacity. The most commonly used type are flat-plate collectors for domestic hot water usage. The thermal collectors are generally used in the Aegean and Mediterranean regions.

In 2015 solar energy contributed only 0.7% to total primary energy supply and 0.2% to electricity generation of Turkey. With respect to the vision 2023 goals of the Turkish MENR, 3,000 megawatts solar photovoltaic installations are planned to be installed by 2023. Nevertheless, only solar projects up to 600 megawatts will be licensed, which prevents the development of large-scale PV installations. The Turkish MENR's estimations concerning solar installed capacity were first increased to 300 MW in 2015, 1,800 MW in 2017 and 3,000 MW in 2019. Nevertheless, the country's solar installations only increased to 571 megawatts in 2016, which was far from the country's 1,800 MW target in 2017 (Tsagas, 2015). Moreover, the increase in distributed electricity generated from solar photovoltaic will require investment in the distribution grids and smart grid management (IEA, 2016). The 2013 Electricity Market Law set limits for solar photovoltaic and wind power plant expansion and created a framework for a gradual expansion of renewable energies, in order to prevent excessive amounts of costs and to benefit from technology learning curves during the expansion of local manufacturing supply chain (IEA, 2016). This limitation stimulated solar and wind energy power plant companies and investors to compete for grid access in case of limited grid capacity. This can be identified as one of the main reasons why the development of solar photovoltaic is much slower than the other renewable sources. The wind power plant projects are, in contrast, far larger than most of the solar photovoltaic plant projects and thus have more acceptance to being installed quickly and with larger amounts of capacity (Tsagas, 2015).

5.6.5. Environmental and Social Obstacles of Solar Power Plants

Despite its significant contribution to the total primary energy supply of countries, and range of utilisation areas (especially in water and greenhouse heating) solar photovoltaic plants may have potential environmental impacts on land use, water use, habitat loss and life cycle global warming emissions.

Larger utility-scale solar facilities can raise concerns about soil degradation and habitat loss. Unlike wind facilities, there is less opportunity for solar projects to share the land with agricultural uses. To reduce the adverse impacts on the land, it is essential that the large utility-scale solar systems are built at lower-quality areas such as brownfields, abandoned mining land, or existing transportation and transmission corridors. Small-scale solar photovoltaic systems can be sited on homes or commercial buildings, where the impact on land use is relatively slight (Union of Concerned Scientists, 2013). For CSP technology, habitat disturbance is also a problem. Concentrated light beams can also be a risk for avian animals.

Solar photovoltaic does not use water for generating electricity. However, concentrated solar thermal plants, like all other thermal electric power stations, require water for their cooling process (Union of Concerned Scientists, 2013), which may cause water scarcity or contamination problems. The photovoltaic cell manufacturing process includes some hazardous materials and chemicals which include hydrochloric acid, sulphuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane and acetone. Thin-film photovoltaic cells contain more toxic materials than the traditional silicon photovoltaic cells, including gallium arsenide, copper-indium-gallium-diselenide and cadmium telluride. If these materials are not disposed of properly, they can pose serious environmental and public health threats (Union of Concerned Scientists, 2013).

There are no global warming emissions detected associated with generating electricity from solar energy. Nevertheless, there are other features, which cause warming emissions like manufacturing, materials transportation, installation, maintenance, decommissioning and dismantlement (Union of Concerned Scientists, 2013).

Turkey is a country with high agricultural activities; agricultural lands compose 49.7% of total land area in Turkey. As solar energy requires placement of solar panels over large areas, a new solar farm have a high possibly to be built on an agricultural area. Additionally, Turkey is coping with deforestation. Currently, only 14.9% of total area is represented by forests. Accordingly, agricultural and forest lands may pose difficulties for solar farm permits (Yazici, 2017).

5.6.6. Public Perception and Social Acceptance of Solar Power

Based on the survey results, performed by (Ertör Akyazi, et al., 2012), almost two-thirds of the 2,422 residents from Urban Turkey supports investment in renewable energy resources (particularly solar and wind), while only a small minority are opposed to it.

According to the 2016 survey results performed by the Kadir Has University, Istanbul, Turkey, 11% of the respondents use solar energy for their heating purposes. 100% of interviewees pay a 100 Turkish Lira bill for using the solar energy. Among the other energy sources, solar energy is identified as the cheapest (Table 27).

Table 27. The share of respondents regarding the amount of monthly spend for consuming a particular energy source

Which type of energy do you consume monetarily at home at most?	**How much do you monthly spend for consuming this particular energy source?**						
	<50 TL (%)	50-100 TL (%)	100-150 TL (%)	150-200 TL (%)	>200 TL (%)	No answer	Nr
Electricity	2.8	30.9	33.4	18.0	13.9	1.0	599
Natural gas	0.4	4.7	24.5	20.9	48.4	1.1	465
Coal	0.0	26.6	34.2	10.1	27.9	1.3	79
Wood	0.0	43.6	30.8	7.7	15.4	2.6	39
Petroleum products	0.0	8.3	8.3	8.3	75.0	0.0	12
Bottled gas	0.0	12.5	25.0	0.0	62.5	0.0	8
Solar	0.0	100.0	0.0	0.0	0.0	0.0	1
Total	1.6	20.6	29.6	18.0	29.1	1.2	1204

Data source: (Ediger, et al., 2016).

Further survey results demonstrate that the respondents thoroughly support the construction of solar and wind power plants in their local areas. Despite the deforestation thread, as both power plants need a larger area to be installed, the social acceptance regarding solar and wind power plants remain positive (Table 28).

Table 28. The social acceptance regarding the utilization of renewable energy sources

%	Definitely no Support	No Support	Neutral	Supports	Definitely supports	No answer
Nuclear	32.5	17.1	14.2	20.7	5.9	9.6
Hydroelectric	13.8	11.2	14.4	34.9	15.5	10.6
Solar	0.9	2.1	7.2	28.7	57.3	3.8
Wind	0.8	1.6	6.6	28.9	57.3	4.8
Bioenergy	6.3	6.6	16.1	28.3	21.8	20.9
Coal	28.1	17.8	20.7	21.2	5.3	6.9
Natural gas	4.4	4.9	16.5	41.5	27.3	5.4
Geothermal	4.8	6.7	15.1	32.2	26.0	15.2

Data source: (Ediger, et al., 2016).

5.6.7. Results and Outcomes

Owing to its climate conditions and geographical location, the Aegean and Mediterranean Regions of Turkey have particularly substantial potential for electricity production and heat generation from solar power. Despite this immense potential for solar power across the country, there are still no large-scale solar power installations. Solar energy is mostly used for water heating, greenhouse heating and for drying agricultural products. In its vision 2023 targets, the Turkish government aims to reach 3,000 MW electricity generation from solar energy. Despite its 571 MW installed solar photovoltaic capacity and rapid installations in the last years, reaching the energy target does not seem feasible.

Solar-photovoltaic creates more employment opportunities in comparison to other renewables, in the construction, maintenance, installation and operation stages. Therefore, incentives, feed-in-tariffs and purchase guarantees by the state authorities play an important role to promote the construction of large-scale solar photovoltaic panels and power stations. The MENR determined a purchase guarantee through feed-in tariff spanning at latest up until 2020. In order to accelerate the electricity generation and promote further investments, prolonging this guarantee is crucial. The regulatory uncertainties and bureaucratic inefficiencies in providing licensing and permits for solar power installation must be eliminated.

6. UNCONVENTIONAL ENERGY RESOURCES IN TURKEY

Unconventional reserves, consisting of tight gas, shale gas and coalbed methane are found in geological formations which are peculiar for conventional natural gas; respectively tight sands, shale formations and coal beds (Turkish Review, 2014). Every shale reservoir has its unique geological structures which determine its production capacity, water consumption and even greenhouse gas emissions level (Turkish Review, 2014). Therefore, adequate knowledge of the geologic structure of the shale reservoir is crucial to estimate costs and keep them under control. On the contrary, conventional gas wells have a relatively stable lifespan, whereas shale gas wells give their maximum production during the first two years, followed by a steady decline (Turkish Review, 2014).

In order to extract shale gas the "hydraulic fracturing" method is frequently used. Fracturing is a water-intensive procedure, which raises many environmental challenges, particularly in water-scarce areas. Contrary to popular myth, Turkey is neither a country with plenteous freshwater resources, nor is it the richest country in the region. The country has only about one-fifth of the water available per capita in water rich regions compared to North America and Western Europe (MFA, 2011). The country has already been suffering from a general shortage of water and high soil salinity. This problematic issue will continue as long as the lakes and wetlands of the country continue to diminish because of unrestricted irrigation. Furthermore, Turkey does not have a compatible and sustainable water management policy. Due to the great receding of water levels in the Central Anatolia region, the Lake TUZ and the Tersakan, Bolluk and Kulu Lakes around it, along with the Eşmekaya wetlands, have all come to the verge of complete desiccation. Because Turkey's agriculture sector is heavily dependent on constant freshwater supplies and its agricultural productivity is substantially dependent upon sustainable irrigation, the agricultural sector would very likely be heavily affected by the shale gas production (Turkish Review, 2014).

The hydraulic fracturing process often requires complicated and highly developed extraction technology (e.g., dewatering coalbed-methane wells, massive fracturing programs for shale gas and different mining activities). Due to the technological shortage, drilling costs in Turkey might be high and vary between $5 million and $24 million per horizontal well under hydraulic fracturing (Turkish Review, 2014). According to Ibrahim Palaz, an energy expert at Hazar Energy Institute, Turkey has not done scientific research on its shale gas reserves. He further declares that there is no Turkish company technologically capable of accomplishing shale gas extractions through the fracturing method. Since each unconventional hydrocarbon well has its own individual geological formation, it is hard to foresee Turkey's shale gas price. While shale gas is unlikely to be cheaper than Russian or Azerbaijani imports, it might be less expensive than Iranian gas (Turkish Review, 2014). Moreover, the level of unconventional hydrocarbon exploration can be challenged by high investment/operational costs and technological challenges. Furthermore, there are enough companies in the sector with sufficient know-how about the hydrocarbon exploration process.

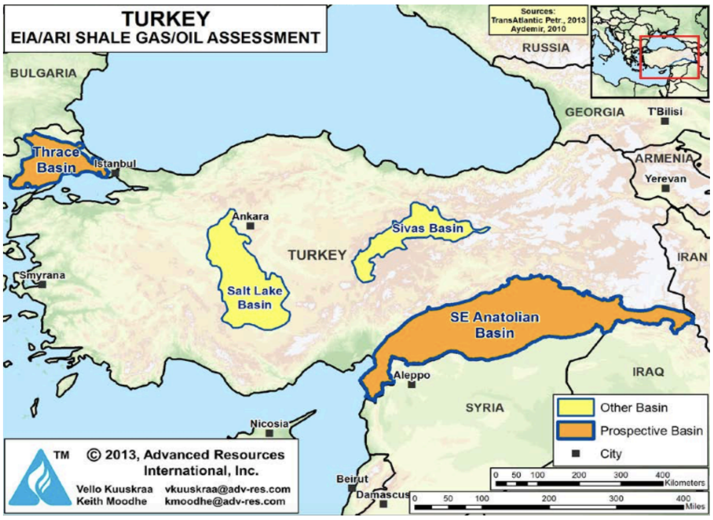
6.1. Shale Gas and Hydraulic Fracturing in Turkey

The combination of two old technologies – horizontal drilling and hydraulic fracturing (fracking) has resulted as a "drilling renaissance" for the shale gas extraction. The shale gas is trapped in thin layers between the rocks und cannot flow through the well by drilling alone. Hence, in order to extract natural gas trapped in shale formations, the producers deployed fracking method, which is able to pump millions of gallons of water, sand and chemicals at high pressure to clear the way and allow oil and gas flow (Sergie 2013). Although natural gas is cleaner and emits lower levels of carbon dioxide than coal or oil, the fracking method has a negative impact on the environment, especially on water (Sergie, 2013). The harmful chemicals mixed with water and injected into wells may leak if the wells are poorly constructed. When the fracturing is done, drillers remove the wastewater, which is then safely disposed of or re-used (Sergie, 2013).

A survey of the EIA about the technically recoverable shale oil and shale gas resources worldwide, show that USA, China, Argentina, and Algeria possess a significant amount of shale gas resources. Furthermore, more than half of the world's shale oil resources are located in Russia, China, Argentina and Libya. Countries like Turkey, Poland and Ukraine, which possess fewer shale resources, see it as potential game changers to reduce their dependence on conventional gas exporters such as Russia and Iran (Sergie, 2013).

Turkey is looking forward to exploiting the estimated 4.6 tcm of shale reserves that have been detected in the country (Kashi, 2013). The country sees shale gas as a potential boom to cut down on its energy bills in the future and focuses predominantly on two shale basins: The South-east Anatolia Basin in southern Turkey and the Thrace Basin in western Turkey (Map 11). Turkish Petroleum and some other international companies actively pursue shale oil and shale gas exploration activities on these two basins. Among them, Turkey may also benefit from shale gas resources in Sivas and Salt Lake basins (EIA, 2013). The available reserves needed for new energy supplies and new cutting-edge technologies galvanised high interest in Turkey's unconventional hydrocarbon potential. Oil and gas production from shale coalbed-methane and other sources can potentially satisfy a considerable amount of Turkey's energy appetite (Turkish Review, 2014).

Map 11. Major shale basins of Turkey



Data source: (EIA, 2015).

With reference to the estimations of EIA and Resources Internation, Inc. (ARI) in 2013, the Dadaş Shale in the South-eastern Anatolian Basin and the Hamitabat Shale in the Thrace Basin contain 163 tcm of risked shale gas in-place, with 24 tcm as the risked, technically-recoverable shale gas resource (see Map 11). Additionally, these two shale basins contain 94 billion barrels risked shale oil in-place, with 4.7 billion barrels as the risked, technically-recoverable shale oil resource (EIA, 2015).

Royal Dutch Shell Plc (RDSA), TransAtlantic Petroleum Ltd. and Valeura Energy Inc. are the explorers to drill shale rock in Turkey that holds as much as 4.6 tcm of gas and 94 billion barrels of oil, according to the EIA's 2013 report (Bauerova, 2014). Turkey is an attractive country for these companies because the government has so far avoided all environmental protests that have hindered the development of shale gas in

Europe. Yvonne Telford, an analyst at Wood Mackenzie in London, assumes that the country's expanding balance of payment deficit and the weakening of Turkish Lira led the government to amend its natural resources law, in order to pave the way for the international explorers (Bauerova, 2014).

The basins with estimated shale reserves in Turkey are as follows:

I) *The South-east Anatolian Basin* is an active and primarily oil-prone basin, which encompasses around 100 oil field discoveries to date (EIA, 2013).

II) *The Silurian Dadaş Basin* contains a 9.2 billion m^2 area and is located in the centre of the 83.1 billion m^2 South-east Anatolian Basin. The estimations of EIA and ARI indicate that 87 billion barrels of risked shale oil and 2.8 trillion m^3 of associated shale gas are in-place (EIA, 2013). In September 2012, the TP, Turkey's state-run energy company and Shell started fracking operations to extract shale gas from Dadaş Shale in the Sari buğday-#1 natural gas field. Anatolia Energy also drilled Dadaş Shale well in the Çaliktepe-#2 field in early January 2012. Texas-based Transatlantic Petroleum Ltd. has already drilled 31 horizontal and deviated wells (25 in south-eastern Turkey and six in north-western Turkey). The company reported flowing gas and light oil from their two Dadaş Shale test wells (Natural Gas World, 2013).

III) *The Thrace Basin* covers 16.8 billion m^2 area in the north-western part of Turkey. Since the discovery of Hamitabat Gas Field in 1970, Thrace Basin became Turkey's largest gas producing area, accounting for 85% of the country's total gas production (EIA, 2013). Up until now, around 350 wells in thirteen gas fields and three oil fields in this basin have been drilled. In the Thrace Basin, significant drilling activities are undertaken by TP and Transatlantic Petroleum. Nevertheless, there was no solid information released about the shale well tests or the performance of the companies until now.

While the drilling activities in two major basins went on, many questions and doubts were raised concerning the fracking method. As of yet, environmental and regulatory challenges appear to be the biggest barrier on the way to Turkey's so-called "unconventional revolution" (Turkish Review, 2014). These are:

- **Lack of reliable data on resources:** There is no official national data available regarding the forecasts of Turkey's shale gas potential. The only reliable data was delivered in the EIA's 2013 report.

- **Lack of technical information and staff on fracking technique:** Turkey does not have the enhanced technology required to apply fracking method. Therefore, the country needs to cooperate with other countries, like the USA, for the technical know-how and to improve the qualification skill of the staff.
- **Uncertainty on the possible profitability of Turkey's shale gas:** It is still unclear whether the exploration of shale gas will be profitable for the country and how this will affect the regional gas and oil prices as well as production costs.
- **Environmental risks of the fracking process:** Rapid expansion in shale gas production has raised serious concerns regarding the impact of operations in areas such as water, road, air quality, seismic and greenhouse gas emissions. There are some arguments that the shale gas development may help reduce greenhouse gas emissions by displacing coal burning. Nevertheless, the fracking method has negative environmental impacts on groundwater, drinking aquifers and residential water wells. Furthermore, extracting shale gas with the fracking method may elicit water depletion and water contamination through releasing fracking chemicals and gasses to the surface. Additionally, noise, seismic activity, cumulative and combined health and environmental impacts on communities and workers in the unconventional gas industry are existent.
- **Lack of legal framework:** Turkey's legal framework is quite different from that of the USA or European countries. The landowners in Turkey – unlike in the USA – do not own the subsurface mineral resources and are only compensated for their land. This may partially reduce the interest level of the local population in shale oil and gas production (Turkish Review, 2014).

As a matter of fact, compared to European countries, Turkey has the necessary framework and market conditions to attract potential investors for the domestic unconventional hydrocarbons sector (Turkish Review, 2014). Poland for instance, ranked as Europe's biggest shale gas holder, but disappointed interested companies like Exxon, Eni SpA (ENI), Marathon Oil Corp. and Talisman Energy Inc. with poor test results, high tax demands and long waiting periods for permits (Bauerova, 2014). Unlike Poland, Turkey ratified its new dynamic Petroleum Law in 2013 and thereby removed territorial restrictions on exploration activities as well as opened the country for international companies (Bauerova, 2014). In this new Petroleum Law, the combination of the Royalty Tax (12.5%) and Corporate Tax (20%) creates an investor-friendly fiscal regime, especially when oil prices undulate around the level of $90-100 per barrel

(Turkish Review, 2014). After taxes, duties, fees, rentals and royalties are paid, the petroleum exploration and production holders may transfer their profit abroad. Additionally, energy companies may export up to 35% of onshore and 45% of offshore oil and gas production in the fields discovered after January 1980 (Turkish Review, 2014).

In light of this information, Turkey still needs a better framework that assesses potential gaps in existing legislation regarding chemical usage disclosure, foul water treatment, the threshold for unconventional exploration, production and for environmental impact assessments. Unconventional gas production may cohere with Turkey's primary energy goals, like the security of supply and affordable energy. Nevertheless, without a compatible legal framework for the proper application of a comprehensive water management and methane leakage control system, unconventional production may contribute negatively to the country's environmental sustainability (Turkish Review, 2014).

Turkey insists on implementing such energy policies, which target the full utilisation of domestic conventional energy sources and nuclear power to diminish its external energy dependency. Nevertheless, since the AKP came to power in 2002 Turkey's reliance on fossil energy imports increased to 73%, rising from 65,1% in 2001 (Gürbüz, 2015).

Selami Incedalcı, former General Director of the TP, emphasised that shale gas drilling only makes economic sense if the value of total organic carbon is over 10%. It is then possible to produce both natural gas and oil if the hydrocarbons contained in shale layers are rich in total organic carbon. Furthermore, there are serious discussions as to whether the hydraulic fracturing method could trigger earthquakes in the region. Turkey, in this sense, is one of the most seismically active areas in the world. Many major earthquakes have had disastrous effects in several provinces of the country.

A common pattern emerging from the larger cities in Turkey has been fast and uncontrolled development, achieved by overrunning green spaces and air corridors and the construction of mostly uninsulated buildings. If these speeds and methods of urbanisation continue, the country could become an urban sprawl in the upcoming decades. In parallel to this expansion, the energy demand of these immense cities has unduly increased. In order to meet the rising energy demand of these cities, the utilisation of shale gas as a local source instead of importing crude oil, natural gas and coal seems to be a better option regarding economic security and security of supply.

Furthermore, the requisite infrastructure for the transportation of shale gas is already available in almost all cities of the country. Notwithstanding this, shale gas and shale oil, in spite of their environmentally friendly nature compared to coal, are still fossil energy resources and cannot be substitutions for renewables. Critically, both the fracking process and the injection of wastewater into deep disposal wells as a recycling method cause small earthquakes.

6.2. Bituminous (Oil) Shale

Oil shale is a general term used for usually fine-grained sedimentary rocks that yield considerable amounts of shale oil upon pyrolysis. Oil shale forms a mixture of tightly bound organic and inorganic materials and is mainly used in thermal power plants and for oil and gas production. The USA has the largest oil share resources known in the world, which constitute 62% of the world's known recoverable oil shale potential (Altun, et al., 2006 S. 211-227)

Oil shale represents the second largest unconventional energy source in Turkey. The most significant oil shale deposits, regarding quality, amount and exploitability, are located mainly in middle and western regions of Anatolia. Up until now, the proven amount of the explored reserves is around 2.2 billion tonnes, while the total reserves are expected to be between 3-5 billion tonnes. Several studies, performed to recover shale oil, have concluded with positive but inapplicable results. Treating oil shale as a supplement to coal or lignite in power production is a more reasonable approach and would be possible in boilers used for firing coal (Altun, et al., 2006).

7. ENERGY, ECONOMICS AND POLITICS IN TURKEY

7.1. Turkey's Energy Security and Impact of Turkish Straits

The geopolitical and geostrategic importance of Turkey arises not only from its geographical position and role as an energy hub but also from having three crucial straits: "The Strait of the Dardanelles, the Sea of Marmara and the Bosporus." For a long time, the Turkish Straits have been serving as a North-South "naval silk road" between the Black Sea and the Mediterranean nations. Due to the rapidly increasing international transportation, the straits gained even more importance, not only for the Black Sea neighbouring countries and provinces, but internationally. Since 1936, the Montreux

Convention has regulated the legal regime of the Turkish Straits. In 1982, United Nations Convention on the Law of the Sea codified the law of the transit passage through straits used for international navigation (Pavlyuk, 1998).

Over the centuries, the Turkish Straits bore witness to the many fights between the nations seeking to overtake the domination of these significant bottlenecks. The Greeks, Persians, Romans, Byzantines, and ultimately the Ottomans respectively maintained the control of the Straits. Until the enforcement of the Montreux Convention, the development of the Turkish Straits regime can be split into three timeframes:

I. *The era of Ottoman Domination (1453-1809)*: The Turkish Straits fell under the Ottoman domination with the conquest of Istanbul in 1453. This era was also the era when the Ottoman Empire was the sole authority controlling the passage regime of the Turkish Straits. The foreign vessels were not allowed to pass through this passage, and this had become a general rule over time during the rise of the Ottoman Empire. This started to lose effect in the 18th century when the Ottoman Empire began declining. As Russia took control of Azak Castle under the Karlofça Peace Agreement in 1969, the status quo in the Black Sea had changed. After that, the European States also became increasingly involved in the "Straits issue" between the Ottoman Empire and Russia. In 1774, under the Treaty of Küçük Kaynarca (between Russia and the Ottoman Empire), Russia obtained authorisation to have a commercial vessel in the Black Sea as well as to engage in trade and pass its trade ships through the straits. Under the Ottoman-Russian alliance agreements, signed in 1798 and 1805, the war vessels of the third States were not permitted to use the Straits as a transit seaway. The 1805 agreement became obsolete as the Russo-Turkish War (1806-1812) erupted.

II. *The bilateral agreements era (1809-1841):* In 1809, under the Treaty of Canakkale and 1829 under the Treaty of Edirne, Ottomans were committed to granting Russian commercial vessels passage through the straits and their free movement both in the Black Sea and in the Straits. The Treaty of Hünkar Iskelesi was signed on July 8, on the condition that the Ottomans would close the straits to France and to Great Britain in the case that Russia came under attack. Through this treaty, Russia gained a significant advantage over the straits and increased its security in the Black Sea. On the other side, the treaty terminated the sole sovereign rights of the Ottoman Empire over the straits. The security of the straits and the geostrategic position themes thus came to the fore.

III. *The multilateral agreements era (1841-1923):* On July 13th 1841, a new era for the Turkish Straits started, as the Ottoman Empire signed "the London Straits Convention" with Russia, United Kingdom, Austria, France and Prussia. The London Straits Convention is significant; it made the straits international passageways, restricted Ottoman sovereignty over the straits, weakened Russian advantage over the straits and increased the security of France and Great Britain in the Mediterranean. The Paris Convention, signed in 1856, forbade the passage of military vessels of all states, including the Ottoman Empire. On March 13th 1871, the London Straits Agreement on the Black Sea was signed, which allowed the navigation of war vessels of the Ottoman Empire's allies through the straits even in peacetime, under the permission of the Ottoman Sultan. Under the London Agreement, the Ottoman state was allowed to open the straits for war vessels of ally countries when necessary for the sake of its security.

The regime of the Turkish Straits, founded under the 19th-century agreements, proceeded until the outbreak of the First World War. The President Woodrow Wilson's principles played a significant role in determining the ensuing legal regime for the Turkish Straits (Inan, 2001). The fourth of Wilson's fourteen principles appointed the establishment of a system on the Straits under the competence of Turkey and other Black Sea Powers (Orekhov, 1946). His fifth principle suggested a joint Turco-Soviet system of defence for the Straits – a system which tacitly contained the idea of Soviet bases. He saw Turkish independence as vital to American interests in blocking Russia's advance to the Persian Gulf and Suez Canal. According to him, the Turks represented a great asset to the stability of the Middle East, and this asset could not be trifled away.

Nevertheless, the twelfth principle of Wilson undermined the power structure of the Ottoman Empire. According to this principle, "the Turkish portion of the present Ottoman Empire should be assured a secure sovereignty, but the other nationalities which are now under Turkish rule should be assured an undoubted security of life and an absolutely unmolested opportunity of autonomous development, and the Dardanelles should be permanently opened as a free passage to the ships and commerce of all nations under international guarantees" (Yale Law School, 2008). This point aimed to separate ethnic groups, gave the Middle East Arabian groups a right to govern their nation – and ultimately caused an internal disorder within the empire's structure. Anatolia was the only area which the Ottomans would rule, because only there they had the majority.

Under the Lausanne Straits Agreement, signed as a supplement to the Lausanne Agreement under Article 23 on July 24th 1923, the straits were made open to commercial vessels, were demilitarised and seizure of foreign war vessels entering the Black Sea in peacetime was subjected to certain limitations. The regime of the Lausanne Straits Convention rested on the principle of freedom of passage of merchant vessels and warships, taking into account whether Turkey was in a time of peace or war and also whether it was a neutral or a belligerent power (Inan, 2001). The Lausanne Straits Convention did not fulfil the expectations of Turkey. The common guarantee system, accepted for the security of the demilitarised zones and the security of Turkey in this region, was weak and proved its insufficiency during 1930 (Inan, 2001). During those years rising incidences began to occur, such as the revisionist policies of individual states, the militarisation of certain areas in the South Aegean (close to Turkish shores) and the failure of global demilitarisation efforts. These circumstances compelled Turkey to appeal to the principle of law known as the *clausula rebus sic stantibus* and ask the parties for a new convention to safeguard its security (Inan, 2001).

"The Montreux Convention Regarding the Regime of the Turkish Straits", signed with the participation of Bulgaria, Great Britain, Australia, France, Japan, Romania, the Soviet Union, Turkey, Yugoslavia and Greece on July 20th 1936, was the primary instrument to govern passage of commercial and war vessels through the Strait (Inan, 2001). The convention regulates the current international status of the Turkish Straits. Turkey's domination and sovereignty over the straits are heavily restricted through the Montreux Convention, which, at the same time, threatens Turkey's energy security dimension. According to the Montreux Convention, "merchant vessels enjoy freedom of passage through the Turkish Straits (Turkish Straits Vessel Traffic Services Centre regulates the passages according to the Maritime Traffic Regulations for the Turkish Straits dated 1998), while passages of vessels of war are subject to some restrictions which vary depending on whether these vessels belong to the Black Sea riparian States or not" (MFA, 2011). The first ordinances of the Convention were as follows:

i. Aircraft carriers are not allowed to pass through the Turkish Straits, regardless of the reason.
ii. Only submarines belonging to riparian states may pass through the Turkish Straits, with the intent of re-joining their base in the Black Sea for the first time after their construction or purchase (MFA, 2011).

iii. The total number and the maximum aggregate tonnage of foreign naval forces authorised to pass through the Straits shall not exceed 9 and 15,000 tonnes, respectively.
iv. In the Black Sea the total aggregate capacity of the vessels of war that one non-riparian State may have is limited to 30,000 tonnes.
v. Vessels of war of the non-riparian states are not allowed to stay more than 21 days in the Black Sea.

Approximately 3.7% of the world's daily oil consumption is shipped through the Straits. Opening the way for such an oil flow through the Straits and increasing the numbers of oil tankers passing this sea passage has raised a considerable amount of natural, geographical, political and environmental concerns (Oztürk, 2002). Turkish Straits are considered to be one of the easiest and cheapest routes to transport the oil and easy money to the petroleum millionaires around the world – from ranches of the oil-rich Texas state, to the major stakeholders in the stock markets of London, Frankfurt and New York (Oztürk, 2002). Nevertheless, the more ships which pass through the Straits, the more the threat of a possible maritime disaster increases. Such a catastrophe would ruin the entire environmental area and cause fatal injuries to thousands of people. The EIA identifies the Bosporus and Dardanelles Straits as "one of the busiest and most dangerous chokepoints in the world". Every year, almost 60,000 vessels, 5,500 of which are oil tankers, pass through these narrow straights, mostly carrying weapons and radioactive materials (Starr, 2014).

Considering this, one of the major maritime disasters, occurred on the Bosporus Straits, was the Independenta mishap (Oztürk, 2002). On November 15, 1979, a collision between the Romanian oil tanker Independenta and the Greek freighter Evriyali resulted in the death of 43 crew members. Around 64,000 tonnes of crude oil was estimated to have spread into the Turkish waters and, over 30,000 tonnes of crude oil was burned for weeks, covering Istanbul with a thick, black, oily cloud (Oztürk, 2002). Another terrifying maritime incident occurred on March 13th 1994, when the 66,822 tonnes Cypriot crude oil carrier Nassia collided with the Cypriot bulk carrier Shipbroker at the Black Sea entrance to the Bosphorus. Twenty-nine crew members lost their lives, approximately 9,000 tonnes of crude oil spilled, and 20,000 tonnes burnt for four days, which caused severe pollution and suspended the traffic on the Straits (Oztürk, 2002).

To enhance the safety of navigation in the Straits and to protect the environment, Turkey enacted the 1994 Turkish Regulations. Under these regulations, all merchant vessels must conform to the technical international rules and legislations of the State whose flag they fly. Furthermore, the Turkish authorities must be informed about any deficiencies in the vessels that may affect the safety of navigation. In addition to these technical requirements, the 1994 Turkish Regulations prohibit the discharge of any pollutants, such as refuse, bilge water and oil into the Sea of Marmara or the Turkish Straits (Pavlyuk, 1998). After the enactment and the implementation of 1994 Turkish Regulations, Greece, Russia and several other states which depend on the Turkish Straits for shipping to and from Black Sea ports objected. They claimed that the Regulations violated the Montreux Convention's grant of free commercial vessel transit through the Straits. They maintained that Turkey had introduced the 1994 Turkish Regulations to diminish oil tanker traffic and to lobby for construction of an oil pipeline through Turkey that would replace boats and bring oil from the Caspian oil shelf, through Turkey, to lucrative Western markets. The international dispute between Turkey, Russia and other states remained unresolved. While Turkey claimed to be ensuring the safety of navigation and environmental concerns, Russia accused Turkey of attempting to obtain oil money and consolidate more power in the region by making all the surrounding states dependent on the maritime shipping through the Turkish Straits.

With the purpose of diminishing the heavy tanker traffic on the straits and increase the energy security of Turkey, the necessity for opening a new waterway emerged. This new gateway, named "Canal Istanbul", was announced for the first time by Recep Tayyip Erdogan in a press conference in April 2011. The plan of the project was to build an artificial sea-level waterway, by digging 400 meters wide and 25 meters deep, crossing through the entire European side of Istanbul, connecting the Black Sea to the Sea of Marmara (Odevci, 2012). On the one side, it could be perceived as an environmentally friendlier project, as due to the decrease of petrol tanker traffic marine life would be normalised which would increase the seasonal fish migration through the Bosphorus.

However, the other side of the medallion hid non-negligible environmental aspects. Istanbul still discharges much of its untreated sewage and wastewater directly into the environment (Orhon, 2014). In the 1970s, as the limited scientific data was available, the studies revealed that all dumping made into the lower layer of the Bosporus and Marmara would be transported to the Black Sea without significant mixing with the upper layer and thus with no detrimental effect on the water quality of the Marmara (Orhon, 2014). Today, more than two-thirds of the Istanbul's raw effluent is poured every day into the Marmara Sea and the Bosporus. This effluent comprises of some 1,100 tonnes of organic matter, 130 tonnes of nitrogen and 20 tonnes of phosphorus, as well as a wide spectrum of other chemicals and hazardous materials (Orhon, 2014). In contrast to the findings in 1970, the greater part of this pollution is not dragged along to the Black Sea. The significant mixing of lower and upper layers of the Bosporus occurs in the zone between the Bosporus and Marmara, which is the most unsuitable location for wastewater disposal. The two primary untreated sewage from the districts of Kadiköy and Yenikapi, which account for around 40% of the total wastewater load in Istanbul, is directly located in this mixing zone.

Along with the dumping of waste at sea, bringing the Canal Istanbul project into action would only worsen the situation. The level of pollution of the Black Sea is much higher than Marmara Sea. Therefore, opening a channel in the mixing zone of Black Sea with Marmara offers a new route for polluted water to head south. Some of the studies demonstrate that more than 30 tonnes of nitrogen and 9 tonnes of phosphorus are carried south each day in the upper flux of Bosporus (Orhon, 2014).

Greenpeace Turkey indicates that opening a large-scale canal will change the native habitat of nature in that area, excavations will cause erosion, while farmlands and water resources will be affected negatively (Odevci, 2012). Furthermore, regarding the Montreux Convention, merchant ships are allowed to pass the Bosporus Strait free of charge. How would it be possible to convince these ships to pass through the Canal Istanbul if they had to pay a certain fee? If there is an absolute risk that the biological structure of the Black Sea will be damaged, should we still take into account what the possible reactions from Russia, Ukraine and Romania would be? These questions need to be clarified before the construction of such an artificial canal, which inherently brings serious environmental and marine damages with it.

According to (Kottari, et al., 2013), Turkey cannot restrict the tanker traffic (innocent passage) through the Straits, "but it can negotiate an international accord so as to be designated to regulate the secure passage through the new canal, possibly levying transit fees." Furthermore, Turkey can allege that the tankers and the new Canal, even excluded from the Convention's provisions, are covered by the Turkish legislation "and thus, control the passage of the commercial ships indirectly, therefore the tankers, through the Canal" (Kottari, et al., 2013). All in all, due to the environmental concerns and different points within the Montreux Convention, the positive contribution of the Canal Istanbul Project to Turkey's geopolitical security is highly speculative.

7.2. Economic Vulnerability and Political Instability Aspects

Turkey's unique geographic position, by being an energy hub between West and East and having significant chokepoints, make the country not only special, it also attributes an important role to be a sustainable and reliable partner in energeopolitical relations in the global arena. Nevertheless, the economic strength and growth of Turkey is very much dependent on the political situation. Due to this heavy dependency, Turkey has been suffering from financial vulnerabilities caused by political instabilities. The party system and political parties have not been fully institutionalised since their emergence in the late 1940s, which increases volatility, fragmentation and ideological polarisation of the Turkish political system. Turkish political history can be roughly divided into six periods between 1923 to present:

1) *1923-1938:* This was the inter-war period, ruled by Mustafa Kemal Atatürk, founder of the Republic of Turkey, on well-established principles of peace, sovereignty and national development. The most esteemed Kemalist foreign policy goals during that period were: to become an equal member of the Western world of nations and to create a strong, modern state which could defend its territorial integrity and political independence without any external assistance (Criss, 1997).
2) *1939-1960:* This was a period of change for Turkey, as it became a NATO member in 1952. Turkey's main goals were to maintain security, political independence and territorial integrity. Nevertheless, the Turkish economy became dependent upon the West and reinforced the pro-Western policy (Criss, 1997).
3) *1960-1980:* This period was characterised through a series of unstable governments and three military *coups d'états* in 1960, 1071 and 1980. Consequently, Turkey suffered from an increased authoritarianism.
4) *1980-1990:* The period was symbolised with further Western alignment and reduced autonomy. During the Cold War, Turkey was a "wing country" under NATO's strategic framework, resting on the geographic perimeter of the Western alliance. Until the 1980s, Turkey was a sort of "closed" economy. Most of the industries, companies, and banks were state-owned. Turgut Özal, who was the Prime Minister at that time, introduced liberalisation reforms to open the Turkish economy and introduce it to the global markets. Additionally, Turkey was dealing with internal and external conflicts in- and outside of the country. Since the mid-1980s Turkey has been suffering from separatist terrorism –namely PKK–

particularly in the Eastern and South-eastern provinces, which have been harming the social and economic welfare, reducing the human and physical capital stock, and introducing higher levels of uncertainty within the society.

5) *1990-2002:* Was a period of high political instabilities and extraordinary power of the military over political affairs. The most remarkable event of this period was the resignation of Turkey's first Islamic-oriented Prime Minister, Necmettin Erbakan, due to heavy pressure from the military. The secular armed forces of the country accused the religious policies of Erbakan to be jeopardising the secular nature and modern values of the country. This event has been called as the "*postmodern coup d'état*" by a Turkish admiral Salim Dervisoglu.

Between 1980 and 2000, Turkey's main goal was economic growth. To achieve this goal, Turkey relied heavily on foreign investment. Nevertheless, the government already had an enormous budget deficit, which incited the already high inflation rates to further increase. The International Monetary Fund (IMF) warned Turkey of the possibility of facing a financial crisis due to the huge budget deficit. The foreign investors observed political turmoil and the government's efforts to eliminate the budget deficit did not yield a positive result. All in all, the investors withdrew around 70 billion dollars from the country within a few months. The political instabilities reached their maximum level on February 19th 2001, during a crisis between the former Turkish President Ahmed Necdet Sezer and the former Prime Minister Bülent Ecevit at the National Security Council (*Milli Güvenlik Kurulu)*. The 2001 crisis was the biggest economic and political disaster in Turkish history, also known as Black Wednesday (*Kara Çarşamba*) and triggered much more economic turmoil. Stocks plummeted, and the interest rate reached to 3.000%.

After the fiscal and financial crisis in 2001, Turkey repaired its public finances, reformed the banking system, tamed inflation and floated the lira (The Economist, 2017 S. 58). In May 2001, Turkey signed a stand-by arrangement called "Transition to the Strong Economy Program" with the International Monetary Fund (IMF). This program was supported by the World Bank credits and introduced by Kemal Dervis, former Head of the United Nations Development Program. The aim of the program was to fight with high inflation, sustain stability and achieve a good relationship between the financial, fiscal and real sector. In the meantime, Recep Tayyip Erdoğan's Islamic-rooted Justice and Development Party (AKP – *Adalet ve Kalkinma Partisi*) won a victory in the general elections on November 3rd 2002. Under the IMF's austerity policy, Turkey had promulgated its 2002-2004 economic program and was able to draw about $16 billion dollars for three years from IMF. This program was indeed successful and helped Turkey to establish new regulations regarding the financial sector and to achieve more economic stability.

6) *2002 – present* is the period in which Recep Tayyip Erdogan's ruling conservative party (AKP) came to power, after the elections of 2002. After the AKP came to power, Turkey made great economic strides over 13 years until 2015. While the average annual growth rate between 1992 and 2001 was 3%, it reached to 5.2% between 2002 and 2012. The inflation rate dropped down to 17.6% in 2013 from 74.9%. Due to the high fiscal deficits, the government debt/GDP ratio was 76% in 1999. This rate glided down to 36.2% in 2012, which was below the Maastricht Criteria (60%). The unemployment rate remained high, which reached above 10% between 1992 and 2001 and 9.7% annually in 2013. The country has become a trusted supplier of high-quality consumer goods and is still Europe's biggest manufacturer of television sets and light commercial vehicles (The Economist, 2016). Based on the World Bank data, Turkey is the eighteenth largest economy in the world and forty-three of the top 250 international construction firms are Turkish. Moreover, Turkey is the world's eighth biggest food producer and sixth most popular tourist destination (The Economist, 2016).

Nevertheless, the annual average growth rates in Turkey have remained modest since 2007, at around 3.5% per annum. There is too much volatility associated with the way the economy is run in Turkey. The economy also suffers from a variety of domestic troubles. Tedious regulations hamper small businesses to grow and become more efficient. One such is that labour-market efficiency in Turkey is rather low; according to *The World Economic Forum;* it ranks 131st out of 144 countries (The Economist, 2016). Low skills are a key barrier to achieving better labour market outcomes in Turkey, as nearly one in five young people is low-skilled, neither employed, educated nor trained. Another example is, according to some economists, Turkey struggles to move up into the club of rich countries from the "middle-income trap" (The Economist, 2016).

Almost all Turkish foreign policy scholars are sharing the same opinion that the traditional language of Turkish foreign policy has changed conspicuously during the AKP era (Yesiltas, et al., 2013). In the first few years of the Islamic-oriented AKP government, many Turkish foreign policy concepts reawakened: *historical dimension*, *good relations with neighbours*, *co-operation among civilisations*. However, some of them came up with new concepts like *Multi-dimensional Enhanced Partnership* and *Energy-Hub Corridor* (Yesiltas, et al., 2013). Nevertheless, Turkey's craving to be a regional superiority and mediator country among different regional actors in such turbulent times has failed.

Since the AKP came to power, it has supported the idea of "Neo-Ottomanism" as a nostrum against the model of the nation-state that has long suppressed cultural plurality and promoted centralist unity. Ottomanism emerged during the decline of the Ottoman Empire in the second half of the 19th century, aiming to guard the Ottoman Empire by two methods: "First, by Westernising the country and becoming part of Europe; second by abolishing the dominant status of Muslims as a *millet system*, thus integrating non-Muslim communities into the state, preventing the emergence of nationalist movements" (Ozkan, 2014). *Millet* system was the social model of the Ottoman Empire. The leading Turkish historian Prof. Ilber Ortayli defines the *Millet system* by referring to the *Millet* as a "form of organisation and a legal status bestowed by the Ottoman Sultan on the believers of monotheistic religions (*ehl-i zimmet*) such as Christianity or Judaism. As various non-Muslim communities were annexed to the Empire, the Sultan recognized their formal status and granted his protection via a societal treaty called *ahidname*" (Ortayli, 2012). Consequently, the idea of Ottomanism concentrated more on the domestic matters and had a defensive nature, although it could be a model for a multicultural and tolerant politic of plurality. The Ottoman Empire was grounded on the traditional, centralised governance of the elite. It was neither a multiculturalist nor a pluralist system. All traditional empires were multi-ethnic identities, but it was never meant to be a multi-ethnic public space, as today's multiculturalism aspires to be. The plurality of ethnicities and religious communities cannot be explained as a sign of pluralism that a democratic polity aspires to achieve (Mert, 2012).

Neo-Ottomanism, on the other hand, mainly came into existence due to the economic and security concerns of Turkey. Ahmet Davutoglu, the former Turkish prime minister, was the figure "behind the scenes" who encouraged the idea of Neo-Ottomanism to implement as a pragmatic tool for Turkish foreign policy goals. In his highly criticised 2001 book "Stratejik Derinlik" (*Strategic Depth*), Davutoglu stated that by using its geopolitical and geostrategic position, Turkey could become a regional as well as a global actor. Therefore, re-enhancing its power status in the Middle East has become one of the major foreign policy goals of the ruling AKP government. Davutoglu sought to emulate the Islamism of the era of Sultan Abdülhamid II. In his view, in the same manner as the Islamism of Abdülhamid's era precluded the disintegration of the Ottoman Empire; it was the only ideology that would make Turkey a leader in the Middle East (Ozkan, 2014). Based on these aspects, it can be claimed that Neo-Ottomanism was born as an opposition against the Kemalist ideology and the Turkish identity, created by the founders of the Turkish Republic, first and foremost against the idea and principles of Atatürk. Furthermore, Neo-Ottomanism is, in nature, rather an aggressive policy. According to the ruling AKP government, increasing Turkey's influence over the former territories of the Ottoman Empire (the Middle East countries) was determined as not only beneficial for the sake of Turkey but also essential for security. However, the situation in the Middle East brought different results than the predictions of Davutoglu: chaos in Libya, Yemen, Tunisia, a military junta in Egypt and civil war in Syria. Furthermore, the increased engagement, even interference in the internal affairs of the countries like Egypt and Syria, strained relationships. Additionally, the Neo-Ottomanism concept raised concerns as to whether Ankara had been moving itself away from being a NATO member and its ultimate goal: to join the EU.

The expectations of Davutoglu did not come true and Turkish foreign policy during the Arab Spring was unsuccessful (Ozkan, 2014). The major reason for this failure was the Pan-Islamist foreign policy of Davutoglu, which was "ideologically ill-suited to the realities of today's Middle East" (Ozkan, 2014). His assumptions within the context of Pan-Islamismus that "it will be possible to wipe out movements like secular Arab nationalism and socialism in one stroke, and set the Middle Eastern clock back to 1914" did not occur (Ozkan, 2014).

The right-wing conservatism is an output of the nation-state in Turkey. Their remonstrance against republican nationalism was limited to their aversion with its secularity. The Ottoman system was an irredentist form of Turkish nationalism since the idea was the Turkish rule over vast lands and various communities rather than the idea of multinational governance. The synthesis of "Turkishness" was embedded in the idea of Ottomanism from the beginning (Mert, 2012). That is why when ex-Islamist conservatives assumed the complete power to reshape Turkish politics, their Ottomanism could not ease to overcome nation-state authoritarianism and could not lead to pluralistic democratic politics. Consequently, the idea of the nation-state turned out to be limited politics of tolerance toward non-Muslim minorities, Alevi and Kurdish openings (Mert, 2012).

Since the AKP came to power, the military's influence over politics has dramatically diminished, as hundreds of officers have been imprisoned by a series of prosecutions – the most notorious cases were "Ergenekon" and "Balyoz." The effort to curtail the military's power to interfere with politics shifted the political atmosphere of Turkey towards civilian control and the strengthening of the civilian institutions, but it has gone far beyond the aim of "democratisation of Turkey." Nevertheless, the role and position of the military in Turkey are dissimilar to the military powers in Europe or other countries. Since the founding of the Turkish Republic in 1923, the military has been a staunch supporter of the founder and leader of the Republic, Mustafa Kemal Atatürk, his secularism, principles, reforms and have "stood as an unquestioned guardian of secular democracy, intervening when it deemed necessary to keep religion out of politics" (Zacharia, 2010). Nevertheless, as a result of the decline in the power of the army, Turkey has become a less and less secular and more and more religious country. Especially since 2007, the AKP has undermined secularism, promoted Islamisation more apparently and maintained and strengthened the main domineering and interventionist state institutions (like Diyanet – Presidency of Religious Affairs) (Somer, 2015). As Ahmet Erdi Öztürk from the University of Strasbourg stated, in recent years, these institutions (especially Diyanet) "has been transformed into a pliable state apparatus geared towards implementing the political ideology" (Oztürk, 2016) of the AKP. These tendencies have brought a deteriorating general pattern of weakening democracy: "diminishing checks and balances and division of powers within the political system, the rise of the AKP as the predominant party, growing government authoritarianism and a lack of accountability" (Somer, 2015). As a consequence, the growing political and social divisions within the country and the polarisation of Turkish society "along societal and political divides of secularism and Islamism" (Kaya, 2015) have heavily escalated. Lastly, on July 15th 2016, Turkey witnessed a failed coup, which marked, however, the bloodiest attempt on record. This enhanced the already existing conservative authoritarian regime of Recep Tayyip Erdogan.

Turkey, as an EU candidate country since 2003, has implemented a series of reforms which promote democratisation, including reforms to its basic framework laws affecting civil society (ICNL, 2018). Nevertheless, Turkey still operates under the 1982 Constitution, which was written immediately following a military coup (ICNL, 2018). Although there are basic guarantees of rights and freedoms, the Constitution is not up to the standards found in developed democracies (ICNL, 2018). The state still has a dominant influence over society and has gained even greater strength since the military attempted (allegedly loyal to the Muslim cleric Fethullah Gülen) the failed coup on July 15th 2016. Since then, the country has been under 'state of emergency' rules. Up until now, the Turkish government has been prolonging 'state of emergency' measures every three months and imposing new and heavier restrictions on civil society in an attempt to punish those who allegedly supported the coup. Following an executive decree issued on November 22nd 2016, Turkish authorities ordered the permanent closure of 375 non-governmental organisations, asserting that they had connections to the Fethullah Gülen Movement or the PKK. According to John Dalhuisen, director of the European and Central Asia Regional Office of the Amnesty International, this closure is a "part of an ongoing and systematic attempt by the Turkish authorities to permanently silence all critical voices" (Amnesty International, 2016).

Consequently, the power of civil societies, non-governmental organisations and unions are getting weaker over the time. Under these circumstances Turkey, which struggles against low wages, lack of union rights and unsteady work, is becoming even more problematic. As an example, after the tragic mine explosion in Soma on May 13th 2014, which killed more than 300 mineworkers, the Prime Minister's Office published a circular claiming that all aid collected by individuals or civil society organisations must be sent to a singular state body named AFAD (Directorate for Disaster and Emergency Management). AFAD were then accredited as the only institution to collect aid for the recovery efforts related to the accident. Such an arbitrary limitation on collection and utilisation of aid by civil society can be articulated as an example that demonstrates the problematic nature of the Law on Collection of Aid in Turkey (ICNL, 2018).

Economic and political instabilities have substantial impacts on Turkey's employment rates. In the last quarter of 2015, the employment rate in Turkey reached to 47.8% – more than 12% points below the OECD average (60.2%). The level of unemployment increased from 9.9% towards the end of 2013 (TUIK, 2014) to 10.5% at the end of 2014. In March 2016, the unemployment rate declined to 9.6% – over three percent higher than the OECD average (6.3%). Regarding the employment rates, a vast majority of the country produces low-value-added goods, which bring less income. Outside the greater Istanbul area and beyond the Aegean coastline - two areas which export products such as refrigerators, washing machines, televisions and vehicles, which generate more income and make the market more dynamic and competitive. (Dombey, 2014). The owners of small and medium-sized companies in Marmara (Bursa, Kocaeli), Aegean (Denizli), Central (Ankara, Kayseri) and Anatolian part of Turkey (Gaziantep, Kahramanmaras), who support AKP, have become the main engine of Turkey's export expansion into the Middle East and North Africa (Jarosiewicz, 2013). These so-called "Anatolian Tigers" are partly traditional family firms, which accumulated sufficient capital stock to compete with Istanbul-based holdings and thus created their elite status in the country (Jarosiewicz, 2013). Nevertheless, many of the Tigers were arrested following an attempted coup on July 15th 2016. The economic boom, which these conservative businessmen helped to create in 2000, is already over; exports from the region have fallen by at least 4% over the past year (The Economist, 2017).

Turkey remains economically vulnerable to withdraw foreign capital, due to its high amount of external debts and deficits. As a matter of fact, the Turkish Central Bank is there to raise the interest rates, but it "has so far tightened only tentatively" (The Economist, 2017). Some economists argue that, despite the central bank's statutory independence, it is too early to contradict Turkey's increasingly powerful president, Recep Tayyip Erdogan, who has "fulminated against the 'interest rate lobby' and demanded lower borrowing costs" (The Economist, 2017). Turkey's growing dependence on foreign investment funds to bolster its economy represent a massive problem to the regulation of its economic volatility. These funds are mostly short-term investment funds and play a significant role in Turkey's economic expansion and finance its growing energy needs. Net foreign direct investment underwrote just US$7.3 billion of the country's US$56.7 billion of current account deficit between August 2012 and August 2013. Turkey suffers from big trade deficit financed by hot money, lots of foreign-currency debt and political instability, which causes fluctuations in the financial market and influences "hot money" flows negatively. The country's persistent current account deficit (estimated to exceed 4% of GDP in 2016) has left Turkey with a short-term external debt amounting to over US$100 billion at the end of November 2016 (84% of which is denominated in foreign currencies). That is roughly equal to its entire stock of foreign-currency reserves (worth less than US$98 billion at the end of November (The Economist, 2017).

The high military expenditures also represent a huge burden for the country's economy. According to the 2015 report of the Stockholm International Peace Research, the level of military spending in Turkey was in 15th place in the world, at $22.6 billion (Global Security, 2016). In its fight against PKK, Turkey has increased its military expenditures by 25% since 2014 and shifted its resources from productive sectors to the defence industry. Furthermore, ongoing terrorism attacks adversely affects specific industries of the country such as airline and tourism since Turkey is a tourism hot spot for many tourists (Bilgel, et al., 2013). These factors consequently impose a huge burden on the country's volatile economy.

Regional inequality has also been one of the major struggles of the Turkish economy (Bilgel, et al., 2013). As Daron Acemoglu, Professor of Economics at the Massachusetts Institute of Technology, asserts, "*The Turkish economy has a very broad dual structure, where some regions – Istanbul, Ankara, provincial cities – have very modern firms producing for the middle class and export sector, but where there are also a number of informal, lower-safety, lower-wage enterprises that are actually holding the economy down*" (Dombey, 2014). In the west of Turkey, we can observe the agglomeration of high economic activity with a better social and economic environment, whereas in the east and southeast there are clusters of relatively low levels of business activity with a social and economic environment well below the Turkish (as well as the European) average (Bilgel, et al., 2013).

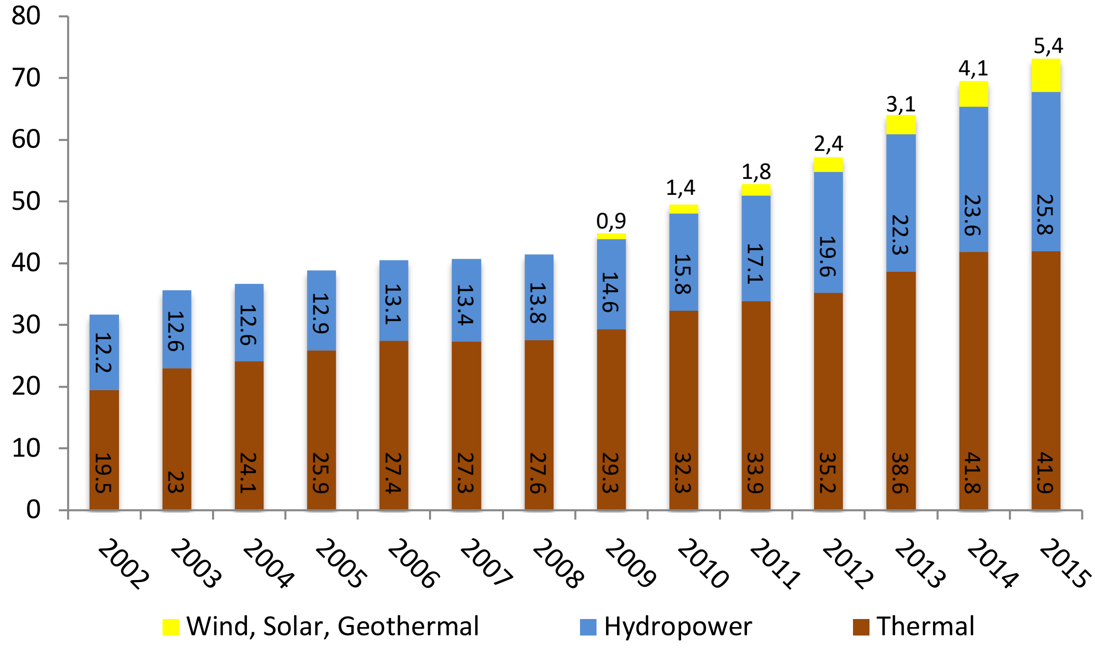
Turkey has still not learned that financing current-account deficits with long-term foreign direct investments are better than relying on hot money. "The record also suggests that if the money has to be hot, it is better that it takes the form of equity, rather than debt. And if it has to be debt, better that it is denominated in the country's currency, not someone else's" (The Economist, 2017). The 2013 – 2014 World Economic Forum, *Global Competitiveness Report* ranked Turkey 44th (dropping one position compared to its ranking in 2012 – 2013) (Schwab, 2013). Due to its rising fiscal deficit and inflation nearing double-digits, the macroeconomic environment has deteriorated slightly (Schwab, 2013). The report clearly states that Turkey, to enhance its competitiveness, must focus on building up its human resources through much better education, training and healthcare, increasing the efficiency of its labour market and reinforcing the effectiveness and transparency of its public institutions (Schwab, 2013). The report further demonstrates that Turkey ranks at an average level concerning social sustainability and environmental sustainability (Schwab, 2013). Turkey's relatively high youth unemployment rate, its large informal sector and its limited social protection, generate the main challenges for its social sustainability dimension (Schwab, 2013). High carbon dioxide emissions, intensive and inefficient water use for agriculture, limited protected land area and lack of commitment to international environmental agreements diminish the viability of long-term competitiveness (Schwab, 2013).

7.3. Energy Outlook and Future Energy Perspectives

With over 75 million inhabitants and GDP levels more than doubling to $850.7 billion dollars in 2017 (World Bank, 2018) up from $303 billion dollars in 2003, Turkey is a booming country in South-eastern Europe. In less than a decade, per capita income in the country has almost tripled and currently surpasses $10,592 dollars (World Bank, 2018). According to the '2015 Annual Report' data of the Turkish Ministry of Energy and Natural Resources (MENR), Turkey was the 3rd highest growing country after China and India by the second quarter of 2015. As a result of this rapid economic growth, especially within the last thirteen years, the rate of electricity demand has also increased to 5.5% per annum. In response to rising electricity demand, 4.3 GW installed capacity licensed electricity power plants were engaged by the MENR in 2015. Furthermore, 396 unlicensed power plants (362 solar, nine wind, one hydro and 24 thermal power plant), with total installed capacity of 270 MW, have joined the national grid system. By dint of government subsidies, the share of renewable energy sources (mainly hydropower, the wind, solar and geothermal) has shown a marked increase in total installed capacity. By the end of 2015, the total installed capacity in Turkey reached 73,148 MW of which 43,2% consisted of renewable energy (hydropower 35.4%, wind 6.2%, geothermal 0.9%, biomass, biogas, and others 0.7%). The remaining 56.8% came from other sources (natural gas 29.1%, thermal plants 20.6%, multi-fueled 5.9% and others 1.2%) (MENR, 2015).

There have been significant changes in the distribution of primary energy supply to resources over the years. In 1971, with 46.5% petroleum constituting the biggest share in total energy supply, 29% of supply came from wood and animal-plant residues and 23.5% from domestic coal (lignite, hard coal, and asphaltite). In 2013, around 240 twh of the total electricity generation of Turkey was supplied from 43.8% natural gas, 25.7% coal, 24.8% hydropower, 4.1% other renewables (including wind, geothermal, waste and other renewable power plants), along with 1.6% fuel oil (MENR, 2015). In 2014, natural gas (with 32.4%) had the biggest share in energy supply. The shares of petroleum and petroleum coke declined to 28.5%, domestic coal to 13.5%, as well as the wood and animal-plant residues to 2.6%, while the share of imported coal (hard coal and coke) increased to 15.6%. In 2015, the share of natural gas in total electricity generation diminished to 37.8%. The share of coal increased to 28.4%, hydro to 25.8%, wind to 4.4%, geothermal to 1.3%, oil (fuel oil, diesel, naphta) to 1.6%, biogas and others to 0.6%. Turkey's total electricity demand increased rapidly and reached 264 terawatt p/hr in 2015 from 132.6 billion kilowatt-hours in 2002 (Figure 23).

Figure 23. Total installed capacity of electricity generation in Turkey (in billion MW)



Data source: Own illustration based on the data from (MENR, 2015).

In the last decade, Turkey's energy consumption has increased by 41.1%, while the energy production only achieved a 27.6% increase. Thus, the growth in energy generation is significantly behind the energy consumption. Accordingly, the energy production/consumption coverage ratio declined to 25% by the end of 2014, from 27.7% in 2004. Domestic energy production did not sufficiently meet the consumption rate. This shortfall was made up by energy imports, the value of which in total supply is gradually increasing. As of 2014, while domestic energy sources met 25.1% of the energy consumption, 74.9% came from import sources. Distribution of net energy imports to resources was 40.1 mtoe natural gas, 34 mtoe oil, and 19.4 mtoe coal**.**

The MENR aims the full utilisation of hydro and domestic coal potential of Turkey for the electricity production by the year 2023. Furthermore, as the nuclear power plants come into operation, the targeted production of electricity will correspond to the electricity production from 14.6 bcm of natural gas. According to the calculations of the Ministry, it is then possible to reduce natural gas imports equivalent to around $3.2 billion. This decline in natural gas imports will particularly contribute to diminishing the country's current account deficit.

MENR is the main institution responsible for Turkey's energy policy and establishing energy strategies. Within MENR, the General Directorate of Energy Affairs is responsible for the coordination of electricity reforms. Additionally, there are other non-ministerial organisations responsible for various aspects of energy policy:

- *Energy Market Regulatory Authority (EPDK):* Responsible for the Energy policy- and/or regulations
- *Turkish Atomic Energy Authority (government entity) (TAEK):* Responsible for the regulatory and supervisory activities in the nuclear field.
- *TÜBITAK Marmara Research Centre (government entity):* Having an energy institute, responsible for the energy efficiency issues
- *Turkish Standards Institute (TSE), International Electrotechnical Commission (IEC):* Responsible for the determination of the energy standards
- *Energy Systems and Environmental Research Institute / TÜBITAK Marmara Research Centre:* Responsible for the Research & Development
- *Clean Energy Foundation, Turkish Wind Energy Association, International Solar Energy Society-Turkish Section, Geothermal Energy Association:* Responsible for the renewable energy regulations.

Despite the existence of a legal framework regarding renewable energy, there is still no institution and no legislation responsible for biomass production and the utilisation of biogas. The only association in Turkey responsible for the biogas investments is *Biyogazder*. This association has, however, no political power of sanction. A long-term strategy regarding the implementation of biogas policy and technology is essential.

Turkey's energy hunger gradually increases each year as a consequence of dynamic economic expansion. Dr. Fatih Birol, Chief Economist of the International Energy Agency in Paris, determined that Turkey needs at least 45 GW additional power capacity to confront its high electricity consumption. The giant Atatürk Dam on the Euphrates River on the border of Adıyaman Province and Şanlıurfa Province in the South-eastern Anatolia Region of Turkey has a total installed power capacity of 2.4 GW and generates 8.9 GWh electric annually. The biggest coal-fired power plant (Afşin-Elbistan-B thermal power plant in Kahramanmaraş Province in southern Turkey) has a total installed power capacity of around 1.4 GW. In order to meet its energy demand, Turkey needs a substantial amount of additional installed capacity in the form of renewable power plants. The country has diverse energy resources. However, most of them are too limited in quantity to fulfil the country's increasing energy needs. Therefore, Turkey imports approximately 72% of its total primary energy needs from energy-exporting countries. Hydroelectric, biomass, thermal, lignite and small amounts of hard coal provide the main indigenous energy resources of Turkey. Turkish energy policy aims to give priority to the development of its lignite and coal deposit in order to reduce its dependence on imported hard coal, natural gas and oil resources. Around 25% of total coal is utilised for electricity production and the rest is used for industry and heating purposes. In coal- and lignite-fired power plants, a great emphasis will be put on installation and utilisation of new technologies to provide low carbon dioxide emission and high efficiency.

The principal objective of Turkey should be to ensure its own energy security by implementing energy strategies compatible with the sustainable utilisation of renewable energy resources. In its budget presentation for the year 2016 to Plenary Session at the Grand National Assembly of Turkey, Dr. Berat Albayrak, Former Minister of Energy and Natural Resources, announced the main energy goals of Turkey as the following:

- Diversifying energy resources, supply routes and source countries, by giving priority to domestic resources.
- Increasing the share of renewables and including nuclear in its energy mix.
- Taking concrete steps to increase energy efficiency.
- Contributing to Europe's energy security.

This is nothing new. Since the early 1990s, the twin goals of Turkey's energy policy have been to secure new energy supplies, and to establish Turkey as the transit country for energy flows from the Caspian Basin to the consumer markets in Europe. There are several challenges for the realisation of these goals, including the ever-changing interests of international oil industry in the Caspian region, disputes over the legal status of the Caspian Sea and the persistent regional conflicts (Hill, 2004 S. 212) in the Middle East and the South-eastern part of Turkey. These challenges have forced Turkey to adopt a neo-political approach to increase its energy transit role on the one side and diversify its energy suppliers, sources and transport routes on the other side.

In light of the government's main goals, the MENR has set its "Strategic plan 2015-19" for the following purposes (MENR, 2015):

1) For ensuring energy supply security:

- Until 2023, increasing the total installed capacity of electricity over 110,000 MW and the total electricity generation to 416 billion kwh.

- Until 2023, the operation of two nuclear power plants and starting the construction of the third nuclear power plant.
- Until 2023, full utilisation of all known lignite and hard coal resources for the electricity generation.
- Until the end of 2019, increasing the electricity generation from domestic coal to 60 billion kwh per annum.
- Until 2020, increasing the coverage ratio of domestic and foreign crude oil production consumption to 13.6%.
- Until 2020, increasing the total natural gas storage capacity to 5.3 bcm and total capacity turnback to 115 mcm per day.
- Until the end of 2016, completing the studies regarding the production potential and of shale gas, methane hydrate and rock oil.

2) For utilising various renewable energy resources:

- Until 2023, increasing the share of renewable energy resources in electricity production to 30%.
- By the end of 2019, raising the total installed power capacity of renewable energy resources to 46,000 MW.
- Until 2023, increasing the total installed capacity of electricity generation from hydropower to 34,000 MW.
- Until 2023, increasing the total installed energy capacity from wind energy to 20.000 MW.
- Until 2023, increasing the total installed capacity of electricity generation from geothermal energy and bio-power from solid biomass to 1 GW for each.

3) For boosting energy efficiency:

- By the year 2023, achieving at least 20% reduction in Turkey's energy consumption per GDP (*energy intensity*) compared to 2011 value.
- By the end of 2019, minimisation of the technical losses in electricity generation, generation and transmission and reduction of the leakage loss rate in electricity energy distribution to 10%.
- By the end of 2019, completion of the necessary maintenance, repair, rehabilitation and modernisation activities in the electricity power generation plants under public liability.
- By the end of 2019, expansion of on-site production and meeting at least 1,000 MW of total consumption from the on-site production.

- Developing the regulatory framework for energy efficiency and increasing the effectiveness of incentives.
- Creating and improving public awareness of energy efficiency and saving energy.

4) For diversifying energy supply sources and routes:

- Until 2020, ensuring the natural gas import dependence on a single country at most 50%.
- Until 2020, reduction of the natural gas-based electric energy production ration in total production to 38%.
- Increasing the share of domestic and renewable energies in the energy mix.
- Preserving the domestic petroleum reserves at a safety level.

5) For using geostrategic position effectively, within the framework of regional cooperation processes, to transform Turkey into an energy base and energy corridor:

- To turn Turkey into an energy terminal by carrying 'energy exchange' and 'international market integration' projects into effect.
- By the end of 2019, redoubling international interconnection capacity.
- Pursuing other pipeline projects and continuation to position itself as a regional energy transit hub.
- With the purpose of making Turkey an energy corridor, starting the construction of at least three international projects and the completion of at least one by the end of 2019.
- Transforming 'Ceyhan Region' into an integrated energy centre where refinery, petrochemical facilities and liquefied natural gas (LNG) export terminals are located and where different quality and specification of crude oil can be offered to international markets.

6) For minimising adverse impacts of the activities in the fields of energy and natural resources on the environment:

- Operating power generation plants compatible with the environment.
- Conducting environmental inspections to the mining enterprises operating in mining areas.

7) For enhancing the investment climate:

- Associated with the establishment of 'Energy Exchange Istanbul (EXIST)' in 2015, the intraday market in the electricity market gained functionality and the energy markets have become more efficient, transparent and reliable.

- To complete the infrastructure works in natural gas balancing and functionality of day-ahead markets.
- By the end of 2015, implementation of governance and process structure to facilitate energy and natural resource investments.

8) **For promoting the effective management of natural resources and their contribution to the economy:**
   - By the end of 2016, establishing an effective supervision and inspection practice for safe and efficient mining held to international standards.
   - Within the scope of the 'E-government Project', the execution of all mining operations on a digital platform.
   - Increasing drilling operations for the mining carried out by public establishments to a total of 200,000 meters by the end of the year 2019.
   - Preparation of the national strategy document for raw materials by the end of 2015 (still in process) and.
   - Increasing production and export of processed goods.

By the year 2023, Turkey's total electricity consumption is estimated to be 530,000 GWh. To meet this high level of consumption, the country is planning to establish an electric power generation capacity of 100,000 MW. According to this plan, 30% of production will come from natural gas, 35% from coal, 30% from renewable energies and ultimately 5% from the nuclear power.

In order to meet its increasing energy demand and be able to supply affordable energy to its citizens, Turkey needs large-scale investments in natural gas and electricity infrastructure, especially in generation and transportation. The energy-intensive manufacturing industries of Turkey will demand competitive energy supplies. The industrial sector requires the most electricity, which is provided from various imported and domestic sources, such as natural gas, petroleum and domestic coal. The Turkish electricity grid already faces challenges from the country's rapid economic growth, as the main centres of consumption, such as Istanbul, Ankara, Izmir and the main centres of industry, such as Izmit, are located far away from the resources, like coal mines and hydroelectricity generation areas.

7.4. The Legal Framework of Turkey's Electricity Market

The liberalisation and privatisation activities in the Turkish energy market began after the 1980s and resulted in the enactment of the Electricity Market Law No. 4628 of 2001. Since then, the share of state-owned enterprises in the energy sector has gradually diminished (EPDK, 2012). Through these revolutionary efforts, the obstructions against competition and private participation in electricity, natural gas, petroleum and LPG markets have been removed (EPDK, 2012). As a result of the reorganisation of state structure in the energy field, EPDK (*Enerji Piyasasi Düzenleme Kurumu*) was established in 2001 through the enactment of the Electricity Market Law. One of the fundamental tasks of the EPDK is to ensure the development of financially-sound and transparent energy markets and to deliver sufficient, good quality, low-cost and environmentally friendly energy to consumers (EPDK, 2012).

Until very recently, there had been quite limited competition in the Turkish electricity sector, due to the monopoly of a single, state-owned, vertically integrated company: the Turkish Electricity Authority. This authority, founded by the Law No. 1312 in 1970, was responsible for rendering of generation, transmission, distribution and trade of electricity services required, as defined in the comprehensive energy and economy policies of Turkey. The initial degradation of the sector occurred in 1994 as the division of the Turkish Electricity Authority into two state-owned companies took place; Turkish Electricity Generation Transmission Company (TEAS), which is responsible for generation and transmission activities and Turkish Electricity Distribution Company (TEDAS), which is responsible for distribution and retail sale activities. Under the enactment of the Electricity Market Law, during the restructuring process of the Turkish Electricity Generation Transmission Company (TEAS), three separate state-owned economic enterprises, which were joint-stock companies, were formed. These companies are: 1) Turkish Electricity Transmission Company (TEIAS), which is responsible for operating the national grid, 2) Turkish Electricity Generation Company (EÜAS), which is in charge of the operation of the state-owned hydro and thermal power plants and 3) Turkish Electricity Contracting and Trading Company (TETAS), which is responsible for purchasing the electricity from the producers and the sale of this electricity to the distribution companies.

Following a trial period that started in September 2010, TEIAS, as Turkey's transmission system operator, signed a long-term agreement in January 2016 becoming the first observer member with the ‘European Network of Transmission System Operators for Electricity (ENTSO-E)' to establish a permanent connection to the continental European grid. By joining the European grid system and through interconnection with Greece and Bulgaria, Turkey plans to increase its net import capacity from 550 MW to 650 MW and export capacity in reverse direction from 400 MW to 500 MW. Two-thirds of the capacity is distributed to the Bulgarian-Turkish border and a third in the direction of Greece. Full ENTSO-E membership would require Turkey to implement the provisions of the EU's third energy package such as those related to transparency, congestion management and market transactions (Sabadus, 2015). The Regional Group of ENTSO-E Europe has decided that the monitoring period for Turkey will remain until the current problems, such as the sudden voltage fluctuations in the grid system caused by the South-eastern Anatolian Region irrigation, are prevented.

In Turkey, all Turkish distribution grid companies were privatised in 2013. Since 2011, Turkey has been in the process of establishing competitive electricity and gas markets, based on similar principles as the EU internal energy market. The country primarily seeks to diversify its electricity generation capacity in two ways; through the development of its significant renewable energy potential and by preparing to include nuclear power in the total energy mix. The liberalisation steps yielded the result that half of the electricity produced in Turkey is now privately operated (EPDK, 2012).

The reform of Turkey’s electricity market increased with the adoption of the **New Electricity Market Law No. 6446 in 2013**. This new law regulated the rights and obligations of all participants in electricity generation, transmission, distribution, wholesale and retail sale, import, export and market operation activities (IEA, 2016). The law increased the maximum capacity threshold for the authorisation of renewable energy plants without a license (from 0.5 MW to 1 MW), in order to encourage distributed generation. Moreover, the law introduced the preliminary licensing mechanism, where a generation company can receive a preliminary license, effective for maximum 24 months, allowing it to proceed with the investment before the finalisation of the environmental and regulatory permits (IEA, 2016).

7.5. Turkey's Climate Strategy and Commitments

One of the most important steps to fight against global warming caused by human activities was taken with the conclusion of the United Nations Framework Convention on Climate Change (UNFCCC). This was opened for signature at the United Nations Environment and Development Conference in 1992, in Rio de Janeiro. The convention came into force on March 21st 1994. More than 190 countries including Turkey and the European Communities are party to the Convention (MFA, 2012). These parties are obliged to reduce gas emissions, cooperate on research and technology and to encourage the protection of sinks in respect to their development priorities, goals and special circumstances (MFA, 2012).

As the greenhouse gas emission levels continued to rise around the world, it was clear that only a binding commitment by developed countries could send a message to convince businesses, communities and individuals to act on climate change and to reduce emissions. Therefore, the member countries started negotiations to create an international agreement which would be linked to the UNFCCC Treaty, but would effectively stand on its own (MFA, 2012). After one and a half years of intense negotiations, on December 11th 1997 the Kyoto Protocol was adopted in Kyoto, Japan and entered into force after the Russian Federation's accession in 2005. The Protocol required developed countries to reduce their greenhouse gas emissions below defined levels which were individually specified for each country, within the treaty (MFA, 2012).

The UNFCCC categorises the countries in line with the fundamental principle, "common but differentiated responsibilities", which refers to the country's national mitigation, adaptation, technology, finance and capacity building policies (CYGMEN, 2010). Regarding these principles, the Convention divided the parties into three categories: Annex I countries, Annex II countries, and countries that were not listed in either of the annexes (the so-called "non-Annex I" countries). Annex I includes industrialised countries as well as many states of the former Soviet Union (the Economies in Transition, or EIT). Annex II is a further subset of Annex I; it includes only countries that were members of the OECD at that time. Thus, non-Annex I countries, which are the large majority, mostly correspond to developing countries (Climate Policy Observer, 2017). Annex I countries are obliged to 'adopt national policies and take corresponding measures on the mitigation of climate change' (Climate Policy Observer, 2017). Annex II countries 'shall provide new and additional financial resources', including for the transfer of technology, to support developing countries in their climate mitigation and adaptation efforts (Climate Policy Observer, 2017). In contrast, non-Annex I countries only have to communicate national inventories of GHG emissions and removals and to "formulate, implement, publish and regularly update national […] programmes containing measures to mitigate climate change" (Climate Policy Observer, 2017).

Turkey is perceived as a developed OECD member country. Therefore, the country was listed both in Annex-I and II when the Convention was signed (MFA, 2012). Turkey rejected this position to become a party to the Convention and started diplomatic efforts to change this position. Later, in 2011, the 7th Conference of Parties has adopted a decision to *"...delete Turkey's name from the Annex II and to place Turkey among the Annex I countries, taking into account its special circumstances, differentiating it from other Annex I countries...*" (MFA, 2012). After this decision was entered into force on June 28th 2002, Turkey could adhere to Convention on May 24th 2004. On February 5th 2009, Turkey ratified an agreement to sign the Kyoto Protocol, after intense pressure from both the EU and international environmental organisations. Given the fact that Kyoto Protocol entered into force in 2005 and was signed by more than 170 countries, Turkey was already late in participating in the United Nations Framework Convention on Climate Change and in ratifying Kyoto Protocol (Hürriyet Daily News, 2008).

Referencing historically low greenhouse gas emissions, Turkey refused any commitment to the reduction of greenhouse gas emissions based on any particular reference year. The main reason for this rejection was that Turkey viewed these kinds of commitments as a threat to further economic expansion. The energy model of Turkey is unsustainable. Referencing economic growth as the only indicator of progress does not only significantly decrease quality of life, but also disrupts the ability to reach food, decreases fresh air, increases water pollution and disturbs the relationship with the planet Earth, which is already disrupted. Furthermore, the unsustainable and growth-oriented energy policy of Turkey adds to its current account deficit and increases its energy dependency as a result of high amounts of fossil fuel imports. Notwithstanding this, Turkey aims to increase the share of renewable energy sources to 90% of the total electricity production by 2050. The new renewables will come mainly from wind, geothermal and solar PV, and contribute 68% of the total electricity generation (Greenpeace International, 2015). The country seeks to increase the share of renewable electricity generation to 47% by 2023 and 65% by 2030. According to country's targets, the installed capacity of renewables will reach 85 GW in 2030 and 156 GW by 2050 (Greenpeace International, 2015). On the other hand, Turkey plans to limit its future greenhouse gas emissions through measures which will not compromise its sustainable development and poverty reduction priorities. Henceforth, the country will carry out mitigation activities in a measurable, reportable and verifiable manner, in agreement with its national programs and strategies.

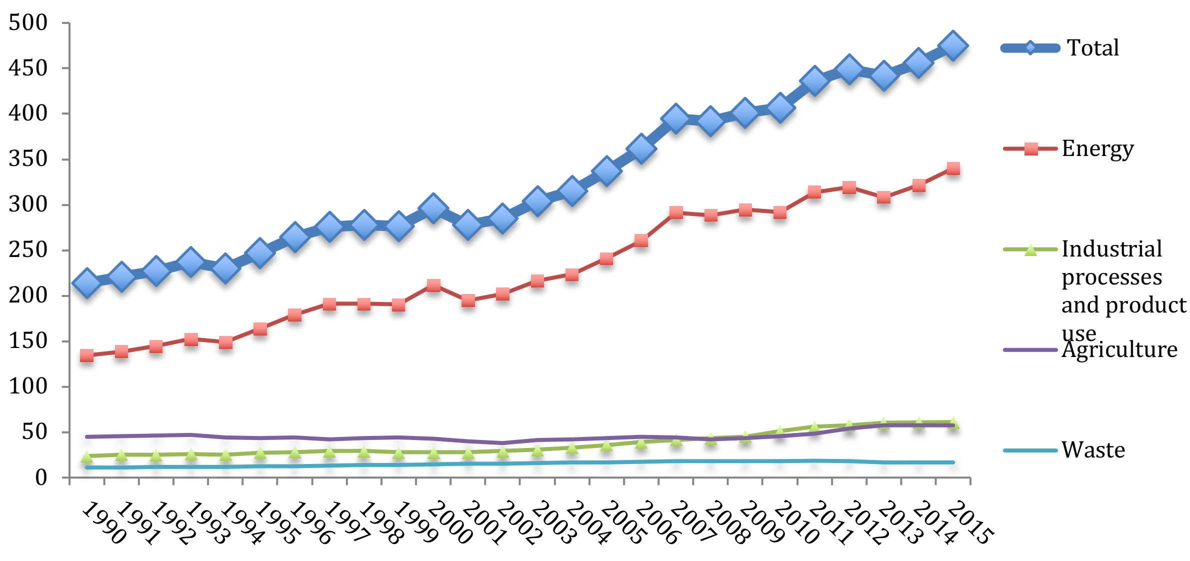
Since the industrial revolution, Turkey has been responsible for only 0.7% of the global emissions. Turkey's greenhouse gas emissions per capita are much lower than the EU and OECD average. In spite of this, the impacts of climate change are already discernible, especially in the Mediterranean region along the southern coast of Turkey. Such notable attributes include alterations in climate parameters, increases in temperature and decreases in precipitation and water exiguity (Kum, et al., 2014 S. 600-608). The International Panel on Climate Change reported that the frequency and intensity of drought is expected to increase in the Mediterranean region (Stocker, et al., 2013). Like the wider Mediterranean and Middle East countries, Turkey will experience mainly decreases in precipitation. Decreases of over 20% are expected in the Southern region of the country, whereas smaller changes between 0% and 10% are projected for the North. These projections show that the average temperature increase in Turkey will be around 2.5-3°C in the North, 3-3.5°C in the Central and South-western regions, and 3.5°C-4°C in the East (Gosling, et al., 2011). The average annual temperature increase between the years 2011 and 2040 is expected to vary between 0.5°C and 1°C (Energy Charter Secretariat, 2014). The scientific research shows that the countries located in the Mediterranean basin will be substantially affected by climate change (MFA, 2012). The amount of rainfall is expected to decrease (mainly in the Mediterranean and South-east Anatolian regions) and increase in the Black Sea area.

Climate change in Turkey has negative impacts on water and soil resources and consequently on rural development. These are vital for food production and food safety. The first signs of global warming were the weakening water resources, desertification due to the reduction in rainfall and ecologic degradation. In this regard, the Konya Basin, the biggest basin of the country and having the most fertile lands, is facing the threat of complete desertification by 2030, in the case that necessary preventative measures are not taken. Furthermore, Gediz and the Greater Menderes Basin in the Aegean coastline, are expected to experience a 50% reduction in surface water by the end of 21st Century (MFA, 2012). The majority of global and regional-scale studies predict declines in maize yields, which is one of Turkey's major crops. Considering land-based food production, Turkey is not projected to face severe food insecurity over the next 40 years. The undernourishment levels in Turkey are very low and the majority of global-scale studies forecast a positive outlook for the impact of climate change on food security within the country (Gosling, et al., 2011).

In the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, for the 2011-2040 period, it is declared that for Turkey, the average increase in temperature is estimated to be around 2.5°C, reaching up to 5°C in inner regions and up to 4°C in the Aegean and Eastern Anatolia areas. The surface temperature is projected to increase all over Turkey by around 0.5°C in winter and 1.0°C in summer (CYGMEN, 2012). During the second period (2041-2070) the amount of growth in surface temperature will be around 1.5°C in winter and 2.4°C in summer (CYGMEN, 2012).

Despite all projections regarding possible climate change impacts, Turkey's approach to international negotiations and national climate change actions are incompatible both to Turkey's vulnerability and its rising greenhouse gas emissions. Based on the Turkish Statistical Institute's data, Turkey's total greenhouse gas emissions reached 475 million tonnes of CO_2 in 2015, from 214 million tonnes of CO_2 in 1990. The country's greenhouse gas emissions have increased more than 120% since 1990 (TurkStat, 2016). Although Turkey is not historically or currently among the top polluters, it is ranked 19th in total greenhouse gas emissions and 81st in per capita emissions (Sahin, 2016) (Figure 24).

Figure 24. Turkey's greenhouse gas emissions in total and by sectors (in mtoe)



Data source: Own illustration based on the data from (TurkStat, 2016).

Economic growth and rapid increase in population have been the main drivers in the increase of carbon dioxide emissions between 1971 and 2010. The energy production sector is responsible for the majority of Turkey's gas emissions: 71% of total greenhouse gas emissions and 83% of carbon dioxide emissions are attributed to the energy sector (TurkStat, 2016). Moreover, the electricity, manufacturing and transportation sectors are counted among the top contributors to energy-related emissions in Turkey. The statistical data shows that there is a constant connection between economic growth and carbon dioxide emissions in Turkey (Sahin, 2016). The leading motive of this constant increase in emissions is the continuous fossil fuel dependency of the Turkish economy.

Turkey's GDP per unit of energy use ranged between $10.9 and $12.0 from 1990 to 2013, while OECD's varied between $6.4 and $8.8 constant 2011 purchasing power parity (PPP) per kilogram of oil equivalent for the same period (IEA, 2015). The country's use of energy intensity is much above the OECD average. Energy intensity is measured by the quantity of energy required per unit output or activity. In this way using less energy to produce a product reduces the intensity (U.S. Department of Energy - Energy Efficiency and Renewable Energy 2012). The energy intensity is the total energy consumption divided by GDP. High energy intensity indicates a high price or cost of converting energy into GDP (Akal 2016). Turkey can reduce its energy intensity through the adoption of energy-efficient technologies and by promoting spheres of production which are less energy-intensive. Therefore, the country needs to focus on the demand side (energy efficiency) substantially and less on the supply side in its energy security policies. In the short-run, shifting emphasis to less energy intensive sectors can be perceived as domestically unfavourable, but in the long-run, it will accelerate Turkey to become an advanced economy. Both technological advances and higher world energy prices contribute to energy use efficiency while lowering energy intensity. Furthermore, higher GDP per capita improves energy efficiency via increasing purchases of energy-saving equipment.

In the early years, Turkey perceived its involvement in international climate policies as a part of international environmental politics. In this regard, the State of Meteorological Institute was the assigned institution to follow the negotiations. The major target of the Institute was to extricate Turkey from the annexes (Sahin, 2016). Only after its exclusion from Annex II in 2001, Turkey started to establish the "National

Climate Change Strategy", to contribute to global efforts to reduce adverse impacts of climate change (while still considering its particular circumstances and capacity). For a long time, the Ministry of Foreign Affairs has been the head of the Turkish delegation during the negotiations (Sahin, 2016). The Ministry of Environment and Urbanisation only began leading the negotiations after 2014, but the influence of MFA on the negotiations is still present. The impact of the economic bureaucracy on Turkey's climate policies is a significant element in Turkey's institutional background. The Ministry of Development and the MENR have been the representatives of Turkey's defensive position on climate policies (Şahin 2016). Therefore, energy security issues and conventional development policies took priority over sustainable, environmentally friendly and low-carbon development in the policy strategies of these two ministries. Until the 2009 Copenhagen Climate Conference, the conventional policy of the Ministry of Development sided with the implementation of environmental policies as long as they did not harm economic development (Şahin 2016). Although the importance of sustainable environmental policies was mentioned in the development goals of the Turkish Ministry of Development, the integration of these policies to economic and social policies have not been optimised. MENR's policy approach aims to increase the utilisation of renewable sources, but still promotes coal to become major national source in its energy policy.

Turkey's "National Climate Change Strategy" program includes a set of objectives to be implemented in the short-term (undertaken or completed within one year), mid-term (within 1 to 3 years) and long-term (over a ten-year period).

The short-term strategies are (CYGMEN, 2010);

- the maximum utilisation of all domestic resources, primarily hydro and wind with cleaner production technologies and best available techniques,
- installation of renewable energy systems at new buildings,
- installation of solar power collectors for central heating and sanitary hot water at new hospitals, hotels, dormitories, sport centres and other non-residential buildings used for accommodation purposes.

The midterm strategies are (CYGMEN, 2010);

- the evaluation of energy efficiency potential in the construction sector and identification of energy efficient construction and material technologies,

- utilisation of low and zero greenhouse gas emission technologies, primarily renewable energy, nuclear power and clean coal technologies,
- rehabilitation of existing thermal plants and more efficient operation of hydroelectric power plants.

The long-term strategies are (CYGMEN, 2010);

- increasing the share of renewables in total electricity generation up to 30% by 2023. Within this framework, full utilisation of economic and hydro potential is targeted. Wind power generation capacity will be raised to 20.000 MW, and geothermal electricity generation capacity will be increased to 600 MW. Electricity generation from solar PV will be promoted.
- Reducing energy intensity by 2020 with respect to 2004 levels,
- decreasing greenhouse gas emissions from electricity generation to be 7% less than the Reference Scenario 2020.

Turkey enhanced its institutional capacity (especially after 2004) with the support of international organisations such as the United Nations Development Program, the Regional Environmental Centre for Central and Eastern Europe (REC)-Turkey and the EU (Sahin, 2016). Nevertheless, a lack of transparency (like non-transparent economic projections), participation and deliberation, still constitute the characteristics of the climate policy field of Turkey (Sahin, 2016). For example, Turkey submitted its "Intended National Determined Contribution" in September 2015, which includes a greenhouse gas reduction decrease of up to 21% from business-as-usual in 2030. Nevertheless, the report did not include Turkey's greenhouse gas emission projects and an emissions peak date, which essentially represent the most important chapter of the report. One of the primary reasons of this secrecy is the insufficient research-based policy making in the climate change policy field rather than a lack of scientific expertise or technology (Sahin, 2016). Other reasons could be that the 2023 energy vision of Turkey to quadruple its coal-fired energy generation capacity. According to this aim, Turkey's gas emissions could peak any time before 2030. This approach could also be attributed to the unwillingness of the Turkish government to adopt sound mitigation policy (Sahin, 2016) due to the fears of scant economic growth.

Turkey will be confronted with air and water pollution as long as the proportion of fossil energy sources in total energy consumption increases. Based on the World Health Organisation's 2012 report, which includes data from the year 2011 on air pollution in cities around the world, seven provinces of Turkey are in the first fifty polluted cities in global terms (Gürbüz, 2014). To ensure cleaner air and water for its environment and also for its citizens, Turkey needs to avoid fossil fuels and head towards the utilisation of renewable energy resources like hydropower, wind, solar photovoltaic and biomass, in which the country shows maximum potential.

As it is indicated in Article 2, the long-term goal of the Paris Agreement is "to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century" (UNFCCC 2015b). The era of the Paris agreement is a great opportunity for Turkey to emancipate itself from its path of energy dependency. Through this, the country may observe the co-benefits of low carbon development policies, such as improving air quality, embracing new energy efficient technologies and enhancing welfare benefits (Sahin, 2016). On the one hand the country is increasing the share of renewable sources in its total installed capacity gradually each year. On the other hand, it still has ambitious coal-friendly energy policies, which are jeopardising its climate policy commitments. If Turkey wishes to achieve the use full potential of renewable energy sources and speed up the deployment in support of climate goals by 2030, the next phase of renewable energy growth requires the adoption of regulatory and administrative changes (IEA, 2016).

8. CONCLUSIONS AND POLICY RECOMMENDATIONS

This thesis aimed to analyse the contribution, role and potential of renewable energy sources in the pursuit of Turkey's energy independence, which would in turn, increase the country's energy security. Furthermore, the thesis elucidated the fact that Turkey has sufficient amounts of renewable energy resources to achieve a gradual independence from external fossil energy imports. Turkey, with its geographical position in the middle of energy-scarce (consumer) and energy-rich (producer) Asian and European countries, plays a significant and emerging role as an energy hub. The country itself is deficient in domestic conventional energy sources (except charcoal) and is highly dependent on fossil fuel imports, particularly natural gas and oil. In geopolitical and geostrategic terms, Turkey is a significant country. It hosts many existing and proposed international oil and gas pipeline projects, which pass through the country's territories. Nevertheless, the pipelines are under the influence of domestic, external political and security challenges, which threaten the energy security of Turkey remarkably. These challenges undermine the development of energy projects and disambiguate the evaluation of Turkey's own energy potential and resources. As a result of the rapid economic growth, the country's energy demand has increased incrementally over the last decades. In order to meet the energy demand, fossil fuel imports were raised substantially, which impose a serious burden on Turkey's current account deficit and price stability. Nonetheless, Turkey has abundant potential for all types of renewables, including hydro- and wind power, solar, geothermal and biomass, which are sufficient to compensate with Turkey's energy gap. By establishing elaborative climate and energy policies and support mechanisms which address the variable distribution of renewable sources, Turkey could increase the electricity generation share from each renewable energy source in its total primary energy supply. Increasing the proportion of renewable energy sources in the energy mix and the gradual abandonment of fossil fuel energy sources are the only compatible and sustainable solutions for Turkey to achieve its transfer to a post-fossil fuel energy era, sustain its long-term energy independence, increase its supply security and contribute to the gradual reduction of greenhouse gas emissions.

Based on these assumptions, the following conclusions and policy recommendations can be provided:

- **Implementation of a "multi-dimensional energy policy":** The country must diversify its energy supply sources and routes, secure its energy hub role in the geopolitical arena as a reliable energy partner while also realising a gradual reduction of conventional energy resources and increasing the share of renewable sources in the country's total energy mix.
- **Withdrawal of energy strategy:** The Turkish government should withdraw its energy strategy, which aims at the full capacity utilisation of domestic coal, including nuclear energy, into the total energy basket. Otherwise, further dependence on conventional sources will jeopardise the energy goals of Turkey, increase energy dependency, reduce energy security, increase greenhouse gas emissions and contradict with country's climate commitments.

- **Reduction of energy dependence:** A high incidence of growth has been observed in Turkey's energy demand, in parallel with demographic and economic expansion over the last two decades. The rising demand is met, to a large extent, through natural gas, coal and crude oil imports, which increase the country's energy dependence on foreign imports and its long-term current account deficit. There are two certain aspects, which could help to reduce external energy reliance: increasing energy efficiency and the gradual shift from fossil to renewable energy sources. In this context, the Turkish government must implement a coherent energy policy in harmony with its national strategies (so called *milli strateji*). Turkey can achieve this by putting more emphasis on the expansion of renewable energies and energy efficiency measures. This will allow Turkey to be more self-sufficient in its energy necessities and to implement a sustainable and environmentally friendlier climate action to achieve a significant reduction in national greenhouse gas emission rates.

- **Re-drafting current energy policies:** Turkey's energy demand has been increasing in parallel with its economic growth for many decades. The country is highly dependent on hydrocarbon imports, which add evermore to its energy bill and thus increase its current account deficit. Turkey should redraft and implement a coherent energy policy by putting more emphasis on reliable climate action and sustainable energy policies such as the expansion of renewable energies and energy efficiency measures. By implementing efficient and convenient energy policies, the country can be self-sufficient in its energy needs. In line with this purpose, the utilisation of renewable energy sources is vital for Turkey to ensure a long-term energy independence and avoid hydrocarbon imports, which are subject to domestic and external political and security challenges.

- **Non-inclusion of shale gas:** Based on the exploitation results, it is proven that Turkey has vast amount of shale gas (around 5.8 trillion m^3), particularly in the Thrace Basin and South-eastern Anatolia Region, which has the potential to contribute to Turkey's primary energy strategy for reducing fossil fuel dependency. Nevertheless, there are some challenges to prevent boosting shale gas extraction such as the lack of technologies and available equipment, high drilling costs, absence of fiscal and regulatory regimes for the shale gas, environmental concerns like water contamination, water scarcity and potential earthquake risks. Therefore, the contribution from shale gas production into the total energy mix of Turkey is not foreseen in the near future. Moreover, the public perception and knowledge regarding the shale gas industry in Turkey is quite low. Therefore, so far there have been no environmental protests in Turkey, particularly in the areas or provinces, which are underpopulated and where the potential reserves have been detected. The lack of sufficient public opinion regarding the ongoing activities also restricts public discussion on shale gas.

- **Inclusion of renewable energy technologies:** Turkey has one of the highest hydropower, geothermal, and wind energy potential among European countries. Its biomass and solar photovoltaic potential are considerably high as well. The continual integration of renewable energy into power generation, as well as adoption of local and small-scale renewable energy projects that serve the local needs (i.e. South-eastern Anatolian Project), will contribute to the country's energy independence. In this regard, besides the new amended laws and regulations, the Turkish government should further promote the purchase guarantees (such as feed-in tariffs) and price incentives for developing the usage of renewable sources for generating electricity.

- **Climate policy challenges:** Since the industrial revolution, Turkey has been responsible for only 0.7% of the global greenhouse gas emissions. Per capita, the greenhouse gas emission of the country are much lower than the EU and OECD average. Through the adoptions of the 'National Strategy on Climate Change' and the 'National Climate Change Action Plan' in 2010 and 2011, Turkey aims to contribute to the collective efforts for combatting climate change in line with its national circumstances and capabilities. Nevertheless, Turkey's coal-friendly energy policy aiming the full utilisation of coal power plants is jeopardising its climate commitments. Furthermore, Turkey's domestic coal production is not solely enough to meet the coal-energy generation targets without the inclusion of coal imports. The imported amount of coal is raising the import bills, which simultaneously puts a burden on the country's economy and contributes to the existing energy dependency. Moreover, Turkish authorities are encouraging mines (like incentives to private companies to invest in thermal power plants, revocation of environmental penalties, lack of a particular climate target) to produce as much coal as possible at a lower price, regardless of the poor and risky working conditions. In order to achieve its national climate targets, the Turkish government should withdrawal its coal-friendly energy policy. Nevertheless, Turkish authorities are still encouraging private coal mining companies, operating under the state-owned mining company Turkish

Coal Enterprises – TKI (*Türkiye Kömür Isletmeleri*); i.e. incentivising multiple companies to invest in thermal power plants and reducing their environmental penalties. This encouragement engenders serious societal and ethical challenges, as these companies are only seeking to produce as much coal as possible at a lower price and hire subcontracted workers to work in inappropriate and precarious working conditions. In this regard, Turkey should opt out of its coal energy programme and target the gradual shut down of coal mines. The government's energy policy aims should be re-oriented towards a more environmentally friendly direction, which dissolves the profit-oriented perception of the agencies.

- **Withdrawal of nuclear plant projects:** The construction of planned nuclear power plants contradicts Turkey's energy policy aims to decrease the external energy dependency. As both proposed nuclear power plant projects – namely Sinop and Akkuyu – are constructed by Japan and Russia respectively, Turkey's external energy dependence will not be terminated. Especially in the case of the Akkuyu nuclear power plant project, the Turkish Government holds no shares in the project company and interacts only as regulator. On the one side, due to the type of reactor, the fuel of the power plant must be produced in Russia, and hence, delivered from Russia. Ultimately, Turkey's energy dependency on Russia will continue and even increase. On the other side, the disposal of waste and reprocessing issues for both power plants remain still unclarified. In this regard, due to the lack of sustainable domestic nuclear infrastructure, unclear frameworks regarding the management of spent fuel and radioactive waste, potential environmental risks and the continuation of non-transparent statements especially regarding the Environmental Impact Assessment Report – CED (*Cevresel Etki Deperlendirmesi Raporu*), both planned nuclear projects should not be pursued. Turkey should immediately withdraw from its nuclear energy programme and head towards the installation of local and national renewable power plants.

- **Extended feed-in-tariffs and incentives for wind power:** Turkey has a high potential for electricity generation from wind power plants, due to its coastal length of 7,200km and high average annual wind velocities. These create the potential for efficient utilisation of the Mediterranean shores, Aegean Sea coast areas and northern and western parts of the Marmara Sea coast. To reach its 2023 target of 20

GW wind power plants, a total installed capacity of nearly 16 GW of wind power plants must be constructed and integrated into the grid between 2015-2023. Due to the high production costs and limited lifetimes of wind turbines, Turkey must invest between $18 and $22.7 billion in total for the construction and operation of wind plants until 2023, which puts a huge burden on country's economy. Furthermore, due to the indefinite number of newly proposed power plants and their investment status, it is not possible to define implicitly whether Turkey will be able to achieve its vision 2023 target regarding the installed capacity of wind energy. Besides the necessity of clear data concerning wind power installations, Turkish authorities need to put new feed-in-tariffs and incentives in place and extend purchase guarantees. Moreover, the construction of wind power plants should be away from the nesting, dispersal, wintering and migration areas of bird species, i.e. especially concerning the Eastern Imperial Eagles. Last but not least, as the amount of electricity generation from wind power plants is very much dependent on wind speeds, air density and turbine characteristics, some necessary measures should be set with the grid connection in order to avoid fluctuations.

- **Re-designation of hydropower projects:** The country needs to add 12,357 MW hydropower installation to its total domestic supply to reach its 36,000 MW hydroelectricity target by 2023. Nevertheless, the calculations state that the construction of plants will be much higher than expected. Therefore, the viable economic potential of the proposed hydropower plants should be widely examined before beginning construction. If feasible, the installation of small-scale (run-of-river) hydropower plants should be considered, as they provide not only electricity and water for both irrigation and drinking purposes, they also create job opportunities in rural areas and prevent migration of local inhabitants. The country also needs to adopt a new water and nature conservation policy to protect the rich biodiversity and normal functioning of ecosystem around the hydropower plants. The construction of new proposed dams and hydroelectric power plants shall first begin when the new policy and legislations on water and nature conservation are enacted and if the installation and operation of proposed new dams and power plants are in line with the new regulations. The design of hydroelectric plants should be developed through a co-creation process, which includes not only the officials of Turkish authorities but also chambers, labour unions, civil society organisations, local inhabitants and other citizens. The inclusion of all related actors into the co-design and co-construction process will enable the operation of hydropower plants, which are compatible with its environment, living species as well as inhabitants. Today, the local people are still forced by the Turkish authorities to abandon their residencies in order to open up the terrains for the construction for dams and hydropower plants. Hence, in parallel to these pending conflicts, the current law permitting the opening of the nature conservation areas to dam and hydroelectric power plant constructions, should be cancelled and redrafted.

Turkey needs to adopt a new water and nature conservation policy to protect the rich biodiversity and normal functioning of ecosystems. The projections regarding the construction of new dams and hydroelectric power plants should be placed on stand-by, until the new policy and legislations on water and nature conservation are enacted. The installation and operation of new dams and power plants should be in line with the new regulations. Moreover, in accordance with the Environmental Law, the authorities should render the full participation milieu of the professional chambers, unions, civil society organisations, local people and other citizens. Turkish authorities should consider the demonstrations of the local inhabitants against the construction of dams, reservoirs and hydroelectric power plants. The violations against the human rights and the forcing of local people to abandon their homes should immediately end. The new law, permitting the opening of the nature conservation areas to dam and hydroelectric power plant construction should be cancelled and redrafted.

The necessity to build large dams and reservoirs should be examined in detail by the authorities. Furthermore, small-scale hydro plants are quite enduring (power plant system can last for 50 years or more with little maintenance). Unlike the other renewable energy sources, they can produce some electricity on demand with no need for storage or backup systems (Dursun, et al., 2011 S. 1233) and consequently, have the capacity to act as an immediate replacement of fossil sources.

- **Expansion of geothermal as local energy source:** Turkey ranks as the seventh richest country in the world and second richest country in Europe with its geothermal energy potential and can produce 5% of its electric energy consumption and 30% of its heat energy consumption. In its "Vision 2023" goals of the Turkish government aims to generate 1,000 MW of electricity from geothermal power generation. With respect to the above-indicated data, there is a substantial increase both in geothermal applications and in electricity generation from geothermal power in Turkey. According to the latest data, Turkey has already achieved its 1,000 MW target. Nevertheless, due to renewable sources accounting for the smallest share of this, geothermal energy can only meet a tiny amount of Turkey's enormous energy demand by 2023. Consequently, geothermal energy should rather be considered as a local energy source than a countrywide energy supply. Moreover, geothermal power may stimulate Turkey to move towards a more decentralised form of electricity generation, where the installed plant meets the necessities of local customers, avoids transmission losses and increases flexibility in system use. Thereby the diversification of power generation plants will be ensured which in turn increases competition in electricity generation.

The geothermal energy facilities should be co-designed, co-developed and co-constructed together with the participation of different stakeholders, such as the local government, energy companies, NGOs, civil society organisations and residents of the planning area. The participation of local people to the co-design process increase the social acceptance and the further development of geothermal energy as a de-centralised energy source in Turkey.

- **Increase of bioethanol and biodiesel production:** Turkey has a substantial amount of wide range biomass sources for the production of biofuels (bioethanol and biodiesel) and biomass-based energy (biogas). The country has an installed capacity of more than 1.5 million t biodiesel plant, including 34 biodiesel facilities. Nevertheless, these plants are not fully utilised due to the low oil seed self-sufficiency ratio and increasing trade account deficit. Therefore, biodiesel production based on oilseeds is not sustainable for Turkey in economic terms. On the contrary, bioethanol production in Turkey seems to be sustainable and can meet the mandatory blending ratio requirement in total biofuel production, as set by the Turkish EPDK. Bioethanol production from sugar beet is a more rational choice than from corn, due to the sufficient plantation areas and the reprocessing of remained molasses as feed and as raw material for the pharmaceutical industry, cosmetic, construction, alcoholic beverages and yeast purposes. Furthermore, compared to corn, sugar beet has less negative environmental impacts such soil degradation, water pollution, and contributes less to greenhouse gas emissions.

- **Inclusion of further biogas plants to the total energy production:** Based on the "Vision 2023" targets of the Turkish MENR, the government intends to increase use of biomass-based energy generation to 1,000 MW by 2023. The country uses two bioenergy pathways to obtain electricity from biomass sources: direct combustion from combined heat power (CHP) plants and biogas plants. Based on the outcomes, the most promising crops in terms of quantities, energy potential and cost for the electricity generation from CHP plants are corn cob and corn husk. Hazelnut shell, groundnut husk, cotton stalk, hazelnut husk, soybean husk, sunflower head and rice husk are also profitable feedstock, which could be used for electricity generation. The total production capacity of these crops ranks 243.4 MW. From the electricity generation in biogas plants, the assessments prove that sunflower heads, cattle manure and poultry layer are the most promising feedstock. Based on the calculations, Turkish provinces would achieve a total combined production capacity of 768 MW from biomass. 243.4 MW production is expected to be obtained from CHP combustion plants for direct residues. Ultimately, Turkey will reach a total capacity of at least 1,011 MW generated electricity. This amount will be sufficient to meet Turkey's energy target for biomass by the year of 2023. Nevertheless, similar to geothermal, the contribution of biomass-based energy to Turkey's total energy production remains low and insufficient.

- **Sustentation of solar power plants:** Owing to its climatic conditions and geographical location, especially in the southern region, Turkey has substantial potential for solar photovoltaic and solar heating. The estimated average sunshine duration ranks 7.2 hours per day, and the solar radiation ranks 3.6 kwh m^2/day. Despite this immense potential of solar power across the country, there are still no large-scale solar power installations. Solar energy is mostly used for water heating, greenhouse heating and for drying agricultural products. In its "Vision 2023" targets, the Turkish government aims to reach 3,000 MW electricity generation from solar energy. Despite its 580 MW installed solar photovoltaic capacity and rapid installations in the last years, reaching the energy target does not seem feasible. Solar photovoltaic creates much more employment possibilities in comparison to other renewables, in its construction, maintenance, installation and operation stages. Therefore, the construction of large-scale solar photovoltaic panels and power stations should be promoted through incentives, feed-in tariffs and purchase agreements by the state authorities. Consequently, if further installations are continued and promoted by the Turkish authorities, solar energy, with its high potential for electricity generation, could be the foremost renewable energy source to increase Turkey's energy independence.

- **Increasing social awareness regarding renewable energy:** The public perception and the awareness of Turkish people regarding the renewable energy sources remain low. According to the results of the survey, performed by the Kadir Has University in Turkey in 2016, 14.2% of 1,200 respondents have no idea regarding the government's renewable energy policy. Despite sufficient promotions, inadequate incentives and lack of regulations for the particular renewable energy sources (such as biomass), 34.9% of people think that the government's renewable energy policies are going well. The majority of the respondents who find the government's renewable energy policies to be in a good situation, are supporters of AKP and MHP, the nationalist right-wing parties. 3.6% of respondents think that Turkey's biggest 5th problem is that the Turkish government does not use the renewable energy potential sufficiently. A huge majority of people (69.9%) find that the biggest energy problem in Turkey is "high energy prices". 62.3% of people complain about the "external energy dependency". 20.3% of respondents remark that the potential of renewable energy is used by the government inefficiently. Although knowledge regarding the renewable energies remain low, 39.5% of respondents raise their voice to say that Turkey should aim to use renewable energies rather than fossil energy, despite the higher related costs.

Under these circumstances, it is clear that government incentives and support for the utilisation of renewable energy sources are not solely enough. Especially for the gradual ascending of local power plants (such as geothermal), public awareness and social acceptance play a very important role. The local renewable energy projects should be installed through the co-design and co-creation process with the inclusion of a broad range of stakeholders coming from industry, civil society organisations, universities, research institutes, investors and citizens. Moreover, the government authorities as well as the universities should organise seminars and activities to inform the citizens regarding the benefits of utilising renewable energy sources, in order to increase the public knowledge and awareness.

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