Federal coordination of complex policy issues in the energy transition: hydrogen governance in Germany

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Panel: Policy Analysis at the Sub-National Level

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Introduction

While being discussed as a potential energy carrier since the 1970s, Hydrogen is again at the center of political debate due to the need for a decarbonization option for hard-to-abate sectors and an alternative to direct electrification (Scita, Raimondi, and Noussan 2020). Therefore, numerous governments have recently formulated hydrogen strategies outlining goals and measures to promote technology development (Albrecht et al. 2020) and build international partnerships to cover their anticipated demand for the 'New Oil' (van de Graaf et al. 2020). Hydrogen seems to play an increasing role not only for national governments but also at the subnational level: In Germany, 14 of 16 states (*Bundesländer*) have so far formulated regional hydrogen strategies since 2019, either alone or in cooperation (Knodt et al. 2022).

Taking Germany as a case, we explore the role of hydrogen at the regional level and analyze the multi-level integration of technology development from scratch, i.e. the *market ramp-up of hydrogen technologies*. Due to the distribution of competencies in German federalism, the German states are responsible for the implementation of a large share of national energy policies. Monstadt and Scheiner (2016) as well as Wurster and Hagemann (2018) indicate that the German states take regional approaches to energy policy implementation that can produce effective solutions in competition with each other but are also subject to redistributive conflicts. Complementary responsibilities combined with uncoordinated action have been recently identified by scholars as a major barrier to a coherent and effective energy transition in Germany (e.g. Benz 2019, Chemnitz 2019).

The integration of hydrogen is likely to increase the complexity of energy policy coordination in the multi-level system. On the one hand, there are spatial questions

regarding the efficient and politically feasible allocation of hydrogen production, hydrogen consumption, and the associated infrastructure. On the other hand, the main strategic purpose of hydrogen is the system integration of renewable energy, by coupling the so far separated sectors of electricity, heat, mobility, and industry which poses a complex multi-level governance problem (Kemmerzell and Knodt 2020).

To explore the federal dimension of hydrogen ramp-up in Germany, we first identify coordination problems of energy governance in federalism. Secondly, we discuss the concept of coordination and develop our approach, based Metcalfe's coordination scale (1994) in combination with Scharpf's ideal types of coordination (1994) and the typology of multilevel coordination of Christensen and Lagreid (2008). Thirdly, we will introduce our methodology and strategy of data collection. In the main section, we present the findings on hydrogen coordination, highlighting three questions: (a) which role does hydrogen play across the German states, (b) which hydrogen policies do they conduct or plan, and (c) how are regional strategies coordinated horizontally and vertically? In the discussion of the findings, we will assess the patterns of realized coordination processes. We conclude with the identification of future research questions in federal hydrogen governance.

Literature review: Energy transition with German federalism

In federal systems, the energy transition is affected by the allocation of competencies between the national and subnational levels. At the same time, transition processes can challenge federal structures, since they often have an impact on the decentralization of energy supply structures. This is issued by a developing research area around so-called *energy federalism* (Boute 2013; Rossi 2016), which explores the various federal configurations between fragmentation and concentration of energy competencies

(Balthasar, Schreurs, and Varone 2019, 4). Central questions are how energy politics are embedded in multi-level structures, what are the consequences for policy making and implementation, and – from a more normative perspective – which governance mechanisms can enhance transition dynamics. One strand of the literature deals in particular with the role of subnational levels in national energy transition processes (ibid.). Karapin (2020) shows how the highly autonomous states in the U.S. experiment with policy instruments. They can drive innovation and facilitate the expansion of renewable energies under competitive federalism, even in the context of conflicting ambitions of the federal administration. At the same time, their position enables states with conflicting interests to delay transformation processes regionally (18). The role of subnational levels both as frontrunners and laggards in energy and climate policy has also been discussed for India (Jörgensen, Mishra, and Sarangi 2015), Russia (Boute 2013), Switzerland (Ejderyan, Ruef, and Stauffacher 2020) as well as Austria, Belgium, and Germany (Wurster and Hagemann 2020). Variance in subnational energy policies, resulting from a certain level of autonomy and/or a lack of coordination, can hamper energy market development, as Saurer and Monast (2021) show in a comparison of renewable energy policies and the associated infrastructure development in Germany and the USA.

For the German case, the latter finding may seem intuitive, as Lijphart (2012, 178) classifies Germany as a 'federal and decentralized' system. However, energy legislation is predominantly centralized at the federal level, as they are part of the so-called *concurrent legislation*, which includes almost all legal instruments of energy market regulation, whereby the states can only take action if there is no federal regulation in place (Ohlhorst 2015). However, the German states participate in national energy legislation through the *Bundesrat*, the central institution of German cooperative

federalism, which has a veto right in areas where the state's fiscal and administrative affairs are affected, as well as in the case of constitutional amendments, and a suspensive veto in all other procedures. But as Benz (2019, 301) notes, the Bundesrat played recently a minor role in federal energy policy-making since its former strong influence on grid development was limited to a suspensive veto.

The situation is quite different when it comes to implementation. Through competencies in spatial planning, nature conservation, and construction (Ehlers and Böhme 2011), the German states can significantly influence the implementation of federal policies. By setting minimum distance requirements for wind power plants Bavaria and North Rhine-Westphalia, for example, effectively stopped the expansion of wind energy promoted by the Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz* – EEG) in their jurisdictions (Saurer and Monast 2021, 13).

Besides regulatory measures, the German states can use financial and administrative instruments to shape regional energy systems. While the EEG has exhausted opportunities for regional support of renewable energies in electricity generation, the states can add particular policies where the federal government does not provide any legal support schemes, for example in renewable heating (Münzner 2014, 49). Since the states have also the authority for regional economic development, they can influence location decisions and support regional economic cooperation and networking (Weidner and Eberlein 2009). In particular, the establishment of energy regions (Monstadt and Scheiner 2016, 182), and R&D funding (Ohlhorst 2015, 308) are part of the toolbox of the states.

The states can also shape energy policy through administrative action, by setting 'green' rules for public procurement (UBA 2020) and establishing energy agencies that provide information. In addition, the states act as intermediaries between regional actors

and higher levels, for example in the acquisition of funding from programs of the federal government or the European Union (Ohlhorst 2015, 308).

According to Monstadt and Scheiner (2016, 183), the centralization of legislative powers leads to a *de facto unification*, which severely restricts competitive dynamics among the states and precludes opposing policies (see Abromeit 1992 for the original argument on de facto unification). Nevertheless, many researchers demonstrate that the states can effectively accelerate or slow down the progress of the energy transition within the framework of the possibilities described above (Galvin 2018; Ohlhorst 2015; Schönberger and Reiche 2016; Wurster and Köhler 2016). Not only geographical conditions, such as suitable areas for wind energy, influence state policies (Schönberger and Reiche 2016, 41), also patterns of regional employment and voting (Goetzke and Rave 2016) as well as dynamics of party politics in case of grid expansion (Fink et al. 2019). In light of diverging interests between the states and their impact on energy policy, Ohlhorst, Tews, and Schreurs (2014, 99 pp.) call for coordination within and between levels as a prerequisite for a consistent and thus efficient energy transition. Coordination arrangements, as an integral part of German federalism, are indeed well established in energy politics, e.g. in form of working groups, commissions, and ministerial conferences (Monstadt and Scheiner 2016, 182). However, they have been criticized for their inefficiency (BRH 2018) resulting partly from the marginalization of obligatory bargaining and the rise of voluntary coordination (Benz 2019).

The concept of coordination

To capture the coordination processes in a descriptive-analytical way, we first need to specify the ambiguous concept of coordination. Fortunately, there is an extensive strand of public administration literature on this ‘oldest problem of the public sector’ (Peters

2015, 10), starting with early organization theory (Gulick 1937) up to the debate on governance as 'structured action coordination' (Sack 2013, 93), which continues to this day. Therefore, a variety of concepts describe coordination, including *policy integration* (Briassoulis 2004), *policy coherence* (May, Sapotichne, and Workman 2006), or *joined-up government* (Bogdanor 2005), which at the same time creates a 'conceptual elusiveness' (Husted and Veit 2014, 18).

In their essence, most or even all concepts understand coordination as a necessary consequence of the division of labor and specialization in public administration, which leads to 'selective perception' (Dearborn and Simon 1958). Thus, specialization ensures efficient handling of limited problems, but at the same time administratively reproduces interdependencies in the socio-economic environment of the organization (Scharpf 1972, 169). In this context, the handling of a complex problem by a specialized organizational unit hardly seems possible, which is why politics and public administration with their traditional boundaries face more often difficulties in more and more globalized and interconnected societies (Trein et al. 2020). On this basis, we understand coordination following Malone and Crowston (1994, 90) as 'the act of managing interdependencies between activities performed to achieve a goal'. Since this general definition is lacking specific dimensions, we specify three concepts in the following, which we use in combination as a heuristic device for our investigation.

Our analysis applies Christensen and Lægreid's (2008) distinction between a horizontal-vertical dimension and an internal-external dimension of coordination in multi-level systems. The observed coordination processes will be categorized according to the resulting four types (Table 1), locating the former in the federal structure of Germany. Thus, we examine how the German states' hydrogen strategies are

coordinated within state governments and with external actors, upwards and downwards the vertical structure.

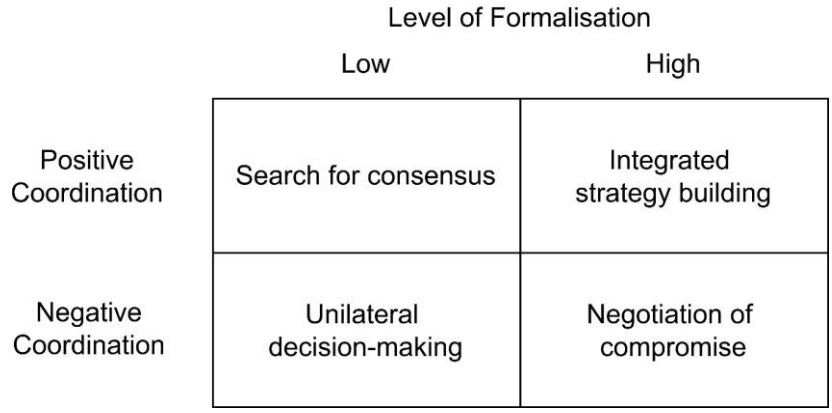
Table 1: Different coordination forms for German states.

	Horizontal coordination	**Vertical coordination**
Internal coordination	Coordination between different ministries, agencies, or policy sectors	Coordination between parent ministry and subordinate agencies and bodies in the same sector
External coordination	Coordination with civil society organizations/private sector interest organizations	Coordination (a) upwards to [federal government] or, (b) downwards to local government

Source: Christensen/Lægreid 2008, 102; adopted by the authors

Going beyond identifying and locating the coordination of state hydrogen strategies, we also want to discuss its intensity or 'level of ambition' (Danken 2017, 17). In this regard, Metcalfe's coordination scale (1994, 281) is regularly applied. It distinguishes the 'coordination capacity' of governments into nine levels between 'independent decision-making' by ministries and an – more idealized – 'overall government strategy'. High coordination capacity requires formalization of coordination in form of *ex-ante* or *ex-post* defined processes such as joint working groups or arbitration mechanisms. Non-formalized, mainly voluntary coordination processes indicate low coordination capacity. Scharpf's ideal typical modes of positive and negative coordination also allow statements about the ambition of coordination processes. Positive coordination means joint decision-making under simultaneous problem processing, based on a common problem definition, and to achieve a maximum collective benefit. Negative coordination describes the search for a Pareto-efficient solution: actors are involved to examine to what extent a policy initiative negatively affects them compared to the status quo (Kemmerzell and Knodt 2020, 367; Scharpf 1994, 38).

Figure 1. Patterns of coordination



For the discussion, we will use a combination of Metcalfe's and Scharpf's concepts and define four patterns of coordination, depending on the coordination mode applied and the degree of its formalization (Figure 1). Thus, negative coordination can be differentiated in *unilateral decision-making*, where alignment with the position of other actors is voluntary, and *negotiation of compromise*, where the approval of other actors is necessary for decision making in formalized structures. *Search for consensus* represents positive coordination in rather informal structures aimed at a common but non-binding agreement, while *integrated strategy-building* represents formalized positive coordination leading to a joint decision.

Data & Methodology

As described at the beginning, we examine (a) which role hydrogen plays at state level, (b) which hydrogen policies are planned/applied by the states, and (c) how state policies are coordinated in the multi-level system. To explore these questions, we use a qualitative research approach based on official documents and interview data.

As the first step, we assessed strategy documents of the state governments. So far, all German states except Berlin and Rhineland-Palatinate have published hydrogen strategies or road maps. In total, there are 12 strategy documents, since the northern

German states (Bremen, Hamburg, Mecklenburg-Western Pomerania, Lower Saxony, and Schleswig-Holstein) have published a joint *Northern German Hydrogen Strategy* and only Schleswig-Holstein has issued a separate state strategy. The eastern German states of Brandenburg, Saxony, and Saxony-Anhalt have published a joint strategy document in addition to their state strategies.

While it is already possible to gather information on our research questions (a) and (b) from the strategy documents, they are not sufficient to make qualitative statements about coordination processes. To address our research question (c) properly, process knowledge about the formulation and implementation of the different hydrogen strategies is required. Therefore, we conducted 14 expert interviews (via web/phone conferences) with representatives of the responsible ministries in the state governments to collect additional data in a yet new field of action. The interviews were conducted with heads or desk officers of the units responsible for formulating the hydrogen strategies. The interviewees were identified via publicly available organization plans and subsequent personal correspondence. Some of the interviewees are assigned to the ministries of environment and some to the ministries of economics, as the formal or de facto responsibility for hydrogen varies among the states. As to create a trustful setting and to increase the willingness to provide information, the interview partners were assured of anonymity. The expert interviews followed a semi-structured approach, enabling general comparability between the different interviews while allowing interviewees to provide additional insights. For structuring the interviews, a guideline was formulated that operationalized the research questions into four thematic complexes and 15 interview questions. Themes include (1) the interviewee's professional position and policy beliefs, (2) process and context of strategy formulation and implementation, and (3) horizontal as well as (4) vertical coordination.

To structure the data from the documents and interviews as well as to ensure a certain degree of reliability, we applied qualitative content analysis (Mayring 2014). For this purpose, we developed a category system based on a literature review. Document coding was conducted with the MAXQDA software.

Findings

In this chapter, we present the key findings from the coded segments organized by our research questions. We use references from the strategy documents and interviews, which we abbreviate for better readability (Table 2).

Strategic perspectives on hydrogen at the regional level

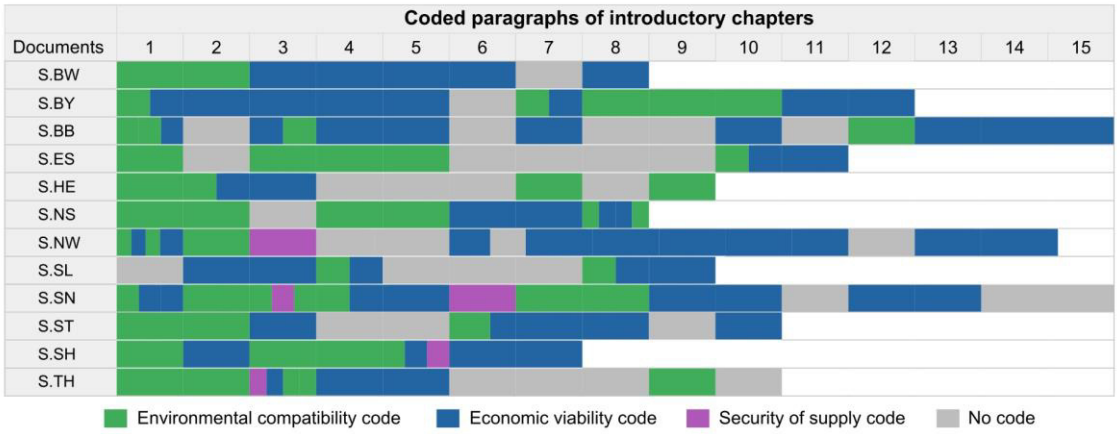
We used the category *relevance* to code segments in the strategy texts, where the general importance of hydrogen for the three energy policy objectives, environmental compatibility (here mostly climate mitigation), economic viability, and security of supply is addressed (Schubert et al. 2015, 46). Figure 1 compares the respective codes in the introductions of the strategies per paragraph. It indicates that climate mitigation plays a central role and serves as a general justification for hydrogen technology development. This is followed among all strategies by a strong emphasis on economic viability, as positive effects of technology development on the regional economy are expected. In contrast, security of supply is addressed in only some of the strategies, and even there it mostly comes second.

Table 2. Used abbreviations for states, interviews and strategies

State	Abbreviation	Interview-ID	Strategy-ID	Joint-Strategy-ID
Baden-Württemberg	BW	I.BW	S.BW	-
Bavaria	BY	I.BY	S.BY	-
Brandenburg	BB	I.BB	S.BB	S.ES
Bremen	HB	I.HB	-	S.NS
Hamburg	HH	I.HH	-	S.NS
Hesse	HE	I.HE	S.HE	-
Lower Saxony	NI	I.NI	-	S.NS
Mecklenburg-Vorpommern	MV	I.MV	-	S.NS
North Rhine-Westphalia	NW	I.NW	S.NW	-
Saarland	SL	I.SL	S.SL	-
Saxony	SN	I.SN	S.SN	S.ES
Saxony-Anhalt	ST	I.SA	S.ST	S.ES
Schleswig-Holstein	SH	I.SH	S.SH	S.NS
Thuringia	TH	I.TH	S.TH	-

Apart from the similarity in the overarching objectives, there are differences in the strategic orientation. In their respective joint documents, both the Northern German states as well as the Eastern German states focus on hydrogen production. The former because of high wind energy potential in the North and Baltic Sea [S.NS, 10], and the latter as a possible reaction to the structural change caused by the phase-out of coal-fired power generation [S.ES, 3]. In contrast, the strategies of the southern states (BW, BY, HE, TH) focus primarily on promoting the development and marketing of technologies and components in the hydrogen value chain. This also applies to the strategies of North Rhine-Westphalia and Saarland, but with an additional focus on decarbonization of the regional energy-intensive industry, especially steel production [S.NW, 9; S.SL, 20].

Figure 2. Comparison of strategies by introductory chapters



Differences between the strategies are also evident in the politicized question of how hydrogen should be produced, which we captured with the *production* category. Although all strategies state that hydrogen should be produced exclusively by renewable energies (*green*) in the long term, some states advocate for the temporary use of hydrogen produced from fossil sources. For example, Hesse emphasizes hydrogen production via pyrolysis of methane and 'by-product hydrogen', (already) produced in the local chemical industry via grid electricity [S.HE, 4]. In addition to pyrolysis, the Eastern German coal states, Thuringia and North Rhine-Westphalia highlight the production of *blue* hydrogen via steam methane reforming in combination with carbon capture and storage (CCS) as a viable option for a 'fast and cost-efficient market ramp-up' [S.NW, 10].

With *import* we coded all statements on the expected share between domestic hydrogen production and imports. All states expect high demand for hydrogen imports in the future. Nevertheless, the need for domestic production is also emphasized by all states, both by those with limited capacities to be able to cover short-term demand [I.BW; I.SL] and to demonstrate technological competence [S.BY, 10], as well as by the above-mentioned states that emphasize economic opportunities of hydrogen production.

Table 3. Addressed end-use sectors for hydrogen in state strategies (NS: Northern states aggregated)

		BW	BY	BB	HE	NS	NW	SL	SN	ST	TH
Industry	Steel	o	o	o	o	+	+	+	+	-	o
	Chemicals	o	o	o	+	+	+	-	+	+	o
	Refineries	+	o	+	-	o	+	-	o	-	-
	Other	+	o	o	+	o	o	o	o	o	+
Heating	Buildings	o	o	o	o	o	+	-	o	-	-
	CHP (central)	o	o	o	+	-	+	+	o	-	o
	Blending (Gas grid)	-	o	+	o	o	+	-	-	-	o
	Other	-	-	+	-	o	o	-	-	-	o
Mobility	Aviation	o	o	o	+	o	o	o	+	o	o
	Heavy-duty transport	+	+	+	+	+	+	+	+	+	+
	Passenger cars	+	+	o	-	o	+	o	o	o	o
	Shipping	o	o	o	o	+	+	o	o	o	o
Power generation		o	o	o	-	o	+	-	+	-	o

(+ = strategic field of action, o = relevant, but no measures defined, - = not addressed/not relevant)

Besides the supply side, all strategies make statements about expected demand and a potential sector allocation (Table 3). The focus areas are partly determined by the industrial structure, e.g. by the cement industry in Baden-Württemberg or the glass industry in Thuringia. The only sector with a high degree of similarity is mobility, where all states have defined heavy-duty transport (trucks, buses, etc.) as a field of action. Heating, on the other hand, is defined as an area for action by only a minority of states, although some see long-term potential, especially in combined heat and power generation (CHP).

Regional hydrogen policies

To achieve their strategic objectives, the states define instruments for promoting the market ramp-up of hydrogen technologies in their strategies. As described above, the *toolbox* includes regulatory instruments to a lesser extent, but financial support, administrative action, and planning policy, for which we have defined corresponding codes.

Financial support appears to be the main policy instrument. In most strategies, direct funding for corporate capital expenditures in hydrogen projects and industrial research and development has been announced. Some strategies announce specific funds, i.e. the *Landesförderprogramm Wasserstoff* [S.SH, 8], others the integration of hydrogen into existing funding programs [S.NS, 28]. As is common in regional economic development, the states act as intermediaries between regional industry and upper political levels also in hydrogen funding. Brandenburg and Saxony-Anhalt, for example, developed a funding program under the European Regional Development Fund [I.BB; S.ST, 10]. For Hesse, the subsidies announced in the National Hydrogen Strategy stimulated the release of an integrated state strategy 'to benefit maximally from these funding billions' [I.HE]. In addition to financial support for corporate projects, the states financially promote research and knowledge diffusion, via tendering feasibility studies [I.NW, I.ST], or enhancing research capacities at universities [S.BW, 22; S.SL, 17].

When asked about financial support instruments, our interview partners particularly highlighted the *Important Projects of Common European Interest* (IPCEI). These IPCEIs are private projects that can be notified by EU Member States to the European Commission and, if accepted under Communication 2014/C 188/02, are subject to special state aid rules. In its National Hydrogen Strategy, the federal government chose this instrument to enable large-scale subsidies for hydrogen projects under European competition law. During an expression of interest procedure (from January 14 to February 19, 2021), companies planning to undertake hydrogen projects were able to apply by submitting project outlines. On May 28, 2021, the Federal Ministry of Economics selected 62 projects to be notified to the European Commission as IPCEIs (at this stage, the approval process is still ongoing). It is planned that the

public funding of IPCEIs will be covered 70 percent by the federal government and 30 percent by the states. In total, 8 billion euros in state aid has been requested, of which 3.5 billion is to be contributed by the German states.[1]

Four instruments of administrative action can be identified. Firstly, all states – except Baden-Württemberg – mention public procurement, mostly for state and municipal fleets, as a suitable option to promote hydrogen technology development [S.NS, II]. Secondly, some states plan to avoid uncertainty and long processing times in the permission process for hydrogen facilities by simplifying administrative procedures and providing information and professional training [S.BB, 49; S.NS, 33; S.ST, 20]. In general, the provision of information for and networking of regional actors can be seen as a further field of action. These tasks are partly delegated to the regional energy agencies, and partly new institutions are established, such as *H2.B* in Bavaria [S.BY] or the *Saxony Hydrogen Competence Office* [S.SN, 11]. To enhance public acceptance, some states announced to strengthen the role of hydrogen in education [S.BB, 55] as well as to establish participation procedures and citizen dialogues [S.BW, 11].

Furthermore, cluster policy, a mix between financial support and administrative action, seems to be a popular instrument. With regional hydrogen clusters, the states initiate and finance organizational structures in which regional actors can network and enter into cooperative ventures, ultimately achieving a concentration of hydrogen activities [I.HB]. Saxony, for example, has established a separate hydrogen cluster [S.SN, 21], and other states are planning to integrate hydrogen into existing energy clusters [S.BW, 26; S.NW, 35; S.HE, 21; S.BW, 26].

Spatial planning is hardly addressed in the strategies. The need to expand renewable energy generation is frequently mentioned. However, almost no planning instruments are issued for the often announced hydrogen hubs. Only in the strategy of

Saxony-Anhalt ‘priority areas of sector coupling’ are mentioned [S.SN, 12]. The Ministry of Environment, responsible for the strategy, already aspired to include this tool in the strategy, but the Ministry of Transport, responsible for planning, doubted its legal basis [I.SN].

It became clear that all states align the policy instruments in their hydrogen strategies with the purpose of technology development. In the following subsection, we examine to what extent the states coordinate their efforts within the federal system.

Coordination of state hydrogen policy

Horizontal-internal coordination

Horizontal-internal coordination includes coordination between ministries within state governments. In the formulation of the hydrogen strategies, the states differ significantly in this regard.

In Bavaria, North Rhine-Westphalia, and Saarland, the ministries of economics and, in Baden-Württemberg, the ministry of environment didn’t share competencies with other ministries and thus were solely responsible for formulating the strategies. While in Baden-Württemberg, Bavaria and North Rhine-Westphalia the formulation was followed by a joint decision of the state government, in Saarland the strategy is primarily one of the Ministry of Economics, although informally discussed with other actors in the state government [I.SL].

The situation was different in three eastern German states (SA, ST, TH) and Hesse. There, the formulation was coordinated in existing or specially established interministerial working groups (IMWGs) at the technical level to gather information [I.HE], to cover turfs [I.SN] and also to anticipate party-political conflicts in the respective coalition and find compromises [I.ST].[2]

In Hesse and Saxony, however, the IMWGs were unable to prevent party political differences from delaying the publication of the strategies by several months after the formulation on the expert level was already finished.

Due to the agenda-setting of the joint strategy of the northern German states (see below), the ministries of economics are in charge of the hydrogen strategy, even though energy was in all states located with another ministry (except in MV). Due to the focus on external interministerial coordination among the states and thus limited capacities, internal coordination during strategy formulation was in all cases not institutionalized and ad hoc [I.MV]. In Schleswig-Holstein, the green-controlled Energy Transition Ministry introduced a separate strategy while the joint strategy of the northern states 'was not easily supported' [I.HB].

Vertical-internal coordination

Following Christensen and Lægreid (2008), we understand vertical-internal coordination as intra-organizational coordination between political or administrative leaders with subordinate units.

All interview partners emphasized that hydrogen as a topic was politically framed and that the agenda setting was primarily determined top-down by the political leadership in the ministries. In Hamburg, the responsible senator had the idea to develop a hydrogen strategy and initiated the process of the Northern German Hydrogen Strategy [I.HH]. In the case of Bavaria, the goal of developing a hydrogen strategy was formulated in the coalition agreement of the two governing parties in 2018 and was the starting point for the formulation [I.BY]. For other states, the already adopted strategies or their announcement, mainly the National Hydrogen Strategy in 2020, represented an 'external pressure' [I.ST] or an incentive [I.HE] to develop separate strategies.

The formulation processes of the hydrogen strategies were then integrated into the conventional administrative hierarchies: The agenda was set by the government, processed at the unit level, reviewed again at the leadership level, and finally got adopted. The political relevance was reflected in a strong interest of the ministers during the formulation process, which was perceived in several cases [I.HH, I.NW]. In Hamburg, a staff unit 'Hydrogen Economy' was established in February 2021, which is directly subordinate to the Senator outside the regular administrative hierarchy, reports directly to him, and is also responsible for the implementation of the Northern German Hydrogen Strategy in Hamburg. This staff unit is intended to improve networking at the working level and 'to overcome inertia effects in the administration' [I.HH].

Horizontal-external coordination

Horizontal-external self-coordination between the state governments usually takes place in the institutionalized *minister conferences*. Although hydrogen is regularly discussed due to its 'virulence in the political arena' [I.HH] at the Conference of Ministers of Economics and the Conference of Ministers of Environment as well as the Meeting of Energy Ministers, all interviewees stated that the state strategies hardly play a role, but rather fundamental questions regarding hydrogen are addressed, which have to be articulated consensually to the federal government. However, due to location interests (especially between north and south) and different party affiliations of the respective ministers, a dedicated hydrogen policy coordination of the federal states within the framework of the conferences is only possible 'at a too high altitude' [I.NI].

On a lower hierarchical level, there was a rather informal body established by the states, the *Hydrogen and Fuel Cell Technology Working Group*, in which heads of units and desk officers responsible for hydrogen in the ministries meet regularly once or

twice a year [I.HB]. This working group was already established in 2008 due to the foundation of the *National Organization Hydrogen and Fuel Cell Technology* (NOW), aiming to 'counterweight' the national effort [I.BB]. However, there is also a link between the levels, as the chair of the working group, who is elected by the members, is always also a member of the advisory board of the NOW. According to the interview partners, the primary purpose of this committee is information exchange [I.HB; I.HH; I.SN], although the current chair wants to restructure the working group to ensure that it coordinates more activities on the part of the states – also vis-à-vis the federal government.

Notably the Northern German states have cultivated intensive cooperation to formulate a joint hydrogen strategy. This is the result of close long-lasting cooperation between the ministries of economics and transport of the five coastal states, which meet twice a year at a joint ministerial conference to discuss strategic issues and adopt resolutions for joint action. At a conference in 2018, on the initiative of Hamburg, the decision was made to develop the North German Hydrogen Strategy [I.MV; I.NS]. Subsequently, a coordination group was set up that met on a regular bi-weekly basis to formulate the strategy. This coordination group reports primarily for the joint conference, with representatives being desk officers from the respective ministries [I.MV]. This coordination group still exists and coordinates the implementation of the joint strategy. Each state representative manages a specific field of action, while draft resolutions are agreed upon jointly in the coordination group [I.NS].

The Eastern German coal states Brandenburg, Saxony, and Saxony-Anhalt also considered developing a joint hydrogen strategy. However, this was 'not politically feasible' [I.SN] since the 'color constellation [meaning the party constellation] in Saxony and Saxony-Anhalt was so difficult that it was assumed that such a strategy

would not have gone through so easily' [I.BB]. The interviews raised the issue of different views on the usage of hydrogen (see Table 3). Therefore, the form of a *key points paper* was chosen, which was finally published only by the ministries responsible for energy and not adopted by the state governments [I.ST] so that the three states subsequently published separate strategies. Apart from the collaborations already mentioned, deliberate coordination on hydrogen strategies, e.g. in the form of bilateral consultation, did not take place, at most in the form of mutual adaptation.

The only exception is Brandenburg, cooperating with the state of Berlin – which is not developing a strategy itself [I.BB]. The state of Brandenburg surrounds Berlin geographically and they together form a metropolitan region causing strong interdependencies that had to be considered. The fact that no common strategy was developed ultimately has political reasons, since the coordination did not always go 'completely smoothly' and Brandenburg wanted to retain the final decision-making authority [I.BB].

Even though there was little bilateral coordination during strategy development among the German states, this might change during implementation and project planning of the first activities. Here the Southern states are planning a stronger regional exchange, especially within the framework of cross-border IPCEIs, which are co-financed by several states [I.HE].

The horizontal-external dimension also includes coordination of ministries with actors from the private sector. In this regard, all strategies show private involvement in the run-up to or during the formulation of the hydrogen strategies. In the case of Baden-Württemberg and North Rhine-Westphalia, research institutes and in Saarland three consulting firms were commissioned to provide scientific support. In most cases, consultation processes with stakeholders were carried out in advance in the form of

surveys [I.BB; I.NW; I.SL; I.SN] or workshops [I.TH] to assess how hydrogen supply and demand will develop regionally in the future, which is why the consultations were also ‘very business-heavy’ [I.NW]. In the case of the Northern German Hydrogen Strategy, intensive participation took place. First, ‘all known actors’ were surveyed with a questionnaire on strategic fields of action. Subsequently, three expert workshops were held with stakeholders ‘especially from business and science’ [S.NS, 2]. The intensive participation continues in the implementation of the North German Hydrogen Strategy. Four strategic fields of action were defined, in which measures for the development of technology are established and which in turn are processed and managed by stakeholders. Within the framework of these fields of action, the ministries primarily have an organizational and advisory function [I.MV].

Vertical-external coordination

The vertical-external dimension encompasses downward and upward coordination. However, our study looks at state coordination with the federal government and not with the local level. Nevertheless, some of the states are engaged in intensive exchange – also as intermediaries – with municipalities interested in hydrogen [I.SN].

Starting with the bilateral exchange between the federal and state level, we asked the interviewees to what extent they were involved in the formulation process of the National Hydrogen Strategy. In this regard, the almost unanimous response was that there was little [I.HB] to no [I.BB, I.HE] involvement of the states. The formulation of the National Hydrogen Strategy was ‘a very isolated process’ [I.SN] or ‘more of a closed shop with the industry’ [I.ST]. Only the interviewee from Hamburg stated that there was an informal exchange on the National Hydrogen Strategy on ‘many channels’ as well as a ‘matching’ between state and federal policy [I.HH]. This exception from the

rule might be a consequence of Hamburg's role as an early mover and location of important R&D projects, which motivated policy makers in federal government to benefit from regional experiences.

Regarding the question of institutionalized coordination of hydrogen topics, the interviewees mentioned two institutionalized bodies in particular: The *National Hydrogen Council* and the *Bund-Länder Working Group on Hydrogen*, which were both introduced by the Federal Government's National Hydrogen Strategy in 2020 (BMWi 2020, 15).

The National Hydrogen Council is an expert body appointed by the German government, gathering 26 experts from industry, science, and civil society that advises on the implementation and development of the National Hydrogen Strategy (ibid.). Four German states also participate in the meetings of the National Hydrogen Council as guests without voting rights. Each state represents a region. While the Northern, Southern, and Eastern German states take turns [I.BW, I.HH], North Rhine-Westphalia permanently represents the other two western states Rhineland-Palatinate and Saarland [I.NW]. However, participation of the states was not initially envisaged and was only included in the current form due to the demands from the states [I.ST].

The Bund-Länder working group on Hydrogen is in turn supposed to be a platform for 'close cooperation between the federal government and the states' (BMWi 2020, 16), which was announced in the National Hydrogen Strategy but was not specified. According to interview statements, the working group meets two to four times a year [I.HH, I.SH] and consists of representatives of the responsible federal ministries as well as the heads of the energy departments of the 16 states. At the meetings, the federal government informs the states about its activities and current developments, after which each state has the opportunity to ask questions or report on

its activities within three to four minutes [I.BB]. Some interviewees consider the working group as an important tool [I.HE, I.SH], while others attribute a ‘questionable quality’ [I.NW] to it. Reasons for the latter are the low frequency of meetings in the face of a high dynamic policy field [I.HB], thematic and personnel overlap with the state working group on hydrogen and fuel cell technology [I.TH] or the fact that it is perceived primarily as an information event of the federal government and not an institution designed for exchange [I.SN, I.ST].

Aside from the institutionalized forms of coordination, the interviewees positively emphasized the IPCEIs as a form of project-based coordination with the federal government [I.BB, I.NW, I.SL, I.SN, I.SH]. Within these projects, the federal government and the states coordinate closely, both on the funding design and the status of the notification by the European Commission. The Eastern German states and the federal government, for example, have institutionalized regular exchanges through the regional IPCEIs [I.BB]. That the states asses coordination with the federal government in the IPCEIs as more substantial than during the formulation of the National Hydrogen Strategy may be explained by the lower level of politicization of the IPCEIs but also because ‘we [the states] co-finance – then you also inevitably play a strong role’ [I.NW].

Patterns of multi-level hydrogen coordination in Germany

With the emergence of hydrogen on the political agenda, a specific coordination structure has developed in the German multi-level system (Figure 3). However, there is variance in the coordination processes chosen for the formulation and implementation of the hydrogen strategies, which we try to assess by our coordination framework based on Metcalfe and Scharpf formulated in Chapter 3.

Looking at the strategy formulation and its internal coordination, at first glance most state strategies appear to be government strategies. Almost all strategies were adopted by the state governments and thus show formalized negative coordination in from of an *ex-post* negotiation of compromise. Only the strategy of the Saarland reflects *unilateral decision-making*, as there was no formalized coordination, only an informal exchange of information with other ministries. In four cases (BB, HE, SH, SN), the use of IMWGs shows integrated strategy building by institutionalizing the seeking for consensus.

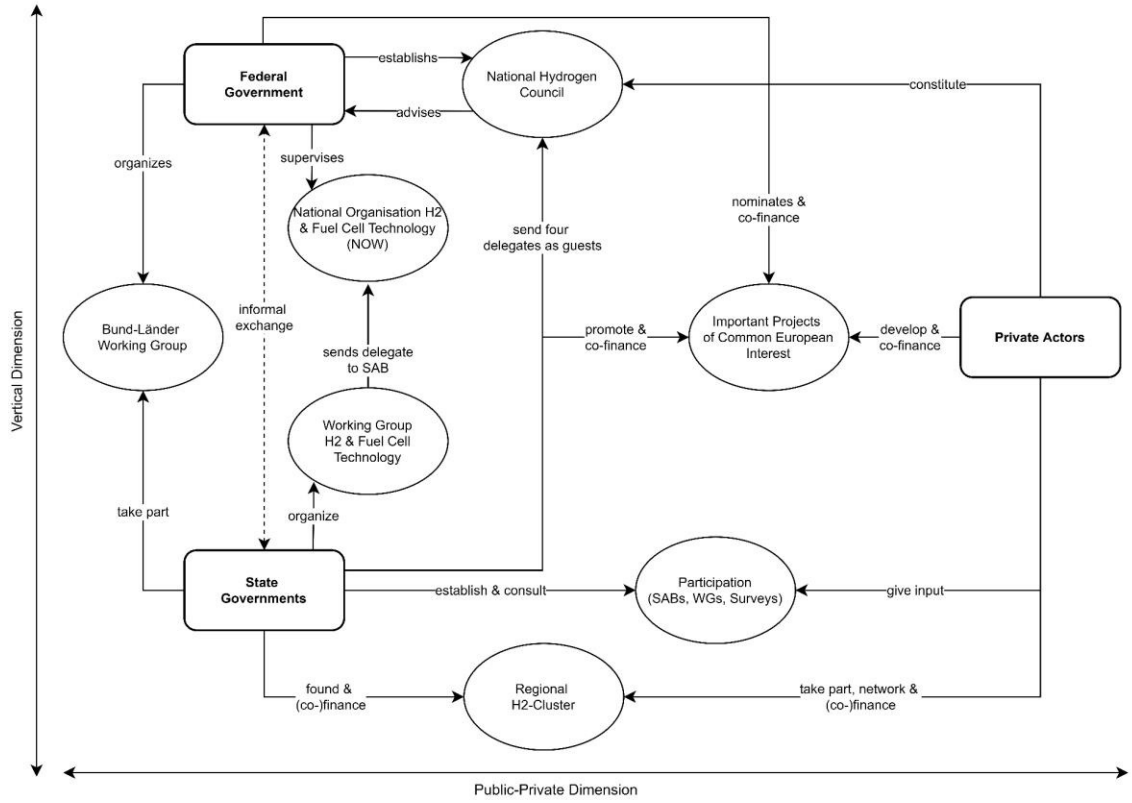
On the horizontal-external dimension, all strategies show similarities in that private actors were consulted, but differ in the coordination patterns with other state governments. The strategy of the five Northern states reflects indeed an integrated strategy building by our definition since it has been drafted by an institutionalized coordination group established to formulate a strategy based on common understanding, which were ultimately adopted by the state governments. The key points paper of the Eastern German coal states was an attempt for integrated strategy building in an established working group of the respective energy ministries but resulted in a 'compromise paper' [S.ST] due to the unbridgeable differences. The remaining state strategies are the result of unilateral decision-making; in these cases, interstate coordination took place at most in the form of an informal exchange of information. Only Brandenburg, according to the interviewee, coordinated 'closely' but informally with its neighboring state of Berlin, although this followed a pattern of negative coordination since the final strategic decision was largely made independently.

Reciprocal vertical coordination of the state strategies with the federal government did not take place. Still, all interview partners emphasized that the National Hydrogen Strategy, or the anticipation of it, was an important point of orientation.

Conversely, the states were hardly involved in the formulation of the National Hydrogen Strategy.

During implementation, the mentioned coordination patterns are initially continued. In particular, the Northern states coordinate the implementation of their strategy jointly, keeping the institutionalized coordination group in charge. However, a revision of the strategy is perceived unlikely due to the high costs of time-consuming positive coordination [I.NS]. Interviews with representatives of the other states show that coordination in implementation probably will be intensified, especially in the context of the IPCEIs, some of which directly and some of which indirectly involve cross-border interdependencies and financial involvement of several states.

Figure 3. Multi-level hydrogen coordination in Germany



Regarding vertical coordination, the newly established *Bund-Länder Working Group* and the *National Hydrogen Council* represent institutionalized information exchange rather than formalized coordination of state and federal policy making. For vertical coordination between the states and the federal level, the IPCEIs play an important role. All interview partners pointed out that no unilateral decisions are made in the context of these projects, but that the actors attempt consensual agreement on joint funding and its design. However, the data doesn't allow precise statements about the coordination patterns within the IPCEIs.

Conclusion

Returning to our initial research questions, it can first be stated that all state strategies consider hydrogen as important for decarbonization policy as well as an opportunity for regional value creation. Security of supply did not yet play a relevant role in the analyzed time frame, but this is likely to have changed with the war in Ukraine. Notwithstanding their common commitment to the relevance of hydrogen, the states differ in their strategic orientation. Some states emphasize fossil-based hydrogen as at least a temporary option to encourage market ramp-up of the technologies, while others focus their strategy exclusively on green hydrogen. On the application side, we found differences in the strategic orientation of the states, especially in cases of hydrogen applications in heating and passenger cars. This variance could be taken up by future research, in order to be analyzed on the basis of political-institutional factors just mentioned here (e.g. party constellations), economic factors (e.g. industrial structure), or cognitive factors (e.g. regional attitudes).

Limited by the centralization of legislative competencies in the field of energy policy, the instruments in the state strategies primarily cover financial support for

private investments and research in hydrogen technologies. This is supplemented by administrative action, e.g. hydrogen-oriented public procurement or information and education services.

The central question of our analysis was how hydrogen strategies and their implementation are coordinated within the political system. The formulation of the respective strategies took place in partly different coordination processes, both within the state governments and between the states. The intensity ranges from nearly unilateral decision-making of an individual ministry to an integrated strategy building of several states in the form of the North German Hydrogen Strategy. This variance could also be explored in future research, e. g. with regard to the reasons for and barriers to coordination identified by Peters (2015, 26 pp.). According to most interviews, vertical coordination of strategy formulation between the federal government and the states did not take place beyond mutual adaptation and informal information exchange. However, this is changing in the implementation phase; as we see several bodies that pursue vertical coordination. Of particular interest here is the project-based coordination in the context of the IPCEIs 'Hydrogen', which are an essential instrument of market ramp-up, while at the same time confronting the states with a budgetary challenge due to planned co-financing. In addition, the IPCEIs require, above all, coordination with the private applicants and, possibly, European coordination due to the strong market intervention and required notification by European Commission. The IPCEIs in particular therefore represent an important topic for future research.

Moreover, the conceptual integration of this nascent policy field 'hydrogen' is an exciting new area of research in the context of energy federalism, with the need for empirical evidence from other federal systems.

Notes

1 Press release of the Federal Ministry of Economics available at https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2021/05/20210528-bmwi-und-bmvi-bringen-wasserstoff-grossprojekte-auf-den-weg.html

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