Synopsis of the Dissertation *Energy Transition Games - Lobbyism, Networks, and Competition*

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Contents

1 Synopsis

The *energy transition* in Germany is the transformation of the energy sector switching from conventional energy such as coal, gas or nuclear power to renewable energy sources such as wind energy, hydro or solar power. However, this transition is more than just an exchange of suppliers. Instead, we observe a change of the entire market sector that affects many different actors.

Before the liberalization of the energy market in 1998, this sector was clearly organized. There were only a few firms involved, and these were responsible for their distributed area. Production, trading, transportation or commerce was highly regulated by the legislator and their authorities. There are two major explanations for this market design. On the one hand, the technologies used to produce energy at that time were primarily nuclear or coal-fired power plants. Constructing and running either type of plants requires a significant amount of capital, including investment risks that go along with it. Thus, the operating firms were promised to face little competition in order to ensure profitability and planning security. On the other hand, the availability of energy is a fundamental part of the economy's infrastructure and therefore the state has the duty to secure energy supply.

Another reason for a strong intervention of the state in the energy sector is the sensitive nature of this market. Without going into physical or engineering details, it is relevant to know that energy supply and energy demand have to equal. In contrast to standard economic theory, this is not a result of market dynamics, but a requirement for energy to be transferred from seller to buyer.

The situation changed gradually, starting with a strong movement against nuclear power in the 1970s. Further alteration became relevant with the aim to reduce emissions that foster global warming, which is important until today. Instead, renewable energy sources are supposed to provide us in the future with the energy we need. The long-term goals of the energy transition is to have 65 percent market share of renewable energies, the reduction of emissions of 55 percent compared to 1990, and reduce total energy demand by 50 percent until 2050 compared to 2008.[1]

While the government has formulated these goals, the implementation of this transition is supposed to be realized by the relevant members. Among these, there

[1] See Bundesministerium für Wirtschaft und Klimaschutz (2022).

are naturally the energy producers, both 'old' producers of conventional energy and the 'new' producers of renewable energies. Then, there are the electricity distributors that could either be the default supplier or new entrants with more commercial liberties. Next, there is the grid operator in charge of the energy infrastructure. Further, we consider the consumers, who may also be local residents next to newly constructed energy sources of power lines. And last, we need to consider the legislator that is supposed to guide the previously listed actors into the directions of the energy transition. Since the legislator is not a homogenous entity, we have to look at parliamentarians, the government, ministries, and special interest groups.

Following Öko-Institut e.V. (2022) we collect table (1) a brief overview over some of the major step stones of the energy transition in Germany.

Table 1: Chronology of the energy transition

Year	Event
1980	First appearance of the term *energy transition* used by the Institute of Applied Ecology.
1986	Foundation of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.
1991	Implementation of the *Stromeinspeisegesetz*, which obliges electricity suppliers to buy the energy produced by renewable energy sources.
1997	Commitment to reduce greenhouse gases in the Kyoto Protocol.
1998	Following a European Energy Directive Germany starts liberalizing the energy market
2000	First version of the *Erneuerbare-Energien-Gesetz* implemented, which guaranteed a fixed price for the suppliers of renewable energy and prioritized access.
2004, 2009, 2012 , 2014, 2017, 2021	Revision of the *Erneuerbare-Energien-Gesetz*
2010	First offshore wind park in the North Sea starts to deliver energy.
2011	Incident of Fukushima followed by the decision to phase out nuclear power.
2012	The power line *Suedlink* is designated by the network development plan to connect Northern and Southern Germany.
2015	Climate Agreement of Paris, where the members committed to restrict global warming below two degrees Celsius.
2022 (Forecast)	The last three German nuclear power plants are shut down.

The table illustrates the diversity of the involved actors that are affected by the energy transition. Moreover, these actors are not only needed, but the success to transform the energy sector relies on their contribution. Hence, we need to develop a better understanding of the processes, of the actors' activities and of the dynamics of the interplay among them. In this light, this dissertation contains three concrete research questions: First, under which conditions do we expect (energy) lobbyists to engage in the legislation process? Second, how can we construct a power network where local protests against certain power lines do not arise? And third, when can we rely on market forces to provide sufficient energy supply under the risk of volatile renewable energies, and when should the state intervene? Before we elaborate on the answers to these questions we will first sort them into a broader context.

1.1 Economic policies

The way the economy is run is embedded in an economic system in every society. This system is a collection of all rules, norms, habits, institutions, and decision making processes in general, which set up the framework for the members of that society to make economic decisions. Around the world there exists various economic systems. The systems can either contain elements of liberalism, such as more responsibility and freedom being granted to the individual. Or the system can have elements of socialism, such that economic activities are rather directed by the state. Typically, a nation's economic system includes both elements, such as the social market economy in Germany.

All economic systems have in common that a system designer uses economic policies for the implementation. These economic policies have been in the center of economic research since the early days of this scientific discipline. There exist various types economic policies, such as monetary policy, fiscal policy, labor market or trade policy, just to mention a few. Balancing these different types of policies and creating an environment for economic activities is then the challenging task of policy makers. Following Daly (1992) we can formulate three major goals that economic policies pursue:

- *Allocation* - this indicates how resources are allocated among alternative production lines. An allocation is considered to be *efficient* if it is in accordance with consumers' preferences and their abilities to pay. The efficient solution is typically determined with relative prices generated by supply and demand in a competitive market.

- *Distribution* - it accounts for the relative division of goods and services among the consumers. A distribution can be considered to be *fair*, if the degree of inequality is within a certain limit.
- *Scale* - here the physical volume to produce the goods and services are measured. This includes the raw materials, the required energy and the amount of waste that is left behind. The lower the volume the better the *sustainability* of an economic system.

Thus, an economic system is supposed to be efficient, fair and sustainable. However, these goals are not necessarily compatible, since, for instance, reduction of production can make an economy more sustainable but less efficient. Finding a smart way to bring these goals in harmony as best as possible marks the supreme discipline for the designer of economic systems.

The immediate question that follows is: What is a smart way to design the economy? In other words, what are good economic policies? Gerhard (2006) pointedly elaborates how it is easy to criticize both the allocative or the distributive market result, depending on the political perspective of the critic. New economic policies then often just try to correct a certain aspect of the market outcome. Instead, a smart designer should consider whether the unwanted market outcome is just a temporary deficit, or if occurred due to deficient infrastructure that should be provided by the state. Further, the designer should check the economic framework for erratic or excessive elements, and look for institutional reasons for the undesired development. However, even if we follow this analysis, it opens up a new chapter of questions instead of giving a satisfactory answer. This is why further methods are needed.

1.2 Game theoretic methods

In game theory, mathematical models are used to describe strategic interactions among players. These players are considered to be rational and make decisions either in conflict with others or in cooperative situations. While basic approaches can be found earlier, modern game theory started in middle of the twentieth century. Pioneering work was provided by Von Neumann and Morgenstern (1953) who formulated expected utility as an analyzing tool for making decisions in a probabilistic environment, or by Nash (1951) who introduced an essential stability concept.

There are different kinds of games which can be clustered into various categories, such non-cooperative vs cooperative, simultaneous vs sequential, or perfect vs imperfect information. All games have in common that they require players, the players' strategies and the players' payoffs. The players can be all sorts of agent that interact in some way. Examples would be an employer and an employee, a seller and a buyer, opposing generals at war, competing firms, or cartel members. Each player can make certain decisions and the sum of the players' decisions causes a result. This result affects the players depending on their preferences and generates the payoff. Hence, when making decisions the players need to consider not only their own but also the other players' strategies.

The results of game theoretic models are based on the concept of the "homo oeconomicus", such that individuals make rational choices. This concept is not validated in empirical literature, since for various reasons people make irrational decisions. The criticism on the concept has even brought up *Behavioral Economics* as a new field within the discipline. However, without ignoring the insights of other research approaches, it is valid to apply this concept to the problem of assessing the framework of economic policies. The reason for this is straightforward: If the planner of the economic system chooses a certain framework then it is obviously helpful to anticipate the peoples' action within this framework. Assuming rational behavior then allows the designer to analyze a benchmark scenario, which does contain valuable information even if it will not be realized to its full degree. Here we can agree with Brams (2011) who states:

> "No satisfactory theory of politics, in my opinion, can ignore the fact that political actors consistently make choices to further certain ends. To be sure, they are constrained not only by the choices of other actors but also by rules, norms, incomplete information, problems of communication, collusive arrangements, and so forth. These constraints, however, can be incorporated into game-theoretic models, just as different goals can be

> postulated for actors that may rationalize behavior previously thought irrational. In a sense, the beauty of game theory, at least to nonmathematicians, is its incompleteness, its different viewpoints, its multiplicity of solution concepts." *(Preface, xvi)*

Economic policies should be evaluated with respect to their efficiency, their fairness and their sustainability. First, efficiency in games can directly be taken into account for the analysis via inspecting the payoff scheme, and is relevant for almost every game theoretic model. Second, there exists an entire branch in game theory that deals with the fairness attribute and is collected in the *fair division* literature (cf. e.g. Moulin (2004)). And third, sustainability in games can be embedded into the cost structure for the players and thus affect their decisions. As in the entire field of economics, the focus on sustainability has grown in importance in recent years (e.g. Jafari et al. (2017) or Raj et al. (2018)). Therefore, it is little surprising that game theoretic knowledge has also been adopted by political scientists. Representatives of this adoption are Nurmi (2006) and De Mesquita and Lalman (2008).

1.3 The energy transition

In the following, we identify three settings in the context of the energy transition in chapters two, three and four. For each setting we are able to construct a game theoretic model which helps us to understand and estimate the activities the relevant actors may or may not do. Each chapter is a paper by itself, can be read independently of the others and is about/meant to be published in scientific journals. Further, the content of the papers can be allocated to different subgroups of game theoretic research, which are coalition formation, network formation, and competition. The related literature and the concrete research gap is presented at the beginning of the succeeding chapters. At this point, we will explain what all three papers have in common: Broadening our knowledge about the impact of the energy transition.

1.3.1 Lobby groups and the legislator

The first paper is called *Coalition formation versus free-riding in rent-seeking contests*. We study the incentives of players to become lobbyists in the presence of competing lobby groups. Lobbying is the attempt by non-parliamentarians to influence the legislation process. There can be many types of lobbyists, such as individuals, firms, unions or charity groups. Often lobbyists are called 'special interest groups', as the member of this group commonly share a certain interest. In order to gain a legislator's favor, these members pool their resources and form a group.

For economists these special interest groups are interesting for various reasons. Apart from the formation of groups, it is also worthwhile to examine the strategies of these groups, the effectiveness of their activities, their influence on the legislator, or their effect on social welfare. However, the attempt to study lobbying is challenging, because the effects are usually difficult if not impossible to quantify. Nevertheless, there is some knowledge that both theoretical and empirical literature has produced.

The overall perception of lobbying can be described in two ways. On the one hand, it is perceived as a legitimate way to provide the legislator with expertise that politicians cannot acquire by themselves. On the other hand, it is rather criticized and compared to corruption. For that matter Campos and Giovannoni (2007) set up a theoretical framework to highlight the relation between corruption and lobbying. In addition, an empirical analysis showed that depending on a variety of factors, these two may be substitutes or complements. Hill et al. (2013) determine the relationship between the value of lobbying for corporations in exchange for contributions for election campaigns. In contrast, Hall and Deardorff (2006) consider the heterogeneity of the parliament and suggest that lobbying expenses are rather legislative subsidies for those politicians or parties that naturally represent the lobbyist's interest. Further, Nelson and Yackee (2012) identify the conditions that actually induce politicians to change their prior opinion.

Loosely speaking we can summarize the literature's knowledge of the connection of lobbying and legislation processes like this: even though the effects cannot precisely be identified, there is something going on. This is sufficient for our motivation to look at the lobbying within the energy sector. Anecdotal evidence can be collected if you look at the registered lobby groups at the German Bundestag. If we search this register, for instance, for the term *wind energy* we currently find 66 special interest groups.[2] We can assume that each group somehow pursues the aim to influence the legislation process in favor of wind energy. This appears to be odd, because from a theorist's point of view we could expect some sort of overlapping preferences or redundancies in their expenses. Given rational behavior of the lobbyists, we then would expect possibilities for either cooperation among the groups or some free riding.

This is the background to our study. We want to gain a general insight into the prospects of agents to either become lobbyists or abstain from lobbying activities. Lobbying can be either done alone or in a collective, in both cases the lobbyists have to spend some resources. Abstinence from lobbying means free riding and does not include costs. Hence, for a better understanding of the legislation process it is relevant to anticipate the involvement of special interest groups. So far the literature has fallen short of providing a theoretical model that allows a precise prediction of the formation of lobby groups in a simplified setup.

To underline the connection of this topic to the energy transition it is helpful to recall the *Erneuerbare-Energien-Gesetz*. When the first version of the bill was passed in the year 2000 there was no other nation that could have acted as a role model, because a successful energy transition had not yet been achieved anywhere. The major reform was to grant priority access of renewable energies to the market as well as a minimal price for each produced kilowatt hour[3]. Within this framework producers of renewable energies almost faced no investment risks and were able to grow in size and importance. However, this *Erneuerbare-Energien-Geset* was altered six times so far. We can imagine various reasons for this alteration. The legislator could have considered improved technologies, a new competitive reality, or just tried to eradicate previous mistakes. In addition, it could have been the influence generated by lobby groups in a gold rush mood, that take advantage of the zeitgeist to ensure significant support from the government.

Yet, if we want to evaluate the success of these reforms, it is not enough to look at the mere share of renewable energies of the entire energy supply. It is important

[2]Among these special interest groups are firms, NGOs, syndicates, foundations, or law offices, cf. Deutscher Bundestag (2022).

[3]Cf. §§3 – 8 Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energien-Gesetz - EEG) (2000).

to create a predictable and trustworthy economic environment. The legislator relies on private actors to transform the energy sector, but these actors need to know that the rules of today will also account for tomorrow. This goes back to Eucken (1965) who identified constancy of the economic system as one of the constitutive principle of the social market economy. Thus, dealing with lobby groups in this matter serves the greater purpose to understand their impact on the design of economic systems.

1.3.2 Central network planner and local residents

The second paper is titled *Network formation with NIMBY constraints*. It addresses one of the major infrastructural challenges of the energy transition, which is the construction of additional power lines. The necessity to expand the current power grid is due to the combination of the inflexibility of renewable energy production and local energy demand. It is in the nature of renewable energies that some places with a lot of wind or more hours of sunshine are more favorable for production facilities. Thus, when finding suitable places to construct renewable energy sources the strategic component of finding close-by customers hardly plays any role. For the German case we can sketch this simplified picture: in the north it is easy to produce renewable energies, e.g. at offshore wind parks in the North Sea, while the south has high energy demand, e.g. thanks to energy-intensive industries.

The solution to this problem appears to be straightforward, at least from a theoretical point of view: create additional power lines to transport the energy from north to south. Since the amount of energy that needs to be delivered exceeds the original power grid capacities, the new power lines need to be bigger, which is why German media came up with the term *highway power lines*. Indeed, the German government has introduced an ambitious investment plan to create these power lines. For the purpose of our work it is sufficient to consider the most prominent one called *Suedlink*. *Suedlink* is a power line designed to connect Brunsbüttel in Schleswig-Hostein with Großgartach in Baden-Wuerttemberg.[4]

Completing such an infrastructural task is challenging for various reasons. On the one hand, engineering and administrative solutions have to be found, which is similar to other projects of public infrastructure. On the other hand, a new obstacle

[4]Cf. Bundesnetzagentur (2022).

has developed in recent years, which is the local resistance against the construction of the power lines. Indeed, along the planned route of *Suedlink*, there are local residents who have formed groups to express their criticism on Suedlink and seek to stop the project.

These groups vary in the degree of professionalism. Some residents have founded registered associations, others have privately set up websites or collect petitions. The *Bundesverband Bürgerinitiativen gegen Suedlink* has listed 52 local groups that are distributed along the planned power line from north to south.[5] They promote the slogan *"Energy transition YES, Suedlink NO"*, which represents a typical attitude for a setting that the literature has classified as a NIMBY-phenomenon.

NIMBY is an abbreviation for *Not-in-my-backyard* and describes the unwillingness of local residents to accept public facilities in their neighborhood. The NIMBY literature is not limited to energy topics as it also considers waste disposal sites, railroad tracks, or new housing areas. Yet, it aptly characterizes the fundamental problem here: on the global level there is broad acceptance of the energy transition and its goals. However, on the local level people are not willing to contribute to the solution, they even oppose and try to hamper it.

The main activities of the local residents include public relations, lobbying, ecological documentation and legal actions. The jurisdictional approach in particular is an effective tool to delay, postpone and potentially alter the government's construction plan. At court, the government has to prove that it sufficiently considered environmental protection, public health concerns and the appropriateness of the project. Especially the last aspect may be difficult for the government if we consider the acquisition of well-protected property rights. In this context the government has to defend its plans against potential alternatives, which means for our example: can the government show that connecting two particular cities with a power line is the best option in comparison to constructing other power line somewhere else?

At this point it is worthwhile to open up the huge chapter of network theory and especially economic networks. This discipline provides us with insights and measurements of the way that different cities are connected with a power network. However, so far, the literature has not considered the aspects of local resistance

[5] Cf. Bundesverband Bürgerinitiativen gegen Suedlink (2022).

against certain power lines. Therefore, we construct a model using a network formation game that incorporates the NIMBY notion. This approach is helpful since we are able to collect the preferences of cities and local residents, which then affect the shape of the power network. Henceforth, we can first identify stable networks in the sense that no local resistance can arise, and second introduce an algorithm to get there.

1.3.3 Investors in conventional energy and in renewable energy

The third paper is about *"Capacity investments in a competitive energy market"*. Here, we discuss the role of the government for the supply side of the energy market. After renewable energies have entered the market and grown in size and importance, we find a specific competition scenario due to the nature of different energy types. On the one hand, there are conventional energy producers, which can rely on their output, but have variable costs for producing the energy. On the other hand, there are the renewable energy producers, which hardly face any additional costs once their plants have been constructed. However, whether or not they can actually deliver energy depends on factors they cannot control, such as the amount of hours with sunshine or the velocity of the wind. Thus, whenever renewable energies are available they are very competitive and able to crowd out conventional energy producers. Yet, conventional energy producers remain necessary if the renewable energy sources fail to deliver.

As already mentioned earlier, this background is challenging for the energy market designer, because supply and demand must be equal at all times in order for the market to function. There are three basic aspects a market designer can address to prevent a market crash, which are flexible energy demand, flexible energy storage and flexible energy supply. Both the demand and the storage are limited in their dimension, since Germany neither has a suitable topology nor is there a technology that allows to store energy at large scale. Also, the consumers' energy demand is typically price inelastic. Even though these two approaches matter, they are not part of our work.

Instead, we focus on the supply side of the energy market. Since the producers can only provide the necessary energy with uncertainty, the idea of capacity mechanisms was introduced and discussed in the literature. The basic concept behind capacity mechanisms is that energy capacities are withdrawn by the state prior to the day it is needed. If there is a shortage on the delivery due to the failure of renewable energies, then the state can use this capacity to prevent a blackout. Among the capacity mechanisms there are various measurements that differ in their degree of how much the state intervenes in the market.

In Germany, the government has introduced a measurement called the *strategic reserve*. This reserve is a rather mild form of state intervention, since it does not affect the prices on the market. Its only purpose is to function as a backup and is used only if no privately produced energy is left. In order to build up the reserve the state has two options. The government can either forbid owners of conventional energy to decommission their power plant or these owners can apply to become part of the reserve. In both cases, the power plants maintain the private property of the owner, who receives some sort of compensatory rent to cover the operational costs.[6]

For various reasons, it is worthwhile to examine and evaluate the government's decision to establish a strategic reserve. First, it is relevant if the capacity choice and the composition of the reserve's power plants are suitable to prevent a blackout. Second, the costs of the reserve is paid by energy consumers, so that the government should not build up more reserve capacities than necessary. And last, we can analyze the impact that the state's intervention has on investment incentives of private energy investors. The latter one is the center of our research.

We set up a competition model between producers of renewable and producers of conventional energy. The model includes two ways to close a gap between energy supply and demand that is induced by the failure of renewable energies. On the one hand, there is the strategic reserve as the state's backup, and on the other hand, there is a market solution with a spot market. Thus, we are able to deepen the understanding of the energy market potential to provide investment incentives. This is crucial knowledge in order to allocate an appropriate role to the government and its regulatory institutions.

[6] Cf. §3 – §5 Reservekraftwerksverordnung - ResKV (2013)

1.4 Outlook

To sum up, there are three papers that pick up a situation induced by the energy transition. We set up game-theoretical models that apply the idea of rational actors in order to describe and predict the consequences of their actions. Hereby, we contribute to the literature in the field of coalition formation, network formation and competition economics. The main results of the papers can be summarized in the following way:

The paper "Coalition formation versus free riding in rent-seeking contests" identifies the turning point when players choose between becoming a lobbyists and free riding. Lobbying can be done alone or in a coalition with other players. Yet, coalition formation can only occur if either players with rather moderate preferences join to oppose players with rather extreme preferences, or if there are two opposing groups and both groups are a coalition of players. In all other lobby group constellations there is free riding.

Next, the paper "Network formation with NIMBY constraints" introduces the concept of 'not-in-my-backyard' to network formation models. We describe how networks look like where no player may protest against any power line within network. The main characteristic of the network is that players are sufficiently connected to a power source, but not with more links than necessary for their own supply. In addition, we provide an algorithm that creates such networks.

Finally, the paper "Capacity investments in a competitive energy market" investigates the possibilities of market forces to provide sufficient investment incentives in the light of volatile renewable energy. Either these forces are strong enough such that the entire energy demand is served, or they are too weak and investments are not profitable. Hence, a state invention that provides a small portion of energy capacities as a backup is not helpful. Instead, we run a welfare analysis and suggest tax-and-subsidy scheme that connects efficient and stable market outcomes.

These insights of all models contain implications that are relevant for those regulators and institutions seeking to implement a successful energy transition.

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