Gas Fired Power Plants in the German Electricity Market: Competition and Investment Incentives

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1. Introduction: Renewable energy sources as benchmark

Germany is heading towards a power supply based mainly on renewable energy. 80% power from renewable sources is the target set by the German Government to be reached by 2050 (Bode, 2013: 1). According to data published by the German Environmental Agency (Umweltbundesamt), share of renewables in power production (including imports) amounted to 15,9% (table 1, last column and figure 1 for the development of renewables' share on total power supply in Germany).

Table 1: Power production, power import and coverage of demand for power by sources[1]

Primärenergieimporte und Versorgungssicherheit

Energieträger	Netto-Importquote 2012	Statistische Reichweite in Jahren (weltweit)	Anteil am Primärenergieverbrauch 2012	Anteil an der Bruttostromerzeugung 2012
Braunkohle	-1,9 %	200	12,0 %	24,5 %
Steinkohle	80,8 %	125	12,9 %	22,6 %
Uran	100 %	25 - 166[1)]	7,9 %	18,1 %
Erdgas	85,7[2)] %	60	21,5 %	13,6 %
Mineralöl	98,3 %	41[3)]	33,0 %	1,7 %
Erneuerbare	k.A.[4)]	unendlich	11,6 %	15,9 [5)]

[1)] Ein Schätzen der Reichweite bekannter Vorräte ist schwierig, da Uran im Gegensatz zu fossilen Energieträgern keinen eindeutig definierbaren Heizwert besitzt. Die extrahierbare Energie pro Gewichtseinheit ist stark vom Brennstoffkreislauf, dem benutzten Reaktortyp und der Kernbeladungsstrategie abhängig. Die Energy Watch Group geht von einer Reichweite von 30 bis 70 Jahren aus, in Abhängigkeit von den Extraktionskosten (Energy Watch Group 2006).

[2)] Nettoimportquote für Naturgase (Erdgas, Erdölgas, Grubengas)

[3)] Nach Analysen der Energy Watch Group wurde das weltweite Ölfördermaximum im Jahr 2006 erreicht. Die Ölförderung wird nach diesem „Peak“ einen steilen Rückgang erleben. (Energy Watch Group [2008])

[4)] Im Gegensatz zu den meisten erneuerbaren Energieträgern wie Wind- und Wasserkraft, Photovoltaik und Solarthermie müssen bestimmte Anteile biogener Brennstoffe – zum Beispiel Palmöl und Bioethanol - importiert werden.

[5)] für Erneuerbare: Anteil am Bruttostromverbrauch, nicht der -erzeugung; Erneuerbare Energien in Zahlen 2013, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)

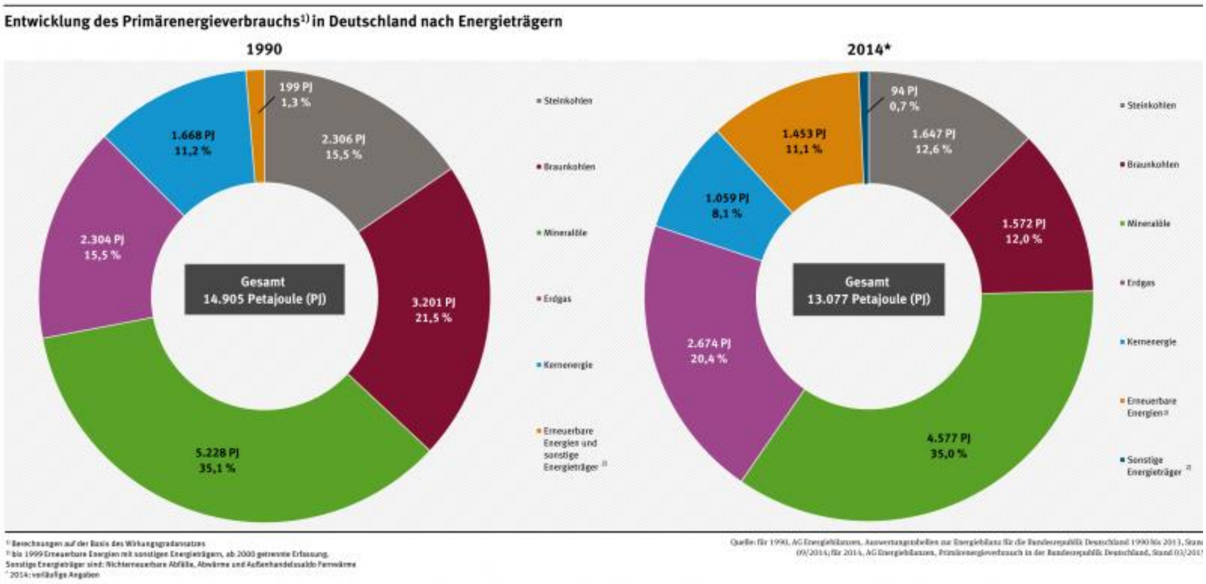
Quelle: Umweltbundesamt: Klimaschutz und Versorgungssicherheit - Entwicklung einer nachhaltigen Stromversorgung, Climate Change 13/2009, Dessau-Roßlau 2009; Arbeitsgemeinschaft Energiebilanzen: Auswertungstabellen zur Energiebilanz für die Bundesrepublik Deutschland 1990 - 2012, Stand 09/2013 und Arbeitsgemeinschaft Energiebilanzen: Sondertabelle, Bruttostromerzeugung in Deutschland von 1990 bis 2012 nach Energieträgern, Stand 12/2013; Bundesministerium für Wirtschaft und Technologie (BMWi) : Zahlen und Fakten - Energiedaten - Nationale und internationale Entwicklung, Stand 08/2013

Accordingly, there is quite some distance to be covered, until the target of 80% power production from renewable sources can be reached. But can it be reached at all? In a study conducted on behalf of the Association of German Coal Importers (Verein Deutscher Kohleimporteure) Hohohm et al. (2012) raise some doubts on the feasibility of this political goal. Referring to the volatility of power produced by renewable sources, volatility which is caused by variation in wind intensity of solar irradiation and calculating what is called

1 http://www.umweltbundesamt.de/daten/energie-als-ressource/primaerenergiegewinnung-importe

secured power supply from renewables they come to a maximum of 20% of total power in 2050 consumption stemming from renewable sources (Hohohm et al., 2012: 18). Accordingly, thermal sources of power supply will have to cover at least 46% to 51% of total power consumption in Germany 2050 (Hohohm et al., 2012: 23). In the same vein Beppler argued quite forcefully against the illusionary target of 80% power supply from renewable sources (Beppler, 2013). Caused by such different assessments of the amount of thermal or non-renewable energy sources needed to cover the gap left between demand and supply by renewable energy, the so called “Energiewende” (power change) has become a battle ground for lobbyists who try to make their case for, e.g., a pumped-storage power plant (Krüger & Rotering, 2014; Moser, 2014) or against it (Hohohm et al., 2012: 26-28); for a capacity market (Achner et al., 2011) or against it (Neuhoff et al., 2013).

Figure 1: Development of share of power production from renewable sources; Germany 1990 and 2014[2]



In any case, the German “Energiewende” runs the serious risk to produce a supply gap. Notable Institutes like the Fraunhofer Institute (2013) or Bertsch et al. (2013) highlight that risk and immanently confirm the fact that additional sources of power supply other than renewable sources will be a part of German power supply for the foreseeable future.

2 http://www.umweltbundesamt.de/daten/energie-als-ressource/primaerenergieverbrauch

Gas power plants and gas turbines will play a major part in securing power supply in the future. According to calculations done by Hohohm et al. (2012: 27) or Bertsch et al. (2013: 9-10) share in power supply for gas will range between 24% and 43%. The actual share depends on gas prices as Bertsch et al. (2013: 9) argue. With Liquefied Natural Gas (LNG) or shale gas or unconventional natural gas (ecoprog, 2012) entering the markets and becoming a major export commodity in the United States, gas prices are expected to decrease considerably (Deloitte, 2013: 2-3), hence, conditions for gas powered plants either to be build or enlarged, seem to be perfect.

1.1 Objectives

The German Energiewende is a political decision (Fraunhofer, 2013: 21-24). Accordingly, it is highly subsidized and runs against market forces to such an extent that some commentators demand for more market and less plan and deem the Energiewende a total failure if political planning prevails (Lambertz & Steger, 2011). Political influence is most notably with respect to prices. German taxpayers heavily fund the transition to renewable energy (Fraunhofer, 2013: 22; Mayer & Burger, 2014: 2). Altogether, the amount of subsidies is a function of market prices. The lower market prices the higher the subsidies. However, since investments (not just returns) in renewable energy have been heavily subsidized in Germany as well, a large increase of investment in renewable energy followed (Fraunhofer, 2013: 19-22). Overcapacities and markets swamped with power resulted (Mayer & Burger, 2014: 23). All the while electricity produced from renewable sources is given priority over conventional forms of power production (Döring, 2015: 72). Accordingly, operators of power grids are committed to use power from renewable sources ahead of power produced in a conventional way. As a result, overcapacities have seen prices in international markets like the European Energy Exchange plummet and conventional power plants run below par, which means their utilization is low, even below the level of profitability. Accordingly, they become abandoned or shut down temporarily (Mayer & Burger, 2014).[3] This entire development is the result of

[3] One of the most famous victims of the Energiewende is one of the most technologically advanced gas fired plant in Irsching close to Ingolstadt. The plant has been running on low utilization rates for years now and is expected to be shut down by its operator E.on. The main reason for the low utilization rate of the plant is the high amount of energy from renewable sources that enjoy priority

political decisions for a transition to a power supply based on renewable sources. Hence, investments in new technology other than renewable source-based technology and decisions to build, enlarge or modernize a gas-fired plant have to be taken within a given space of opportunity that not only affects demand, but also profitability.

This thesis will assess, whether it is feasible to invest in whatever way in gas-fired plants. Accordingly, a theory about how investment decisions are made is needed. The respective theory used in this thesis stems from finance and is the basis of a number of well-known theories about financial decision making. In 1964 it has been introduced by Sharpe and is known as the Capital Asset Pricing Model (CAPM). In essence, the model postulates that investment decisions are a function of risk and return. The higher the possible return, the higher the risk, an investor may be willing to take and the higher the risk, the higher the expected return (Sharpe, 1964: 430). The model is built on a number of assumptions about risk-taking or risk-averseness of investors as well as the expectations that investors are rational actors who, given the choice between a high-risk low return and a low risk high return scenario choose the latter. In order to be able to make a rational decision, investors rely mainly on price information as Fama showed in his work on the efficient market hypothesis (Fama, 1970, 1991). However, in order to make rational decisions, investors have to assess probability of returns and profitability of alternative investments. Both assessments depend on the information at hand. Obviously, a decision to invest in a gas-fired plant and to enter the German power market (or increase ones stance) does not depend on price-expectations alone. More important is the probability for price expectations to materialize.

As has been shown in the previous chapter, price in German power markets is skewed by political intervention. Investors in renewable energy bear no risk, while investors in conventional forms of energy bear not just a political risk, but a market risk as well, since prices do not bear the information required by, e.g. the hypothesis of efficient markets. Hence, power markets are non-efficient markets. Accordingly, further information is needed before investment decisions can be made. Information needed refers to the competitive situation in the market and it refers to variables that shrink or increased the opportunity space

access to power grids. Hence, power produced in Irsching is only needed at peak times or in times, wind and solar power is not sufficient to cover demand.
http://www.augsburger-allgemeine.de/wirtschaft/Gaskraftwerk-Irsching-Stilllegung-nach-nur-fuenf-Jahren-id33567512.html

for investment decisions. Michael Porter (1979, 1980) developed a useful framework that allows for determination of the status quo in a market by analyzing five forces. The five forces refer to an open market with non-state intervention. They are meant to provide a certain amount of information that enables managers to make informed decisions, with respect to the amount of rivalry, the bargaining power of supplies and customers, the threat of new entrants and the threat of substitutes. For the present thesis, the framework provided by Porter is a useful starting point for gathering the variables that influence the opportunity space within which a decision to invest in a gas-fired plant has to be taken. However, political decisions are much more important in the energy market, they quite literally reduce the space of opportunity. Thus, information gathered on the basis of Porter's Five Forces need to be supplemented by information about political and subsequently legal conditions that structure, influence and skew market outcomes. Hence, the thesis will deploy another framework, known as PESTLE-framework as well. "PESTLE analysis looks at political, economic, social, technological, environmental and legal changes which are likely to affect the business. A PESTLE analysis is a very detailed study of these changes using a range of published statistics about the state of the economy, social trend surveys, as well as some primary analysis" (Dransfield, 2004: 444-445). Already it is obvious, that political conditions and their legal imprint determine the opportunity space for investment decisions. However, social and environmental conditions are important as well, e.g. with respect to the amount of resistance an endeavor to reap the benefits of fracking in Germany does or will meet.[4] Equally important are technological changes that provide higher utilization rates or more load efficiency (Steele, 2012).[5] Thus, a careful assembly of conditions structuring the opportunity space within which the decision to invest in gas-fired plants is required.

This thesis will provide this assembly and attempt to model a comprehensive opportunity space. This opportunity space will provide the input for a number of different computer simulation models which will be run in order to analyze the threats and opportunities of such an investment and confront them with the strengths and weaknesses attached to the respective

4 https://www.greenpeace.de/themen/endlager-umwelt/fracking-ist-keine-zukunftstechnologie

5 These are but a few of the relevant variables. Numerous other factors that structure the space of opportunity will be sampled, e.g., the problem of lacking development of the power grid, the problem of a supply gap in the South of Germany, amplified by the lacking development of the power grid and so forth (see, e.g., Bertsch et al., 2013: 2)

investment.[6] However, to integrate the assumptions about individual decision-making and the conditions that form the opportunity space in one theoretical model, a theoretical approach is needed that allows for a link between macro- and micro-level variables. The respective theoretical approach is taken from Neo-institutionalism. Fritz W. Sharpf (1997) is the main proponent of this approach called: actor-centered institutionalism. Actor-centered institutionalism highlights the importance of an institutional setting which defines conditions for actors, who gather in actor constellations and develop modes of interaction depending on the opportunities provided or permitted by the institutional setting. Hence, actor-centered institutionalism links macro- and micro-level and in doing so, allows for the analysis of individual decisions that take place in a respective setting. Thus, the present thesis uses a layered approach to answer the following research questions:

- Are investments in gas-fired plants feasible given the conditions that prevail in the German energy market?
- What are the main obstacles preventing investors to invest in gas-fired plants?
- What are the main incentives motivating investors to invest in gas-fired plants?

1.2 Structure of the thesis

In order to answer the research questions what has been called a layered approach will be used. It starts with introducing the framework of actor-centered institutionalism and deriving the main modes of interaction and the main institutional parameters that guide subsequent analysis (chapter 2). Within the context set by chapter 2 concrete conditions affecting investment decisions will be sampled by using the Porter's Five Forces as well as the PESTLE framework. Both approaches will be elaborated in chapter 3. Chapter 4 adds the individual level and provides a decision model based on CAPM and the model of rational choice. With chapter 5 the sampling of variables affecting investment decisions begins. Porter's Five Forces as well as the PESTLE framework will be used to sample the relevant variables. It is within this framework that measures that structure the market like the renewable energy law (Erneuerbare Energien Gesetz), the EU-trading scheme for CO_2-

[6] As the wording suggests this will be done by using SWOT-analysis (Eden & Ackermann, 2004; Wheelen & Hunger, 2004).

emissions or subsidies and legal requirements skewing the energy market will be discussed. Also, determinants of profitability like running hours, utilization rate, subsidies and price developments for gas supplies will be discussed. The main aim is to provide the basis for a simulation model that uses the respective variables as input and calculates different scenarios for investment-likelihood (chapter 6). Based on the results of these simulations in chapter 7 a SWOT-analysis will be performance and a the research questions will be answered.

1.3 Theoretical framework

This thesis uses a layered approach, i.e. a number of theoretical approaches are used and combined in what may be called a meta-theoretical approach that allows for a combination of various other theoretical approaches. This meta-theoretical approach, the actor centered institutionalisms is the first approach to be introduced in this chapter. It is followed by a brief description of two theoretical approaches, Porter's Five Forces and PESTLE that allow sampling variables relevant for making investment decisions insofar as they provide the antecedents conditions that determine the outcome. While from a formal point of view the actor-centered institutionalism is situated on the macro-level of this analysis and Porter's Five Forces and PESTLE form the meso-level, individual decisions about how and where to invest are taken on the micro-level of analysis. Actors take this decision and they do so, by calculating the probability of a benefit to be gained by certain decisions under given antecedents conditions. Hence, a model or individual decision making under uncertainty and under consideration of what is known about antecedents conditions is needed and provided by the rational choice model. Since the purpose of this thesis is to explain investment decisions, the number of antecedents conditions will be enlarged with one further variable, enshrined in the Capital Asset Pricing Model, that makes a number of assumptions about the impact risk has in investors decisions to invest. The theoretical approached mentioned so far will be integrated in the framework provided by the actor-centered institutionalism and used for subsequent analyses.

2. Actor-Centered Institutionalism

Actor-centered institutionalism (ACI) is an analytical instrument that enables its users to analyze individual decision making within an institutional framework, made-up of variables that directly and indirectly influence an individual's decision-making process. In some way, ACI enlarges the model of rational man by adding individuals' embedding, e.g. in constellations or typical constellations of actors as well as individuals' motivations and interests and the way, actors interact with each other, captured as interaction-modus. ACI is firmly rooted within neo-institutionalism and as such it is based on a rational model of man, a fact that makes it easier to integrate a number of different theoretical approaches in the model of ACI. Accordingly, this chapter will outline the main components of ACI and it will start by discussing neo-institutionalism that introduced an entirely new vista of rational decision-making.

2.1 Neo-Institutionalism as basis

Neo-Institutionalism defines the end of a process that saw the model of rational man that was based on a fully informed actor transform to the model of a bounded rational (Williamson, 1998) man. The process started in the 1950s with increasing unease among economists used to work with what can be called the normative model of rational man (Simon, 1982: 178). Criticism was directed towards the limited scope of the model, its high degree of abstraction and the almost total lack of consideration for institutional variables that would influence actor's decisions in daily life. (Döring, 1998: 8).[7] Approaches resulting from this kind of

[7] Major milestones in this process are presented by the works of Amos Tverky and Daniel Kahneman (e.g., 1986) as well as Herbert Simon (1982). In their respective work they not only raised major doubts concerning the feasibility and usefulness of the normative model of rational actor, but also provided frameworks for a new model that substituted full information with bounded information, information an actor had indeed not information an actor could have or should have. The normative model, imminent in the works of von Neumann and Morgenstern and ground breaking for such economic developments as game theory came more and more under the influence of the new model of subjected expected utility as Savage (1954) called it. E.g. Tversky and Kahneman summarized their results as follows: „The modern theory of decision making under risk [=Rational Choice-Theory] emerged from a logical analysis of games of chance rather than from a psychological analysis of risk and value. The theory was conceived as a normative model of an idealized decision maker, not as a description of the behavior of real people. ... We argue that the deviation of actual behavior from the normative model are too widespread to be ignored, too systematic to be dismissed

criticism are usually sampled among the umbrella term “neo-institutionalism”. The common denominator of these different approaches is to consider institutional settings in their analysis. Institutions and institutional settings are defined as systems of norms, including warranties, used for the purpose of directing individual action in a particular direction (Richter, 1994: 2). All different approaches gathered under the umbrella of neo-institutionalism have further premises in common:

- Actors want to maximize their utility of benefit (Cezanne & Mayer, 1998: 1345);
- Actors act rational and their decision is formed using the information accessible and known to them. There are no fully informed actors. (Richter, 1994: 3-4; Simon, 1982);
- Social relations are reciprocal relations formed for the purpose of exchanging material or immaterial assets (Schmid, 1989: 345);

As, e.g., Oliver Williamson puts it for transaction cost theory, assumption within this framework are based on the assumption that “human agents are subject to bounded rationality” (Williamson, 1981: 553). Accordingly, they act on the information at hand: “Instead, although bounded rational agents experience limits in formulating and solving complex problems and in processing (receiving, storing, retrieving, transmitting) information (…) they otherwise remain ‘intendedly rational” (Williamson, 1981: 553). The way, information is processed and decisions are made within the context of neo-institutionalism will be elaborated in chapter 4 in some detail. Suffice to say at this point of the analysis that actors act according to their target of maximizing their utility. They weigh alternatives, assess

as random error, and too fundamental to be accommodated by relaxing the normative system“ (Tversky & Kahneman, 1986: 251-252). If the theory is too restrictive and unable to adequately describe reality, its restrictions have to be relaxed. That is exactly, what Herbert Simon proposed by introducing the concept of bounded rationality: “The term bounded rationality is used to designate rational choice that takes into account the cognitive limitations of both knowledge and computational capacity. … The theory of subjective utility (SEU) underlying neo-classical economics postulates that choices are made (1) among a given fixed set of alternatives; (2) with (subjectively) known probability distribution of outcomes for each, and (3) in such a way as to maximize the expected value of a given utility function. … Theories of bounded rationality can be generated by relaxing one or more of the assumptions of SEU theory. Instead of assuming a fixed set of alternatives among which the decision maker chooses, we may postulate a process for generating alternatives. Instead of assuming known probability distributions of outcomes, we may introduce estimating procedures for them or we may look for strategies dealing with uncertainty that do not assume knowledge of probabilities. Instead of assuming the maximization of a utility function, we may postulate a satisficing strategy” (Simon, 1982: 291).

probabilities and do so within the opportunity space (Frey, 1990) presented to them by their very own information. Viewed from the angle of neo-institutionalism, ACI is just a model to include individual actors into the opportunity space presented to them by institutions, opportunities and other actors.

2.2 Actor-centered institutionalism

Actor-centered institutionalism is not a theory, but a perspective of social sciences, writes Benz (2001: 80). The core of this perspective put together in social sciences, is that actors and their actions can only be understood when placed in their institutional setting, within the opportunity space presented to them by institutions. Without considering actors, structural analysis will be void as will analysis of actor's decisions and actions if institutions are not taken into consideration (Mayntz & Scharpf, 1995: 46). Within ACI Institutions are defined as aspects of regulation (Mayntz & Scharpf, 1995: 40). They may come as a law or a regulation, a directive or a norm, all of which aim at directing individual behavior as well as relations between actors (Mayntz & Scharpf, 1995: 47). Hence, institutions define what is left as an opportunity space (Frey, 1990: 181-182) for individual action. The institutional frame or opportunity space left to individual actions accordingly determines individual actions and intentions towards actions. "The institutional frame, that defines the rules to which one must adhere and of which one can expect that others adhere to them as well, it determines actors and actor constellations, it structures access to resources, influences intentions and decisions to act and as such defines the most important aspects of a situation an actor is confronted with (Mayntz & Scharpf, 1995: 49). The passage quoted from Mayntz and Scharpf (1995) stresses the importance of institutions as aspects of regulation or simply as rules that guide or determine individual decision-making and subsequent actions. Accordingly, what is deemed an institution needs some elucidation:

- Institutions result from social construction (Scharpf, 1990: 484);[8]
- Institutions gather behavioral knowledge common to most actors (Scharpf, 1990: 484). As such they constitute security of expectations with respect to one's own behavior and the behavior of others;[9]

[8] Accordingly, institutions rely on their legitimacy and acceptance.

- Accordingly, institutions as rules provide the secure basis for interaction based on mutual expectations that are not only shared but sound as well;[10]
- Institutions lay the foundation for structures that enable division of labor and regulate positions of different actors with respect to each other (Mayntz & Scharpf, 1995: 49);
- Institutions bring forth corporate actors. Corporate actors are formal organized gatherings of people that may act in their own rights and command centralized resources assign to the corporate actor and not the individual actors who form it (Mayntz & Scharpf, 1995: 49-50).

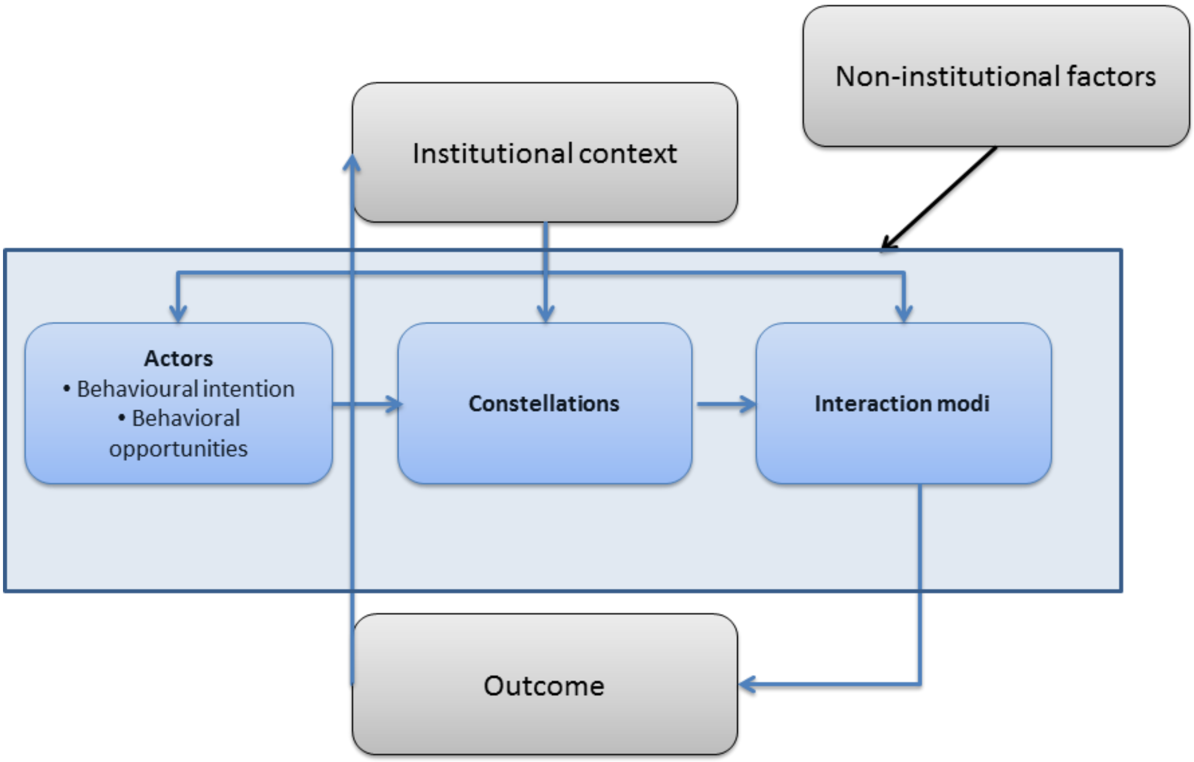
Summing up it can be said that the main purpose of institutions is to direct individual behavior. In doing so, institutions enable individuals to form well-based and usually met expectations about their own behavior as well as the behavior of others. Hence, institutions facilitate or narrow the set of decisions available to actors, but they determine more or less how the outcome of the respective decisions will be assessed by individual actors – hence, institutions influence or determine actors' preferences with respect to a particular set of behavioral decisions (Scharpf, 2000: 78). Scharpf's description provokes the question how, if institutions are seen as some kind of bed of Procrustes defiant or even delinquent behavior is possible – or to put it differently: how is it possible that individual behavior neglects the set of decisions set out so nicely by institutions? The answer given by Mayntz and Scharpf (1995: 49) refers to access to resources. Access to resources can be restricted and it can be monitored but it is not possible to control the respective access so that nobody can gain access by means unknown to the controlling entity. The argument here is some kind of derivative of sociological theory that stresses the unintended consequences of action or the fact that information is widely distributed among e.g., members of a community and hence never to be found in one single space at once (Boudon, 1982). In other words, there are things between heaven and earth that even the best regulator can has not dreamt of. However, with one question answered, another question arises: Why is it that people adhere to institutions and rules? The answer, given by Mayntz and Scharpf (1995: 52) refers to the process of

9 A good example are social rules present when one enters a public house. One would expect to be served and be expected to pay for what has been served. One would be well-advised not to stand on tables and throw glasses out of the window and so forth.

10 Criminal law is a codex of rules about property and behavior that acts as a direction to act and as a direction to expect. One would only expect being robbed in a particular vicinity and act according to the law as long as the probability to increase one's own utility by, e.g. delinquent behavior is not higher than the probability to increase one's own utility by complying with the law.

socialization and biographical development. Conformity, or adherence to rules for the authors, is a result of both. Deviant behavior is, as a consequence, socialization gone awry. Socialization, it is stipulated, directs individuals' behavior in a cognitive and motivational fashion. Cognitive direction refers to the awareness of different variables within a given situation by the actor. Motivational direction refers to the way, an actor chooses among the different behavioral alternatives. Hence, given the same situation, the same information different choice will be explained by differences in cognitive and motivational direction caused by differences in socialization and biographical development within ACI (Mayntz & Scharpf, 1995: 53).

Figure 2: The model of actor-centered institutionalism



To make ACI useful for scientific analysis, it is necessary to develop what has been said so far into a model that allows for structured research.[11] Therefore, it is further necessary to

[11] The aim of this research is described by Scharpf as follows: "The primary business of interaction-oriented policy research within the framework of actor-centered institutionalism is to explain past policy choices and to produce systematic knowledge that may be useful for developing politically feasible policy recommendations or for designing institutions that will generally favor the formation and implementation of public-interest-oriented policy" (Scharpf, 1997: 43). Accordingly, the decision

supplement some variables to the picture already painted. Accordingly, figure 2 displays the main model of ACI. It shows, that institutions or institutional settings influence actor constellation and the way, actors interact with each other, which in turn influences back on the institutional settings. So far, a closed system has been described. To allow for change, it is necessary to supplement the model with extra-institutional variables. Figure 3 shows a development of figure 1 adding further routes of influence and direction.

Figure 3: Actor-centered institutionalism as policy framework

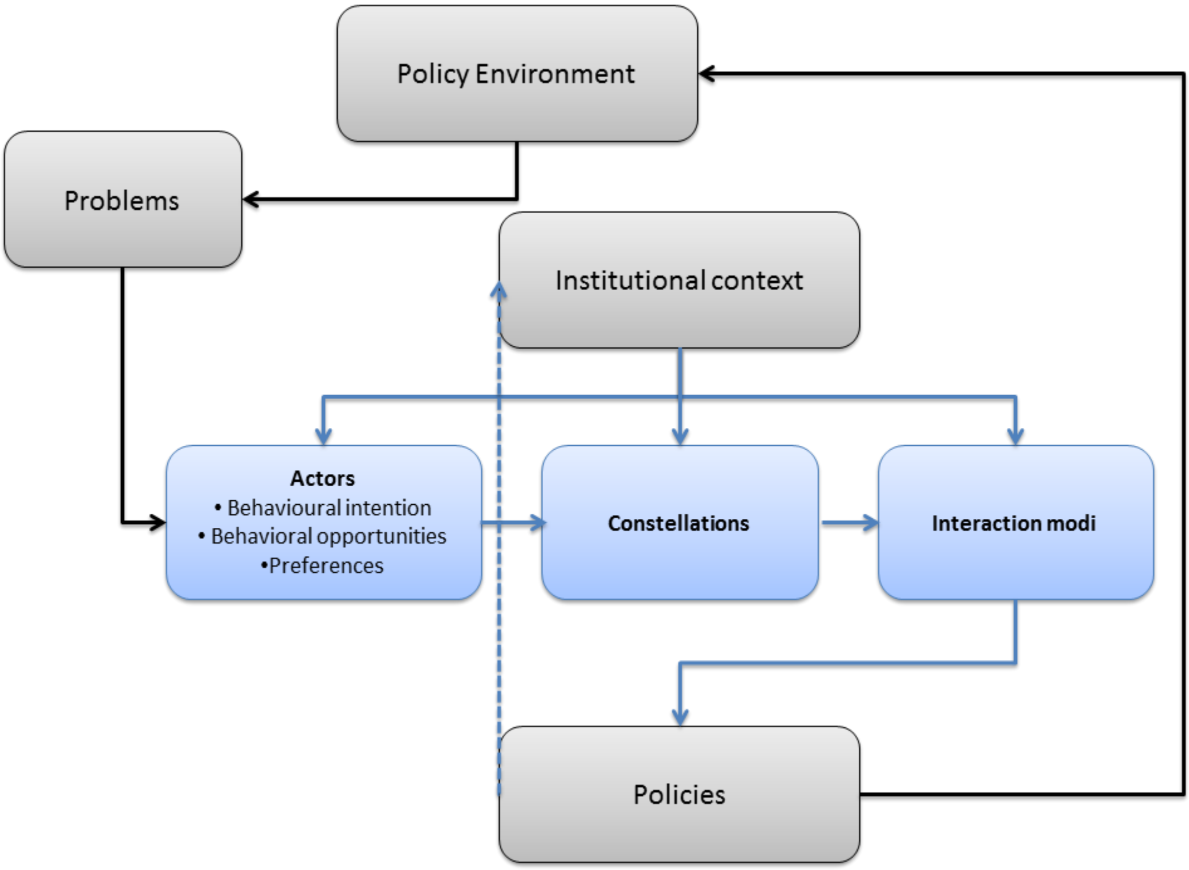


Figure 3 displays the way, ACI is used to analyze social phenomena via individual action and constellations. Scharpf describes the respective process as follows: „Within our framework, we need first to identify the set of interactions that actually produces the policy outcomes that are to be explained. This set constitutes our unit of analysis. Only then can we identify the actors, individual and corporate, that are actually involved in the policy process and whose

to invest in gas-fired power plants will be treated analogous to a policy decision, i.e., it will be explained within the framework of ACI.

choice will ultimately determine the outcome" (Scharpf, 1997: 43). It is interesting to note, that ACI starts with the explanandum and gives actors a certain degree of freedom that may result in different actions though the same set of regulations and institutions is given. This is captured by "preferences", a variable loaned from economics, where preferences are the main variable to differentiate actors and the main variable that drives different decisions. Hence, actor constellations may vary, even if they encompass the same actors and interaction modes may display a different degree of institutionalization: „Institutional design may influence the problem-solving effectiveness of policy processes through rules determining the constitution of actors and their institutional capabilities – which also affect their inclusion, and their strategic options, in the policy relevant actor constellations. But the actor constellation still describes a static picture rather than the actual interactions producing policy outcomes. These can differ widely in character, and we describe these different modes of interaction by using the descriptors 'unilateral action', 'negotiated agreement', 'majority vote', and 'hierarchical direction'" (Scharpf, 1997: 46).

For the purpose of this thesis, the framework of ACI will be used as free variable parameter, i.e., variables that constitute the institutional context will be sampled using Porter's Five Forces and PESTLE, while actors preferences and behavioral intentions will be modelled using the rational choice model and CAPM to adapt it to financial markets. Actor constellations will result from the combination of institutional settings and actor preferences while the result will be derived from the combination of the different variables. The question, whether it is feasible and rational to invest in gas fired power plants is treated as a policy problem, hence, the answer to the question is a function of actors' preferences, intentions and orientations given the respective institutional setting, the opportunity space, provided by the institutional setting and the possible actor constellation that may alleviate investment decisions for or against a gas fired power plant. As can be seen in figure 3 the answer to the investment decision will inevitably influence the policy environment and by doing so, it will influence if not determine actors preferences and intentions. In other words, if the answer to the question about an investment decision is no, because institutional settings provide a policy environment that leads to a narrow opportunity space with high risk attached to it, then, the policy environment will change, because decisions to build the respective plants will not be made. This in turn will influence the security of power supply in Germany. As can be seen from this little mental model, ACI is a useful framework to model the research question at hand. The next chapter will introduce two frameworks that allow for sampling the institutional setting that influences the decision to invest.

3. Porter's Five Forces and PESTLE

When conditions that affect a decision to invest are addressed the first that comes to mind is competition. It is hardly feasible for a company to invest in a saturated market with no possibility to develop or increase and with two incumbents that command the share of the market between them. Hence, to model the conditions for investment decisions it is important to assess market opportunities and evaluate the players that are already in the market. Porter's Five Forces are a tool that allows just that. However, it is not just competition that influences success in a market. There are a number of factors that determine, put strain on or reduce the probability of success. These factors may be political or economic or they may be legal. In any case, the PESTLE framework provides a framework that samples these kinds of variables.

3.1 Five Forces and industrial organization

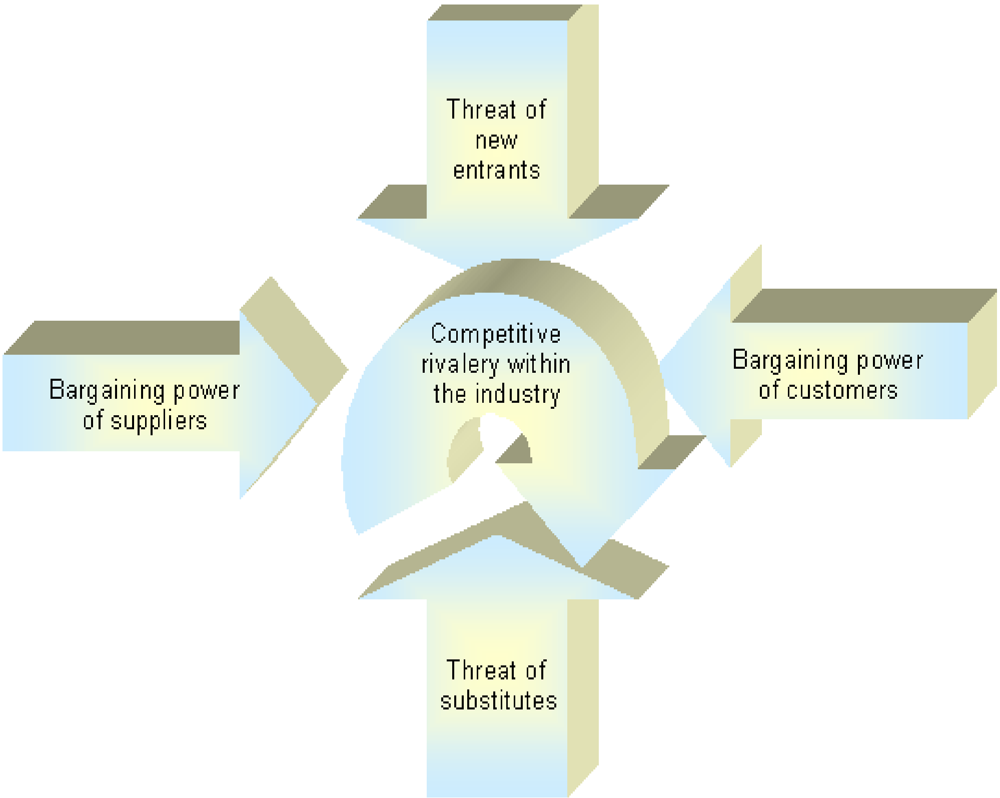
Michael E. Porter's framework of Five Forces is rooted in industrial organization view established by Joe Bain (1968) in the 1960s. Bain was the frontrunner of a theoretical approach that deemed management superfluous and argued that the success of a firm depends on the structure of the industry: Structure would influence conduct of a firm which would determine performance (Porter, 1981: 610). Since the so-called SCP-model is based on deterministic relations, Bain argued that "we could ignore conduct and look directly at industry structure in trying to explain performance (Porter, 1981: 611). However, some argued that the role of management was too far "downplayed" (Porter, 1981: 609), while others attested that "industrial organization had little effect on the business policy concept of strategy" (Heracleous, 2003: 9). Be it as it may, Porter reformed the industrial organization approach and came up with something different: "According to this [new] approach, firms are not seen as passive entities, similar in every aspect except size. Instead they are active decision makers, capable of implementing a wide range of diverse strategies … Highly influential … is Porter, whose five forces model of the firm competitive environment is heavily S-C-P influenced" (Lipczinski, Wilson & Goddard, 2005: 16).Actually, the aim of

Porter’s Five Forces is to provide information necessary to decide on a competitive strategy. Porter distinguishes three generic competitive strategies that are of no further interest for this thesis. Of interest, however, is the way, information to base a decision about which competitive strategy to pursue upon are gathered, because the very information can also be used as the basis of an investment decision into a gas fired power plant. The decision to invest into a gas fired power plant can be seen as a single competitive strategy decision that influences the long-term success of a firm, either in the one or the other direction. Consequently, a strategic decision to invest in a new plant, in a new gas fired power plant should be based on the same sound ground as a decision about a long-term strategy. Decisive for the decision to invest is the profit to be made off this decision. This is because a firm is expected to maximize profits. The profit that can be gained by opening a new gas fired power plant is a function of prices, costs and demand, with demand under perfect competition or under oligopolistic structure (Cabral, 2000: 99-103) being a function of intensity, size and number of competition: “The state of competition in an industry depends on five forces … The collective strength of these forces determines the ultimate profit potential of an industry. … Whatever their collective strength, the corporate strategist’s goal is to find a position in the industry where his or her company can best defend itself against these forces or can influence them in its favor” (Porter, 1979: 87-88). If this position cannot be found it is rather unlikely that a firm will enter a market or make a decision to invest in the respective market. Those Five Forces, Porter has been writing about, are the following:

- The amount of rivalry, the fierceness of competition already present in a market;
- The threat of new competitors entering the market;
- The threat of substitutes;
- The bargaining power of suppliers;
- The bargaining power of customers;

As can be seen in figure 4, four of the five forces are expected to revolve around rivalry, which is in the center of Porter’s framework.

Figure 4: Porter's Five Forces



Source: Recklies, 2001

Rivalry is in the center of Porter's framework and its intensity and fierceness is influenced by a number of factors, such as:

- The more firms compete the fiercer the competition;
- Slow market grow increases competition and rivalry;
- High overhead costs increase competition because firms are forced to sell most of their products in order to recoup overhead costs;
- Low switching costs for customers increase competition
- Product homogeneity increased competition and rivalry;

The power market in Germany ranks high on each of the five criteria: a vast number of firms, especially a vast array of alternative energy producers compete for a shrinking market (Hohohm et al. 2012), overhead costs to run a power plant are considerable, switching costs for customers are low and since the owners of the power grid are expected to buy give alternative power sources an exclusive treatment, gas fired power plants face not only low switching costs but uncertain demand. Since there is no difference in power for customers, i.e. they are not able to distinguish between power produced by renewable sources or power produced by burning oil, product homogeneity is at its maximum. Hence, it is fair to say, that energy markets constitute a high rivalry environment. And this high rivalry environment is further fuelled by the remaining four forces.[12]

- Bargaining power of supplier: "Suppliers can exert bargaining power on participants in an industry by raising prices or reducing the quality of purchased goods and services. Powerful suppliers can thereby squeeze profitability out of an industry unable to recover cost increases in its own prices" (Porter, 1979: 90). Clearly, the energy market is shaped by the bargaining power of suppliers, not the suppliers of power that is, but the suppliers of prices, namely the German Government, that is capable to skew markets and distort prices by simply deciding to up or down the subsidies paid on power produced from renewable sources. Hence, suppliers of power from non-renewable sources are at the governments mercy, which means the bargaining power of suppliers is at its maximum.
- Bargaining power of grid operators is equally influenced by Government regulation, since operators are required to give power from renewable sources priority feed-in.
- New entrants in the market: It is stipulated in industrial organization view (Bain, 1968: 112) that each new competitor reduces the slice of the cake, left for remaining competitors. Again, the threat of new entrants in a market is high, because incumbents are unable to build hurdles that prevent new entrants from entering the market. By contrast, government regulation provides incentives to invest in alternative energy sources, hence, reducing thresholds to the market even further, for firms that want to produce power from renewable energy sources that is. As a result, firms dealing in conventional methods to produce energy are deferred from entering the market by high entrance costs and uncertain profit opportunities.
- Substitutes. Again, conventional power supplier face a hostile environment, insofar as substitutes to conventional power are highly subsidized, with the consequence that conventional power's competitiveness is reduced, costs for supplying conventional

[12] All arguments made in subsequent passages are rudimentary at best and will be elaborated in chapter 5.

power increased and uncertainty about profit opportunities is high. Substitutes reduce the size of the market for other supplier of power.

Altogether this cursory look at the Five Forces already provided a glimpse of the hostile environment, supplier of conventional energy may face when they decide to enter the power market via building a new plant or increase their stake in the market on that account. It has become clear, that every single one of the five forces is heavily influenced by government regulation, subsidies and other forms of state interference in the power market. Hence, a further framework is needed that directs the view to the variables that form the environment for the forces discussed in this chapter.

3.2 PESTLE

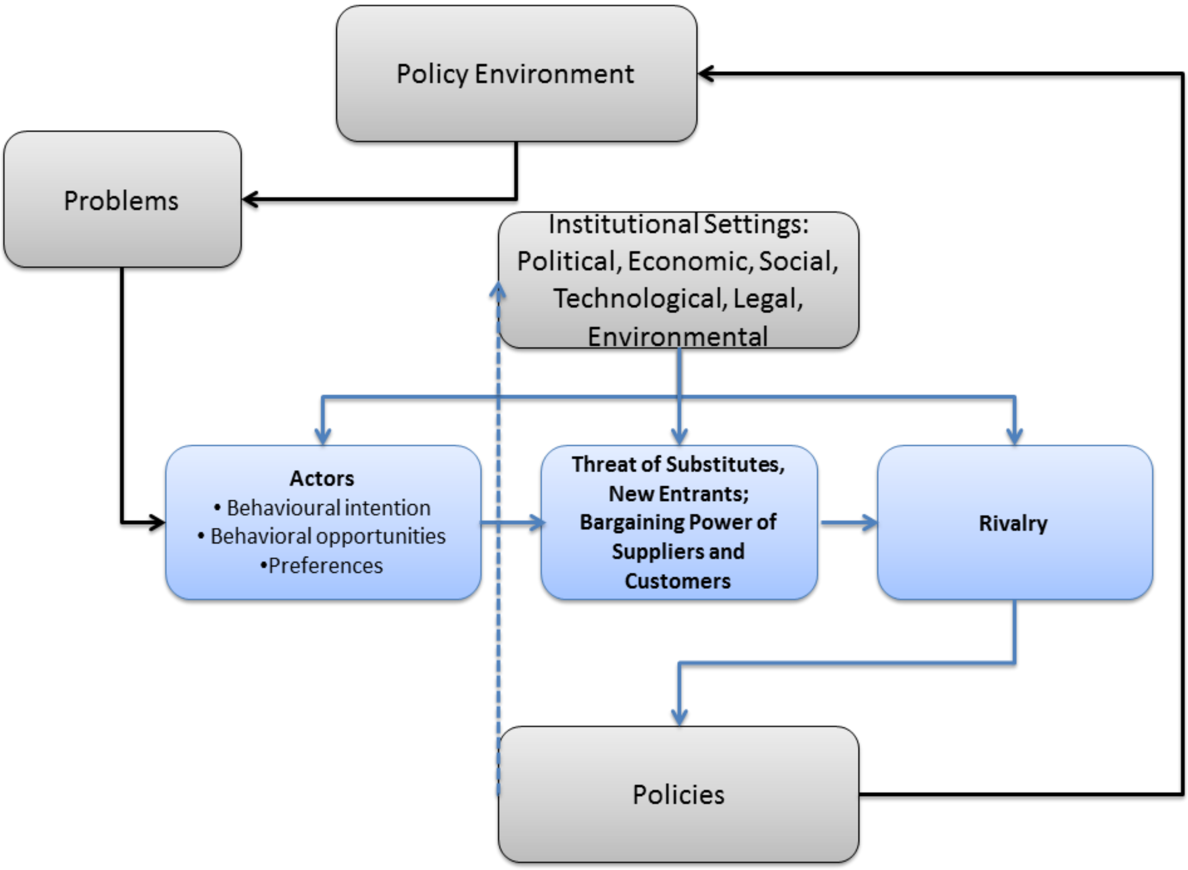
Consider figure 3: While Porter's Five Factors constitute the field of constellations and interaction modes, PESTLE[13] refers to the policy environment, the conditions that shape the opportunity space and make some constellations more likely or more feasible than others, some interaction modes the sensible choice, while others are rather a nuisance and so forth. PESTLE is no theoretical approach, it is rather a heuristic a list of variables that might or will influence individual decision making via the way they constitute opportunity spaces, provide interaction models and allow for constellations. "PESTLE analysis looks at political, economic, social, technological, environmental and legal changes which are likely to affect the business. A PESTLE analysis is a very detailed study of these changes using a range of published statistics about the state of the economy, social trend surveys, as well as some primary analysis" (Dransfield, 2004: 444-445). It is as simple as that. PESTLE is nothing more than a list of fields, one might say, policy areas that can be used to gather data. The framework leaves the content, to be sampled under each topic of PESTLE very much to the user and gives neither hint nor recommendation. It is, after all, an open framework (Cheverton, Foss & Hughes, 2004: 28-29).. Accordingly, further analysis will consider institutional settings for the following (policy) areas:

13 Sometimes the acronym PESTEL can be found in the literature. Sind PESTLE is only a heuristic with no theoretical claim, there might be no harm doing it either the one way or the other.

- Political
- Economic
- Social
- Technological
- Legal
- Environmental

Adding the two frameworks discussed in chapter 3 to the theoretical model of ACI provides the following amendment to figure 5.

Figure 5: Amended ACI-Model



What remains to be filled in figure 4 is the complex that deals with actors, their decision-making, the way, they form preferences and try to set preferences into action. This void will be filled by using a financial decision-theory, which seems appropriate. After all, the research question asks for the feasibility of investments in gas fired power plants, hence, a financial decision takes center stage.

4. A Model of Decision making under uncertainty

It has been stipulated in chapter 2 that actors act rationally, they follow what has been called subjective expected utility (Savage, 1954), which means that given the information at hand they try to maximize utility. This is not a model of objective rationality, where choices always lead to the best outcome, but a model of subjective rationality, bounded rationality (Simon, 1982), subject to the information at hand, where choices may lead to the best outcome, but do not need to. This reasoning refers decision models, like the one put forward by von Neumann und Morgenstern (1944) to a normative space, an ideal world that describes what could be, if all were to follow the path of objective rationality and all actors were fully informed. However, this is clearly no model for everyday life decisions and it is clearly no model that is feasible for the research question, addressed in this thesis. However, the decision to build a gas fired power plant or not to build it, is a decision that should be rather close to the best outcome. This target is reflected in the elaborate way, variables that might influence the feasibility and the profitability of a gas fired power plant have been sampled. Now, it is time to address those variables, which might influence the financial calculus that determines preferences and behavioral intentions as well as motivations. Hence, this chapter will briefly discuss to normative models meant for descriptive use in finance, that provide a frame for modelling individual decision in general and financial decisions in particular: the hypothesis of efficient markets, put forward by Fama (1970; 1991).

4.1 Efficient markets

Efficient markets are the baseline construct for financial decision-making. After all, to make an informed investment decision, it is important to know some particulars about past and future developments and therefore it is necessary to have a model that allows for modelling these particulars. Fama (1970) produced the foundations for such a model. Sharpe (1964) built the theoretical house on these foundations. This may seem odd, given the publication dates in parentheses, however, publication dates only tell half of the tale.

The hypothesis of efficient markets is a simple one: “I take the market efficiency hypothesis to be a simple statement that security prices fully reflect all available information. A precondition for this strong version of the hypothesis is that information and trading costs, the costs of getting prices to reflect information, are always 0. A weaker and economically more sensible version of the efficiency hypothesis says that prices reflect information to the point where the marginal benefits of acting on information (the profits to be made) do not exceed the marginal costs” (Fama, 1991: 1575). The simplicity of the efficiency hypothesis is mirrored in the number of variables that need to be considered:

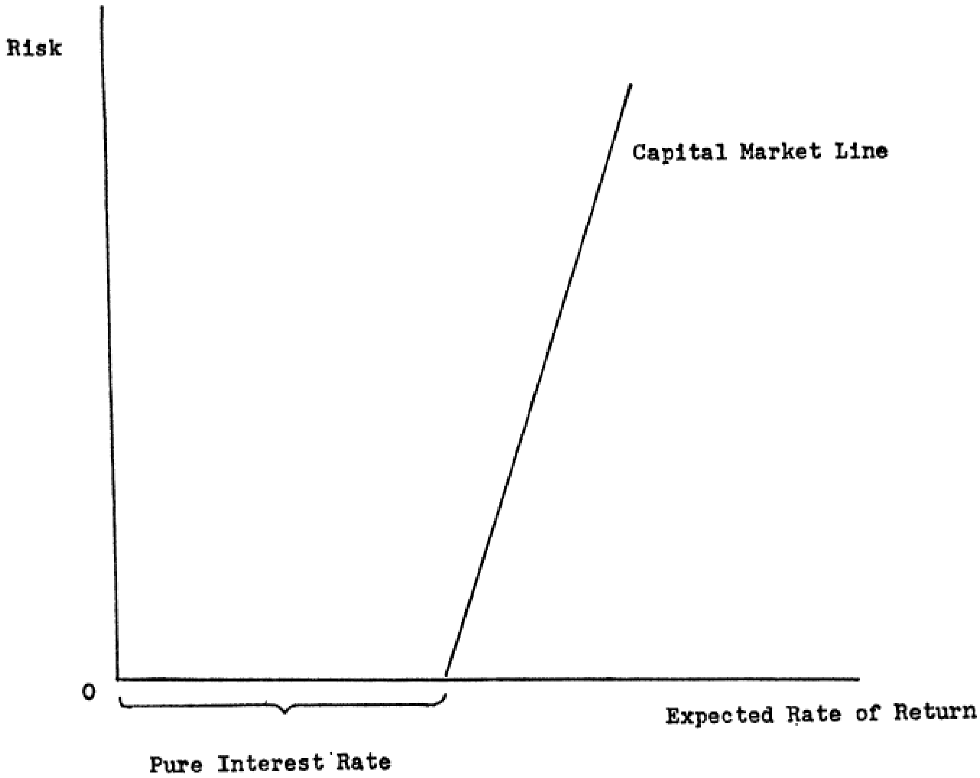
- The speed for information to spread in a market;
- Availability of information and capability of market actors to access and use private information;
- Space for arbitrage. Arbitrage is action designed to exploit mispricing in markets that has the effect to clear the mispricing;

Fama argues that numerous studies based on these three variables showed that (1) prices adapt to information, (2) arbitrage corrects mispricing and (3) that price distortions caused by private information will be corrected by arbitrageurs rather sooner than later (Fama, 1991: 1609-1610). What makes the hypothesis of efficient markets interesting for this thesis is the assumption that actors base their investment decisions on available information and that their investment-decision is reflected in the market either as noise or as informed decision. In the first case, arbitrage will corrected the deviation of price and information, in the second case no deviation will occur. As long as actors in markets can rely on the information available, they can make poorly informed and bad investment decisions, but these decisions will not distort the market, so that price information for other actors is still feasible, even after a series of bad decisions. However, the entire game changes, if one actor holds the key to market distorting, if one actor is capable of dictating prices and distorting prices at will. This is, as will be shown in chapter 5 the case in the power market: The German government has the ability to distort prices which leaves investors with a high risk decision as far as conventional power supply is concerned. High risk decisions have a particular effect on expectations towards profit, which leads to the Capital Asset Pricing Model developed by Sharpe (1964).

4.2 Capital Asset Pricing Model

“One of the problems which has plagued those attempting to predict the behavior of capital markets is the absence of a body of positive microeconomic theory dealing with conditions of risk” (Sharpe, 1964: 425). Accordingly, Sharpe aims at creating such a theory “in which the price is the result from the basic influences of investor preferences, the physical attributes of capital assets, etc.” (Sharpe, 1964: 426). Starting point for Sharpe’s analysis is the relationship between risk and return as shown in figure 6.

Figure 6: Risk and return (expectations)



“In equilibrium, capital asset prices have adjusted so that the investor, if he follows rational procedures (primarily diversification), is able to maintain any desired point along a capital market line” (Sharpe, 1964: 425). For this thesis, two consequences result from this reasoning:

1. The decision to invest in a gas fired power plant is not an isolated decision, but a decision within a portfolio of decisions. As a consequence, investors especially firms,

can be willing to accept financial losses, because this may provide a tax shield needed to reduce corporate taxes (Brigham & Ehrhardt, 2008: 622).

2. With increasing risk, investors expect increasing returns. This consequence counters consequence 1. Accordingly, the decision to invest in high risk ventures is either integrated in a portfolio of high risk decisions with respective returns or it is not feasible.

Mathematically, the relationship between risk and expected return is captured in the capital market line and in the following equation:

(1) $$\mu = r + \frac{\mu_M - r}{\sigma_M}\sigma$$

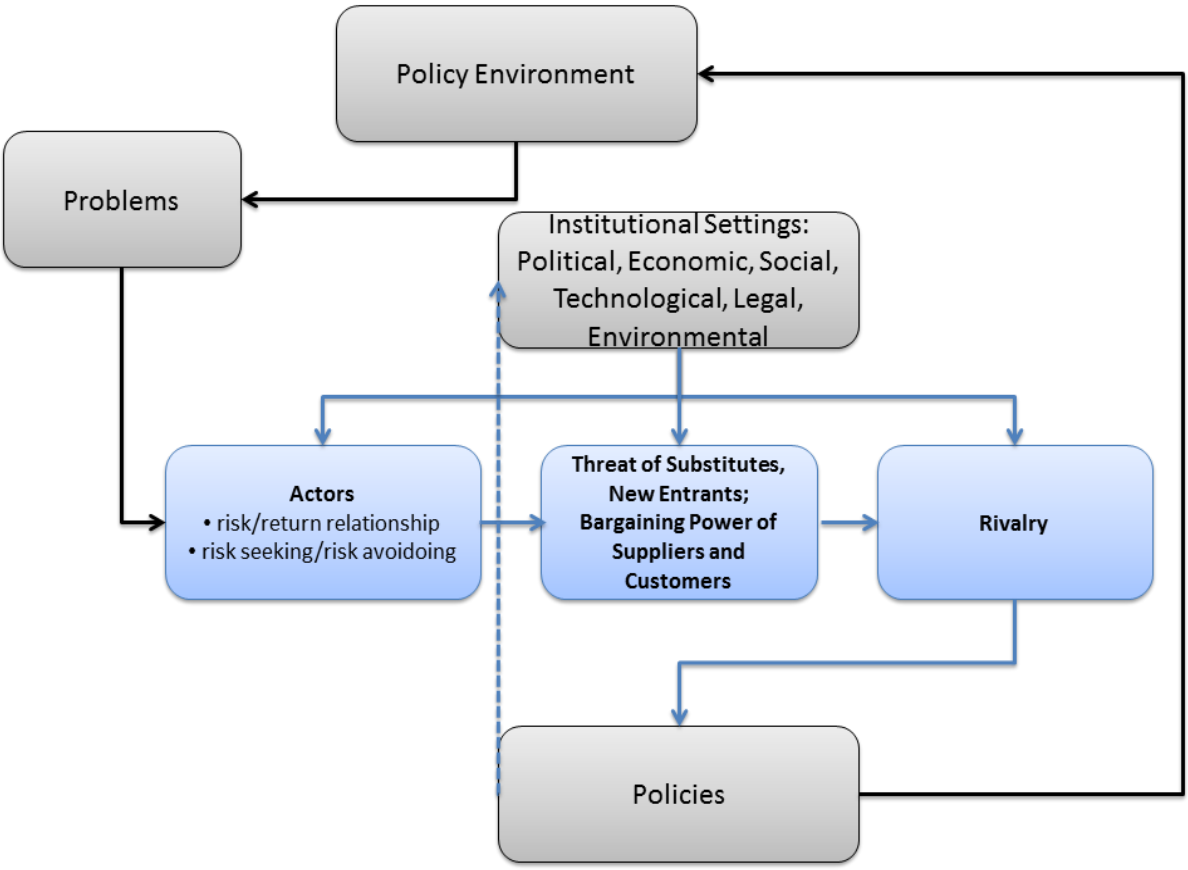
r = secure interest, e.g., government bonds
μ_M = expected return for a market portfolio
σ_M = standard deviation of return for the market portfolio;[14]

Accordingly, rational investors would expect returns to increase with risk, which transferred to the current research means that with increasing risks attached to the decision to invest in gas fired power plants returns in terms of profit have to increase as well. Accordingly, the decision to invest has to weigh current and future profit opportunities, it has to simulate price development in the power market,[15] and weigh the benefits that accompany the respective investment decision with opportunity costs resulting from investments in technologies that use renewable energies for power production. This leads to the final variable, relevant for this thesis: the attitude towards risk. As can be seen in figure 5 the capital market describes a linear function, i.e. the return depends on the risk, one is willing to take. Hence, preferences enter the fray, i.e. preferences in relation to risk. Usually, in the literature a differentiation between risk seeking and risk adverse behavior can be found. This thesis will stick to this differentiation and dichotomies preferences in either risk seeking or risk avoiding preferences (Tversky & Fox, 2000: 115-118).

[14] The standard deviation is the measure for risk. The higher the standard deviation the higher the risk.
[15] A complex matter given the fact that prices in power markets are subject to political distortion.

The variables gathered in this chapter allow for a further amendment of the theoretical model used in this thesis. Figure 7 shows the final model:

Figure 7: Final ACI model



5. Space of Opportunity

The discussion in previous chapters provided a first glimpse of challenges, threats and opportunities attached to gas fired power production. It is fair to say that prospects for gas fired power production is rather good on an international level, it is rather bad in Germany: "On balance, as far as investors are concerned Germany is a very big exceptional case – similar to Norway, but very different nevertheless. In the end the energy policy turnaround with the decision to exit nuclear power generation and heavily expand renewable sources of energy will have a considerable impact on the power generation mix. In 2012 renewables already contributed 22% towards electricity production. In 2020 the figure should already have risen to 35% and in 2050 then be 80%. The preferential feeding into the grid of 'green electricity' stipulated in the Renewable Energy Act (EEG) leads to gas and hard coal power plants generating electricity for ever shorter periods. This reduces their profitability. Ultimately, the consequence is that investments in gas and hard coal power plants are of little interest – at least as long as the political framework remains unchanged" (Auer, 2013: 11-12). The prognosis for the profitability of gas fired plants is dire, or non-existing, given the legal framework that is in place in Germany. Hence, the main driver of the decision to invest in gas fired power production is already identified. However, a number of authors and institutions calculated the development of demand for power in Germany and contrasted their results with the optimistic targets for renewables set by the German Government. The result has been calculations that see power supply from renewables fall short of demand resulting in supply gap (Bertsch et al., 2013: 6; Hohohm et al., 2012: 23) that might influence the profitability of gas fired power production even in Germany. At the moment, however, the power market is characterized by over-capacity and a skewed distribution of risk. While producers of renewables face next to no market risk, conventional producers of power take all the risk. Hence, a rational investor would abstain from investing in building a new gas fired plant, especially so, because lay-off time and foreseeable underutilization of the respective plant combined with rather high overhead costs will contribute to their not being profitable. However, this conclusion is the result of a cursory look at the evidence. Subsequent chapters will therefore take a closer look and start with the legal framework that wraps entrepreneurial endeavors and dampens hopes of profit.

5.1 Political and legal conditions

Germany is committed to the Energiewende, the switch from conventional and Nuclear sources of power to renewable sources, like wind, water, manure and solar energy. As a matter of fact, the German Erneuerbare Energien Gesetz (Renewable Energies Law) defines renewable energy as energy produced from water, wind, solar rays, geo-thermal or from manure (Point 14, Paragraph 5).[16] As such, the Renewable Energies Law sets the tone for future investment in power production. It not only skews the market by guaranteeing fixed prices for the producers of renewable energy, it also sets targets for the development of renewable energy production plants. Hence, the Government acts as market maker in the classical sense of a monopolistic actor without being active as a trader or supplier herself. This legal framework and especially the political will behind it, has to be taken into consideration when making the decision whether or not to invest in a gas fired plant. Since the political will of all major German parties is to strengthen renewable energy, it is of little use to hope for a deviation from the targets reported in the next chapter. Thus, the political environment has to be deemed as being hostile to investments in carbon based energy production.

5.1.1 Renewable Energy Law

From an economic point of view, the rationale to be drawn from the German Renewable Energies Law provides a bleak outlook for investment in conventional methods to produce energy, namely gas:

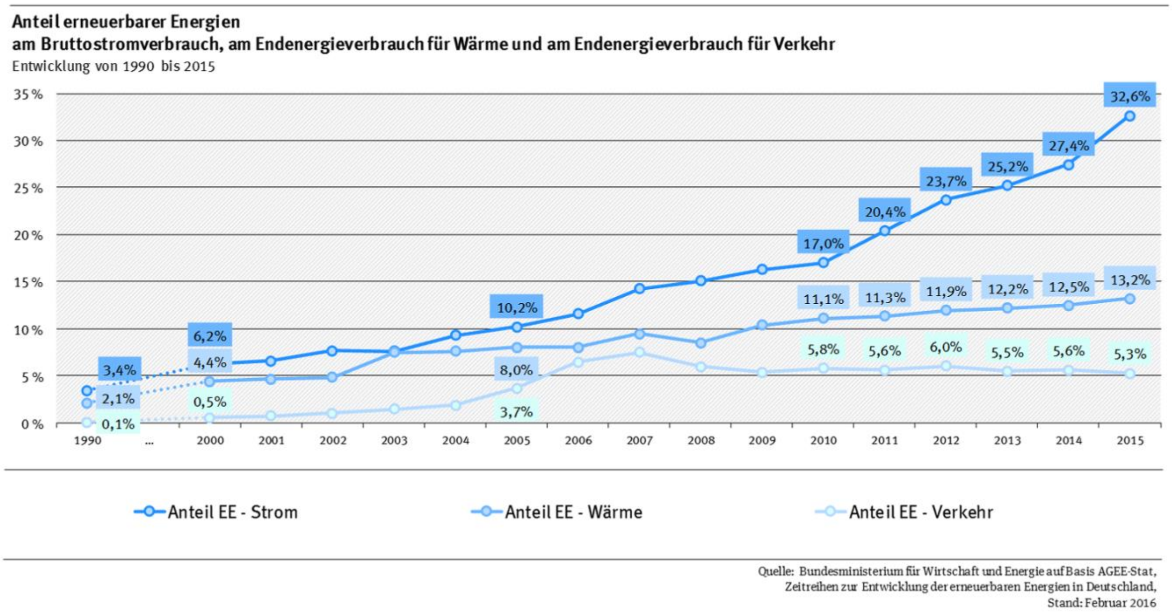
- Alternatives to gas, namely renewables are heavily subsidized;
- Energy from renewables can be sold to a fixed price;
- Capacity development is fixed with targets imposed on the amount energy produced from renewable energies;

16 http://www.bmwi.de/BMWi/Redaktion/PDF/G/gesetz-fuer-den-ausbau-erneuerbarer-energien,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

- Renewable energy is treated with priority in every respect;
- Producers of renewable energy face no price risk and no market risk. They are not even liable to shifts in demand;
- Conventionally produced energy is second best energy, a backup-source of energy that holds no potential for future development.

This is the digest of 74 pages of renewable energies law.[17] In detail these interventions in the energy market take the following shapes:

Figure 8: Share of energy from renewable sources, Germany: 1990-2015[18]



Paragraph 3 sets the targets for renewable energy development and caps the increase, e.g., for energy produced form wind in offshore parks to 6,500 MWh in 2020 and 15,000 MWh in 2050. Yearly increases are set for solar energy with 2,500 MWh per anno and on shore wind energy parks for the same amount. This shows the political will to increase the amount of energy from renewable sources and hence it reduces the opportunity space for the production of energy by conventional means, by gas for example. Hence, in the wording of Michael E. Porter (1979, 1980) thresholds for entering the market exist, because the market share is

17 http://www.bmwi.de/BMWi/Redaktion/PDF/G/gesetz-fuer-den-ausbau-erneuerbarer-energien,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

18 http://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen

designed to get smaller from year to year. However, feasible economic decisions require at least the expectation of an increasing market share. Assuming that the German target of 80% energy from renewable energy sources in 2050 and in between 40% to 45% in 2025 will be met the remaining slice for carbon based energy production has to be distributed between in the main coal based energy production, oil based and gas based energy production.[19] At present the situation in Germany is such that about a third of energy consumption in power is covered by energy produced on the basis of renewable energy sources. As figure 8 shows, since 2010 power production from renewable sources has seen a surge, hence it can be expected that Germany is well on its way to meet the 40% to 45% target in 2020. As a consequence, the market share for conventional or carbon based energy production is reduced to about 55% of the market.

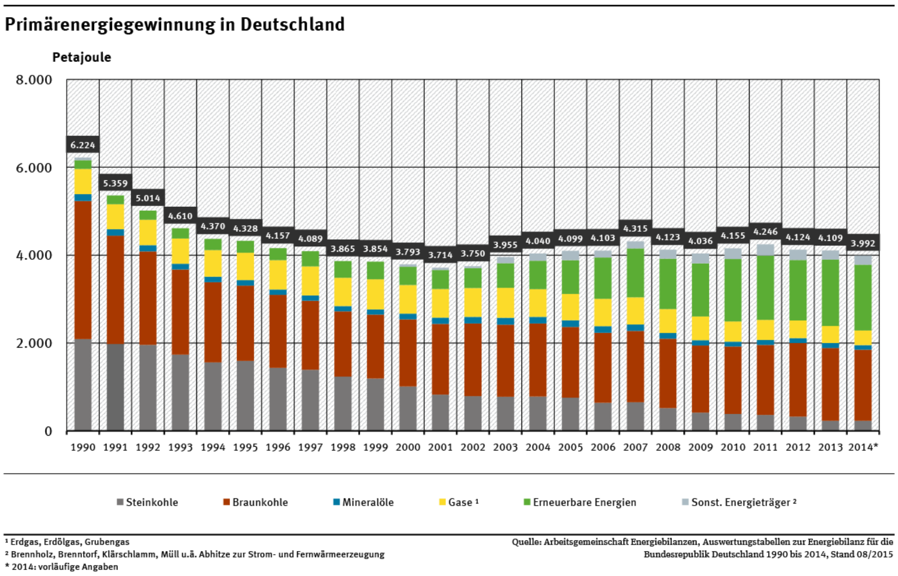
Figure 9 shows that especially energy production from hard coal has dropped considerably with renewables being the main beneficiary. Over the period of 25 years that is displayed in figure 9, share of lignite in energy production remained almost the same (ignoring the drop in the early 90s), while energy production from gas has seen a slight reduction. Hence, there are some things that are obvious from historical data:

- Coal, hard coal is not a competitor in the market for energy production anymore.
- Ignite is a stable source of energy production;
- Gas as a source for energy production has seen a drop not an increase.

Hence, while hard coal is almost completely vanished from the energy production market, gas made no grounds. On the contrary, gas as a source of energy production lost ground as well. It is hard to imagine that this trend can be reversed in 2020 when German nuclear energy will vanish from the energy market as well. Thus one has to conclude that there is no window of opportunity or even a favorable development that might increase demand for gas fired energy production.

19 As reported above, nuclear energy is not an option in Germany.

Figure 9: Primary energy production by sources: Germany 1990 to 2015[20]



So, political targets to some extent transform into reality. Accordingly, investments in energy production by means of gas have to calculate with decreasing market shares from the very beginning. Furthermore, conventional energy production is put at a disadvantage by a number of measures laid down in the Renewable Energies Law. The most important of these measures is a price guarantee to producers of green energy, as it is called. Since 2012 these producers can choose between either a market premium or a fixed price for their produce. This choice results from one major alteration. Since 2012 producers of renewable energy are allowed to trade their produce on the EPEX in Paris, which is on the spot market for energy. However, they do so at no risk as one might expect, because of the peculiarities of the renewable energy price mechanism. The latter consists of EEG-account. It consists of all the money from selling energy at the EPEX Spotmarket and the receipts from the so-called EEG-Umlage (Renewable Energy share in the costs). From the account producers of renewable energy will get a guaranteed income from either a market premium or a fixed price scheme. So altogether the get the same price whether they sell on the spotmarket or to a fixed price. The only variable costs in the calculation are the costs imposed on consumers via the so-called renewable energy tax.[21] This guarantee to producers of renewable energy is the result of a peculiar mechanism that secures them a fixed rate revenue irrespective of spot prices,

20 http://www.umweltbundesamt.de/daten/energie-als-ressource/primaerenergiegewinnung-importe
21 At present, the tax is 6.354 ct/kWh.

shifts in demand or supply or other factors that have an influence on prices (). To understand this mechanism, a closer look at the renewable energy law is required.

The most important part of the law is to be found in the paragraphs 40 to 51. In these paragraphs prices for energy produced from different forms of renewable sources are fixed. E.g., energy produced from water is guaranteed a price of 12,52 ct/KWh up to 500 KW produced. With increasing production, subsidies decrease to 4,28 ct/KWh for more than 50 MW produced (§ 40, Renewable Energies Law). For energy produced by means of wind, fixed prices are 3.9ct/KWh for offshore production (§ 40 Renewable Energies Law) and 4.95 ct/KWh for onshore production. Energy from use of solar energy is rated at 9,23ct/KWh up to a maximum of 10 megawatts (MW) (§ 51 Renewable Energies Law). To see, how this fixed price works out, a look at the Energy Exchange EPEX in Paris is quite useful. At peak time on a Wednesday spotprice for one MWh of energy is 35.16€/MWh.[22] The producer of renewable energy from onshore wind use is guaranteed a price of 42,95 €/MWh. If he sells his produce at the price of 35.16 €/MWh. So obviously, as compared to his guaranteed price of 42.95 €/MWh he makes a loss of 7,79 €/MWh. Not so in the realm of the Renewable Energy Law. The seller holds a 7,79 €/MWh claim against the common EEG-Account and the difference between spot prices and fixed prices is accounted for by the tax payers, via the renewable energy tax. So, whatever the spot price the producer of renewable energy will get the price guaranteed in the Renewable Energy Law. However, the contribution of taxpayers depends on spot prices, the lower spot prices for energy the higher the amount taxpayers have to cover (see Gawel, Korte & Tews, 2016: 52, Schröder, 2015: 101 for the functioning of the EEG-tax). The balance payment to be issued by taxpayers is subject to the market premium given to those producers of green energy that market their produce directly via the Paris EPEX.[23] By contrast, producers of conventional carbon-based energy do not get any kind of guarantee. Worse still, grid operators are expected to treat producers of renewable energy with priority (e.g., § 14, renewable energies law). Hence, the amount of energy, producers of carbon-based or conventional energy are able to sell, depends on the amount of energy

22 https://www.epexspot.com/en/market-data/dayaheadauction;
The example is based on the highest price at peak times. Usually and off-peak time prices are much lower, falling to 6.7 €/MWh on early Sunday mornings.

23 See Appendix 1 of the Renewable Energy Law for the concrete calculation of the Market premium. You will find a lot of text for a rather simple calculation.

produced from renewable sources. Thus, the legal environment within gas fired production of energy is fitted sees:

- Competitors, producing from renewable energy sources given priority in competition;
- Competitors, producing from renewable energy sources given a price guarantee;
- Competitors, producing from renewable energy presented with no cap on the amount of energy the can deliver;

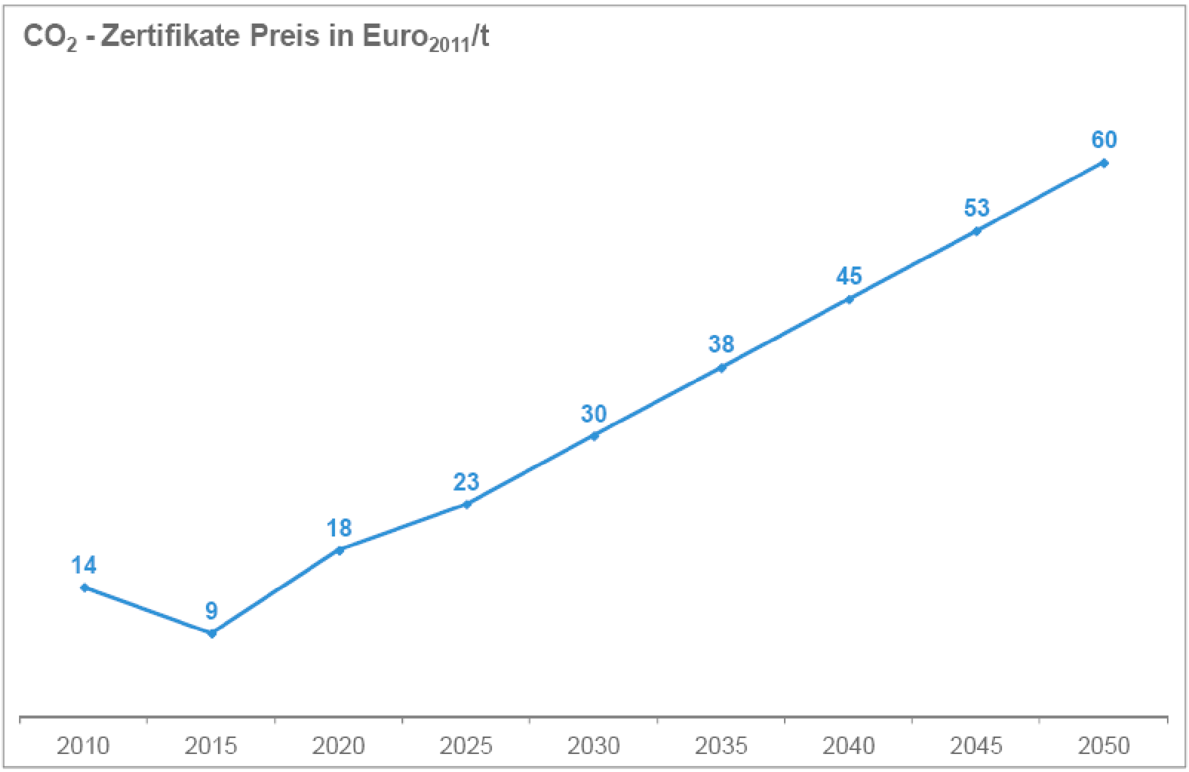
Hence, it is no wonder that energy markets suffer from overcapacity and that renewable energy production and especially the subsidies for renewable energy production lie at the core of that problem (Lehman et al., 2016: 346; Moriarty & Honnery, 2016: 4; Wolisz, 2016; Zhang et al., 2016: 825) .Given the political targets set by the German Government and given the heavy investment in and large subsidies for renewable energy production, it comes as no surprise that a report assembled in the Fraunhofer Institute concludes that overcapacities in the energy markets are due to conventional forms of energy production and recommend to reduce the number of facilities (Mayer & Burger, 2014: np). Overall, one has to say that the conditions for investing in a gas fired plant for energy production are not in the least favorable.

5.1.2 EU Emission Trading Scheme

In brief, the EU ETS emission trading scheme is designed to reduce the amount of CO_2 emitted in the EU. It does so by putting a cap on the allowance of CO2 emissions. Whoever exceeds his daily or monthly allowance has to pay for it. Since 2013 all power generators are required to “by all their allowances” (European Commission, 2015). At the moment the EU ETS system is transformed into an auctioning system with about 40% of allowances traded at exchanges. Hence, the costs for CO2 production will go up, especially so for energy producers, since they have to buy all their allowances (figure 10). Thus, the EU hands a further handicap to carbon-based Energy producers and increases the fixed costs for every unit of power produced on a carbon base. Again, carbon-based producers of energy are put on the back foot.

The amount of handicap added to the tally can be taken from figure 11 taken from a report of the UK Parliament. Accordingly, gas holds an advantage over coal, however, as has been shown in the previous chapter, coal is not a competitor on the German energy market any more. Especially, the new Carbon capture and storage (CCS) technology reduces the cost incurred by CO2 emissions, however, at a trade-off because innovative technology is more expensive than conventional technology.

Figure 10: Price-Development of CO_2 Certificates

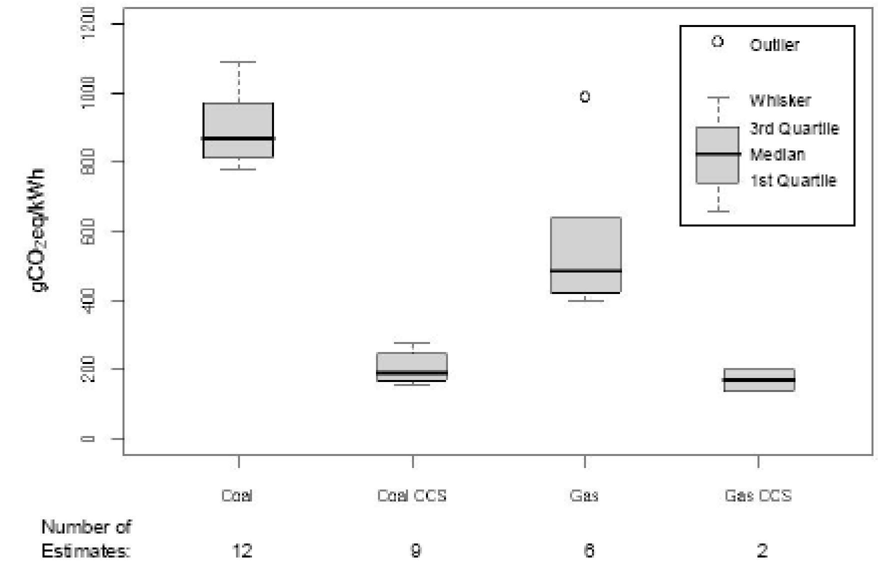


Source: Hobohm (2012: 33)

However, even with CCS CO2equivalents per kWh amount to about 200 units which is far more than the emission of renewable energy production (figure 12).

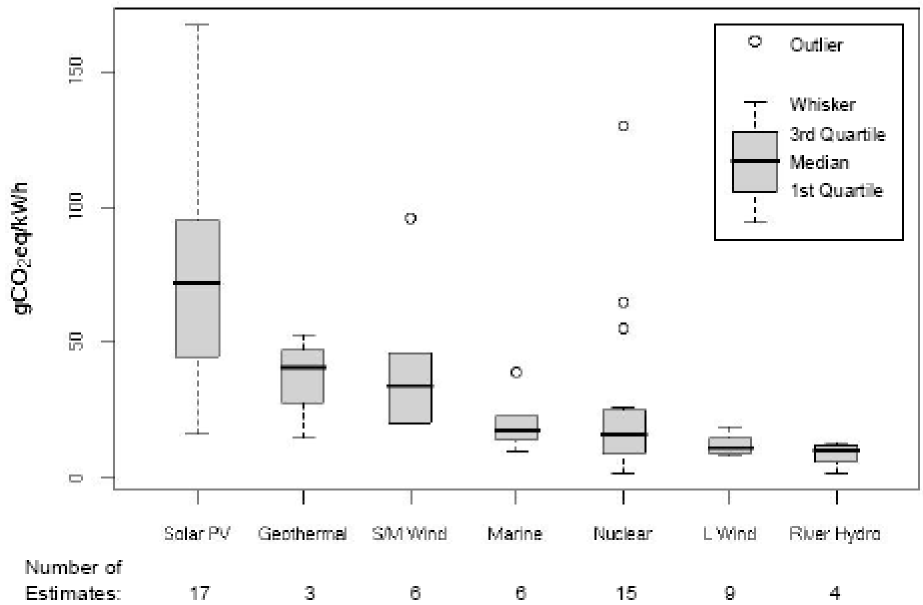
Hence, the position of carbon based energy production within the market is again impaired by legal regulation, added further fixed costs to the fray. Thus, not only has carbon based energy production to deal with a demand-side risk, as far as demand for the respective energy depends on the amount of renewable energy production, it also has to handle a cost disadvantage, because a number of regulations imposes costs on carbon based energy production and raises the overhead costs, while the respective costs of renewable energies are not touched. Thus, the discussion of the legal obligations rested on the shoulders of carbon-based energy producers leads to the result that investment in gas fired energy production on the German market is not feasible. However, economic parameters might be more favorable.

Figure 11: Carbon imprint of gas fired energy production



Source The Parliamentary Office of Science and Technology (2011: 2)

Figure 12: Carbon imprint of renewable energy production



Hence, the position of carbon based energy production within the market is again impaired by legal regulation, added further fixed costs to the fray. Thus, not only has carbon based energy production to deal with a demand-side risk, as far as demand for the respective energy depends on the amount of renewable energy production, it also has to handle a cost disadvantage, because a number of regulations imposes costs on carbon based energy production and raises the overhead costs, while the respective costs of renewable energies are not touched. Thus, the discussion of the legal obligations rested on the shoulders of carbon-based energy producers leads to the result that investment in gas fired energy production on the German market is not feasible. However, economic parameters might be more favorable.

5.2 Economic conditions

Economic conditions will be assessed by using Porter's Five Forces. Already, in previous chapters, it was not avoidable to introduce some economic considerations. Hence, it is possible to make this chapter a brief one.

5.2.1 Porter's Five Forces

The power market in Germany ranks high on each of the five criteria: a vast number of firms, especially a vast array of alternative energy producers compete for a shrinking market: Demand for power is decreasing (Hohohm et al. 2012) and the market share of carbon-based or conventional power production is reduced by means of the Renewable Energy Law. Furthermore, the following economic conditions for running a gas fired plant can be put together:

- Overhead costs to run a power plant are considerable; (Apart from running costs, overhead and legal costs are considerable, while sale is independent of price and production capacity)
- Switching costs for customers are low, since most end consumers will not be able to differentiate between the quality of power provided;

- Competitive position as compared to producers of energy from renewable sources is hampered by legal barriers and a priority treatment of the latter producers, which allots them a 100% sale guarantee without any market risk and guarantees even the price, while sale of energy produced conventionally or carbon-based depends on the amount of renewable energy produced.
- Hence, it is fair to say, that energy markets constitute a high rivalry environment as far as producers of carbon-based energy are concerned. And this high rivalry environment is further fuelled by the remaining four forces.[24]

Another possibility to look at rivalry is to consider the power plants already in construction or in planning. The German Bundesverband der Energie- und Wasserwirtschaft (bdew) regularly publishes a list with all the planned or built power plants on it. In 2015 74 projects had been planned, started or were close to being finished. Among these 74 projects are 24 gas fired power plants, 50% of which did not get out of the planning phase yet because they could not find investors or get a planning permission. However, lack of financing is the main reason for the realization of planned gas fired plants being postponed in Germany. Hence, bdew warn that investments in power plants that are not based on harvesting the energy of the wind, will almost seize completely.[25] At the moment 42 of the 74 projects scheduled to be build or under construction are based on wind energy (BDEW, 2015).

- Bargaining power of supplier: "Suppliers can exert bargaining power on participants in an industry by raising prices or reducing the quality of purchased goods and services. Powerful suppliers can thereby squeeze profitability out of an industry unable to recover cost increases in its own prices" (Porter, 1979: 90). Clearly, the energy market is shaped by the bargaining power of suppliers, not the suppliers of power that is, but the suppliers of prices, namely the German Government, that is capable to skew markets and distort prices by simply deciding to up or down the subsidies paid on power produced from renewable sources. At the moment subsidies amount to 6,345 ct/kWh. As has been argued above, this guarantees producers of renewable energy prices that exceed spot market prices by far. Hence, suppliers of

[24] All arguments made in subsequent passages are rudimentary at best and will be elaborated in chapter 5.

[25] https://www.bdew.de/internet.nsf/id/bdew-kraftwerksliste-2015-veroeffentlicht-de?open&ccm=900030

power from non-renewable sources are at the governments mercy, which means the bargaining power of suppliers is at its maximum.

- Bargaining power of grid operators is equally influenced by Government regulation, since operators are required to give power from renewable sources priority feed-in.
- The threat of new entrants in a market is high, because incumbents are unable to build hurdles that prevent new entrants from entering the market. By contrast, government regulation provides incentives to invest in alternative energy sources, hence, reducing thresholds to the market even further, for firms that want to produce power from renewable energy sources that is. As a result, firms dealing in conventional methods to produce energy are deferred from entering the market by high entrance costs and uncertain profit opportunities.
- Substitutes. Again, conventional power supplier face a hostile environment, insofar as substitutes to conventional power are highly subsidized, with the consequence that conventional power's competitiveness is reduced, costs for supplying conventional power increased and uncertainty about profit opportunities is high. Substitutes reduce the size of the market for other supplier of power.

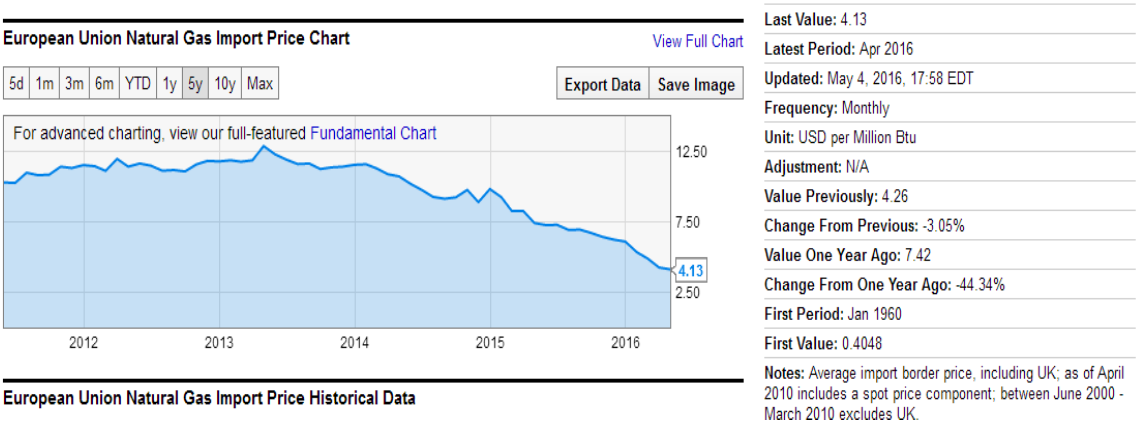
Again, the summary of the arguments put forward in this chapter has only one conclusion: It is not feasible and it is economically irrational bordering on madness to invest in gas fired production of energy in the German market.

5.2.2 Price developments and supply gap

Two factors that might have a positive impact on the feasibility of investing in a gas fired plant in Germany can be summarized as follows: Gas prices may drop in the long run, making it profitable to run a gas fired plant even at underutilization in a stand-by mode and with large overhead costs incurred by Government regulation. Furthermore, renewable energy targets set by the German Government may be too optimistic and not reachable, leaving an energy gap that has to be filled with conventional carbon-based energy production. Both arguments will be put to the test in this chapter.

Figure 12 shows the development of prices for gas imported in the European Union. As can be seen, prices are falling since peaking in early 2014. Hence, price development seems favorable for running a gas fired plant.

Figure 12: Price development of natural gas imported in the EU[26]

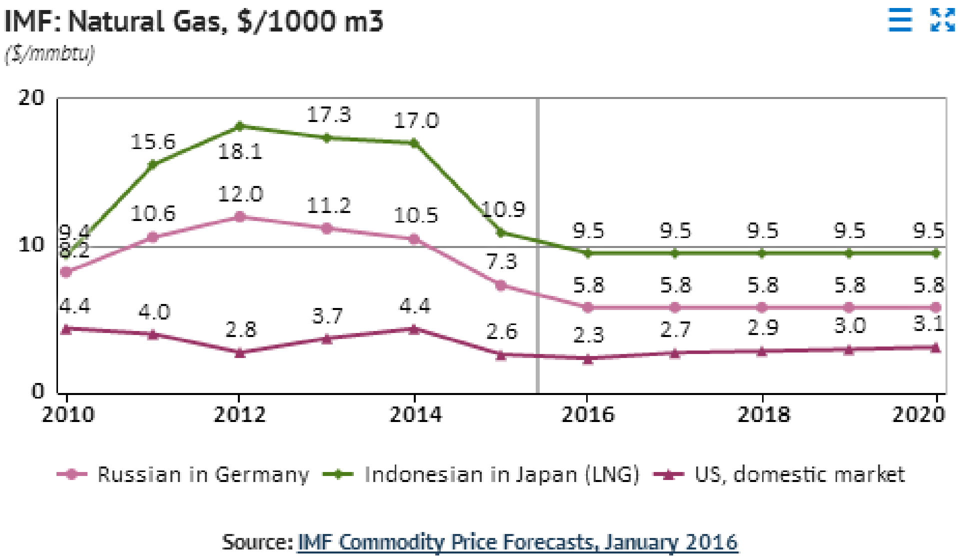


Figures 13 shows that gas prices are expected to fall even further and then remain level, making gas fired energy production even more interesting.[27]

However, it seems appropriate to remind oneself of the legal and environmental conditions in Germany and the statement by Kost et al. (2013: 24) according to which the profitability of gas fired plants will depend on prices of resources, prices of emission certificates and the amount of renewable energy produced. As has been shown in previous chapters, EU ETS certificates increase in price, while cost of resources (gas) are bound to fall as has been shown in the present chapter. Amount of renewable energy produced will increased. Hence, the market share of conventionally produced energy will decrease and so will utilization leading to Kost et al. (2013: 25) forecasting that hours of full utilization will drop and costs for energy production will raise further, making gas fired plants according to their calculation less profitable and liable to higher production costs as coal or oil based energy production (Kost et al., 2013: 24). Hence, Auer's verdict still stands: "gas and hard coal power plants are of little interest" (Auer, 2013: 12).

26 https://ycharts.com/indicators/europe_natural_gas_price/chart/
27 https://knoema.com/ncszerf/natural-gas-prices-long-term-forecast-to-2020-data-and-charts

Figure 13: Prognosis: Price development of natural gas

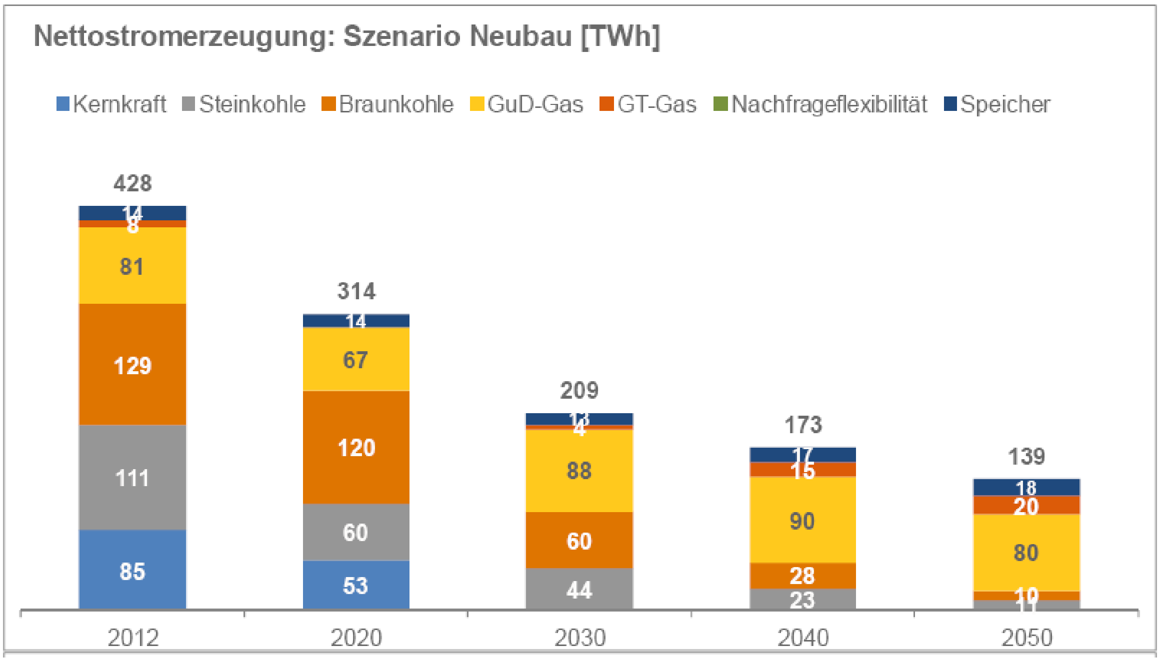


But what if the amount of energy produced from renewable sources is not enough to cover the demand for the respective energy? Hobohm et al. (2012) do not share the optimism of the German Government with respect to the targets mentioned in the Renewable Energy Law. Hence, 80% from renewable sources is a myth to Hobohm et al. (2012: 23). They calculate that thermal energy will have to contribute in between 46 % and 51 % of the energy supply in 2050 (see figure 14). Based on this calculation they reckon that demand for gas fired energy production will increase in a scenario that requires building new installations, hence, the importance of gas-turbines as a technology for energy production will increase according to Hobohm et al. (2012: 27).

However, this is a stand-alone prognosis not shared by others. As a matter of fact, energy producers are closing down plants not opening or even planning new once. And as a further matter of fact, Germany is on the forefront of plant-closure with 39 plants to be closed by the end of 2017 (see figure 15).[28]

[28] http://www.energypost.eu/ubs-closures-coal-gas-fired-power-plants-europe-accelerating/

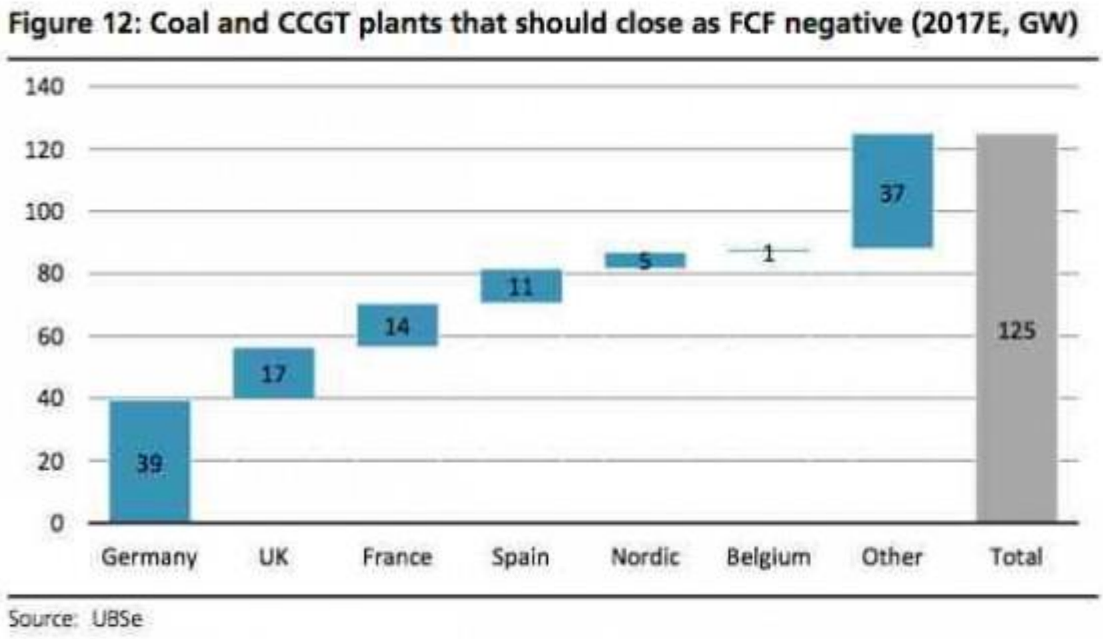
Figure 14: Importance of different carbon-based energy sources: forecast



Source, Hobohm (2012: 27).

With respect to the underutilization of gas fired power plants The Economist wrote in 2014: “In contrast, the amount of energy generated from gas has fallen sharply. It dropped by a third between 2011 and 2013, and so far this year by a further 24%. That seems strange given its relatively green credentials. Coal-fired power stations emit twice the amount of carbon dioxide for each unit of electricity generated that gas ones do, as well as producing fly ash that releases 100 times as much radiation as a nuclear plant with the same generating capacity would emit. The worrisome result of this has been to raise greenhouse-gas emissions, but without any corresponding reduction in electricity generation from nuclear sources. That outcome is the exact opposite of the intentions of the original policy. The main reason for this appears to be that the sharp fall in the price of solar energy in recent years has undermined the economics of gas more than it has coal. In Germany, as in America and Britain, there is a sustained peak in electricity demand in the middle of the day, with consumption falling overnight. Solar power neatly meets the noontime peak, often producing too much at that point in the day, while at the same time making no contribution to power demand at all overnight. Since gas-fired plants are easier to switch on and off quickly than coal and nuclear ones, the gas plants used to be used to fill any gaps at peak times. But with the larger peak now satisfied by the growth of solar and other renewable-energy sources, gas plants are now underemployed. In the past seven months, they have rarely passed 50% of their capacity; many are now losing money for their owners".[29]

Figure 15: Expected closure of carbon-based power plants



Once again, renewable energy is the culprit for gas fired power generation being a non-profitable source of energy production. Hence, the conditions for gas-fired plants in Germany are not suitable for a respective investment.

5.3 Social, environmental and technological conditions

In previous chapters the question of economic as well as legal conditions has been addressed, of those conditions that vitally influence the profitability of a gas fired power plant. The result of the respective discussion is devastating: Legal conditions place gas fired power plants at a disadvantage as compared to energy produced from renewable sources and economical consideration shows that building a gas fired power plant is simply not feasible. In the present chapter gas fired plants as a variant of carbon-based energy production will be addressed with from a social and environmental perspective. As a matter of fact, the latter

29 http://www.economist.com/news/business-and-finance/21620080-germanys-reliance-russian-gas-fallingbut-not-sustainably-going-out-gas

perspective has already been satisfied in previous chapters. Namely in chapter 5.1.2 it has been shown, that costs for EU ETS credits that will have to be purchased by plant operators will soar over coming years, adding even more to fixed costs for running the respective plant. However, carbon imprint of gas fired plants, as shown in figure 11, has been greatly reduced especially by introducing carbon capture and storage technology (The Parliamentary Office of Science and Technology, 2011). However, carbon dioxide emissions are still larger than those emitted when producing energy from renewable energy sources, hence the competitive disadvantage that results from legal costs imposed on carbon-based technologies of power production still exists. Hence, it can be said that environmental costs will rise in coming years, thereby increasing the gap in fixed costs between carbon-based and so-called green methods of energy production even more. Accordingly, competitiveness of carbon-based energy production will suffer increasingly. Furthermore, it is imminent when looking at Germany, that in particular some Non-Governmental Groups take a rather hostile stance against carbon-based technologies of power production.[30] A closer look, however, reveals something unexpected. In a report that argues for a closure of coal fired power plants, Götz, Heddrich and Lenck make the case of gas fired power plants and argue that closing goal fired plants would not only reduce CO_2-emissions, but also allow for gas-fired plants utilization rate to increase bringing them close to full capacity. The show (figure 16) that compared to hard coal, ignite and nuclear energy, overhead cost for gas fired plants are the lowest, emissions are lower as with hard coal or ignite power production and efficiency is about 60%, which is much better than the efficiency that can be reached by burning hard coal or ignite.

Figure 16: Some environmental parameters of power plants

Typ	Wirkungsgrad in %	Emissionsfaktor (t CO_2/MWh_{th})	Fixkosten (ohne Kapitalkosten) in €/MW/a
Kernkraft	33	0	78.000
Braunkohle	39	0,36	42.000
Steinkohle	43	0,34	42.000
Gas	60	0,2	25.000

Hence, they argue to replace gas for coal. This gives the first hint, that social acceptance, at least with respect to non-governmental organizations does indeed exist. The same argument

30 http://www.greenpeace.de/search/field_tags/Kohlekraftwerk-573

can be found for the German BUND für Natur- und Umweltschutz: cheap coal hurts the environment and has underutilization for gas fired plants as a consequence. Shutting down coal fired plants would serve the environment and increase utilization rates of existing plants.[31] Acceptance for gas fired plants is reduced to existing plants as it seems. However, acceptance with non-governmental organizations is one thing, acceptance with investors quite another as can be derived from the Kraftwerksliste (power plant list) or the Bundesverband der Energie- und Wasserwirtschaft (BDEW, 2015). While gas-fired plants have been the second choice only to be surpassed by wind energy plants, realization of the respective projects is in doubt for 50% or of the 24 scheduled projects, because most of these 12 projects are unable to find investors or had investors that withdraw from the project. This signifies that investors shy away from the risk attached to gas fired plants or that they see the relation between risk and return skewed in a manner that precludes any kind of investment. Whether gas fired power plants find the same resistance in the general public as some other power plants mainly hard coal or ignite based power plants do[32] is an open question because gas-fired plants are subject to closure rather than construction. As early as 2012 E.On, one of the biggest distributor of energy, shut down gas-fired power plants and abstained from the construction of new ones.[33] The reason for the closure of even highly modern and environment-friendly gas-fired plants is that the respective plants are under-utilized and cannot cope with the disadvantages imposed on them by legal means and political will.[34] Hence, it is rather of no importance whether locals resists the building of gas fired power plants because their hardly seem to be one.

31 http://www.bund.net/themen_und_projekte/klima_und_energie/kohle_oel_und_gas-/kohlekraftwerke/bund_abschaltplan/

32 E.g.: http://www.bund.net/themen_und_projekte/klima_und_energie/kohle_oel_und_gas/-kohlekraftwerke/uebersicht_standorte/;
or:
http://www.berliner-zeitung.de/widerstand-gegen-geplanten-neubau-von-steinkohlekraftwerk-in-suedhessen-beklagt-eon-bekraeftigt-interesse-an-netz-ag-15652434 or:
http://www.derbund.ch/bern/stadt/Widerstand-gegen-Wasserkraft-ist-riesig-/story/26250820?track

33 http://www.heise.de/tp/news/Eon-schliesst-Gaskraftwerk-und-zeigt-wenig-Interesse-an-Neubauten-2006448.html

34 http://www.rp-online.de/wirtschaft/energiewende-darum-sind-effiziente-gaskraftwerke-chancenlos-am-markt-aid-1.4925225

5.4 Technological conditions

As Robert Steele pointed out in 2012, gas fired power production has one of the best conversion rates you can get. Improvements in turbine technology result in efficiency rates of 65%, that is, conversion from fuel in electricity is at a high standard (Steele, 2012). Furthermore, CO_2 emissions have been greatly reduced due to technological improvement as has been already mentioned above. However, other authors do not share the efficiency optimism of Robert Steele and calculate the efficiency of gas fired power production less favorable: “Natural Gas fired (including LNG fired) power plants account for almost 20 % of the world’s electricity generation. These power plants use Gas Turbines or Gas Turbine based combined cycles. Gas turbines in the simple cycle mode, only Gas turbines running, have an efficiency of 32 % to 38 %. The most important parameter that dictates the efficiency is the maximum gas temperature possible. The latest Gas Turbines with technological advances in materials and aerodynamics have efficiencies up to 38 %. In the combined cycle mode, the new "H class" Gas turbines with a triple pressure HRSG and steam turbine can run at 60 % efficiency at ISO conditions. This is by far the highest efficiency in the thermal power field”.[35]

However, these factors that normally would make gas fired power production the technology of choice, once, nuclear energy and hard coal fired plants are out of the equation do not apply in Germany, because in Germany Renewable Energy Law rules and it rules out that gas fired power plants can operate with any kind of profit or security with respect to the utilities. Hence, it is not necessary to point out the advantages or disadvantages of the respective technology, because the respective technology does not count.

35 http://www.brighthubengineering.com/power-plants/72369-compare-the-efficiency-of-different-power-plants/
The same efficiency rates are calculated by the US Energy Information Administration: http://www.eia.gov/electricity/annual/html/epa_08_01.html

6. Likelihood to invest in gas-fired power plants

Previous chapters have summarized the conditions that are crucial for operating a gas fired power plant in Germany. It has been shown, that legal conditions are hostile, economic conditions are adverse as far as it seems not plausible that gas fired plants can be run with any kind of profit. Furthermore, environmental costs and disadvantages because of the priority that is given to energy from renewable sources also dwarf the possibility of making a profit from operating a gas fired power plant. However, as has also been shown, a gap between demand and supply might appear a few years down the line and it might even be, that hostility against hard coal and ignite powered plant – as discussed in the previous chapter – make gas fired power plants the plants of choice. But, as has also been shown in previous chapters, investment in gas fired plants is sluggish, if it is at all existent. 50% of planned plants will not materialize due to the unfavorable conditions on the German energy market, despite gas fired plants being promoted by environmental groups that want coal fired plants to be shut down. Thus, the question, whether it is possible to run a gas fired plant with any kind of profit, boils down to a mathematical question or in economic terms a question of discounted cash flow (DCF), which is a simple method to calculate the benefit that results from an investment with respect to a number of conditional variables that influence the respective benefit. Accordingly, discounted cash flows have been calculated for an investment in a gas fired plant and by assuming a number of costs imposed upon operating the respective plant as well as benefits that can be made from running the plant and selling energy on the market.[36]

36 Calculating discounted cash flows (DCF) is a method that enables to account for the risk attached to a particular investment, and to do so on a dynamic basis. Hence DCF is the premium to be gained with a certain investment, given a particular period of time and a particular discount on investment. This „premium can be measured by the spread between the discount rate for the risky asset p and for the risk-free asset r_f. Generally, we have the expected value of a risky cash flow $[E(r_n^*)]$, where each payment is made by the end of a period" (Ho & Yi 2004: 14). A period of n points in time is covered by the following equation:

$$DCF = \frac{E(r_1^*)}{(1+p)} + \frac{E(r_2^*)}{(1+p)^2} + \ldots + \frac{E(r_n^*)}{(1+p)^T}$$

Calculations in this chapter follow the reasoning behind the DCF and include a number of factors that increase or decrease cash flow and the risk attached to it.

6.1 Input Variables

In order to answer the question, whether it is possible to run a gas fired power plant in Germany under the current market conditions a model with discounted cash flows over the lifetime of the plant has been developed. Three different scenarios have been assessed based on their economic viability. The input factors that are crucial to operate a gas fired power plant have been identified in the course of this thesis by means of the theoretical model (figure 7). Hence, variables included in the empirical model must satisfy the condition that they are either the result of political or legal, economical or technological conditions, that they satisfy the conditions present on a market (or at least, what is supposed to be a market) and that they be the same for a number of competitors in a particular segment of the market.

The modeled technological characteristics represent a normal combined cycle gas fired power plant, with an installed capacity of 450 MW, a heat rate of 5600 Btu/kWh and a life time of 20 years. There are certainly other configurations for gas fired power plants in the market, but given the previously described space of opportunity it is assumed that a new installation in Germany will likely be in the size to replace phased out nuclear capacity. For a power plant of this size, it takes three years to complete construction and commissioning.

Table 2: Key characteristics of a combined cycle gas fired power plant that were used in the investment model

CCGT characteristics	
Size[37]	450 MW
Heat rate[37]	5600 Btu/kWh
Life time	20 years

Locking in financial conditions on today's levels result in a real discount rate of 5,4% over the lifetime of the power plant. A variety of factors impact the real discount rate applied in the model (table 5). Given the current financial market dynamics and the monetary policy of

[37] http://www.energy.siemens.com/co/pool/hq/power-generation/gas-turbines/SGT5-8000H/downloads/SGT5-8000H_brochure.pdf
https://powergen.gepower.com/content/dam/gepower-pgdp/global/en_US/documents/product/gas%20turbines/Fact%20Sheet/9ha-fact-sheet-oct15.pdf

the European Central Bank, inflation, interest and debt premium rates are at extremely low levels. The assumptions used in this model are therefor even on the upper end of the spectrum: inflation in Germany has dropped to below 0,5% in 2015[38], debt is merely free of interest[39], and risk free government bonds are traded for negative rates[43]. In contrast, taxes in Germany are among the highest in the industrialized world: companies have to expect in average a tax burden of approximately 30% of their income[40]. In such a challenging fiscal environment, it is likely that risk averse investors expect a return of approximately 10% for an investment as big 400 M€ for a gas fired power plant[44].

Table 3: Digest of the most important financial inputs for the investment model

Financial		
Inflation[38] Debt premium[39] Various taxes[40]	1% 2% Income, property, etc.	5,4% real discount rate
Owner's share	15 % of equipment cost	

The owner's share is assumed to be 15% of the total cost to build the power plant, and annual operations and maintenance costs are the sum of fixed 1,5% of the initial investment and of variable 3,00 €/MWh of produced electricity[41]. On top of that, CO_2 emissions are a it is still a cost factor not to be underestimated, though electricity generation in gas fired power plant produces only less than half of the CO_2 per MWh compared to coal fired power plants[42].

Table 4: Key economic assumptions about the construction and operation of the modelled power plant

Equipment	
Construction period	3 years
O&M cost[41]	Fixed 1,5% of equipment cost + flexible 3,00 €/MWh
Fuel CO_2 Rate[42]	116,98 lbs/mmBtu

38 https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Preise/Verbraucherpreisindizes/Verbraucherpreisindizes.html
39 http://www.finanzen.net/leitzins/
40 http://www.bundesfinanzministerium.de/Content/DE/Monatsberichte/2014/04/Inhalte/Kapitel-3-Analysen/3-2-wichtigsten-steuern-im-internationalen-vergleich-2013.html
41 https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/

Table 5: Overview of all constants used in the model to calculate LCOE

Constant	**Value**
Plant characteristics	
Size [MW][37]	450
Heat Rate [HHV] [Btu/kWh][37]	5.600
Plant Life [Years]	20
Capital cost	
Owners Share [% of EPC Cost]	15
Construction Period [Years]	3,0
Operation and maintenance	
Fixed O&M [% of EPC Cost][41]	1,50
Variable O&M [€/MWh][41]	3,00
Environmental emission cost	
Fuel CO2 Rate [lbs/mmBtu][42]	116,98
Financial assumptions	
Inflation Rate [%][38]	1,00
Debt Premium [%][39]	2,00
Risk-Free Interest Rate [%][43]	0,016
Debt Share [%]	70
After-Tax Equity Hurdle Rate [%][44]	10,00
Property Tax Rate [%][40]	0,50
Insurance Rate [%][45]	1,00
Marginal Effective Income Tax Rate [%][40]	30,00

These inputs remain identical for all three scenarios, so it can be guaranteed that the results of the calculations are comparable. Additionally to these well-defined constants, a set of variables is used in order to calculate the model under different market situations: the

42 http://www.eia.gov/oiaf/1605/coefficients.html
43 http://www.bloomberg.com/markets/rates-bonds
44 http://www.ft.com/cms/s/0/6446e5cc-c29f-11e4-a59c-00144feab7de.html#axzz4EBmDIWhC and https://www.pwc.in/assets/pdfs/finance-effectiveness/approaches_to_calculating_project_hurdle_rates.pdf
45 http://www.investopedia.com/terms/i/insurance-premium.asp

utilization rate, or capacity factor, of the power plant, the initial equipment, installation and commissioning cost, the current market prices for fuel and CO_2.

All input factors are affected by uncertainty, and one can find a large variety of parameters and assumptions around the construction and operation of gas fired power plants. To account for these uncertainties, the three different scenarios cover a range of values and assumptions that can be found in literature. Hence, the base case represents today's market conditions, while the positive and negative cases are the upper and lower borders of the range of values respectively.

Table 6: Variables used in the model to represent different market conditions

	Negative	**Base**	**Positive**
Capacity factor [%][46]	15	30	50
Equipment cost [€/kW][47]	1000	800	650
Fuel price [€/mmBtu][48]	14,25	8,97	6,86
CO2 price [€/t][49]	5,00	15,00	30,00

46 http://www.forschungsradar.de/metaanalysen/einzelansicht/news/die-auslastung-von-kraftwerken-im-zuge-der-energiewende-1.html

47 http://www.forschungsradar.de/metaanalysen/einzelansicht/news/studienvergleich-entwicklung-der-investitionskosten-neuer-kraftwerke.html
and
https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/

48 https://www.destatis.de/DE/Publikationen/Thematisch/Preise/Energiepreise/Energiepreisentwicklung.html
and
http://www.forschungsradar.de/grafiken/grafiken-zu-metaanalysen/einzelansicht /news/metaanalyse-zur-entwicklung-der-preise-fuer-fossile-brennstoffe.html
and
https://www.unitjuggler.com/convert-energy-from-GJ-to-MMBtu.html

49 http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF-Studie_Den_europaeischen_Emissionshandel_flankieren.pdf
and
http://ec.europa.eu/clima/publications/docs/factsheet_ets_en.pdf
and
http://carbonmarketwatch.org/wp-content/uploads/2014/07/ETS-POLICY-BRIEF-JULY-2014_final_1.pdf

6.2 The Model

The following table shows the variables in blue and constants in green that are included in the three scenarios of the empirical model, while calculated intermediate results are denoted in black.

Table 7: Formulas used in the model

	B	C	D
7	**Levelized Cost of Electricity ($/MWh)**		
8		Capital Cost	=D5*D$7*ABS(10^6*PMT(D80;D17;D46)/D20)
9		O&M Cost	=D5*PVOM(D$7*((10^6*(D$50)/D$20)+D$53);D79;D68;D17)*ucrf(D79;D17)
10		Fuel Cost	=D5*D$7*D$58
11		Carbon Cost	=D5*D$7*D$65
12		Tax Benefits	=-D$7*D91*D5
13		**Total**	**=SUM(D8:D12)**
14	**Plant Characteristics**		
15		Size (MW)	450
16		Heat Rate (HHV) (Btu/kWh)	5.600
17		Plant Life (Years)	20
18		**Capacity Factor (%)**	**50%**
20		Annual Output (MWh)	=D15*8760*D18
32	**Capital Cost**		
33		**Equipment Cost (2015 €/kW)**	**650 €**
40		Owners Share (% of EPC Cost)	15%
41		Owners Cost (€/kW)	=D39*D40
42		Construction Period (Years)	3,0
43		Construction Interest Rate (%)	=D71+0,02
44		Interest During Construction (€/kW)	=idc(D39;D42;D43)
45		Total Capital Cost (€/kW)	=D39+D41+D44
46		Total Capital Cost (Million €)	=D45*D15*1000/10^6
47		Annualized Capital Payment (€/MWh)	=10^6*ABS(PMT(D80;D83;D46))/D20
48	**O&M**		
49		Fixed O&M (% of EPC Cost)	1,50%
50		Fixed O&M (Million €)	=D49*D39*D15*1000/10^6
51		Fixed O&M (€/kW-yr.)	=1000*D50/D15
52		Variable O&M (€/MWh)	3,00 €
54	**Fuel Costs**		
55		Fuel CO2 Rate (lbs/mmBtu)	116,98
56		**10-Year Average Fuel Price (€/mmBtu)**	**=6,5*1,05587**
58		Fuel Cost (€/MWh)	=D57*D16/1000
59	**Environmental Emissions Costs**		
61		Plant CO2 Rate (lbs/MWh)	=D55*D16*(1-D60)/1000
62		Tons of CO2 per MW/yr.	=(D18*8760/2000)*D61
63		**CO2 Price (2015 €/tonne)**	**30,00 €**
65		CO2 Cost (€/MWh)	=D61*D64/2205
66		CO2 Cost (Million €/yr)	=(D61*D20/2205)*D65/10^6
67	**Financial Assumptions**		
68		Inflation Rate (%)	1,00%
69		Debt Premium (%)	2,00%
70		Risk-Free Interest Rate (%)	0,016%
72		Financing Term (Years)	=D17
73		Debt Share (%)	70%
74		Equity Share (%)	=1-D73
75		After-Tax Equity Hurdle Rate (%)	10,00%
76		Property Tax Rate (%)	0,50%
77		Insurance Rate (%)	1,00%
78		Marginal Effective Income Tax Rate (%)	30,00%
79		Discount Rate (%)	=(D$73*D$71+D$74*D$75)/(1-D$78)
81		Real Discount Rate (%)	=((1+D79)/(1+D68))-1

Table 8: Calculation of the model

	B	C	D	E	F
4			**Negative**	**Base**	**Positive**
7	**Levelized Cost of Electricity ($/MWh)**				
8		Capital Cost	114,30 €	45,72 €	22,29 €
9		O&M Cost	16,56 €	8,69 €	6,00 €
10		Fuel Cost	79,82 €	50,26 €	38,43 €
11		Carbon Cost	1,49 €	4,46 €	8,91 €
12		Tax Benefits	-13,48 €	-5,39 €	-2,63 €
13		**Total**	**198,69 €**	**103,73 €**	**73,01 €**
14	**Plant Characteristics**				
15		Size (MW)	450	450	450
16		Heat Rate (HHV) (Btu/kWh)	5.600	5.600	5.600
17		Plant Life (Years)	20	20	20
18		**Capacity Factor (%)**	**15%**	**30%**	**50%**
20		Annual Output (MWh)	591.300	1.182.600	1.971.000
32	**Capital Cost**				
33		**Equipment Cost (2015 €/kW)**	**1.000 €**	**800 €**	**650 €**
40		Owners Share (% of EPC Cost)	15%	15%	15%
41		Owners Cost (€/kW)	150 €	120 €	98 €
42		Construction Period (Years)	3,0	3,0	3,0
43		Construction Interest Rate (%)	4,16%	4,16%	4,16%
44		Interest During Construction (€/kW)	83 €	67 €	54 €
45		Total Capital Cost (€/kW)	1.233 €	987 €	802 €
46		Total Capital Cost (Million €)	555 €	444 €	361 €
47		Annualized Capital Payment (€/MWh)	114 €	46 €	22 €
48	**O&M**				
49		Fixed O&M (% of EPC Cost)	1,50%	1,50%	1,50%
50		Fixed O&M (Million €)	6,75 €	5,40 €	4,39 €
51		Fixed O&M (€/kW-yr.)	15,00 €	12,00 €	9,75 €
52		Variable O&M (€/MWh)	3,00 €	3,00 €	3,00 €
54	**Fuel Costs**				
55		Fuel CO2 Rate (lbs/mmBtu)	116,98	116,98	116,98
56		**10-Year Average Fuel Price (€/mmBtu)**	**14,25 €**	**8,97 €**	**6,86 €**
58		Fuel Cost (€/MWh)	79,82 €	50,26 €	38,43 €
59	**Environmental Emissions Costs**				
61		Plant CO2 Rate (lbs/MWh)	655	655	655
62		Tons of CO2 per MW/yr.	430	861	1.435
63		**CO2 Price (2015 €/tonne)**	**5,00 €**	**15,00 €**	**30,00 €**
65		CO2 Cost (€/MWh)	1,49 €	4,46 €	8,91 €
66		CO2 Cost (Million €/yr)	0,26 €	1,57 €	5,22 €
67	**Financial Assumptions**				
68		Inflation Rate (%)	1,00%	1,00%	1,00%
69		Debt Premium (%)	2,00%	2,00%	2,00%
70		Risk-Free Interest Rate (%)	0,16%	0,16%	0,16%
72		Financing Term (Years)	20	20	20
73		Debt Share (%)	70%	70%	70%
74		Equity Share (%)	30%	30%	30%
75		After-Tax Equity Hurdle Rate (%)	10,00%	10,00%	10,00%
76		Property Tax Rate (%)	0,50%	0,50%	0,50%
77		Insurance Rate (%)	1,00%	1,00%	1,00%
78		Marginal Effective Income Tax Rate (%)	30,00%	30,00%	30,00%
79		Discount Rate (%)	6,4%	6,4%	6,4%
81		Real Discount Rate (%)	5,4%	5,4%	5,4%

6.3 Results

The profitability of any power plant is a function of levelized costs of electricity LCOE, the costs for which it can produce electricity, including all operational costs and duties, and the current price at which the produced electricity can be sold. As calculated in the empirical model, the levelized cost of electricity of a combined cycle gas fired power plant are approximately 100 €/MWh, under the current market conditions that prevail in Germany. In the negative scenario, which includes a lower capacity factor, higher costs for natural gas and the equipment itself, as well as reduced CO_2 prices, the LCOE almost doubles compared to the base scenario. In contrast, the results of the positive scenario show only a 30% reduction in levelized cost of electricity for our model power plant (table 8).

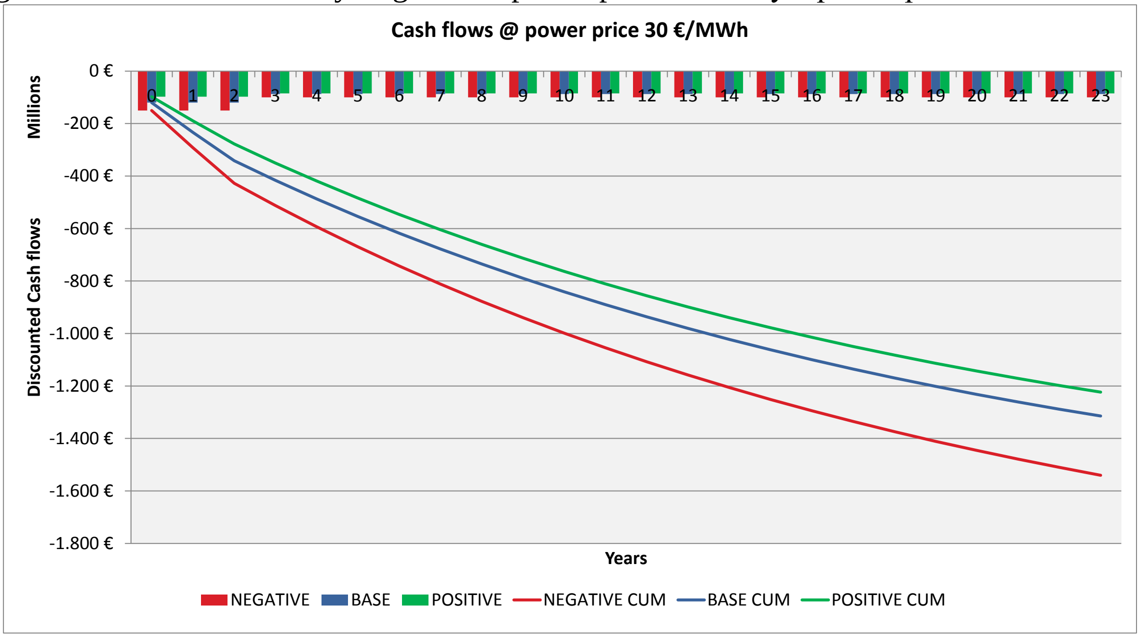
Table 9: Levelized cost of electricity of the modelled power plant in the three scenarios

Scenario	**Negative**	**Base**	**Positive**
Capital Cost	114,30 €	45,72 €	22,29 €
O&M Cost	16,56 €	8,69 €	6,00 €
Fuel Cost	79,82 €	50,26 €	38,43 €
Carbon Cost	1,49 €	4,46 €	8,91 €
Tax Benefits	-13,48 €	-5,39 €	-2,63 €
Total LCOE	**198,69 €**	**103,73 €**	**73,01 €**

Calculations confirm what has been stipulated throughout this thesis: Under the current market situation in Germany, where even peak power prices rarely exceed 35 €/MWh and base load prices are as low as 20 €/MWh[50], it is not possible to run a gas fired power plant at any kind of profit, even if we would face very favorable conditions in terms of utilization rate, fuel and investment and operating costs. Figure 17 shows the cumulative discounted cash flows over the lifetime of a gas fired power plant for the three scenarios – the results are obvious:

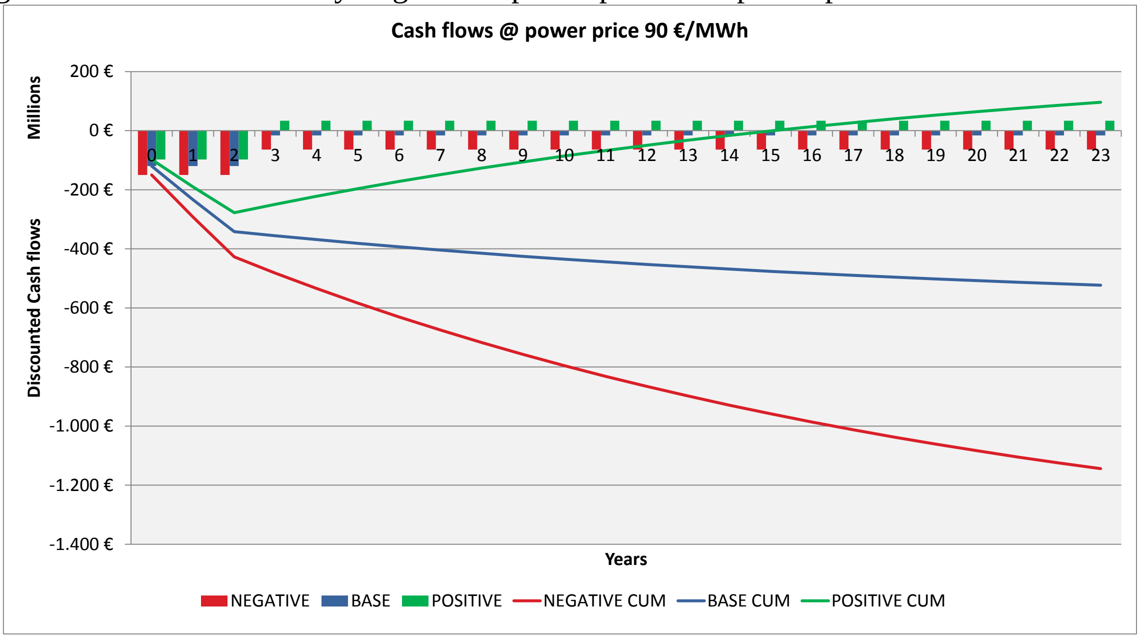
[50] http://www.eex.com/de/marktdaten/strom/spotmarkt/auktion/#!/2016/07/12

Figure 17: Profitability of gas fired power plants at today's power prices



But even higher electricity prices are hardly enough to compensate for bad economic environment operators and investors of gas fired power plants find themselves in in Germany. Figure 18 shows an assumed price level of 90 €/MWh, which was the case 5-10 years ago, and still only the positive scenario would have a positive net present value. Nevertheless, it would take until year 15 of the project until the break-even point is reached – probably too long for any investor.

Figure 18: Profitability of gas fired power plants at a power price of 90 €/MWh



Thus, within the given market environment it is not possible to gain profits form an investment into a gas fired power plant in Germany. Electricity as the only sellable product of such a power plant is not enough to generate operate profitably. Hence, additional revenue streams would have to be tapped. A gas fired power plant has significant advantages: low CO_2 emissions for a fossil fuel, fast startup times that could add additional flexibility to the electricity grid or the possibility to produce heat and steam for industrial applications, just to name a few. Especially the first two are needed to make the Energiewende a success, and it is up to policy makers to build an environment where these capabilities are valued and create the right incentives for investors.

7. Summary and conclusions

It is not feasible to gain any profit with operating a gas fired power plant in under the current market conditions in Germany. This is the conclusion from an in-depth analysis that looked at the opportunity space available for an operator of a gas fired power plant. As it appears the opportunity space is rather tiny, if at all existent. First of all, legal regulation and political will permit only a slice of the energy market and this slice is of varying size. While operators of gas fired plants rely on market prices, producers of renewable energy have fixed prices for their produce, prices that run at about three times the level of market prices. As a consequence, investment in renewable energy, mainly wind energy is high. At the moment the German Bundesverband für Energie und Wasserwirtschaft report 42 projects aiming at the construction of a wind based power plant. A further 11 projects target the harvest of renewable energy sources, which add the tally to 53. Thus, 72% of investments in energy production are investments in renewable energy sources. The remaining 28% are mostly investments in gas fired power plants, intended investment that is, because some 50% of the planned building sites are still plant building sites, because up to now investment has not been secured.

Thus, construction of energy producing facilities follows very much the targets given in the Renewal Energy Law, which is hardly surprising because the targets and the respective energy production facilities are heavily subsidized. As a consequence, markets are swamped with cheap energy, prices are falling and conventional producers of energy who have no price guarantee given to them by the government suffer. They have to sell their energy at low prices. Accordingly, revenues drop. And so does utilization, because energy from renewable sources is given priority in the grid, i.e. whenever two suppliers ask a grid operator to deliver their energy, energy from renewable sources comes first. All this adds up to underutilization and to plant closures because they cannot be run with a profit. Further costs are incurred through environmental taxes. The EU ETS system puts a cap on CO_2 emissions. As a result, producers of carbon based energy have to purchase EU ETS credits for each unit of CO_2 they produce in excess of the cap. Again, renewable energy production is handed a competitive advantage, while carbon based energy production is handed a handicap. All these political and legal obstacles add up to make investment into carbon based energy production in general and in gas fired energy production in particular an action of madness. So it seems.

But the tale has another twist. Renewable energy production is not enough to satisfy demand for energy. A gap between demand and supply is the forecast; hence, building a gas fired plant may be profitable after all. Even environmental NGOs lobby for gas fired power plants and want to use them to force a shutdown of hard coal and ignite fired plants. So is there a twist that makes gas fired power production the method of power production that covers what renewable energy sources cannot provide? No, there is no twist. Calculations performed in the course of this thesis, based on data gathered from different sources shows that it is not possible to run a gas fired power plant with a profit. Not even when model parameters are chosen in the most favorable of terms for gas fired power plants is it possible to do so. Utilization rates and prices for emission certificates prevent it. Thus, an environment shaped by political will, or madness as others deem it,[51] exists in Germany, which allows for profit only when energy is produced by using renewable sources. But with the right political will, this could be fixed. Gas fired power plants can offer a number of competitive advantages, both against subsidized renewable energies and old coal fired power plants. If their flexibility, low CO_2 emissions and industrial applications were valued, this alone should offer enough incentives to profitably invest into new a gas fired power plants in Germany.

However, as most subsidy-systems imposed by states, the present one is flawed as well, because it purchases uncertain future supply by requiring tax payers to shoulder energy bills that are much higher than they have to be, only to transfer tax payers' money to renewable energy providers. By providing strong incentives for setting up a renewable energy plant, the German Government is responsible for collapsing energy prices on the spot market, which has as its consequence higher prices for German taxpayers because of the price guarantee given to the renewable energy producers. How long such as system is able to survive is the question behind the present field test in Germany. Besides this question it is certain beyond any kind of a reasonable doubt that the field test wiped out any inclination to invest in carbon based energy production facilities in Germany or even to invest in the technological advancement of the respective methods to produce energy.

51 http://notrickszone.com/2012/09/02/forbes-germany-insane-or-just-plain-stupid/

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