Through the Marktprämienmodell towards a necessary

Flexible Electricity Production from Biogas

in Germany?

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Abstract:

This thesis elaborates the question whether or not the newly introduced ‚*Marktprämienmodell*' represents a big enough incentive for operators of biogas plants in Germany to switch from base-load electricity production towards a flexible production pattern, in order to integrate more electricity of intermittent renewable energy sources into the grid.

To answer this question, the report will provide the reader with the necessary background knowledge, explain the main underlying terms and concepts and perform calculations on the expected revenues through the *'Marktprämienmodell'* as well as the necessary investments for the participation. Furthermore, it includes the results of an experts' discussion on the topic and offers a possible outlook on the future of the production pattern of biogas plants in Germany.

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Abbreviations

CDIAC	- Carbon Dioxide Information Analysis Center
CO_2	- Carbon Dioxide
CSP	- Concentrated Solar Power
DIW	- Deutsches Institut für Wirtschaftsforschung
EEG	- Erneurerbares Energien Gesetz
EEX	- European Energy Exchange
EU	- European Union
GDGE	- Genossenschaft Deutscher Grünstrom Erzeuger
GHG	- Greenhouse gas emissions
GMST	- Global Mean Surface Temperature
IEA	- International Energy Agency
IPCC	- Intergovernmental Panel on Climate Change
ISET	- Institut für Solare Energieversorgungstechnik
kW	- Kilowatt
kWh	- Kilowatt hour
LPX	- Leipzig Power Exchange
MWh	- Megawatt hour
OTC	- Over The Counter
RES	- Renewable Energy Systems
PV	- Photovoltaic
PHELIX	- Physical Electricity Index
UBA	- Umweltbundesamt

Translation of Terms

Bundesnetzagentur	= Federal Network Agency
Doppelvermarktungsverbot	= Prohibition of multiple sale
Einzelstundenkontrakte	= single-hour contracts
Erneurbare Energien Gesetz	= Renewables Energy Act
Grünstromprevileg	= green electricity privilege
Langfrisitge Basisversorgung	= long-term basic electricity supply
Stromeinspeisegestetz	= Act on Sale of Electricity to the grid
Umweltbundesamt	= Federal Environmental Agency

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1. Introduction

1.1 Background

Worldwide, the release of greenhouse gases (GHG) and especially of Carbon Dioxide (CO_2) continues unabatedly, enhancing global warming with all its adverse effects for the human and non-human world. According to the latest report of the Carbon Dioxide Information Analysis Center (CDIAC) of the U.S Department of Energy, CO_2 emissions from fossil-fuel combustion and cement manufacture have reached a new record level in 2010, exceeding the most pessimistic forecasts (Friedlingstein P. 2011).

So far, the Kyoto Protocol is the only legally binding treaty with the aim to reduce the release of CO_2 emissions and thus prevent an unchecked rise in the global mean surface temperature (GMST) with its severe and unpredictable consequences (Warren 2011).

The industrialized countries have committed themselves under the Kyoto Protocol to reduce their CO_2 emissions by a total of 5% between 2008 and 20012, compared to 1990 levels. The European Union (EU) has set a total reduction target for this period of 8%, in which Germany has committed itself to cutting its emissions by 21% until 2012 and 40% by 2020, compared to 1990 levels. These targets are ambitious but not unfeasible, especially when considering that Germany has slightly over-fulfilled its 2012 CO_2 reduction obligation (Bundesregierung 2011).

According to the German Federal Environmental Agency, *Umweltbundesamt* (UBA), the reduction of the CO_2 emissions during the first half of the 1990's is mainly caused by the reorganization of the East-German economy after the re-unification, therefore also referred to as 'wall fall profits'. Especially the increase of energy efficiency, the shut down of outdated industrial facilities and a switch to energy sources with lower emissions have contributed to the decrease during this period. From the mid 1990's on, climate and energy related policy can be seen as the main driving force for a further reduction of CO_2 emissions in Germany (UBA 2011); (Schleich 2001).

Considering that the energy sector in Germany still mainly relies on the burning of fossil fuels that makes this sector on the one hand to the largest contributor of CO_2 emissions in Germany, also makes it, on the other hand, the sector with the most reduction potential. Especially the replacement of electricity from lignite-fired power-stations (ca. 1200g CO_2 emissions/kWh_{el})

with renewable energy offers a vast CO_2 saving potential. Thus, policy instruments designed to increase the share of renewable energy systems (RES) play an important role to reach the national CO_2 reduction targets, determined at the Kyoto Protocol.

The most important policy incentive during the last decade is the German Renewable Energy Act (org. *Gesetz zum Vorrang Erneuerbarer Energien – Kurztitel: Erneuerbares Energien Gesetz, EEG*). This law is designed to ensure the privileged access of electricity from renewable sources into the grid and also guarantees producers a fixed tariff for their produced electricity for a time period of 20 years, giving them planning reliability and therefore allowing secure investments in Renewable Energy Systems (RES). Since the introduction of the EEG in the year 2000, the share of renewable energy in Germany has tripled from 6,4% to more than 20% in 2011 and has been adopted by about 60 countries and 25 states or provinces worldwide (BMU-1 2011); (REN21 2011).

1.2 Problem Description

In order to react on technological, political and economical circumstances, the EEG has been amended several times since its introduction, with the latest version coming into effect on Jan. 1st 2012. Besides the adjustment of the feed-in rates and the possibility for compensation of electricity from storage, the most important amendment in the 2012 version is the introduction of incentives for the direct sell of electricity from RES. The aim is to counteract the intermittent character of renewable energy sources, which rapid growth is causing grid instability. Therefore in the EEG 2012, the so-called *Marktprämienmodell* is introduced to enable producers of renewable energy to sell their electricity directly at the spot market. The difference between the price for electricity on the stock market and the guaranteed EEG feed-in tariff is paid through the *Marktprämie.* The amount of the average monthly stock market price for electricity plus the *Marktprämie* corresponds exactly with the EEG's Feed-in tariff. Thus, the producer of renewable energy does not experience any financial loss when selling its electricity directly through the spot market but rather has the chance to make an extra profit when selling its electricity at times of peak demand, when the price is above the monthly average. Furthermore, the operators of controllable RES have the chance to profit from other bonus systems, such as the *Managementprämie* and the *Flexibilitätspräme,* which rewards operators who are able to forecast their electricity production and adjust their production quickly. Additionally, for operators of biogas plants there is the possibility to participate on the market for operating reserves, allowing them to be exempted from the prohibition of multiple sale *(Doppelvermarktungsverbot)* of the EEG.

The aim of these amendments is to counteract the intermittent character of RES and to make their electricity production more predictable.

A detailed description of the bonuses systems and the need for more flexible renewable energy production in Germany can be found in Chapter 3.

1.3 Research Question

In consideration of the new regulations and the resulting opportunities for direct marketing in the EEG 2012, the following research question is posed:

'Is the Marktprämienmodell in the EEG 2012 sufficient incentive for biogas operators in Germany to switch from base-load to flexible electricity production?'

1.4 Analytical Workflow and Report Structure

In order to allow a comprehensive and thorough answer to this question the changes in the EEG 2012 has been analyzed and transferred to one possible situation in which a biogas plant shifts its production pattern from base-load towards flexible production. The modeling software *'energyPRO'* and the calculation program *'Excel'* have been used to construct a corresponding model, to calculate the electricity production, the expected additional revenues and the necessary investment costs of a flexible production pattern.

The structure of the thesis follows a logical pattern and thus making the content and finding of the thesis easily accessible for the interested reader. This **first chapter** gives a general introduction on the topic, **the second chapter** will introduce the research methodology used in the thesis. **Chapter three** will provide the reader with background information on the EEG and the energy stock exchange and further elaborate the need for more flexible electricity production to balance off the intermittent production scheme of RES. In addition to that, the changes of the

EEG 2012 version and the new *Marktprämienmodell* is explained in detail, followed by an an overview of technical possibilities, necessary for a flexible electricity production from biogas plants.

The fourth chapter identifies one possible case in which a 500 kW biogas plant, producing base-load electricity, shifts toward the '*Marktprämienmodell*', using a 750 kW turbine and a gas storage. The revenues of both cases (base-load operation and *Marktprämienmodell*) are calculated, as well as the payback time for the additional investment, necessary to shift to the *Marktprämeinmodell*.

T**he fifth chapter** contains a detailed presentation and analysis of the calculations and findings of Chapter 4.

In **chapter six**, interviews with experts are conducted providing an additional input and opinion on the research question.

The concluding **chapter seven** recalls the principle research findings and the experts' discussion. Furthermore it provides an answer to the research question, names scopes and limitations of the thesis and suggests possible further research on the topic.

1.5 Scopes and Limitations

In order to guarantee accessibility to the information embedded to as many persons as possible this thesis is written in a low-tech language. However, a basic knowledge about energy systems, renewable energy and the energy markets in particular is recommended for a thorough understanding of some chapters of this thesis

This thesis only focuses on the new emerging possibilities of the EEG for biogas plants but not on other RES such as photovoltaic or wind energy. However, it does not intend to offer a business plan for biogas plants using the *Marktprämienmodell* but rather elaborates on the question whether the incentive and new opportunities under the EEG is sufficient to shift from base-load to a flexible electricity production for biogas plants.

2. Methodology

This chapter presents the concepts and methodologies applied in the thesis.

2.1 Analysis EEG 2012

To identify the relevant wording of the law regarding the direct marketing of electricity in general and the *Marktprämienmodell* for electricity from biogas in particular, the EEG 2012 has been analyzed and the relevant paragraphs identified (see Appendix G for the exact text). For a better understanding of the original wording, comments, interpretations and summaries of legal experts have been reviewed and a summary along with an explanation is given in Chapter 3, section 3.3

2.2 Scientific Literature Review and Document Analysis.

The review of scientific literature is used to understand and provide information on the electricity market in general and the German market in particular. Furthermore, it is also used to obtain information on the intermittent character of renewable energy sources, especially wind and photovoltaic (PV), and their consequences on the electrical grid.

Non-scientific documents, such as guidelines, legal documents and essays provided by stakeholders of the biogas sector are analyzed in order to collect information on the *Marktprämienmodell* and other relevant information concerning the direct marketing of electricity from biogas.

2.3 Energy System Modeling

The modeling software '*energyPRO*' has been used to construct a simple energy model of a 750 kW and 1000 kW biogas plant. Instead of a base-load operation under the EEG compensation scheme, a flexible production pattern with the electricity sale on the spot market (PHELIX-2011) has been simulated for both cases. For simplicity reasons, no restriction from the heat production has been considered. Furthermore, various '*energyPRO'* models have been performed during the process of determining the optimum framework conditions and maximum electricity production of the simulated biogas plants.

Box 1: Description modeling software ‚energyPRO'

*"energyPRO is a complete modelling software package for combined techno-*economic analysis *and optimisation of both cogeneration and trigeneration projects as well as other types of complex energy projects with a combined supply of electricity and thermal energy (steam, hot water or cooling) from multiple different energy producing units.*

energyPRO is typically used for techno-economic analysis of energy projects such as district heating cogeneration plants with gas engines combined with boilers and thermal storage, industrial cogeneration plants supplying both electricity, steam and hot water to a site, cogeneration plants with absorption chilling (trigeneration), biogas fuelled CHP plants with a biogas store, biomass cogeneration plants. Other types of projects, e.g. geothermal, solar collectors, photovoltaic or wind farms can also be analysed and detailed within the software. energyPRO can also be used for analysing hydro pumping stations, compressed air energy storage and other electricity storage projects.

energyPRO allows the daily optimization of the operation to be made against fixed tariffs for electricity or against spot market prices. The optimization is taking into account the limited sizes of thermal and fuel stores."

Source: energyPRO 2012

2.4 Economic Calculation and Evaluation

The calculation program '*Excel'* has been used to perform economic calculations of both cases. The results from *energyPRO* on electricity production and sales revenues were then used as basis to calculate the economic feasibility of both plants. The results are then summarized and evaluated regarding their economic attractiveness in terms of pay back time and incentive to leave the fixed EEG compensation scheme. To use realistic parameters and correct data for the expenditure, revenues and marketing costs, experts have been consulted or asked for their opinion on the used parameter.

2.5 Qualitative Expert Interviews

Qualitative interviews are flexible in the process of interviewing. The aim is to understand the perception, views and preferences of the interviewee. Qualitative interviews can be divided into **unstructured-** and **semi-structured interviews**. The unstructured interview encourages the interviewee towards free narrative passages during the interview by giving only an initial input by the interviewer with little or none interaction afterwards. The aim is to understand the interviewee's story in depth and possibly learn about other facts, not originally intended.

In a **semi-structured interview**, the interviewer follows a previously prepared "*list of questions or fairly specific topics to be covered, often referred to as an interview guide"* (Brymann 2008).

In this thesis, semi-structured interviews were conducted since the interviewer desired expert's opinion on concrete questions on the flexible production vs. EEG compensation scheme and the motivations for a shift in production patterns.

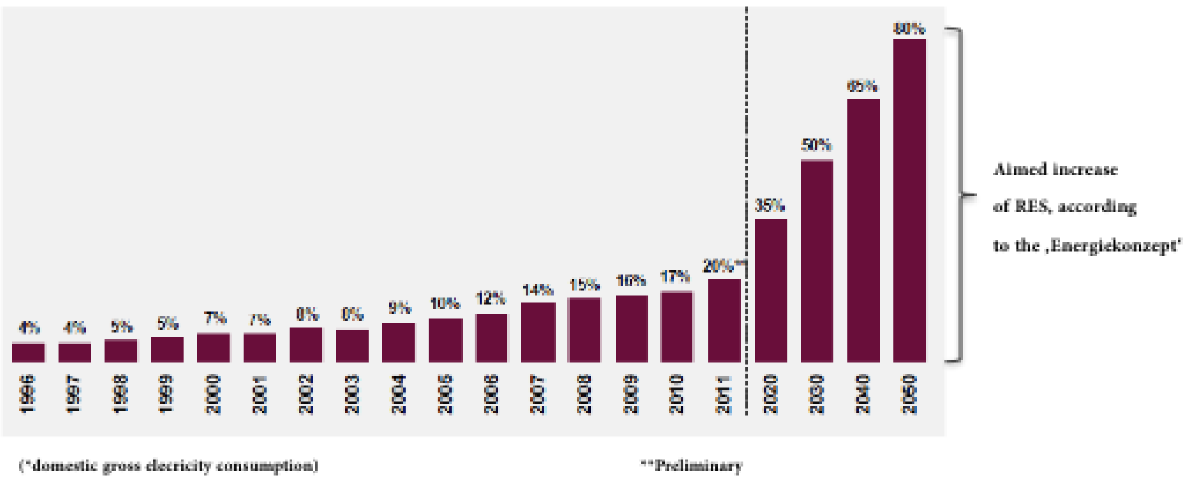
The interviews were recorded for transcription and were held in German language. The transcripts then served as basis for a further analysis of the information obtained. The complete transcripts can be found in the appendix.

3. Integrating Intermittent Energy Sources

This chapter will elaborate on the option to integrate more renewable electricity from fluctuating sources through a change in the production patterns of biogas power plants. (3.1) It will also provide the reader with background information on the power exchange EEX (3.2) and the EEG (3.3) Furthermore, it will describe the changes made to this law in 2012 and the Marktprämienmodell will be explained in detail (3.4) before elaborating on the technical preconditions that must be fulfilled by biogas plants in order to participate on the Marktprämienmodell (3.5).

3.1 Options for Integrating more Intermittent PV and Wind into the System

Historically, low levels of intermittent renewable electricity have been fed into the national grid in Germany, therefore demanding minimal requirements to balance the electricity transmission system. The increase of RES among the German electricity generation has led to a higher share of intermittent energy sources at the national grid.



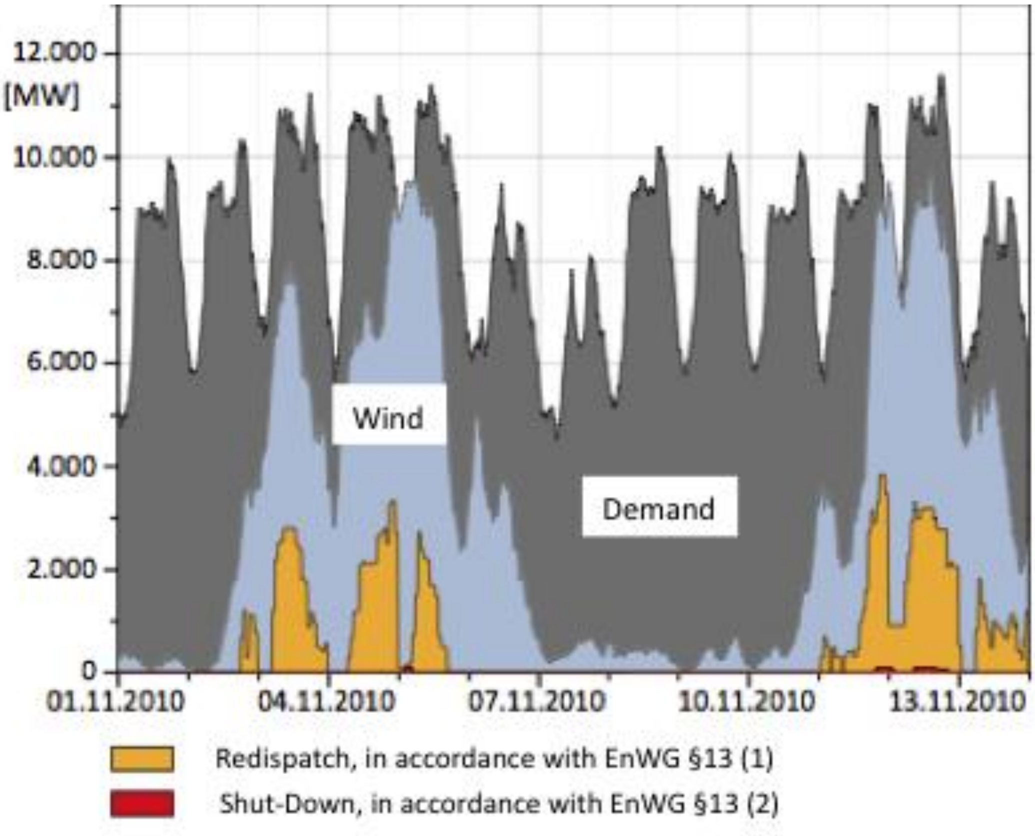
Graph 1: Share of electricity from renewable Energy in Germany
Source: BDEW 2011

In the light of the socially and politically desired gradual switch towards an electricity supply based on renewable energies, the electricity generation from wind – and to a lesser extend of both PV and concentrated Solar Power (CSP) - is likely to play a significant role during the next two decades (Pérez-Arriaga 2012). Both sources, wind and solar, are of intermittent characteristics, which means that they have a non-controllable variability and therefore are partial unpredictable. *"Although the output of any actual power plant is variable and unpredictable to a certain point, wind and solar generation have these characteristics in a degree that justifies the qualification of 'intermittent'"* (Pérez-Arriaga 2012).

According to EURELECTRIC (2010), on average, only 5,5% of the total wind installed capacity in Germany has a probability of 95% of being present all the time, a figure which can be compared to the level of availability of conventional power plants. Even though wind energy output of large geographical areas are easier to predict than of single wind turbines and techniques to forecast the energy yield have improved over the last years, only very near-term wind predictions (1-2 hours ahead) are highly accurate, whereas day-ahead forecasts have an error margin of up to 20% (Milligan 2006).

PV solar power is, in comparison to wind, generally more predictable due to low forecast errors on sunny days. Furthermore, satellites can be used to detect and calculate the arrival of upcoming clouds. The peak output of PV systems is during summer and during the middle of the day, whereas the production in winter (November – March) is only 30% of the annual average (Ehlers 2011) and there is zero electricity generation during the nighttime. This means that the electricity production of PV correlates quite well with hours of peak demand of many grid systems but it also is the renewable source with the highest volatility (see Box 3-1). Thus, a large contribution of PV in the electricity system requires high proportions of temporarily flexible power reserves.

Even today, technical problems occur when inside a ruled area the generation of electricity from renewables exceeds the demand and the coupling capacities are not large enough to remove the surplus (Ehlers 2011). In such so-called *'Redispatch'* - cases, the responsibility for measures to balance the grid remains with the transmission network operator (EnWG 2005), since the existing marked design in Germany does not offer the possibility to regulate the power reduction locally.



Graph 2: Redispatch measurements inside the ruled area of 50 Hertz
Source: Ehlers, 2011

Graph 2 shows the grid situation of the '50Hertz' ruled area in November 2010. Clearly recognizable is the dispatch intervention in accordance with §13 EnWG during times of high feed-in of wind electricity. The expected and demanded further increase of electricity from wind and PV will increase the need for such regulative interventions. Therefore, to counteract this development more controllable RES need to be integrated into the market in Germany.

From all renewable energy sources **biomass**, **hydro** and **geothermal energy** are technically capable to deliver base-load electricity as well as balancing power into the grid. Today, electricity from **geothermal sources** is not available at a significant scale in Germany and, even though it is expected to increase sharply, will not be able to contribute substantially within the next two decades (Nitzsch 2008).

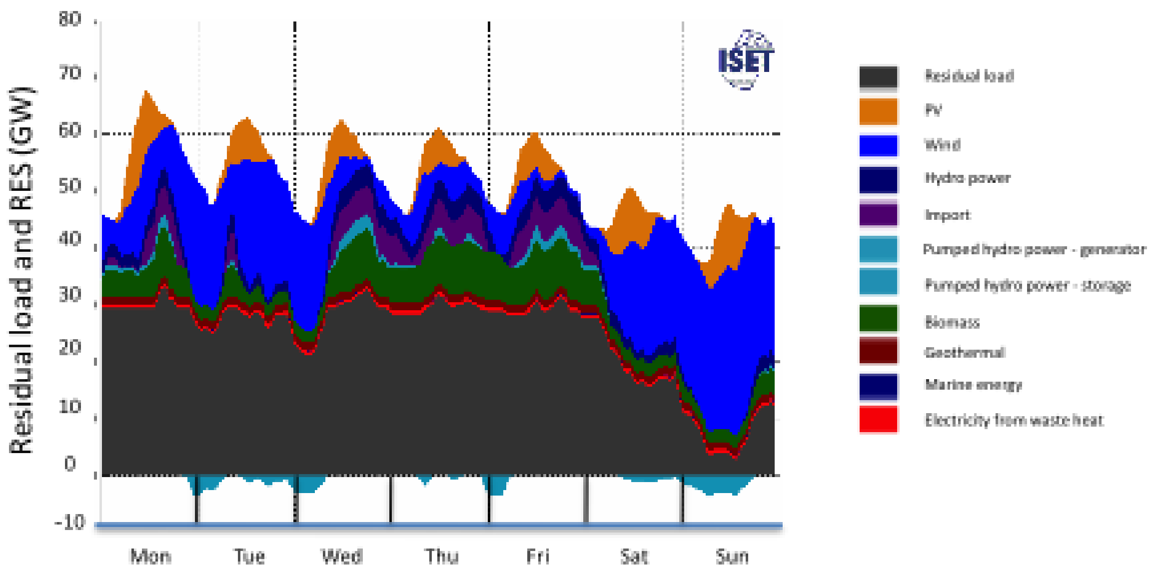
Hydropower is the oldest and longest commercially used form of renewable electricity and its economically available potential is therefore largely depleted. Furthermore, those generating facilities suitable for balancing power, mainly pumped storage power stations, are already delivering balancing power.

Thus, neither geothermal energy nor hydropower seems to be able to additionally contribute balancing power on a significant scale in the near future.

In contrary, electricity from the existing 7000 biogas plants in Germany (Fachverband Biogas e.V. 2011) might be a feasible option for the necessary higher share of controllable renewable electricity in the German grid without lowering the overall amount of renewable electricity. So far, almost all biogas plants in Germany are operating in base load modus, providing constantly about 1/3rd of the total electricity produced from renewable sources.

A study of the '*Institut für Solare* Energieversorgungstechnik' (ISET) suggests that a shift in the production patterns of the biogas plants in Germany from base-load production towards balancing power could demonstrably reduce the fluctuation of wind and PV in the electrical grid (Saint-Drenan 2009). The simulated scenario (Graph 3) assumed a share of 43% renewable electricity production in Germany and that the electricity production from biogas is controllable through the existence of gas storages and generators with twice the generating capacity of the annual average electricity output of the plant.

Clearly recognizable is the balancing character of controllable biogas plants on high wind days but also during slacks.



Graph 3: Feed-in of all available renewable energies in combination with residual load source: Saint-Drenan et al, 2009

3.2 EEX

For various reasons, electricity is a special trade commodity. On the one hand, participants in the electricity trade never see the actual traded product, on the other hand it requires a tremendous infrastructure and resources to acquire, generate and distribute it. It is traded like other goods on special dedicated stock exchanges but, unlike other goods like iron, wheat or oil, it cannot be stored and must be available at exactly the agreed time to prevent dangerous mains fluctuation and eventually blackouts.

3.2.1 Origin

In the course of the liberalization of the electricity market in Europe, the trading of energy gained importance for the electrical power companies. Power stock exchanges were created in order to enable and facilitate delivery contracts based on market prices, just like on other stock exchanges. Driving force behind this development was the assumption that free markets always allocate resources best, which was the economically pre-dominant doctrine during the 1990s. A role model in the creation of European energy exchanges had the Scandinavian energy exchange ‘Nord Pool’, which was created in 1993 as a result of the early liberalization of the Scandinavian electricity market.

The German counterpart to ‘Nord Pool’ is the European Energy Exchange (EEX), which is based in Leipzig, arose from the merger of the Frankfurt-based European Energy Exchange (EEX) and the Leipzig Power Exchange (LPX) in 2002. Even though the EEX is the biggest energy exchange in continental Europe with more than 200 stock exchange participants from 19 countries only about 20-25% of the electricity in Germany is traded at the EEX. The remaining 75-80% of the electricity is traded ‘Over The Counter’ (OTC), meaning outside the EEX.

3.2.2 Trade and Products

The main important index for the electricity price at the EEX is the ‘Physical Electricity Index’ (PHELIX), which acts as the reference price for different periods of time and can be traded in two different ways: on the **spot market** and the **derivatives market**. The difference between both markets is the varying delivery periods of the electricity.

On the spot market, short-term intraday trades are executed. Traders are able to buy additional amounts of electricity until 75 minutes before the actual time of delivery in order to balance sudden electricity shortages or sell electricity to ditch excess capacities. The electricity prices on the spot market can vary substantially from one day to another and also during a single day.

On the derivates market, medium and long-term delivery contracts, so called PHELIX-Futures, are traded. Those contracts have a duration of up to 6 years and guarantee the producer long term sales of its electricity and the consumer stability of prices in future time. The prices for such futures are closely linked to the spot market prices but are traded OTC (Storck 2008).

Besides electricity, other energy-related products like coal, natural gas and CO_2 emission certificates are also traded at the EEX.

3.2.3 Critics

Even though energy stock exchanges were created to enable a free electricity market in order to guarantee the best price for consumers the system is often criticized and vulnerable for manipulation. Main reasons are the non-transparency of the market, the dominance of few market participants and the fact that only a small share of all the traded electricity is traded at the EEX.

In Germany, four power supply companies (E.on, Vattenfall, RWE and EnBW) have a market share of roughly 80% on the electricity generation (Greth 2012). These companies are also market participants at the EEX, which means that their traders have a key advantage towards other traders since they have better information access to unforeseen events like the shut-down of power plants, which have direct consequences on the electricity prices at the EEX. Therefore they can react faster compared to their competitors.

As mentioned before, only a small share of the electricity in Germany is traded directly on the EEX. Nonetheless, the prices on the spot-market act as reference level for the OTC trades. Thus, large power supply companies have a vital interest in high prices at the stock market and therefore are also acting as one of the main buyers of electricity on the EEX.

The main burdens towards a free formation of electricity prices on the EEX is the relatively small number of market participants with only a few dozens dominating the trade and that only about one fifth of the total electricity in Germany is traded on the exchange market (Greth 2012), whereas at the Scandinavian exchange market North Pool it is about 75% of the total electricity. This makes the system in Germany open for abuse.

It remains to be seen if an increase of traded electricity from RES through the *Marktprämie* incentive can have a positive effect on the pricing at the EEX.

Box 2: Explanation of electricity products at the EEX:

To accommodate the changing load profile during the day, the electricity traded on the EEX is divided into different units, depending on the duration of the electricity supply.

Besides the long-term basic electricity supply (Langfristige Basisversorgung), which is traded on a separate derivates market and often have long-term contracts for several years, the base load demand is met by 24 hours delivery contracts. One base-load electricity block means a constant power delivery of 1 MW for 24 hours (24MWh), starting form 00:00 and lasting until 24:00h. Furthermore, peak load blocks are traded to meet the increased electricity demand during the day. These blocks have a constant power delivery of 1 MW for 12 hours (12MWh), from 8:00h – 20:00h. To allow even more gradations single-hour contracts (Einzelstundenkontrakte) are traded at the EEX. Again, the constant power delivery is 1 MW, lasting for 1 hour (1MWh). These single-hour contracts are can either be off-peak contracts or peak-load contracts, depending if they are needed during peak-load times (8-20h) or at any other time.

The main reason for this rather complicated division of the power supply is that electricity cannot be stored economically and therefore must be generated exactly at the time of demand.

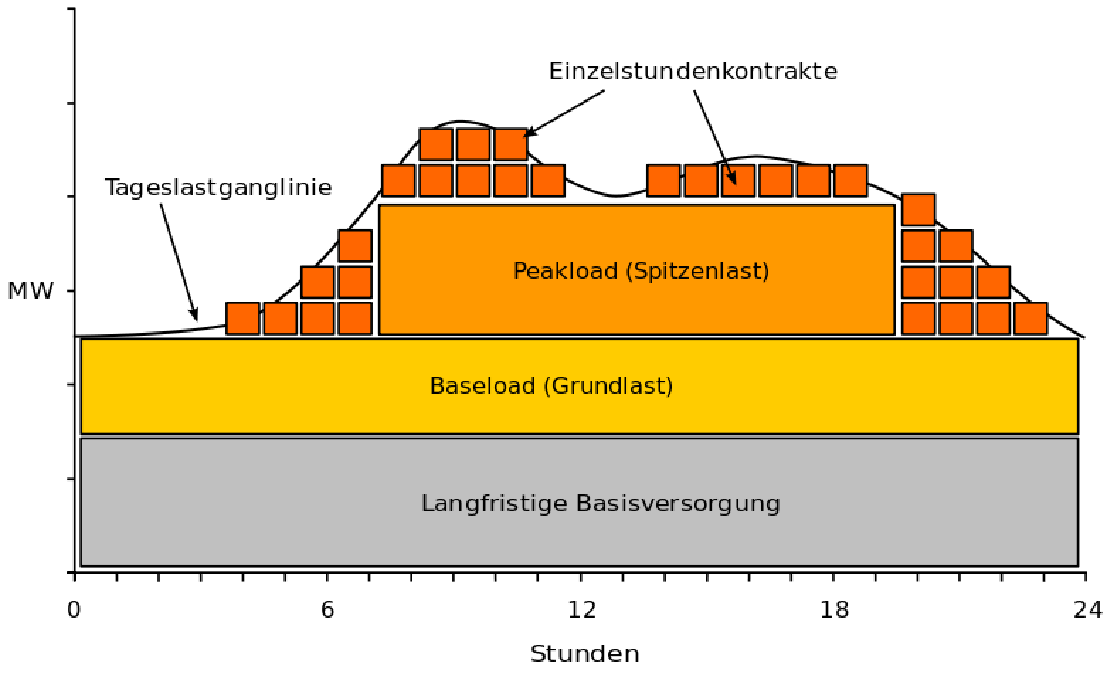


Figure 1: Load profile of an average business day in Germany
Source Figure: : Wikipedia[1]

3.3 EEG

The EEG law governs the preferential feed in of electricity from renewable energy sources into the German national grid and guarantees the operators of renewable energy systems grid access and a fixed compensation for their electricity over a certain period of time. The aim of this law is to decrease the emission of CO_2 and therefore to mitigate global warming and to promote the development of RES, which will eventually lead to an energy supply based on renewable energy sources. As a consequence the EEG helps to reduce the dependency on fossil fuels, to save finite resources and to lower the long-term economic costs of the energy supply by including external costs into the energy price.

3.3.1 Origin and Content of the EEG

The EEG has its origin in the 'Act on the Sale of Electricity to the Grid' (*Stromeinspeisegesetz; StromEinspG*) from 1991. This law marked a turning point at the German electricity market since it enabled producers of renewable electricity to have access to the grid for the first time. Furthermore it guaranteed a compensation for renewable electricity, coupled on the average electricity prices. In 2000, the law was replaced by the first version of the EEG, which was amended three time ever since to react on current trends in the electricity market and to counteract undesirable developments.

The main feature of the EEG is the so-called feed-in tariff, a guaranteed compensation for electricity from renewable energy sources for a time period of 15-20 years. The amount and the duration of the compensation depend on the technology used to generate the electricity. Entitled for compensation is electricity from the following renewable energy sources:

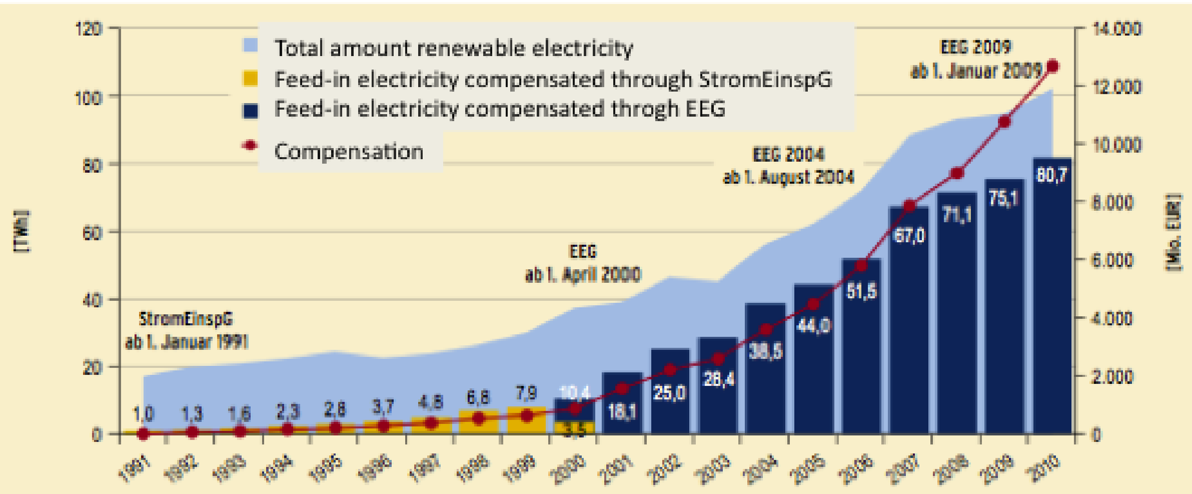
- Hydropower
- Landfill gas, mine gas, sewage gas
- Biomass
- Geothermal energy
- Solar radiant energy (PV)

To give producers and operators of RES incentives for cost reduction and efficiency increase, the feed-in compensation is paid on a diminishing scale. This means that the amount for the compensation depends on the year when the system is put into operation and is decreasing every year but remains the same for 20 years, once the system is operating.

The feed-in compensation is paid by the grid operator, who is also required to guarantee grid access and connect the RES to the grid. In turn, the grid operator can allocate the additional cost (compensation rate minus the market price for electricity) on the electricity price through the so-called EEG reallocation charge. Thus, the EEG is not a governmental subsidy but the additional costs are paid by the consumers.

3.3.2 Effects and Critics

Among experts it is undisputed that both laws mentioned (StromEinspG and EEG) have boosted the development of renewable energies in Germany and were the initial spark for the rapid growth of this industry. Graph 4 visualizes the massive growth of RES in Germany after the feed-in laws came into force as well as the growth related to the compensation paid. Today, the share of renewable electricity in Germany have reached 20% of the total amount produced (BMU-1 2011).



Graph 4: Growth of RES in Germany in relation to feed-in laws and total compensation
Source: BMU 2011[2]

Due to its success, the EEG has served as an archetype for similar legislations in other countries and has been copied by at least 60 other countries and 25 states around the globe, making it the most copied energy law in history (REN21 2011).

Critics of the law argue that it causes an increase of the electricity price and therefore rises consumer prices and is a competitive disadvantage for the German economy.

When taking a closer look it becomes clear that the increase of the EEG reallocation charge is to a large extend due to a change in the calculation basis and also the profit seeking of the main energy supplying companies (Horst 2012). Moreover, the costs of the reallocation have to be compared with the economic benefits of an increased share of renewables. Such benefits include a positive effect on the pricing of electricity at the energy exchange (Merit-Order Effect), avoids import costs for fossil fuels, supports a substantial saving of CO_2 and therefore helping to decrease external costs caused by global warming. Also the strengthening of the regional value added chain and a massive growth in the renewable energy sector, which today employs more than 340.000 people in Germany (BMU-3 2011) has shown great benefit.

Other critics argue that the law does not contribute to a reduction in CO_2 emission since the EEG cannot cause higher CO_2 savings than the European emission trading schemes allows. The amount of CO_2 saved by the EEG is released elsewhere through emission trading. Clearly, this is not the failure of the EEG but an error in the EU emission trading system and therefore needs to be adjusted at this level.

One last main point of criticism is that the EEG includes small-scale hydro power in its compensation scheme. Those systems often have no protection for fishes and other aquatic creatures and can be an insurmountable barrier for fishes wandering upstream. This problem was solved in the 2012 amendment of the EEG, as any small-scale hydro plant now must consider these points.

Summarizing, the EEG can be regarded as a very successful tool for the integration of renewable energy. This is confirmed by several different expert committees such as the DIW (Deutsches Institut für Wirtschaftsforschung), the EU Commission, the IPCC (Intergovernmental Panel on Climate Change) and the IEA (International Energy Agency) and is regarded superior to other regulatory instruments such as a quota systems and auction mechanisms (Mitchell 2011); (IEA 2008); (Buttler 2004).

3.4 EEG 2012

The following section will highlight the main changes in the EEG 2012, with special focus on the newly introduced possibilities for RES operators to sell their electricity directly. The remuneration model for the direct sell of electricity under the EEG is called '*Marktprämienmodell*' and will be explained in detail later in this chapter. The corresponding § 33 a-i on direct sale can be fund in Appendix G, along with the complete EEG 2012 (Appendix F).

3.4.1 Main Changes

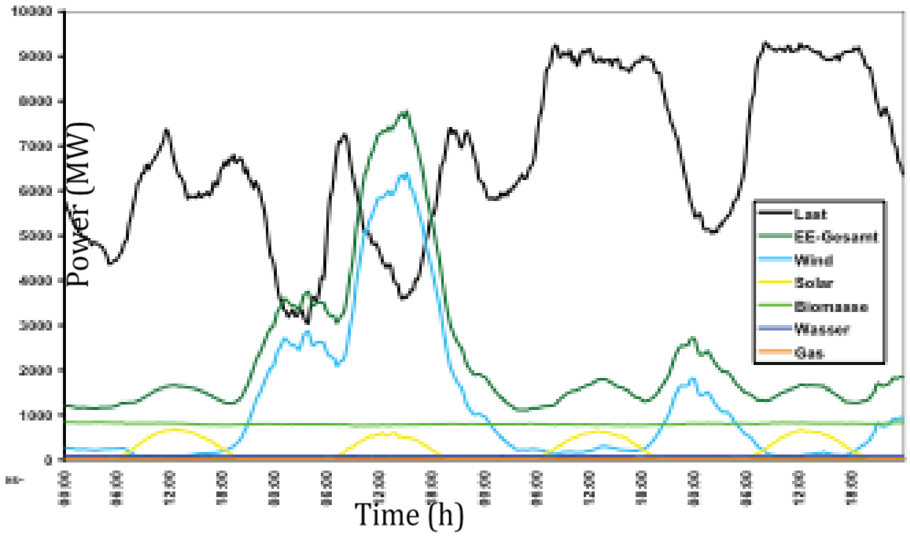
One key feature of the EEG 2012 is the reorganization of the feed-in tariffs for the different renewable energy sources. Remarkable here is a drastic decrease in the feed-in tariff for photovoltaic and a moderate increase of the compensation for off-shore wind energy. However, it is not purpose of this thesis to look at these changes in detail, nor to assess or comment on this issue.

The second remarkable amendment to the EEG is the newly introduced '*Marktprämienmodel'*. As mentioned in section 3.1, one main challenge for the integration of more electricity from wind and PV is to balancing their intermittent production pattern.

The need for a higher share of controllable electricity production among renewables and an increase of remote-controlled power generation has also been recognized by the German legislators. Consequently, the 2012 version of the EEG includes incentives for renewable electricity producers for

- the direct sell of renewable electricity
- the accurate forecast of electricity production
- the production at times of peak demand

Even though electricity from all renewable energy sources are eligible for direct sell under the *Marktprämeinmodel*, this thesis will focus on electricity from biogas plants. The reason focusing on biogas is that even though biogas is the best controllable energy source among all renewables (besides hydro power) the biogas plants in Germany are currently almost exclusively producing base-load electricity by running on full capacity. This is due to the prevailing rigid remuneration model, which compensate every kWh equally and therefore promotes a maximum production of electricity at all times. Thus the easily controllable electricity production from biogas contributes to the base-load capacity instead of a flexible production at peak demand, as Graph 5 illustrates.



Graph 5: Grid load and feed-in of the 50Hertz ruled area, 06-09. June, 2010
source: Thüringer Landesanstalt 2011

3.4.2 Detailed Explanation of the Marktprämienmodell

Generally speaking, there are **3 possibilities** for the producers of renewable electricity to sell their product directly to the consumer without using the EEG remuneration model. **First**, the operator can sell its electricity directly at the EEX in Leipzig on the electricity market. This option is hardly ever used by any renewable electricity producer since the price difference compared to the EEG compensation is too large. **A second option** is the direct marketing, which means a direct sell of the electricity to wholesalers or industrial consumers. The producer can fetch a higher price for its good than on the EEX since the buyer is exempted from the EEG reallocation charge when having a certain share of 'green' electricity in his portfolio (*Grünstromprevileg*)

Since January 2012, when the latest amendment of the EEG came into force, there is a **third option** for the direct sell of renewable generated electricity, the so called '*Marktprämienmodell*'.

This option allows producers to sell their electricity directly without a financial disadvantage compared to the EEG compensation since the difference between the monthly average electricity price at the EEX and the EEG compensation is paid by the grid operator through the

'*Marktprämie*'. The aim of this amendment is to attract as many producers as possible to shift towards a direct sell of their electricity in order to create a new market environment for the past EEG era. Furthermore, especially operators of easily controllable plants (i.e. biogas plants) should be given incentives to produce electricity at times of high demand and thus stabilizing the grid and balance intermittent electricity sources.

To make a production shift attractive, the EEG2012 includes several additional guarantees and bonuses apart from the '***Marktpräme***', such as the '***Managementpräme***', the **'*Flexibilitätspräme*'** and the possibility to participate on the market for balancing energy, which allows producers to exempt their plant from the prohibition of multiple sale (*Doppelvermarktungsverbot*).

Marktprämie

The so-called *Marktprämie* is an instrument of the EEG 2012, aiming to advance the market integration of RES. This premium is paid to producers of electricity from renewable energy sources if they sell their electricity directly at the power exchange instead of using the EEG compensation scheme. Since the price for electricity on the stock market is lower than in the EEG compensation scheme, the '*Marktprämie*' will compensate this difference. The basis for the calculation of the price difference is the *average monthly electricity price* on the EEX, which is deducted from the plant-specific EEG compensation. Therefore, the formula for the *Marktprämie* is the following:

$$\mathbf{MP = EEG\text{-}AEP_{(EEX)}}$$

MP: Marktprämie

EEG: EEG compensation

AEP: Average Electricity Price at the EEX

Attention should be paid to the fact that if the producer sells its electricity above the average monthly electricity price he can generate additional revenues since the *Marktprämie* is not proportionally reduced. This is typically the case during times of high demand and/or low supply.

Furthermore the electricity producer can decide every month if he sells its electricity through the *Marktprämienmodell* or through the fixed EEG scheme. Neither the statuary length, nor the fixed amount of the feed-in compensation is affected by a shift to the *Marktprämienmodell*.

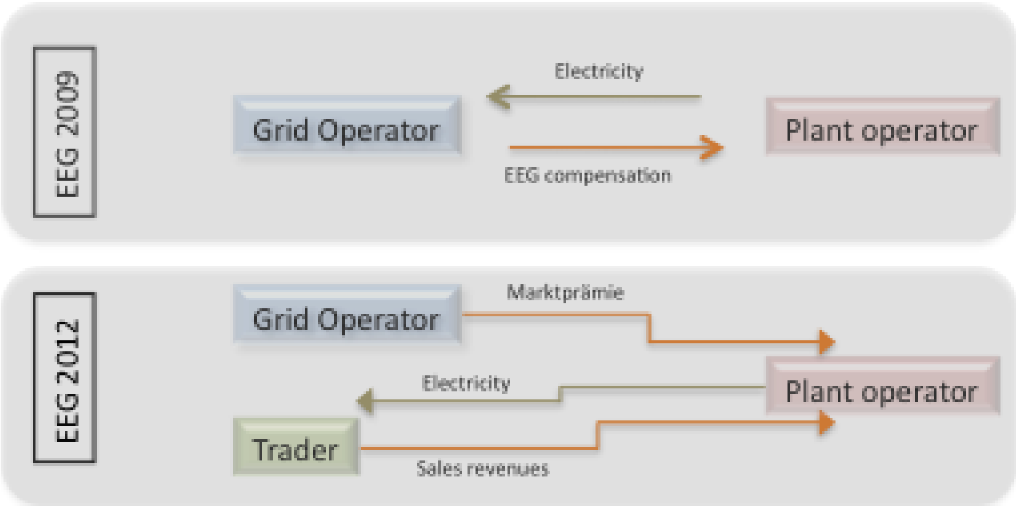


Figure 2: Cashflow - Difference in EEG 2009 and EEG 2012
source: own source, based on Dreschner et al. 2011

Managementprämie

If a RES operator shifts from the EEG compensation to the *Marktprämienmodell*, and therefore offers his electricity on the stock market, he is bound to make predictions on how much and at what times he will feed his electricity into the grid. This is necessary to keep fluctuations in the grid as low as possible. This feed-in projection is relatively complex for certain renewable energy sources, especially wind and PV, since their electricity production pattern depends on meteorological circumstances. For other energy sources, especially hydro and biogas, predictions are far easier to make since these sources are easily controllable, if equipped with the right control technology (see 3.5).

If an electricity producer fails to keep his feed-in projections and produces more or less electricity than expected he has to pay a fine. To minimize this financial risk factor the EEG 2012 includes the *Managementprämie*. This premium is paid as a lump sum for all operators to compensate them for their additional expenses and risks. Therefore, operators of easily controllable power plants, like biogas plants, will receive fixed additional revenues for making accurate and reliable feed-in projections.

Nonetheless, the *Managementprämie* is relatively low and thus it is financially not attractive for biogas operators to focus solely on this premium without changing the feed-in pattern. Also, the *Managementprämie* is declining every year since market participants are expected to have lower additional expenses and financial risks over the years due to increased marketing experiences and expertise.

Year	2012	2013	2014	2015
ct/kWh	0,300	0,275	0,250	0,225

Table 1: Decrease of Managementprämie 2012-2015
Source: own source

Participation on the balancing power market

Yet another income possibility for operators of controllable power plants is the participation on the balancing power market by providing or absorbing electricity at short notice.

Balancing power describes a service, which is provided by power plant operators to the transmission system operators to balance short-term mains fluctuations. This service guarantees the compliance of the 50 Hertz mains frequency and thus a reliable operation of the grid. Depending on the grid situation, balancing power can be either positive or negative. **Positive balancing power** describes a situation when the electricity demand exceeds the supply of electricity in the grid, whereas **negative balancing power** is used in times of an electricity surplus in the grid.

To ensure the availability of enough balancing power lies in the responsibility of the grid operators. The German national grid is divided into four sections and is operated by four different companies (see Figure 3).
Due to competition laws, the grid operators are not allowed to own and operate power plants by themselves and must therefore purchase the necessary balancing power on the market. The tendering of the balancing power is organized through a website and is controlled by the Federal Network Agency (*Bundesnetzagentur*). Balancing power is divided into three different forms: **the primary reserve**, **the secondary reserves** and **the tertiary control power.** Biogas plants can provide secondary reserves and tertiary control but not primary reserve as this is controlled

on a European scale through the grid operator ENTSO-E through big thermal power stations which react automatically to minor fluctuation in the grid.

In order to offer any form of balancing power the power plants must meet minimum requirements regarding the capacity of balancing power offered. For secondary reserves the minimum biding capacity is 5 MW and for tertiary control 10 MW. These requirements cannot be met by individual biogas plants but the grid operators admit operators of small power plants to align and form a virtual power plant to meet this criteria. Thus, the alignment of several biogas plants is a crucial criterion to participate in the balancing power market and is therefore not considered in the calculations of the thesis.

Figure 3: ruled areas of the grid operators in Germany
Source: Wikipedia[2]

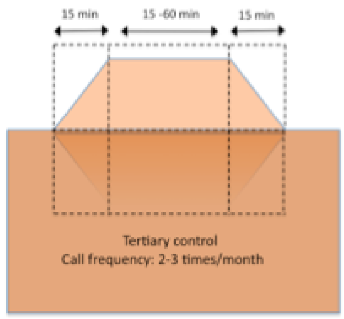
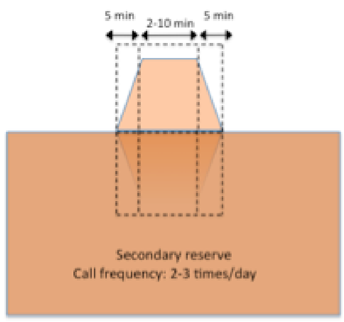
<table>
<tr>
<td>Tertiary control power
(Minutenreserveleistung
'MRL')</td>
<td>The participating power plant must be able to regulate its power output within 15 minutes and keep this changed output for up to 4 hours before reaching its original power output within 15 minutes. In average, the tertiary control power is demanded</td>
<td>
</td>
</tr>
<tr>
<td>Secondary reserve
(Sekundärreserveleistung
'SRL')</td>
<td>The participating plant must be able to change its power output within 5 minutes and retrieve to its original power output within 5 minutes whenever requested by the grid operator. Typically, this request occurs 2-3 times per day for a total time of 4-6 hours per month.</td>
<td>
</td>
</tr>
</table>

Figure 4: explonation tertiary control power and secondary reserve
Source: own source, based on Dreschner et al. 2011

Flexibilitätsprämie

The *Flexibilitätsprämie* is one last incentive, especially designed for - and therefore restricted to- biogas plants. The aim is to promote investments in additional generating capacity, gas storages and power transformer to establish more flexible generating capacity. In order to be entitled for the *Flexibilitätspräme* the biogas plant must fulfill the following requirements:

1) participation on the direct sell of the produced electricity
2) proof of the ability for flexible production (biogas generation or an appropriate storage)
3) actual use of a the flexible production through demand-driven production.

If the biogas plant meets these requirements, the operator receives ca. 130 € for each kW additionally installed capacity over a time horizon of 10 years.

To minimize possible free-rider effects, the *Flexibilitätsprämie* is only paid up to a limit of 50% of the originally installed capacity.

3.4.3 Summary Marktprämienmodell

As mentioned above, the newly introduced *Marktprämienmodell*, has the aim to make the electricity production more flexible and level out the intermittent renewable energy sources. Therefore, all instruments and incentives of the *Marktprämienmodell* (*Marktprämie, Managementprämie, Flexibilitätspräme* and participation on balancing power market) are designed to shift the electricity production from biogas plants towards times of high demand. Therefore, it will be crucial for biogas operators to produce and offer the electricity more flexible. The currently prevailing base-load operation will become less profitable and therefore less interesting in the future. A shift of electricity production through the investments in flexible production techniques and the ability to absorb surplus electricity will enable the operator to generate additional revenues, even though the total amount of electricity produced remains the same.

3.5 Technical Requirements of Biogas Plants

For a change in the production pattern of a biogas plant from base-load operation towards a complete flexible production, the plant has to undergo several technical changes. One crucial component is the extension of the turbine capacity by either installing a new engine with a bigger capacity or by installing an additional engine and combine both engines. This is one precondition to enable a temporal shift in the electricity production, which allows the operator to produce more electricity at times of high demand and consequently obtain higher prices. Additional engine capacity is also precondition to be entitled to the *Flexibilitätsprämie*. Furthermore, additional available engine capacity allows a possible participation on the positive secondary balancing power market.

A second important precondition for a real flexible production pattern is the installation of a gas storage to store the produced gas when the engine is not in operation, e.g. during times of high electricity supply and thus low electricity prices. The stored gas can then be used to supply the engine with the necessary increased fuel demand during peak load operation.

Beside the additional engine and gas storage, an interface between the biogas plant and the marketing partner must be installed. This allows a remote control of the plant, according to the production demand and also a real time analysis of the electricity production. Moreover, a remote control is crucial if the plant is part of a bigger virtual power plant, necessary to participate in the balancing power market.

Due to the higher power output of the plant, the grid connection must be intensified and the transformers must be adapted to the increased power output.

4. Case Studies and Calculations

In this chapter, one new opportunity of the EEG 2012 is identified: the change in the production pattern of one biogas plant from base-load electricity production to flexible production, using the *Marktprämienmodell.*

In order to participate at the *Marktprämienmodel* the technical and organizational relevant investments have been calculated using the energy-system modeling software '*energyPRO'*. Furthermore, '*Excel'* is used to calculate revenues and expenses of the two possibilities and to double-check the results. The aim of the models and the calculations is to find out whether the expected revenues justify the risks involved in the additional investments.

4.1 EEG 2012 Opportunity: Direct Marketing of a 500 kW Biogas Plant

In the initial situation, a biogas plant with a capacity of 500 kW_{el} is operating at base-load production under the EEG compensation scheme, thus producing the maximal possible amount of electricity at all times.

In the following models and calculations it is simulated that this 500 kW_{el} plant is equipped with a bigger engine and a correspondent gas storage in order to enable a temporary shift in electricity production from hours of low demand to times of high prices. The total amount of produced electricity must not exceed the initial capacity in order to be entitled for the *Marktprämienmodell.*

Two different scenarios are calculated with two different compensation rates each.

In scenario 1 the capacity of the engine is increased to 750 kW_{el} and a 2100 m^3 gas storage is installed.

In scenario 2 the original capacity is increased to 1000 kW_{el} and a gas storage of 3500 m^3 is installed.

In both cases the additional investments and the expected revenues of the *Marktprämienmodell* are calculated and compared to the fixed EEG compensation scheme. For each scenario, two possible EEG compensation schemes are applied: 18 ct/kWh and 20 ct/kWh, depending on the biodegradable material used.

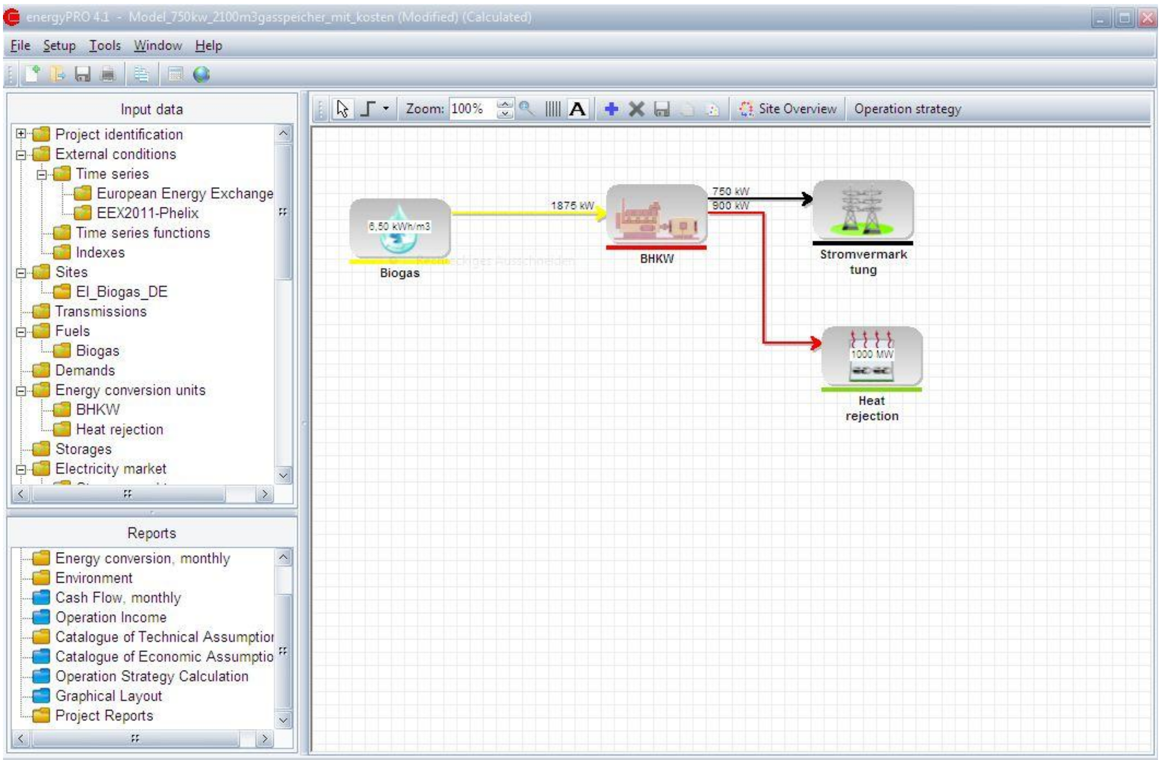
At the end, a simple pay back time of total revenues and the cost is calculated, which allows to evaluate if the expected additional revenues justify the risks involved in the investments.

4.2 Modeling and Calculation Approach

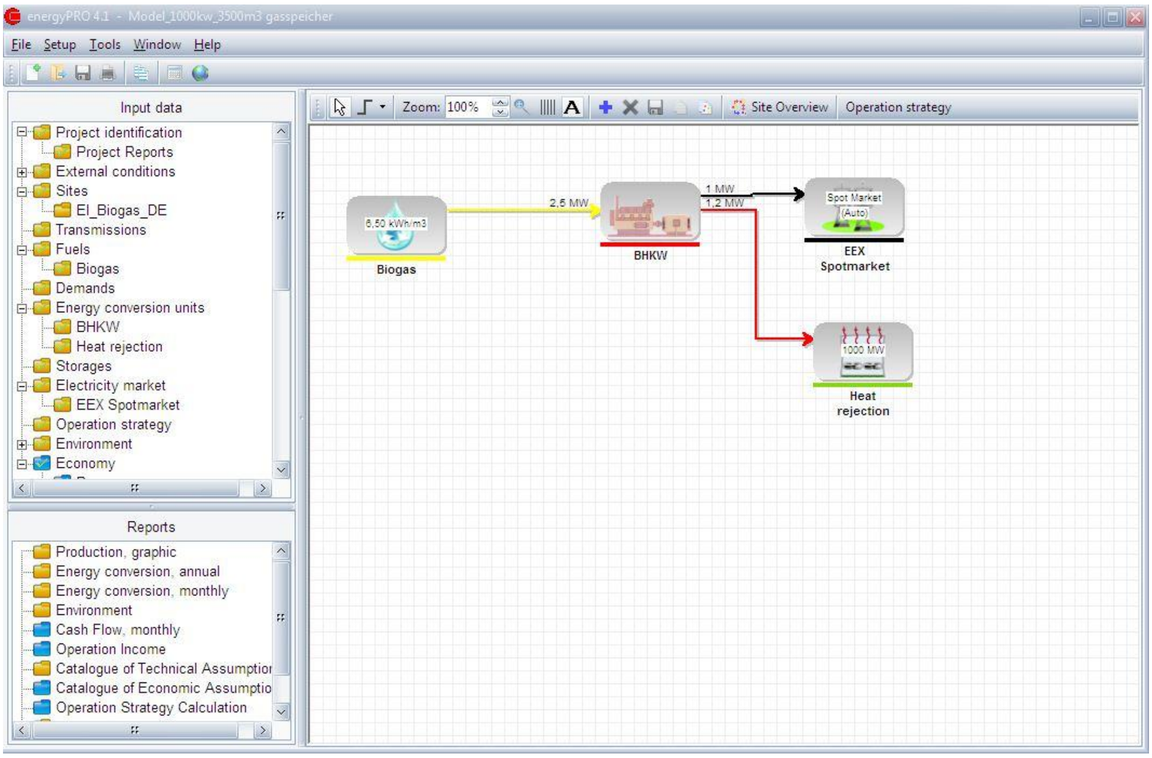
The modeling software *'energyPRO'* (see Box 1) is used to construct models for a 750 kW and 1000 kW CHP plant. These models allow to calculate possible revenues from the spot market through a flexible production pattern

4.2.1 Model Structure

As a first step, a simple model of a biogas-fired CHP plant for electricity production is created, using '*energyPRO*'. The model consists of the CHP unit and the necessary biogas supply, which also includes the biogas store. Furthermore, a heat rejection is included as well as a link to the EEX-PHELIX spot market for the sale of the produced electricity.



Picture 1: Screenshot of graphical layout, energyPRO model 750kW
Source: own source



Picture 2: Screenshot of graphical layout, energyPRO model 1000kW
Source: own source

4.2.2 Production Pattern and Electricity Sale

The operational strategy of the CHP plant is set on 'minimizing net production costs' and there are no restrictions for the electricity production by the heat production considered in this model, since it only focuses on the production and the sale of electricity through the *Marktprämienmodell.*

The projection is set on 'DESIGN', allowing the calculation of the energy conversion in a specific year, including the operational economics. The time series 'EEX-2011 PHELIX' is chosen for the electricity sale on the spot market which allows a detailed calculation of the revenues on the German and Austrian electricity market. The quality of the spot prognosis is set on detailed.

4.3 Assumptions

In a second step, the calculation program ‚Excel', the results from the ‚energyPRO' models and other sources (see Box 3) have been used to determine assumptions, preconditions and limitations for a concluding calculation of profitability (4.4).

4.3.1 Fuel and Storage

For the fuel, an energy content of 6,5 kWh/m^3 biogas is calculated, as this corresponds with an average methane concentration of 60-65% (IWR 2012).

In order to find out the best ratio of invested capital for the storage and expected additional revenue through the shift of electricity production to high-price times, a calculation has been made, using the software program 'Excel':

A 1500m^3 gas storage, which allows a peak load production of 4-5 hours, is chosen as a point of departure. Every additional installed m^3 has been calculated with 40 €. The additional investment for the storage is then compared to the higher revenues from the electricity sale on the spot market, which is calculated in a corresponding 'energyPRO' model.

The results show that the most profitable gas storage for the 750 kW_{el} plant would be a 2100m^3 storage, enough to allow a peak production of 7,5 hours. Compared to the initial 1500m^3 storage, this storage generates a net gain of 8.000 € through more electricity production during times of higher prices.

For the 1000 kW_{el} plant, a storage of 3500m^3 has been calculated as most profitable, enough for a peak production of approximately 9 hours. The investment in this storage generates a net profit of 17.000 €.

This corresponds almost exactly with experts' opinion, suggesting a temporal shift in electricity production of 7-9 hours (Niklaus 2012).

	size gas storage (in m³)	earnings from electricity prodoction[1]	original earnings	addional costs gas storage	net gain compared to refernece model
	Reference model [1]				
	1.500	*223.844€*	*223.844€*	*x*	*x*
750 kW	1.600	230.496€	223.844€	400€	6.252€
	1.700	231.416€	223.844€	800€	6.772€
	1.800	232.729€	223.844€	1.200€	7.685€
	1.900	233.224€	223.844€	1.600€	7.780€
	2.000	233.856€	223.844€	2.000€	8.012€
	2.100	**234.516€**	**223.844€**	**2.400€**	**8.272€**
	2.200	234.615€	223.844€	2.800€	7.971€
	2.300	234.895€	223.844€	3.200€	7.851€
	2.400	235.483€	223.844€	3.600€	8.039€
	2.500	235.735€	223.844€	4.000€	7.891€
	3.000	237.127€	223.844€	6.000€	7.283€
	3.500	238.363€	223.844€	8.000€	6.519€
	4.000	239.126€	223.844€	10.000€	5.282€

[1] source: eneryPRO

Table 2: calculation gas storage 750 kW plant
Source: own source

	size gas storage (in m³)	earnings from electricity prodoction[1]	original earnings	addional costs gas storage	net gain compared to refernece model
	Reference model [1]				
	1.500	*221.343€*	*221.343€*	*x*	*x*
1000 kW	2.000	233.637€	221.343€	2.000€	10.294€
	2.500	240.281€	221.343€	4.000€	14.938€
	3.000	243.112€	221.343€	6.000€	15.769€
	3.100	244.511€	221.343€	6.400€	16.768€
	3.200	244.511€	221.343€	6.800€	16.368€
	3.300	245.203€	221.343€	7.200€	16.660€
	3.400	245.203€	221.343€	7.600€	16.260€
	3.500	**246.648€**	**221.343€**	**8.000€**	**17.305€**
	3.600	246.487€	221.343€	8.400€	16.744€
	3.700	247.356€	221.343€	8.800€	17.213€
	3.800	247.356€	221.343€	9.200€	16.813€
	3.900	247.989€	221.343€	9.600€	17.046€
	4.000	248.048€	221.343€	10.000€	16.705€
	4.100	248.513€	221.343€	10.400€	16.770€
	4.200	248.513€	221.343€	10.800€	16.370€
	4.500	249.601€	221.343€	12.000€	16.258€
	5.000	250.809€	221.343€	14.000€	15.466€
	5.500	251.725€	221.343€	16.000€	14.382€
	6.000	253.280€	221.343€	18.000€	13.937€
	8.000	256.643€	221.343€	26.000€	9.300€

[1] source: eneryPRO

Table 3: calculation gas storage 1000 kW plant
Source: own source

4.3.2 Economy

On the revenue side, the earnings of the *Flexibilitätsprämie*, the *Managementprämie* and the *Marktprämie* are considered. Furthermore, the revenues form the electricity sales on the Spotmarket 'EEX-2011 PHELIX' are included in the calculations.

Possible revenues from the balancing power are not included because the minimum biding capacity is 5 MW for the secondary reserves and 10 MW for the tertiary control market. See chapter 3.4.2 and Chapter 7.4 for a detailed explanation.

The operational expenditures include the necessary investments in a bigger engine, and an appropriate gas storage.

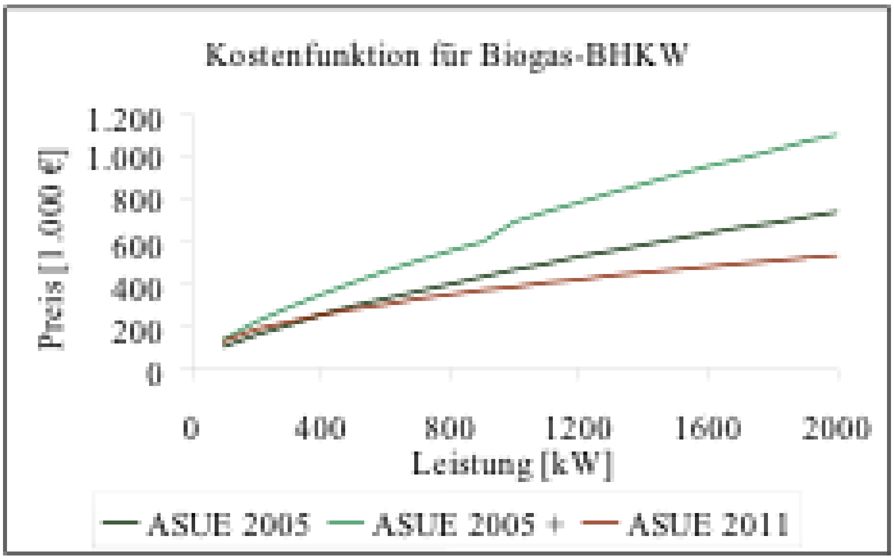
Furthermore, additional costs evolve form the remote control unit, which is necessary to regulate the plant inside the marketing pool with other CHP plants. Also, additional costs for the boost in the grid connection and additional labor-, and administrative cost are considered as well as cost for the insurance, the traders sales provision and marketing costs and the increased O&M costs.

The following Graph shows all assumption and limitations used for the calculation and modeling.

Box 3: Assumptions and limitations of the energy modeling.

General Assumptions	• Period covered for calculations: 01.01.2011 – 31.12.2011 • Spot market prices used: EEX-PHELIX • EneryPRO is used to operate flexible plant during times of best spot-market prices • The electricity sale is executed through a power trader • The minimum hours of operation for flexible plant is set to 4 hours • The capacity of the gas storage is designed for a peak-load production of 7-9 hours. The most profitable size has been chosen. • 2 different EEG compensation schemes are applied: 1) 18 ct/kWh [1] 2) 20 ct/kWh [2]
Costs Assumptions *For all calculations, a discount rate of 6% is applied, payable during 10 years*	• Investment costs for gas storage: 40 €/m3[3] • Investment costs additional engine capacity: 750 €/kW[4] • Marketing costs: 4 €/MWh (incl. 1,5 €/MWh sales provision, 2,5 €/MWh for all other expenses: IT connection, labor costs, trading costs etc.)[4] • Remote control unit: 3% of total turbine investment cost[4, 5] • Increased O&M costs: 2,5 €/MWh[4] • Increased insurance costs: 0,5% of total investment cost[4. 6] • Boost of grid connection: 56,8 €/kW[4] • Increased administrative cost: 1000 €/a[4] • Increased labor costs: 10.950 € (1h/day * 30 €)[4]
Limitations	• For simplicity reasons there are no restrictions of the heat production assumed • No consideration is given to environmental impacts and emission release • No participation on the balancing power market is considered • The model is a simplified model, considering only the electricity production • The calculations are not intended to be a business plan or the like, nor do they claim to be complete

Sources:
[1] Capacity ≤ 500 kW; Einsatzstoffvergütungsklasse I
[2] Capacity ≤ 500 kW; Einsatzstoffvergütungsklasse II
[3] Source: Thüringer Landesanstalt für Landwirtschaft, 2011
[4] Source: EMD Model 'Flexibilitätsprämie_2x550_kW'
[5] Total turbine investment costs: 550.000€ (750 kW)/700.000€ (1 MW), according to ASUE 2005 incl. IWES correction factor, see Graph 6
[6] Total investment cost small biogas plant: 4000€/kW Source: IWR/Fachverband Biogas



Graph 6: The total turbine investment costs, according to ASUE, including the IWES correction factor (ASUE 2005+)
Source: Rohrig et al. 2011

4.4 Calculation of Profitability

In a third step, the spreadsheet calculation program 'Excel' is used to calculate all expected revenues from the incentives of the EEG 2012 *Marktprämienmodel*, as described in Chapter 2.4

All calculation and results of the spreadsheet are discussed in detail in Chapter 5 and are attached in the appendices D and E.

The relevant formulae are provided in the EEG 2012, §33g.*ff* (see Appendix G for the original text in German).

The **first page** of the Excel spreadsheet gives a brief overview of the content.

Overview

Calculation of revenues from Marktprämienmodell

Content:
Sheet 2: Total revenues and assumptions
Sheet 3: Calculation revenues Marktprämie
Sheet 4: Calculation revenues Managementprämie
Sheet 5: Calculation revenues Flexibilitätsprämie
Sheet 6: Calculation revenues Spot Market Sales

Through the Marktprämienmodell towards a necessary Flexible Electricity Production from Biogas in Germany?

Master Thesis - Jakob Graf
2012

Picture 3: Overview of Excle calculations
source: own source

The **second page** sums up all calculations made on the following pages. This provides the reader with an overview of all expected revenues through the various incentives and the electricity sale on the spot market.

Furthermore, all the necessary investments for participating at the *Marktprämienmodel* are calculated. Assumptions for these calculations and the sources are shown in the comments and in Box 3.

At the bottom of the table, the total revenues (incl. the necessary additional investments) are compared to the fixed EEG compensation for the plant.

These calculations allows an evaluation whether the expected surplus justify the risks involved in the flexible production pattern.

All calculations have been made for the 750 kW_{el} plant as well as the 1000 kW_{el} plant and for both possible EEG compensation schemes of 18 / 20 ct./kWh, depending on the biodegradable material used.

	Paid by	750 kW capacity in €/year 1)	750 kW capacity in €/year 2)	1000 kW capacity in €/year 1)	1000 kW capacity in €/year 2)
Marktprämie	Grid operator	542.376	624.636	545.803	628.583
Management Prämie	Trader	6.170	6.170	6.209	6.209
Flexibilitätsprmie	Grid operator	30.550	30.550	62.434	62.434
Spot Market Sales	Trader	234.516	234.516	246.648	246.648
Total revenues		**813.612**	**895.872**	**861.094**	**943.874**
1)= 18ct/kWh	2)= 20 ct./kWh				
Comparison Marktprämienmodell and EEG Feed-In					
Plant capacity		750 kW 1)	750 kW 2)	1000 kW 1)	1000kW2)
total revenues Marktprämienmodell		813.612	895.872	861.094	943.874
EEG compensation		740.340	822.600	745.020	827.800
additional revenues Marktprämienmodell in %		**9,9**	**8,9**	**15,6**	**14,0**
additional investments necessary					
extention generator		18.750	18.750	37.500	37.500
gas storage		8.400	8.400	14.000	14.000
control unit		1.650	1.650	2.100	2.100
boost grid connection		1.800	1.800	3.780	3.780
increased administrative & Labour costs		11.950	11.950	11.950	11.950
increased maintenance costs		10.283	10.283	10.348	10.348
increased insurance costs		1.500	1.500	2.000	2.000
marketing costs		16.452	16.452	16.556	16.556
total necessary investments:		70.785	70.785	98.234	98.234
Revenues Marktprämienmodel minus investmens		742.827	825.087	762.860	845.640
EEG compensation		740.340	822.600	745.020	827.800
Extra annual earnings Marktprämienmodell		**2.487**	**2.487**	**17.840**	**17.840**
simple payback time in years:		**28,5**		**5,5**	

Table 4: calculation of revenues from Marktprämienmodell 750kW/1000kW
Source: own source

The **third page** shows the calculations for the *Marktprämie.* At the top of the table, the formula used is shown, along with an explanation. In the middle, the expected revenues for both plants and EEG compensations schemes are calculated. The figures used are the average monthly electricity prices on the PHELIX 2011 spot market, provide by the corresponding 'energyPRO' model (Appendix A and B).

On the bottom of the table, the calculated revenues are highlighted in green.

Formular Marktprämie: **MP = EEG-RMP**

MP: Marktprämie
EEG: EEG compensation
RMP: Refernce Market Price
(Average monthly electricity price (EEX) - Managementpräme)
1) EEG compensation in €/MWh 180
2) EEG compensation in €/ MWh 200

Month	Average Price €/MWh	RMP (€/MWh)	Marktpräme €/MWh 1)	Marktprämie €/MWh 2)	Modell 1000 kW: el. produced (MWh)	Modell 1000 kW: Revenues 1	Modell 1000 kW: revenues 2	Modell 750 kW: el Produced (MWh)	Modell 750 kW: revenues 1	Modell 750 kW: revenues 2
Jan 11	50,13	47,13	132,87	152,87	348	46.239	53.199	348	46.239	53.199
Feb 11	50,86	47,86	132,14	152,14	317	41.888	48.228	314	41.492	47.772
Mrz 11	54,40	51,40	128,60	148,60	354	45.524	52.604	352	45.267	52.307
Apr 11	51,58	48,58	131,42	151,42	346	45.471	52.391	340	44.683	51.483
Mai 11	56,83	53,83	126,17	146,17	348	43.907	50.867	348	43.907	50.867
Jun 11	52,30	49,30	130,70	150,70	340	44.438	51.238	337	44.046	50.786
Jul 11	46,40	43,40	136,60	156,60	352	48.083	55.123	351	47.947	54.967
Aug 11	48,57	45,57	134,43	154,43	352	47.319	54.359	349	46.916	53.896
Sep 11	52,64	49,64	130,36	150,36	347	45.235	52.175	341	44.453	51.273
Okt 11	51,68	48,68	131,32	151,32	351	46.093	53.113	350	45.962	52.962
Nov 11	55,36	52,36	127,64	147,64	339	43.270	50.050	339	43.270	50.050
Dez 11	42,90	39,90	140,10	160,10	345	48.335	55.235	344	48.194	55.074
Source: EnergyPro Model 750/1000kw										
				Total	**4.139**	**545.803**	**628.583**	**4.113**	**542.376**	**624.636**

Plant capacity	Revenues Marktprämie 1)	Revenues Marktprämie 2)
750 kW	**542.376**	**624.636**
1000 kW	**545.803**	**628.583**

Table 5: calculation of revenues from Marktprämie 750kW/1000kW
Source: own source

The **fourth page** indicates the expected revenues of the *Managementprämie* in both cases, which are usually shared equally between the operator of the plant and the trader.

year		2012	2013	2014	2015
ct/kWh		0,3	0,275	0,25	0,225
Capacity	Produced Electricity (MWh)	Revenues			
750 kW	4.113	**12.339**	11.311	10.283	9.254
1000 kW	4.139	**12.417**	11.382	10.348	9.313

Table 6: calculation of revenues from Managementprämie 750kW/1000kW
Source: own source

The **fifth page** shows the calculations of the *Flexibilitätsprämie,* according to the formula of the EEG2012§33i. An explanation of the abbreviations of the formula is provided in German as well as in English. Again, the expected revenues are highlighted at the bottom in green color.

Formular to calculate the Flexibiliätsprämie in acordance §33i EEG2012

$$FP = \frac{P_{Zusatz} \times KK \times 100}{P_{Bem} \times 8760 \frac{h}{a}}$$

$$P_{Zusatz} = P_{Inst} - (f_{Korr} \times P_{Bem})$$

Explonation of the Formular and the variables included (German)

FP	Flexibilitätsprämie [€ct/kWh]
P_{Zusatz}	zusätzlich installierte Leistung [kW_{el}]
P_{Bem}	Bemessungsleistung Gesamtanlage [kW_{el}]
P_{Inst}	Installierte Leistung der Gesamtanlage [kW_{el}]
KK	Kapazitätskomponente [€/kW_{el}]
f_{Korr}	Korrekturfaktor

gesetzte Werte

KK ist im EEG auf 130€/kW festgesetzt

f_{Korr} beträgt bei der Vor-Ort-Verstromung 1,1 und 1,6 bei Biomethan-BHKWs

Source: EEG 2012

Abbreviation	Tranaslation Engl.	Unit	750 kW	1000kW
P_{inst}	new inst. Capacity	kW el	750	1000
	Full load hours of new plant	h	5484	4139
P_{bem}	rated output	kW el	470	472
f_{korr}	correction factor	-	1,1	1,1
P_{Zusatz}	additional capacity, according to EEG2012 Anex 5	kWel	234	480
KK	Kapazitätskomponente	€/kWel	130	130
FP	Flexibilitätspräme	€ct/kWh	0,74	1,51
Bisher installierte Leistung	original installed capacity	kw	500	500
Bisher realisierte Vollaststunden	Full-load hours at base load operation	h	8.278	8.278
Flexibilitätsprämie pro Jahr	**Revenues Flexibilitätsprämie/year**	**€**	**30.550**	**62.434**

Table 7: calculation of renevenues from Flexibilitätsprämie 750kW/1000kW
Source: own source

The **sixth, and last page**, gives an overview of the expected revenues from the electricity sale on the spot market and the provision of the sales trader. Figures for the revenues are taken from the 'energyPRO' model (Appendix A and B)

Installed capacity	Revenues from electricty sale (€) 1)	Electricity produced (MWh 1)	Sales Provision trader (1,5€/MWh)	Total revenues
750 kW	**234.516**	**4.113**	**6.170**	**228.347**
1000 kW	**246.648**	**4.139**	**6.209**	**240.440**
1) source: EnergyPro Model 750/1000kw				

Table 8: calculations of revenues from electricity sale on spot market 750kW/1000kW
Source: own source

A detailed summary and an analysis of the results along with an expert discussion is provided in the following two chapters.

5. Results

In this chapter, the results of the calculations performed in Chapter 4 are summarized and analyzed.

First, possible revenues from the *Marktprämienmodell* for both models (750 kW_{el} and 1000 kW_{el}) are summarized and compared to the revenues from the EEG compensations scheme. This section also provides an explanation for possible differences in the revenues of both models.

In the following section, the net gain is summarized and evaluated for both cases. Finally, the necessary investments enabling a flexible production are evaluated and compared to the expected net gain.

All numbers and figures are rounded for an easier reading and understanding.

5.1 Revenues Marktprämienmodell

For the 750 kW_{el} model, the total annual revenues are **813.000 €**, considering an EEG compensation of 18 ct/kWh and **896.000 €** in the case of 20 ct/kWh compensation. As mentioned in Chapter 4.1, the EEG compensation depends on the biodegradable material used in the digester. The difference of **82.000 €** between the two compensation schemes is only due to the different amount of the *Marktprämie*, which compensated the difference between the average monthly electricity price at the power exchange and the EEG compensation scheme. All other revenues are the same in both cases as they depend on the amount of electricity produced.

For the 1000 kW_{el} model, the revenues are **861.000 €** (18 ct/kWh EEG compensation) and **943.000 €** (20 ct/kWh EEG compensation) respectively. Again, the difference between the two compensation scheme is approximately **82.000 €**, as it is for the 750 kW_{el} model.

The main reason for the difference in revenues (**48.000 €**) between the two models is the *Flexibilitätsprämie*, which is more than twice as much for the 1000 kW_{el} model (**62.000 €**) compared to the 750 kW_{el} model (**30.000 €**), as they depend on the additional installed capacity.

Furthermore, the revenues on the spot market are approximately **12.000 €** higher for the 1000 kW_{el} model, due to the larger engine capacity, which allows to produce more electricity during times of high prices.

The *Marktprämie* is only marginal higher for the model with the larger engine, whereas the *Managementprämie* is almost the same in both cases.

	Paid by	750 kW capacity in €/year 1)	750 kW capacity in €/year 2)	1000 kW capacity in €/year 1)	1000 kW capacity in €/year 2)
Marktprämie	Grid operator	542.376	624.636	545.803	628.583
Management Prämie	Trader	6.170	6.170	6.209	6.209
Flexibilitätsprmie	Grid operator	30.550	30.550	62.434	62.434
Spot Market Sales	Trader	234.516	234.516	246.648	246.648
Total revenues		**813.612**	**895.872**	**861.094**	**943.874**
1)= 18ct/kWh	2)= 20 ct./kWh				

Table 9: Total revenues Marktprämienmodell for 750kW/1000kW under different EEG compensation
Source: own source

5.2 Expenditures

In order to participate at the *Marktprämienmodell* and to be entitled to all incentives and possible additional revenues, the plant operator has to invest in the production facility, the grid connection and control units. Furthermore, some money has to be allocated for increased insurance-, maintenance-, administrative- and labor cost. All assumptions for the necessary investments are listed in Box 3 a discount rate of 6% is applied, payable within 10 years.

An analysis of the cost factors reveals that in both cases the highest single cost is the extension of the generator (**37.500 €**/1000 kW_{el} and **19.000 €**/750 kW_{el}), followed by the marketing costs of **16.500 €** for both models, since they are calculated as a fixed price of 4 €/MWh.

For the 1000 kW_{el} model, the investment in the gas storage represents the third largest investment (**14.000 €**), followed by increased labor and administrative costs (**12.000 €**) and the increased maintenance costs (**10.000 €**).

Remarkable at the 750 kW_{el} model is that the increased labor and administrative costs represents the third highest cost factor (**11.000 €**), followed by the increased maintenance costs (**10.000 €**). This means that the investment in the gas storage is only the fifth highest investment costs (**8.500 €**), whereat it is the third highest at the 1000 kW_{el} model.

additional investments necessary					
Plant capacity		750 kW 1)	750 kW 2)	1000 kW 1)	1000kW2)
extention generator		18.750	18.750	37.500	37.500
gas storage		8.400	8.400	14.000	14.000
control unit		1.650	1.650	2.100	2.100
boost grid connection		1.800	1.800	3.780	3.780
increased administrative & Labour costs		11.950	11.950	11.950	11.950
increased maintenance costs		10.283	10.283	10.348	10.348
increased insurance costs		1.500	1.500	2.000	2.000
marketing costs		16.452	16.452	16.556	16.556
total necessary investments:		70.785	70.785	98.234	98.234

Table 10: additional investments necessary for participation in Marktprämienmodell
Source: own source

5.3 Net Gain

When comparing only the revenues from the *Marktprämienmodell* to the one from the EEG compensation scheme it becomes clear that the *Marktprämienmodell* allows the plant operator an increase in revenues of 10-15%, compared to the EEG compensation.

Comparison Marktprämienmodell and EEG Feed-In					
Plant capacity		750 kW 1)	750 kW 2)	1000 kW 1)	1000kW2)
total revenues Marktprämienmodell		813.612	895.872	861.094	943.874
EEG compensation		740.340	822.600	745.020	827.800
additional revenues Marktprämienmodell in %		**9,9**	**8,9**	**15,6**	**14,0**

Table 11: comparison revenues Martprämienmodel-EEG
Source: own source

In order to display the annual net gain, the necessary investments (divided into a 10-year period at a discount rate of 6%) are subtracted from the expected annual revenues for both cases.

According to the ‘enegyPRO’ model and the resulting Excel calculations, the expected annual net gain for the 750 kW plant is **2.400 €** and ca. **18.000 €** for the 1000 kW_{el} plant.

The main reason for this proportional large difference, compared to the difference in the size of the engine, is the relatively large difference in the revenues for from the *Flexibilitätsprämie.*

Furthermore, other important cost factors are either calculated as a fixed price (increased administrative and labor costs) or correspond to the amount of electricity produced, which is very similar in both cases (4113 MWh / 4139 MWh).

This means that the net gain for the 750 kW_{el} plant is a mere 0,3% compared to the EEG scheme. Even though the expected net gain for the 1000 kW_{el} plant is more than 7 times higher than for the 750 kW_{el} plant, it remains very low, generating only a 2% higher annual profit than the EEG compensation.

When calculating a simple pay back time it reveals that the invested money would be paid back in **28 years** in the 750 kW_{el} case and **5,5 years** in the case of a 1000 kW_{el} engine extension.

Plant capacity		750 kW 1)	750 kW 2)	1000 kW 1)	1000kW2)
Revenues Marktprämienmodel minus investmens		742.827	825.087	762.860	845.640
EEG compensation		740.340	822.600	745.020	827.800
Extra annual earnings Marktprämienmodell		**2.487**	**2.487**	**17.840**	**17.840**
simple payback time in years:		**28,5**		**5,5**	

Table 12: Extra annual earnings and pay back time fort he Marktprämienmodell 750kW/1000 kW
Source: own source

5.4 Conclusion

In conclusion it becomes clear that the investments necessary to fully participate in the *Marktprämienmodell* eats up almost all of the otherwise attractive profit generated from the *Marktprämienmodell*.

It also seems that the smaller the additional engine capacity, the less attractive the investment becomes. This is due to the fact that most cost factors are either fixed-priced or correspond to the amount of electricity produced, which remains more or less the same in both cases as it must not exceed the initial installed capacity in order to be eligible for the incentives and bonuses.

Therefore it must be doubted that, under the assumed circumstances and plant capacity, the *Marktprämienmodell* offers an attractive enough incentive for biogas operators to invest in a new engine, gas storage and controlling equipment, to leave the secure EEG compensation scheme, and participate on the free market.

6. Experts' Interviews

This chapter summarizes the semi-structured interviews with two experts. In these interviews, the possibilities of the *Marktprämienmodell* for operators of biogas plants were evaluated, the motivations for participating are examined and an outlook on the future development is given. A transcript of the interviews in German language can be found in Appendices H and I.

6.1 Reasons for and Advantages of the Interviews.

The previous parts of the thesis consist of an extensive theoretical discussion and explanation of the EEG 2012 and the purpose of the *Marktprämienmodell*. Furthermore, detailed calculations on possible revenues were performed, based on well-researched assumptions and estimations through experts of several different fields which allows a theoretical evaluation if the incentives of the EEG 2012 are strong enough for a shift to flexible production.

To allow a more comprehensive evaluation, interviews were conducted with the purpose to find out how the target group of the *Marktprämienmodell*, in this case the operators of biogas plants, evaluate the new possibilities and what consequences they draw from the new regulations. This offers an insight into the daily operation of the branch and allows a further evaluation whether the *Marktprämienmodell* has the intended effect. Thus, these interviews will help to answer the posed research question.

6.2 Interviewee Rainer Weng.

Mr. Rainer Weng is a farmer and one of two operators of a joint biogas plant. The plant has an accumulated installed capacity of 850 kW_{el}, divided into two CHP plants with 520 kW and 330 kW capacity.

Furthermore, Mr. Weng is spokesperson of the local branch of the interst club '*Fachverband Biogas e.V.*'. This regional branch consists of 4 counties and is located in the southwest of the federal state of Bavaria. In his function, Mr. Weng is also responsible for the organization of regular meetings on current topics concerning the production and marketing of electricity from biogas. During the last 9 months he had held several meetings and symposia on direct marketing through the *Marktprämienmodell*.

6.2.1 Summary of Interview with Rainer Weng

- **About his plans for direct marketing of biogas electricity**

The idea to participate in the direct marketing of electricity from biogas came up on one of our first meetings on this topic. During the discussion it became clear that there would be numerous advantages if we organized the direct marketing as a group of biogas plant operators. The outcome of the meeting was that a group of 50-60 plant operators got together and met on a regular basis to plan and organize the first steps into the direct marketing. Together we have an accumulated installed capacity of approximately 30 MW_{el}.

- **About the motivation and anticipated advantages from the direct marketing**

Clearly, the motivation is the same as for every entrepreneur: to make money. The direct marketing offers slightly more chances to earn money than the EEG compensation scheme. In contrast to the fixed EEG compensation scheme the direct marketing guarantees some extra revenues through the *Managementprämie* and, further more, offers the possibility to generate extra profits on the free market. The *Managementprämie* is 0,3 ct/kWh and is shared between the plant operator and the marketing partner, depending on the negotiation skills. Usually it is shared 50/50. Moreover, there is the possibility to participate on the positive and/or negative secondary reserve or tertiary control power.

- **About the intended use of incentives and bonuses**

Besides the *Managementprämie* we will participate on the negative secondary reserve. Our CHPs have been operating at base-load production and the gas production is now optimized, allowing an almost perfect operation scheme. Therefore we do not have any additional capacities and no additional capacity is planned. Also additional capacity would mean additional investments in grid connection, transformers and such. Thus we will continue to run in base-load and allow a downsizing if really needed. The maximum temporal shut down is 1 hour but in average only 20-25 minutes. Our gas storage is big enough to compensate the additional gas production. We aim to offer 650 kW of the existing 850 kW as negative secondary reserve.

- **About technical changes on the CHP**

There won't be any technical changes, apart from a remote control unit, necessary to switch off the engine when the negative secondary reserve is needed.

- **About reasons for not using the *Flexibilitätsprämie* and thus higher revenues on the spot market**

Our plant is operating very well and we do not want to risk any disturbances. Furthermore the necessary investments would be considerable and the expected additional revenues would probably not justify them. At the moment we are not having any risk since we can switch back to the EEG compensation scheme anytime we want. If the additional engine capacity is installed this would not fully be possible any more.

- **About the expected additional revenues**

It is quite simple to calculate:

The revenues from the *Managementprämie* will be 0,15-0,18 ct/kWh. We produce around 7 million kWh per year, so this would be something between 10.500 € and 12.500 € year extra.

For the negative secondary reserve we calculate approximately 50.000 € per year per MW. This means that in our case (650 kW) we expect additional revenues of 30.000-40.000 €/year, depending on how good the marketing partner can sell the reserve power.

In total we expect additional revenues of 40.000-52.00 € per year, without significant changes in the production pattern.

- **About the future outlook and the willingness of other plant operators to switch to flexible production.**

Clearly, we are pioneers in this field. I don not know of many plant operators who have switched to flexible production already. We will start on July 1st and I expect more and more others to follow, maybe until the end of the year. So far most of the colleges I know of wait and see what happens and what experiences other plant operators make. If they have success there will be many more to switch to direct marketing.

6.3 Interviewee Sebastian Fenner.

Mr. Sebastian Fenner is a farmer and operator of a 500kW biogas plant and uses the direct marketing since the enforcement of the EEG 2012 on January 1st 2012. Furthermore he is founder member of the *Genossenschaft Deutscher Grünstrom Erzeuger (GDGE)*

6.3.1 Summary of Interview with Sebastian Fenner

- **About the GDGE**

  The GDGE is a collective of German renewable energy producer. The aim is to bundle as many individual renewable energy producer in order to reach together a better market position and eventually reach better conditions with the marketing partner. All renewable energy sources are represented at the GDGE with the wind energy having the highest share as measured by installed capacity.

- **About the used incentives and bonuses**

  We started the direct marketing on January 1st, 2012. The process was easy, only the payment was delayed in the beginning, due to the new situation for the grid operator. Now everything works without any problems. At the moment we are only using the *Marktprämie* along with the *Managementprämie*. In addition to this we are currently installing an interface, which enables us to participate on the balancing power market in the future. We are intending to participate at the negative secondary power market by the end of this year. At the moment we cannot offer positive balancing power, neither can we participate on the *Flexibilitätsprämie* since we have no additional free capacity.

- **About the motivation and anticipated advantages from the direct marketing**

  We have always tried to further optimize the revenues from our plant but we have reached a level where no further increase was possible. Therefore we decided to switch to the direct marketing. The main motivation is of course the money. But apart from that we hope to establish renewable energy further in Germany. Especially electricity from biogas has a big potential since it is a controllable renewable energy and therefore has a special role. But the primary motivation clearly is the money.

- **About changes in the course of the direct marketing**

  So far not much has changed. There is no change in the operation strategy of our plant, the only thing that has changed is the money flow. ¾ of the money still comes from the grid operator, ¼ from the GDGE.

- **About possible technical changes in the future**

  We are intending to install additional engine capacity some time in the future. But not any time soon. We also do not intend to just add another engine but rather change the whole engine when the old engine has reached its maximum life time. There are consideration to change the existing 500 kW to a 800 kW to enable real flexible production. But we will wait and see how things develop. Luckily our gas storage is large enough for such a installed capacity, so there would be no need for additional gas storage.

- **About the additional revenue necessary to make the direct marketing attractive**

  In our case we are aiming to make use of the *Marktprämie*, the *Managementprämie* and the negative secondary reserve. This should generate a surplus of 20.000-30.000 € per year. Less than that would be unattractive. The *Marktprämie* together with the *Managementprämie* alone is not attractive enough, especially when considering that the *Managementprämie* is declining every year.

- **About the accusation that a concentration solely on the *Managementprämie* and the negative secondary reserve is a free-rider effect *(Mitnahmeeffekt)***

  I would not call this a free-riding effect, at least not for case of biogas, since the *Managementprämie* is very low. The participation on the negative secondary reserve cannot be regarded as a free-riding effect either since this is only applied when really needed and operators of all kind of power plants participate and get the same compensation. Of course, the optimum is a power plant that is controllable in both ways but the investment in additional engine capacity is not worth the compensation. I think this needs very careful calculations, it is probably somewhere close to being profitable but not worth the risk involved, compared to the EEG compensation scheme or the *Marktprämie / Managementprämie* / secondary reserve version. I could imagine a switch towards a flexible production only if the engine has to be replaced. In my opinion, big investments such as an additional gas storage etc, do not make a lot of sense under the current incentives and bonuses offered. It remains to be seen if the introduction of the electrical power meter and the related bigger difference between HT (high price) and NT (low price) electricity will have an impact. I could imagine that there are new possibilities.

- **About the future outlook and the willingness of other plant operators to switch to flexible production.**

  I have the feeling that most of the plant operators are waiting to see what happens and how things are developing. So far things are developing dragging. But almost all of my colleges are recognizing that a flexible production is the future of the biogas industry.

  However, the season of the year does play an important role in a farmer's life. At the moment people are busy and may do not have the time to care about other things. I could imagine that the interest and willingness to deal with this topic will be bigger during the next winter.

6.4 Summary

When summarizing the interviews with Rainer Weng and Sebastian Fenner, it becomes clear that a shift towards the direct marketing of electricity from biogas does not require a change in the production pattern of the CHP plant but still allows a base-load operation. This is due to the fact that the *Managementprämie* and participating on the negative secondary reserve is enough incentive to switch to direct marketing, at least at the moment. The shift towards the direct marketing is simple and smooth and the cooperation with the marketing partner works well, no bureaucratic obstacles were reported. The willingness to invest in the equipment necessary for a real flexible production pattern (i.e. a bigger engine and gas storage) is very low, due to the risk involved and the possibility to gain extra revenues without changing any crucial component on a well-functioning biogas plant.

Generally spoken, there is an interest and the willingness among plant operators to shift towards a real flexible production and also the necessity and the advantages for the industry has been recognized but most actors prefer to wait for the first results and the experiences of the pioneers.

7. Conclusion and Outlook

The closing chapter will provide the reader with a summary and an interpretation of the main findings of the thesis and give an answer to the research question posted. Moreover, it will give an outlook on the possible perspective of the *Marktprämienmodell* as well as a critical view on the performed research in this thesis. At the end, suggestions for possible further research on the topic are stated.

7.1 Summary and Interpretation of Findings

In the course of the research on the integration of electricity from fluctuating sources and their impact on the grid, it became clear that a flexible electricity production from biogas plants could significantly contribute towards a stabilization of the grid. Thus, a shift towards a flexible production pattern of biogas plants in Germany would, in consequence, allow the integration of more intermittent renewable energy sources, especially wind and PV, into the German electricity grid (Chapter 3.1).

The conducted simulations and calculations on the profitability of a 750 kW_{el} and 1000 kW_{el} biogas plant with flexible production pattern (Chapter 4) showed that under the assumed circumstances and without a participation on the balancing power market it is not attractive for small biogas plants to shift production pattern. The calculated annual net gain for the 750 kW_{el} plant is approximately 2500 €, which means that the pay back time for the investment is almost 30 years. For the 1000 kW_{el} plant the net gain is approximately 18.000 € and the pay back time for the invested capital around 5 years, which means it is close to being a profitable investment (Chapter 5). However, these are theoretical calculations and, even though all underlying assumptions have been carefully selected, reviewed and checked by experts, the reality seems to look somehow different and more complex, as the interviews with plant operators and stakeholder representatives reveal (Chapter 6). The biggest burden for a shift towards a complete flexible production does not seem to be the amount of compensation and possible revenues but the necessary structural alteration of the biogas plant. The doubling of the engine size, as it is the case in the 1000 kW_{el} plant, requires fundamental structual changes on the plant. Apart from a change of the engine, a bigger or additional gas storage and possibly changes on the digestion line would have to be made. Such a massive intervention in a well functioning biogas plant is very likely to be rejected by the operators as it contains the risk of a malfunction of the new plant and consequently long and expensive adjustments.

Referring to the experiences from plant operators, which have shifted to a flexible production or aim to do so, it seems that there is only one feasible possibility for existing biogas plants for direct marketing at the moment. In this option, the plant operator makes use of the *Marktprämie* and the *Managementprämie* and further participate on the negative secondary reserve. The additional revenues of ca. 50.000 € annually for every MW, offered at the negative secondary power market seems to be attractive enough to leave the EEG compensation scheme (Appendices H and I).

However, precondition to this option is that the existing gas storage has some additional capacity to absorb the gas production when the engine is shut down. Furthermore, it cannot be taken for granted the same revenues will be generated in the future, as the *Managementprämie* is declining every year and the price for negative secondary reserve is expected to fall if the available capacity increases due to a higher supply.

7.2 Interpretation and Outlook

At moment, the operators of biogas plants already using the direct marketing are picking the ‘low hanging fruits’ by generating extra revenues without any substantial shift in the production pattern of the power plant or any additional investments. Whether or not this can be regarded as a free-rider effect remains disputed and may depends on the personal perception. On the one hand, to collect additional revenues without delivering the desired effect, in this case a flexible production pattern, can be regarded a classical free-riding effect. On the other hand it can be seen as the necessary preparation towards a flexible production pattern of most biogas plants in Germany, which can significantly contribute to the solution of one of the most pressing issues of the future electricity supply, namely the integration of more intermittent renewable energy sources into the grid. Furthermore, revenues from the *Managementprämie* are very low and most additional revenues comes from the negative secondary reserve, which is a free market open to all power plants, which means that there are no additional costs for the society involved.

In the future there are good chances for a drastic increase of flexible electricity production from biogas plants in Germany through the *Marktprämienmodell*. The reasons are that all new small and medium-sized plants (< 750 kW_{el}) are obliged for direct marketing and that within the next 4-5 years almost all existing biogas plants will have to replace their existing engine, assuming base-load operation and an engine life-cycle of 30.000-40.000 hours. The chances are high that the operators will install a bigger engine capacity to profit from the *Marktprämienmodell*, especially if it is true that a flexible electricity production is considered as the future of most biogas operators (Appendix I).

7.3 Answer to Research Question

Concluding, the question whether the *Marktprämienmodell* of the EEG 2012 is a sufficient incentive for operators of biogas plants in Germany to switch from base-load towards a flexible electricity production cannot be answered with a clear yes or no.

The anticipated effect also depends on other factors, which play an important role in the operator's decision on the production pattern: this includes the willingness to take a risk, how much additional time and resources the operator is able and willing to allocate, whether the site-specific characteristics allow physical changes and how smooth the existing plant is operating.

How successful the *Marktprämienmodell* will be and if it is able to produce the desired effects can only be said for certain in a few years time, when the effects on the grid and electricity prices are evaluated.

7.4 Critical View on Performed Research

The *Marktprämienmodell* only came into effect in the beginning of 2012 and thus is new to all actors. Therefore there are hardly any stakeholder with experiences on this topic and little profound knowledge is available. As a consequence, the experts statement on the *Marktprämienmodell* and their experiences so far are only of limited value.

This is also the reason why all data for the 'energyPRO' models and the 'Excel' calculations rely on general and personal assumptions and experiences of the consulted experts. Nonetheless all data and statements have been carefully selected and cross-checked whenever possible.

After an initial research on the topic and consultation with experts on their assessment, no participation on the balancing power market was included in the modeling and the calculation. A participation on the balancing power market was regarded as too abstract and complex for individual plant operators and at the most of them considered an option for a change in the future, when the plant has shifted to a flexible production. As mentioned earlier, this is again an evidence that in a theoretic and ambitious wish theory and practice might seems the same but in reality they aren’t.

For the experts discussion, only two interviews have been conducted, due to the fact that very few stakeholders have gained experiences and are therefore able to make a statement. Nonetheless these interviews can be considered very meaningful, since both interviewees are very active in their sector and have leading positions as important stakeholder in their advocacy group. Therefore both posses an excellent partner network and thus can be seen as representatives for most of their partners and colleagues.

7.5 Suggestions for Further Research

After intensely dealing with the topics of integrating intermittent renewable energy sources, the direct marketing of renewable electricity and flexible production pattern of biogas plants the following areas are suggested for further research by the author:

- Possible improvements and suggestions for amendments on the Marktprämienmodell.
- Profound and reliable evaluation of the impact of the Marktprämienmodell, 1-2 years after its introduction.
- Medium - and long-term impacts and effects of a flexible electricity production of biogas plants on the grid stability and the electricity prices.

8. Appendices

The appendices are provided on the following pages in the report, as well as in digital format on an enclosed CD-ROM, which includes the energyPRO models. Due to their length, appendices F and G are also provided in digital format.

A. energyPRO Model 750kW (provided at the CD-ROM)
B. energyPRO Model 1000kW (provided at the CD-ROM)
C. energyPRO Model EMD_Flex (provided at the CD-ROM)
D. Excel Table: 'Revenues from Marktprämienmodell'
E. Excel Table: 'Calculations_Gas_Storage'
F. EEG2012 complete
G. EEG §33a-i
H. Interview transcript Rainer Weng
I. Interview transcript Sebastian Fenner

Appendix D

	size gas storage (in m³)	earnings from electricity prodoction[1]	original earnings	addional costs gas storage	net gain compared to refernece model
	Reference model [1]				
	1.500	*223.844€*	*223.844€*	*x*	*x*
750 kW	1.600	230.496€	223.844€	400€	6.252€
	1.700	231.416€	223.844€	800€	6.772€
	1.800	232.729€	223.844€	1.200€	7.685€
	1.900	233.224€	223.844€	1.600€	7.780€
	2.000	233.856€	223.844€	2.000€	8.012€
	2.100	**234.516€**	**223.844€**	**2.400€**	**8.272€**
	2.200	234.615€	223.844€	2.800€	7.971€
	2.300	234.895€	223.844€	3.200€	7.851€
	2.400	235.483€	223.844€	3.600€	8.039€
	2.500	235.735€	223.844€	4.000€	7.891€
	3.000	237.127€	223.844€	6.000€	7.283€
	3.500	238.363€	223.844€	8.000€	6.519€
	4.000	239.126€	223.844€	10.000€	5.282€

[1] source: eneryPRO

Appendix E

Overview

Calculation of revenues from Marktprämienmodell

Content:
Sheet 2: Total revenues and assumptions
Sheet 3: Calculation revenues Marktprämie
Sheet 4: Calculation revenues Managementprämie
Sheet 5: Calculation revenues Flexibilitätsprämie
Sheet 6: Calculation revenues Spot Market Sales

Through the Marktprämienmodell towards a necessary Flexible Electricity Production from Biogas in Germany?

Master Thesis - Jakob Graf
2012

	Paid by	750 kW capacity in €/year 1)	750 kW capacity in €/year 2)	1000 kW capacity in €/year 1)	1000 kW capacity in €/year 2)
Marktprämie	Grid operator	542.376	624.636	545.803	628.583
Management Prämie	Trader	6.170	6.170	6.209	6.209
Flexibilitätsprmie	Grid operator	30.550	30.550	62.434	62.434
Spot Market Sales	Trader	234.516	234.516	246.648	246.648
Total revenues		**813.612**	**895.872**	**861.094**	**943.874**
1)= 18ct/kWh	2)= 20 ct./kWh				
Comparison Marktprämienmodell and EEG Feed-In					
Plant capacity		750 kW 1)	750 kW 2)	1000 kW 1)	1000kW2)
total revenues Marktprämienmodell		813.612	895.872	861.094	943.874
EEG compensation		740.340	822.600	745.020	827.800
additional revenues Marktprämienmodell in %		**9,9**	**8,9**	**15,6**	**14,0**
additional investments necessary					
extention generator		18.750	18.750	37.500	37.500
gas storage		8.400	8.400	14.000	14.000
control unit		1.650	1.650	2.100	2.100
boost grid connection		1.800	1.800	3.780	3.780
increased administrative & Labour costs		11.950	11.950	11.950	11.950
increased maintenance costs		10.283	10.283	10.348	10.348
increased insurance costs		1.500	1.500	2.000	2.000
marketing costs		16.452	16.452	16.556	16.556
total necessary investments:		70.785	70.785	98.234	98.234
Revenues Marktprämienmodel minus investmens		742.827	825.087	762.860	845.640
EEG compensation		740.340	822.600	745.020	827.800
Extra annual earnings Marktprämienmodell		**2.487**	**2.487**	**17.840**	**17.840**
simple payback time in years:		**28,5**		**5,5**	

Formular Marktprämie: **MP = EEG-RMP**

MP: Marktprämie
EEG: EEG compensation
RMP: Refernce Market Price
(Average monthly electricity price (EEX) - Managementpräme)
1) EEG compensation in €/MWh 180
2) EEG compensation in €/ MWh 200

Month	Average Price €/MWh	RMP (€/MWh)	Marktpräme €/MWh 1)	Marktprämie €/MWh 2)	Modell 1000 kW: el. produced (MWh)	Modell 1000 kW: Revenues 1	Modell 1000 kW: revenues 2	Modell 750 kW: el Produced (MWh)	Modell 750 kW: revenues 1	Modell 750 kW: revenues 2
Jan 11	50,13	47,13	132,87	152,87	348	46.239	53.199	348	46.239	53.199
Feb 11	50,86	47,86	132,14	152,14	317	41.888	48.228	314	41.492	47.772
Mrz 11	54,40	51,40	128,60	148,60	354	45.524	52.604	352	45.267	52.307
Apr 11	51,58	48,58	131,42	151,42	346	45.471	52.391	340	44.683	51.483
Mai 11	56,83	53,83	126,17	146,17	348	43.907	50.867	348	43.907	50.867
Jun 11	52,30	49,30	130,70	150,70	340	44.438	51.238	337	44.046	50.786
Jul 11	46,40	43,40	136,60	156,60	352	48.083	55.123	351	47.947	54.967
Aug 11	48,57	45,57	134,43	154,43	352	47.319	54.359	349	46.916	53.896
Sep 11	52,64	49,64	130,36	150,36	347	45.235	52.175	341	44.453	51.273
Okt 11	51,68	48,68	131,32	151,32	351	46.093	53.113	350	45.962	52.962
Nov 11	55,36	52,36	127,64	147,64	339	43.270	50.050	339	43.270	50.050
Dez 11	42,90	39,90	140,10	160,10	345	48.335	55.235	344	48.194	55.074
Source: EnergyPro Model 750/1000kw										
				Total	**4.139**	**545.803**	**628.583**	**4.113**	**542.376**	**624.636**

Plant capacity	Revenues Marktprämie 1)	Revenues Marktprämie 2)
750 kW	**542.376**	**624.636**
1000 kW	**545.803**	**628.583**

year		2012	2013	2014	2015
ct/kWh		0,3	0,275	0,25	0,225
Capacity	Produced Electricity (MWh)	Revenues			
750 kW	4.113	**12.339**	11.311	10.283	9.254
1000 kW	4.139	**12.417**	11.382	10.348	9.313

Formular to calculate the Flexibiliätsprämie in acordance §33i EEG2012

$$FP = \frac{P_{Zusatz} \times KK \times 100}{P_{Bem} \times 8760 \frac{h}{a}}$$

$$P_{Zusatz} = P_{Inst} - (f_{Korr} \times P_{Bem})$$

Explonation of the Formular and the variables included (German)

FP	Flexibilitätsprämie [€ct/kWh]
P_{Zusatz}	zusätzlich installierte Leistung [kW_{el}]
P_{Bem}	Bemessungsleistung Gesamtanlage [kW_{el}]
P_{Inst}	Installierte Leistung der Gesamtanlage [kW_{el}]
KK	Kapazitätskomponente [€/kW_{el}]
f_{Korr}	Korrekturfaktor

gesetzte Werte

KK ist im EEG auf 130€/kW festgesetzt

f_{Korr} beträgt bei der Vor-Ort-Verstromung 1,1 und 1,6 bei Biomethan-BHKWs

Source: EEG 2012

Abbreviation	Tranaslation Engl.	Unit	750 kW	1000kW
P_{inst}	new inst. Capacity	kW el	750	1000
	Full load hours of new plant	h	5484	4139
P_{bem}	rated output	kW el	470	472
f_{korr}	correction factor	-	1,1	1,1
P_{Zusatz}	additional capacity, according to EEG2012 Anex 5	kWel	234	480
KK	Kapazitätskomponente	€/kWel	130	130
FP	Flexibilitätspräme	€ct/kWh	0,74	1,51
Bisher installierte Leistung	original installed capacity	kw	500	500
Bisher realisierte Vollaststunden	Full-load hours at base load operation	h	8.278	8.278
Flexibilitätsprämie pro Jahr	**Revenues Flexibilitätsprämie/year**	**€**	**30.550**	**62.434**

Installed capacity	Revenues from electricty sale (€) [1]	Electricity produced (MWh [1]	Sales Provision trader (1,5€/MWh)	Total revenues
750 kW	**234.516**	**4.113**	**6.170**	**228.347**
1000 kW	**246.648**	**4.139**	**6.209**	**240.440**

1) source: EnergyPro Model 750/1000kw

Appendix H

Interview mit Herrn Rainer Weng, Betreiber einer Biogasanlage und Regionalgruppensprecher Bayern (Schwaben Nord), Fachverband Biogas e.V. zur Direktvermarktung von Strom aus Biogasanlagen

18-05-2011

Bitte beschreiben Sie kurz Ihre Tätigkeit sowie Ihre Funktion beim Fachverband Biogas e.V.

Herr Weng:

Ich bin Betreiber einer Gemeinschafts Biogasanlage, die von 2 Personen betrieben wird. Die Anlage hat insgesamt 850 kW. Die Anlage setzt sich aus 2 BHKWs zusammen, mit einmal 526 kW und einmal 330 kW.

Zudem bin ich Regionalgruppensprecher vom Fachverband Biogas e.V. für den Bereich Schwaben-Nord der aus 4 Landkreisen besteht. Dort organisiere ich auch die Veranstaltungen.

Von Ihrer Kollegin Frau Bath hatte ich erfahren, dass Sie planen, in die Direktvermarktung von Strom aus Biogas einzusteigen. Können Sie mir darüber etwas mehr erzählen?

Herr Weng:

Bei einer unserer Veranstaltungen hatten wir das Thema Direktvermarktung und es stellte sich sehr schnell heraus dass man als Gruppe deutliche Vorteil erzielen könnte; Genauso wurde es dann gemacht und es hat sich eine Gruppe aus dieser Fachverbandsgruppe heraus gebildet, die ab dann immer regelmäßig an Treffen teilnahm. Es waren an die 60-70 Teilnehmer, von denen sich dann eine Gruppe von 50-60 Anlagenbetreibern zusammen getan hatte mit insgesamt ca. 30 MW an Anlagenleistung.

Was war die Motivation für Sie, in die Direktvermarktung einzusteigen? Welche Vorteile versprechen Sie sich davon?

Herr Weng:

Ganz klar: die Motivation eines jeden Unternehmers, nämlich irgendwie Geld zu verdienen; Und die Direktvermarktung bietet doch ein bisschen mehr Chancen als die klassische EEG Vermarktung. Bei der EEG Vermarktung haben wir die EEG Standartvergütung während bei der Direktvermarktung kann man die Managementprämie einerseits und zugleich Mehrerlöse am freien Markt erzielen.

Die Managementprämie beträgt 0,3 ct/kWh für den Bereich Biogas. Diese wird dann aufgeteilt zwischen Stromhandelsunternehmen und Anlagenbetreiber. Je nachdem wie gut man verhandelt werden die Erlöse aufgeteilt, in der Regel 50/50.

Darüber hinaus gibt es die weiteren Möglichkeiten: Nutzung der Flexibilitätsprämie bzw. Nutzung der positiven und negativen Sekundärreserve oder auch Minutenreserve, je nachdem wo man einsteigen möchte.

Beteiligen Sie sich an der positiven und negativen Sekundärregelleistung?

Herr Weng:

Nur an der negativen Sekundärreserve. Unsre BHKWs sind bisher zu 99% im Volllastbetrieb gelaufen da die Gasproduktion konstant gut ist bei unseren Anlagen. Daher haben wir bei unseren BHKWs keine freien Überkapazitäten um weiter nach oben regeln zu können. Neue BHKW Anlagen sind nicht geplant, da die Anlagenstandorte relativ ausgereizt sind. Auch die Trafos müssten alle erneuert werden, deshalb fahren wir weiter klassisch im Vollastbetrieb mit der einzigen Option des ‚Runterregelns', wenn es sein muss

Das heißt, Sie fahren die BHKWs weiter im Vollastbetrieb?

Herr Weng:

Zu 96% fahren wir weiter im Vollastbetrieb und sobald abgeriegelt werden muss wird abgeriegelt. Bei der Sekundärregelung ist die maximale Dauer der Abriegelung 1 Stunde, im Durchschnitt 15-25 Minuten. Diese Zeitspanne können die Gasspeicher in der Regel immer aufnehmen.

Das heißt, Sie haben technisch keinerlei Veränderungen an ihren BHKWs vorgenommen?

Herr Weng:

Nein. Es bleibt alles gleich, die einzige technische Veränderung ist ein Zusatzmodul, ein elektronischer Baustein, welcher das Signal des Direktvermarkters empfängt und unser BHKW dann runter regeln kann. Von den 850 kW unserer Anlagen wollen wir 650 kW als Spanne nutzen.

Also geht es bei Ihnen auch nicht darum durch zeitliche Verlagerung der Produktion die höheren Strompreise auszunutzen durch zusätzliche Anlagenkapazitäten?

Herr Weng:

Nein!

Welche Gründe hat dies? Wäre das zu kostenintensiv bzw. die Investitionskosten zu hoch?

Herr Weng:

Genau. Es ist auch keine Maßnahme in dem Bereich geplant, da unsere Anlagen sehr schön rund laufen. Von daher ist nur die Teilnahme an der negativen Sekundärregelung und die Nutzung der Managementprämie geplant.

Wie hoch in etwa sind die Mehrerlöse, die Sie sich versprechen?

Herr Weng:

Was die Managementprämie angeht ist es relativ einfach und genau zu kalkulieren:

Bei ca. 7 Millionen erzeugten kWh jährlich rund 0,15-0,18 ct./kWh (entspricht 10.500-12.500 € pro Jahr)

Was die Sekundärregelung angeht sind das in etwa 50.000 € pro MW. Für unsere 650 kW bedeutet dies Mehrerlöse von 30.000-40.000 € pro Jahr, je nachdem wie geschickt der Vermarktungspartner die Regelenergie an der Strombörse vermarktet.

Bei meinen Recherchen nach Anlagenbetreibern die das Marktprämienmodell bereits nutzen hatte ich wenig Erfolg. Wissen Sie von Kollegen die bereits flexibel produzieren?

Herr Weng:

Zukünftig werden einige einsteigen, bisher schon nutzen tun es die Allerwenigsten.

Wir werden zu 01.07.2012 in die Direktvermarktung wechseln, demnächst wird dies wohl auch die Mehrzahl der Anlagen tun. Von daher gibt es in ein paar Monaten wohl den interessanteren Austausch. Im Moment wird Ihnen jeder ähnlich viel oder ähnlich wenig sagen können wie ich. Wenn die ersten Zahlungsströme gelaufen sind kann man wohl deutlich mehr sagen.

Appendix I

Interview mit Herrn Sebastian Fenner, Betreiber einer Biogasanlage und Gründungsmitglied der Genossenschaft deutscher Grünstrom Erzeuger (GDGE) zur Direktvermarktung von Strom aus Biogasanlagen

24-05-2012

Bitte stellen Sie sich kurz vor, wie Sie im Bereich Biogasverstromung tätig sind und Ihre Funktion bei der GDGE.

Herr Fenner:

Ich bin Landwirt und wir betreiben seit 2007 eine Gemeinschafts-Biogasanlage. Zudem bin ich freier Mitarbeiter der Firma MT Energie im Vertrieb, und mit unserer Biogasanlage sind wir Gründungsmitglied bei der GDGE. Seit dem 1.01.2012 nehmen wir mit unserer Biogasanlage an der Direktvermarktung von Strom aus Biogas teil.

Zur GDGE: Es ist ein genossenschaftlicher Zusammenschluss von Anlagenbetreibern erneuerbarer Energien mit dem Ziel möglichst viele Anlagen zu bündeln um eine möglichst gute Marktposition zu erreichen und diese letztendlich mit einem Vermarktungspartner zu bestmöglichen Konditionen vermarkten zu können. Alle erneuerbaren Energien sind in der GDGE vertreten, den größten Anteil hat wahrscheinlich die Windkraft.

Bitte beschreiben Sie etwas detaillierter Ihrer Biogasanlage und Ihren Einstieg in die Direktvermarktung

Herr Fenner:

Wir haben eine 537 kW Anlage, mit der wir als Gündungsmitglied der GDGE seit Anfang 2011 dabei sind und haben uns dann im November 2011 umgemeldet zur Direktvermarktung, beginnend am 1.1.2012. Das Ummelden hat problemlos geklappt, lediglich der Netzbetreiber hat am Anfang etwas länger gebraucht um die Marktprämie zu bezahlen, da auch er gerade sein System umgestellt hatte. Mittlerweile funktioniert dies jedoch problemlos.

Für Ihre Anlage: Welche Prämien und Anreize aus dem Marktprämienmodell nutzen Sie?

Herr Fenner:

Aktuell nutzen wir nur die Marktprämie, einschließlich der Managementprämie. Darüber hinaus sind wir momentan dabei eine Schnittstelle zu installieren um in der Zukunft auch am Regelenergiemarkt teilzunehmen. Bisher haben wir also an der Anlage nichts umgebaut. Flexibilitätsprämie oder positive Regelenergie können wir zur Zeit nicht machen, da wir momentan keine Leistung vorhalten. Bis Ende des Jahres haben wir vor an der negativen Sekundär-Regelenergie teilzunehmen.

Das heißt, dass sich im Betrieb, in der Fahrweise des BHKWs, hat sich nichts geändert?

Herr Fenner:

Nein, bisher überhaupt nichts. Wir fahren die Anlage weiter wie gehabt. Das Einzige ist dass sich die Zahlungsströme etwas verändert haben. ¾ der Vergütung kommt weiterhin vom Netzbetreiber, ¼ von der GDGE in Form der Marktprämie.

Das heißt auch, dass keinerlei technische Veränderungen in der Anlage bisher vorgenommen wurden?

Herr Fenner:

Bisher nicht, wir sind aber gerade dabei die Datenschnittstelle zur Leistungsregelung zu installieren, dies ist aber noch nicht abgeschlossen. Das dient der Regelbarkeit aber auch dazu dass der Vermarkter direkte Einsicht auf die Menge des von uns eingespeisten Stroms hat. Bisher bekommt er dies nur online vom Netzbetreiber 24 Stunden später mitgeteilt. Das heißt er (der Vermarkter) weiß momentan nicht ganz genau wie viel er verkauft. Wir geben zwar an wie viel wir produzieren. Ob das auch so stimmt, erfährt er erst am nächsten Tag.

Haben Sie vor, Ihre Motorenleistung zu erweitern?

Herr Fenner:

Ja, das haben wir vor, allerdings ist nicht geplant einfach einen weiteren Motor hinzuzufügen. Vielmehr gibt es Überlegungen diesen Schritt in 1-2 Jahren zu gehen wenn eine große Revision bzw. eine Austausch des jetzigen Motors ansteht. Dann gibt es Überlegungen einen größeren Motor einzubauen, ca. 800 kW der dann flexibel gefahren werden kann. Es ist angedacht aber bis dahin ist noch ein bisschen Zeit.

Ihnen schwebt also eine Erweiterung von jetzt 540 auf 800 kW vor? Etwa in dieser Größenordnung?

Herr Fenner:

Ja, das trifft es in etwa denn bei dieser Größenordnung müssten keine anderen baulichen Maßnahmen an der Gesamtanlage getroffen werden.

Wäre ein zusätzlicher Speicher in diesem Falle dann auch angedacht?

Herr Fenner:

Nein, für diese Größe ist unser Speicher ausreichend.

Was war für Sie die Hauptmotivation für einen Einstieg in die Direktvermarktung und welche Vorteile versprechen Sie sich?

Herr Fenner:

Wir haben stets versucht, die Erlöse der Bestandsanlage weiter zu optimieren. Dabei sind wir nun an eine Grenze gestoßen, wo dies nicht mehr möglich war. Daher kam die Geschichte mit Direktvermarktung und besonders Regelenergie auf. Die Hauptmotivation ist natürlich mehr Geld zu verdienen. Darüber hinaus ist auch eine Motivation, die erneuerbaren Energien stärker zu positionieren, besonders die regelbare Biogas Verstromung. Biogas ist regelbar, behauptet *dies auch schon lange von sich und muss dies nun auch tun, auch im Lichte der angestrebten Energiewende. Primär geht es jedoch natürlich ums Geld*

Haben Sie im Vorhinein Berechnungen gemacht bezüglich höherer Wartungskosten, höherem Personalaufwand etc.?

Herr Fenner:

Richtige Kalkulationen dazu haben wir noch nicht gemacht, bisher läuft das so im Alltagsgeschäft mit. Natürlich habe ich jedoch den Genossenschaftsbeitritt und die Installation der Schnittstelle mit in das Betriebsergebnis einkalkuliert.

Wie funktioniert die Zusammenarbeit mit dem Vermarkter bisher? Gab es Bedenken gegen einen Einstieg in die Direktvermarktung?

Herr Fenner:

Unser Vermarktungspartner ist Energy2Markets, die Zusammenarbeit läuft bisher sehr gut. Die Managementprämie wird 50/50 geteilt. Bedenken gegen einen Einstieg gab es bei unsere Anlage nicht, was auch daran liegt dass wir den Vermarkter persönlich kennen. Außerdem kann man ja jederzeit wieder zurückwechseln zum EEG Modell.

Ab welchem Mehrerlös lohnt sich ihrer Ansicht nach der Einstieg in die Direktvermarktung?

Herr Fenner:

Ohne eine Motorenerweiterung wären bei unsere Anlage unter Ausnutzung der Marktprämie, Managementprämie und negativer Sekundärregelung wohl so zwischen 20.000-30.000 € möglich. Dies sollte es dann auch sein, weniger wäre unattraktiv. Die Markt- und Managementprämie allein ist langfristig nicht attraktiv genug.

Würden Sie eine Beschränkung auf die Markt - und Managementprämie und/oder auf die negative Sekundärregelleistung als Mitnahmeeffekt beschreiben?

Herr Fenner:

Das würde ich nicht als Mitnahmeeffekt beschreiben, zumindest im Biogasbereich nicht, da ja die Managementprämie so gering ist. Da kann man nicht von Mitnahmeeffekt sprechen.

Die Teilnahme an negativer Sekundärregelung würde ich auch nicht als Mitnahmeeffekt beschreiben, denn diese wird ja nur abgerufen, wenn man sie wirklich gebraucht wird und jeder tut das was er kann. Natürlich ist es noch besser wenn man die einzelne Anlage positiv und negativ regeln kann, aber wenn das Stromnetz den Bedarf nach negativer Regelenergie hat, dann kann man das nicht als Mitnahmeeffekt bezeichnen, meiner Meinung nach.

Das Optimum ist natürlich eine komplett regelbare Anlage, allerdings lohnt sich hier die Investition in die zusätzliche Motorenleistung eher nicht. Da muss man schon hart kalkulieren, das liegt wohl so gerade an der Grenze. Höchstens, wenn ein Motorentausch ansteht ist dies eine Überlegung wert. Große zusätzliche Investitionen wie ein Gasspeicher tragen sich eigentlich nicht, meiner Einschätzung nach. Abzuwarten bleibt, wie sich die Einführung der elektronischen Stromzähler und damit der Unterschied zwischen HT und NT Strom entwickelt. Eventuell ergeben sich dann weitere Möglichkeiten.

Wie schätzen Sie als Branchenkenner und direkt Betroffener die Stimmung unter Ihren Kollegen ein? Ist man der Direktvermarktung gegenüber aufgeschlossen oder abwartend?

Herr Fenner:

Ich habe momentan das Gefühl dass viele abwarten und schauen, wie es läuft. Bisher läuft es schleppend an. Allerdings ist bei Landwirten das auch jahreszeitlich bedingt, ich könnte mir vorstellen dass das Interesse im Winter größer ist, da dann mehr Zeit ist. Die grundsätzliche Meinung unter den Landwirten scheint aber zu sein, dass dies die Zukunft der Biogasbranche ist. Aber noch haben sich nicht viele dazu entschlossen es selber zu tun, sonder warten erste Erfahrungen bei anderen ab.

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