LUND UNIVERSITY
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Green jobs.

Real employment effects of renewable energies in north-east Germany

by
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Abstract: The very recent catastrophe in Fukushima Japan has led to new incentives for promoting electricity generation through renewable energies in Germany. In this article the economic implications of those incentives for one German federal state, namely Mecklenburg – Western Pomerania, are highlighted. By `diving´ into this region and by applying several different forecasting methods as well as questioning for different scenarios, I here argue, in contrary to of what is often claimed by politicians and environmentalists, that the shift from conventional to renewable energy carriers does not have too many positive economical effects and that it brings relatively few people into work in the next ten years. In the long term however, a more positive picture will show up and the costs will probably equal the gains.

Key words: Energy, Employment, Energy economics, Green jobs, Renewable energy, Mecklenburg – Western Pomerania

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Green jobs.
Real employment effects of renewable energies in north-east Germany

Berlin was so lovely alive,
so electrified with an unordinary electricity.
(Hedwig Baum 1962, own translation)

28.07.2011

1. Introduction

With this short quote, Hedwig Baum describes quite impressively the atmosphere of Berlin in the early 20th century in her Autobiography of 1962. And even if at this point in time she couldn't know anything about actual events, a today's reader might think that she only employs this metaphor to describe the actual political atmosphere in the German government in Berlin.

The terrible catastrophe of Chernobyl in 1986, the accidental melting of the core of the nuclear reactor, has shown how dangerous and harmful energy generation through nuclear power might be. To this day, after more than 25 years, the serious consequences of this tragedy are still visible in Ukraine as well as in other countries. Even in Germany, there is still a higher radiation measurable as for example in the mushrooms of the Bavarian forests due to this happening.

The discussion has risen again very recently due to the horrible catastrophe in Fukushima, Japan, in March 2011, where millions of litres of radioactive water have poisoned the sea and where many people will probably die because of inevitable cancer caused through radiation.

Since then, the German government hectically reconsiders its atom phase-out strategy and is now willing to accelerate this phase-out due to the high pressure of the people. Right now, there is a lot of action and the Chancellor Merkel and the rest of the government seem to be \`lovely alive´ and sort of \`electrified´ with a, for many still, \`unordinary´, namely renewable, \`electricity´.

But the mentioned nuclear power is apparently not the only disadvantageous type of energy. Other types of conventional energies like coal or oil seem to have harmful side effects too and are therefore losing prestige in the German public as well. Long term human induced climate change could be such another example. It has, since the early 1990s, led to many debates and influenced actors and actions in the field of energy politics and beyond.

All of those issues have in turn led to the development of environmental laws (e.g. the Kyoto Protocol on the international level and the Feed-in tariff law for renewable energy (EEG[1]) on the German national level) and the creation of guidelines for firms and even whole countries in order to save energy and to reduce CO_2 Emissions. These laws and guidelines, often supported by huge funds allocated to those willing to help implementing them, are also stimuli for the support and promotion of renewable energies (RE).

By taking furthermore into consideration that many scholars believe that "[r]enewable energy promotes innovation" (Pehnt, M./ Jessing, D./ Otter, P. 2009:18, Nej in lecture 2010) and by understanding innovation in turn as one of the drivers of and contributor to sustainable economic growth (cf. Porter 1985: 47), it might be inferred, so the starting point here, that other positive impacts than "only" securing the environment can be achieved through the promotion of RE. By extending this short line of thought, one may assume that the promotion RE should have had and could have a positive economical impact in terms of job creation and adding value as well.

Economic issues inside the RE field are, of course, first of all interesting for both regional as well as national politicians. Nowadays, job creation, economic growth and well being are always of high political interest.

By taking all the just mentioned into account, not surprisingly, the German government now wants to exceed all the aims of former written self set guidelines and accounts therefore on the help of every federal state, as for example the state of Mecklenburg-Western Pomerania (M-WP). The states in turn, work out and set up guidelines and aims for promoting and spreading energy generation with RE themselves. However, in this study, the research focus shall not lie on the question how much the federal states can help the German government. Instead, the main interest lies in the economic implications of achieving the goals of those self set guidelines. More specific, gross and net employment effects when fulfilling those guidelines and the economic value of these jobs, namely productivity, competitiveness and sustainability will be investigated.

1.1. Previous research

That it is reasonable to assume that the promotion of RE has such a positive economical impact is rather supported in the respective literature. Support can be found both on a national level, for Germany and for other countries, as well as on a regional level, for different German federal

[1] Gesetz über die Einspeisung von Strom aus erneuerbaren Energien in das öffentliche Netz (Stromeinspeisungsgesetz); full text in German: http://archiv.jura.uni-saarland.de/BGBl/TEIL1/1990/19902633.1.HTML.

states or regions and for regions in other countries. Proceeding from a more aggregate state level to a more specific regional level, former studies reveal the following:

Wei/ Patadia/ Kammen study the general employment effect of RE on the US labour market and ask how many jobs the clean energy industry might generate from 2009 – 2030. To answer this question they review 15 job studies, reuse the data and create a model for possible job creations up until 2030. They try a normalization approach by "taking average employment per unit energy produced over plant lifetime" (Wei/ Patadia/ Kammen: 925) and find out that "half-a-million total jobs are generated from 2009 to 2020 and 1.9 million total job-years from 2009 to 2030" (ibid.) for their medium scenario.

For the European area, Blaco/ Kjaer make a study on the employment development in the European wind energy sector (Blaco/ Kjaer 2009). They use surveys and data bases like the Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME), Arbeitsgemeinschaft Erneuerbare Energie (AEE), Danish Wind Industry Association (DWIA), and Federal Ministry of the Environment in Germany (BMU) for their data. By analysing and evaluating them, they predict that the employment in the wind energy sector in Europe will more than double from 154000 in 2007 to almost 330000 in 2020. However, their projections include indirect employment, "referring to the "supplier effect" of upstream and downstream suppliers" (Wei/ Patadia/ Kammen: 921) which might distort the overall picture since we don´t know exactly to what extend each firm supplies either only or just marginally other firms in the sector. For instance, Nordex Rostock produces off-shore cranes. But if those cranes are finally used for the construction of off-shore windmills or the loading of goods in a harbour cannot be said. Therefore, this issue must be discussed further in the methodological part.

In another study, executed by Lehr/ Nitsch/ Kratzat et. al. for Germany, an Input–Output-analysis (I/O) with data gathered from surveys was used and combined with two different policy scenarios for Germany until 2030. The researchers claim that first and foremost due to exports "the employment in the [...] sector could reach more than 400,000 by 2030" and that "net employment effects will be positive" (Lehr/ Nitsch/ Kratzat: 2007:117). Important here is that they distinguish between gross job effects and net job effects, meaning the clearing out of job gains and losses. For them, the most important negative impact on the economy is brought by the so called "budget effect". This means that "additional expenditure on [renewable energies] leads to foregone expenditure in other sectors and to less employment in these sectors (Lehr/ Nitsch/ Kratzat: 115).

By going down on the regional level, three highly relevant studies shall be mentioned: Moreno/ Lopez forecast the "effect of renewable energy on employment [for t]he case of Asturias (Spain)" (Moreno/ Lopez 2006: 732). By using and I/O model for their calculations they predict an increase in employment of 5007 in the relevant sector for the period 2005- 2010. Since it is still too early to know if they were right or wrong, these results can/ must still be treated as predictions. This study is of importance because of the geographical, economical and demographical similarities to the federal state which shall be studies in this paper. However, Moreno/ Lopez only look on gross direct job creation for the three sectors electricity, heating and fuels. This might as well distort the picture as it shows a far too positive result.

The two most relevant studies for the purpose of the present paper however were carried out by Kriedel in 2008 and Hirschl/ Aretz/ Bother in 2011. Kriedel studies employment effects of the promotion of RE in northern Germany. For some reason, he excludes the region which shall be studied here. In general, Kriedel looks at electricity generation through wind energy, photovoltaics and bio-fuels, breaks down the total German generation – employment relationship to the regional level and adjusts this development currently to the predicted rising electricity generation in the two federal states he studies, namely Hamburg and Schleswig-Holstein. He comes to the conclusion that 21200 new gross jobs will be created up until 2020 together in both regions. Due to the geographical closeness, this study might be a good starting point to carry out the research for the state M-WP. However, with his method, Kriedel ignores the specific economic and geographical basic conditions as well as the regional peculiarities of the regions he studies. On the other hand, due to the fact that no database provides the researcher with enough specific information to apply more sophisticated methods until now, Kriedel had few choices for a method. At the same time, his results cannot be proven to be right or wrong do to the just mentioned problem.

Very recently, as one of the first, Hirschl/ Aretz/ Bother specialise on M-WP in their study. This underlines both the growing interest for M-WP as a promising place for RE exploitation as well as the actual relevance for the issue. The researchers take the guidelines set up by the government of M-WP and formulated in „Energieland 2020[2]" and its related, to an even faster development adjusted, follower „Aktionsplan Klimaschutz[3]" as a reference for calculating four different scenarios. With those, Hirschl/ Aretz/ Böther project possible developments for job creation and value added for eight different RE and three types of energy generation: electricity, heating and

[2] Engl.: „Energy land 2020".
[3] Engl. about "Climate protection: Plan of action".

fuels. The researchers calculate the value added effect first with a model for regions and parishes suggested by Hirschl et. al in 2010 and, out of this, derive the employment effects. As a result of their study they predict, with a range from the most pessimistic to the most optimistic scenario, an additional direct gross employment of 5474-9887 from 2010 to 2030 (Hirschl/ Aretz/ Bother: 17,21,33). However, they say very little about any potential disadvantages or net employment effects.

Apparently, there is a broad canon to see positive employment results of the promotion of RE in the near future. Still, there is, more recently, a growing number of scholars finding different and less optimistic results in their studies. Calzada/ Jara/ Julián et al. for instance show that many „net jobs are destroyed by a green job program for each one that it is intended to [be] create[d] (Calzada/ Jara/, Julián et al. 2009: 27). They use two different methods: first, they compare the average amount of "capital destruction" (ibid.) , which is the subsidised part of the investment, necessary to create a green job against the average amount of capital that a job requires in the private sector; second, they compare the average annual productivity that the subsidy to each green job would have contributed to the economy if it had not been consumed in such a way, with the average productivity of labour in the private sector that allows workers to remain employed (cf. Calzada/ Jara/, Julián et al.: 27f.). In the end, they claim that, on average, 5,06 jobs are lost per installed megawatt.

Michaels/ Murphy review respective literature and `dismantle´ weaknesses of former calculations. Even though they do not make a quantitative analysis of job losses, they seem to be convinced that renewable energy jobs are not long term lasting without subsidiaries from the government. This is because of the higher prices per unit of electricity generated from RE. They argue that the state should therefore not go to fast with their promotion and financing: "If a megawatt of solar capacity requires four times the workers as a megawatt of coal-fired power, building the solar plant makes the nation poorer, other things equal" (Pollin et al. in Michaels/ Murphy 2009: 17). Partly true one might say. The problem here is that other things are just not always equal, as for example the so called external costs which are long term costs caused by environmental damage. One might at least think of a scenario where the external costs could equal or even exceed the payment of some more workers per GWh, or just look at Fukushima and Japan. Still, to be fair, this is only the second example where Michaels/ Murphy are surely wrong for now. However, Germany has recently decided not to take such a risk anymore.

A last example for a very critical assessment of job creation in the renewable energy field is a study carried out by Morriss. By looking at qualitative factors as well, Morriss argues that former studies lack clear definitions of what a green job is, that former researchers do often base their results on dubious and simplified economic models and that they often only focus on gross job creation and forget to take into account the negative effects (cf. Morriss 2009: 2).

So, the main arguments of the last three studies are first that, amongst others, due to high prices of RE and the higher labour intensity, the net employment effects are of a negative nature. Second, without state subsidies electricity generated with RE would have no chance to compete on the market and does, therefore, not create sustainable jobs.

The studies which have been reviewed here show very different approaches to model the employment effects of RE. They differ in focus, method and, of course, outcomes, which are specific for the geographical area they research as well. It is, therefore, important too to define the terms used, to choose the most appropriate focus and the most appropriate method for the region M-WP with its specificities.

1.2. Research question and purpose

Following the discussion of the literature, the impact of the public promotion of renewable energies[4] on the labour market in the German federal state of Mecklenburg-Western Pomerania (M-WP) for the period 2010-2020 shall be studied in this paper. It shall be answered "*how many net jobs are likely to be created from 2010-2020 by fulfilling the self given guidelines and of what economical value those jobs are?"* in order to see economic chances of RE for the region and to give valuable council for policy makers to exploit those chances.

The choice fell on this federal state because of two main reasons: first because of the economical backwardness of the region in comparison to other German states. Since most of the literature suggests positive impacts of the promotion of RE, M-WP may have a chance to exploit for growth possibilities. Second, M-WP was chosen because of an above average potential for the implementation of RE due to the Geography of the region. Especially this federal state seems to be able to diffuse RE to a rather high extend. For example, the connection to the sea allows the promotion of off-shore wind energy, the above average of sun hours in respect to Germany may attract photovoltaic industry and the very rural character of the region gives opportunities to peasants who want to produce bio fuels.

[4]Here defined as an attempt made by the German state or, respectively by one of its federal states, to diffuse and enlarge electricity generation through renewable energies with public means like e.g. laws, guidelines, allocation of funds.

The just mentioned properties should allow the researcher to make meaningful assessments about the number and the quality, herby meaning economic value, competitiveness and sustainability, of the created jobs. By combining the geographical advantages, the overall results of the reviewed literature and a faster than expected development of the promotion of RE in the last couple of years, the three following hypothesis could be deducted and formulated:

1) Fulfilling the self-set guidelines for environment protection creates additional gross employment in M-WP and exceeding these guidelines creates even more gross jobs

2) The gains of these gross employment effects will exceed the losses of jobs in the fossil electricity sector

3) Jobs in the renewable energy sector are not as productive as jobs in the conventional energy sector. They are not competitive and are therefore not sustainable without public aid by now, but are likely to be so in the future

How these hypotheses will be tested shall be explained later in the methodological part of this paper.

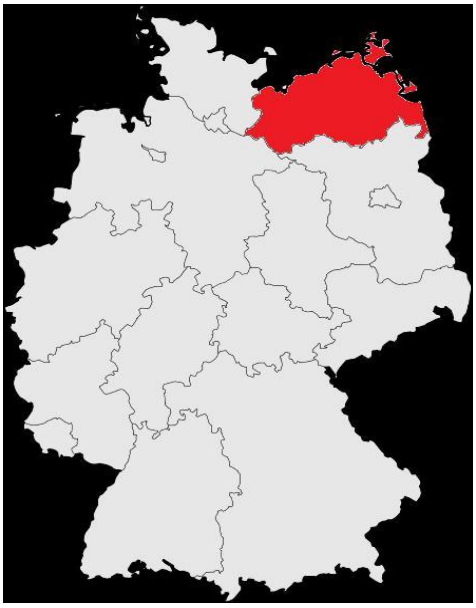
The importance of this study becomes clear rather quickly by looking at the economical facts of the federal state: Mecklenburg-Western Pomerania is, as will be worked out, among the poorest states, or even the poorest state in Germany from an economical point of view. Unemployment is usually high and bringing people back into the work one of the greatest concerns for policy makers. This study might contribute to the public discussion and show what effects for the economy and for the people the public promotion of RE could have. In the end, the outcomes may help policy makers to make reasonable decisions and to adjust their decision making towards a positive direction.

The paper consists of five sections. Succeeding the introduction part, section 2 presents the region which is studied here. In this part, necessary background information for the following sections are given. The following section then describes which methods are used to achieve the above mentioned goal of the study. In the fourth section the survey and calculation results are discussed. Finally, in section five a short summary of the results as well as a conclusion are done. Then the reader will find suggestions and further study possibilities.

2. Mecklenburg-Western Pomerania – facts, figures and self set guidelines

Germany is subdivided in 16 federal states. This work will deal with the federal state of Mecklenburg-Western Pomerania (M-WP) which is located in the north east of Germany, on the coast of the Baltic Sea and on the land frontier with Poland (see following Map 1 & 2).

Map 1: Location of M-WP in Germany



Source: own.

Map 2: Location of M-WP in Europe

Source: http://www.rcbi.info/usr/layout/enpi-cbc-baltic-sea-programme.jpg, adapted.

In 2009, M-WP had a GDP of 35,229 billion Euro[5]. Despite of a continuous amelioration of its performance in GDP, 2,3% per annum[6] since 1995, and GDP per capita since 1991 (from 7536 to 21338 Euro in 2009[7]), the region´s inhabitants are still amongst the poorest, or are even *the* poorest in Germany[8]. The constantly high unemployment, reaching 20% several times this decade[9] and standing at 14,8% in January 2011[10], contributes a lot to this fact.

Since the last heavy blow in the history for M-WP, the fall of the Berlin Wall and the disappearance of the inner German borders and the German Democratic Republic in general, the region suffers of heavy population losses. This but has only intensified a long history of being

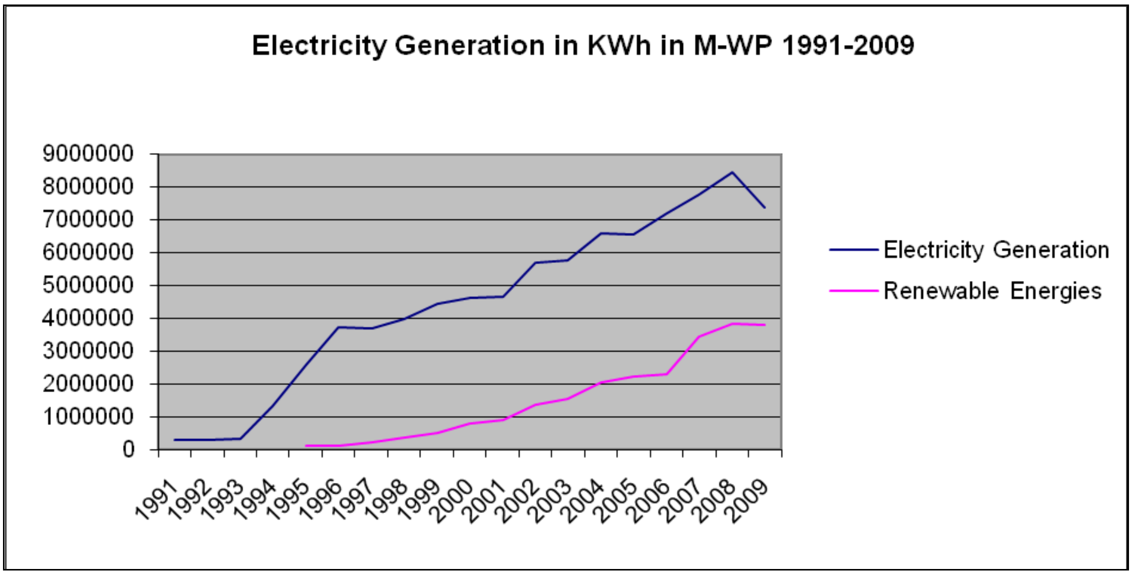
[5] http://www.statistik-mv.de/cms2/STAM_prod/STAM/de/vw/index.jsp.
[6] http://www.sis-online.de, own calculations.
[7] http://www.statistik-mv.de/cms2/STAM_prod/STAM/de/vw/index.jsp; http://www.statistik-mv.de/cms2/STAM_prod/STAM/de/bhf/index.jsp.
[8] http://www.welt.de/die-welt/article3764381/Vorpommern-ist-die-aermste-Region-Deutschlands.html.
[9] http://www.statistik-mv.de/cms2/STAM_prod/STAM/de/er/index.jsp.
[10] http://www.pub.arbeitsagentur.de/hst/services/statistik/000000/html/start/karten/aloq_kreis.html.

sparsely populated in German terms. Today, the land counts for about 1,6 million inhabitants[11], with a strongly declining trend for the next decades (cf. Grüttner 2011: 49).

Despite an at the first glance seeming balanced budget for 2011[12], it becomes obvious rather quickly that this is only possible because of the allocation of funds from the government in Berlin and because of the eating up of savings. Taking this and again the declining population into consideration, which let easily predict a decline of funds since these are also calculated by population, it becomes clear that this budget and the future development of the economy of this region is all but well balanced even in the midterm. This is why policy makers should first of all here attempt to create sustainable and competitive jobs.

A means to achieve this, so the hope of many, is the creation of green jobs in the field of RE, as seen in the literature review in chapter one. In 1990, the federal parliament in Berlin (Bundestag) approves the Renewable Energy Sources Act (EEG). In 1995, apparently after the confusions of the end of the cold war and the restructuring of the eastern German economy and administration, the effects of this law show up in the energy statistics of M-WP. Since then, the absolute amount and the share of electricity generation with RE in M-WP has risen significantly:

Figure 1: Electricity generation in M-WP 1991-2009*



Source: http://sisonline.statistik.m-v.de/; http://sisonline.statistik.m-v.de/sachgebiete/E400404L_Aufkommen_und_Verwendung_von_Elektrizitaet; http://sisonline.statistik.m-v.de/sachgebiete/E400405L_Aufkommen_von_Elektrizitaet_aus_erneuerbaren_Energietraegern.
* for detailed information see appendix table 16-18, figure 3&4.

[11] http://www.statistik-portal.de/Statistik-Portal/de_zs01_mv.asp.
[12] http://www.regierung-mv.de/cms2/Regierungsportal_prod/Regierungsportal/de/fm/Themen/Haushalt/Einnahmen/index.jsp; http://www.regierung-mv.de/cms2/Regierungsportal_prod/Regierungsportal/de/fm/Themen/Haushalt/Ausgaben/index.jsp.

By having a first look into Figure 1, one may be tempted to infer that the Electricity added after 1996 is rather exclusively provided by RE. When then looking into the data, this impression is strongly supported: The additional electricity since 1995 actually is about 95% generated through renewable energies[13].

The next table shows that such a fast development is rather unique in Germany when comparing it with the respective history of other federal states:

Table 1: Share in % of total electricity generation through renewable energy systems in several federal states and Germany 1990 - 2009

(Federal) State/ Year	**M-WP**	North Rhine-Westphalia	Thuringia	Schleswig-Holstein	Germany
1990	**-**	0,3	-	-	3,4
1995	**3,7**	0,7	13,9	-	4,7
2000	**17,4**	1,1	23,3	-	6,2
2005	**33,7**	5,3	25,6	11,7	10,4
2009	**51,5**	5,9	41,6	29,1	16,0

Source: http://www.lak-energiebilanzen.de/sixcms/detail.php?template=liste_indikatorenhttp://www.repowering-kommunal.de/laenderinformationen/sh/.
http://www.amt-neuhaus.de/textonly/Portaldata/1/Resources/stlg_dateien/stlg_dokumente/veranstaltungen/1_EE-Strom_BRD_1990-2010_-_Quaschning_2011-01.pdf.
Personal interview with Dr. Kleider, Dipl. Ing. Roock, Minstery of Economics of M-WP, department for energy economics.

As Table 1 shows, at least up until 2009, M-WP is the only federal state which generates more electricity through renewable than through conventional energies. However, only in 2004, M-WP achieves to produce as much electricity as is consumed in the land[14]. Since then, M-WP has become a net exporter of (renewable) energy[15]. Taking into account the steadily worldwide growing demand for energy, one might see an economic potential here.

By taking the guidelines of the German state as point of departure, the federal government of M-WP has formulated the following quantitative aims, adapted to the specific characteristics of the region:

13 http://sisonline.statistik.m-v.de, own calculations.
14 http://sisonline.statistik.m-v.de/sachgebiete/E400404L/stand/14/Aufkommen_und_Verwendung_von_Elektrizitaet.
15 Personal interview with Dr. Kleider, Dipl. Ing. Roock, Minstery of Economics of M-WP, department for energy economics: exported energy comes from renewables close to 100%

“Increases in electricity generation 2005 – 2020 of

- wind to almost 6-times as high as in 2005 , from 1774 GWh to 10137 GWh,
- biogas to almost 6-times as high as in 2005, from 112 GWh to 598 GWh,
- photovoltaics to 3-times as high as in 2005, from 7.85 GWh to 23.9 GWh and
- other (including biomass and water), from 312 GWh to 505 GWh

and thus

- in renewable energies in total to 5-times as high as in 2005, from 2206 GWh to 11264 GWh.”

In the heat consumption, the share of RE sources shall increase in the same period to 2,5-times as high as in 1995 -fold, from 2.7 PJ to 7.0 PJ, and fuels 2,8-times as high as in 1995 - fold, from 2.5 PJ to 7.0 PJ (Energieland2020: 11).

“High goals” one might say. However, the increases that have occurred since the data collection in 2005 let infer an even faster development than expected (cf. ibid.). Therefore, the development has been adjusted and new goals have been set in “Aktionsplan Klimaschutz”:

- “wind to almost 6-times as high as in 2005 , from 1774 GWh to 10137 GWh,
- biomass and biogas to 1,7 times respectivly 13,4 times as high as in 2005, from 364 GWh to 1930 GWh,
- photovoltaics to18,8-times as high as in 2005, from 7.85 GWh to 150 GWh and
- other (including water), from 65 GWh to 61 GWh

and thus

- in renewable energies in total to 6-times as high as in 2005, from 2206 GWh to 12278 GWh”.

The preliminary present situation for 2010 as well as the respective planned installation of power to achieve the goals are presented in the following table:

Table 2: Installed power in MW-P (in MW)

Technology	Year 2010	Year 2020
wind onshore	1454	2861
wind offshore	53	2975
Photo-voltaics	52	170
water	3	4
biogas	175	211
biomass	105	155

Source: Energieland 2020, Aktionsplan Klimaschutz, Netzintegrationsstudie.

In Table 2 it becomes clear that the lion share of new installation of power will be done in the on and off-shore wind sector. It will therefore be more in the foreground than the other renewable energy types.

Qualitative aims, like reduction of the space heating requirements of residential buildings or expansion of the country as a key location for the research, production and application of environmentally friendly energy technology, were formulated as well (cf. ibid.) but can only be partly integrated into this quantitative study.

3. Methodology

In this study, either due to the constraints of time and space or to the lack of data, it will not be possible to study all factors involved in the subject. Therefore, in this section, it will first be presented what should be included in such a study, then what can and will be included in this study.

Out of the literature the best approach for the present study shall now be derived. By starting again with the articles reviewed in part 1 of the paper, the following schemes of applied methods and focuses can be derived:

Table 3: Literature summary 1: Method

		Authors								
Type of study	**Type of model**	Wei[16]	Blanco	Lehr	Moreno	Kriedel	Hirschl	Calzada	Michaels	Morriss
qualita-tive	Lit. review & critical assessment	x							x	x
quantit-ative	analytical	x	x			x	X	x		
	I/O			x	x					

With Table 3 it becomes clear that all studies reviewed above can be subdivided into two main types of study, namely qualitative and quantitative. Furthermore, a model type can be allocated to them. While the researchers who did a qualitative study always relied on the literature and its critical assessment, the researchers who did a quantitative study chose between an analytical or an Input/Output (I/O) model. Only Wei/ Patadia/ Kammen combine two types of study and two types of models.

Anyway, the studies do not only differ in their method. Differences can be seen as well in what regards the researchers´ focus. As a summary, the following table shall visualize what has been studied:

Table 4: Literature summary 2: Focus*

Energy type	**Gross employment**			**Net employment**	
	Direct employment	Indirect employment	Exports-imports	Substitution effect	Budget effect
Electricity	1,2,3,4,5,6,7,8,9	1,2,3,6,8	3,6	3,8	3,7,8,9
Heating	3,4,6,9	3,6	3,6	3	3,9
Fuels	3,4,6,9	3,6	3,6	3	3,9

Source: Impetus from Kratzat/ Lehr 2007: 6, adapted.
*Every article was given a number from 1-9 according to its rank of appearance in the literature review section:
Wei = 1, Blanco = 2, Lehr = 3, Moreno = 4, Kriedel = 5, Hirschl = 6, Calzada = 7, Michaels = 8, Moriss = 9. Every number indicates what was studied in the respective article.

[16] In order to make the authors´ names feasible for the table, only the first author of each article is mentioned.

Table 4 shows the different focuses of the studies. The authors did either look at gross employment effects or gross and net employment effects in one or three energy types. Gross employment here means created jobs which have been calculated without taking into account potential job loss effects on the other side of the equation.

By “one job”, one full time workplace of 40 hours per week is meant. The concept of a “Green job” is proposed by the United Nations in their Environment Program where it describes

> "work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute(s) substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution" (United Nations Environment Programme2008: 3).

The gross employment can be further subdivided into direct and indirect employment. Direct employment here describes jobs which are directly involved in either production, such as wind mill turbine construction, or energy generation and plant maintenance, such as repairing – thus all the jobs which are involved directly with either the construction and maintenance of the plant and the energy generation itself.

Indirect employment instead describes jobs which are indirectly involved in the renewable energy field as for example jobs involved in the above mentioned off-shore crane manufacturing or marine divers who search for suitable ground – thus all the workers which are which do not work immediate with the plant. These jobs are very hard to count because, as visible in the off shore crane manufacturing, it is not known how many employees spend how much time on a unit which is then used only for the constructing of a renewable energy plant. For the moment, there are no reliable statistics of to what extend how many workers are involved in which companies in the production of which complementary parts for which renewable energy plants. This problem may be solved by counting average needed jobs for installing one unit of power for the different renewable energy technologies.

Import/export effects concern energy exports as well as plants and/or components exports. Since a positive difference between export and import is expected, import/ export effects are located on the job creation side of the equation. If this expectation holds true, will be tested as well.

On the other side of the equation some scholars have added the job losses which may appear due to the promotion of RE. Job gains minus job losses describe net employment effects. To find out more about these effects, the researchers looked either at the substitution effect or at the budget effect or both.

The substitution effect normally describes the effect that, due to the shift from conventional to renewable energy, new created jobs in the RE only replace former jobs and don't create new net jobs. By assuming that labour intensity per KWh is higher in RE than in conventional energies (CE), the losses should not exceed the created jobs.

The budget effect describes, depending on the researcher, both less investments in other industries due to higher investments in the renewable energy sector and losses of money for the population due to higher prices for the same amount of electricity. Less investment means less employment (Lehr/ Nitsch/ Kratzat: 115), less money for the people means less purchasing power, thus less costumer demand and finally fewer jobs in a weaker market.

Now, seen several concepts of former relevant studies, the most appropriate focus, type of study and model for the present study as well as the most appropriate method to test the hypothesis and to finally answer the research question can be presented. What should be included in such a study has been elaborated by now. What can be studied (focus) here and how it will be done shall be explained in the following:

3.1. What will be researched?

To visualise what will be studied in this paper, the Literature summary 2 may be taken again as a reference:

Table 5: Focus of the present study

RE type	Gross employment			Net employment	
	Direct employment	Indirect employment	Exports	Budget effect	Substitution effect
Electricity	X	X	X	X	X
Heating					
Fuels					

As visualised in Table 5, it shall be tried to estimate employment effects as exact as possible by taking into account all the important relationships involved in RE job creation for electricity. The reason for choosing only one of the three energy types lies in the observable fast development for electricity generation with RE in M-WP (see again Figure 1). A continuing fast development is

expected which might exemplify employment developments and possibilities best. The restriction to only one type allows being more specific as well.
Other than some examples in the literature, the net employment effects will be calculated too. This may result in a realistic picture of what can be achieved or not in the labour market with the promotion of RE.
To be able to see as much potential as possible, the gains of trade in the sector, namely import/ export effects, shall be included in the study as well.
As this description let infer, this study will mainly be of a quantitative nature. Still, in order to critically assess the results and to compare them with those in the literature, qualitative elements will be found as well.

3.2. How will the research be carried out?

It must be acknowledged that even the most relevant studies found do not provide a satisfying approach for the purpose of this study and cannot be just copied thus: For example, Hirschl, Aretz, Böther specialise on direct employment only, for all three renewable energy types found in the literature, namely electricity, heating and fuels. However, they only focus on gross employment effects and thus ignore net employment effects which might cause a too positive evaluation and distort the overall picture. As already indicated and criticised, Kriedels approach is just too simple and therefore probably inexact. For this reason it will not be applied here either. Furthermore, Lehr/ Nitsch/ Kratzat et. al., as another example, look at all of the shown variables but not on the region which is in focus here and use an I/O model for their approach. Thus their approach cannot be just copied either, due to the difficulties with this method which are going to be explained right now.
Since in this study the overall aim is not primarily to review and to ameliorate former studies but to make a proper new one, the present study will mainly be of a quantitative nature as has been said. To do so, an analytical model, relying on actual data has been chosen for several reasons: as just seen, one possible method for doing projections of the development of employment in the renewable energy sector is through an input – output (I/O) analysis. However, due to the constraint of time, it might be impossible to gather all the necessary data. As Wei/ Patadia/ Kammen claim:

> "[i]n practice, I/O models are very complex and can be opaque to understand. Within a larger I/O model there are also disaggregation problems in modeling the employment generated by specific technology types such as solar PV or wind and in isolating the impact of specific policies versus a suite of policies. Collecting data to build an I/O model is highly data and labor intensive, and I/O models also can suffer from time delays between when industry data has been collected and when the I/O model has been run" (Wei/ Patadia/ Kammen: 921).

Since a larger use of RE for electricity generation has started only quite recently, it is very difficult to find complete continuous data reaching further back than 1995, in some cases 1990, especially in the former soviet governed states of Germany due to the quasi nonexistence of environmental policies before 1990. This lack of data excludes other methods, as for example the application of regression analyses, since a reasonable statistical significance cannot be achieved due to the small number of possible observations. Therefore, other models have to be used until enough time has passed to be able to gather and evaluate more data in this subject.

The overall structure is divided into two main steps, which consists of several sub steps. The first is to calculate the gross employment development for M-WP in the renewable energy sector until 2020. The second is to calculate the job losses in the sector until 2020 which leads to the simple equation Xgrossjobs2010-2020 – Yjoblosses2010-2020 = Enetjobs2010-2020. The result can then be discussed.

3.3. Scenarios and assumptions

The just developed formula shall be applied for two different scenarios. Before starting however, it must be clear what `scenario´ shall mean and what its functions are here. "Scenario", coming from the Latin word "scena", English "scene", shall describe a possible future development of something. It can be understood as a "play" with several variables which projects this "scene" into the future[17]. Further, it establishes a causal relationship between the variables and the outcome: if A, then B. Still, it does not *predict* because A is just *one* possibility and if not A, then not B. Instead it does imagine one possible future. The following scenarios are build up upon several assumptions:

- The first assumption is that a growing economy needs more energy and will therefore consume more electricity as well. A full literature review about this issue cannot be done in this study. However, there is apparently a generally accepted supposition that GDP growth and energy consumption are correlated and that the development of the GDP allows drawing conclusions about the development for electricity consumption. Chontanawat/ Hunt/ Pierse for instance, support this assumptions at least for the OECD countries (cf. Chontanawat/ Hunt/ Pierse 2006: 18), Gales/ Kander/ Malanima et al. underline it by studying historical long term developments of energy intensity for the Netherlands, Spain and Italy (Gales/ Kander/ Malanima et al. 2010: 23). However, as a point of departure and to give some more support that the present case is not an exception, this assumption shall be tested for the present study for the period 1991-2009 by calculating the correlation coefficient r (X,Y):

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}},$$

where X is the GDP, Y the electricity consumption of the entire economy (incl. housholds).

Table 6: Correlation coefficient r

	Consumption
GDP	0,78143089 (>99,9%)[18]

Source: own calculations

Even if a rather high correlation was found here with a statistical significance of 99,9%, one cannot be totally sure that the assumption holds true for the present case. However, history has shown that "to some degree the different levels of energy consumption naturally are connected to the size of the economy, basically how many people each country has" (Gales/ Kander/ Malanima et al.: 14). By taking thus into consideration this calculation, the outcome of Chontanawat/ Hunt/ Pierse´s, Gales/ Kander/ Malanima et al. and other´s studies and by thinking logically over it, the first assumption is at least strongly supported. Anyhow, as seen, M-WP has a declining population but produces more and more energy. This has to be kept in mind as well.

- The second assumption is that if more electricity shall be generated, more jobs will be necessary to fulfil the targets set. Unfortunately, due to the lack of data, a similar calculation for this variable which ensures that there is correlation between both variable does not have

[17] Cf. http://oxforddictionaries.com/definition/scenario?region=us.
[18] The statistical significance is derived from Table 8 in Oliver/ Boyd 1963: 146.

statistical significance (< 90%) and will therefore not be taken into account. However, the data shows such correlation for the past in the energy supply sector.

- The third assumption is that all components of a RE plant are produced in M-WP. This assumption has to be done in order to limit the data gathering and calculations to the here studied region. Surely, this assumption is the most unrealistic and has therefore to be discussed further later on.

- The fourth assumption is that the oil price, even if it changes dramatically, does not have a too large impact on electricity generation since the amount of electricity generated through oil is rather neglectable. Further, it is assumed that the price for coal, which is important for the German electricity generation, does not change dramatically. These assumptions are made in order to simplify the calculations and to save time. In case one of the assumptions is completely wrong, the scenarios will have a significantly different outcome which cannot be foreseen by now.

Of course, trends do not last forever. However, since the researched time period here covers the next ten years only, the assumptions made (at least 1,2 and 4) and the developed scenarios appear to be rather of a realistic nature.
By departing from these assumptions, the gross employment shall be calculated in the following way: The self set guidelines presented in section 2 will be used to model three scenarios to forecast the development of electricity generation from 2010 – 2020.

The first scenario is the reference scenario developed in “Energieland 2020”. Here, a GDP growth of 2,0% per year from 2007 until 2020 is assumed. Furthermore, 11264000 KWh shall be generated with RE in 2020. It shall be compared with the following scenario to test the first hypothesis.

In the second, the `optimistic´ scenario, the same GDP growth is expected. However, in this scenario the faster than expected development of RE extension from 2005-2010 shall be used and extrapolated until 2020.

The third scenario is more pessimistic. Moriss warns against “huge growth rates” (Moriss: 26). Therefore, in this scenario, an annual GDP growth of only 1,79%, which is the growth rate of 2000-2009 and maybe thus more realistic than 2,0, will be assumed. In consequence, backed up with the correlation calculation, energy consumption will be less for the entire economy. The expected electricity generation will be adapted to this lower growth by currently adjusting it.

3.4. The data

Data and sources can be classified into three main groups: 1. Primary data from data bases, 2. Secondary dara from respective literature sources and 3. Primary data from a self made survey.
1. Most of the data, primarily the economical data about M-WP and its energy situation, was gathered from the state’s own online data base http://sisonline.statistik.m-v.de. The data used here are part of an annual growing data base which is controlled and adjusted annually to ensure its quality. In case of a lack of background information about the data, it was possible to go ad fontes in the Ministry itself and ask colleagues for specific information about them.
At the same time other quantitative data was used from other public statistical agencies. The “Deutsches statistisches Bundesamt”[19] provides more general economic data both for the German state as a whole as well as for the federal states on the so called “Statics Portal of Bund and Länder” (federal and state governments´ portal), a subdivided part of the former. Since a large number of economists and other researchers are dependent on this agency, it may be assumed that it works very professional and that the provided data doesn´t contain many errors. Moreover, public database guarantees easy access to the existing data.
The very same may be assumed for the data base of the Federal Ministry for Environment, Nature Conservation and Nuclear Safety[20] (BMU), an agency which is very similar in set-up, quality, providing data and access.
To fill up the still lacking data, the online data bases of big German energy enterprises like Eon or EnBW and Vattenfall were used as well. Since those enterprises are highly interested in prices, investments and so on in order to make profit, the data in their data bases can be considered to be relatively exact as well.
2. The projections used which were not self calculated, for example the future population development, were all derived from the literature, namely from Grüttner 2011, respectively

[19] http://www.destatis.de/jetspeed/portal/cms/.

Hirschl/ Arets/ Böther 2011 who used the most actual numbers available. This may, of course, be risky since the second researcher relies heavily on his or her former colleague and will therefore automatically copy eventually occurred errors. It is therefore important to know the former studies quite well in order to understand the researches goal and to see how the data was gathered, sampled and used to avoid bias in their interpretation. Even though there are those kinds of disadvantages, the advantages of this sort of data are obvious as well, namely the profit of saving time one normally does not have to accomplish a study like this without secondary data. Some of the original data used by the former researcher might not even be accessible for the next one, either due to disappearance or legal constraints[21].

Other, less regionally specific literature was used as well to find out more about general relationships. Wissel, Rath-Nagel, Blesl et al. 2008 for example provide that data for necessary investments and costs for renewable energies, Wei/ Patida/ Kammen the data for needed workers per unit of energy.

3. Furthermore, to find out more specific details, a self made questionnaire was made and sent out to energy supply firms. With this, it was attempted to find out more about employees both in the mains operation & administration as well as in the plant operation & administration sector in the energy supply establishments they work in. It was also done to find out more about employment rates and the suppliers´ employment expectations for the future. They were asked about quantity and quality of people employed in the renewable energy sector and future estimations. This data may serve as additionally data to back up and control the projections at the same time. This might be a big advantage for carrying out a more adequate study. Unfortunately, one can never be sure about the number of answers. A non complete answer catalogue could significantly distort the overall picture and/ or create bias. This has to be taken into consideration when interpreting the results.

Finally, it must be acknowledged that, with the exception of the survey, most of the data is taken from 2009/2010: some are even older and thus already obsolete. Whenever possible, more actual data were taken and the projections adjusted to them.

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[20] http://www.bmu.de/english/aktuell/4152.php.

[21] In order to see public and private investments for the last 10 years and planned public and private investments for the next 10 years, after having read his article about economic implications of public off-shore promotion, Prof. Ochsen from the University of Rostock was contacted. He wrote that “[…] with the data, I cannot help you. This data is usually not accessible. I got this part only with special permission”.

3.5. Variables and respective calculation methods

The overall method proposed here can be called "peal the onion" because it starts with counting gross employment effects which are then subtracted by net employment effects. The variables involved and the way to calculate them are the following:

3.5.1. Gross employment

A) Direct employment in energy supply firms: the planned electricity generation through RE in 2020 is taken as the reference. From the overall growth factor of Aktionsplan Klimaschutz from 2010-2020, an annual growth factor could be derived; from this, the electricity generation through RE was counted backwards from 2020 to 2010 for the years in this interval. Then, by looking at how many more jobs were needed to produce the additional electricity from 2000-2010, a relationship between electricity generation and energy suppliers´ employment can be established. The theoretical gross job development could be derived by currently adjusting the employment to the electricity generation. Since no former study about employment in energy supply firms was found, this calculation method differs from the second, for which it was possible to find more data.

In order to get a numerical value for how many people in the energy supply sector work for RE, the number of workers was adjusted to the share of renewable energy production. At the same time this seems to be quite logical because an operator does the same job, regardless which energy flows. Only the amount is of importance for job effects. However, his job must be counted as green one when he works with renewable energy instead of conventional energy. Therefore the decision was made to take the share of RE of the total energy production as an indicator for "green operators". To back up these assumptions, the results of the survey shall serve as well.

B) Direct employment in operation & maintenance and direct and indirect employment in construction & installation and component production: here the planned installed power with renewable energies for each technology was set up for 2020 with the guidelines from Energieland 2020, respectively Aktionsplan Klimaschutz. Then, by taking an average employment coefficient per unit of each technology, derived from about 20 different studies (mostly reviewed by Wei/ Patida/ Kammen and Fankhauser/ Sehheller/ Stern 2008), the gross employment was calculated for direct employment in operation & maintenance (O&M) and direct and indirect employment

in construction & installation and component production. This method has the big advantage that direct *and* indirect employment in construction & installation and component production can and must be summarised in one factor, namely computer integrated manufacturing (CIM), since it is not possible to install a unit of power, or a whole plant without *all* necessary components.
The method to calculate the gross employment can be visusalised as follows:

- Gross employment effects:

- Direct employment
    - energy supply firms
    - plant operation & administration
    - plant construction & installation
- indirect employment
    - component production

Table 7: Gross employment effects: data and calculation methods summary

	direct employment			**indirect employment**
Branch	Energy supply firms	plant operation maintainance & administration	Construction & installation	Component Production
Data	SIS-online Database, Survey	Aktionsplan Klimaschutz; Fankhauser/ Sehheller/ Stern, Wei/ Patida/ Kammen	Aktionsplan Klimaschutz; Fankhauser/ Sehheller/ Stern, Wei/ Patida/ Kammen	Aktionsplan Klimaschutz; Fankhauser/ Sehheller/ Stern, Wei/ Patida/ Kammen
forecast	Currently adjusting to electricity generation	Jobs needed for untis of installed power	Jobs needed for untis of installed power	Jobs needed for untis of installed power
		O&M	CIM	

In Table 7 it is shown which variables are involved in the gross employment effects and where the data for each variable come from. Different kinds of jobs are indicated for (branches) as well as the forecasting method for each variable.
As already indicated, no study which dealed with the first column was found yet, maybe because it is generally not expected that new jobs will be created there. However, the last ten years have shown different results: in this period, where the electricity generation has risen of about

172,12%, an annual employment growth of 3,38% could be observed in the energy supply firms in M-WP. If the overall amount of energy generation shall be doubled or more in the next ten years, a similar growth rate must be expected though.

After those calculations, to calculate the net employment, growth limiting factors such as technical limits, limit of installation capacity, demand, budget effect, gross job reducing effects like a learning curve or substitution effects will be added to the former results.

This method makes it easy for the reader to follow the steps and easy for the researcher not to lose the red line. It seems to be the most appropriate method for this study because of the availability of respective data and the feasibility for the regions characteristics as well. It allows further to test each of the hypothesis.

3.5.2. Net employment

- Learning curve
- Substitution
- Budget (costs)
  - Personal budget
  - Industry budget
  - Public budget

A) Learning curve

In the currently adjustment for jobs in the energy supply sector, one must not forget the technical progress which happens throughout the years. Therefore, in a next step, it shall be calculated how many workers are needed to generate 1 GWh from 2000 to 2009 for each year. A first learning curve (LC1) can be derived out of this by continuing this calculation and by currently adjusting the result annually up until 2020 with the electricity generation prediction set up in “Energieland 2020” respectively “Aktionsplan Klimaschutz”. A possible formula might be the following:

$$\mathbf{LC1} = \frac{\text{(worker/ GWh generated electricity)}}{y,\ y+1,\ y+2\ \ldots\ y+n}$$

y = base year 2000; year 2000 because no data is available before this date here 2000-2010 – declining factor of 0,0163 (1,63%). For data see appendix table 21.

A second learning curve (LC2) of worker needed per install one unit of power will be webbed into O&M and CIM employment effects with the help of an expected technical progress proposed by Staiß (in Lehr/ Nitsch/ Kratzat et al. 2008: 115, see appendix table 22).

B) Substitution

As mentioned, it is likely that a shift from CE to RE produces employment substitution. To see how big this effect will be, again, the self set guidelines serve as a reference. The substitution effect can be calculated by following the already proposed method for employment effects in the energy supply firms, namely adjusting employment currently to electricity generation and by then calculating the job losses in the CE sector in the same way. Therefore the job losses due to substitution should be calculated by generation loss in the CE sector.

To calculate the substitution of all the other directly and indirectly involved jobs, it could be calculated how many workers are needed to produce one unit of electricity within the CE electricity mix of M-WP. Then, the reduced amount of electricity and the needed workers could be subtracted from the gross employment.

The problem here is, that there are no visible guidelines for substituting conventional energy generation with renewable one. Instead, as far as it seems, energy generated through renewables shall only be added. In consequence, this would mean that there won´t be any job losses on the other side of the equation. Therefore, the job losses due to the substitution effect are expected to be zero or at least so marginal that they can be neglected.

However, to back up this assumption again, in the survey it was asked how many people are employed in the RE. Then, the interviewee was asked to estimate how many jobs have been created in the renewable energy sector and if those new places were filled with existing or new personal.

With this method, the general substitution effect can be exemplified by the development of the energy supply firms.

C) Budget

A more complicated picture shows up by trying to estimate the budget effect(s). While in the literature only defined as the budget of single persons (private) or the public budget for investments, in this study the industrial budget is meant as well.

First, the personal costs will be calculated. How much less money has a person in the end of the day because of clean but more expensive energies? To calculate the private and the industrial budget effect, the expected amount of household electricity consumption will be derived from Grüttner 2011, the expected amount of industry electricity consumption currently adjusted and projected to 2020. Then the price per unit without apportionment (the price without RE carriers) will be multiplied with the units of consumption and subtracted from the price for the units of electricity with apportionment. Here, a learning curve (LC3) for the apportionment will be derived from the literature to forecast possible developments for 2020. Additionally, the costs of the extension of new necessary grid, often forgotten to be taken into account, must be calculated as well for a more exact understanding of this effect. The outcome describes the additional costs for households, respectively the industry in M-WP.

Finally, the public investments for the next ten years shall be calculated by extrapolating the necessary investment for one unit of electricity for each of the renewable technologies respectively.

The net employment effects (without learning curves), the data and the respective calculation method are summarised in the following scheme in Table 8:

Table 8: Net employment effects: data and calculation methods summary

Effect	**Substitution**	**Personal Budget**	**Industry Budget**	**Public Budget**
Data	Survey, Energieland2020, Aktionsplan Klimaschutz	Wissel, Rath-Nagel, Blesl et al., sis-online.de	Grüttner, Aktionsplan Klimaschutz, sis-online.de	Grüttner, Aktionsplan Klimaschutz, Hirschl/ Arets/ Böther, Vattenfall, EnBw
forecast	answers survey, electricity gen with conventional energies	currently adjusting to consumption	currently adjusting to consumption	Cost per installed MW times planned installation

Where it was possible, the specific data for M-WP has been used. The data for investments however, is derived from the general German pattern.

After having calculated all the costs, it must not be forgotten to add some gains of Import and Export which will be done as shown in table 9.

Table 9: Import/export: data and calculation methods

Product	Electricity	Plants	Components
Data	Sis.online	-	-
forecast	Currently adjusting El Gen – El Cons	-	-

As can be seen in Table 9, the amount of electricity imported, respectively exported per annum will be offset against each other. Possible losses or gains can then be estimated. The table shows furthermore, that, unfortunately, it was not possible to gather enough data to make reliable statements about plant and component import/export relationships. Therefore, this has to be worked out in another study.

In order to save time and to avoid the multiplication of the scenarios, the net employment effects costs will only be calculated for the second and the third scenario, since the first scenario can be considered to be obsolete and only served to test the first hypothesis. Thus, two possible outcomes for each of the three variables will appear.

Now, after having found the most appropriate method for the purpose of this study, the calculation results shall be presented, evaluated and discussed in the next section. As well, the labour intensity of generating electricity through renewable energies and through conventional energies will be discussed. This shall be done in order to see how much more or less efficient the jobs are in the different energy sectors in the economy. This issue is of a high relevance when it comes to be able to forecast costs and the impact of the branch on the GDP. It shall be tested in order to see if Morriss is right by claiming that "[g]reen job models are built on promoting inefficient use of labor, favoring technologies because they employ large numbers rather than because they make use of labor efficiently. In a competitive market, factors of production, including labor, earn a return [are] based on productivity" (Morriss: 34).

4. Results and discussion

Before interpreting now the results, it shall be acknowledged again that all projections must be treated with care as history has shown for all kinds of studies. During the calculations, it became obvious that marginal changes in one of the parameters inside and outside the scenarios can already cause strongly diverging results. It is therefore, and especially in the rapidly changing environment of RE, quite hard to really predict something. Still, the calculation results can show what may happen and what might be done to achieve growth and well-being.

4.1. Gross employment effects

Already after having done only the first part of the calculations, namely the quantitative study of gross job effects, three things becomes obvious rather quickly. First, the guidelines assume a quintuplication or more of renewable electricity generation in only one decade. This appears to be hard to pursue already for the mid- and even impossible for the long term. However, for the next ten years only, this aim set by the government of M-WP seems to be achievable and even, as the development for the last four years has shown, surpassible. By comparing the expected development with Grüttners study, who predicts even faster developments in each of his scenarios compared to the present, this study still appears rather to be cautious (Grüttner: 25).
The second point which becomes clear quickly is that, the first hypothesis made, 1) “Fulfilling the self-set guidelines for environment protection creates additional gross employment in M-WP and exceeding these guidelines creates even more gross jobs”, is strongly supported by the projections.

The different scenarios show a possible gross job gain from about 556 to 659 (table 13 Sc2, appendix table 19 Sc1, table20 Sc3) only for the electricity supply sector, depending on GDP growth and added electricity generation through RE. And even if in Sc2 and Sc3 the guidelines will probably not be fulfilled, gross jobs are created anyhow. Exceeding the guidelines and following the pattern of the last four years, would mean even bigger gross employment effects in the sector (ibid.).
The very same counts for the jobs outside the energy supply sector, namely CIM and O&M as can be seen in the following tables:

Table 10: Estimated employment in Renewable Electricity sector in 2010 in M-WP*

Technology	CIM	O&M	Total
wind onshore	1405,7	364,9	1770,6
wind offshore	61,3	15,9	77,2
Photovoltaic	2028,2	132,7	2161
biogas	58,2	149,9	208,2
biomass	35,4	91,3	126,8
Sum	3589,0	754,9	4344

Source: own calculations
*without suppliers

The actual employment in RE in M-WP has to be estimated because there are no reliable data available for now. The local wind energy network talks about 4000 employees in the sector[22] but nobody knows who is included in there and to what extent. By looking at Table 10, this number is hard to convey. The next table however shows the here estimated employment in 2020.

Table 11: Estimated employment in Renewable Electricity sector in 2020 in M-WP*, Sc 2**

Technology	CIM	O&M	Total**
wind onshore	2218,2	575,9	2794,1
wind offshore	4589,9	1191,6	5781,5
Photo-voltaics	3561,0	233,1	3794,1
biogas	57,9	149,1	207,0
biomass	44,6	114,9	159,6
Sum	10471,7	2264,6	12736,3

Source: own calculations
*without suppliers
** 2015 as base year for labour coefficients

[22] http://www.wind-energy-network.de/

As can be seen in Table 11, about 12700 people will work in O&M and CIM in 2020 in M-WP. The installation of the planned power would thus mean an additional jobs need of 8392,3 from 2010 -2020. So, taken this and the jobs in the energy supply sector together, 9000 gross jobs can be estimated to be created, other than in Hirschl/Ahrets/Böther´s 5500-10000, here direct and indirect employment is meant together. This result is already here far under what is expected by them, as well as even more far under the 21000 direct and indirect jobs estimated in Aktionsplan Klimaschutz (Aktionsplan Klimaschutz: 4).
As expected, those new jobs are mostely created in the off shore and on shore wind sector, as well as in the photovoltaic industry. The other RE energy sources do not have a significant impact: in the biogas production some jobs may even be lost due to the learning curve.
A third result worth mentioning is that the electricity generation through renewable energy carriers is apparently not so much dependent on the GDP growth and even less dependent on the overall electricity consumption in M-WP. Quite often, when more energy shall be generated, this is due to more need of it. In the case of M-WP however, after 2005, this relationship seems to be uncoupled due to the fact of orientation to the guidelines set, not to the need of additional electricity. Therefore, for the fulfilling of the guidelines and the gross job creation, scenario 3 seems to be irrelevant here as well. For sure, it will be relevant again when it comes to consumption later on. As well, it is reasonable to ignore scenario 1 from now on, since it is already obsolete and was useful just for answering hypothesis 1, which has been done already.
However, testing this first hypothesis does not say anything about the likelihood to achieve those high growth rates. In consequence, they do neither say anything about real employment effects nor about the economical value of the jobs created. Therefore, net employment effects, as well as hypothesis 2) “The gains of these gross employment effects will exceed the losses of jobs in the fossil electricity market” have been tested as well.

4.2. Net empoyment effects

With the results of the net employment effect calculations it is possible to make further remarks:

A) Limiting factors

Before testing hypothesis 2 itself, the limiting factors and their impact on job creation have to be taken into account in order to see if it is possible to fulfill the guidelines. By believing Grüttner again, the maximum installable capacity for renewable energies in M-WP with the technology known right now is about 14000 GWh, without off shore wind[23].

Table 12: Technological capacity for installing RE in M-WP (in GWh)

Technology	today´s use	political aims in Aktionsplan Klimaschutz	technical potential right now with known technologies
wind onshore	2328	3281	8400
wind offshore	0	6586	21600
Photovoltaic	51	150	2600
Water	5	6	14
landfill gas	44	55	400
Biogas	954	1500	2100
Biomass	258	430	600

Source: Grüttner in lecture, results from the not yet published "Energieatlas" 2011

As can be seen in Table 12, from a technical point of view there are apparently no constraints to fulfil or to exceed the self set guidelines. For the next ten years, no limiting factor was thus found here.

Instead a related limiting factor was found: a too slow grid expansion. Electricity might be generated but without an appropriate grid, the produced electricity cannot be fed in, customers do not pay for the electricity and the energy suppliers do not get recompense. This, of course, costs jobs since the guidelines won´t be fulfilled and production will be reduced, To quantify this problem was not possible. Still, it has to be kept in mind.

A sometimes underestimated limiting factor, it does not show up neither in this nor in any other table, comes into the play when trying to spread the use of RE in general, namely public acceptance. It is not possible to discuss here all disadvantages of all kind of RE used in M-WP. However, the noise of windmills and the smell of biogas production indicate the sometimes lacking acceptance of the people. This has to be taken into account.

By thinking further about the issue of job limiting factors, one might be worried that the industry will move out of the state or even out of the country due to higher electricity prices through RE and/ or the fear of unreliable electricity as well. Unfortunately it is hard to quantify this. It was not possible to do so in this study either.

The last main limiting factor which could be found is the not yet solved problem to store the not used energy and to use it when the wind doesn't blow and the sun doesn't shine. This may cost jobs in the energy supply establishments because no stable and reliable mid or long term

[23] Grüttner in lecture 2011.

planning about electricity generation is possible. This issue has therefore to be taken into account as well. Quantification was not possible here because it is not possible to predict amount of wind and sun hours. And even if an average of both would be taken, a calculation would be too vague to make reliable statements. Therefore, such a calculation was left out.

B) Substitution

By starting with the interpretations of the survey results one gets a first idea of trends and substitution effects: With the Ministry in the back it was possible to get 10 answered surveys out 21, a rate of almost 48% in about three weeks. Still, the answers differ quite significantly. Only three out of these 10 have answered rather every question in the questionnaire. This reflects only 14,2% of the overall picture.

Moreover, since the sub regions of the grid providers and energy suppliers differ strongly in size as well as the number of customers, the range of employees does so as well. A quantity range from 30 (Stadtwerke Gevesmühlen) to 1800 (Eon edis) employees could be detected. This is a problem because some small grid providers and energy suppliers do sometimes not have employees in the renewable sector at all.

Further, at least one mistake was made by the researcher himself. Unfortunately, the idea of changing the question “how many people are employed in your `establishment´ in the region” into “how many people are employed in your `enterprise´”[24] was overtaken in the questionnaire. Since most of the interviewees are surely not economists, they do not separate between those two technical terms. So, some answered with numbers of the establishment in the region, others for the whole enterprise. This has to be acknowledged in a next survey for which time was too short in this study. As well, some apparently did not separate there enterprises between energy supplier and grid operators. The by law demanded “unbundling” (EnWG §26) is thus apparently not accomplished in reality.

Due to this, the aim to sub classify the employees into the mains operation & administration as well as in the plant operation & administration sector was not achieved. Apparently, some interviewees did not know that the grid operator and the supply firm are legally not allowed to be one entity[25]. Some thus answered that they are such and that they cannot sub classify the employees further.

[24] The German equivalents here would be `Betrieb´ and `Unternehmen´.
[25] See again EEG.

In consequence, and due to the discussed quality of the answers it is not possible to extract any exact numerical information about the region. However, one important issue can be discussed further here, namely that the restructuring of jobs, here meaning the allocation of already employed people to tasks with renewable energies – in other words substitution – is not so significant: Most of the answers show the general expectation that a positive trend in form of new employees will continue or start respectively. This supports the positive outcomes of the calculation results exemplified with scenario 2 in Table 13 to some extent.

Table 13: past and projected electricity generation, consumption and employment in the energy supply sector, Sc 2

Sc2 - GDP 2,0%		Electricty generation in KWh			Consumption in KWh			Employment energy suppliers	
Year	GDP in 1000€*	Total M-WP	RE	share of RE in %	Total M-WP	Households	Industry	Total	RE
1995	27359	2583305	95101	3,68	5394121	1973745	3420376		
1996	28372	3741461	129663	3,47	5560489	2115441	3445048		
1997	28909	3674520	216898	5,90	5547930	2100210	3447720		
1998	28993	3977892	348151	8,75	5652203	2135687	3516516		
1999	29792	4456732	491833	11,04	5703862	2174384	3529478		
2000	30061	4632176	805141	17,38	6018247	2137497	3880750	2006	349
2001	30658	4649628	893313	19,21	6303688	2254828	4048860	1877	361
2002	30878	5695374	1349710	23,70	6509854	1945474	4564380	1826	433
2003	31118	5780646	1534160	26,54	6746815	2318665	4428150	1946	516
2004	31837	6577260	2029610	30,86	6572471	2184652	4387819	1876	579
2005	32230	6554506	2211853	33,75	6617463	2168600	4448863	3245	1095
2006	33059	7202253	2308137	32,05	6483739	2236911	4246828	2993	959
2007	34781	7762068	3435716	44,26	6579182	2153821	4425361	2927	1296
2008	35695	8439009	3841450	45,52	6720590	2090708	4629882	2853	1299
2009	35229	7372326	3796488	51,50	6488815	2179110	4309705	2198	1132
2010	35934	7972772	4223973	52,98	6533720	2166351	4367369	2252	1193
2011	36652	8622123	4699592	54,51	6588715	2150934	4437781	2311	1259
2012	37385	9324360	5228766	56,08	6644173	2133391	4510782	2371	1329
2013	38133	10083792	5817525	57,69	6700097	2116379	4583719	2432	1403
2014	38896	10905077	6472578	59,35	6756493	2101493	4654999	2495	1481
2015	39674	11793252	7201391	61,06	6813363	2087140	4726223	2560	1563
2016	40467	12753765	8012267	62,82	6870712	2072786	4797926	2627	1650
2017	41276	13792508	8914448	64,63	6928543	2058432	4870111	2695	1742
2018	42102	14915852	9918215	66,49	6986861	2043547	4943314	2765	1839
2019	42944	16130689	11035006	68,41	7045670	2028130	5017540	2837	1941
2020	43803	17444326	12277548	70,38	7104974	2011650	5093325	2911	2049
2010-2020								**659**	855

Source: Energieland2020, Aktionsplan Klimaschutz, Grüttner, sis-online, own calculations

* until 2010 in respective prices, after 2010 in current prices

The last two columns in Table 13 show the calculated employment effects in the energy supply firms. As can be seen, the total number of jobs grows only because of the new jobs coming from the RE. The jobs lost in the CE sector are due to its own learning curve.

However, the survey has shown that the estimated job creation of 659 is probably too high, since most of the firms do not count with too many additional employees needed.

Furthermore, the interpretation of the answers do yet not fully confirm, but still strongly support the assumption that in M-WP the substitution effect is rather neglectable.

By summing up now the results of the substitution effect exemplified on the energy supply firms, it can be said that the numerical impact of job losses due to both fulfilling or exceeding the self set guidelines of electricity with RE in M-WP has been and will very likely be only marginal. This supports the respective assumption done in part 3 and strongly hypothesis 2. Furthermore, it refutes thus the substitution arguments of the literature for the state of M-WP in general. However, by extending the frame farer to other German states, it appears to be very likely as well, together with the aims of the federal government, that a significant substitution effect might only be outsourced to those states which close conventional plants and are forced, by laws or guidelines, to import electricity from M-WP. Economic profits and employment gains could thus be kept in M-WP on the one hand, but job losses can be expected in importing states on the other hand.

By considering now the generally higher costs of the more expensive electricity generation trough RE as well, one might anyhow draw conclusions about additional negative numerical effects in M-WP. Therefore, the budget effects have been calculated.

C) Budget effects & costs

The difference costs between conventional electricity and renewable electricity, which results in the so called “apportionment” for households and industry, is calculated by looking at the prices for both goods at the European energy stock exchange in Leipzig and by taking then the difference costs per unit. As show the calculation results, the different budget effects from 2010-2020 for both scenarios will be of a negative nature, standing in line with the development in the past. The following table visualizes the just mentioned.

Table 14: Additional Electricity costs through apportionment* for Households and Industry, sc 2, variant 1&2; sc 3, variant 1&2 (in 1000000€***)**

	Sc2, Variant 1		**Sc2, Variant 2**		**Sc3, Variant 1**	**Sc3, Variant2**
Year	Costs Housholds	Costs Industry	Costs Housholds	Costs Industry	Costs Industry	Costs Industry
2000	8,549988	15,523000	8,549988	15,523000	15,523000	15,523000
2001	9,695760	17,410098	9,695760	17,410098	17,410098	17,410098
2002	10,700107	25,104090	10,700107	25,104090	25,104090	25,104090
2003	14,375723	27,454530	14,375723	27,454530	27,454530	27,454530
2004	15,511029	31,153515	15,511029	31,153515	31,153515	31,153515
2005	19,300540	39,594881	19,300540	39,594881	39,594881	39,594881
2006	24,158639	45,865742	24,158639	45,865742	45,865742	45,865742
2007	26,491998	54,431940	26,491998	54,431940	54,431940	54,431940
2008	28,433629	62,966395	28,433629	62,966395	62,966395	62,966395
2009	32,904561	65,076546	32,904561	65,076546	65,076546	65,076546
2010	54,158778	109,184225	58,491480	117,918963	108,721679	117,419413
2011	62,377090	128,695646	75,282695	155,322331	127,263170	153,593481
2012	64,001721	135,323465	76,802065	162,388158	132,847868	159,417442
2013	63,491366	137,511559	82,538775	178,765027	134,055052	174,271568
2014	65,146298	144,304979	86,161233	190,854972	139,782313	184,873382
2015	64,701332	146,512916	87,659870	198,501370	141,052511	191,103401
2016	62,183581	143,937766	89,129799	206,310798	137,742823	197,431379
2017	61,752968	146,103321	88,512588	209,414760	138,994487	199,225432
2018	57,219314	138,,412799	87,872518	212,562512	130,907024	201,035787
2019	52,731379	130,456047	89,237718	220,771772	122,661102	207,580327
2020	48,279594	122,239789	88,512588	224,106280	114,254511	209,466603
2010-2020	656,043420	1482,682511	910,201329	2076,916943	1428,282539	1995,418214

Source: Own calculations

*for apportionment and its development see appendix table 26

**Household consumption is not expected to change significantly with GDP and is therefore assumed to be nearly the same for scenario 2 and 3

***until 2010 in respective prices, after 2010 in current prices

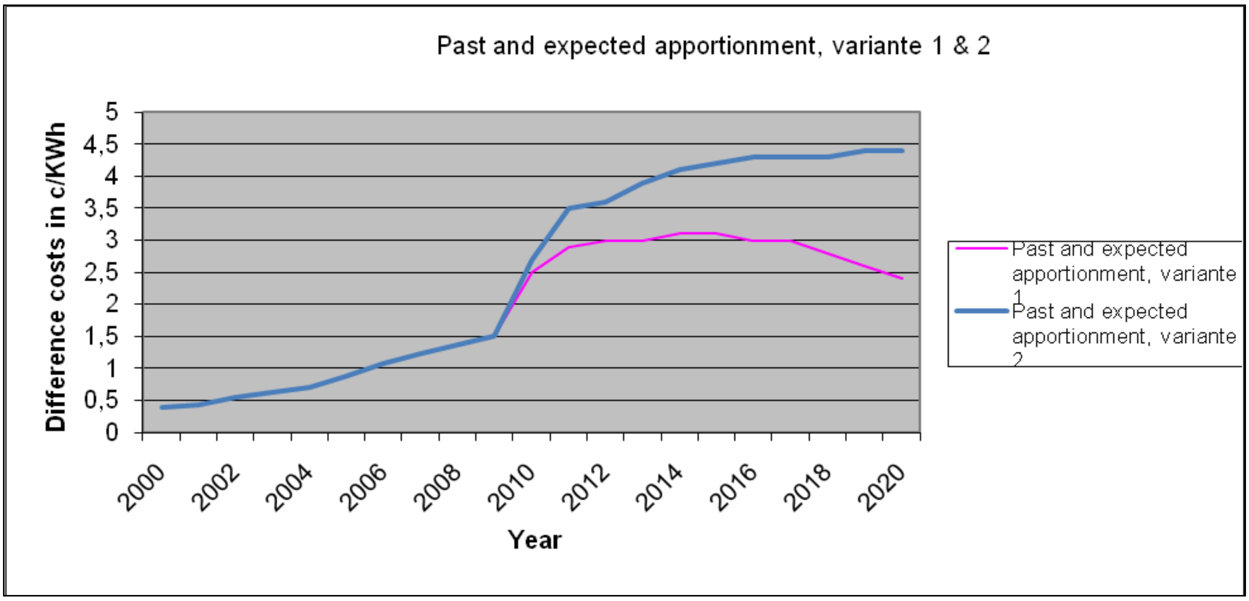
Table 14 shows that the additional amount of money for the renewable electricity caused by higher costs allocated through apportionment to the customers will be around 650 million to 910million € in the next ten years. In other words, every household pays 75 to 104 € more per annum for cleaner electricity. This money will thus be absent in the federal state´s economy and will not be spent for other goods which surely will cost some jobs. Anyway, 65 to 91 million € lacking per annum in an economy with a GDP of currently about 35 billion € might not have an impact which will be felt too strongly in the economy as a whole. However, some jobs will surely be lost in the retail industry since the market will become weaker.

The costs for the industry are of about 1,5 to 2 billion € for the next ten years. Since electricity costs play a rather marginal role in the overall portfolio of firms, these costs should not cause too big problems for the industry either. But still, higher costs always mean that additional possibilities for savings have to be searched. The one or other employee might feel this effect. Some larger enterprises might use this cost argument (maybe as an excuse) for outsourcing their production into cheap labour countries as well. More jobs would be lost in case.

Nonetheless, Table 14 does not show only negative results. The projections for the price differences made by the German Ministry of Environment and Nuclear safety let infer the beginning of a trend. Apparently, over time, the agency calculates with declining costs for electricity generated through RE. This might be called a third learning curve (LC3) to some extend since the energy producers learn to save costs for generating electricity. Still, on the other hand, the difference price between renewable electricity and conventional electricity is highly dependent on the price for conventional electricity itself, thus coal etc. Therefore, this LC3 can only be partly directly influenced (for example with technical progress or large scale production).

The following figure visualizes the here used two variants of the expectations of the difference price development of electricity generated through renewable energies compared to conventional electricity generation.

Figure 2: Learning Curve 3



Source: Federal Ministry for the environment, nature conservation and nuclear safety (BMU)

In Figure 2 the price differences from the past and the BMU expected price differences for the future between RE and CE per unit electricity are visualised. The figure shows a rather jumping increase of the price difference per unit electricity generated from 2009 on. This is due to the bigger amount of energy generated with photovoltaics and off-shore wind, which are, at the moment, still quite expensive. However, with time, those difference costs will probably go down. This curve as well as the learning curves presented in part 3 of the paper are interesting for another reason, as they support the second part of hypothesis 3): Jobs in the sector are not competitive and are therefore not sustainable without public aid by now, but are likely to be so in the future. Public aid is needed to sustain an artificial competitiveness because no form of electricity generated through RE is competitive yet. These necessary compensation costs are the apportionment, payed by private and industrial customers, as just seen.

Why the apportionment is necessary, becomes clear when looking at the newly built and only twelve weeks ago commissioned off-shore sea park "Baltic 1" in the Baltic Sea. The installation of 48MW power had 300 million Euro investment costs, which would mean investment costs of about 6200€/kW. The expected investment costs for the next ten years for M-WP only when fulfilling the guidelines can be visualised in the following table:

Table 15: Investment costs* (in 1000000€)

Year/ Technology	2010	2020	2010-2020
wind onshore	1792,782	3380,986	1588,204
wind offshore	328,600	17403,750	17075,150
photovoltaics	125,146	350,9083	225,761
biogas	8,205	10,652	2,447
biomass	478,625	561,919	83,294
Sum	2733,358	21708,216	18974,858

Source: own calculations, see table 2, 25 appendix
*2010-2020: specific investment cost have 2015 as base year
**until 2010 in respective prices, after 2010 in current prices

As can be seen in Table 15, fulfilling the self set guidelines will cost about 19 billion €, without taking the grid extension cost into account[26]. This frightening amount of money is mostly due to the plans for off-shore wind energy in the Baltic Sea. Of course, these costs are not only taken by M-WP. More or less everything is carried by the participating states and the European Union.

[26] Expected to be of about 1,2 billion Euro (discussion with Dr. Butt/ Dipl.-Ing. Roock).

This additional expenditure on RE however, leads thus to foregone expenditure in other sectors and to less employment in these sectors and makes them probably less competitive as have claimed Lehr/ Nitsch/ Kratzat.

But, as usual, there are savings on the other side of this equation as well. For instance the saving of so called external costs like the penalty payment for the violation of CO2 production limit, set in the Kyoto protocol which supports the critical judgment on the article of Micheal/ Murphy done in chapter one.

Another plus effect are possible exports both of energy and component production. It is known that plant producers of M-WP have an export rate of 70%[27]. Additionally, in Table 27 appendix it can be seen, how much electricity potentially could be exported as well, namely about 52-55 GWh in the next ten years. However, the financial gains with this export can surely be expected to be marginal for M-WP itself, since M-WP does and will not own the big offshore plants in its country due to `foreign´ German and other foreign investments. Furthermore, lots of those financial gains will flow out of the federal state to the headquarters of the big energy firms which are located everywhere but in M-WP.

In the end, it is pretty hard to say exactly how many jobs will be lost on the other side of the equation. Some jobs will be lost here and there but it can be expected, first and foremost due to the fact that CE shall not be replaced but RE only added, that the number of gross jobs does not differ too much from the number of net jobs, in the special case of in M-WP.

4.3. How many net jobs and what is their economic value?

So, to answer finally the first part of the research question "*how many net jobs are likely to be created from 2010-2020 when the self given guidelines are fulfilled"* the scenarios reveal a number of about 9000 on average from which some few hundreds have to be subtracted due to all the net effects mentioned. So, in the end, the study reveals a number of about **8000 jobs** to be created.

Despite the estimations given here, it appears to be very tough to make exact numerical statements about which employment effects should be expected. Nonetheless, the study has shown that the public promotion of RE does in fact create net jobs.

Seen the difficulty of answering the first part of the question, answering the second part "*and of what economical value those jobs are"* becomes even trickier. By comparing the labour intensity

[27] Energieland2020: 13

between renewable and conventional energies, it becomes clear that there is a big disadvantage for the former. When calculating the needed job years to fulfil the self set guidelines by the government, it becomes obvious that electricity generation through conventional energies is almost as double as efficient as electricity generation through RE. To generate the 12278 GWh through renewables, about 8000 jobs would be needed, as seen. Instead, if all this would be generated through coal and/or natural gas, the calculation results show a job need of only about the half which supports again hypothesis (see Wei/ Patida/ Kammen: 922). By looking at this point, it becomes obvious that the economy in fact does become poorer and I have to agree with Morriss critiques that inefficient labour is promoted and that “Economic growth cannot be ordered by Congress. Interference in the economy by restricting successful technologies in favor of speculative technologies favored by special interests will generate stagnation“ (Morriss: 96).

Because of this and because of fewer investments in more profitable sectors at the same time, the economy becomes less competitive. This can cost (many) jobs in the long term because the highly on exports dependent German economy looses competitiveness on a high competitive world market. Only if electricity generation through CE would become more expensive, which, in my view, is not very likely in the next ten years at least, the tide would turn.

It can be said as well that the renewable energy sector cannot bring, as often claimed, overall prosperity. First, is not yet as competitive as the conventional energies and second it neither very labour intense, nor does it have an economic impact to be significant for the entire economy in for example adding value. Fulfilling the guidelines is a good start but it will not help M-WP or the rest of the east to catch up significantly with the south.

However, the economic value of those new jobs however is that more payed jobs generated more taxes. At the same time, social welfare recipients would not have to be paid anymore.

The created jobs in the energy supply firms can be considered to be long lasting and present in the region itself due to the fact that they deal a lot with administration which has to be done and with delivering energy which is always needed. Anyway, their economic value must be expected to be only marginal.

Nearly the same counts for the jobs in plant administration and maintenance. They will be sustained because the functioning of the plants has to be controlled, broken plants repaired. Nonetheless, the economic value of these jobs has to be expected to be very marginal since very few jobs will be needed to maintain these plants.

The jobs in setting up plants can only be considered to be punctual since an installation limit will be reached some day. Thus, these jobs are not of a longer lasting nature. Still, for the period researched here they seem to be of a certain economic importance.

However, at least the component production jobs can probably be considered to be of a higher economic value for an export orientated economy like the German one: other countries might set ambitious aims for electricity generation through RE in the future as well (surely Japan due to recent happenings and maybe Italy due to recent votes) and will probably rely on German products. Therefore, a competitive advantage here can bring export gains, market leadership and keep people employed in the sector. By knowing of course that the same products are cheaper when buying them from developing countries, Germany can only stay competitive with a competitive advantage in technology leadership and quality. In order to achieve these competitive advantages, research has to be enforced.

What has to be acknowledged here is that it was assumed that all the manufacturing for the necessary amount of plants in terms of installation was assumed to be completely done in M-WP. Unfortunately, this assumption done in part 3 of the paper is unrealistic as for example shows the solar panel production which does nearly not take place in M-WP but in its neighbor states like Saxonia-Anhalt. It might even be the case that many components are bought from outside because of lower prices. If so, many jobs, maybe even most of the jobs may fall away additionally.

Some geographically specific indirectly created economical value could be seen nevertheless: M-WP might be a test land, due to its geography for other RE as well like wave energy for instance. Furthermore, the University of Rostock is involved in research and projects of electro mobility. This makes the touristic region more attractive for growing eco tourism, at least for some month per year. According to Franke (2011 in lecture), this eco tourism is of interest for 60% of the German tourists. It would be interesting to quantify influences on the decision making of tourists.

5. Summary and conclusion

In the present study the impact of the public promotion of renewable energies on the local labour market of the federal state of Mecklenburg – Western Pomerania was in focus. After a literature review has been done, the region was presented. Then, the research focus was specified, a research question and hypotheses formulated and the method to answer them elaborated and presented as well. Finally, the hypothesis and the research question were answered, the results presented and discussed.

The study has shown that it is difficult to make exact numerical statements about this issue due to the lack of data. Even though it was tried to be as exact as possible in the gathering data and in calculating, still, the numerical results must be treated rather like rougher estimates which can only be taken serious if all the assumption made here in advance are correct. However, even if no exact numerical results could be estimated, trends could be found and interpreted. Nevertheless, it could be observed that the outcomes of many of the former studies presented in section 1 are far too positive. Often, they just do not take negative factors of RE into account. Some, on the other hand, are far too negative in turn as well since they only account for costs what does not represent the whole picture.

The truth lies, as so often, in between most of the studies. Electricity generation through RE has disadvantages for the economy, but can protect people from great harm. As well, most of the about 8000 net jobs which will probably be created from 2010-2020, in M-WP have the potential to be longer lasting. This number of jobs, and first of all the expected economic value of those jobs for M-WP, are still rather disappointing when comparing it the expectations and promises of many policy makers and scholars. Moreover, as has been worked out, M-WP is a predestinated location for the implementation of RE could in turn mean that implementing and substituting CE in other federal states must be even less successful both in terms of job creation and economically. Still, even though the positive economical effects are quite marginal for the economy, they might be large for bring well being and health. However, as many other parts of the earth show and the present case show, health is not for free and people have to accept noise and smell for this luxury.

Finally, often misinterpreted, with RE not the environment is protected but people. The environment \`doesn´t care´; it just exchanges some ten thousand species, maybe including humans, and goes on with different forms of life. We thus have to acknowledge that we protect us from harm, not anything else. Everybody has thus to decide for him- or herself if it is worth to have a safer life and to accept therefore economical and maybe some personal disadvantages of this.

Some critical voices claim that it is totally useless to force the atom phase out in M-WP or Germany as a whole since right next to its borders we find several active nuclear plants. This is true, but the recent discussion has diminished the acceptance for nuclear power quite remarkably in Europe and it is reasonable to assume that it is just a matter of time that policy makers of neighbour countries will follow the German development at least to some extent due to the pressure of the people.

After all, we saw that the government in Berlin really is lovely alive and that it apparently spreads renewable electric sparks not only throughout Germany and its north-eastern edge, Mecklenburg-Western Pomerania, but throughout Europe as well.

5.1. Implementations for policy and decision makers

According to the present study, the following policy implementations make sense:

First, it might be a good idea not to force the spread of RE too much, but to take away the limiting factors instead. In other words, this but counts for other states than M-WP, to achieve or even to surpass goals, it is important to break down first of all technical barriers. This can only be done through research. This in turn may, according to many theories (see again for instance Porter 1985: 47) lead to a longer lasting competitive advantage.

Second, and this is very important for M-WP, to generate this competitive advantage for a specific region, policy makers should make incentives for respective research and make sure that it’s done in the region itself. Moreover, the outcomes should be protected by law, for example through patents, for having the possibility to exploit them economically. This competitive advantage however will only bring financial gains if RE will be accepted and make their way throughout Europe or even farer. M-WP might for instance constitute a positive example for a geographically similar regions like for instance Skane in Sweden. Germany in turn could be a positive example maybe for Sweden itself which has great possibilities for RE but generates about half of its electricity through nuclear power.

Third, the study has shown furthermore that it is important to produce components in the region in order to create jobs and economical gains there. The in other federal states already existing manufacturing industry for RE must be attracted, for instance by a special tax relief for green jobs or so, since the geographical advantages are apparently not enough.

Fourth, therefore, policy makers should try as well to force acceptance both nationally and internationally. Because of this, it is important to discuss the risks of conventional energies openly, as well as the pros and cons of RE, with representatives of governments and/ or of the renewable energy industry. More acceptance may spread RE and lower prices; lowering prices can and will create even more acceptance. This spiral has to be initiated/ forced.

Fifth and last, policy makers may try to keep energy costs as low as possible by forcing the economy to be more energy efficient, as already initiated in M-WP and formulated in Energieland 2020 and Aktionsplan Klimaschutz.

5.2. Further research possibilities

A study like this has, as seen, many limitations. Therefore, it is desirable to add different studies about related research fields as well to fill up the here generated overall picture: as already indicated, one might for example look at patent registration to learn more about the development of innovations and to be able to make more statements about a long term sustainable competitive advantage.

As well, the `greenness´ of those green jobs might be researched. Since energy generation through RE is more labour intense, this might harm the environment because more people go to work by car or produce more rubbish or so.

Further, it must be acknowledged that all the calculations have been done only for electricity. Apparently, as seen in the literature review, and the present study cannot be excluded from this fact, current research focuses mainly on only this product. Even if a substitution of nuclear power and coal which are still big parts of electricity generation might be achieved in the long run, such an aim becomes far more unrealistic when trying to substitute oil, which is needed nearly everywhere wherever other energy than electricity is needed. Heating and fuel substitution should be stressed more in general since electricity consumption constitutes only one third of the total energy consumption.

As seen as well, a researcher who would extend the frame to calculate job losses in renewable electricity importing states, both on the national and international level might do an important study to see a full picture of substitution effects throughout the country. Moreover, every researcher who helps quantifying not yet quantified issues accounts for a more realistic picture of employment effects of RE.

Finally, new laws like the recently adopted nuclear phase-out law or adjustments in older ones, like the planned modification of the EnWG in 2012, always ask for updates.

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All finally checked: 28.07.2011.

7. Appendix

7.1. Abbreviations used

CE – conventional energy

CIM – computer integrated manufacturing

El gen – electricity generation

El cons – electricity consumption

EnBW – German energy law

Engl. - English

LC - Learning curve

O&M – operation and maintenance

RE – renewable energies

Sc – scenario

7.2. General facts and figures

Table 16: Electricity Generation in M-WP

Year	Total	RE
1991	300152	
1992	288138	
1993	322069	
1994	1319113	
1995	2583305	95101
1996	3741461	129663
1997	3674520	216898
1998	3977892	348151
1999	4456732	491833
2000	4632176	805141
2001	4649628	893313
2002	5695374	1349710
2003	5780646	1534160
2004	6577260	2029610
2005	6554506	2211853
2006	7202253	2308137
2007	7762068	3435716
2008	8439009	3841450
2009	7372326	3796488

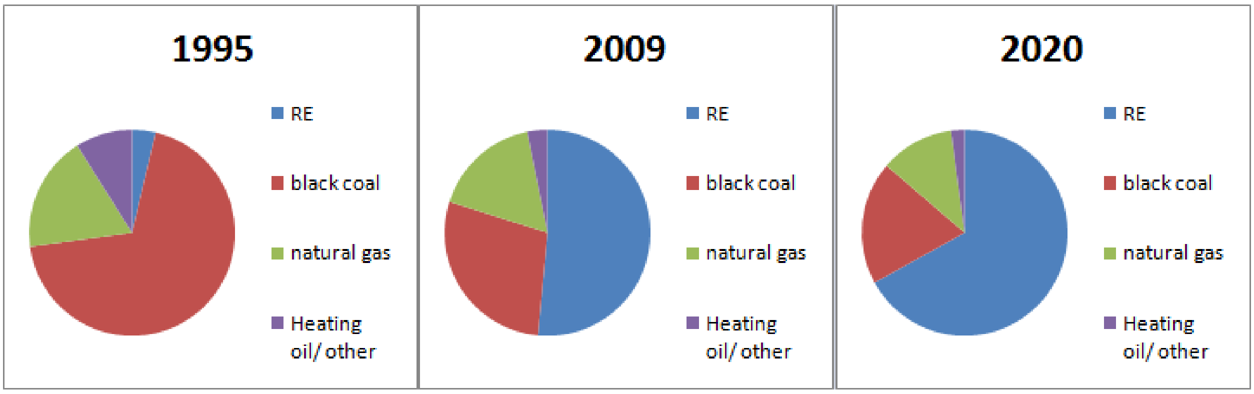
Source: sis.online

Table 17: Past and expected electricity mix in M-WP

	Generated Electricity in MWh		
Energy carrier	1995	2009	2020
RE	95101	3796488	12277548
black coal	1787249	2091525	3539920
natural gas	469618	1251881	2118817
Heating oil/ other	231337	232388	393318

Source: sis-online, Aktionsplan Klimaschutz

Figure 3: Past and expected mix of generated electricity in M-WP



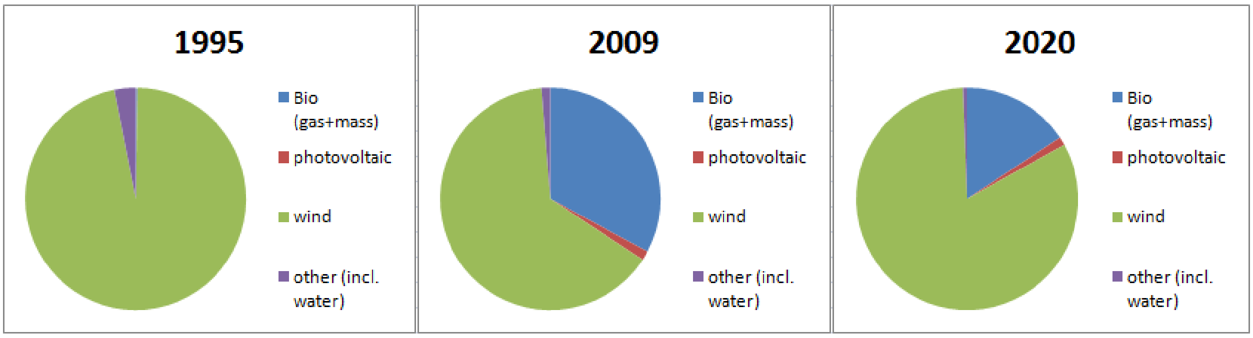
Source: Table 17

Table 18: Past and expected share of total renewable electricity generation

	Share in %		
Technology	1995	2009	2020
Bio (gas+mass)	0,2292	32,5809	15,7198
Photovoltaic	0,0210	1,3654	1,2217
Wind	96,6772	63,7777	82,5653
other (incl. water)	3,0725	1,2610	0,5864

Source: sis-online, Aktionsplan Klimaschutz

Figure 4: Past and expected share of total renewable electricity generation in %



Source: Table18

7.3. Electricity generation, consumption and employment

Table 19: past and projected electricity generation, consumption and employment in the energy supply sector, Sc 3

Sc1 - GDP 2,0%		Electricty generation in KWh			Consumption in KWh			Employment Energy Suppliers	
Year	GDP in 1000€*	Total M-WP	RE	share of RE in %	Total M-WP	Households	Industry	Total	RE
1995	27359	2583305	95101	3,7	5394121	1973745	3420376		
1996	28372	3741461	129663	3,5	5560489	2115441	3445048		
1997	28909	3674520	216898	5,9	5547930	2100210	3447720		
1998	28993	3977892	348151	8,8	5652203	2135687	3516516		
1999	29792	4456732	491833	11,0	5703862	2174384	3529478		
2000	30061	4632176	805141	17,4	6018247	2137497	3880750	2006	349
2001	30658	4649628	893313	19,2	6303688	2254828	4048860	1877	361
2002	30878	5695374	1349710	23,7	6509854	1945474	4564380	1826	433
2003	31118	5780646	1534160	26,5	6746815	2318665	4428150	1946	516
2004	31837	6577260	2029610	30,9	6572471	2184652	4387819	1876	579
2005	32230	6554506	2211853	33,7	6617463	2168600	4448863	3245	1095
2006	33059	7202253	2308137	32,0	6483739	2236911	4246828	2993	959
2007	34781	7762068	3435716	44,3	6579182	2153821	4425361	2927	1296
2008	35695	8439009	3841450	45,5	6720590	2090708	4629882	2853	1299
2009	35229	7372326	3796488	51,5	6488815	2179110	4309705	2198	1132
2010	35934	7972772	4191740,37	52,6	6533720	2166351	4367369	2128	1119
2011	36652	8622123	4627262,19	53,7	6588715	2150934	4437781	2184	1172
2012	37385	9324360	5108034,73	54,8	6644173	2133391	4510782	2240	1227
2013	38133	10083792	5638759,54	55,9	6700097	2116379	4583719	2298	1285
2014	38896	10905077	6224626,66	57,1	6756493	2101493	4654999	2357	1346
2015	39674	11793252	6871365,37	58,3	6813363	2087140	4726223	2419	1409
2016	40467	12753765	7585300,23	59,5	6870712	2072786	4797926	2482	1476
2017	41276	13792508	8373412,92	60,7	6928543	2058432	4870111	2546	1546
2018	42102	14915852	9243410,52	62,0	6986861	2043547	4943314	2612	1619
2019	42944	16130689	10203800,9	63,3	7045670	2028130	5017540	2681	1696
2020	43803	17444326	11264000	64,6	7104974	2011650	5093325	2750	1776
2010-2020								**623**	657

Source: Grüttner, own calculations

*until 2010 in respective prices, after 2010 in current prices

Table 20: past and projected electricity generation, consumption and employment in the energy supply sector, Sc 3

Sc3 - GDP 1,79%		Electricty generation in MWh			Consumption in MWh			Employment energy suppliers	
Year	GDP in 1000€*	Total M-WP	RE	share of RE in %	Total M-WP	Households	Industry	Total	RE
1995	27359	2583305	95101	3,68	5394121	1973745	3420376		
1996	28372	3741461	129663	3,47	5560489	2115441	3445048		
1997	28909	3674520	216898	5,90	5547930	2100210	3447720		
1998	28993	3977892	348151	8,75	5652203	2135687	3516516		
1999	29792	4456732	491833	11,04	5703862	2174384	3529478		
2000	30061	4632176	805141	17,38	6018247	2137497	3880750	2006	349
2001	30658	4649628	893313	19,21	6303688	2254828	4048860	1877	361
2002	30878	5695374	1349710	23,70	6509854	1945474	4564380	1826	433
2003	31118	5780646	1534160	26,54	6746815	2318665	4428150	1946	516
2004	31837	6577260	2029610	30,86	6572471	2184652	4387819	1876	579
2005	32230	6554506	2211853	33,75	6617463	2168600	4448863	3245	1095
2006	33059	7202253	2308137	32,05	6483739	2236911	4246828	2993	959
2007	34781	7762068	3435716	44,26	6579182	2153821	4425361	2927	1296
2008	35695	8439009	3841450	45,52	6720590	2090708	4629882	2853	1299
2009	35229	7372326	3796488	51,50	6488815	2179110	4309705	2198	1132
2010	35860	7892812	4179087	52,95	6515218	2166351	4348867	2252	1192
2011	36501	8450045	4600242	54,44	6539319	2150934	4388385	2302	1253
2012	37155	9046618	5063841	55,97	6561653	2133391	4428262	2354	1317
2013	37820	9685309	5574160	57,55	6584881	2116379	4468502	2406	1385
2014	38497	10369092	6135907	59,17	6610600	2101493	4509107	2460	1456
2015	39186	11101150	6754265	60,84	6637221	2087140	4550081	2515	1530
2016	39887	11884891	7434940	62,56	6664213	2072786	4591427	2571	1608
2017	40601	12723964	8184211	64,32	6691582	2058432	4633150	2628	1691
2018	41328	13622276	9008991	66,13	6718798	2043547	4675251	2687	1777
2019	42068	14584009	9916890	68,00	6745865	2028130	4717735	2747	1868
2020	42821	15613640	10916284	69,92	6772254	2011650	4760605	2808	1963
2010-2020								**556**	771

Source: Grüttner, own calculations

*until 2010 in respective prices, after 2010 in current prices

Table 21: Learning Curve 1: energy supply

Year	Worker /MWh
2000	0,43305781
2001	0,40368821
2002	0,32061108
2003	0,33664058
2004	0,28522515
2005	0,49507926
2006	0,41556441
2007	0,37709023
2008	0,33807287
2009	0,298142
2010	0,29431996

Source: sis-online.de, own calculations

Table 22: Learning Curve 2: CIM and O&M

	2004	2010	2020
Wind	100.0	86.7	62.4
Photovoltaic	100.0	74.5	44.3
Collector	100.0	80.7	60.8
Hydro	100.0	94.3	81.2
Biomass	100.0	84.5	59.5
Biogas	100.0	83.2	54.2
Geothermal	100.0	85.9	65.0
CSP	100.0	78.2	60.1

Source: Staiß in Lehr/ Nitsch/ Kratzat et al.: 115.

Table 23: Labour coefficients per unit installed

	Jobs/MW 2010		Jobs/MW 2015		Jobs/MW 2020	
Technology	CIM	O&M	CIM	O&M	CIM	O&M
wind onshore	0,9	0,2	0,8	0,2	0,6	0,2
wind offshore	1,8	0,5	1,6	0,4	1,3	0,3
photovoltaics	20,5	1,3	16,3	1,1	12,2	0,8
water	-	-	-	-	-	-
biogas	0,3	0,9	0,3	0,7	0,2	0,6
biomass	0,3	0,9	0,3	0,7	0,2	0,6
Coal	0,3	0,7	0,3	0,7	0,3	0,7
Gas	0,3	0,7	0,3	0,7	0,3	0,7

Source: Frankhauser/ Sehlleier/ Stern; Wei/ Patida/ Kammen; own calculations

Table 24: Job creation 2010-2020, Sc 2

technology	CIM*	O&M*	Total**
wind onshore	812,4714	210,930075	1023,40148
wind offshore	4528,58016	1175,68908	5704,26924
photovoltaics	1532,7675	100,3266	1633,0941
biogas	-0,3416	-0,87962	-1,22122
biomass	9,15	23,56125	32,71125
Sum	6882,62746	1509,62739	8392,25485

Source: own calculations
*2015 as base year for labour coefficients
**without suppliers

7.4. Costs

Table 25: Specific investment costs per technology

	Specific investment costs in €/KW***		
Year/Technology	2010	2015	2020
Wind onshore	1233	1182	1131
Wind offshore	6200	5850*	5500*
Photovoltaics	2406	2064	1721
Biogas	2735	2663	2591
Biomass**	2735	2663	2591
Coal	1300	1300	1300
Natural Gas	600	600	600

Source: Hirschl, Arets, Böther, Vattenfall, EnBw
*personal conversation with Dr. Butt, Dipl.-Ing. Roock, Ministery of economics of M-WP
**Proxi, derived from Biogas
*** until 2010 in respective prices, after 2010 in current prices

Table 26: Past and expected apportionment*

Year	In c/KWh, variant 1	In c/KWh, variant 2
2000	0,4	0,4
2001	0,43	0,43
2002	0,55	0,55
2003	0,62	0,62
2004	0,71	0,71
2005	0,89	0,89
2006	1,08	1,08
2007	1,23	1,23
2008	1,36	1,36
2009	1,51	1,51
2010	2,5	2,7
2011	2,9	3,5
2012	3	3,6
2013	3	3,9
2014	3,1	4,1
2015	3,1	4,2
2016	3	4,3
2017	3	4,3
2018	2,8	4,3
2019	2,6	4,4
2020	2,4	4,4

Source: German Federal Ministry of the Environment and Nuclear Safety
*Including 0,2c grid extension costs/KWh

7.5. Import/ Export

Table 27: Past and projected energy import/ export*

Year	Sc 2 in KWh	Sc 3 in KWh
1995	-2810816	-2810816
1996	-1819028	-1819028
1997	-1873410	-1873410
1998	-1674311	-1674311
1999	-1247130	-1247130
2000	-1386071	-1386071
2001	-1654060	-1654060
2002	-814480	-814480
2003	-966169	-966169
2004	4789	4789
2005	-62957	-62957
2006	718514	718514
2007	1182886	1182886
2008	1718419	1718419
2009	883511	883511
2010	1439052,36	1377593,94
2011	2033407,85	1910725,45
2012	2680187,45	2484964,96
2013	3383694,68	3100428,54
2014	4148583,88	3758491,6
2015	4979888,73	4463929,12
2016	5883053,19	5220677,6
2017	6863964,89	6032382,5
2018	7928991,3	6903478,46
2019	9085018,76	7838144,28
2020	10339351,7	8841385,63
2010-2020	58765194,8	51932202,1

Source: own calculations
* “-“ indicates net energy import; “+” indicates net energy exports

7.6. Questionnaire

Fragebogen zu den Auswirkungen erneuerbarer Energien auf Arbeitsmarktentwicklungen

13.04.2011

Zweck:	Datenerhebung zu Arbeitsplätzen im Bereich erneuerbare Energien
Ziel:	Möglichst präzise und statistisch relevante Aussagen in einer Masterarbeit mit dem Thema „Voraussichtliche Entwicklung des Arbeitsmarktes im Bereich erneuerbare Energien" zu treffen
Interessenten:	Wirtschaftsministerium Mecklenburg-Vorpommern; Benjamin Matuzak (Student, Lund University/Schweden)

Fragebogen zu den Auswirkungen erneuerbarer Energien auf Arbeitsplatzentwicklungen

A) An die Netzbetreiber

Beschäftigung

1. Wie viele Menschen arbeiten in Ihrem Unternehmen und wie viele davon sind im Bereich erneuerbare Energien beschäftigt?

2. Wie hat sich die Beschäftigung seit der Förderung der erneuerbaren Energien in Ihrem Unternehmer entwickelt? Und daran anschließend:

3. Sind neue Arbeitsplätze geschaffen worden oder wurde lediglich umstrukturiert?

Erwartungen

4. Was erwarten Sie von der Zukunft? Gibt es Prognosen zur Beschäftigungsentwicklung? Glauben Sie, dass zukünftig weitere Arbeitsplätze im Bereich erneuerbare Energien entstehen werden?

B) An die Energieversorgungsunternehmen

Beschäftigung

1. Wie viele Menschen arbeiten in Ihrem Unternehmen und wie viele davon sind im Bereich erneuerbare Energien beschäftigt?

2. Wie hat sich die Beschäftigung seit der Förderung der erneuerbaren Energien in Ihrem Unternehmer entwickelt? Und daran anschließend:

3. Sind neue Arbeitsplätze geschaffen worden oder wurde lediglich umstrukturiert?

Erwartungen

4. Was erwarten Sie von der Zukunft? Gibt es Prognosen zur Beschäftigungsentwicklung? Glauben Sie, dass zukünftig weitere Arbeitsplätze im Bereich erneuerbare Energien entstehen werden?