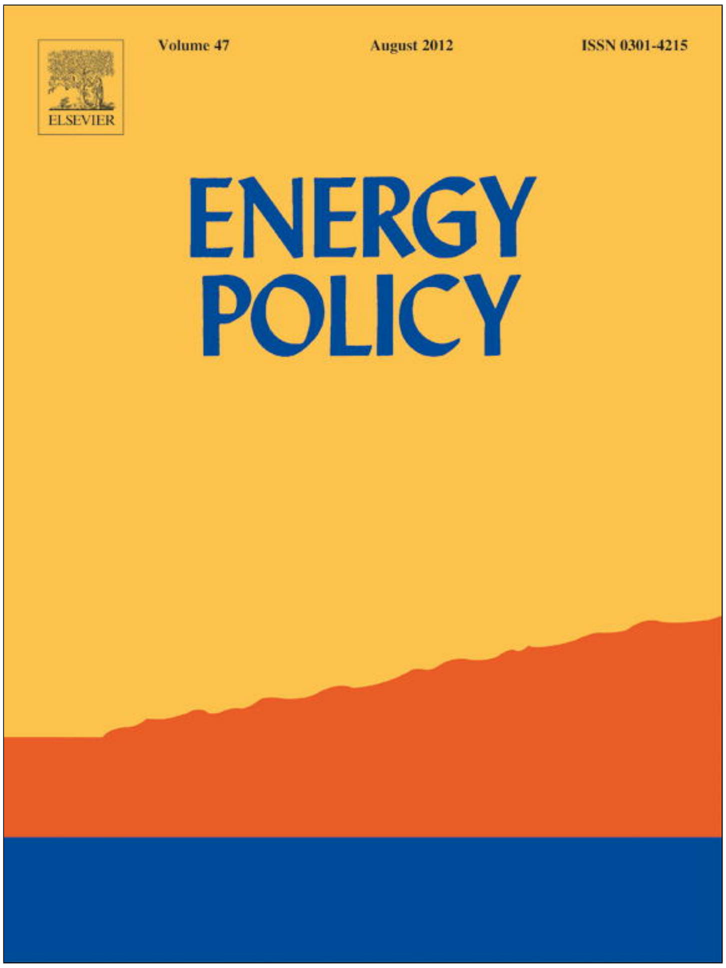
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Green jobs? Economic impacts of renewable energy in Germany

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HIGHLIGHTS

- ▸ This paper analyzes labor market implications of large investment into renewable energy (RE) in Germany.
- ▸ It shows the overall effects under different assumptions.
- ▸ The development of world markets and German RE exports are very important.
- ▸ Net employment of RE expansion will reach around 150 thousand in 2030.
- ▸ Gross employment will increase to between 500 and 600 thousand in 2030.

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ABSTRACT

The labor market implications of large investment into renewable energy (RE) are analyzed in this text. Although a growing RE industry can be observed in Germany the overall effect of large increases of RE based electricity and heat generating technologies on the German economy require a careful model based analysis. The applied model PANTA RHEI has been used among others to evaluate the German energy concept in 2010. It takes positive and negative impacts of RE into account. The paper shows the overall effects under different assumptions for fossil fuel prices, domestic installations and international trade. The results are sensitive to assumptions on the development of RE world markets and German exports to these markets. Almost all of these scenarios exhibit positive net employment effects. Under medium assumptions net employment of RE expansion will reach around 150 thousand in 2030. Only with assumptions for German RE exports below today's level, net impacts are slightly negative. Gross employment will increase from 340 thousand in 2009 to between 500 and 600 thousand in 2030.

1. Introduction

The positive impacts of an increasing share of renewable energy (RE) on the mitigation of climate change as well as on reduced energy import dependency are indisputable. However, such are currently still the additional costs of heat and electricity generation from most renewable energy sources (RES). Additional investment in RES will obviously induce economic activity and employment. Recent studies often focus on these gross employment impacts. They show the importance of the RE industries concerning employment and other economic factors. Wei et al. (2010) apply a spreadsheet-based model for the US that synthesizes data from 15 job studies. Cetin and Egrican (2011) find positive job impacts of solar energy in Turkey. They build their analysis on international literature, which is also positive about job impacts. Rutovitz and Atherton (2009) include regional aspects such as specialization and regionally different productivity in an international employment projection in the energy sector. Regional studies include Ratliff et al. (2010) for Utah, Loomis and Hinman (2009) for Illinois or Lantz (2009) for Nebraska. Situational analyses, such as Delphi (2007), account for the past development of employment in the renewable energy sector. The annual publication of the renewable energy status report (REN 21, 2011) or the annual update by O'Sullivan et al. (2010, 2011) fall under this category.

Another type of papers applies econometric methods to analyze the past relation between the RE industry or the use of RES and economic development. A cross-country econometric study by Apergis and Payne (2010) reveals a possible correlation between RES investment and economic growth for a panel of OECD countries for the years 1985 to 2005. Fang (2011) also reports a positive correlation between RES and GDP growth for China in the period 1978 to 2008 based on econometric analysis. Mathiesen et al. (2011) analyze a long-term shift of the Danish energy system towards RES and find a positive impact on economic growth.

Frondel et al. (2010) however doubt positive employment impacts of RES increase driven by the German feed-in-tariff in

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the long run. They argue that higher cost for RES will be "counter-productive to net job creation". They highlight the importance of international market developments. Especially for photovoltaic (PV), they conclude that due to high import shares the net employment impact of German PV promotion will be negative. They build on earlier studies such as Hillebrand et al. (2006), who concluded that RES promotion will have positive net employment impacts in the short run due to RES installations, which will turn negative in the long run due to the long-term costs of the feed-in tariff, which guarantees fixed tariffs for 20 years.

Studies on the net employment impacts of the promotion of RES take also negative impacts into account. The comprehensive EMLPOY-RES study (ISI, 2009) for the EU Commission applies two complex models, ASTRA and NEMESIS, for calculating the net impacts. Though showing some differences in detail, both models report positive GDP and employment net effects of advanced RES deployment of the EU in comparison to a no policy reference scenario. These net impacts are significantly smaller than the gross impacts. A study for Germany based on the econometric model SEEEM suggests overall positive net economic and employment effects of the expansion of RES in Germany (Blazejczak et al., 2011).

In 2010, the German government decided on its energy concept for a long-term strategy to orient the energy system towards RES (BMWi, 2010; Prognos et al., 2010). In 2011, Germany confirmed these targets, while speeding up the phase-out of all nuclear power plants until 2022. According to this concept, the German government will seek to make renewable energy account for 60% of gross final energy consumption in 2050 and 80% of gross electricity consumption contributed by RES by that year. The German feed-in tariff under the regime of which the share of RES in electricity consumption increased from below 5% in 1998 to 20% in 2011 will still play a major role in this development, but it is intended to make the future expansion of renewables more cost-efficient. The further integration of more and more RES is challenging, as the electricity market design has to be adapted to cope with the growing share of fluctuating RES and to give the right price signals for non-fuel based electricity generation.

Therefore, the overall balance of positive and negative effects under different possible future development pathways of fossil fuel prices, global climate policies and global trade is of interest. To account for all effects in a consistent framework, an econometric simulation model is employed. Economic impact of RES expansion is measured via the comparison of economic indicators such as GDP and employment from different simulation runs. Overall net positive effects can be seen for instance as higher employment in one simulation run compared with the other. The model consistently links energy balance data to economic development on sector level. It is enlarged by detailed data on 10 RES technologies based on comprehensive survey data. Additionally, the sector disaggregation of our model leads to a wide array of interesting results in terms of winners and losers of policies to support renewable energy.

This contribution is organized as follows: This introduction is followed by Section 2 on the methodology applied. The concept of net impacts and the modeling framework are explained. In Section 3 different scenarios are described. Section 4 presents modeling results followed by a discussion. In Section 5 results are discussed and some conclusions drawn.

2. Methodology

2.1. Net economic effects

The discussion about employment effects of the increase of renewable energy, as pointed out above, is often not precise concerning gross and net impacts. The rising installation of renewable energy systems in some European countries such as Germany, Denmark and Spain, more recently also in other parts of the world such as China, has intensified the discussion of costs and benefits of renewable energy systems. One suggestion is that price increases from increasing shares of renewable energy lead to job losses somewhere else in the economy and the net effects will be negative.

Production, installation, operation and maintenance of windmills, solar modules, biomass power plants or heating systems as well as biogas and solar thermal applications have a positive short-term investment effect on the respective industries (Fig. 1). Employment in these sectors increased steadily in Germany over the last years (O'Sullivan et al., 2010) and is often referred to as gross employment. Gross employment refers to the RE sector as such. A similar approach for fossil fuel based energy technologies would have to take into account employment in the mining sector, in the building and operation of power stations etc. Such analysis is not suggested here. International demand for RE technologies increases employment in these sectors. The German wind industry, for instance, makes up to 70% of its 2009 turnover from exports. Hydro energy and solar modules also exhibit high export shares in their respective turnover.

Negative impacts on the economy stem from two different sources: first, investment in renewable energy technologies crowds out investment in fossil fuel technologies such as coal fired power plants, oil fired heating systems and maybe at some future point gasoline driven cars. This substitution effect leads to profit losses in the respective economic sectors.

The second negative effect is larger than the substitution effect and comes from the additional costs of RE systems. Additional costs are added to the energy costs of households and firms. In the electricity sector, this is done by incorporating the burden sharing process from the German Renewable Energy Sources Act (EEG) in the model. In this regulation, technology specific feed-in tariffs are defined as to reflect additional costs of electricity generation from renewable sources. In the heat sector, a similar procedure is assumed, though currently there is no regulation to set heating tariffs, due to the decentralized nature of heat generation. Therefore, an add-on to heating costs is derived and implemented in the model. Lower costs would make RE expansion more feasible, higher costs less feasible. This so-called budget effect (Fig. 1) reduces the available budget for other expenditures resulting in job losses in the respective sectors. The effects on employment of different scenarios for RE expansion have been analyzed in Lehr et al. (2008). The budget effect can work in either direction, as high PV electricity production during midday already avoids price peaks. With the further reduction of production costs and the better integration of RES into the electricity system, the average of

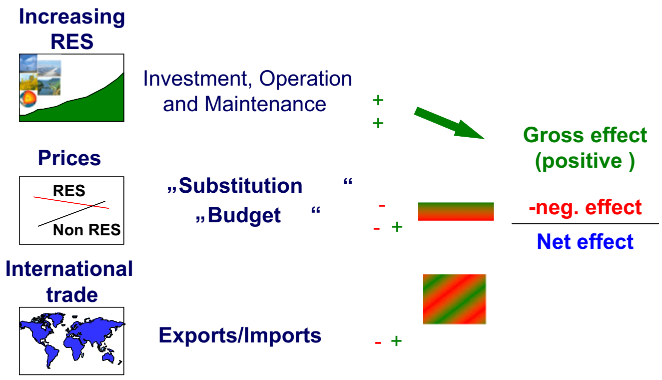

Fig. 1. Economic effects of an RE increase on the labor market (Lehr et al., 2011).

future budget effects will tend to become less negative or even getting positive in the long run. Higher electricity prices may endanger international competitiveness of electricity intensive companies. In Germany those companies are widely exempt from the feed-in-tariff.

Positive and negative impacts can induce additional indirect impacts throughout the economy (so-called second round effects): additional employment results in additional expenditure on consumption and additional jobs in the respective sectors as well as additional taxes and therefore increases in the governmental budget. Negative impacts affect the economy through the same channels. For information on the net effects one has to employ a model of the total economy.

2.2. Model

The economy-energy-environment model PANTA RHEI is at the core of our methodological approach. PANTA RHEI (Lutz et al., 2005; Lehr et al., 2008; Meyer et al., 2012) is an environmentally extended version of the econometric simulation and forecasting model INFORGE (Ahlert et al., 2009; Meyer et al., 2007). A detailed description of the economic part of the model is presented in Maier et al. (forthcoming). Among others it has been used for economic evaluation of different energy scenarios that have been the basis for the German energy concept in 2010 (Lindenberger et al., 2010; Nagl et al., 2011). A similar model with the same structure for Austria (Stocker et al., 2011) has recently been applied to the case of sustainable energy development in Austria until 2020. The paper gives very detailed insight into the model philosophy and structure.

The behavioral equations reflect bounded rationality rather than optimizing behavior of agents. All parameters are estimated econometrically from time series data (1991–2008). Producer prices are the result of mark-up calculations of firms. Output decisions follow observable historic developments, including observed inefficiencies rather than optimal choices. The use of econometrically estimated equations means that agents have only myopic expectations. They follow routines developed in the past. This implies in contrast to optimization models that markets will not necessarily be in an optimum and non-market (energy) policy interventions can have positive economic impacts.[1]

Structural equations are usually modeled on the 59 sector level (according to the European 2 digit NACE classification of economic activities) of the input–output accounting framework of the official system of national accounts (SNA) and the corresponding macro variables are then endogenously calculated by explicit aggregation. In that sense the model has a bottom-up structure. The input–output part is consistently integrated into the SNA accounts, which fully reflect the circular flow of generation, distribution, redistribution and use of income.

The core of PANTA RHEI is the economic module, which calculates final demand (consumption, investment, exports) and intermediate demand (domestic and imported) for goods, capital stocks, and employment, wages, unit costs and producer as well as consumer prices in deep disaggregation of 59 industries. The disaggregated system also calculates taxes on goods and taxes on production. The corresponding equations are integrated into the balance equations of the input–output system.

Value added of the different branches is aggregated and gives the base for the SNA that calculates distribution and redistribution of income, use of disposable income, capital account and financial account for financial enterprises, non financial enterprises, private households, the government and the rest of the world. Macro variables like disposable income of private households and disposable income of the government as well as demographic variables represent important determinants of sectoral final demand for goods. Another important outcome of the macro SNA system are net savings and governmental debt as its stock. Both are important indicators for the evaluation of policies. The demand side of the labor market is modeled in deep sectoral disaggregation. Wages per head are explained using Philips curve specifications. The aggregate labor supply is driven by demographic developments.

The model is empirically evaluated: The parameters of the structural equations are econometrically estimated. On the time consuming model-specification stage various sets of competing theoretical hypotheses are empirically tested. As the resulting structure is characterized by highly nonlinear and interdependent dynamics the economic core of the model has furthermore been tested in dynamic ex-post simulations. The model is solved by an iterative procedure year by year.

The energy module captures the dependence between economic development, energy input and CO_2 emissions. It contains the full energy balance with primary energy input, transformation and final energy consumption for 20 energy consumption sectors, 27 fossil energy carriers and the satellite balance for renewable energy (AGEB, 2010). The energy module is fully integrated into the economic part of the model.

To fully assess the impacts from the production and operation and maintenance of renewable energy systems, input–output structures for the renewable energy sectors have been developed and integrated in the modeling framework (Lehr et al., 2008). Input–output tables provide detailed insights in the flows of goods and services between all sectors of the economy and the interdependence of the economy of a country and with the rest of the world. They are closed accounting schemes where the identity of the sum of inputs and the sum of outputs has to hold in each sector. This consistency check of course also holds true for the newly created sector ‘‘Production of systems for the use of RES’’. The new sector is defined in economic terms by its input and output structure, being represented by a new column and a new row in an existing table. The input or cost structure describes the amounts of goods and services required as intermediate inputs from all other domestic sectors, the amount of imported intermediate inputs and the value added in the sector itself. The output or sales structure describes the amounts of goods and services delivered to other sectors as intermediate goods or as final goods to final demand: Wind energy off-shore and on-shore, PV, hydro, solar thermal heat generation, biomass electricity generation, biomass heat generation, geothermal electricity generation, heat pumps and biogas generation (for a detailed description of methods see Section 2.3 in Lehr et al. (2011)).

To account for the variety of technologies involved in RES use the newly created sector is build up in a bottom up process based on 10 subsectors each of which represents a defined RES technology. Compared to a previous study (Lehr et al., 2008) the larger number of technologies distinguished improves the homogeneity of subsectors which is beneficial for empirical quality of representing technologies in an input–output framework. Fig. 2 shows examples of the cost structures in percent of gross production volume (GPV) derived for the production of systems for the use of wind energy and photovoltaic systems in comparison to systems for the use of fossil fuels. The difference in structures shows the importance of creating a new sector in the system, since the intermediate inputs used for the respective production processes come from very different sectors of the economy so that the

[1] Our analysis, however, is limited to a macro-econometric approach. More detailed analysis of institutions, legal frameworks, transactions costs as are known from institutional economics could provide a deeper insight in the deployment of RE technologies. For this type of analysis see Johnstone et al. (2010), or Jacobsson et al. (2009) and the references therein.

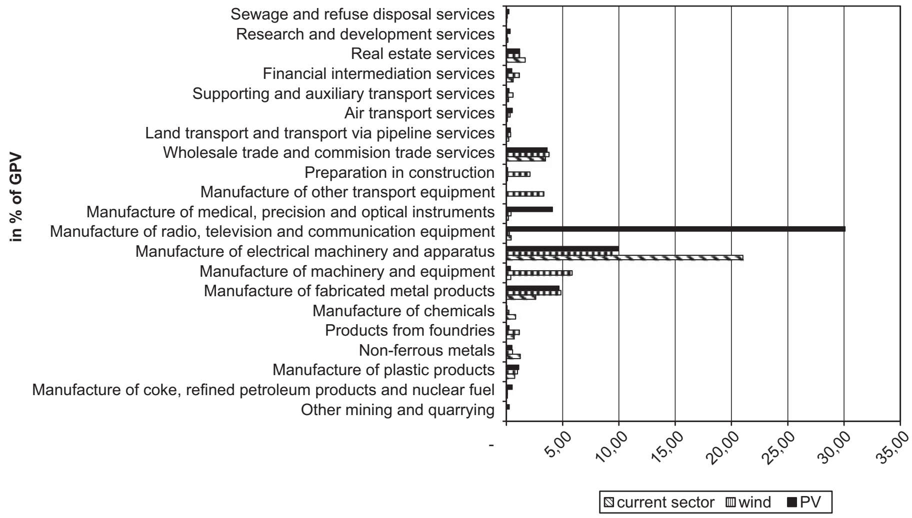

Fig. 2. Cost structure for the production of systems for the use of different energy types.

overall and sectoral impacts are depending on a reliable empirical representation of the new RES technologies in the applied analytical tool.

To examine the economic effects of increasing shares of renewable energy in Germany our analysis applies PANTA RHEI to a set of scenarios and compares the resulting economic outcomes.

3. Scenarios

Scenarios, in contrast to forecasts, present consistently derived different possible future developments. They enable a "what-if" analysis. For Germany, we make use of the official scenario for the development of new RE installations, the so-called "Lead Scenario" (Nitsch et al., 2010). This scenario includes bottom-up modeled cost-structures of RE technologies, based on the learning curves for 10 RE technologies. It is a target oriented scenario, in which 84.7%RE will be reached in electricity generation, 49.4% in heat generation and 49.5% in primary energy supply in 2050. A scenario with zero investment in RE since 2000 serves as the respective (hypothetical) reference development.

The scenario technique is often applied when future development depends on the development of some crucial quantities, whose development is highly uncertain. Future employment effects from expanding RE, for instance, critically depend on the relative costs of RE compared to fossil fuels, on national policies for the support of RE and on international climate regimes and RE strategies.

Thus we constructed the following scenarios for the development of each of these decisive factors (see Table 1):

1. two different price paths for international energy prices,
2. three different scenarios for the domestic RE investment,
3. four different RE export scenarios, which vary by the share of imports and domestic production in 10 world regions and 10 technologies and with respect to the trade shares of Germany.

3.1. *International energy prices*

International energy prices determine the reference price for the additional costs of renewable energy systems in Germany, because large shares of fossil fuels are imported. The future development path of import prices for fossil fuels is highly uncertain considering the large fluctuations in the past couple of years. Therefore we implement a lower price scenario and a higher price scenario with the respective consequences for renewable energy diffusion. The price scenarios follow essentially the projections of the IEA. The higher price level coincides with the projections in the World Energy Outlook (IEA, 2009). The lower price level is lower than the more recent projections in IEA (2010), but the upper price level exceeds the assumptions there. To keep the analysis on the safe side, in the following we report the findings for the lower price level, which is less favorable for the cost-effectiveness of RE installations.

3.2. *Domestic RE investment*

Germany has experienced a boom in the installation of photovoltaic panels in 2010. While the German government annually updates its "Lead Scenario" (Nitsch and Wenzel, 2009) for the future development of electricity and heat from renewable energy, the latest update in 2009 did not include this rapid increase. Therefore, we included two more scenarios in our analysis, taking the likely PV development into account. It turned out that the higher path of this set was overachieved by 10% in 2010, so that only the results of the original scenario and the highest sensitivity will be reported here.

3.3. *Additional costs of RE systems*

Currently, the additional costs of RE systems are the main driver of negative economic effects. They spur the budget effect through increases in the electricity prices from the burden sharing mechanism of the German feed-in tariff and through additional expenditure for hot water and heat generation. From the cost development observable in the past and industry information estimates for future cost development in Germany are obtained (Nitsch and Wenzel, 2009). Fig. 3 shows the development of the additional costs for electricity and heat generation. Germany has seen large PV installations in 2010 – almost half of the world market – which drove PV costs down and the costs of the feed-in tariff up. The figure therefore shows the additional costs for electricity generation with and without the PV costs.

3.4. *International development and exports*

Export is a major driver of the economic performance in Germany. This holds for the economy as such as well as for the sector of the production of facilities for the use of RE. Earlier

Table 1
Important scenario assumptions (highlighted scenarios are reported further), real prices (2005).

	2009			2020			2030		
1. Import prices	Oil ($/bbl)	Gas (€/GJ)	Coal (€/t)	Oil ($/bbl)	Gas (€/TJ)	Coal (€/t)	Oil ($/bbl)	Gas (€/TJ)	Coal (€/t)
a. High	58	5.79	79	96	10.70	155	118	13.80	202
b. Low	58	5.79	79	79	8.40	123	94	10.00	147
2. Dom. investment		Billion €							
a. Lead scenario		20.4			15.4			15.1	
b. Higher PV		20.4			16			14.1	
c. High PV		20.4			16.6			14	
3. Export		Billion €							
a. Minimum		8.6			7.1			7.1	
b. Slow		8.6			19.9			32.7	
c. Optimistic		8.6			32.9			47.8	
d. Maximum		8.6			41.3			59.1	

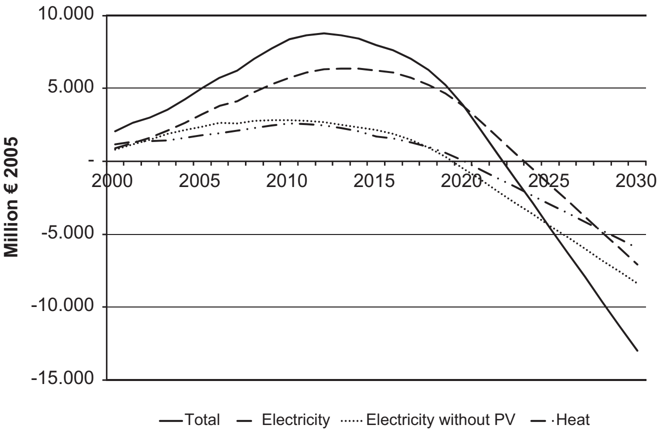

Fig. 3. Additional costs of renewable energy systems compared to the respective fossil fuel based generation in million € 2005 (Nitsch and Wenzel, 2009).

studies (Lehr et al., 2008) have shown that net employment strongly depends on assumptions on export levels. Therefore, RE technology exports have been modeled in great detail. Our analysis follows an idea developed by Edler and Blazejczak and Edler (2008) for "green" goods. They analyze the world market for green goods and derive German export quantities from shares of traded goods in this market and shares of German producers in world trade. We follow a similar logic and determine the trade volume of RE technologies in the year 2007 as a calibration for our projections of future exports. For this year, the trade shares of German producers can be estimated from statistical data and additional structural knowledge. For the future we develop four scenarios, all of them based on the Energy [r]evolution scenario for global installations RE systems (Krewitt et al., 2008).

The minimum case for exports is defined by holding the volume of German exports constant until 2030. This translates into a high loss of German trade shares. The maximum case is determined by holding the trade shares constant on a rapidly expanding world market, which can be seen as an almost tenfold increase of export volumes. Both scenarios serve as an upper and lower boundary to the more likely developments. One of them, the more optimistic scenario, assumes that Germany maintains significant shares in global trade of RE systems. The slower scenario can either be seen as a slowdown in German competitiveness or as a tendency to wall off markets in the future. Table 1 gives an overview of the main scenario settings.

Instead of a business-as-usual reference, which in many studies describes a development under which no further measures are taken (e.g., ISI, 2009), this study uses a zero scenario. The same approach has been applied in Lehr et al. (2008). It describes a consistent hypothetical development of German energy generation without renewable energy promotion from 2000 onwards and includes the additional fossil power plants and heat generation plants that would then be necessary along with the associated investment[2]. In this scenario, RE makes only a very limited contribution to the heat and electricity supply, for the latter predominantly from large-scale hydropower, which was already competitive even before the Renewable Energy Sources Act came into force.

In the following analysis results will be reported for the low price path and the high domestic investment path. All export scenarios will be included in the reported results.

All other things are equal across the scenarios, i.e., regulations, taxes, etc. are taken as given.

4. Results

The PANTA RHEI model calculates endogenously economic development and labor market effects in the different scenarios. The zero scenario based on the low price path is now compared to a development with differing degrees of domestic investment in RE and differing export trends based on the same price path. The comparison of simulation results shows macroeconomic effects such as net employment effects which can be traced back to the different scenario assumptions.

4.1. Net employment

To gain an overview of selected results in all the simulation runs, Fig. 4 shows the results for net employment over time. Absolute deviations from the zero scenario with the low price path are shown. Positive values should be seen as positive net employment by comparison with a development without expansion of RE. Negative values indicate that employment lags behind the value it would have had without the expansion of RE.

The increase of RE leads in most of the scenarios studied to positive net employment, rising steadily, particularly from 2020 onwards, when global RE markets are expected to increase strongly according to Krewitt et al. (2008). The net effects are negative in the scenarios with minimal exports (i.e., remaining constant at today's level), although this should be seen here more as a notional lower limit. In this case, for the two expansion paths (Lead Scenario and High PV) lower values for employment are observed by comparison with the zero scenario. However, at the end of the observation period there is a reversal in these cases:

[2] Total investment in coal and gas fired plants and fossil fuel based heat systems amounts to 52 billion € until 2030. Details can be found in Lehr et al. (2011) page 138.ff.

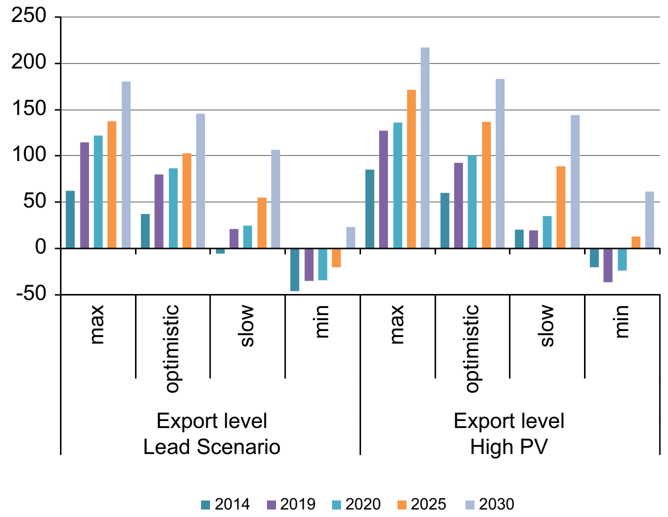

Fig. 4. Employment in absolute differences to the zero scenario, in 1000 persons.

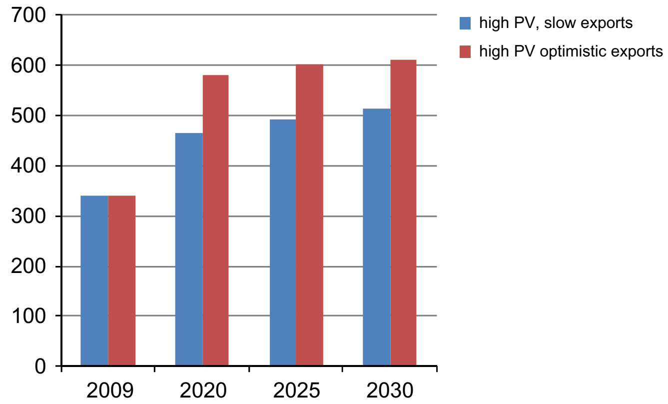

Fig. 5. Gross employment in 1000 for two selected scenarios based on high domestic photovoltaic increase combined with slow (blue) or optimistic (red) exports. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).

the net employment effects become slightly positive or are neutral. The influence of exports on the domestic employment level also becomes very evident in the scenarios studied: using the optimistic expectations, the positive net employment effect rises by 2030 to values in excess of 150 thousand. In combination with cautious export expectations, there are less positive deviations from the zero scenario up to 2015. After that the positive employment effects of exports become apparent.

Since we are showing only the low price path here, the higher additional costs of RES, brought about by low prices for fossil energy sources, attenuate the positive net employment effects in comparison to a scenario with a higher energy price path.

Overall, the highest net employment stems from maximal export in combination with high PV expansion. In this case, net employment in 2030 is a little more than 200 thousand people higher than it would have been without expansion of renewable energy in Germany.

Gross employment in the RE industries may increase to around 500 to 600 thousand people compared to more than 370 thousand today (O'Sullivan et al., 2011). The figure rises with German RE industries continued success on growing international markets. The importance of global markets can be read from Fig. 4. The different assumptions about exports lead to 100 thousand jobs more in the RE industry in the optimistic export scenario.

The future increase in gross employment will not be as fast as it has been in the past. In Germany, the RE industry doubled its employment between 2004 and 2009 (O'Sullivan et al., 2010). In 2009, 339.500 people worked in the production, operation and maintenance, fuel production and input production of RE systems. The further increase in gross employment figures will be below turnover increase as labor productivity will also grow substantially along the learning curves with the maturing of the RE industries. But the results still show a further increase by factor 1.5 to 1.8 until 2030 compared to 2009.(see Fig. 5)

5. Discussion and conclusions

Our analysis shows possible positive impacts of the expansion of RE in Germany—and the conditions and policy implication for a positive development.

Positive net employment effects strongly depend on further growth of global markets and German RE exports. When relating the results to studies which report negative impacts of RES promotion, the treatment of international market developments in the studies can explain at least part of the differences. Another important factor for employment impacts are expectations of future cost reductions of different RES technologies.

The literature also provides analysis with the prediction of negative impacts of RES expansion—for Germany and other countries. Frondel et al. (2010) calculate the additional costs of a projected increase with a national focus and claim that especially the costs of PV systems cannot be balanced. For Spain, Alvarez (2009) showed negative economic impacts, only focusing on the domestic market. However, the main Spanish wind energy systems producer, Gamesa, realizes more than 90% of its turnover abroad. A sensible consideration of exports and global markets helps to understand the dynamics of countries which developed a RE industry sector.

The discussion of net impacts of RES has also to be related to the primary target of RE: the reduction of fossil fuel use and related externalities such as global warming, local air pollution or damages of fossil fuel extraction. If (national) accounting systems take fully account of these additional benefits of RE compared to fossil fuels, as proposed by the Commission on the Measurement of Economic Performance and social progress (Stiglitz et al., 2009) or the OECD (2011) green growth strategy, the evaluation of RE will become even more positive. Thus far, few studies have attempted to quantify these effects for Germany. Breitschof et al. (2011) provide a systematic approach to fully assess cost and benefits of renewable energy expansion, including transaction costs, savings from decreasing energy imports, increasing energy security and avoided damages. Sensfuß et al. (2008) provide examples for the so-called Merit-Order-Effect, i.e., the price decreasing effects of RE on the electricity spot market. The long-term development of this effect, however, is still subject to debate.

The issue of economic impacts of the expansion of RE will be part of the sustainability discussion for the time to come. On the one hand, increasing installation will bring down the specific costs through learning curves and scale effects. On the other hand, parity of electricity generation costs from RES will only be reached within the next 10 to 15 years. The German example shows how a large domestic market leads to the development of a successful industry. Therefore, since exports of conventional power plants are not crowded out in this exercise, net employment from the lower export scenario gives a taste of the overall positive employment effects of a change to a RE based energy system. However, these successes are vulnerable to abrupt policy changes, as experiences with the US industry or the Spanish market show.

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