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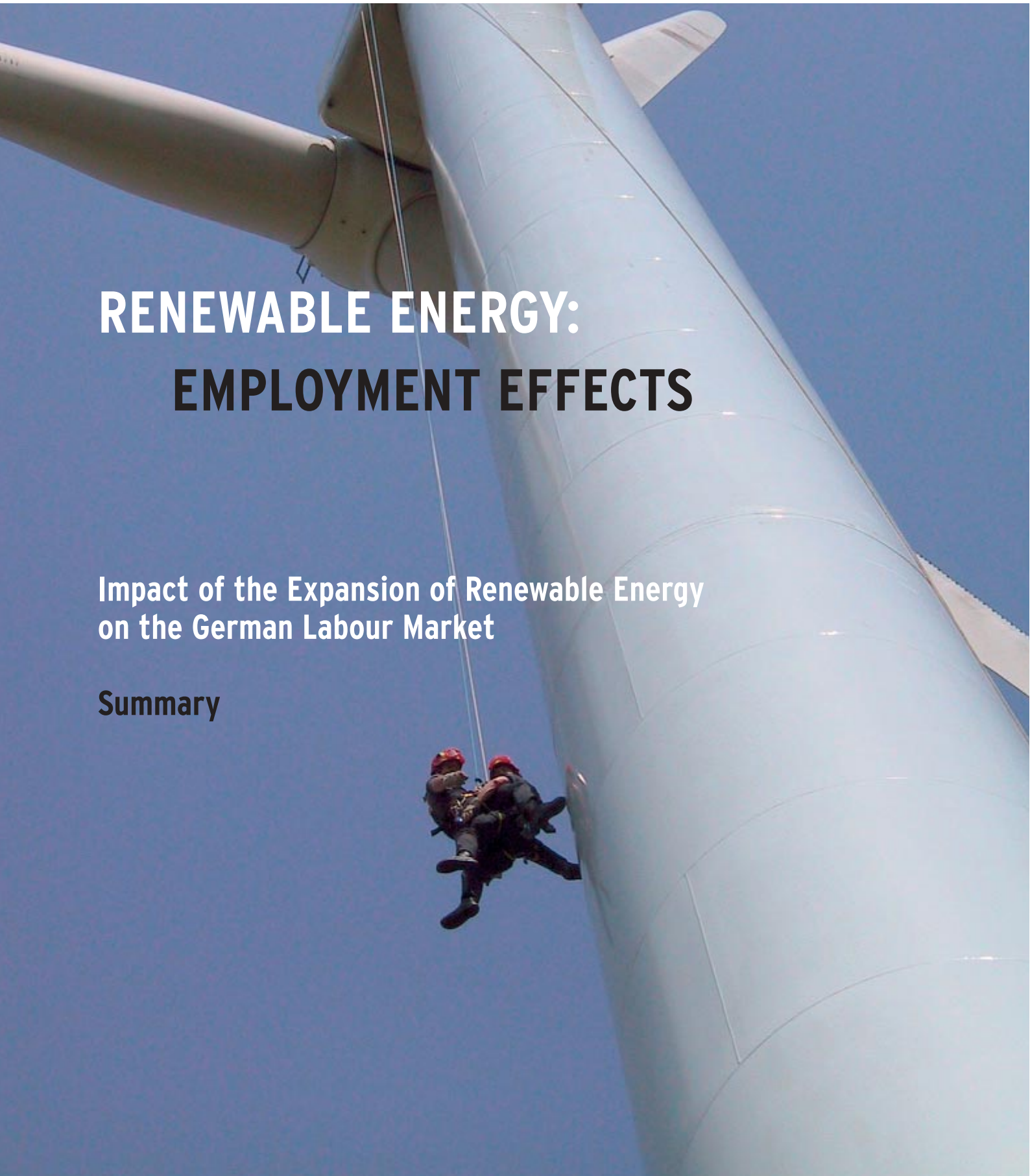

RENEWABLE ENERGY: EMPLOYMENT EFFECTS

Impact of the Expansion of Renewable Energy on the German Labour Market

Summary

IMPRINT

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DEAR READER,

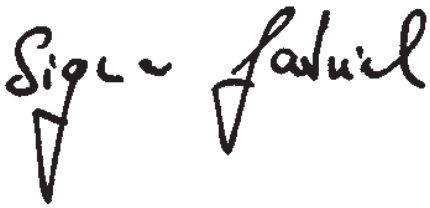
One of the pivotal challenges of the 21st century will be to change the energy supply structure. We need this change to protect our environment and the climate. We need it to reduce our dependence on energy imports and to stabilise energy prices. And we need it as an opportunity and engine for innovation and economic growth.

The key task is to sustainably transform our energy system. As I see it, the concrete tasks are to: reduce energy consumption, increase energy efficiency, and use more renewable energy sources. Clear goals have already been set: for example, in 2020 at least 10% of the total energy demand in Germany and at least 20% of our electricity should already be generated from the renewable resources wind, water, biomass, solar energy, and geothermal energy. Current studies indicate that it is quite possible to meet these goals. For example, they calculate a share of about 25% for renewable energy in the electricity sector. The long-term goal set by the German Federal Government in its sustainability strategy to supply half of our total energy demand using renewable energy sources by the middle of this century is similarly possible to achieve.

In this context, the economic significance of renewable energy has increased over the last few years: in 2005 this sector already earned more than 16 billion Euros just from the construction and operation of systems. About 170,000 jobs are attributed to renewable energy in the meantime. Nevertheless, despite these success stories, the long-term impact of the expansion of renewable energy on growth and employment is still being disputed since the continued start-up financing must also be calculated to determine the net effect.

The study presented here: “Impact of the Expansion of Renewable Energy on the German Labour Market with Special Consideration of Foreign Trade” examined this question in detail based on an extensive questionnaire involving more than 1,000 companies and extensive theoretical models. The study demonstrates that the increased use of renewable energy and job creation can permanently go hand in hand. Accordingly, employment in the renewable energy field could double by 2020 even when applying rather conservative assumptions. Furthermore, the net impact – after subtracting all possible negative employment effects – is also a clear and sustainable positive employment stimulus.

A decisive prerequisite for this favourable balance is that Germany continues to play an important role in the growth of the international renewable energy market. The study clearly shows that this will not happen by itself, but that the German economy is very well situated to keep this position. Germany is now the technological leader in most renewable energy sectors, especially thanks to the continuing favourable national conditions. The German Federal Government will continue to support this process, for example by increasing efforts in research and development, by fortifying the export initiatives in renewable energy, and last but not least also by our lasting commitment to renewable energy on an international level.



Sigmar Gabriel
Federal Minister for the Environment,
Nature Conservation and Nuclear Safety

CONTENT

GOALS AND FRAMEWORK OF THE STUDY

From the energy and environmental policy point of view, the existing and future expansion of renewable energy is largely undisputed on both national and international levels. However, since financial support will still be required for some time, the goals can conflict with other political fields. In view of the high unemployment level in Germany, the employment effects related to renewable energy play a particularly important role.

The impact of the expansion of renewable energy on the German labour market has been a controversial subject in the past. The dispute did not concern so much the magnitude of the effect, but rather the central question of the direction – whether using renewable energy leads to increased employment or rather job losses when considering the overall economic situation. The debate is complicated on the one hand by the complexity of the issues, and on the other hand by an insufficient data basis in some fields. Finally, assumptions about future developments play a significant role and allow room for interpretation in different directions depending on the time horizon. Figure 1 shows exemplarily the correlation between various macroeconomic impacts caused by expanding renewable energy use.

In order to characterise the employment effects, two terms are used which must be carefully distinguished from one another. Firstly, investments in systems and their operation results in direct employment by manufacturers, operators, and service companies. These companies in turn require goods from other economic sectors and thus indirectly provide employment with subcontractors and suppliers. Thus, for example in 2004, "only" one third of the German employment attributed to wind energy is related to the production of wind power stations – the other two thirds are related to the suppliers. The spectrum here ranges from steel production to the manufacture of important components like gearing or generators.

The so-called gross employment results from the sum of the direct and indirect employment. While this figure is always positive, a satisfactory macroeconomic analysis must also consider possible negative employment effects. The so-called net employment effect represents the balance of all effects and can therefore be positive or negative. Whereas the gross employment can be determined within one scenario, the net employment must be determined as the difference between two realistic future scenarios. If positive, it represents the true additional employment due to the increase of renewable energy.

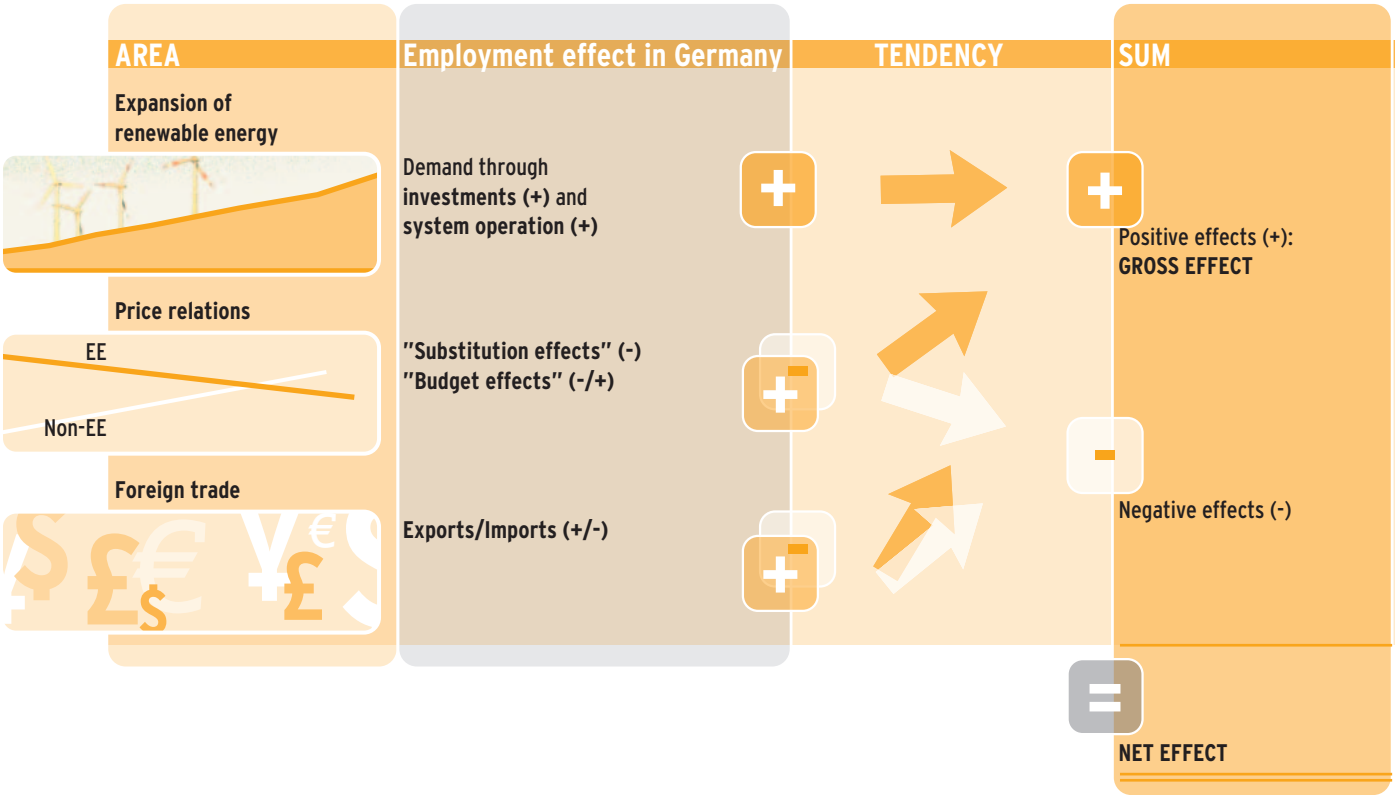


Figure 1:
Schematic representation of the correlation between the gross and net employment effect of renewable energy use

The products of renewable energy – electricity, heat, and fuels – generally replace fossil energy. Although about three quarters of the non-renewable energy in Germany is imported, developing biomass, hydropower, wind energy, solar energy, and geothermal energy also leads to negative impacts on the domestic investment and thus employment in the fossil energy sector. However, the burden on public and private budgets is significantly stronger than this substitution effect. Since, except for a few exceptions, renewable energy is not yet price-competitive with conventional energy, the difference must be shouldered by the energy consumers. This money is then not available to consume other goods. This so-called budget effect results in negative employment impacts in other fields and must also be considered in a net balance.

Finally, the influence of foreign trade on employment can not be determined in advance. It ultimately depends on whether more goods are exported or imported. This particular aspect will continue to gain importance in the future.

The present study was carried out from late 2004 until June 2006 and assesses all points mentioned above. In particular, a wide survey of businesses in the summer of 2005 provided a large information base which enabled us to answer the most important questions of this study:

- How can we reliably represent the investments in renewable energy and the operation of the systems within the complex matrix of the various economic sectors and foreign trade?
- What is the value of the employment effect in the base year 2004?
- Which regional effects can be derived?
- How might the renewable energy market develop in the middle and long term, domestically and abroad?
- How will the differential costs between renewable and non-renewable energy sources develop?
- How high is the export potential for products and services “Made in Germany”?
- How do domestic businesses in this sector judge their competitive position and Germany as a business location?
- What employment effects are to be expected by the year 2030?
- Which policy recommendations can be derived from these results?

THE MOST IMPORTANT RESULTS AT A GLANCE

The goal of the present study is to answer the questions posed above and, in the process, to improve the database and further develop methodological approaches. At the same time, a transparent portrayal of the results should ensure their comprehensibility since the considerable breadth of the questions required several assumptions to be made – e.g. related to developments in the international markets or the future development of renewable energy. Plausible considerations are used to reliably estimate orders of magnitude from which sustainable recommendations can be derived for strategic decisions. This study thus provides a constructive contribution to further discussions about the effects of using renewable energy on employment, as will continue both in political and in scientific forums.

A flash summary of the most important results is presented in the following, whereby the content is necessarily abbreviated and we refer to the further details in this summary report as well as the derivations, classifications, and interpretations presented in the complete report:

METHODICAL RESULTS:

1.

The renewable energy sector can be integrated into the economic input-output table for analysis. It is recommended to map it using the vectors “production of systems for using renewable energy” and “operation of systems for using renewable energy”. This process simplifies the study of the input links and thus also the determination of the direct and indirect employment effects.

2.

Net employment effects can only be entered into the balance sheet with sufficient accuracy in a complex macroeconomic model. The difference between two consistent future development models (scenarios) must be considered for this purpose. The scenario “Energiereport IV” provides a suitable moderate reference development for the expansion of renewable energy. It is compared here with a dynamic expansion which complies with the expansion and climate protection goals set today. It would have been disproportionately more difficult to find plausible assumptions to support considerations of a hypothetical past development in which renewable energy had no relevant growth due to a lack of promotion instruments.

THE STARTING POINT: Survey results for 2004

3.

In the base year 2004 the gross employment totalled 157,000 positions; 64,000 of which are in the wind sector, 57,000 in the bio-energy sector, and another 36,000 in the sectors of solar energy, hydropower, and geothermal energy. About half of all employees are involved in the production and operation of systems and the other half are employed by suppliers or upstream economic sectors like engine construction and electrical device manufacturers, but also including the steel and glass industry as well as company-specific services and the insurance industry[1].

4.

The renewable energy industry is presently dominated by medium-sized enterprises. Especially in economically underdeveloped regions there are employment prospects which however depend on successfully boosting the regional value added for these sectors. **The share of regional value added is particularly high in Northern Germany (ca 50%); it is presently lowest in Eastern Germany (ca 20%).**

5.

More than 1,100 enterprises were surveyed for the study in order to obtain an important database for detailed analyses and to address higher-level questions. They indicate Germany as the most attractive business location for most enterprises – followed by other countries in the European Union.
By 2010, the enterprises intend to increase their number of employees by 50% compared to 2004.

[1] Based on these results, a gross employment effect of ca 170,000 positions can be estimated for 2005.

DEVELOPMENT OF GROSS EMPLOYMENT until 2020/2030

6.

The share of the German primary energy consumption supplied by renewable energy can increase from 4.6% in 2005 to 13.9% by 2020 if the total final energy consumption is simultaneously reduced by 10% through energy-saving and efficiency measures. Their share in the electricity market increases from 10.2% (2005) to 25.6%; the installed capacity increases from 25,840 MW to 56,300 MW.

7.

Over the time period from 2005 to 2020, cumulative investments of €$_{2000}$130 billion (all data given in prices from 2000) **in systems for using renewable energy (electricity, heat) are associated with this development.** Investments in production systems – not explicitly calculated here – should also be added in. The annual domestic turnover in the sector, including system operation, will increase to nearly €$_{2000}$ 15 billion/a by 2020 (2005: €$_{2000}$ 10 billion/a).

8.

Renewable energy contributes decisively to achieving climate protection goals. With further expansion, an annual reduction of CO_2 emissions by 160 million t/a (2005: 84 million t/a) can be achieved by 2020. This fact is of crucial importance to meet goals which go beyond the Kyoto protocol currently in effect.

9.

The additional costs (so-called differential costs) caused by the increased use of renewable energy in Germany will continue to increase for about ten years according to a conservative estimate of the future energy prices. According to an energy price scenario which assumes an oil price of US $$_{2000}$ 60 per barrel and a CO_2 certificate price of €$_{2000}$ 15/t in 2020, the differential costs will reach a maximum of €$_{2000}$ 5 billion/a in 2015 (2005: €$_{2000}$ 3 billion). The increase is significantly less than proportional to the expansion of the final energy contribution from renewable energy. **The total renewable energy mix can become price-competitive** (differential costs less than or equal to zero) **by about 2020**. If the general energy price level increases faster, then this point will be correspondingly earlier and all in all the differential costs will turn out to be much lower.

10.

Successful foreign trade plays a central role for further positive employment stimuli. A dynamic development on a global scale which proceeds analogous to the development in Germany will increase the energy production from renewable sources from 60,000 PJ in 2004 to 145,000 PJ in 2020. However, due to the simultaneous increase in the energy consumption, the share of the global energy consumption will "only" increase from 13.5% to 22%.

11.

The relevant technologies from the German point of view – primarily electricity-generating systems, the thermal use of solar energy and geothermal energy, as wells as various technologies for the energetic use of biomass – have potentially higher growth rates. **In the electricity generation field alone, a rapid expansion could increase the global installed capacity from 900,000 MW in 2004 to 2,160,000 MW in 2020 and 4,070,000 MW by 2030.**

12.

With this expansion, the **global investment volume** for renewable energy systems will **increase six fold from € 43 billion in 2004 to ca €$_{2000}$ 250 billion/a by 2020 and will further increase to ca €$_{2000}$ 460 billion/a by 2030**. Even for a (moderate) reference development, the annual investment volume will increase considerably to €$_{2000}$ 115 billion/a in 2020. Renewable energy thus most definitely represents a global growth market, resulting in considerable export potential for German enterprises.

13.

Since the international expansion of renewable energy will be accompanied with increased local production in the site countries, the share of German companies in the world market, currently at 17% averaged over all technologies, will decrease. Nevertheless, in areas with sophisticated technologies (e.g. photovoltaic modules, gearing and generators for wind power and hydropower stations, measuring and control engineering for biomass plants, etc.) **high shares of the world market of 15-20% are by all means realistic also in 2020. However, the absolute values which can be achieved are more decisive. Investments in electricity-generating systems of German origin alone can increase from ca € 6 billion in 2004 to €$_{2000}$ 20 billion in 2020 according to a "cautious" export scenario.** If we include heat supply systems, then this value increases to ca €$_{2000}$ 24 billion/a.

14.

If we subtract the domestic investments from these amounts, then the export volume for 2020 amounts to €$_{2000}$ 16 billion, with €$_{2000}$ 14.5 billion for electricity producing systems and another €$_{2000}$ 1.5 billion for heat generating systems. The **export ratio** (proportion of foreign turnover to total turnover) **for German manufacturers then averages to 69%**, with values of 70% or higher achievable in specific sectors (e.g. wind power and photovoltaics).

15.

Under these conditions **the number of jobs in the German renewable energy sector could increase to over 300,000 (gross employment) by 2020**. A significant increase in the work productivity is already considered in this figure, i.e. the earned revenue per employee is about 36% higher than it is today. Continuing this development, more than 330,000 jobs by 2030 are realistically conceivable.

NET EMPLOYMENT

16.

The net employment effect is calculated from the difference between two dissimilar but consistent expansion scenarios. **Compared to a reference development, a dynamic expansion of renewable energy can lead to a continuously increasing positive net employment effect in the range of over 70,000 jobs by 2020 and increasing to over 80,000 jobs by 2030.** Since the expansion scenario fulfils climate protection goals, these results demonstrate that an effective climate protection policy can simultaneously be an advantageous macroeconomic employment strategy if the growth dynamics induced by the pioneering national policies can be transferred to export markets successfully and in good time.

17.

Admittedly, the effect depends strongly on the general energy price development and the foreign demand for renewable energy. Sensitivity calculations were performed to explore the extent of these dependencies. **If the future energy price level lies above the relatively moderate energy price scenario assumed here (compare with Point 9), then the net employment will increase to nearly 120,000 jobs by 2030.** If the export development is more favourable (export scenario "optimistic behaviour") then the values could even increase to between 150,000 and 180,000 jobs by 2030. Negative net employment effects can only be calculated for the improbable case that the exports of renewable energy technology practically break down and the energy prices drop down to the levels of 2000 to 2002 (i.e. a real oil price of US $\$_{2000}$32 per barrel in 2020).

18.

The current status of renewable energy expansion causes a positive net effect of about 35,000 to 40,000 employees as compared to a fictive state without renewable energy use. This value is only a relatively rough approximation for methodological purposes.

19.

The successful development of renewable energy and therefore also the employment effects will still depend appreciably on the political conditions for about 20 years. In order to continue with the positive results, just like in other economical sectors, it is important to maintain Germany's attractiveness as a business location, to secure a top technological position internationally, and to support the exportation of products and services. At the same time, the enterprises themselves must further strengthen production sites in Germany.

20.

Since the developments are very dynamic, it is extremely important to continuously monitor the further expansion of renewable energy and its impact on the labour market so that erroneous trends can be corrected in time and positive trends can be actively supported (see below).

Due to the complexity of the subject, especially the future-oriented results depend on a series of assumptions. In order to better classify them, the most important factors are summarised in Table 1. They are described in more detail in the following. Further details can be found in the complete report.

		BASE JEAR	REFERENCE SCENARIO Germany: Energiereport IV World: IEA			EXPANSION SCENARIO Germany: NatPlus-2005 World: EREC-DCP		
GERMANY	Unit	2004	2010	2020	2030	2010	2020	2030
Primary energy consumption (PEC)	PJ/a	14 438	14 122	12 981	12 080	13 369	11 767	10 325
Share of RES in PEC	%	3.6	5.7	8.3	10.7	6.9	12.7	21.5
Investments in new systems (excl. local heat grids) Revenue from system operation	billion €$_{2000}$	7.193 2.293	3.958 3.045	3.868 2.949	5.266 3.729	7.170 3.324	9.573 4.573	10.386 6.735
Revenue for German companies in Germany	billion €$_{2000}$/a	5.379	3.267	3.282	4.736	5.753	7.400	7.991
Average energy costs for the RES mix based on 2004 = 100[1]	%	100	80	55	50	90	65	50
Average labour productivity (2004=100) ExS "cautious"	%	100	79.83	60.88	54.25	79.83	60.88	54.25
Average labour productivity (2004=100) ExS "cautious optimistic"	%	100	76.27	55.81	47.14	76.27	55.81	47.14
CO_2 emissions	million t/a	840	811	768	695	739	641	497
CO_2 emissions avoided by using RES	million t/a	71	95	115	130	110	160	220
Energy price for oil in EPS "Energiereport IV"	$$_{2000}$/b	35	28	32	37	28	32	37
Value for RES electricity in the EPS "Energiereport IV"	ct$_{2000}$/kWh	2.8	3.0	3.5	4.1	3.0	3.5	4.1
Differential costs for EPS "Energiereport IV"	billion €$_{2000}$	3.222	5.513	3.744	2.914	6.970	8.018	8.345
Energy price for oil in EPS "DLR 2005 + CO_2" and "Surcharge[2]"	$$_{2000}$/b	35	52	60	65	52	60	65
CO_2 surcharges in EPS "DLR 2005 + CO_2" and "Surcharge[2]"	€$_{2000}$/t	0	7.50	15.00	22.50	7.50	15.00	22.50
Value for RES electricity in EPS "DLR 2005 + CO_2"	ct$_{2000}$/kWh	3.0	3.4	4.5	5.6	3.4	4.5	5.6
Differential costs for the EPS "DLR 2005 + CO_2"	billion €$_{2000}$	2.714	3.123	-0.912	-3.596	4.300	2.250	-1.963
Value for RES electricity in EPS "Surcharge[2]"	ct$_{2000}$/kWh	4.5	4.9	6.0	7.1	4.9	6.0	7.1
Differential costs for the EPS "Surcharge[2]"	billion €$_{2000}$	1.749	1.575	-3.233	-6.875	2.597	-1.183	-8.159
WORLD								
Investments in new systems	billion €$_{2000}$/a	43.200	64.700	115.800	174.400	120.100	251.700	461.700
Total revenue for German companies ExS "cautious" thereof exports	billion €$_{2000}$/a	7.370 1.991	6.772 3.505	7.688 4.406	8.620 3.884	14.348 8.595	23.639 16.239	28.789 20.798
Total revenue for German companies ExS "cautious optimistic" thereof exports	billion €$_{2000}$/a	7.370 1.991	7.617 4.350	9.045 5.762	11.020 6.284	16.175 10.422	29.726 22.326	41.310 33.319
EMPLOYMENT EFFECTS								
Gross employment[3] ExS "cautious" ExS "cautious optimistic"		157 074	161 314 170 777	169 903 181 821	179 683 197 421	244 102 262 893	306 691 353 541	332 848 415 010
Net employment[4] ExS "cautious" and EPS "DLR 2005 + CO_2" Employees[5]						46 040 55 230	56 610 73 600	62 040 84 410
Net employment[4] ExS "cautious" and EPS "Surcharge[2]" Employees[5]						46 330 55 520	61 140 78 270	94 540 118 910
Net employment[4] ExS "cautious optimistic" and EPS "DLR 2005 + CO_2" Employees[5]						55 250 65 870	89 910 112 800	113 700 147 500
Net employment[4] ExS "cautious optimistic" and EPS "Surcharge[2]" Employees[5]						55 510 66 120	94 410 117 440	146 230 182 060

RES = Renewable Energy Sources
PEC = Primary Energy Consumption
ExS = Export Scenario
EPS = Energy Price Scenario

[1] Differences between the average energy costs in the expansion scenarios are due to the mobilisation of different technologies
[2] This energy price scenario (EPS) is based on the "DLR 2005 + CO_2" scenario with all prices increased by ct 1.5 /kWh
[3] Employees and the self-employed which contribute to social insurance
[4] Employees which contribute to social insurance
[5] Includes employees which contribute to social insurance as well as the self-employed and public servants

Table 1:
Significant assumptions and quantified results from the study for the base year 2004 and for the years 2010, 2020, and 2030.

NATIONAL AND INTERNATIONAL SCENARIOS FOR EXPANDING RENEWABLE ENERGY

Germany is an international leader in the market introduction of renewable energy systems, especially for the use of wind energy and photovoltaics. Due to their pioneering role in these and other technologies it can be assumed that German manufacturers will profit substantially from the strong growth expected on the global market. For this reason one emphasis of this study is on foreign trade.

Scenarios at the national and international level are analysed to determine employment effects. The energy industry reference forecast "The Development of the Energy Markets up to the Year 2030" (Energiereport IV) was prepared for the German Federal Ministry of Economics in 2005 and is used here as the reference scenario for Germany. An alternative development path (NatPlus-2005), which assumes a more rapid expansion of renewable energy, represents an updated extrapolation of the corresponding scenarios from the "Ecologically Optimised Expansion for the Use of Renewable Energy in Germany" study prepared for the German Federal Environment Ministry in 2004. In the reference development, renewable energy attains an 8.3 % share of the primary energy consumption, which remains nearly constant, by 2020. The German Federal Government's expansion goal of at least 10 % by 2020 is not achieved in this scenario. Stronger energy-saving and efficiency measures are included in the alternative scenario so that the primary energy consumption is reduced and a 12.7 % share of renewable energy can be achieved.

The resulting **investments in systems to generate electricity and heat from renewable energy in Germany increase from € 7.7 billion/a in 2004 to €$_{2000}$ 10.7 billion/a in 2020 in the "NatPlus-2005" scenario**. In the more cautious reference development, however, the investments drop to €$_{2000}$ 4.1 billion/a (Fig. 2). Additional revenues of €$_{2000}$ 2.9 billion ("Reference") or €$_{2000}$ 4.6 billion ("NatPlus-2005") are earned through operation of the systems.

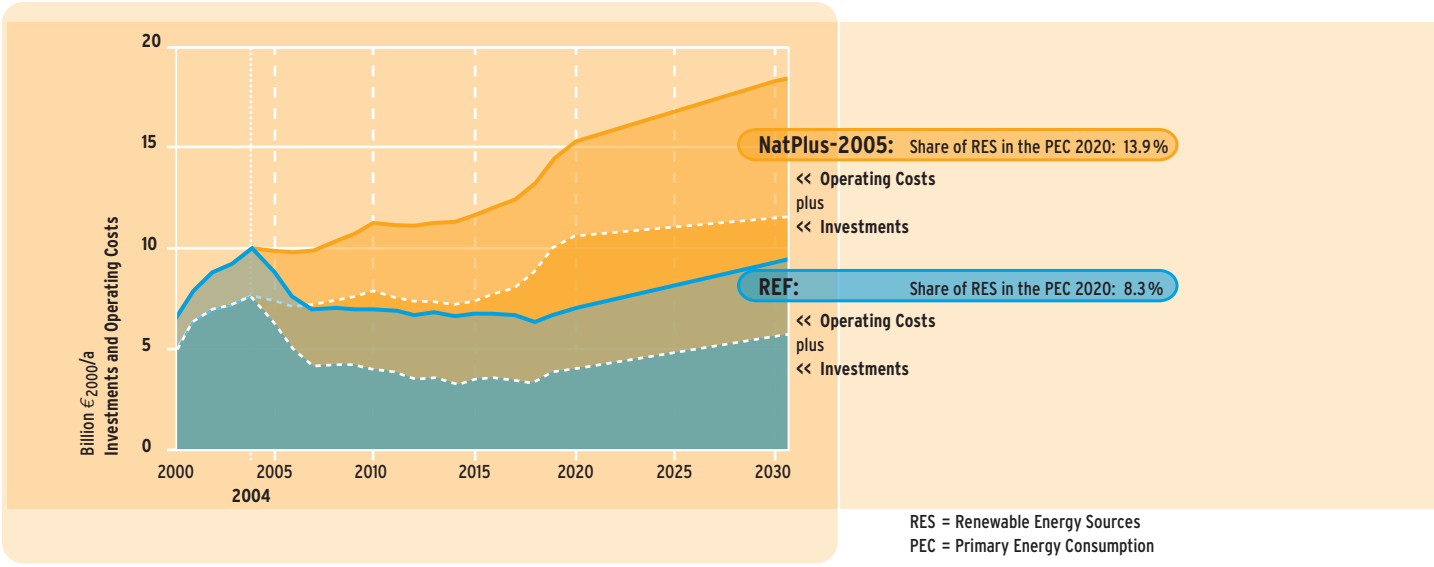


Figure 2:
Breakdown of the investments and operating costs for the electricity and the heat sectors according to the NatPlus-2005 scenario and compared with the reference scenario (REF).

The **development of differential costs** for the expansion of renewable energy is highly dependent on the energy price development. This fact is true for both the general energy price level, which is set at a very low price in the Energiereport IV (price of crude oil in 2020: US $\$_{2000}$ 32/b compared to US $\$_{2000}$ 60/b in the "NatPlus-2005" scenario), and the price of renewable energy assessed for individual applications. For example, a very conservative value is assumed for the electricity market in the Energiereport IV energy price scenario – increasing from ct_{2000} 2.8/kWh in 2005 to ct_{2000} 3.5/kWh by 2020 (or to ct_{2000} 3.9/kWh taking a CO_2 credit of $€_{2000}$ 10/t into account). On the other hand, a more realistic value from today's point of view of ct_{2000} 4.5/kWh is achieved in 2020 in the "NatPlus2005 + CO_2" scenario, including a CO_2 credit of $€_{2000}$ 15/t CO_2. In order to represent the uncertainties in the future development of electricity prices, a further variant includes an additional credit of ct_{2000} 1.5/kWh over the entire time period and thus better characterises the current situation.

Figure 3 indicates a pronounced sensitivity of the differential costs to the allowable costs assumed for renewable energy according to the quantity scenario "NatPlus-2005" (electricity, heat, and fuel). The maxima lie between $€_{2000}$ 2.7 and 9 billion and will be achieved around 2015. They will only stay at a high level for a longer period of time in the very unrealistic case of the overall energy prices sinking again in the medium term (Energiereport IV) and without considering climate protection costs. **The differential costs of the total renewable energy mix will become negative around the year 2020 when considering higher, more realistic energy prices. Thus, after this point in time it will be cheaper to supply energy from renewable sources than from conventional sources** and the financial advances provided for the market penetration of renewable energy will be permanently reclaimed.

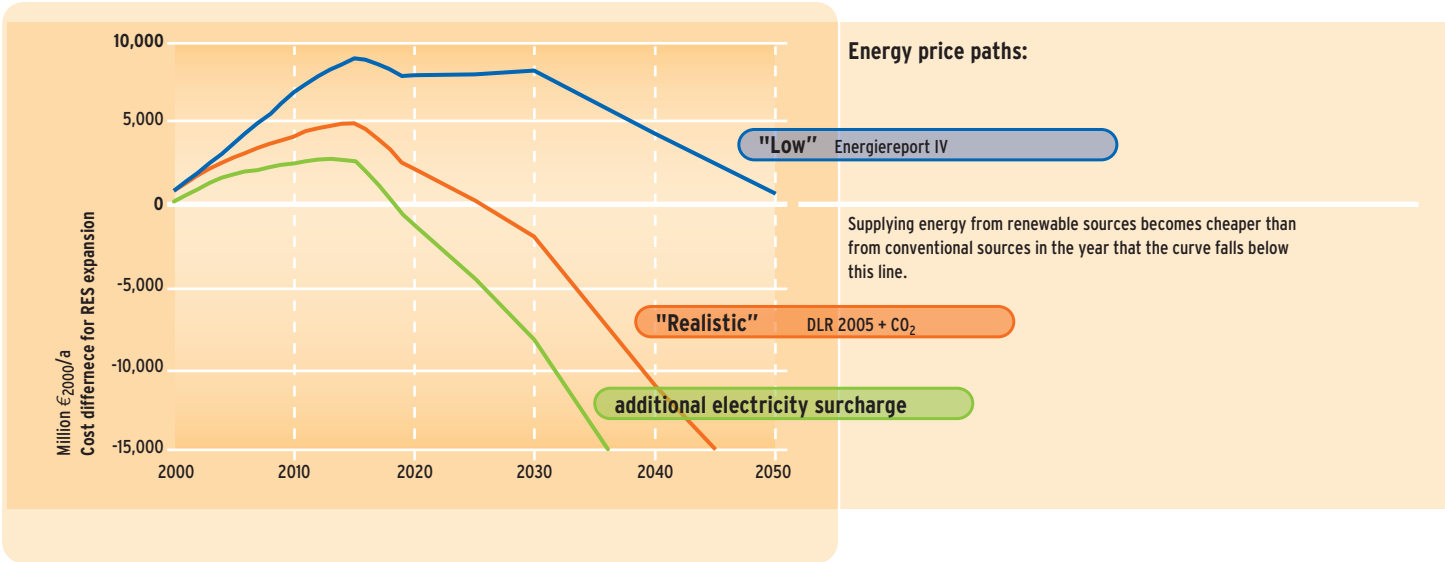


Figure 3:
Progress of the differential costs for the overall expansion of renewable energy (electricity, heat, fuel) in the NatPlus-2005 scenario for three energy price variants.

A strong expansion is expected for renewable energy in the **world market** over the next years and decades. Even the conservative reference development published by the International Energy Agency (IEA) in 2004 indicates that the investments in renewable energy will nearly triple from the current €$_{2000}$ 40 billion to €$_{2000}$ 115 billion by 2020. In Figure 4 a scenario based on a study by the European Renewable Energy Council (EREC), which is consistent with the "NatPlus-2005" scenario, even indicates a six-fold growth to a total of €$_{2000}$ 252 billion. Both cases provide considerable export potential for German companies due to their good competitive position. If this potential is tapped, then exports could become considerably more important than the domestic market within the next few years. **Thus German enterprises could expect revenues in the range of €$_{2000}$ 24 to 30 billion/a in 2020** (excluding revenues from the operation of domestic systems) if the export potential is tapped, especially in the sophisticated technologies like photovoltaic modules, gearing and generators for wind turbines and hydropower stations, measuring and control technology for biomass plants, etc. For a domestic market of €$_{2000}$ 10 billion, and considering system imports, domestic revenue of €$_{2000}$ 7.4 billion and an export rate of 70 to 75% is calculated. If, however, the conservative reference developments should actually come about, then German enterprises involved in renewable energy will only realise an overall turnover of €$_{2000}$ 8 to 9 billion in 2020.

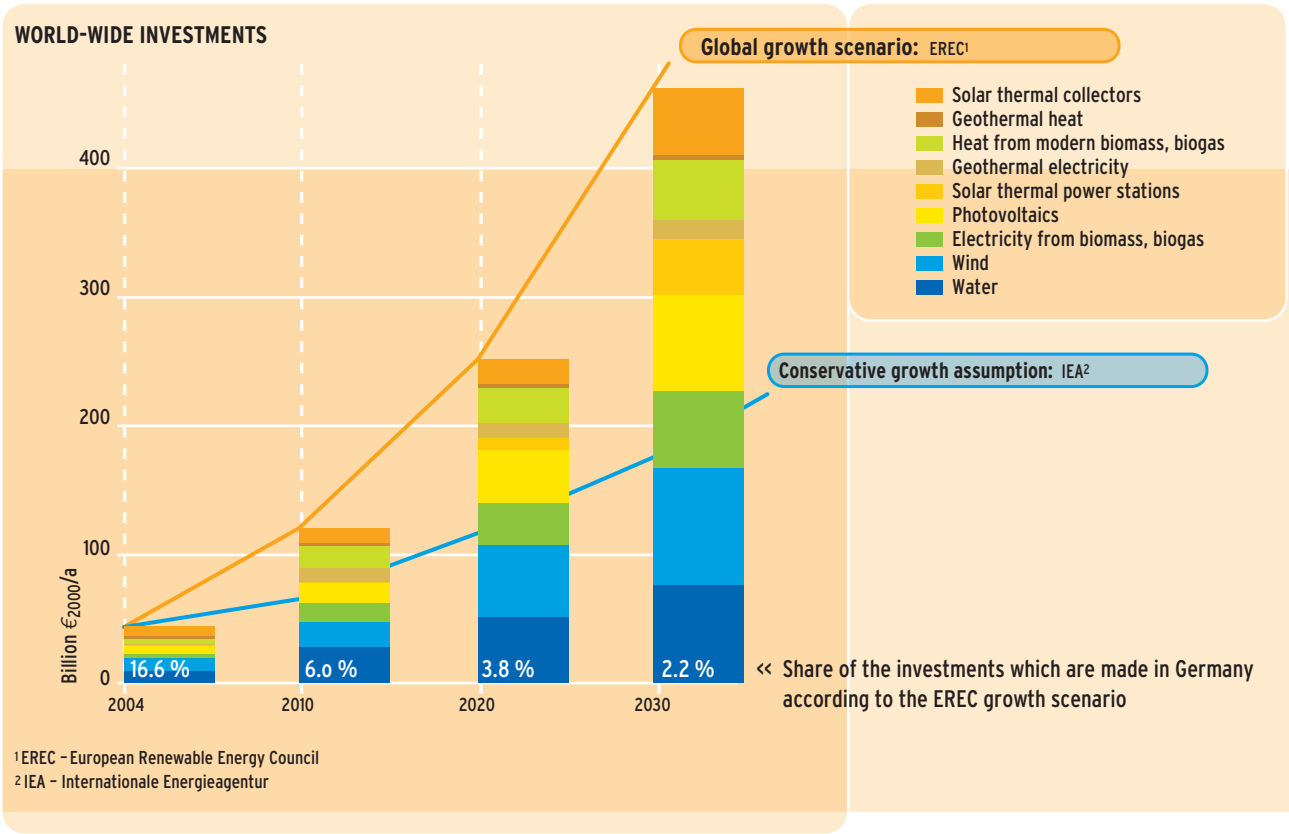


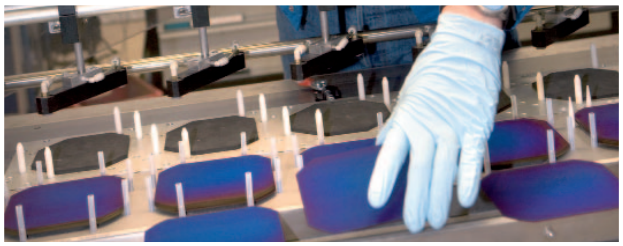
Figure 4:
Future investments in renewable energy in a global growth scenario (based on the European Renewable Energy Council (EREC) report) as compared to the reference scenario (based on the International Energy Agency (IEA) reference development study).

THE INDUSTRY SURVEY – OBTAINING FIRST-HAND INFORMATION

"First-hand information" is indispensable for balancing employment numbers and for evaluating the competitive position of the sector and therefore also to realistically estimate the potential for exports. For this purpose **the most comprehensive survey to date of more than 1,100 companies in this subject area was performed in the summer of 2005** in cooperation with the German Renewable Energy Federation (BEE) and the Institut für Sozialforschung und Kommunikation. Addressees included system manufacturers, suppliers, developers and planners, system operators, financers, insurers, and retailers. They represent 26,400 jobs, whereas 84% of the companies employ less than 250 people. The field is thus clearly dominated by medium-sized enterprises at the present time.

The survey results allow conclusions to be made about the links between the companies with other economic sectors which extend throughout the entire value chain. Additionally, information about foreign trade in systems, components, and preliminary products could be acquired. The information forms an important database for balancing the direct and indirect employment effects caused by the use of renewable energy via the input-output analysis (see below).

Furthermore, numerous questions from other subject areas were also answered, e.g. about the type and extent of the employment, the composition of the staff according to education, sex, and job location, but also about the company's demands on the job market and the political conditions, their expectations for the future and company strategies. One of the most significant results is that the vast majority of the companies look optimistically to the future. Altogether, the surveyed companies expect to increase their number of employees by 54% by 2010, the sectors of solid biomass and photovoltaics even expect to double their employment figures (Figure 5).



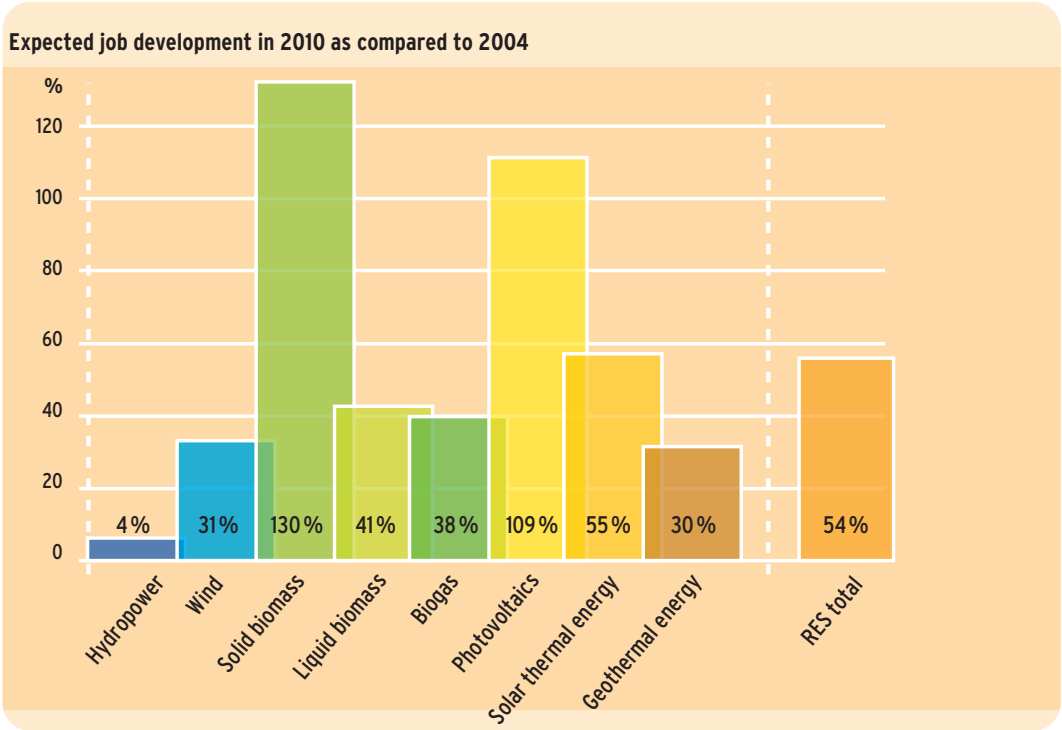


Figure 5:
Survey results on the expected job development.

These expectations can be justified on the one hand by positive German market trends and on the other hand by the increasing foreign business. **The companies consistently rate their international competitive position as good to very good.** One indication for this rating is the export ratio in the trade sector, defined here as the ratio between the export of systems and preliminary products (e.g. components) and the company turnover including services, since the entire value-added chain can thereby be taken into account. According to the survey, the export rate was 28% in 2004. Various other publications exclude the service sector when calculating the export ratio. The corresponding export ratio for 2004 then amounted to 35% for the entire sector, with significant differences between the individual lines of business: it was nearly 50% for wind power, and even nearly 80% for hydropower – for considerably lower absolute values. In contrast, exports are still of little significance in the sector of biomass use with less than 10%, and in photovoltaics with 20%.

Approximately two thirds of the export revenues in 2004 were earned in the European Union member countries (EU-25), another 15% in Asia, and 10% in North and Central America. The European market will presumably continue to play an important role for exports from Germany in the future. In this respect measures for continued expansion of renewable energy in Europe are most important in the medium term for the foreign business development of this sector.

The survey results indicate that Germany is a very attractive location for the businesses, despite the high labour costs. A number of political and structural conditions make Germany attractive. Among them are not just the domestic sales market, which is supported by political instruments like the Renewable Energy Sources Act or the Federal Market Stimulation Programme, but also the availability of qualified personnel, a good infrastructure, and excellent technology development which is linked to the strong research activities in the sector of renewable energy (Figure 6).

Attractive Locations
for the Entire Renewable Energy Industry

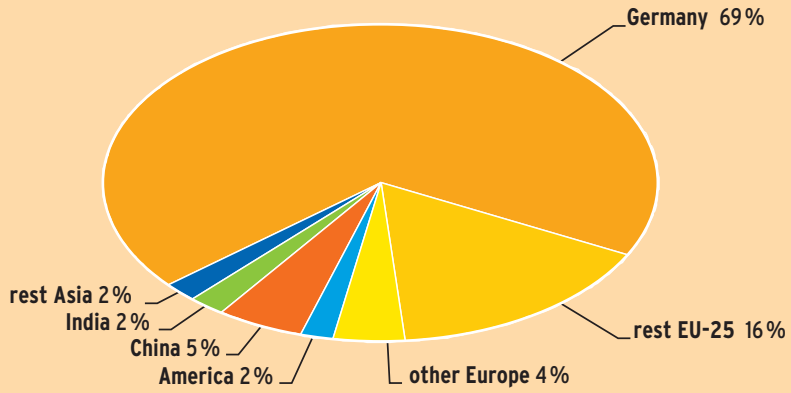


Figure 6:
Survey results about location attractiveness.

ANALYSING RENEWABLE ENERGY WITH THE INPUT-OUTPUT CALCULATION

Input-output tables provide a detailed insight into the flow of goods and interdependencies of industries within the German economy and with foreign countries. The official tables of the Federal Statistical Office are organised into 71 production sectors and are a versatile database for economic analyses, in particular also for disaggregated models. **Expanding the existing schema to include production sectors for renewable energy enables conclusions to be made, not just about the direct, but also the indirect employment effects of the expansion of renewable energy in the other industrial sectors based on the additional empirical information.**

The empirical information base in the area of system manufacturing was considerably improved with the data from the comprehensive industry survey. Together with data from other sources, these results can be used to represent renewable energy in the context of an input-output analysis (Figure 7).

The economic effects activated by the use of renewable energy, especially the impact on employment, are based on both the investments in new systems and expenditures for the operation of existing systems.

The investments lead to the so-called manufacturer effects. They result from the annual investments in Germany, insofar as domestically produced products are purchased, and from the systems which are produced in Germany and exported to other countries. In contrast, the effects caused by operating the systems (electricity and/or heat generation) are independent of where the systems were produced.

The different natures of these two effects indicate that they should be represented separately in the input-output calculation. For this reason, and also considering other requirements for modelling the net employment effects, the two **production sectors** are considered separately:

- **manufacturing of systems for the use of renewable energy,** including the manufacturing of components, and system-related services like developing and planning, and
- **the operation of systems for the use of renewable energy** including maintenance and repairs.

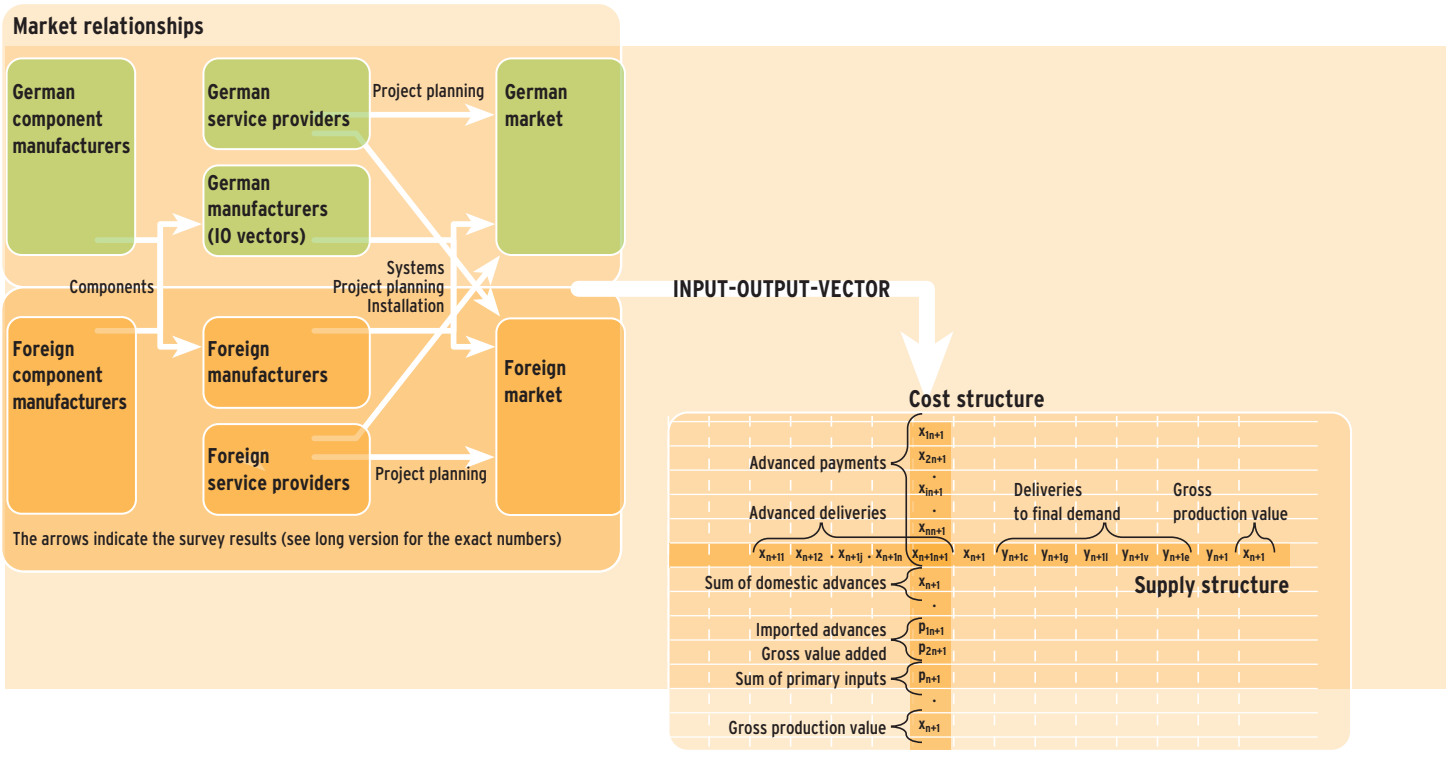


Figure 7:
Empirical data collection in the renewable energy industry.

GROSS EMPLOYMENT EFFECT OF USING RENEWABLE ENERGY IN 2004

The input-output analysis does not just determine the direct employment in those companies which, e.g., produce renewable energy systems, but also the indirect employment in companies supplying preliminary products. For example, the share of the work volume of a steelworker which goes toward producing steel for a wind power station is assigned to the sector of renewable energy, although this connection with his/her work may not be known to the worker. The indirectly employed are very relevant for the renewable energy sector, since they account for over half of the jobs. The gross employment effect is calculated from the sum of the direct and the indirect employees.

The gross employment effect in the field of renewable energy can be estimated at 157,000 jobs for 2004. The gross production value per employee is thereby € 167,000 for system manufacturing, and € 148,000 for system operation. Wind power remains the category with the largest employment (64,000 jobs), followed by biomass (57,000 jobs) – including effects induced by the demand for biogenous combustibles and biofuels – and the solar industry (25,000 jobs). The employment stimulus of the latter two grew faster than for the wind industry in recent years.

Furthermore, Figure 8 indicates that the current growth phase for renewable energy is clearly dominated by the manufacturing effect as compared to the operation effect. This will presumably continue in the future, although the operation effect will gain importance in the German market as the number of systems in Germany increases. The manufacturing effect, however, increases through increasing exports resulting from international market growth.

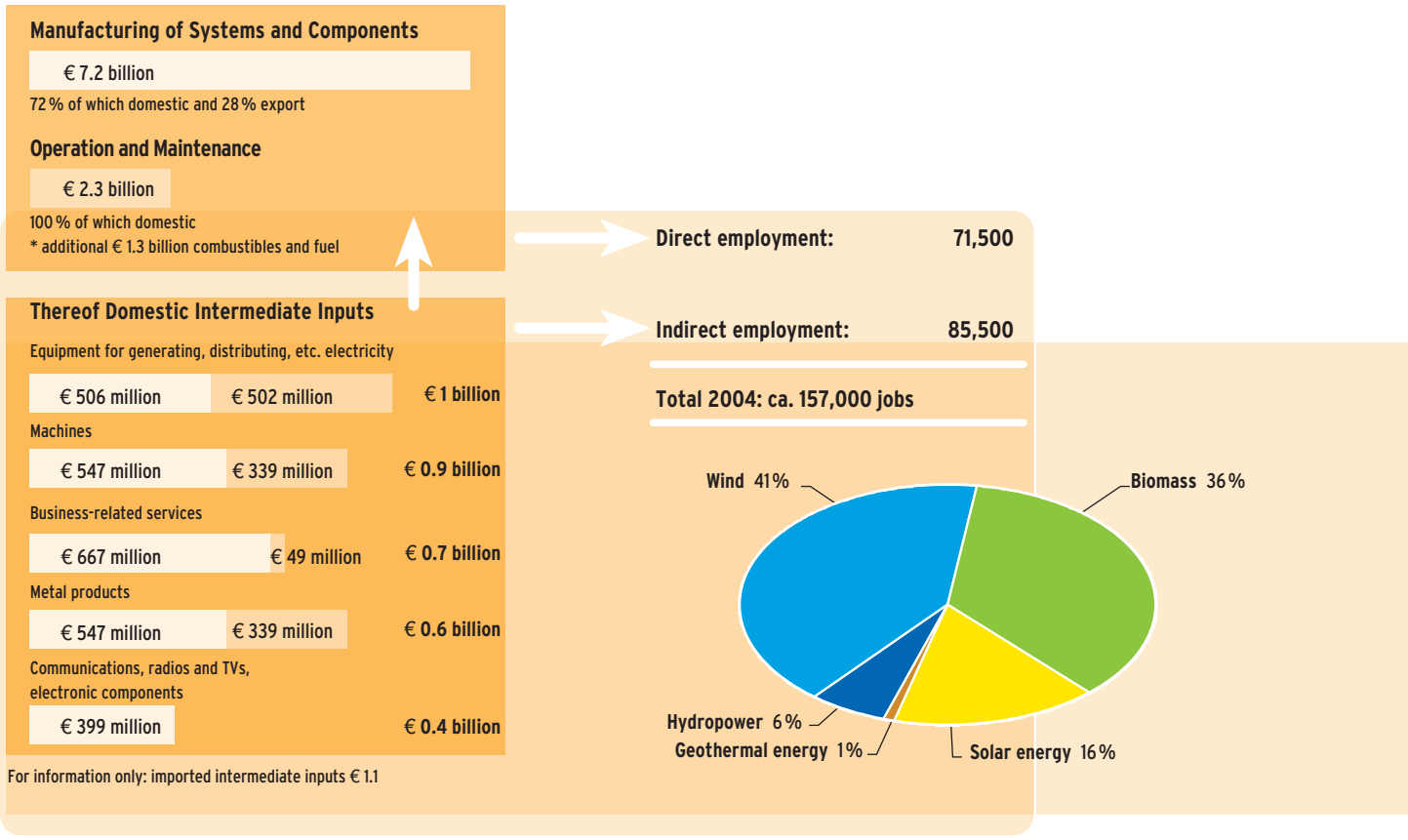


Figure 8:
Gross employment in the renewable energy industry in 2004

Very different economic sectors profit from the production and the operation of renewable energy systems. This effect is indicated in Figure 8 in that the gross production values (revenues) are also listed which cannot be associated with the production sectors "Manufacturing of Renewable Energy Systems" and "Operation of Renewable Energy Systems" and therefore represent intermediate inputs. Corresponding to the official structure of the economical statistics, the sectors **"Equipment for Electricity Generation and Distribution", "Machines", "Metal Products", and the so-called "Business-Related Services"** (e.g. developers) profit from the manufacturing of systems. Sectors like the insurance industry profit from the operation of the systems.

Other employment elements related to the use of renewable energy, like those involved with the distribution or sales of the green electricity, the employment in research institutes induced by the corresponding energy research programmes, or the people who are involved with the administration aspects of the expansion of renewable energy in administration departments or ministries, are however not yet considered in the estimation presented here. The investment expenditures by renewable energy system manufacturers to expand or modernise their production capacity is also not yet considered. **Therefore, the gross employment results calculated here are best considered as a lower limit of the true renewable energy employment effects.**

REGIONAL EMPLOYMENT EFFECTS

The regional correlation of direct employment with the German federal states is difficult since the data basis is still very narrow. However, statements can be made about the intermediate input and supply flows between the four regions of Northern Germany (Schleswig-Holstein, Lower Saxony, Hamburg, Bremen), Southern Germany (Hesse, Baden-Württemberg, Bavaria), Western Germany (North Rhine-Westphalia, Saarland, Rhineland-Palatinate), and Eastern Germany (Mecklenburg-Western Pomerania, Berlin, Brandenburg, Saxony-Anhalt, Saxony, Thuringia). Furthermore, the regional distribution of installed systems provides information about the direct employment in the areas of operation and maintenance.

Figure 9 graphically summarises the employment by region related to local system operation and the production of systems, as far as could be determined from the industry survey. The intermediate input flows are shown in the colour of the region receiving the input for production in that region. The sum of intermediate inputs from other regions and those remaining in the region is 100 %. The solid-coloured circles present the share of direct employment from system operation in the region. The numbers in dashed circles in the centre of Germany represent the distribution of the answers from the surveyed companies regarding direct and indirect employment in system production.

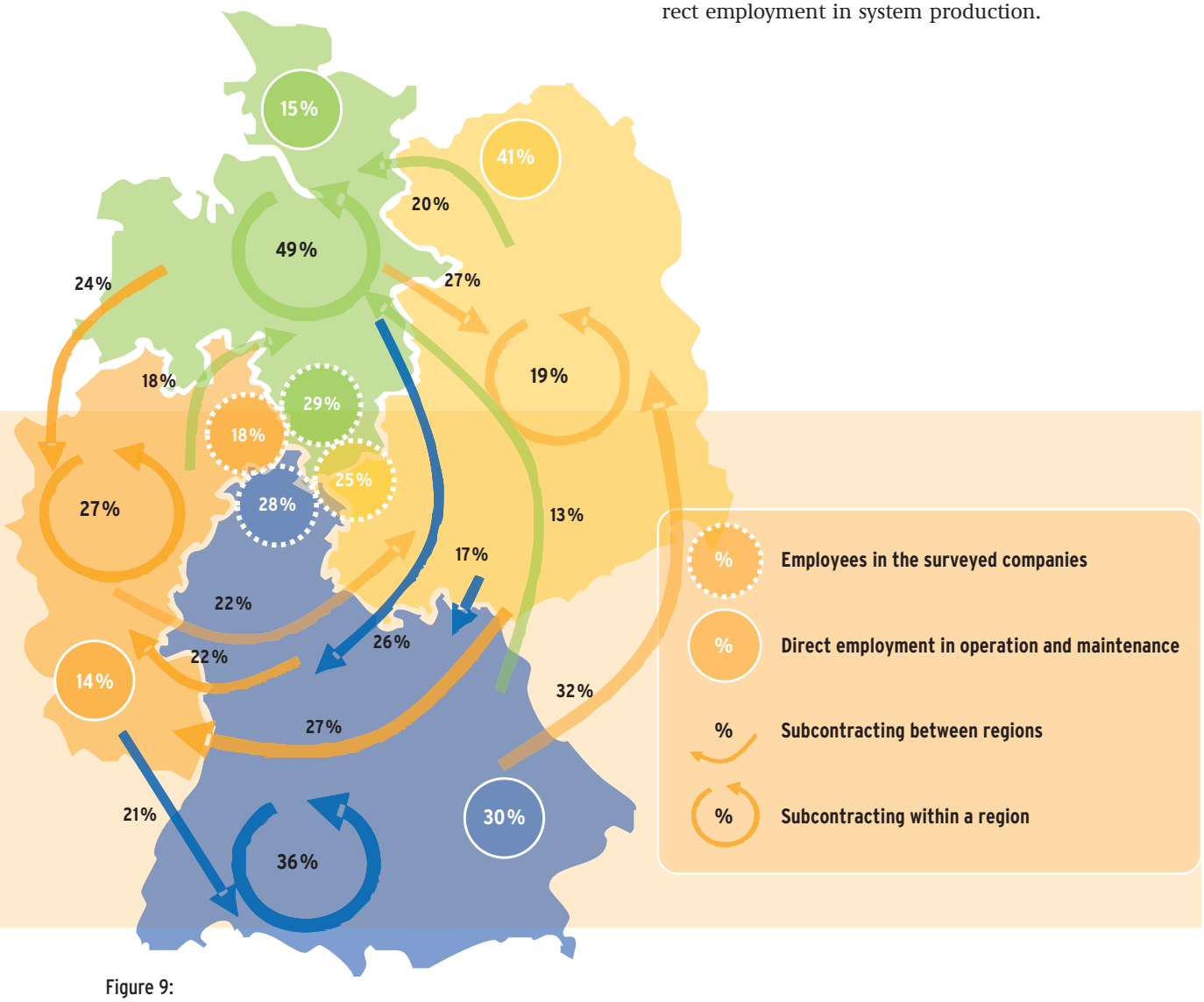


Figure 9:
Employment related to the local operation of systems and to system production.

GROSS EMPLOYMENT EFFECTS OF THE EXPANSION OF RENEWABLE ENERGY THROUGH 2030

The future development of gross employment in Germany can be estimated based on the analysis of the present employment situation, the results of the industry survey, and the national and international scenario drafts regarding the expansion of renewable energy. Since the domestic investment is losing importance as compared to exports, foreign countries will increasingly drive the growing employment in the area of system production. The employment figures in the operation and maintenance of systems, on the other hand, are practically exclusively dependent on the domestic developments.

A wide range of possible export success for German businesses can be imagined, not just because of the relatively long time period under consideration (until 2030), and is covered by four very different export scenarios. **The export scenarios b) "cautious" and c) "cautious optimistic"** represent the central range. The market development in Germany drafted in the "NatPlus-2005" scenario and the corresponding international development is clarified in Figure 10. **The world market share of systems and components "Made in Germany"** decline from **17% in 2004 to 9.4 or 11.8% in 2020** due to global market growth. Nevertheless, even the rather conservative export scenario b) in Figure 10 indicates an increase in system investments to **€$_{2000}$ ca 24 billion/a (thereof export €$_{2000}$ 16 billion/a) in 2020** for German companies domestically and abroad. At the same time, the **gross employment increases from 157,000 to 244,000 in 2010 and up to 307,000 jobs. In export scenario c) the investments even increase to €$_{2000}$ 30 billion/a (export €$_{2000}$ 22 billion/a) by 2020, and the jobs increase up to 354,000 (2010: 263,000).** The gross employment in 2030 can be estimated at 333,000 employees for export scenario b) and 415,000 for export scenario c).

Although this range is considered most realistic by the authors, other developments are also possible. In the case of the pessimistic export scenario a), a world market share of only 6.9% in 2020 describes an export market which is not much larger than the domestic revenues in Germany. The establishment of the German renewable energy industry in the world market would have to be considered unsuccessful in this case. The optimistic export scenario d), on the other hand, assumes that German companies will be able to approximately maintain the current world market shares of 14.2% until 2020. With a sales volume of €$_{2000}$ 36 billion in 2020 and €$_{2000}$ 54 billion in 2030, the employment figures then increase to about 0.5 million jobs by the end of the considered time period. This case rather represents an upper limit, which however is already deemed possible for 2020 by the German Renewable Energy Federation.

Conversely, if the future market growth for RES is assumed to be significantly stunted, as indicated by the REF scenario, then the increase in gross employment would stagnate. The corresponding values for 2020 would then be 170,000 employees for export scenario b) and 182,000 for export scenario c). In this scenario, the export growth – provided there is any growth at all under these extremely unfavourable conditions – would barely compensate for the shrinking domestic market.

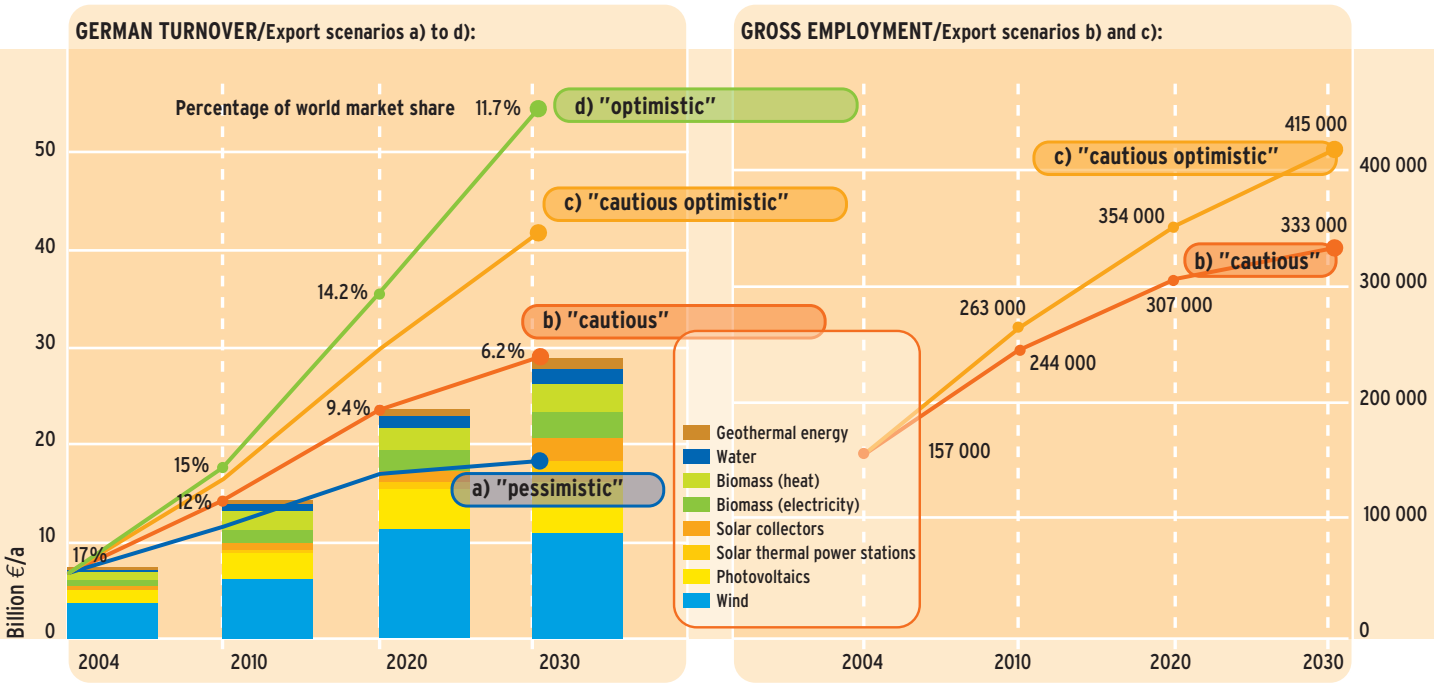


Figure 10:
Turnover of German businesses domestically and abroad, as well as the corresponding gross employment effects until 2030 for various export scenarios (bars represent the investments in export scenario b).

NET EMPLOYMENT EFFECTS OF THE EXPANSION OF RENEWABLE ENERGY THROUGH 2030

It is a methodological challenge to determine the net employment related to the expansion of renewable energy and the result is significantly influenced by the chosen assumptions. In particular, the energy price scenarios and estimates of the investment and export volumes play an important role. The latter also activate various quantity effects in the upstream sectors (intermediate input demand), which can be met with both domestic production and imports. Changes in energy prices also affect the entire price structure of the economy, influencing intermediate and final demand, production, and imports. Increased production can lead to more value added, but also to more imports and more use of intermediate inputs. Developments in prices, wages, and productivity play an important role in this distribution, and the question of whether or not additional value added also leads to more employment. Higher wages and more employment provide higher disposable incomes which then influence the final consumption. For this reason, dynamic effects of a changing economic structure and technical progress must be included in the analysis of net employment. The net employment analysis is therefore determined by numerous influence factors and interdependencies (Figure 11).

In contrast to the analysis of gross employment, which is limited to investment, operation, and foreign trade effects, the substitution and budget (disposable income) effects are also determined during the assessment of the net employment effect. The budget effect results from the differential costs incurred when supplying energy from renewable sources instead of from non-renewable resources. Both effects influence the entire economy and not just the renewable energy industry and its suppliers like the gross employment described above. Therefore, changes in the economy caused by the increased expansion of renewable energy cannot be derived directly. In order to quantify these changes, the total effect of the expansion of renewable energy must be compared with a reference case. The net analysis must therefore be based on the comparison of two different developments. In this study, the differences between the "Reference" and the "NatPlus-2005" scenarios are considered after the base year 2004.

In particular, a sufficiently long time period must be considered, since the different (positive and negative) employment impacts affect the economy at different times, and only long-term stable effects are economically favourable. Short-term stimuli, like from strong investments, can be opposed by the longer-term budget effect. Therefore, employment figures for individual years are not very significant.

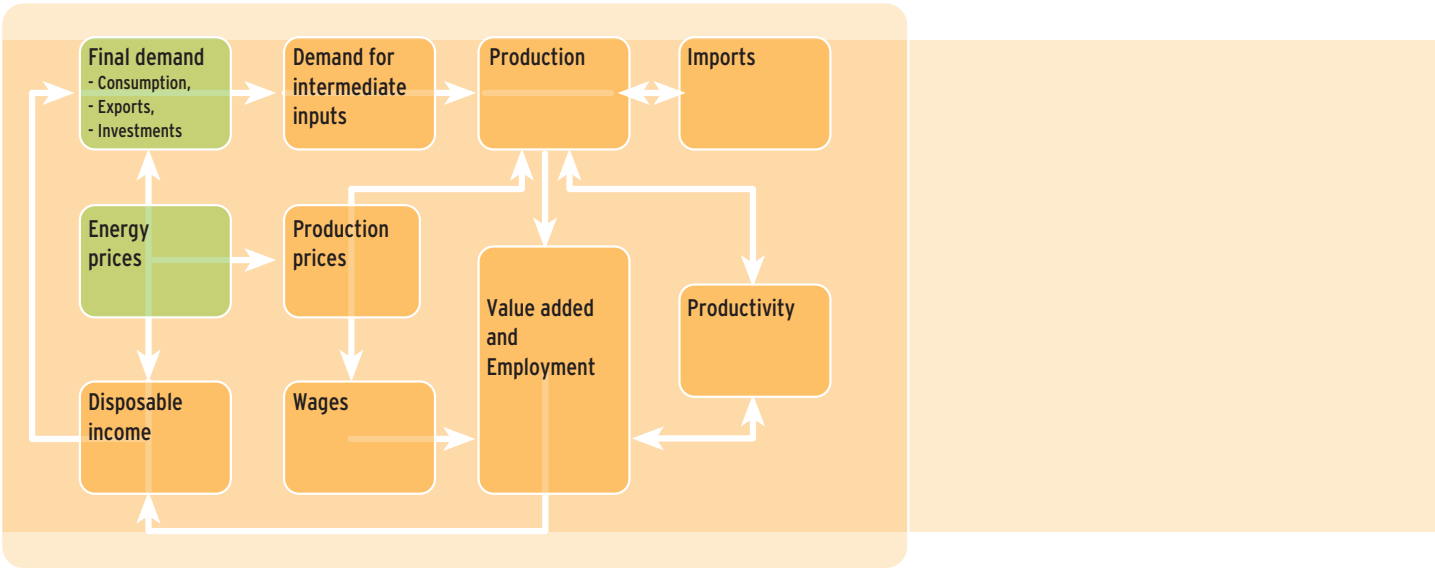


Figure 11:
Simplified representation of the impact relationships used to determine the net employment effects caused by the expansion of renewable energy.

The key to seriously determine employment effects is thus to consider the differences between two future development scenarios over a longer period of time. The scenarios must be consistent with each other and the pertinent technologies must experience very different developments. Here, starting in the base year 2004, the reference development describing a very slight expansion of renewable energy in the long term (Energiereport IV) is compared with a dynamic, goal-oriented expansion (NatPlus-2005) which simultaneously fulfils the targeted climate protection goals. The long time period (until 2030) illustrates the very large differences in the market introduction of renewable energy in its second half. Therefore, all relevant impacts of the expansion of renewable energy on the labour market could be represented with sufficient differentiation.

The national level overlaps with export scenarios for renewable energy. In general, the work productivity in processing industries will continue to increase in the future and will enable significantly more production volume per employee in 2020, and even more so in 2030, than is possible today. At the same time, however, the energy productivity of the German economy will also increase overall. If it increases faster than the energy prices, then energy prices will lose their influence on the economy as a whole.

The simulation and forecasting model PANTA RHEI is a tool for determining the net employment effects and has been used for various environmental-economical questions over the past few years. Figure 12 illustrates the most important results of a comparison of the national scenarios mentioned above with this model – first together with the rather conservative export scenario b) "cautious" export development and the electricity price variant "DLR 2005 + CO_2" (solid red bar in Figure 12).

The net balance of scenario "NatPlus-2005" indicates nearly 74,000 more wage earners[2] in 2020 than the reference scenario, and continues to increase afterwards. Throughout the time period under consideration the gross production, the gross domestic product and its components are all higher than for the reference scenario due to the increased production of systems for using renewable energy. However, at this point it also becomes clear that increased production does not necessarily increase the added value (gross domestic product) to the same extent. On the one hand, a portion of the additional production will be purchased abroad, which appears as an increase in imports. On the other hand, the use of preliminary products will also increase.

Since the expansion scenario also meets the climate protection goals, these results demonstrate exemplarily that **effective climate policy can simultaneously be a macroeconomically favourable employment strategy,** provided that the growth dynamics generated by a national pioneering policy is successfully and timely transferred to export markets. In this way, initially negative factors (like the additional costs of expansion over a particular time period) can be overcompensated. In the long term, the budget effect becomes negligible or even positive and supports the development.

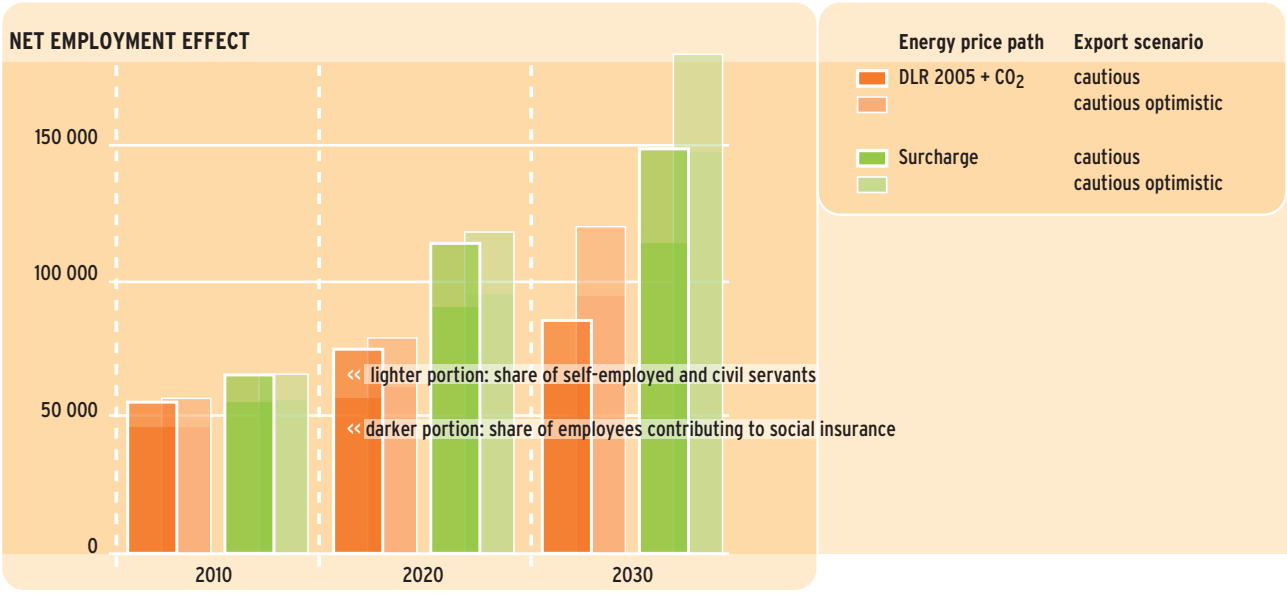


Figure 12:
Net employment effects between the scenarios "NatPlus-2005" and "Reference" in combination with two export scenarios with different energy price variants.

[2] Figure 12 also indicates the number of employees contributing to social insurance, as provided by the Bundesagentur für Arbeit labour statistics. The employment figures are based on the micro-census results.

The positive macroeconomic impact of accelerating the expansion of renewable energy according to the "NatPlus-2005" scenario is primarily sustained by the equipment investments and exports on the demand side. As time passes, the export effect increases significantly along with the strong growth in the world market for the pertinent technologies. The stimulus from domestic investments increases only slightly until 2020, but remains positive over the entire time period.

Figure 12 also shows a sensitivity calculation with regard to the price of electricity from renewable energy. While the base variant "DLR 2005 + CO_2" assumes a moderate increase from ct_{2000} 3/kWh in 2004 to ct_{2000} 3.4/kWh in 2010, ct_{2000} 4.5/kWh in 2020, and ct_{2000} 5.6/kWh in 2030 (for comparison: the average spot market price for base load electricity on the Leipzig Electricity Exchange EEX was already ct_{2000} 4.6/kWh in 2005; it has however dropped slightly since then), **the "Surcharge" price variant always assumes that the price of electricity from renewable energy will be ct_{2000} 1.5/kWh higher.** It is clearly evident that the resulting net employment increases, especially in 2030. This development is a result of the renewable energy mix becoming cost-competitive, also reflected in the differential costs becoming negative (compare with Figure 3). **Since the budget effect then becomes positive, the net employment effect of the expansion of renewable energy in the "NatPlus-2005" scenario as compared to the reference development suddenly jumps to a total of ca 120,000 jobs in 2030.**

Several other sensitivities can be considered in the same way, as shown by the "cautious optimistic" export scenario c) included as an example in Figure 12. It is also important to note that negative net employment effects are only calculated for the unlikely case that the exports of renewable energy technology stagnate and the energy prices drop back to the levels from 2000 to 2002 (i.e. oil prices of US $\$_{2000}$ 32/barrel in 2020).

SUMMARY AND OUTLOOK

The present study could clarify a series of questions regarding the impact of the expansion of renewable energy on employment. Based on the largest industry survey carried out so far on this subject, the impact of renewable energy use on employment could be analysed consistently and reliably. **A steadfast result of this study is that the previous development of renewable energy has lead to significantly positive employment effects so far, and that the so-called first-mover advantages are in effect – expressed by an international, efficient industry, strong in exports in key sectors of renewable energy.**

Significant employment increases are expected to continue in the future. However, especially the net employment increase will not happen by itself. The positive stimuli from investments in systems for the use of renewable energy and the operation of the systems are opposed by substitution effects and especially by the budget effect caused by the additional cost of renewable energy as compared to conventional energy generation. This compensation will be in effect until renewable energy becomes widely price-competitive, at which time however the advanced start-up financing of renewable energy will pay off in the long term, also in terms of employment. **Particular attention must therefore be paid to the transition phase, which will likely still continue for another 15 to 20 years depending on the development of the cost relationship between the renewable and the non-renewable energy mixes.** A rather moderate price development for fossil energy carriers was assumed for the reference case. Sensitivity calculations indicate the strong dependence of the results on this cost relationship. Furthermore, the expansion dynamics for renewable energy must be sustained for both those technologies which are close to the market and those further from market, in order to continue to mobilise their cost-reduction potentials.

Based on the scenarios described here, it can be assumed for Germany that the **differential** costs for the continued expansion of renewable energy in all areas (electricity, heat, fuel) **will increase to the absolute (not specific) maximum sum of €$_{2000}$ 5 billion/a for about another 10 years**. Afterwards, however, the costs will quickly drop to zero despite further growth and become negative between 2018 and 2028, depending on the energy price scenario. **The dampening of the employment impact until that time can be compensated or even overcompensated for by an increased foreign demand for products and services from Germany in this technology area**. In this case, it is also e.g. in the interest of labour policy to promote the expansion of still relatively expensive technologies like photovoltaics. The development in the foreign markets also play an important role for Germany, since the cost reductions achievable over time (learning curve) for renewable energy increasingly depend on the global market.

The results of the industry survey indicate that Germany is a particularly attractive location for the mostly medium-sized enterprises in the renewable energy sector, and that significant employment increases are to be expected in the next few years. At the same time, the businesses will increase their export activities. The favourable starting position should be deployed and stabilised by politics. This goal can be achieved by designing reliable financing conditions for the heat and fuel markets similar to those offered by the Renewable Energy Act (EEG) for the electricity market and by the continued reduction of other obstacles. Since the German market is open for foreign suppliers, favourable conditions are a necessary but not yet sufficient prerequisite for a parallel growth of domestic employment. Imports of systems and components for the use of renewable energy can be best limited by ensuring that the technological competitive position remains in Germany. An essential prerequisite for this development is in any case to maintain the present level of private and public support for research and development. **Especially technology areas which will be important in the future international markets must be supported.** Examples include the development of offshore wind energy potentials, solar thermal technologies like solar process heat or solar thermal power plants for countries with high solar irradiance, and complex and efficient techniques for biomass conversion like new methods for fuel synthesis. At the same time, a clear commitment to locating in Germany should be demanded of the businesses, since decisions about location changes or value added shares are ultimately made there.

It is just as important to improve the conditions for renewable energy use on the international level. Initiatives like the International Action Programme which was started in Bonn during the "renewables2004" conference for renewable energy and which comprises nearly 200 substantial actions and the newly founded international policy network "Renewable Energy Network – REN 21" move in this direction. Bilateral agreements or co-operations within the framework of development co-operations are also effective. The Export Initiative based at the German Energy Agency can and should continue to provide important assistance to medium-sized enterprises to develop foreign markets.

The European dimension is particularly important in the area of renewable energy. The industry survey performed for this study indicates that Europe is currently

the most important sales market by far – a situation which will continue in the medium term. A whole series of goals for the expansion of renewable energy were formulated by the European Commission and the Parliament in the past. An exemplary goal was already set in 1997 to double the contribution of renewable energy to 12% by 2010. The European Parliament has been demanding for some time to increase the share to at least 20% by 2020 and recently concluded that 25% could also be possible. The goals are backed up by a series of measures. For example, the EU guideline from 2001 for the promotion of renewable energy in the electricity market sets indicative goals for the member states. In this guideline, the share of renewable energy in the electricity supply should increase from 14% in 1997 to 22% in 2010 (EU-15: 22%, EU-25: 21%). Another example is the guideline from 2003 in which renewable fuels should achieve a share of 5.75% by 2010. This guideline is flanked by a series of measures like the Biomass Action Plan from 2005 or the further promotion of research and development.

Without a doubt, all of these measures have led to success. Nevertheless, it is foreseeable that most goals will not be achieved on time at the European level. A particularly inhibiting element is that the development proceeds differently in each of the individual member states and that the required expansion dynamics are currently limited to a few countries. **The imminent German EU Council presidency during the first half of 2007 should therefore be used to achieve mandatory long-term European expansion goals, to stabilise the overall process, and to involve all countries in this process.**

Although the results of the present study provide a reliable basis for strategic decisions, **further research is necessary**. In some areas, the complex relationships are only beginning to be understood. Starting points for further investigation are to be found both in the methodology and in the content. Although it is possible to balance the gross employment effects of renewable energy use by employing official input-output tables, they are still inevitably caught in the present interdependencies between the economic sectors. It is therefore reasonable for long-term projections to assume that the interdependencies are not static and instead fit them to trends which can already be recognised, and also to study possible structural changes, e.g. related to changes in the acquisition of preliminary products from abroad. Approaches in the balancing of net employment effects should proceed in the same direction, by more closely linking national model systems to international model systems, so that the export chances for German companies can be better analysed. For this purpose, a better defined **identification of components and systems which are particularly interesting for exporting is necessary and will also indicate where further research and development measures are required**. Cues can also be taken from analyses of world trade shares for renewable energy, like those already performed for environmental protection goods, but which are only in their beginnings for renewable energy.

Besides improving the methodological basics, the study offers a series of starting points for improving the database and for in-depth analysis. Since there are some uncertainties in the data basis, especially in the sector of bio-energy carriers, conservative assumptions were made regarding their monetary value and thus also regarding their impact on employment. It would therefore be good to work through the data again, since bio-energy carriers represent an important sector of renewable energy in Germany, to also include the value added structures for bio-fuels. **Furthermore, the employment impact of some areas was neglected, since it was not possible to calculate their penetration within the framework of this study.** Such areas include employees in research institutes and public administration, but also **predominantly the employees involved in the construction of new production plants for manufacturing systems for renewable energy use**. This effect is not insubstantial, especially during capacity expansion phases like those presently underway both nationally and internationally.

The question of the **past and present impact** of a political instrument (especially the EEG) on the net employment is also posed in the interest of energy policy. In order to formally and correctly answer this question, it would be necessary to consider a fictive “reference development” starting, for example, in 1990 to model the developments without the EEG or other instruments promoting renewable energy for comparison with the factual development until 2004. This case would also involve observing the differences between two different development paths, whereby one path has a purely hypothetical character and several assumptions must be made to develop it. How would other support programmes, which promoted renewable energy earlier, have developed? How could foreign developments have influenced exports? Which energy carriers or savings would have closed the gaps? Starting which year could the support have been discontinued? Resolving these questions would be a necessary start for the proper analysis of the employment effect of renewable energy.

This complex method, which bears the risk of arbitrary assumptions that cannot be verified by the real development in the past, was not chosen for this study. The impact of the expansion of renewable energy so far was instead indirectly approximated from the differences in the future development of investment volumes, differential costs, and energy amounts between the two scenarios and from the gross employment determined for 2004. Uncertainties arise through work productivity, investable energy prices, and other export relations which deviate from the past values. Taking these influences into consideration, a positive net employment between 35,000 and 40,000 employees can be derived for the base year 2004 with a gross employment of 157,000.

A little more than 70% of this value is attributed to the impact of the EEG, the remaining 30% is equally distributed between the heat market (market stimulation programme) and the fuel sector (tax exemption).

It is recommended to continue the in-depth observation of regional employment impacts, especially in the New German States. It is already now becoming apparent that the businesses involved in the production of systems for renewable energy use located in the New German States procure nearly 80% of their preliminary products from the other regions in Germany. A partial cause of this situation is that factories located in the New German States have close business connections with western "parent companies", like happens for example in the wind sector. Another cause, however, is that apparently companies in the western regions can look back on long-established supply contacts, or that clusters have formed in local regions. A more extensive database would be necessary to clarify whether or not special promotion of networks can contribute to the long-term creation of more value added in the eastern region. This aspect therefore leads to questions of structural policy, which is connected with **the analysis of location factors for companies, and thus must also be seen in connection with avoiding possible production outsourcing to foreign countries. Both aspects are parts of the question of how so-called lead markets can be developed and secured in the sector of renewable energy**.

The development dynamics in renewable energy suggest that this process should be observed, especially regarding the impact on employment, and that surveys should be performed regularly. The positive experience with the recent industry survey indicates that companies are willing to support the monitoring measures necessary for the state and the economy to act concertedly to correct erroneous trends and to selectively support positive trends.

A growing number of studies confirm that a significant contribution from renewable energy sources will be essential for solving or alleviating the energy supply problems pertaining to environment and climate protection, reducing import dependencies, avoiding conflicts over fossil resources, etc. Their significance is thus beyond dispute. However, concerns regarding the necessary financial expenditures during the expansion phase, and the resulting burdens for some economic sectors, are expressed. These concerns are becoming less and less sustainable because they usually originate from a short-sighted national perspective, the interests of individual economic sectors, or an assumption of permanently low energy prices. Recent developments in the global energy markets have demonstrated more clearly than ever that long-term international solutions are essential.

The present investigation demonstrates that the structural changes in the energy supply associated with the expansion of renewable energy can lead to remarkable macroeconomic advantages in Germany in the medium and longer term. The use of renewable energy has a price-stabilising effect in the long run because it depends primarily on technology developments and not on resources which are becoming exceedingly scarcer. Their expansion is therefore also an important component of a strategy for the future which depends more on education, research, and technology development. At the same time, renewable energy can contribute to the achievement of structure and regional policy goals. Most notably, however, the study demonstrates that the employment perspectives related to the expansion of renewable energy are favourable, especially for foreign trade. Although the success will not occur on its own, and many questions must still be answered, the conditions for German companies to profit from growth in the international renewable energy market, and thus to secure and create employment to a considerable extent must be considered as very favourable.

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