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Employment from renewable energy in Germany: expansion and operation -
now and in the future, third report on gross employment

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Gross employment from renewable energy in Germany in 2013

– a first estimate –

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INTRODUCTION

The strong expansion of renewable energy continued worldwide in 2013. However, investment in renewables dropped by 14%, down for the second year in succession. As in 2012, this trend is primarily due to a price effect, i.e. the same – or even a greater – amount of new capacity can be provided with less money. The trend towards a regional shift in new installations and investment has also continued from 2012. Asia is now definitely registering the greatest efforts and successes in the expansion of renewables, whilst the uncertainties for investors are increasing in the U.S. and in Europe [UNEP 14], with the result that China invested more in renewables in 2013 than all the European countries together.

In Germany, the proportion of renewables has now grown to more than 25.4% [AGEE Stat 14] of gross electricity generation. However, the focus of the public debate has increasingly moved away from the economic potential offered by renewables to center instead on the risks involved and the cost burden on consumers and the way that the burden is shared by different groups of consumers. All this has led to consumers and investors becoming increasingly wary. This is why the new German Government decided in its Coalition Agreement that it would overhaul the Renewable Energy Sources Act and do so quickly. The recasting is well under way, with the key points having been approved by the Federal Cabinet in January 2014, followed by an agreement between the federation and the Länder in April and the publication of the draft bill on 8 April¹.

This study into the development of employment and employment structures in the renewables sector provides valuable insights into how the industry is faring in this rapidly changing environment. For the first time in the eight years covered by this report and previous editions, overall employment in the sector has fallen quite considerably. The largest decline was in the photovoltaics industry and is mostly attributable to developments on the domestic market, namely the newly installed capacity in Germany plummeting by more than half.

Worldwide experience has shown that it is easier for an industry to venture into international markets and be successful there if the industry experiences stable growth on its home market. This means that a stable and reliable framework for the expansion of renewables in Germany, including clear dependable targets, is absolutely vital for the country's industry.

This report, which is published annually, provides a review of current developments in the sector as well as on gross employment in 2013. It is part of a large-scale research project entitled "Employ-

The data base for this annual estimate published here is updated with survey-based data on a regular base. For 2012, this leads to a revised figure of 399,800 for gross employment from renewable energy. All comparisons to the previous year are based on this revised figure.

¹ The new Renewable Energy Act came into force on Aug 1, 2014.

ment from renewable energy in Germany: expansion and operation - now and in the future”, which was commissioned by the Federal Ministry for the Environment and for which responsibility has since transferred to the Federal Ministry for Economic Affairs and Energy. Unlike this annual short-term analysis, which focuses on gross employment in the industries linked to the manufacturing and use of renewable energy installations, the larger research project also factors in all of the additional costs incurred and any shifts or relocation effects, thus providing a much more complete picture of the overall future net effects the expansion of renewables is likely to have on the economy at large.

From a methodological perspective, the first step had to be to estimate the turnover of all companies based in Germany producing renewable energy (RE) facilities. These figures are equivalent to domestic and the international demand met by domestic production. The figures were calculated using the data available on investment in Germany and own estimates on the development of foreign trade in 2013. All calculations are done separately for eleven individual technologies. Based on the results for demand effective in Germany gross employment was determined by using input-output (I-O) analysis.² The technology-specific vectors used to map the renewables sector in an I-O framework have been especially developed for our methodological approach, using data including those from three primary studies of the renewables sector (base years: 2004, 2007, 2012). Just like in the previous estimates, key benchmark figures, including the development of labor productivity for each industry, have been adjusted to reflect the current set of data [BMU 06/BMU 07/BMU 08/ BMU 09/BMU 10/BMU 11a/BMU 11b/BMU 12/BMU 13].³

A similar methodological approach is used to estimate levels of employment generated by the operation and maintenance of facilities installed in Germany.⁴ Employment generated by the provision of biofuels is also quantified using input-output method.

Publicly funded research and the public administration are other areas where the expansion of renewables is generating new jobs.

This research project is increasingly also taking into account jobs created by German producers of equipment for the manufacturing of RE installations – albeit in the absence of an integrated approach to including these in the method. This edition of the report is the first to include more detailed information on this industry.

2 The empirical starting point for both for the current estimate for 2013 and the revised estimate for 2012 is the Input-Output Table for 2010 published by the Federal Statistical Office [StaBu 14]. This marks the first time that an official table developed by the Federal Statistical Office which is in line with the WZ 2008 classification of economic activities has been used in our ongoing analysis. WZ 2008 classification is characterized by a much more differentiated classification of key services industries, whereas some manufacturing sectors that used to be classified individually under the previous WZ 2003 classification have now been grouped together. In total, the official WZ 2008 table lists 73 individual sectors of the economy.

3 The final report, which is to include a detailed description of the business survey, the I-O vectors, and the employment figures calculated on this basis, is due to be released in November 2014.

4 The figures provided in this report have been calculated using a new classification. The modification of this classification was part of this project and will be described in detail in the final report.

EMPLOYMENT GENERATED IN MANUFACTURING OF FACILITIES

In 2013, investment in renewable energy installations totaled €16.09bn in Germany. Compared to the revised figure of €20.21bn⁵ for 2012, this represents a fall of more than 20% year-on-year (cf. Figure 1). This first estimate is based on the preliminary results for 2013 published by the Interministerial Working Group on Renewable Energies Statistics in mid-March [AGEE-Stat 14]. A closer look at the figures reveals that the main reason for the slowdown in investment again has to do with developments in the photovoltaics (PV) sector. Unlike in the preceding years, however, the 2013 downturn in the sector was not caused by price erosion in the PV market, but by a decline in the quantity of new PV installations. Investment in biomass and solar thermal installations was also down in 2013, whereas wind energy experienced a positive development. Most of the increase was due to a strong rise in investment in offshore wind farms⁶, but the expansion of onshore facilities also contributed to this positive trend.

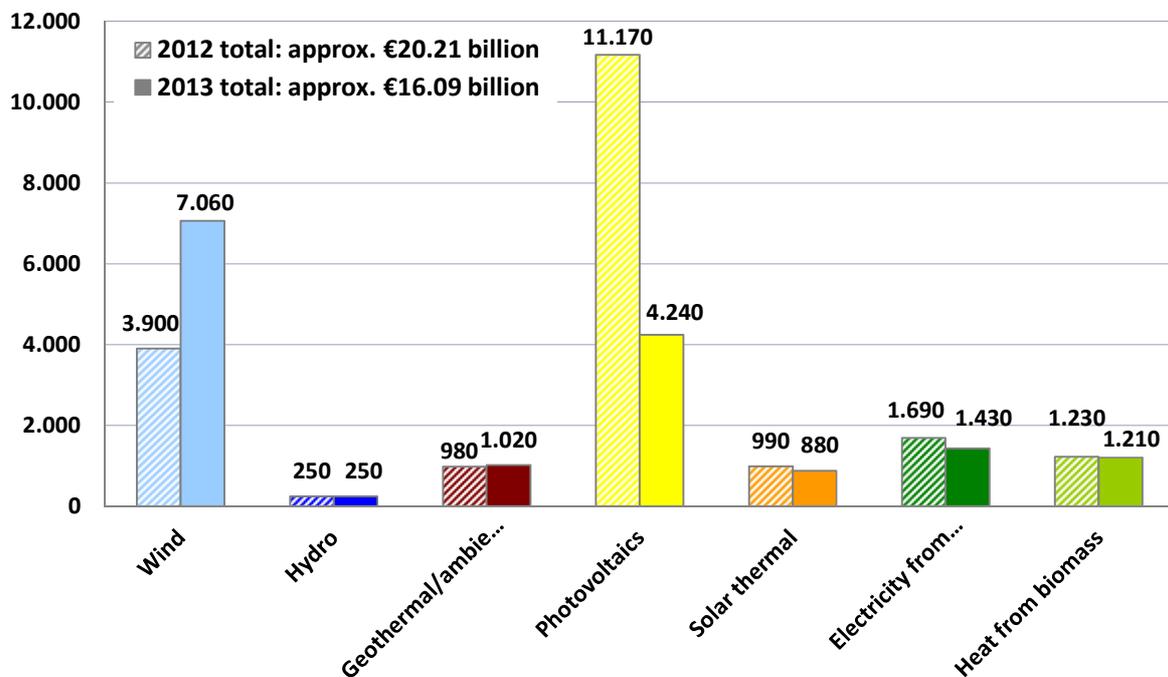


Figure 1: Investment in renewable energy installations in Germany in 2012 and 2013, (in € millions) [ZSW 14].

According to this first estimate, combined turnover from the sale of facilities and components made in Germany was around €22.70bn in 2013, (cf. Figure 2). down from €26.01bn in 2012. In other words, German businesses are likely to have experienced a decline in turnover to the tune of nearly 13%. The PV sector was hit particularly hard, although the loss in turnover (-56%) was not as strong as the fall in investment (-62%). The German biogas industry and manufacturers of solar thermal power plants and of biomass heating and/or power plants also saw their turnover decline. The heat

⁵ The last estimate of gross employment, published in March 2013, had assumed a preliminary figure of €19.49bn.

⁶ Under this approach, investments are factored in as soon as the facilities in question have been installed and irrespective of whether they have been connected to the grid.

sector stagnated, with turnover in solar thermal energy slightly down and near-surface geothermal energy/ambient heat recording a slight increase in turnover. The industry with the highest increase in turnover was onshore wind energy, whereas turnover in the offshore wind energy sector was roughly the same as in the previous year.

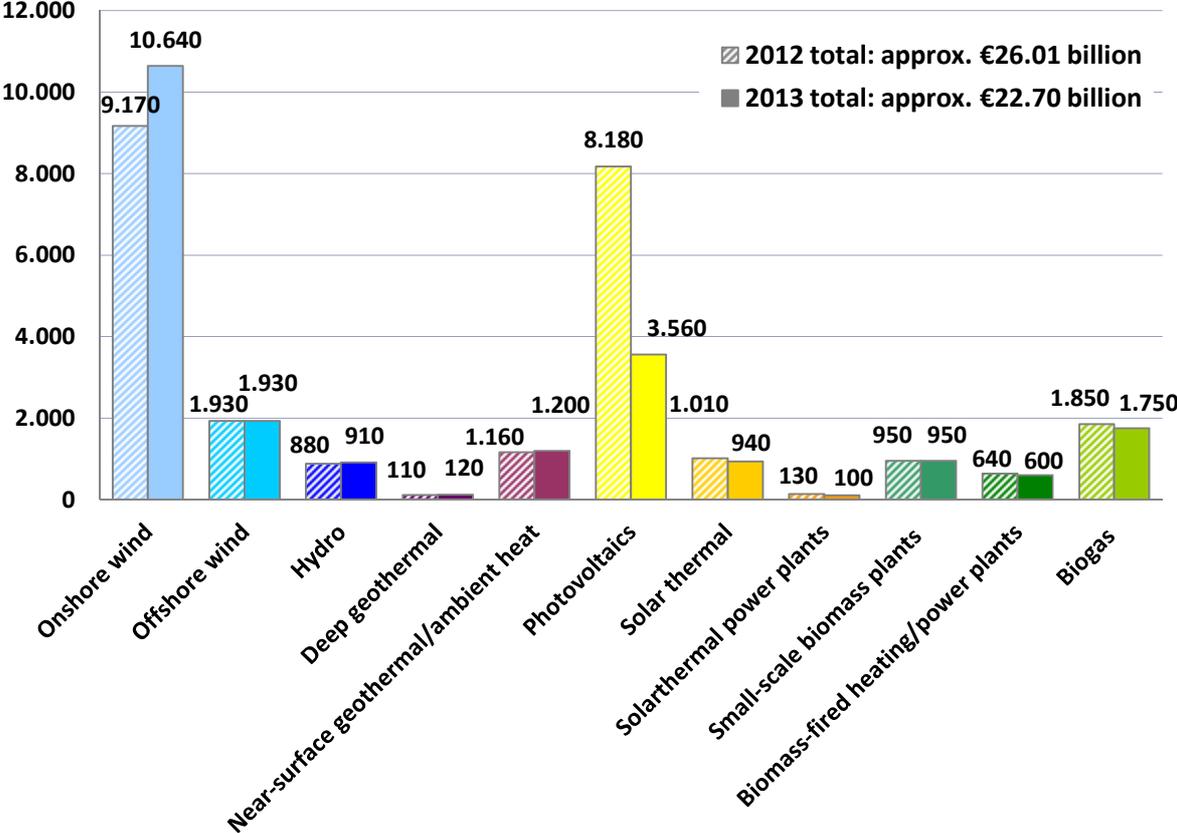


Figure 2: Turnover of German-based manufacturers of renewable energy installations, including exports of facilities and components in million euros. Figures for 2012 and 2013.

Gross employment resulting from the turnover generated by manufacturers of renewable energy installations totaled approx. 230,800 persons in 2013, down nearly 13% from the figure for 2012 (cf. Table 1). Of these employees, 56% (128,800 persons) owe their jobs to the expansion of renewables capacity within Germany, with the remaining 44% of jobs (102,000) generated by exports of installations and components, which account for a significant proportion of output, particularly where power generation technologies are concerned.

EMPLOYMENT GENERATED IN THE OPERATION AND MAINTENANCE OF INSTALLATIONS AND BY THE SUPPLY OF FUELS

The estimate for the number of jobs generated in the operation and maintenance of existing facilities is based on these facilities' operating costs (excluding fuel costs), which can be calculated as an annual percentage of year-by-year investment in the facilities stock. Gross employment in this area grew by 6% to 63,500 persons in 2013 (cf. Table 1). As the number of facilities that are up-and-running increases, employment levels in operation and maintenance are becoming more significant over time, rising to 17% of total gross employment in the renewables sector in 2013.

As far as biomass is concerned, the provision of biomass and biofuels is another area to be taken into account. Employment levels in this area remained unchanged from the previous year, at approx. 68,800 persons.

All in all, operation and maintenance and the provision of fuels accounted for 36% of total gross employment in the renewables sector.

EMPLOYMENT GENERATED BY PUBLICLY FUNDED RESEARCH AND IN THE PUBLIC ADMINISTRATION

In addition to the turnover generated by German producers of installations and components, by the operation and maintenance of installations in Germany, and by the provision of biomass and biofuels, publicly funded research and funding provided by non-profit institutions to promote the development of renewables also generate employment. This funding is provided by the federal and Länder ministries, the EU, and by foundations. Most of it is used to finance demonstration facilities and research projects, some of it for PR work. The employment figures stated in this report also include administrative staff, for instance that of the federal and Länder ministries.

According to a first estimate, public research funding and funding by non-profit institutions totaled €541m⁷ in 2013, generating some 7,500 jobs. On top of this, there were some 300 persons directly employed by federal and Länder ministries. This figure is approx. the same as in the preceding years. For the first time, this report also factors in the 500 public-sector employees who taught classes in 2012 and 2013 that count towards the approx. 140 higher-education degrees in the field of renewables. Altogether, total employment generated by publicly funded research and in the public administration was calculated at 8,300. This figure represents an increase of nearly 14% compared to 2012.

⁷ The definition of the funding used to calculate employment levels for 2012 and 2013 has changed. The funding provided by the federal level was calculated based on the Energy Research Report and its provisional findings.

Table 1: Employment in the renewables sector in Germany in 2013

	Employment generated by investment (incl. exports)	Employment generated by operation and maintenance	Employment generated by the provision of biomass and biofuels	Total employment 2013	Total employment 2012
Onshore wind energy	100,800	18,200		119,000	<i>104,000</i>
Offshore wind energy	17,500	1,300		18,800	<i>17,800</i>
Photovoltaics	45,100	10,900		56,000	<i>100,300</i>
Solar thermal energy	10,100	1,300		11,400	<i>12,200</i>
Solar thermal power plants	1,100			1,100	<i>1,400</i>
Hydropower	8,300	4,800		13,100	<i>12,900</i>
Deep geothermal energy	1,300	200		1,500	<i>1,400</i>
Near-surface geothermal energy	13,300	2,500		15,800	<i>15,000</i>
Biogas	17,200	11,800	20,200	49,200	<i>50,400</i>
Small-scale biomass systems	10,100	3,900	14,600	28,600	<i>28,800</i>
Biomass-fired heating/power plants	6,000	8,600	8,400	23,000	<i>22,900</i>
Biofuels for transport			25,600	25,600	<i>25,400</i>
Total	230,800	63,500	68,800	363,100	<i>392,500</i>
Publicly funded research/public administration				8,300	<i>7,300</i>
Total				371,400	<i>399,800</i>

Gross employment attributable to the renewables sector totaled 371,400 persons in 2013, down 7% from the preceding year (cf. Table 1). Some 112,900 of these jobs (or 30%) were generated by exports of facilities, components, biomass, and biofuels for transport.

BREAKDOWN OF GROSS EMPLOYMENT FIGURES

Altogether, **private-sector gross employment** in the field of renewables in 2013 totaled approx. 363,100 persons, down more than 7% from the figure for 2012 (approx. 392,500 persons). A breakdown of the figures according to the ways in which this energy is used shows that the installation and operation of facilities used for **power generation** accounted for just under 74% of employ-

ees (267,400), followed by facilities used to **generate heat** (approx. 19% or 70,100 persons), and by the **production of biofuels** (7%).⁸ Electricity generation dominated the market in 2013, as it has done for a number of years.

Employment attributable to the effects of the **Renewable Energy Sources Act (EEG)** totaled 261,500 jobs in 2013. Of these, 137,800 persons worked in the wind energy sector, followed by 63,000 in the biomass industry, and approx. 56,000 in the PV industry. Hydropower provided approx. 3,400 jobs and 1,300 persons worked in the field of geothermal energy. As can be seen from Figure 3, 98,000 persons of the total 160,500 employed in the renewables sector in 2004, i.e. 61% of the sector’s workforce, owed their jobs to the effects of the Renewable Energy Sources Act. This figure rose to 73% of gross employment in 2012 and fell back to 70% in 2013.

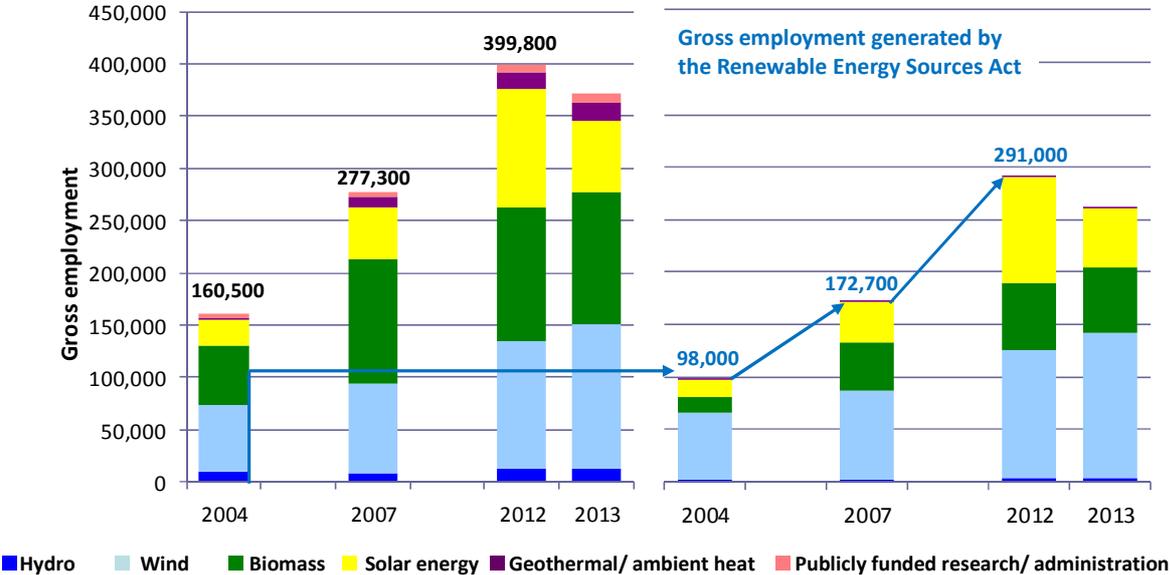


Figure 3: Development of employment in the field of renewable energies and employment induced by the Renewable Energy Sources Act between 2004 and 2013

Since 2012, this series of reports on the development of gross employment has been complemented by an analysis of the changes in employment levels in the individual Länder (latest publication [Ulrich 2013]). A breakdown of gross employment in 2013 into the 16 Länder is forthcoming in September 2014. Given the location of the production sites for facilities designed for the use of wind and solar power and that of new installations, it is likely that the negative developments in the PV industry have had a disproportionate effect on production sites located in the New Länder. This means that the proportion of jobs located in the New Länder is likely to have dropped and that this effect can be expected to have been even more pronounced than it was in 2012 and 2011. From a number of companies filing for insolvency in 2012 the losses in employment did not come into effect until 2013. Moreover, demand for new installations – particularly in the wind energy and PV industries – was considerably weaker in 2013 than in the preceding year, thus giving less of a positive boost to the

⁸ For detailed information on the approach used to differentiate between the different categories, see [BMU 11a] (available in German only).

sector. In fact, the number of new PV installations fell disproportionately compared to the national average.

BACKGROUND

2013 was yet another very successful year for the German **wind energy** sector. Some 2,997 MW of additional onshore capacity was installed in Germany, more than 28% more than had been added in 2012 and the second-highest annual amount after 2002 with 3,240 MW. Also installed were 595 MW of offshore capacity. As of the end of 2013, 394.6 MW of the overall capacity of 914.9 MW had not yet been connected to the grid [DEWI 14]. By this time, four offshore wind farms with a combined capacity of 616.3 MW had been completed, with another eight wind farms still under construction. This means that, for instance, another 266 foundations were laid, thus generating sales and employment [WindGuard 14]. Internationally, an additional 35.5 GW of combined on and offshore capacity was installed, representing a fall of approx. 21% compared to the preceding year. The US figures are particularly striking with a mere 1 GW of new capacity in 2013, following the installation of 13 GW in 2012. China once again registered the largest increase in capacity. According to initial estimates, the country added approx. 16 GW, up 16% from the preceding year. In contrast, Europe saw a negative trend in new installations. Altogether, the European market shrank by almost 6%. Taking Germany out of the equation reveals a much more drastic drop of 15% for the rest of Europe [GWEC 14]. The special circumstances applying in Spain and Italy, where the market collapsed after Italy changed its promotional programme for wind energy and Spain scrapped its programme altogether, account for much of the fall. The positive trend seen in some other European countries, including Denmark, the Netherlands, Ireland, Turkey, and Portugal was not enough to compensate for the developments on these two very important markets [EWEA 14]. Based on the data provided by the companies it can be assumed that German manufacturers' foreign trade activities have been largely unaffected by the downturn on the European market. The fact that foreign trade accounted for a smaller proportion of total turnover in 2013 than it did in 2012 is solely due to the strong performance of the domestic market. The reason is that German companies are particularly active in countries with growth in the wind sector. Moreover, as can be seen from Nordex's press releases regarding the company's success in South Africa, they seem to be quite successful when it comes to breaking into new markets. [NTV 13]. Altogether, turnover generated in the onshore wind energy sector is estimated to have grown by 16% to €10.64bn. The German offshore wind energy industry, despite benefiting from the expansion of domestic capacity, was unable to increase its total turnover, which is expected to be virtually unchanged year-on-year, at €2.39bn. The decline in the construction of new facilities was offset by an increase in installation work. Based on total turnover in the sector, overall employment in the wind energy sector – including in installations and maintenance – is estimated at approx. 137,800 jobs. Of these, 119,000 are attributable to onshore wind energy, with the remaining 18,800 generated by the expansion of offshore wind energy. (cf. Table 1).

2013 was another difficult year for the German **photovoltaics industry**: according to the Federal Network Agency, 3.3 GW of PV capacity was newly installed in Germany in 2013, reflecting a decline of 57% of the domestic market. Investment in additional capacity was worth approx. €4.24bn – down nearly 62% year-on-year. These figures show systems prices to have fallen by just under 13%, representing a much smaller decrease than between 2011 and 2012, when they plummeted by 27%. The

total capacity of all new installations across the world is estimated at 37 GW.⁹ and there have been marked changes in the development of the most important markets for PV: the European market has shrunk quite considerably and accounted for less than 28% of the global market in 2013 (2012: 59%). China added 11.3 GW of new capacity in 2013, which is more than 30% of the new global PV capacity. Japan was in second place (6.9 GW), followed by the US, which added 4.8 GW of PV capacity [EPIA 14]. As can be expected, the collapse of the domestic market by 57% had dramatic implications for project designers, systems providers, and installation companies, leading to a number of them leaving the market in course of 2013. Manufacturing of solar modules – an area that has a key influence on employment levels – fell by one third in 2013, with the production of solar cells down approx. 40% [Photon 14]. So far, there are no figures available regarding the production of inverters. The information provided by the companies concerned does however suggest that the decline of the German market was not fully offset by the higher exports, meaning that a significant fall in output can be expected in this area as well. The turnover generated by German manufacturers and the supply industry in 2013 is estimated at approx. €3.56bn, which is 56% less than in the preceding year. Based on this figure and taking into account operation and maintenance, employment is estimated at 56,000 jobs, representing a fall of 44% year-on-year.

The German market for **solar thermal energy** shrank by 11% in Germany in 2013, with the total collecting area newly installed that year totaling 1,020,000 m². The information provided by the companies suggests that they were able to partly offset the decline with higher exports, leaving the industry with €940m in turnover, which is 6% less than in the preceding year. Total employment in this industry, including operation and maintenance, is estimated at 11,400 jobs.

For the industry of **solar thermal power plants**, 2013 was a year marked by Flabeg's German solar division's filing for insolvency. The fact that a lack of new orders forced the company to take this step is indicative of the trend towards buying from manufacturers from other countries and towards generating more local value-added outside Germany, which has been apparent on the market for solar thermal power plants for a few years now. Companies based in Germany are estimated to have generated €100m in turnover, representing a fall of nearly 37% year-on-year. Approx. 1,100 persons were employed in the industry.

There are no indications of investment in the **hydropower** industry having increased between 2012 and 2013. The industry is, however, likely to have increased its turnover, following the results of a company survey regarding export expectations. Gross employment in the industry in 2013 totaled approx. 13,100 jobs.

Investment in **geothermal energy and ambient heat** increased by 4% over the preceding year in 2013, totaling €1.02bn. Both deep geothermal energy and the heat pump industry¹⁰ contributed to this positive development. Just like in the years before, there was a growing trend in 2013 towards installing air-to-water heat pumps. While growth in the number of new installations of brine-to-water and water-to-water heat pumps slowed down once again in 2013, installations of air-to-water heat pumps were up 13% year-on-year, increasing their share of the market to approx. two-thirds. The data available so far suggests that the European market for heat pumps stalled once again in 2013 [EHPA 14]. Altogether, turnover in the near-surface geothermal energy and ambient heat industry is estimated to have grown by 4% to €1.2bn in 2013. The respective figure for geothermal

9 No clear results available yet. The estimate provided by UNEP, for instance, is 39 GW of new capacity.

10 Including air-to-water heat pumps

energy is expected to be approx. €120m. Based on these figures and factoring in employment in operation and maintenance, the number of jobs provided in these industries is estimated at 17,300, with near-surface geothermal energy and ambient heat accounting for 15,800 of them and the remaining 1,500 being provided in the field of deep geothermal energy.

Investment in the **biogas** sector fell once again, down 15% to €1.23bn. Companies were able to offset part of this decline with their activities outside Germany. Within Europe, the French and UK markets appear to have been developing particularly well, whereas the introduction of a new funding system in Italy led to a collapse in demand. [EBA 14]. The information provided by the companies suggests that turnover in the industry only fell by just under 6% to €1.75 bn. Based on this figure and the estimate for operation and maintenance, employment in this area has been calculated at approx. 29,000 jobs, with an additional 20,200 employees in the biogas sector working in the provision of biomass. This brings the estimate of employment generated by the use of biogas plants to a total of 49,200.¹¹

Investment in **small-scale biomass systems**¹² has remained approx. at the same level compared to the preceding year. The same is true of the industry's turnover, which remained stable at €950m. At 14,000 jobs, the number of jobs in systems construction, operation and maintenance is similar to the figures of the preceding year. The same holds for employment in the provision of biomass, which stood at 14,600 in 2013. This means that total employment generated by the manufacturing and use of small-scale biomass systems was 28,600 jobs.

Investment in **biomass-fired heating/power plants** was down approx. 11% in Germany year-on-year. The results of the business survey suggest that some of the losses in turnover were offset by higher exports. The industry's turnover in 2013 has been calculated at approx. €600m, down 6% from the figure for 2012. Employment generated by the construction and operation of manufacturing equipment in 2013 is estimated at 14,600 jobs, with the provision of biomass providing another 8,400. Total employment in the industry remained stable year-on-year, at 23,000 jobs.

This means that the level of gross employment generated by the **provision of biomass** in 2013 was similar to 2012, totalling 68,800 jobs.

Sales of **biofuels for transport** declined by 9% in terms of volume in 2013. This applies to biodiesel as well as vegetable oil and ethanol. The total area used to grow biodiesel and vegetable oil was approx. 5% smaller than in 2012. [FNR 14]. In contrast, the production of rapeseed oil for use as biofuel was up nearly 2%. [BLE 14]. The production of biodiesel is assumed to have totaled approx. 3.2m tons in 2013, which is 9% more than in the preceding year. This assumption is based on the foreign trade statistics provided by the Federal Statistical Office, which have been evaluated by the Agricultural Market Information Company (AMI) [UFOP14]. Employment attributable to the production of biodiesel in Germany in 2013 was up 1% year-on-year at 20,000, whereas employment in the production of vegetable oil was 94% lower, totaling 50 jobs. The amount of bioethanol produced in 2013 was nearly 10% higher than in the preceding year and stood at 672,028 t [BDBe 14], whereas the area

11 The operation of stationary liquid biomass installations and the provision of liquid biomass have been subsumed under "biogas". This simplified approach is being introduced here because of the absence of investment that this technology has experienced for years as well as the absence of political backing which is likely to continue into the foreseeable future and the negligible role that the technology plays in total energy production.

12 For detailed information regarding the differentiation between the various technologies, cf. [BMU11].

used to grow crops for the production of bioethanol remained roughly the same, at 200,000 ha [FNR 14]. The number of jobs provided in this industry stood at 5,550, which is close to 5% more than in 2012. Total employment attributable to the provision of biofuels for transport in Germany in 2013 totaled 25,600 jobs.

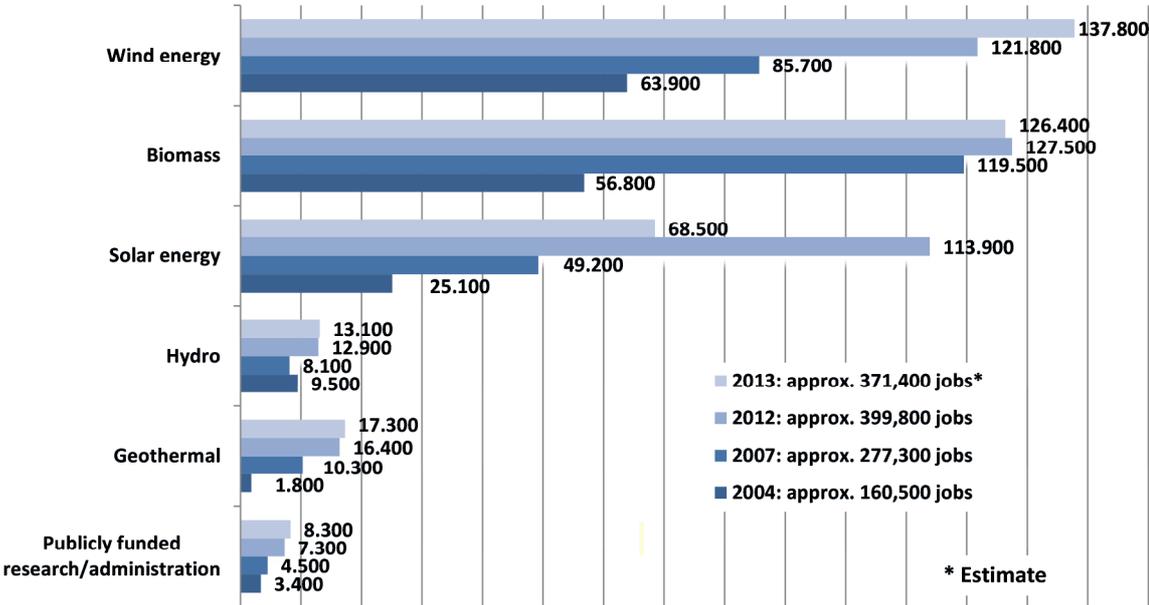


Figure 4: Development of employment in the renewables sector in Germany

Based on this first estimate, gross employment in 2013 was approx. 371,400 (cf. Figure 4). Wind energy (roughly 137,800 jobs in total) contributed 37% of these jobs, followed by biomass (126,400 jobs), which accounts for 34%. In third place is solar energy at 18% (68,500), followed by geothermal energy at nearly 5% (17,300) and hydropower at 4% of gross employment (13,100 jobs). Employment in publicly funded research and in the public administration stood at close to 2% of gross employment (8,300).

EMPLOYMENT GENERATED BY THE EXPANSION OF PRODUCTION CAPACITY

Estimating the effects of developments in the global production capacity for renewable energy technologies (RE technologies) on employment in the German manufacturing equipment sector is a challenge in terms of methodology. Whilst the method used to calculate indirect effects on employment does factor in the cost of the expansion of capacity as reflected in the prices charged by plant manufacturers, it does not allow the cost to be attributed to the exact year in which employment was generated. Instead, the cost is apportioned across the entire depreciation period of the production equipment.

This is despite the fact that this is an industry in which the time aspect is of particular interest: any investment in expanding existing production facilities or constructing new ones must occur prior to the planned production and therefore reflects the industry’s expectations with regard to market development and sales opportunities. This means that investment in expansion, but also – albeit to a lesser degree – investment in replacements is often countercyclical to a company’s turnover at that

time. Because of these particularities, a more comprehensive approach (which is partly based on business surveys) is being used in the “ Employment from renewable energy in Germany: expansion and operation - now and in the future” research project to arrive at a more exact estimate of the scale of employment generated by the production of manufacturing equipment (machinery and equipment) for RE technologies.

The effects recorded here apply to employment and turnover in the machinery and equipment sector to the extent that it is directly linked to investment in replacing, expanding, or constructing new production facilities for RE technologies anywhere in the world – not only in Germany. Investment in buildings, plots of land, other operating and office equipment, and services and any resulting indirect effects from this on employment and production in the mechanical engineering sector have been disregarded for the purposes of this research project, because these all have local effects on production. Indirect effects resulting from the demand of intermediate inputs by producers of manufacturing equipment from German engineering and manufacturing companies have also been disregarded.

The figures for turnover have been calculated based on the data published by the companies regarding costs / replacement costs. With regard to necessary investments in replacements, the mean depreciation period for machine installations has been assumed to be 10 years. This is a conservative estimate, given that this is usually the maximum period of useful life stated in the annual reports. In order to avoid any distortion of the figures for turnover due to complex import relations, the relevant data on world market shares broken down by industry [VDMA 2012] have also been factored in. The average weighted figure for turnover generated in the manufacturing of computer equipment, electronic and optical goods, electric equipment, and in mechanical engineering has been assumed to be €182,000 per gainfully-active person in 2012 and €188,000 for 2013 [StaBu13, 14a]¹³.

Turnover generated by German producers of manufacturing equipment for RE technologies is estimated based on the estimated global volume of investments in replacing, expanding, and constructing new means of production for RE technologies and on the respective world market shares. This method also allows for developments on the German RE market to be used to determine domestic demand for manufacturing equipment for RE technologies and thereby to arrive at an estimate of the value of total exports.

The estimate of effects on output and employment generated by the sector manufacturing equipment for RE technologies (machinery and equipment) for 2012 reveal a very mixed picture:

Overcapacity in the photovoltaics sector, which had already been described in last year’s report, led to a situation whereby turnover from the sale of machinery and equipment halved year-on-year. It can be assumed that more than 90% of turnover was generated on foreign markets, given that the majority of German PV producers did not invest in replacements or additional capacity in 2012, due to the poor market situation. The market share held by German producers of machinery and equipment remained stable year-on-year, at approx. 50% [VDMA 12].

The situation for German producers of manufacturing equipment for PV technologies appears not to have changed in 2013. Just like in the preceding year, the overcapacity built up by manufacturers of PV technologies up to 2011 shaped the market in 2013 as well. In fact, the German Engineering Fed-

13 This is based on the assumption that the ratio of employment to overall gainful activity, including self-employment, was the same in 2012 as the 2007-2010 average and that the figure for 2013 was the same as the 2008-2011 average.

eration (VDMA) even reported a slump of approx. 45% year-on-year in the turnover generated by producers of manufacturing equipment, causing the figure to fall to approx. €700m. The share of the global market held by German manufacturers remained unchanged and continues to be approx. 50% [cf. VDMA 14a,b]

The first figures for 2014 suggest that the tide is turning for German producers of manufacturing equipment: the German Engineering Federation is reporting higher numbers of new orders, an improved business climate, and a good competitive edge held by German producers of manufacturing equipment.

With regard to onshore wind energy, a large number of manufacturers continued to press on with their strategies for market entry in 2012. Large international conglomerates including Hyundai, Mitsubishi, and Hitachi entered the market with their own turbines, whilst established manufacturers (e.g. GE and Enercon) expanded their production facilities, leading to additional capacity in the onshore sector being built up in spite of a rather slow-growing market for new installations.

This development in the onshore wind energy sector came to a halt in 2013, as installation rates fell across the globe. Installation rates in Asia in 2013 also remained below the figures for 2011 and 2010 [GWEC 2014]. There were no significant increases in capacity.

Wind energy is an area where the contrasting developments in the expansion of installed capacity and the expansion of production capacities is particularly apparent. Employment in the offshore wind energy sector more than doubled in 2012. Due to the industry's mid-term prospects being very uncertain, however (which is particularly true for Germany and the Netherlands) manufacturers did not invest in additional production capacity in 2013. What happened instead was that projects that had already been agreed upon entered the construction phase. The situation is expected to change in 2014, with large manufacturers investing (or having stated their intention to invest) in new production capacities, for instance in Denmark, the UK, and France.

Given the aforementioned market expectations for the biogas industry, the estimate for investments in production capacities only includes investments in maintaining existing capacities. Industry experts say that – with the exception of Japan – there is no relevant market for biogas outside Europe. First of all, this is due to the absence of funding schemes comparable to the ones in Europe. Second, it is due to the fact that countries outside Europe tend to focus much more strongly on using biogenic resources as fuel for transport. The market for manufacturing equipment for the biofuel-for-transport industry was also stagnant: global production of biofuels for transport has not experienced any significant rise since 2010; in fact, the figure for 2012 even shows a slight decline year-on-year [BP 13].

The statistical benchmark figures for the European and global markets for 2013 were not available during the research period.

As the European market for small-scale biomass systems has remained stable for some years now, there have not been any major changes in the capacity for producing manufacturing equipment in this segment. This means that investment in replacing existing manufacturing equipment is the only type of investment potentially generating employment opportunities for German producers of machinery and equipment.

The market for manufacturing equipment for large-scale biomass-fired heating/power plants is not substantially different from the market for other power plants that use grate firing or fluidized bed combustion systems, or from the market for RDF-fired power plants. However, new plants are being

built only in the industrial power plant sector and – in some individual cases – in connection with CHP systems. Whilst entering non-European markets (the US, South Africa, South America) is an option for German plant construction companies, it would be quite a complex feat, given that entry to these markets is often rendered difficult by technical regulations and a strong position of regional competitors. All this has led many plant construction companies (Alstom, ABB, Siemens, Hitachi) and their suppliers to cut their production capacities in Europe. At least as far as Europe is concerned, investments were strategically held back during the companies' consolidation phases.

The total number of jobs in companies producing manufacturing equipment for use as a replacement of existing equipment or to create additional production capacity stood at 13,500 in 2012. All of the jobs provided in the biogas, biomass, heat pump, and solar thermal energy sectors can be attributed to investment in replacements. This is true for just under 1,000 jobs. More than 90% of jobs are provided in the biofuels-for-transport, wind energy, and photovoltaics sectors. Employment in the biofuels-for-transport industry can mostly be attributed to investments in replacements (78%), whereas more than 50% of the investment in wind energy and PV is in expanding capacities – despite there being global overcapacities. Investment in replacing existing production capacity accounts for less than 50% of overall investments.

In 2013, the situation of producers of manufacturing equipment for PV and the onshore wind energy industry changed quite markedly: producers of PV manufacturing equipment saw their turnover collapse by 45%, placing considerable pressure on employment and leading to the number of jobs in the industry being cut by 2,700. Slow expansion in onshore capacity led to the number of jobs in the onshore manufacturing equipment industry falling by approx. 600 in 2013. The overall number of jobs provided by German producers of manufacturing equipment for RE technologies was 10,100 in 2013.

Table 2: Employment generated by producers of manufacturing equipment in 2013*

	Investment in re-placements		Investment in additional capacity		Total	
	Volume (in € m)	Jobs	Volume (in € m)	Jobs	Volume (in € m)	Jobs
Onshore wind energy	110	600	40	200	150	800
Offshore wind energy	-	-	60	300	60	300
Photovoltaics	140	700	560	3,000	700	3,700
Biogas	80	400	-	-	80	400
Small-scale biomass systems	50	250	-	-	50	250
Biomass-fired heating/power plants	30	150	-	-	30	150
Biofuels for transport	620	3,400	180	180	800	4,300
Estimated breakdown for other industries (geothermal energy / heat pumps / solar thermal energy)	40	200	-	-	40	200
Total	1,060	5,700	840	4,400	1,900	10,100

- = Estimate not possible due to lack of reliable data and/or up-to-date statistics.

* Due to problems of differentiation and the concomitant possibilities of multiple counting, these employment effects cannot be counted towards the number of jobs generated by investment in and operations of RE technology.

FUTURE PROSPECTS

In the next two years, the reform of the Renewable Energy Sources Act currently being deliberated, will influence those industries in the German renewables sector that produce equipment for electricity generation. Investors and project designers must prepare for the shift in the support mechanism towards tendering, and acquire the necessary expertise. Overall, companies will continue to seek to break into export markets so as to reduce their dependence on the German market. Furthermore, large parts of the industry will keep a strong focus on developing new business models, e.g. for optimising self-consumption of small PV installations or for rendering existing biogas plants more flexible.

The expansion of onshore wind farms in Germany is likely to continue at a relatively steady pace, as the target corridors specified by the Federal Government in its reform bill do not impose any major restrictions in this area. At global level, the use of wind energy is set to expand once again, as indicated by the strong expansion of capacity that is already underway in the US [AWEA 14]. This suggests that employment levels in Germany can be maintained.

The expansion of offshore wind energy in Germany is likely to continue at a high pace over the next two years. Despite this, companies based in Germany are complaining of empty order books and

delays in some projects, which force them to resort to lay-offs and short time working. This discrepancy is due to Siemens' overwhelming dominance of the European market for offshore wind systems: 60% of the total capacity installed at the end of 2013 was produced in the group's production plants in Denmark and the figure for new capacity was as high as 74% [EWEA 14a]. A possible explanation for this market dominance could be the fact that offshore wind energy is a highly capital-intensive business in which investors tend to shy away from incalculable risks. It seems that reference projects therefore play a major role when contracts are being awarded. At the same time, take-up of large-scale installations with a capacity of 5 to 6 MW and developed especially for use in offshore wind farms, has been very slow. It would appear that investors feel safer with smaller-scale installations (such as the ones produced by Siemens and Vestas) that have already been tried and tested in on-shore use. All this makes it difficult to make out a clear trend in employment in Germany. In fact, it seems that employment is developing independent of market development. One thing a thorough analysis of ongoing projects does show, however, is that employment levels can be expected to drop quite considerably in 2014, unless the current status of some of the project in which German based producers are involved changes.

In its draft bill for the revised Renewable Energy Sources Act, the Federal Government sets out an annual expansion target of 2.5 GW for PV, which is approx. a quarter less than the size of the market in 2013. It can therefore be assumed that the domestic market will be smaller in the years to come than in 2013. A surprise boom like the one witnessed between 2010 and 2012 can be all but ruled out. First of all, because systems prices cannot be expected to fall this dramatically once again, and second, feed-in tariffs under the revised Renewable Energy Sources Act will be adjusted with the "breathing cap" according to recent market developments four times per year. At global level, however photovoltaic installations are expected to grow strongly : analysts expect the size of the 2014 market to be 40 to 46 GW, with an additional 10 GW to be installed in 2015 [IHS 14; IWR 14]. The main drivers of this growth will be China, Japan, and the US. The effect on employment in Germany is twofold: the smaller size of the domestic market will have a negative impact on employment, as far as systems providers, project designers, and installation companies are concerned. Unlike these, manufacturing companies will have more options of selling their products abroad. This means that, while another fall in employment levels is possible, it is unlikely to be as substantial as the decline experienced in the 2012/2013 period.

Prospects for the German biogas sector are not particularly bright for the years to come, mostly because of the outlook for the domestic market. Over the past few years, many companies have increased the amount of business they do abroad – a trend which is likely to continue. Europe is likely to remain Germany's most important export market in the foreseeable future, with France and the UK being of particular interest in the years to come. As far as the German market is concerned, finding ways of rendering existing installations more flexible will be a key business field. It is quite possible that employment levels will not fall before 2015, given that owners of the installations that are currently under construction will do everything they can to ensure that their installations fall under the current version of the Renewable Energy Sources Act.

The heat sector is unlikely to undergo any major changes – even though these would surely be necessary. Whilst sales arguments for heat pumps have weakened because of their high operation costs due to the high cost of electricity, the market is likely to benefit from a combined use of heat pumps and PV systems.

Overall, the total number of jobs generated by the expansion of renewables is likely to fall both this year and next. In the long term, the growing need for the operation and maintenance of existing installations and – where applicable – the provision of biomass to power these installations should have a stabilizing effect on employment levels.

Employment will also be generated in areas linked to the efforts to integrate renewables in the overall energy system – areas for which figures have not been recorded yet in this report. Both the integration of renewables and the combination of different RE technologies have the potential to create innovative solutions and new services. In the medium and long terms, employment in the sector will much depend on what additional steps are taken to ensure that the regulatory reforms and technological developments coming with the Energiewende usher in a modern, innovative and environmentally-friendly energy system that also offers security of supply.

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