

# The German Energy Transition and Its Stumbling Blocks-Promotion of Power Generation from Photovoltaic Systems and Its Influence on the German Energy Transition

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**Abstract**—The energy transition that began in Germany in 2000 is widely accepted by the population. Opinion research institutes report that more than 90 per cent agree with the policy adopted. Nevertheless, in the public debate in recent years increasingly critical opinions were voiced. In particular, the increased costs of the energy transition are discussed, which are to be borne by the population and the economy.

Despite increased burdens in all areas of the energy transition, the criticism is mostly due to the increased burden on electricity customers through the increased use of renewable energy. One reason for this is the increase in the Renewable Energy Act (EEG / Erneuerbare-Energien-Gesetz) surcharge, which finances the expansion of renewable energies and which ultimately has to be borne by the customers of the energy supply companies. This surcharge increased by 74 per cent in the years 2012 to 2014 alone. One of the main reasons for this was the excessive subsidization of electricity from photovoltaic systems from 2008 to 2012, which was primarily used by major investors and resulted in a massive expansion. Although the share of renewable energies in the German electricity mix has thus increased, an economic equivalent, such as a sustainable increase in jobs or high export figures among the companies that produce these plants, was not observed.

Today, economists ask to what extent this mistake could have been avoided and to what extent this has damaged the reputation of the energy transition. The economic policy debate on this issue is led by various interest groups whose opinions are widely divergent. Establishing public consensus is difficult, yet essential for a successful continuation of the energy transition.

**Keywords**—sustainable energy, sustainable development, solar energy, Germany

## I. INTRODUCTION

The German energy transition beginning in 2000 remains widely accepted by the population. According to public opinion research, more than 90 per cent of respondents agree with the adopted policy [1].

The reasons for the severe acceptance are as follows:

- It is widely agreed on phasing out nuclear energy;
- The effects of climate change become increasingly perceptible;
- Fear of missing the national climate control goals;
- Concerns about declining reserves of conventional sources of energy and rising global consumption.

Nevertheless, the public debate in recent years has been increasingly critical. Particularly, the rising cost of the energy transition, which are paid for by households and businesses, have been met with criticism. Despite increased investments in branches such as grid expansion and energy efficiency in mobility and housing, the discussion revolves around the rising cost of electricity and the burdens it entails for consumers due to the increased use of renewable energies.

An argument repeatedly cited by critics is the disproportionate funding of power from solar plants between 2008 and 2012. Today, science and politics wonder whether this mistake could have been avoided and how future damage can be averted from further proceedings of the energy transition.

## II. FUNCTIONING, DEVELOPMENTS AND DISCUSSION

After the first participation of the Green Party in the German Federal Government in 1998, its goal to introduce a law promoting renewable power sources was quickly implemented. The Green Member of the Bundestag Hans-Josef Fell and the SPD politician Herman Scheer were in charge of the respective piece of legislation.

The Renewable Energy Sources Act (Gesetz für Vorrang Erneuerbarer Energien, EEG) [2] introduced on 1 April 2000 provided for the following three framework conditions for power generation from renewable sources of energy:

- 1) Plant operators are obliged to connect their plant to the power grid while network operators must implement

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the connection immediately [3].

- 2) Network operators must expand the grid in order to reliably transmit the generated power [4].
- 3) The plant operators receive specific and technology-dependent remuneration from the network operator rated per kilowatt hour fed into the grid [5].

The feed-in tariff is disbursed by the network operator for a period of 20 years and financed by the surcharge on electricity consumers. The EEG surcharge is equal for all customers regardless of the local power supplier and its amount is recalculated every year. For this purpose, the so-called EEG account is used. It is financed by the revenues of the EEG surcharge and used for remuneration of renewable power plant operators. For reasons of international competitiveness, a hardship provision was included for energy-intensive companies exempting them from the EEG surcharge.

Initially, this simple and transparent cost allocation system was hardly taken seriously by the representatives of the conventional energy industry and sometimes even ridiculed as an April fool's joke. However, as it had become evident that the EEG provided incentives for investments in renewable energies, similar measures have been adopted by other countries.

Eventually it has been agreed that this law was a milestone in the sought German energy transition. The share of renewable energies in national electricity production increased from 6.6% in 2000 to 35.0% in 2018 [6]. Germany ranks fourth in the world in terms of installed capacity of plants generating electricity from renewable sources. It also ranks fourth in terms of installed photovoltaic capacity [7].

The increase of the EEG surcharge has been the most regarded point in the public debate on the cost of electricity generated from renewable energies. As Fig. 1 shows, the EEG surcharge has risen since its introduction in 2000 from 0.19 to 6.41 euro cents per kilowatt hour consumed by the end customer in 2019.

Currently, the EEG surcharge accounts for about 20 per cent of the electricity price in Germany. Assuming an electricity price of 30 euro cent per kWh, a family of four with an annual consumption of 3,500 kWh receives an electricity bill of 1,050 euros of which about 224 euros are allocated to the EEG surcharge.

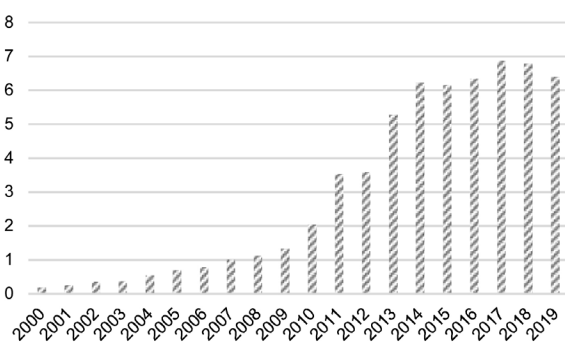


Fig. 1. EEG surcharge for end consumers [8].

The sharp increase of the EEG surcharge from 2012

to 2014 of 2.65 euro cents (74 per cent) is attributed to the funding of electricity production from photovoltaic systems in previous years.

Chronologically, this development can be summarised in three steps:

#### A. The years 2000 to 2007

Despite high remuneration rates, photovoltaic plants did not significantly contribute to the German energy production. Solar modules were priced uncompetitively high and their technical reliability was insufficient. Among investors scepticism about the ability of the then state-of-the-art technology to achieve an operating life of at least 20 years prevailed.

The first plants to profit from the EEG subsidy, on the other hand, were onshore wind energy farms due to the advanced level of technology and the attractive remuneration rates for investors. Also, building and environmental laws caused affordable expenditure and the planning procedure was usually quick.

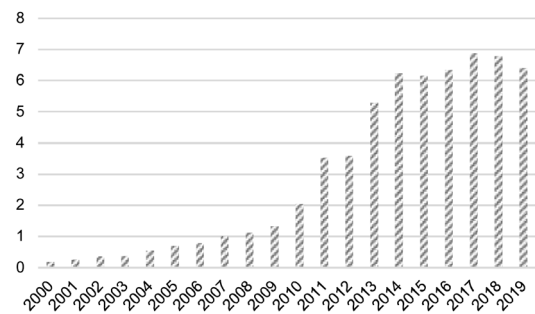


Fig. 2. Year 2003 in wind energy: Installation and total capacity [9].

With a growth in wind power output from 9.5 billion kWh in 2000 to 26.4 billion kWh in 2004 [10], Germany achieved the world's leading position in this power generation technology. As shown in Fig. 2, the year 2003 particularly depicts this advancement—Germany superseded countries with considerably higher wind potential such as England, Spain and the USA in terms of total installed capacity as well as increase in installed capacity.

Regarding the high population density of Germany and the fact that quality of life in the vicinity of a wind power plant leaves much to be desired, the disadvantages of this development are swiftly revealed. Eventually, the areas designated for the construction of wind plants decreased and the negative aspects of this rapid growth became visible. Voices calling for slower growth became louder and were heard by politicians. The first amendment to the German Renewable Energy Sources Act (EEG) in 2004 contained a significant reduction in remuneration rates for wind power plants. The later growth of wind power therefore predominately roots in the installation of new offshore wind turbines and repowering.

As the remuneration rates for wind power have had been reduced and the search for locations for constructing wind farms has had been restricted by building and environmental law, many investors in green technologies sought alternative investments discovering the potential of solar energy, particularly photovoltaic.

There were two predominant reasons for this development:

Firstly, in the initial amendment of the EEG of 2004, the legislator again increased the subsidy rates for electricity generation from photovoltaic [11]. This was a necessary measure since a reduction in the growth of wind energy was expected and needed to be compensated for in order in order not to jeopardise the overall objective to expand electricity generation from renewable energies. The remuneration of electricity generation from photovoltaic plants had already been the highest in the EEG of 2000 and has now reached a level of more than 50 euro cents per kWh. The gross electricity price for the end consumer at that time amounted to about 18 euro cents per kWh.

Secondly, the technological progress combined with increasing competition leading to more economic procurement prices of solar modules, improved quality as well as a longer operating life.

These aspects have triggered the boom in the German solar industry. The number of manufacturers of solar modules and also the newly erected photovoltaic systems rose rapidly.

As depicted in Fig. 3, the cumulative photovoltaic output in Germany grew from 1.11 GWp in 2004 to 4.17 GWp in 2007, and in 2012 even reached 33.3 GWp.

#### *B. The years 2008 to 2012*

Characteristic for these years was further technical progress and the increasing competition on the solar module market. Module prices declined as performance and reliability increased. Lobbying by the solar industry prevented effective countermeasures such as a rapid and substantial reduction of the remuneration for solar power or the introduction of a market-based remuneration linked to market energy prices. Thus the aforementioned ample growth was possible with new records after each year [13]. Balancing the EEG account however could only be facilitated by substantially increasing the EEG surcharge as Fig. 1 shows.

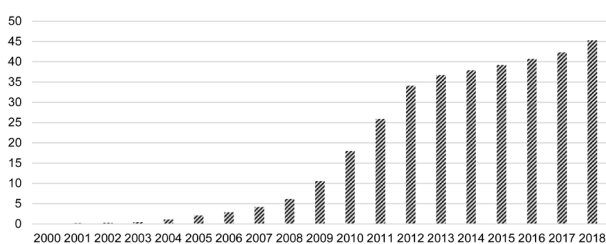


Fig. 3. Cumulative installed capacity of photovoltaic plants in Germany [12].

A major argument presented by the lobby was a vast job creation which was mainly enabled through national subsidies in economically underdeveloped Lands of the Federal Republic such as Saxony-Anhalt and Saxony. Unfortunately, this development was not sustainable, as the import of solar modules from Asia had already increased massively in 2009. The domestic solar industry was not competitive with suppliers from the Far East, who often received subsidies from their governments. The production costs of German companies alone were up to 15 percent higher than those of Asian competitors [14]. The market share of German manufacturers for

the domestic market fell to 15 percent. Fig. 4 depicts the resulting decrease in the number of employees of the German solar industry starting in 2011.

There were no protective measures such as import tariffs for the domestic solar industry during this period. The increasingly adverse sentiment in the industry combined with rising electricity prices, which to a large extent were attributed to the rising EEG surcharge and thus directly to the growth of photovoltaic output, significantly changed public opinion from 2012 onwards.

Simply put—photovoltaic served as a scapegoat for the increase in the EEG surcharge.

In the first two quarters of 2012 discussions inflamed in the media about the sharp increase of the EEG surcharge pushing electricity prices and the struggling incipient solar industry. Lobby associations representing various stakeholders as well as the public demanded swift political intervention and—resultant thereof—changes in legislation.

The representatives of the solar industry demanded the high remuneration rates to be maintained, further state aid to be provided for the domestic solar industry and import duties to be imposed on foreign manufacturers. The latter were modelled on the US customs regulations, which imposed high import duties on Chinese solar modules in May 2012 to protect their domestic manufacturers.

The trade and industry associations of the other sectors criticised the high energy prices and warned of the resulting disadvantages for the German economy in international competition. The loss of purchasing power of the local population was also often cited as an argument here.

The representatives of the left-wing opposition parties and the trade unions criticized the electricity prices for citizens and businesses and questioned the further development of the energy transition with regard to costs [15]. For socially weaker sections of the population, the additional burden of rising energy costs remains a considerable risk of poverty today.

The then federal government, consisting of a coalition of the conservative parties of the CDU/CSU and the more economically liberal FDP, came under pressure, especially in view of the upcoming federal elections in 2013. The responsible Federal Environment Ministry under the then Federal Environment Minister Norbert Röttgen announced reforms of the EEG, which however were not considered sufficient by the government and other stakeholders with the exception of the German solar lobby. The remuneration rates were only reduced insignificantly and market-oriented remuneration models were not mandatory for investors.

Reducing the growth of electricity production from photovoltaic systems as well as the EEG surcharge could not have been expected and the loss of jobs in the German solar industry was already visible. In May 2012, the minister was dismissed from the government cabinet and thus was bearing a vast portion of the political responsibility.



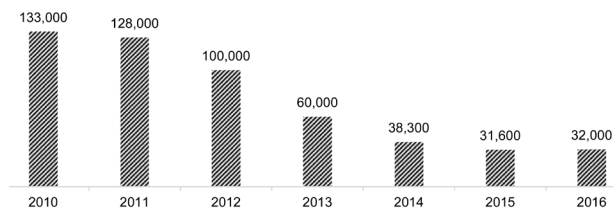


Fig. 4. Number of employees in the German photovoltaic industry from 2010 to 2016 [16].

Eventually, the German government decided to amend the EEG in August 2012 with retroactive effect to 1 April 2012. It included a retroactive reduction of the remuneration, but a mandatory market-based remuneration with a higher risk for the investors had not yet been implemented. Other countries in the European Union faced—albeit not to this extent—similar problems with the unbearably rapid growth of electricity production from photovoltaic plants, which were usually solved by retroactive reductions in subsidies. Economists agreed that this was the only way to prevent a further rapid increase in energy costs.

### C. The years 2013 to 2018

In 2013, the German solar industry was in a rather difficult state. Numerous companies filed for bankruptcy, the number of employees fell from 133,000 thousand in 2010 to 60,000 in 2013 as shown in Fig. 3. The European Union’s protective tariffs were not introduced until May 2013. For suppliers from China, a minimum price for the solar modules and an annual quota for imports were determined. The terms were negotiated cautiously as other industries headed by the automotive industry feared countermeasures restricting the access of their products to the valuable Chinese market. The declining trend in employment was not stopped in the following years either. In 2016 there were only 32,000 employees left in the solar sector and in 2018 Solarworld AG, the last German mass manufacturer of solar modules, disappeared from the market. Only manufacturers producing specialised products with small quantities are still available today.

In response to rising electricity prices, politicians have made numerous attempts not to allow the EEG surcharge to further increase. In 2013, the new Federal Environment Minister Peter Altmaier presented proposals to minimize the further increase of the EEG surcharge containing a provision limiting the increase to 2.5 per cent annually. However, the possible measures of reducing the remuneration combined with a suspension of disbursement were not implemented in the current EEG.

In 2014, the EEG was again amended to include a mandatory market-based solution for large solar power plants. The last amendment to the EEG in 2017 introduced a new regulation, requiring tenders for large solar installations. In these cases, the bidder with the lowest bid for feed-in remuneration is awarded the contract. This amendment to the EEG enables a controlled promotion of the individual forms of energy with binding target corridors.

These measures stabilised the EEG surcharge at the

high level and prevented further growth. However, a significant reduction is not to be expected in the next few years, due to the 20-year funding period of the rigid old regulation.

### III. SUMMARY

In summary, it is to be stated that the history of the German law on promoting renewable energies is a successful one. The mistakes were not inherent in the law, but rather due to adhering to rigid remuneration regulations, which were also preferred by investors, for too long. The EEG surcharge, which has now increased to 6.41 euro cents, is an essential component of the high electricity prices in Germany of approx. 30 euro cents. This still provokes criticism in politics and business [17].

Also the lack of inclusion of the citizens is to be considered a problem here. A visible change in the landscape—especially in the case of wind energy—in conjunction with rising electricity prices has regularly caused dissatisfaction among the population. The population was and still remains positive about the energy transition, but the aspect of rising costs eventually allocated as profits to anonymous investors does not contribute to the positive image of the EEG. Here the partially already existing co-ownership of plants by citizens could soothe the waters.

Also the fast loss of thousands of jobs in the German solar industry can be seen as a stumbling block of the German energy transition, because especially in the economically underdeveloped regions the affected people faced difficulties when seeking new employment.

Prospectively, therefore, a swifter monitoring, quick political reactions to technical and economic changes and lowering the influence from individual lobby associations will be crucial.

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