
Projected EEG Costs up to 2035

Impacts of Expanding Renewable Energy
According to the Long-term Targets of the
Energiewende

STUDY

Agora
Energiewende



Projected EEG Costs up to 2035

IMPRINT

STUDY

Projected EEG Costs up to 2035

Impacts of Expanding Renewable Energy According to
the Long-term Targets of the *Energiewende*

COMMISSIONED BY

Agora Energiewende
Rosenstraße 2 | 10178 Berlin

Dr. Patrick Graichen
Mara Marthe Kleiner
Christoph Podewils

Contact:

maramarthe.kleiner@agora-energiewende.de

WRITTEN BY

Oeko-Institut e.V.
Merzhauser Strasse 173 | 79017 Freiburg

Dr. Markus Haller
Charlotte Loreck
Verena Graichen

Editor: Mara Marthe Kleiner

Translation: WordSolid, Berlin
Typesetting: UKEX GRAPHIC, Ettlingen
Cover picture: ©Thomas Francois - Fotolia.com

Translation of a Study published in May 2015

079/14-S-2015/EN

Published: February 2016

Please cite as:

Oeko-Institut (2016): *Projected EEG Costs up to 2035*.
A study commissioned by Agora Energiewende.

www.agora-energiewende.de

Preface

Dear Reader,

The *Energiewende* – Germany’s transition to a sustainable, efficient energy system dominated by renewable energy – is a long-term project that will span generations. Nevertheless, since being announced, the question “How much will it cost?” has occupied the centre stage of political debate. To help answer the question, in 2013 we developed the EEG Surcharge Calculator, which in just seconds can project specific costs and benefits up to 2018.

To get long-term answers, we asked the Oeko-Institut to expand the capabilities of our software to calculate EEG surcharges as well as many other values through 2035. Such far-reaching projections require many assumptions. A crucial one – for the sake of simplicity – is that Germany’s surcharge system for renewable energy will remain essentially unchanged over this period. Yet within this framework, key parameters such as expansion levels, electricity prices, and electricity use can be varied to represent different future scenarios. Like the original EEG Surcharge Calculator, the new software is available in an expert version and an easy-to-use one for decision-makers.

This background paper outlines the essential aspects of a reference scenario estimated by our software. For the period through 2019, the scenario relies on the medium-term forecast from Germany’s transmission network operators. For the period thereafter, the scenario assumes that renewable energy will expand in accordance with the goals of EEG 2014, the latest revision of the German Renewable Energy Act, and that the basic parameters – electricity use, the electricity trading price, regulations governing industry use, exemptions, and in-house electricity use – remain constant. In addition to the reference scenario, this study presents a sensitivity analysis that shows how the EEG surcharge changes with different key parameters.

I invite you to try out the EEG Surcharge Calculator and to find out the effects that, say, rising electricity prices, lower electricity use, or sinking costs have for expanding renewable energy. The calculator can be found on our Website at www.agora-energiewende.de/eeg-rechner. I hope you learn much and enjoy the read.

Yours sincerely,
Patrick Graichen, Director, Agora Energiewende

Key Findings at a Glance

1

Initial EEG investments will begin to pay out in 2023: From then on, the EEG surcharge will fall despite increasing shares of renewable energy. The main reason is that starting in 2023, EEG funding for renewable plants from the early years with high feed-in tariffs starts to expire, and new renewable energy plants produce electricity at a considerably lower cost.

2

If the expansion of renewables continues at its ambitious pace, electricity costs will rise by 1-2 ct/kWh until 2023, but then fall by 2-4 ct/kWh by 2035. The sum of the EEG surcharge and wholesale electricity price, after being adjusted for inflation, will climb from around 10 cent per kWh today to 11 to 12 cents in 2023 and then sink to 8 to 10 cents by 2035.

3

In 2035, electricity will cost the same as today, but 60 per cent will stem from renewable sources. According to the current law, the share of renewables in electricity use is to rise from today’s 28 per cent to 55-60 per cent in 2035. Yet, the electricity cost in 2035 will be on the same level as today.

4

Main factors driving the EEG surcharge in the future will be the wholesale power price, the level of power demand, exemptions for industry and the amount of self-consumption. Since renewable energy plants have now become affordable alternatives for energy production, these drivers – not the costs and volumes of renewables – are essential for the EEG surcharge level.

Contents

List of Figures	5
1. Introduction	7
2. How is the EEG Surcharge Calculated?	9
3. Reference Scenario: Meeting EEG Expansion Targets	11
3.1. Generating capacities and electricity volumes	11
3.2. Payment flows and the EEG surcharge	15
4. Sensitivity Analysis	19
4.1. Electricity prices	19
4.2. Technology costs	20
4.3. Electricity demand	20
4.4. Exemptions	23
5. Summary	25
References	27

List of Figures

Figure 2-1:	Relationship between electricity price and feed-in payments (qualitative diagram)	9
Figure 3-1:	Annual gross gain of new generating capacity from renewable energy	12
Figure 3-2:	Relationship between gross and net gains in generating capacity for solar energy	12
Figure 3-3:	Production generating capacities in the reference scenario	13
Figure 3-4:	Electricity from renewable sources	14
Figure 3-5:	In the reference scenario the share of renewables in gross power consumption slightly exceeds the 2025 target set by the German federal government	14
Figure 3-6:	Renewable energy payments (revenues of plant operators)	15
Figure 3-7:	EEG surcharge levels and the most important factors that influence them	17
Figure 3-8:	Sum of electricity price (Phelix Base Year Future) and EEG surcharge	18
Figure 4-1:	Electricity price variation: If electricity price rises, the EEG surcharge decreases	19
Figure 4-2:	Electricity price variation: The sum of the electricity trading price and the EEG surcharge remains roughly the same	20
Figure 4-3:	Effects of technology costs on the EEG surcharge	21
Figure 4-4:	If electricity use decreases, the surcharge increases (and vice versa)	22
Figure 4-5:	Share of renewables in gross electricity use: Meeting targets depends on electricity use	22
Figure 4-6:	By restricting exemptions, the surcharge decreases considerably	23

1. Introduction

Since 2000, the German Renewable Energy Act (EEG) has promoted the building and operation of plants for the generation of renewable energy. A renewable-energy levy – the EEG surcharge – on every kilowatt hour apportions the costs among most of Germany's electricity users. The expansion of renewable energy in past years has been a resounding success: from 2010 to 2014 the share of renewables in electricity use increased from 17 per cent in 2010 to 27.3 per cent in 2014 (AGEB 2015). In the same period, the EEG surcharge rose noticeably. In 2014 the surcharge amounted to 6.24 cents per kilowatt hour, or around 21 per cent of the average retail electricity price for private and commercial electricity users (BDEW 2014). In 2015 the surcharge dropped only slightly, to 6.17 cents per kilowatt hour.

The surcharge has led to intensive discussions about the costs of expanding renewable energy, with much focus on the surcharge price. What is often missing from these discussions is that the surcharge is a highly inappropriate indicator for the costs for specific renewables or for the cost of the energy transition in general. The surcharge level depends on various factors, including the electricity trading price, electricity use, exemptions for high-use industries, mandatory payments for existing plants, forecast errors, and political considerations. These factors have been investigated in a variety of studies (Mayer and Burger 2014; Loreck et al. 2013; Haller et al. 2013).

As the energy transition continues, the German electricity market can expect some turbulent times ahead. Sinking electricity prices and operating hours will push conventional power plants from the market. The last remaining nuclear power plants will be phased out by 2022. All the while, the share of renewable energy will expand. By 2017 the EEG will be completely reformed according to EU directives. Henceforth, a bidding process will determine feed-in payments.

This will prompt discussion about the costs of expanding renewable energy, and how much renewable energy Germany wants and can afford. Various scenarios are imaginable. This study will consider if-then statements about future costs for renewables and – taking into account the complex interactions – the changes in the EEG surcharge price. The presented scenarios make plain that even in the future an ambitious expansion of renewables will not unduly burden electricity users.

The methodological basis for this analysis is the EEG Surcharge Calculator (Oeko-Institut 2015). Agora Energiewende commissioned the Oeko-Institut to develop this software in order to explain the factors influencing EEG prices and help ensure that debates about the energy transition are based in fact. The software can simulate various scenarios for the development of the EEG surcharge. All the important parameters that shape its development can be modified by the user.¹

The analysis covers the period from the present to 2035. This period is interesting for two reasons. The first is that 2035 represents a clearly defined EEG target for the share of renewables – and a basis to assess the scenarios. The second is that in the course of the next 20 years funding for existing renewable energy plants will expire and the old facilities replaced. This transition from (expensive) existing plants to more affordable new facilities will play an important role in renewable energy costs. The study is organized as follows. Section 2 briefly explains how the EEG surcharge is calculated. Section 3 presents a scenario in which the expansion of renewables meets government targets by 2035. In section 4, the effects of some important determining factors for the EEG surcharge price will be discussed. Section 5 provides a brief summary of the study's findings.

¹ The EEG Surcharge Calculator is available for download at www.agora-energiewende.de/eeg-rechner as a Web application and in Excel format.

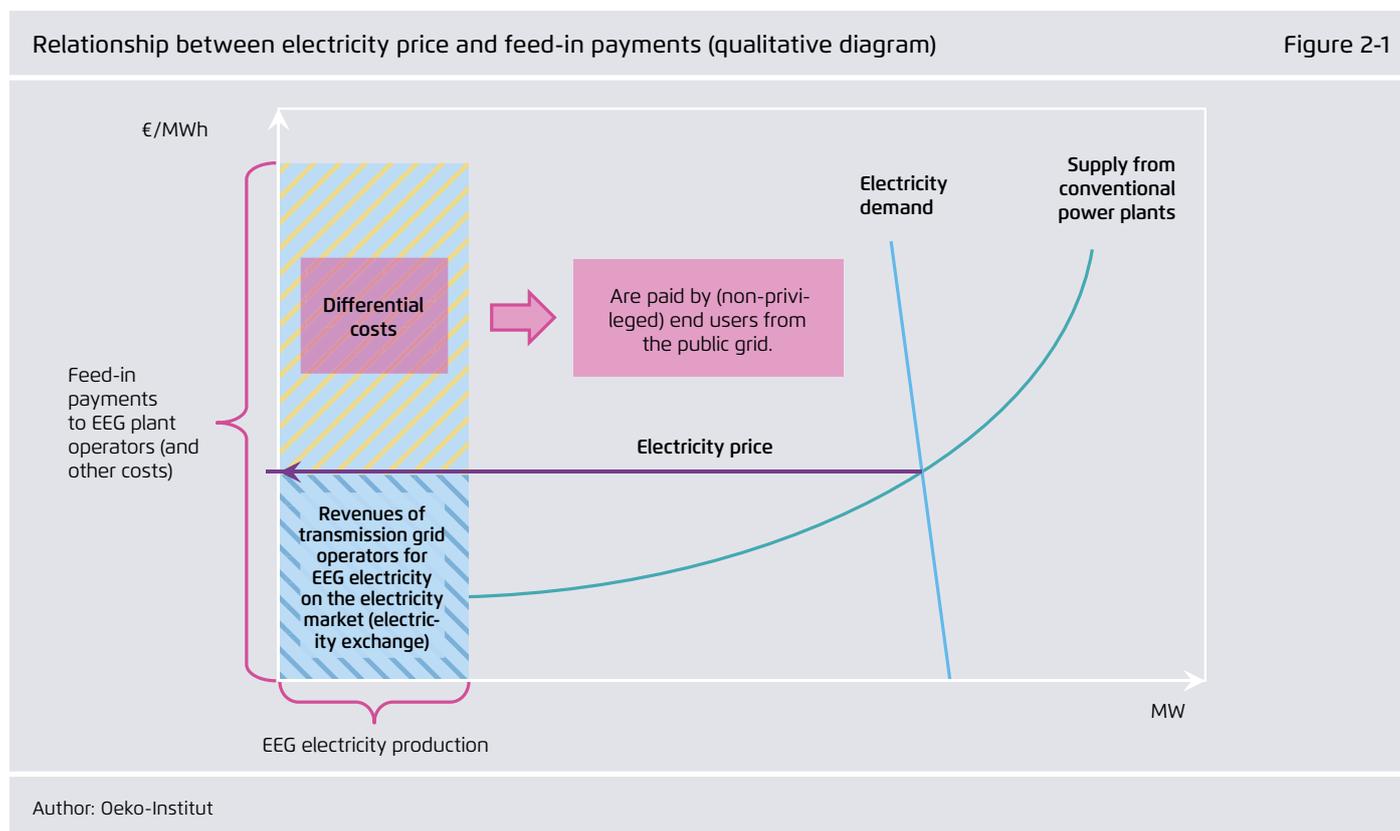
2. How is the EEG Surcharge Calculated?

The aim of the EEG is to encourage the expansion of electricity generation from renewables. In the past years, as producers have gathered more experience, the cost of generating renewable electricity has declined appreciably. Nevertheless, the generation cost is still higher than the price on the electricity market. The difference between production costs and market value (represented schematically in Figure 2-1) is borne by the German public through the EEG surcharge. Here it does not matter whether the surcharge amount is set by law (as is the case today) or determined by a bidding process (as will occur after the planned EEG reform in 2017).

The EEG surcharge is meant to make up the difference between market revenues for renewable electricity and the set feed-in tariffs for renewable energy plants. The surcharge is influenced by a variety of factors, which do not depend solely on renewable capacity. For that reason, the EEG sur-

charge level is not a suitable indicator for the costs of expanding renewables or for the costs of the energy transition in general.

To determine the surcharge, first the electricity generation from EEG subsidized facilities is estimated for the next calendar year. This estimate is informed by the number of renewable energy plants, the expected expansion, and the number of use hours per year. The estimated costs depend in particular on the respective feed-in tariffs, which vary considerably depending on the technology and the time it was put into operation. The projected revenues from the sale of renewable electricity on the stock market are also based on the expected electricity generation and on the trading price of electricity at the time of feed-in. The electricity price, in turn, depends on demand and the (fossil-fuel) power plant that sets the respective price.



When estimating costs and revenues, errors can occur, and these must be balanced out in the subsequent years on the EEG account. This account can hold a cash reserve of up to 10 per cent of the projected shortfall. The needed revenues also go to determining the necessary surcharge amount.

The surcharge amount is levied on electricity use. A share of every kilowatt hour goes to financing EEG costs. However, a portion of electricity output – most of the electricity used for operating the electricity generating plants – is not subject to the surcharge (this is the case for own consumption of power plants, and for consumption where consumer and owner of the generating plant are identical). In addition, some of the electricity used in the manufacturing and railway industries is eligible for a reduced surcharge. After taking into account revenue losses for these privileged end users, the missing subsidy amount is divided by the total amount of non-privileged end consumer use. Projected electricity use is thus another important factor for determining the EEG surcharge, as it shows how many “shoulders” must bear the EEG costs.

3. Reference Scenario: Meeting EEG Expansion Targets

This section uses the reference scenario to explain the main factors that determine EEG surcharge levels. Under the assumed expansion rate for renewable generating capacity, the EEG renewable electricity targets will be met up to 2035. Until 2019, the assumptions of the trend scenario from the current medium-term forecast by Germany's transmission system operations is used whenever applicable.² The following assumptions have been made for the period from 2020 to 2035.

- Net electricity use will remain constant at 510 terawatt hours per year.
- The wholesale electricity price will remain constant at 35 euros₂₀₁₅ per megawatt hour after adjusting for inflation.
- The exemptions for electricity-intensive industries and railways and for self-consumption of power plants will remain unchanged.
- With regard to feed-in tariff levels, electricity generation costs will drop moderately (Table 3-1).

The detailed parameterisation can be taken from the Excel version of the EEG Surcharge Calculator. Generally, the assumptions have been chosen so that EEG costs and the EEG surcharge tend to be overestimated rather than underestimated.

3.1 Generation capacities and electricity volumes

Figure 3-1 shows the annual gain in new electricity plants (gross gain). Until 2019 the expansion rates follow the medium-term forecast of the transmission network operators.³ Starting in 2020, gross gains of three gigawatts per

² Once a year the transmission system operators commission studies to determine the surcharge calculation for the following year and to provide a forecast of essential parameters for the next five years (Energy Brainpool 2014; Prognos 2014; Leipziger Institut für Energie 2014)

³ As the figure shows, the forecasts of the transmission system operators assume that the EEG expansion target of 2.5 gigawatts

year are assumed for photovoltaics and onshore wind farms. The expansion rate for offshore wind farms is assumed to be 0.85 gigawatt per year. At this rate, the expansion targets in the EEG – 6.5 gigawatts by 2020; 15 gigawatts by 2030 – can be met. Other technologies tend to play a subordinate role for future expansion.

The total generating capacity of renewable energy plants results from the sum of the existing plants and the gain in the plants for current year. The EEG guarantees a set feed-in tariff for a period of 20 years. After the funding period expires, the plants receive no more feed-in payments, that is, they exit the EEG system even if they remain in operation. Since the great majority of plants in the past have remained in operation for significantly fewer than 20 years, only some plants have exited the EEG system. Looking at the period through 2035, it must be considered that not only new plants will be built but also that existing plants will drop out. The net gain⁴ can in some circumstances considerably deviate from the gross gain. By 2035, all plants that became operational before 2015 will have exited the EEG system.

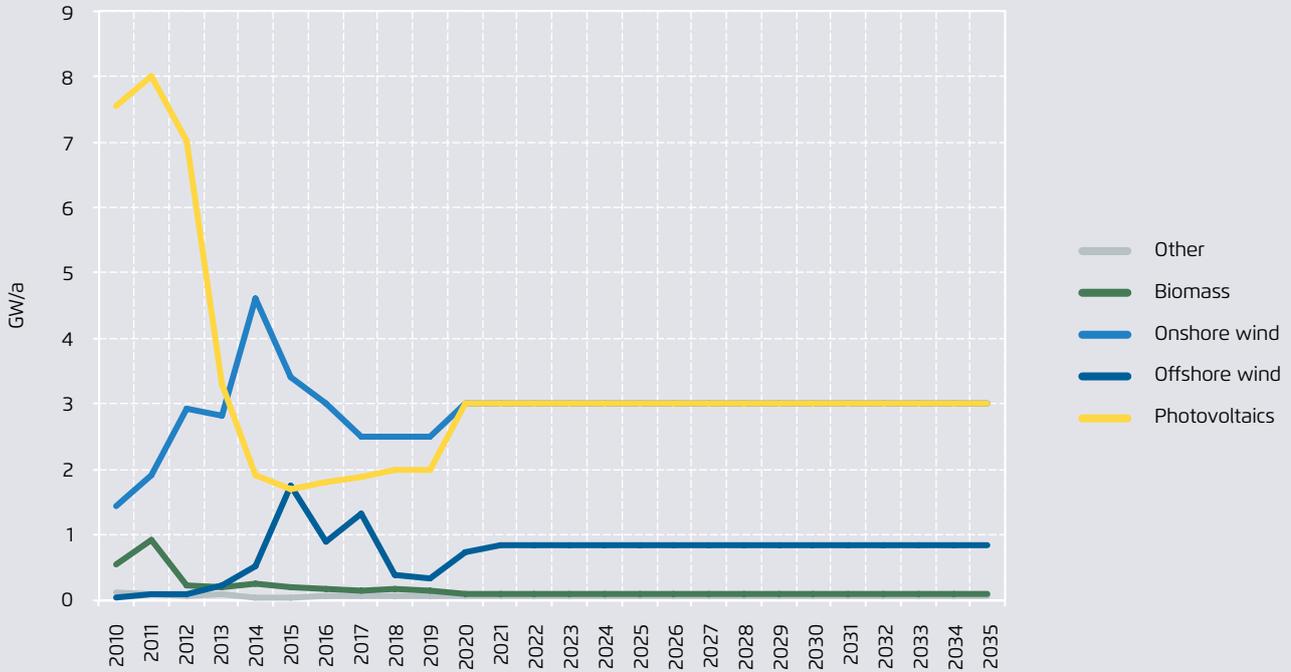
Figure 3-2 illustrates the relationship between gross and net gains in capacity in the case of solar energy, where the effect appears with particular force. Currently, gross and net gains are the same. The very high gain rates from 2010 to 2012 led to a concentrated exit of plants from the EEG system between 2020 and 2022. To avoid a net decline of capacities in these years, the gain rates must be comparatively high, as in the period from 2010 to 2012. The reference scenario assumes that the "solar boom" is unique and that the concentrated exit will not generate an increased production of plants 20 years down the road. For this reason, it is assumed that gross gain rates will remain the same for all technologies.

per year for photovoltaics will not be met. They attribute this to a low feed-in tariff.

⁴ In this study, net gain is defined as gross gain minus the plants exiting the EEG system.

Annual gross gain of new generating capacity from renewable energy

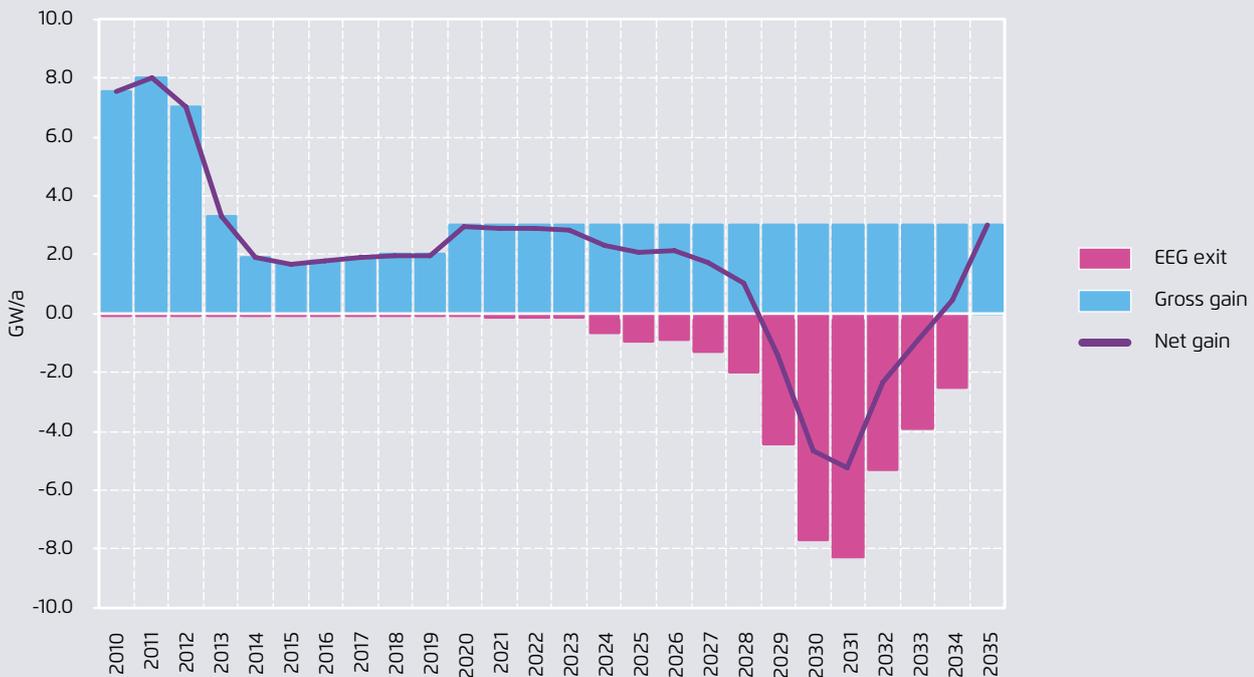
Figure 3-1



EEG Surcharge Calculator (Oeko-Institut 2015)

Relationship between gross and net gains in generating capacity for solar energy

Figure 3-2

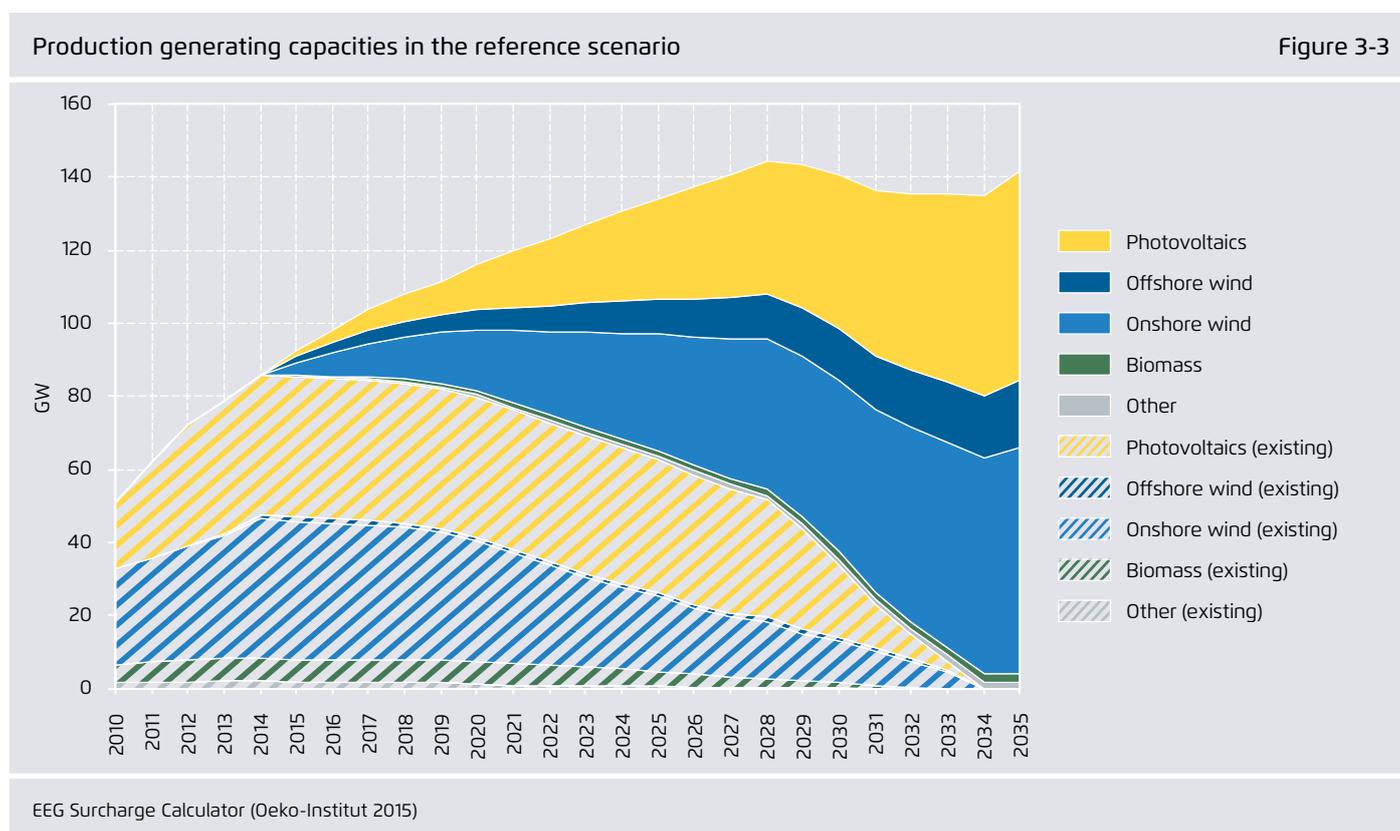


EEG Surcharge Calculator (Oeko-Institut 2015)

Figure 3-3 shows generating capacities for all renewable technologies available by 2035. The data are presented separately for existing plants (launched by the end of 2014) and for new plants (launched in 2015 and after). With regard to installed capacities, the mix for existing plants will be dominated by wind and solar farms. This trend will continue in the subsequent years, though offshore wind energy will gain increasing importance. Due to the high full load hours for offshore wind farms, this trend is even more pronounced for the electricity mix (Figure 3-4).

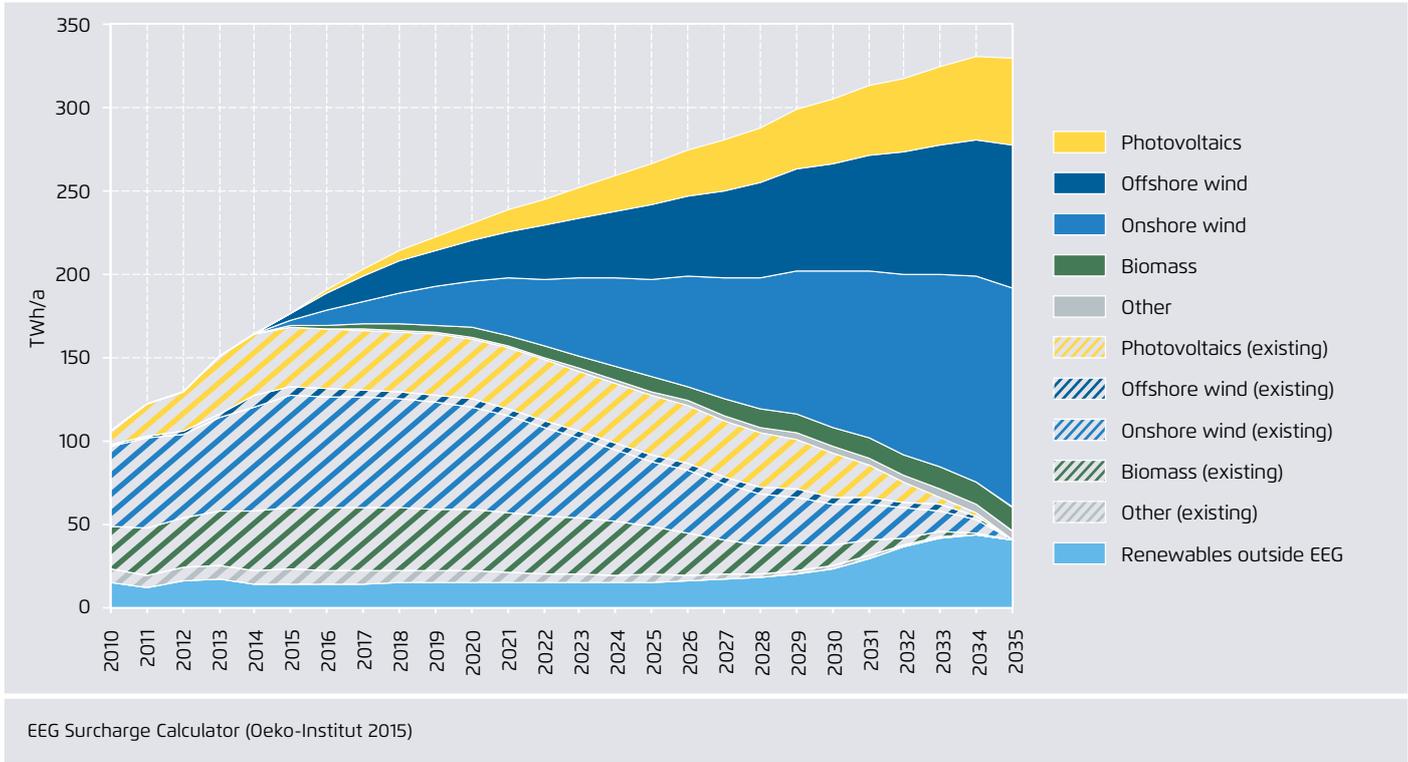
Total generation capacities decline noticeably in the years after 2025. This can be attributed to the fact that by this point a significant portion of existing plants will have reached the end of their funding period and withdraw from the EEG system. This effect is only partly compensated by constant gross gain in new capacity. In 2035 all plants put into operation before 2015 will no longer be covered by EEG funding.

Figure 3-4 shows how each technology contributes to power generation and the share of electricity from existing and new plants. Beginning in 2025, available production capacities decline, but the amount of generated electricity increases. This is mainly caused by two effects. First, the average plant load increases as the share of electricity from offshore wind farms rises. Here it is assumed that new on-shore wind farms will increase full load hours. The second effect is that starting in 2025, electricity from renewable energy not funded by EEG increases markedly in the reference scenario. Here it is assumed that solar farms will be in operation for five years after the funding period ends, as they are likely to be still profitable and in working order. For electricity generation from other renewable sources that are not funded by EEG (hydropower in particular), it is assumed that they will remain constant at 2014 levels. In total, electricity from renewable sources not funded by the EEG will increase by 2035 by around 50 terawatt hours per year. Figure 3-5 shows the targets of the German federal government stipulated by the EEG for the share of renewables in gross power use (40–45 per cent by 2025; 55–60 per cent by



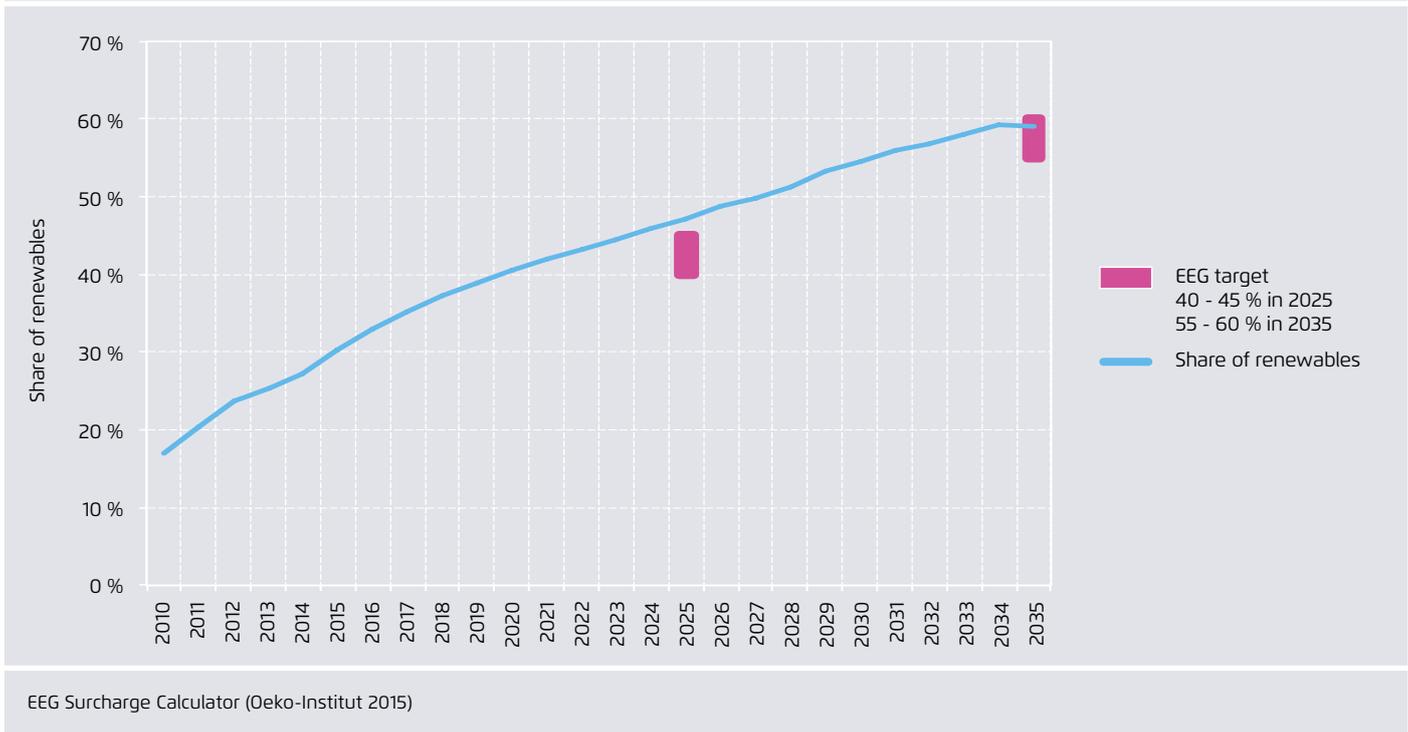
Electricity from renewable sources

Figure 3-4



In the reference scenario the share of renewables in gross power consumption slightly exceeds the 2025 target set by the German federal government

Figure 3-5



2035). The essentially constant gross gain in capacity and the increasing number of existing plants that exit the EEG over time will slow the rise of the renewable energy share. So for 2025, the renewable energy share is projected to lie slightly above the target. In 2035 its share is 59 per cent, which is within the target area.⁵

3.2 Payment flows and the EEG surcharge

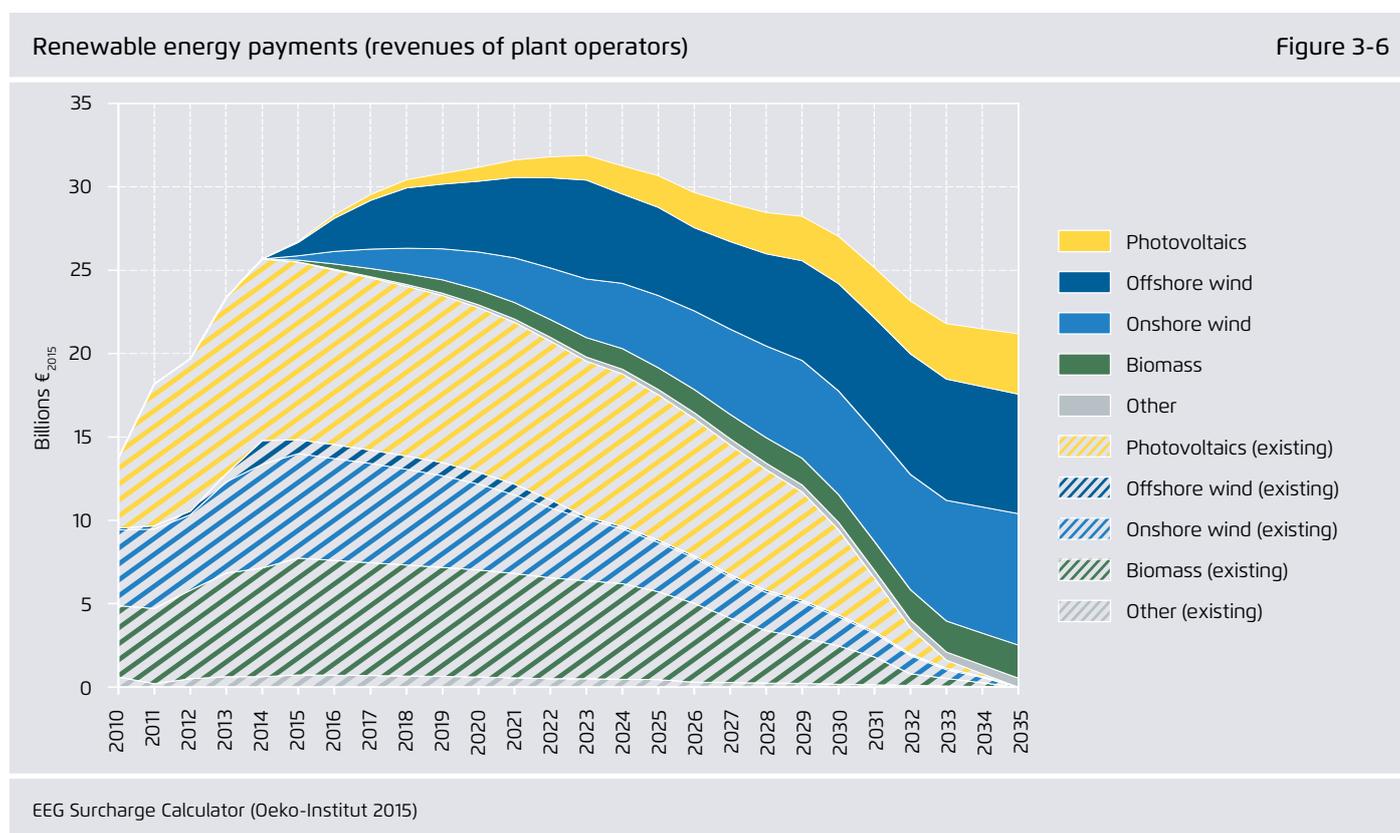
Figure 3-6 shows the projected development of plant operator revenues. These consist not only of the differential costs to be apportioned by the EEG, but also the total other revenues of plant operators. For electricity output that receives a fixed feed-in tariff, this is the sum of paid reimbursements; for directly sold electricity, it is the sum of premiums and revenue from electricity sold. The total plant revenues pro-

vide a picture that deviates markedly from the development of remunerated electricity output.

On the one hand, feed-in tariffs for new plants are noticeably lower than those for existing plants (see Table 3-1). That is to say, as the old plants exit the EEG system, feed-in tariffs sink markedly despite the expansion of electricity generated. On the other hand, the distribution of costs among the technologies shifts over time. In 2014 around 40 per cent of all feed-in payments went to photovoltaic power stations (the primary cause being the high feed-in tariffs for stations built before 2013); biomass electricity also received strong funding. For plants built after 2015, a considerably larger share of feed-in payments went to wind farms (both onshore and offshore).

Figure 3-7 shows EEG surcharge levels through 2015 as well as its levels through 2035 in the reference scenario. The figure shows which factors have a positive or negative influence on the surcharge:

⁵ When calculating the share of renewables, electricity from renewable energy plants not funded by the EEG was taken into account (Figure 3-4).



- The largest expense item by far is the *feed-in payments to the plant operators*. The influence of these feed-in payments on the surcharge amount is presented separately for existing plants (launched before 2015) and for new plants (launched after 2014).
- The most important revenue items are proceeds from the sale of renewable energy on the stock market.⁶ The market proceeds increase considerably through 2020 due to the growing volumes of electricity sold on the market. Thereafter, proceed levels stabilize, mostly due to sinking market value factors.⁷
- The EEG account balance is factored into the annual calculation of the surcharge and can positively or negatively affect the surcharge, depending on whether a positive or negative balance exists at the time of the calculation.
- The *cash reserve* is a security buffer of up to 10 per cent of the projected shortfall; it can be used by transmission

6 This item takes into account the market value of all electricity remunerated as part of EEG, regardless whether the producers sell the electricity directly on the market or the electricity fetches a set price and is sold on the market by transmission system operators.

7 The market value factor describe the relationship between the annual average stock market price and the average electricity price achieved from the sale of renewable electricity. When plenty of renewable energy is available, the electricity price on the stock market drops. In the hours when the renewable energy feed-in is high, market proceeds are low, usually less than the annual average price for electricity. Hence, the profile factors sink when the share of renewables in the electricity mix increase.

system operators when calculating the surcharge to offset forecast errors.

- *Other items*, such as avoided grid fees, costs of green electricity privileges, interest costs, etc. play a relatively minor roll.

Like total plant revenues, the EEG surcharge deviates considerably over time from the development of (the continually growing) electricity volumes (see Figure 3-4). In the period from 2012 to 2015 the surcharge was strongly influenced by shifting effects between the years.⁸

Given the expectation of a high EEG account surplus, it can be assumed that for 2016 the surcharge will remain essentially stable. For subsequent years, two important expenditure items will influence the surcharge level: first, feed-in payments for existing plants, which remain almost constant through 2020 and than decline to zero by 2035; second, feed-in payments for new plants with considerably lower feed-in tariffs, which will completely replace existing plants by 2035.

8 For political reasons, in 2012 the surcharge was increased relative to 2011 although in the years 2010 to 2012 a strong gain in photovoltaic capacity led to an increase in revenues. The markedly negative account balance at the end of 2012 was one of the reasons for the disproportionately large surcharge rise in 2013.

Feed-in tariffs for new plants in the reference scenario (ct₂₀₁₅/kWh)

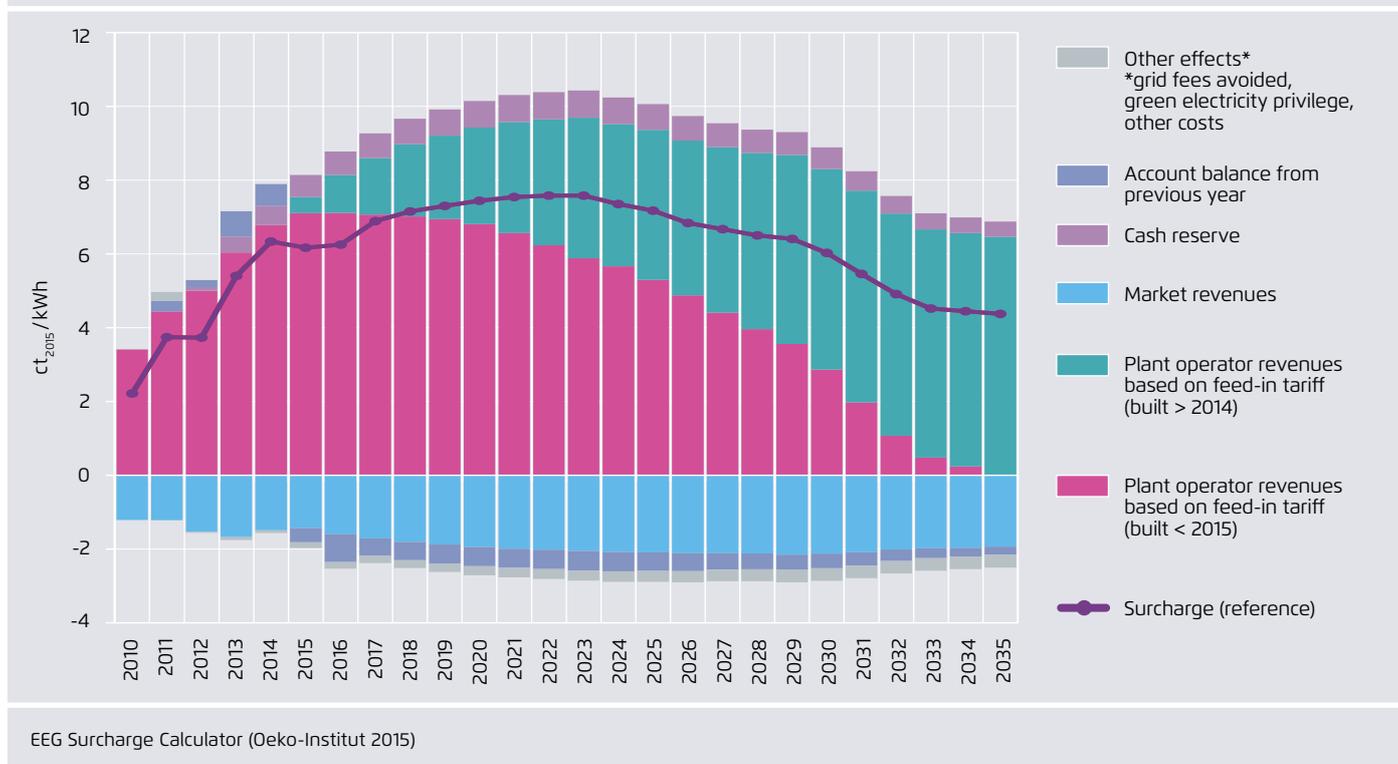
Table 3-1

	Ø Through 2014	2015	2025	2035
Onshore wind	9.3	8.9	7.2	5.3
Offshore wind	18.1	19.4	14.3	10.9
Solar energy	31.2	11.0	10.3	8.4
Biomass	18.0	17.7	16.0	14.5
Geothermal	24.2	25.2	19.6	15.2
Hydro	9.0	11.7	11.2	10.6
Gase	7.6	8.2	8.0	8.0
Ø Plant mix	17.0	14.8	10.6	8.1

Author: Agora Energiewende

EEG surcharge levels and the most important factors that influence them

Figure 3-7

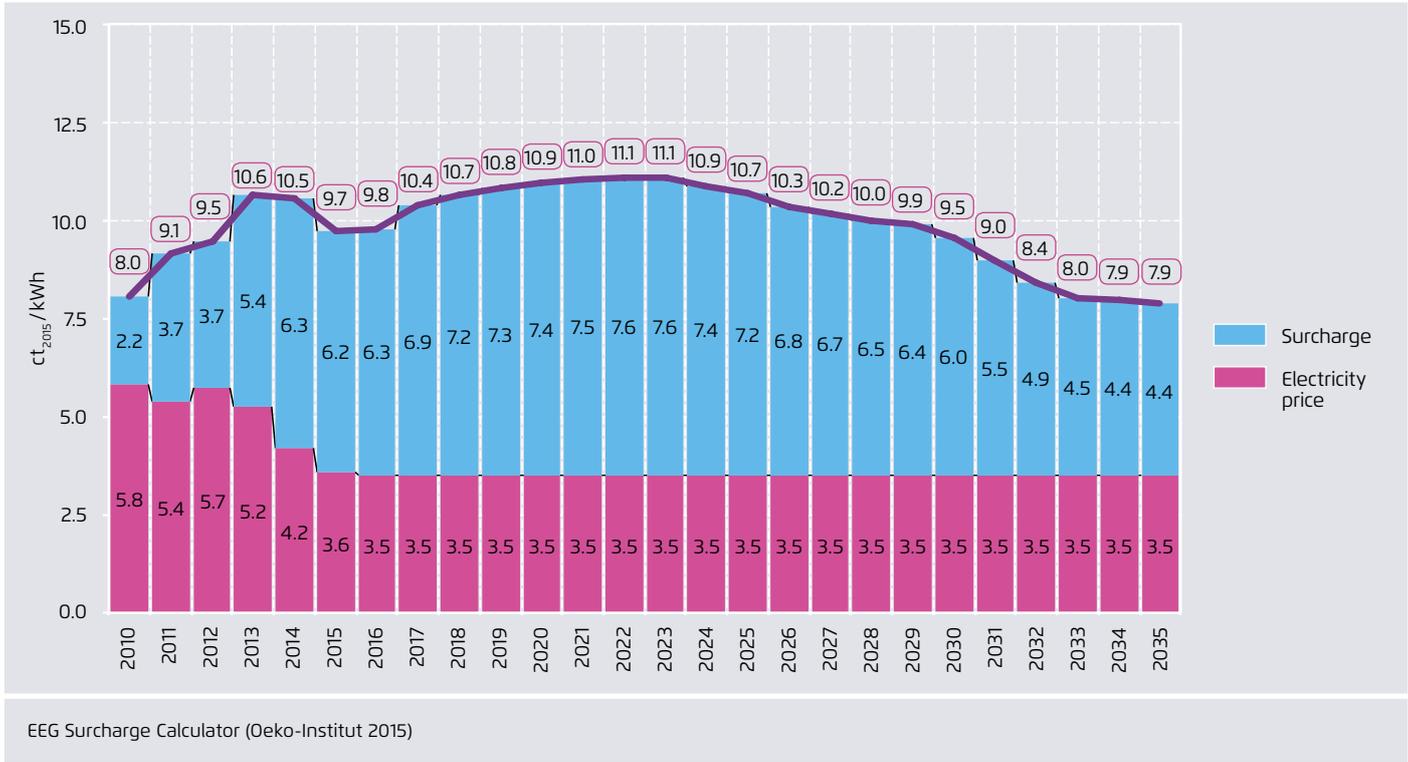


For any subsequent plants built by 2035 as well, market revenues from generated electricity will not be enough to cover the entire cost of investment. But if this is the case, then the EEG surcharge could sink to zero and EEG funding could expire. Due to the expected reduction of the full costs – especially for offshore wind and photovoltaics – a considerable reduction of feed-in tariffs in the coming 20 years can be assumed. In total, this will lead to a moderate rise in the surcharge through 2020 to around 7.6 cents₂₀₁₅ per kilowatt hour, followed by a constant decline to around 4.4 cents₂₀₁₅ per kilowatt hour in 2035.

Figure 3-8 shows the yearly sums of the electricity trading price and the EEG surcharge in the reference scenario. The reference scenario assumes that the electricity trading price remains constant. The following section presents a sensitivity analysis (see Figure 4-1) showing how a deviation in the electricity trading price affects the EEG surcharge level.

Sum of electricity price (Phelix Base Year Future) and EEG surcharge

Figure 3-8



4. Sensitivity Analysis

Developing scenarios over 20-year periods is accompanied by significant uncertainty. The reference scenario described in the past section represents only one of many possible scenarios that the EEG Surcharge Calculator can generate. This section presents several other alternatives.

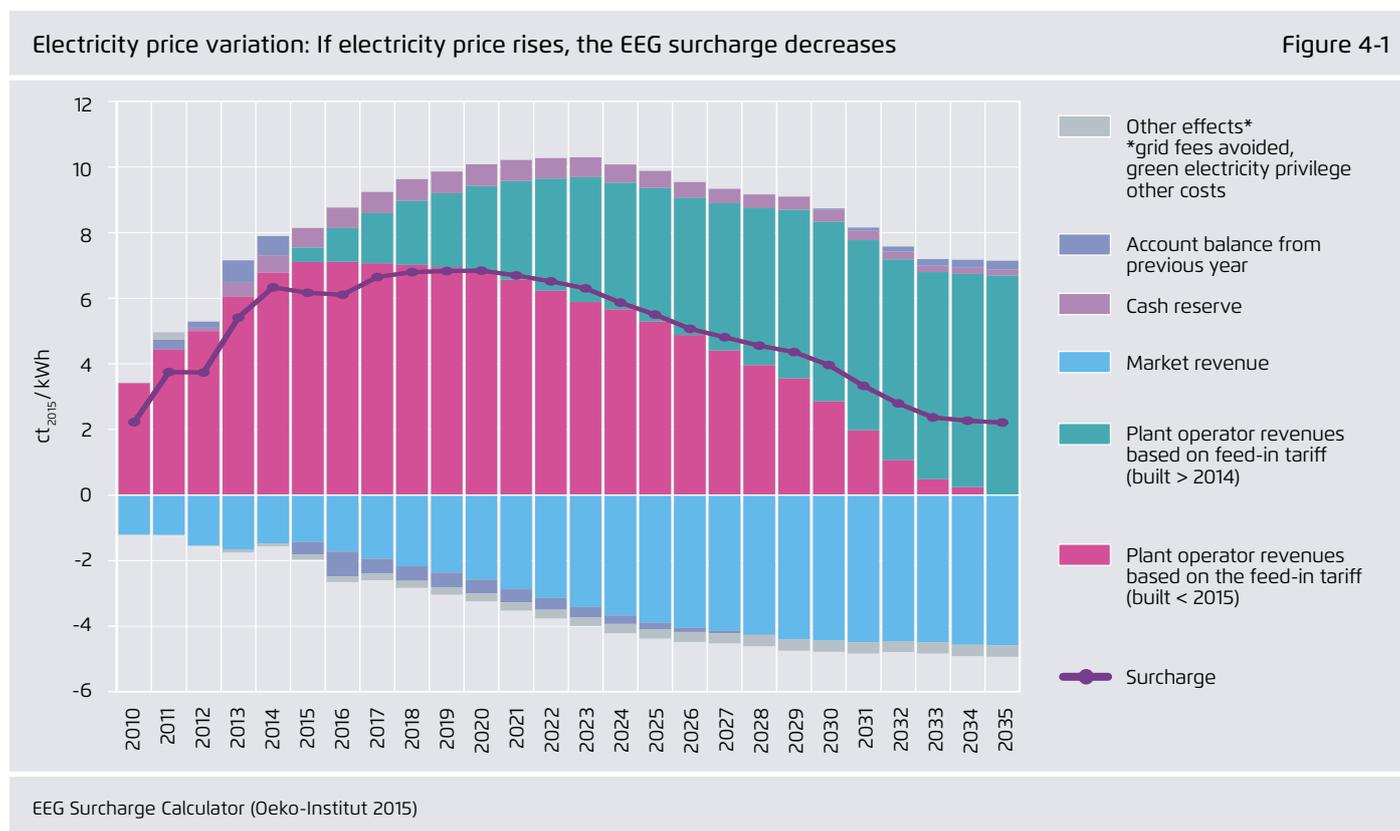
4.1 Electricity price

Since the shortfall funded by the EEG depends on the difference between feed-in tariffs and the market value of electricity, there is a direct relationship between electricity price and the EEG surcharge. If the electricity price increases, the surcharge decreases (and vice versa). The reference scenario assumes that the electricity price remains constant at the current low level. However, numerous studies assume that the electricity price could rise markedly in the medium term.

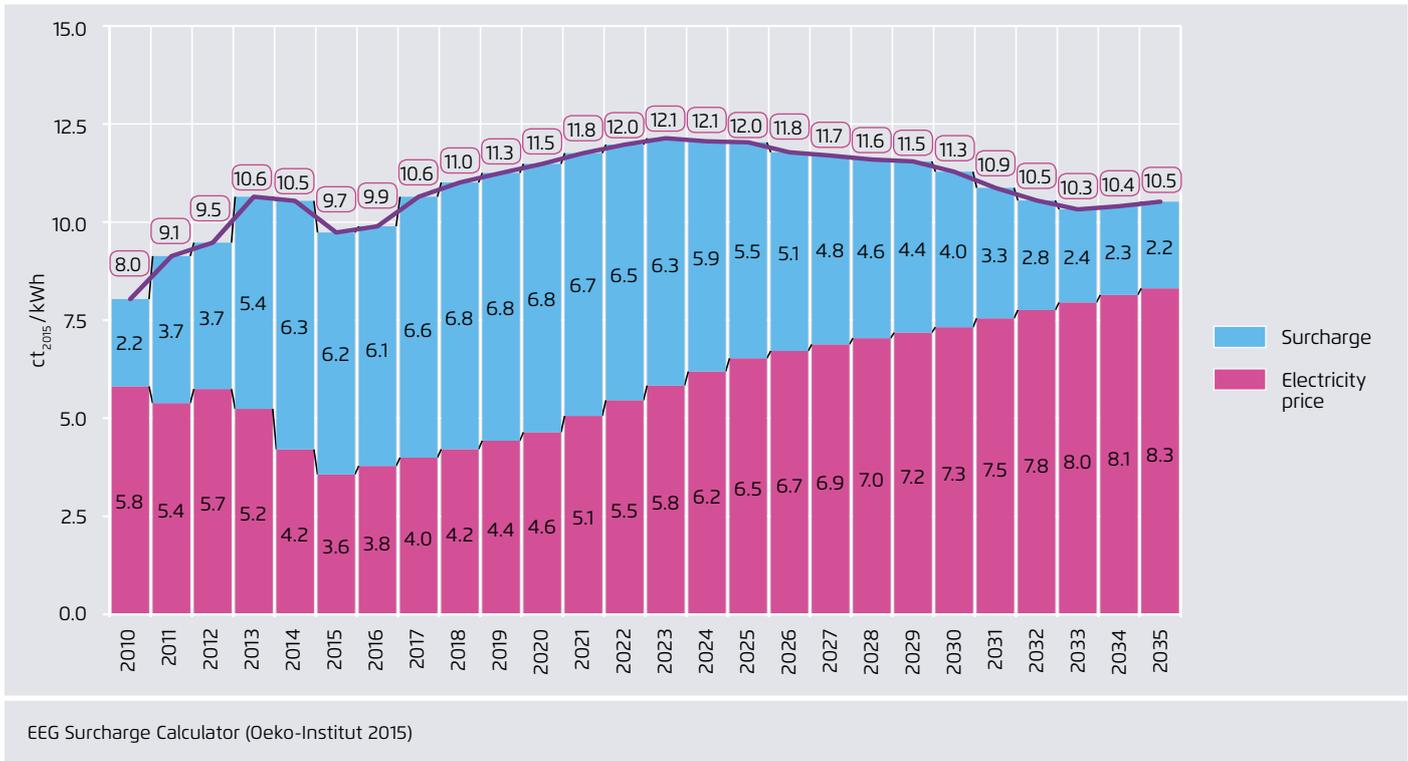
Such a rise could be caused by the reduction of power plant surplus capacity or an increase in CO₂ prices, among other reasons.

Figure 4-1 shows how the EEG surcharge changes if the wholesale electricity price increases to 8.3 cents₂₀₁₅ per kilowatt hour by 2035.⁹ The resulting increase in market revenues leads to a significant decrease in the EEG surcharge, to 2.2 cents₂₀₁₅ per kilowatt hour by 2035. This does not mean that the overall financial burden on end users decreases. On the contrary, the sum of the wholesale electricity price and the EEG surcharge is significantly higher than in the reference scenario (Figure 4-2). The rise wholesale prices is only partly compensated by the lower EEG surcharge.

⁹ This scenario corresponds to the one presented by Prognos, EWI, GWS 2014.



Electricity price variation: The sum of the electricity trading price and the EEG surcharge remains roughly the same Figure 4-2



4.2 Technology costs

Experience gained in the past years has enabled producers to lower the cost of generating power from renewable sources considerably. This is one of the major accomplishments of EEG funding so far. Further cost reductions are expected in the future, though the amount remains uncertain. The potentials for cost reduction vary strongly from one technology to the next. While solar energy has already experienced important cost reductions, offshore wind power producers are still at the start of the learning curve. The reference scenario assumes a moderate decline in feed-in tariffs (Table 3-1). Figure 4-3 shows how a deviation from this scenario influences the surcharge price.

A 20-per cent deviation in feed-in tariffs by 2035 changes the surcharge by 0.6 cent₂₀₁₅ per kilowatt hour. The figure also displays a scenario in which the costs for new plants do not sink but remain stable at 2015 levels after adjusting for inflation. In this (very unlikely) case, the EEG surcharge in 2035 is the same as today's, though the volume of gener-

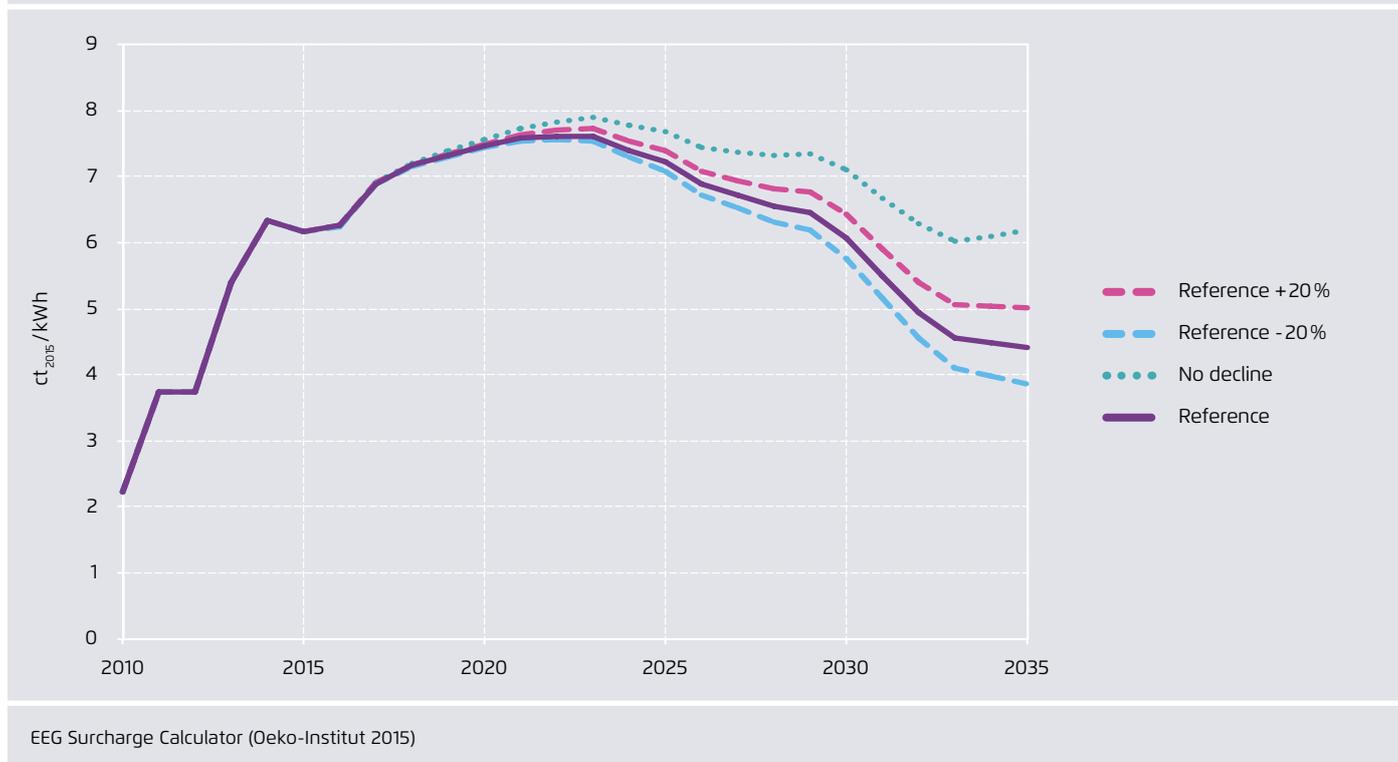
ated renewable electricity is almost twice as high as in 2015 (Figure 3-4). This is because the feed-in tariffs today are already significantly lower than the average feed-in tariffs for existing plants, which determine the current surcharge price.

4.3 Electricity demand

Electricity demand is of great significance for various reasons. A decline in electricity use leads to an increase in the EEG surcharge, since the differential costs are distributed across a lower volume of electricity. An increase in electricity consumption leads to the opposite effect. Since 2011 net electricity consumption in Germany has dropped, contributing to an increase in the EEG surcharge. Added to this is the expanded volume of electricity output completely or partly exempted from the EEG surcharge. This does not reduce total electricity use, just the volume of electricity that must bear the differential costs. In other words, expansion of the surcharge exemption increases the EEG surcharge (section 4.4).

Effects of technology costs on the EEG surcharge

Abbildung 4-3



Electricity demand also influences the amount of renewable generating capacity needed to reach the expansion targets stipulated by the EEG. Since the targets are defined as relative shares of renewable electricity generation in gross electricity use, an increase in electricity demand means a greater amount of renewable electricity is needed to meet EEG targets (and vice versa).

In the medium term, of course, electricity demand estimates carry a degree of uncertainty. Improvements in energy efficiency can lead to a decline in electricity use. Growing levels of electrification in different sectors over the medium and long terms – due in no small part to the spread of electric vehicles – can also increase electricity demand. Finally, demand depends on overall economic development.

The reference scenario assumes that net electricity use will sink slightly by 2019 and then stabilize at a level of 510 terawatt hours per year. (This accords with the trend scenario in the end use forecast by Germany's transmission system operators.) Figure 4-4 shows how the EEG surcharge

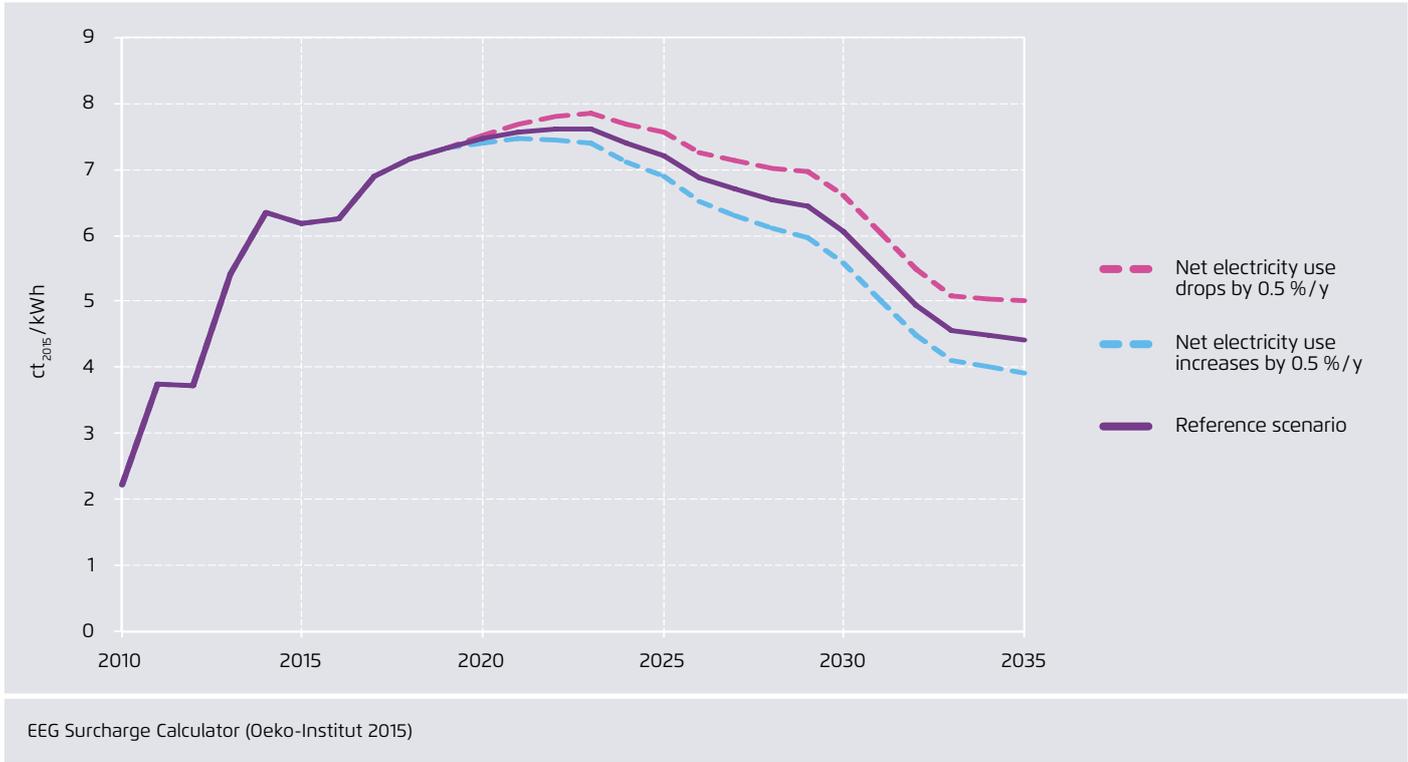
responds to changes in net electricity use. A change in the growth rate of net electricity use by 0.5 per cent per year starting in 2020 – equivalent to an absolute change in 2035 by around 40 terawatt hours per year – changes the 2035 EEG surcharge by around 1 cent per kilowatt hour. Figure 4-5 shows the relationship between electricity use and the meeting of target goals. A change in the growth rate of net electricity use by 0.5 per cent per year by 2020 changes the renewable energy share in gross electricity use by roughly 5 per cent.

4.4 Exemptions

In principle, the shortfall covered by the EEG is spread pro rata across total electricity use in Germany. In practice, some electricity use is exempted from the surcharge, while other users pay a reduced fee. The loss in money is made up by non-privileged electricity use. A rise in privileged and exempted electricity is similar in its effect on the EEG surcharge to sinking electricity use (section 4.3), namely, it increases the EEG surcharge. If, by contrast, privileged or

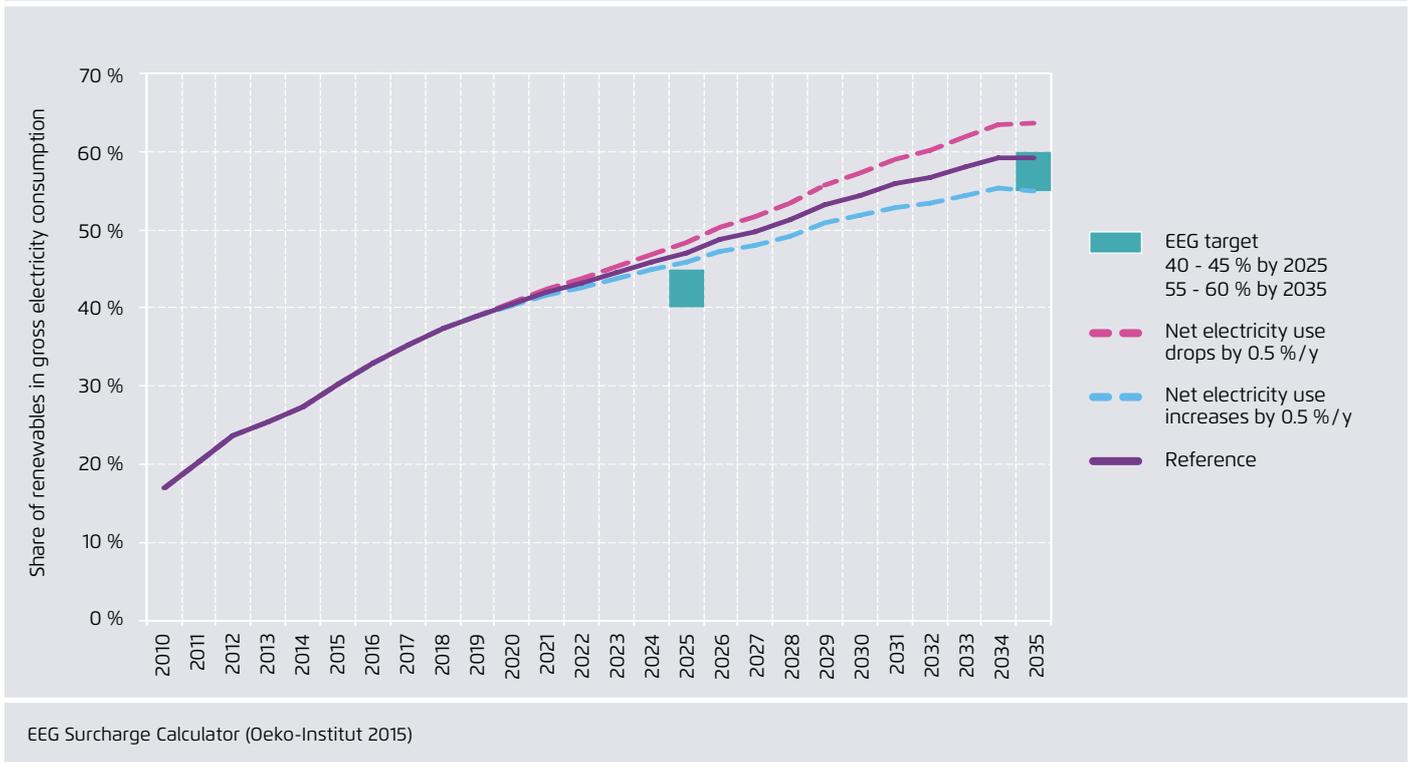
If electricity use decreases, the surcharge increases (and vice versa)

Figure 4-4



Share of renewables in gross electricity use: Meeting targets depends on electricity use

Figure 4-5



exempted electricity volumes are reduced or their rate is raised per kilowatt hour, the EEG surcharge sinks.

In 2015 Germany had a net electricity use of 521 terawatt hours. Of them, 351 terawatt hours fall under the category of non-privileged end use and are thus subject to the full EEG (Prognos 2014). Users who benefit from the exemptions (on whom 32 per cent of the electricity volume accrues) carry only two per cent of the payments needed to fund the shortfall.

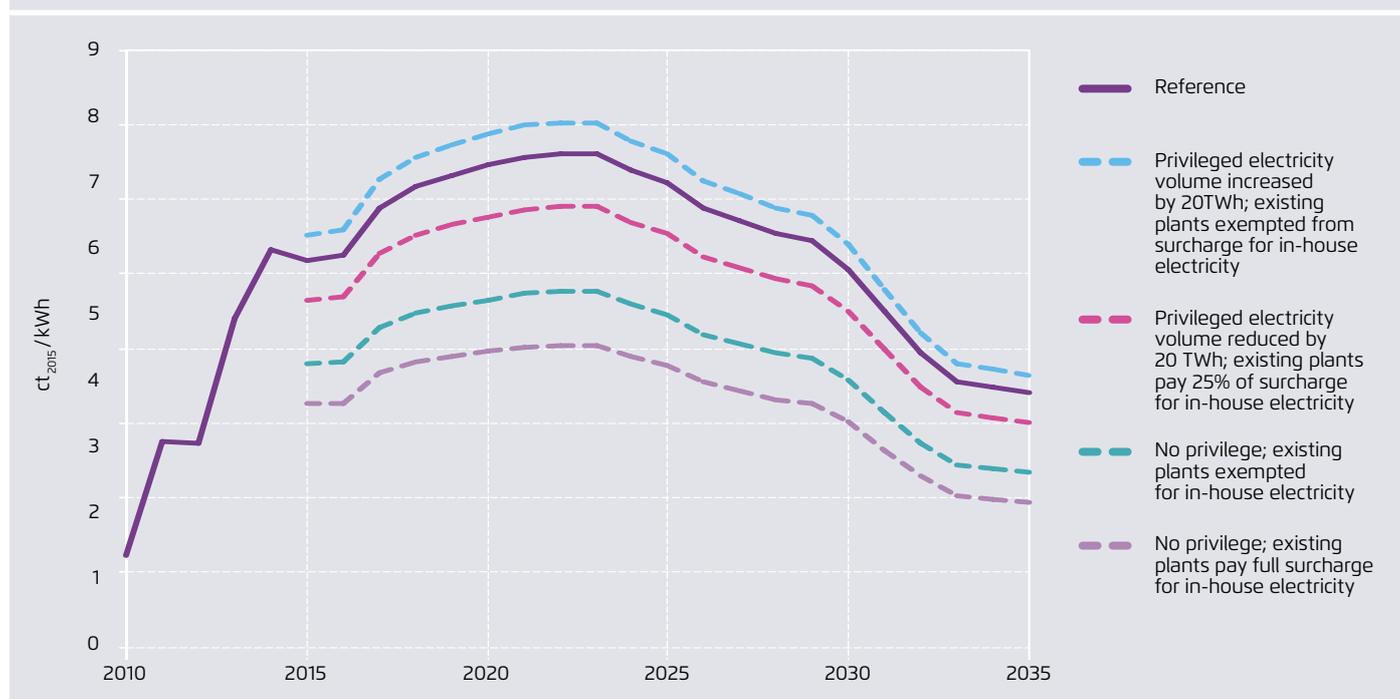
58 terawatt hours are completely exempted from the surcharge. Until 2014, self-consumption – the electricity used by a plant that it generates itself – was completely exempted from the EEG surcharge. This exemption continues to apply to existing plants and new plants that replace existing ones. In the future, new fossil-fuel power stations will pay the complete EEG surcharge for in-house electricity use. Plants that generate renewables above a certain level and plants for power-heat cogeneration pay a share of the surcharge. This share will increase to 40 per cent by 2017.

110 terawatt hours are subject to a reduced tariff. EEG's special equalisation scheme (BesAR) sets down detailed conditions that railways and electricity-intensive manufacturing companies must fulfil to qualify for reduced rates and regulates their surcharge contribution. Currently, railways pay 20 per cent of the EEG surcharge. Privileged manufacturers pay up to 15 per cent of the EEG surcharge but at least 0.1 cent per kilowatt hour (or 0.05 cent per kilowatt hour in the case of the non-iron metal industry).

These exemptions have a noticeable effect on the EEG surcharge for non-privileged end users. Figure 4-6 shows that a complete retraction of exemptions for electricity-intensive industries would sink the EEG surcharge in 2015 by 1.4 cents per kilowatt hour. If, in addition, existing plants were completely exempted from the surcharge for in-house electricity use, the surcharge would sink by 1.9 cents per kilowatt hour. But even a moderate limitation of exemptions – a reduction of privileged electricity volumes by 20 terawatt hours and the requirement that existing fossil-fuel power stations pay 25 per cent of the surcharge for in-

By restricting exemptions, the surcharge decreases considerably

Figure 4-6



EEG-Rechner (Öko-Institut 2015)

house electricity use – could provide noticeable relief. In this scenario, the surcharge would sink in 2015 by 0.5 cent per kilowatt hour and never exceed 7 cent₂₀₁₅ per kilowatt hour. An expansion of the privileges, by contrast, would increase the surcharge. If the privileged electricity volume increases by another 20 terawatt hours, the EEG surcharge would increase by around 0.4 cent₂₀₁₅ per kilowatt hour to 8 cent₂₀₁₅ per kilowatt hour in 2023.

5. Summary

Germany's *Energiewende* is a long-term project, yet debate about the costs and benefits of funding renewables is often shaped by the vagaries of day-to-day politics. The updated EEG Surcharge Calculator makes it possible to examine different scenarios for the expansion of renewable energy generation, their associated costs, and the distribution of these costs, both for the short term and for periods spanning up to 20 years.

The scenarios reveal that the gain in new plants (offshore wind farms in particular) will further increase funding costs over the coming years. These costs will peak between 2021 and 2023 and then decline markedly. This is because, from 2024 onwards, the EEG funding periods for old plants (which receive particularly high feed-in tariffs) will begin to expire.

Thanks to the considerable surplus on the EEG account, the EEG surcharge will likely remain at its current level next year. Thereafter, assuming a constant electricity price of 35 euros₂₀₁₅ per megawatt hour and a constant net electricity use, the surcharge will increase around 1.5 cents₂₀₁₅ per kilowatt hour by 2023. Subsequently, as old (and expensive) plants exit the system, the surcharge will sink to around 4.4 cents₂₀₁₅ per kilowatt hour by 2035, while the share of renewables in electricity use will climb to 50 per cent, more than double 2014 levels.

In isolation, the amount of the EEG surcharge is not a suitable indicator for the costs of expanding renewables. It is influenced by electricity demand and how many electricity users benefit from exemptions to the surcharge. Both factors determine the number of shoulders that bear the costs of EEG funding. The trading price of electricity also influences the surcharge rate, since it determines the market value of electricity from renewable sources. In other words, the financial burden borne by end users results from the electricity trading price and the EEG surcharge. Cost reductions from new technology for generating renewable electricity also influence funding costs.

The EEG Surcharge Calculator can be used to analyse all these parameters for the next 20 years in various combinations and project their influence on funding costs and EEG surcharge levels. It shows that the construction of new plants is, not surprisingly, associated with additional costs, but that, even after accounting for uncertainties, the expansion of renewables will remain affordable.

Ultimately, we must remember that over the next 20 years investments in the electricity sector will be necessary on any score. Even in an alternative scenario without an expansion of renewables, new fossil-fuel power capacity will need to be developed, and that will come at a considerable expense. In a follow-up project, we will compare the respective costs.

References

AGEB (2015): *Bruttostromerzeugung in Deutschland ab 1990 nach Energieträgern*. Stand: 27. Februar 2015 2015.

BDEW (2014): *BDEW-Strompreisanalyse Dezember 2014*. Haushalte und Industrie 2014.

Energy Brainpool (2014): *Ermittlung des Marktwertes der deutschlandweiten Stromerzeugung aus regenerativen Kraftwerken*. Studie für die vier deutschen Übertragungsnetzbetreiber im Auftrag der TenneT TSO GmbH 2014.

Haller, Markus; Hermann, Hauke; Loreck, Charlotte; Matthes, Felix Chr.; Cook, Vanessa (2013): *EEG-Umlage und die Kosten der Stromversorgung für 2014. Eine Analyse von Trends, Ursachen und Wechselwirkungen*. Öko-Institut. Berlin 2013.

Leipziger Institut für Energie (2014): *Mittelfristprognose zur EEG-Stromeinspeisung bis 2019*. Auftraggeber: TenneT TSO GmbH, 50Hertz Transmission GmbH; Amprion GmbH; TransnetBW GmbH. Leipzig 2014.

Loreck, Charlotte; Haller, Markus; Hermann, Hauke; Cludius, J. (2013): *Analyse der EEG-Umlage 2014. Kurzstudie im Auftrag von Agora Energiewende*. Öko-Institut. Berlin 2013.

Mayer, Johannes N.; Burger, Bruno (2014): *Kurzstudie zur historischen Entwicklung der EEG-Umlage*. Fraunhofer ISE. Freiburg 2014.

Öko-Institut (2015): *EEG-Rechner. Berechnungs- und Szenarienmodell zur Ermittlung der EEG-Umlage*. Erstellt im Auftrag von Agora Energiewende 2015 (Modellversion 3.0).

Prognos (2014): *Letzverbrauch bis 2019. Planungsprämissen für die Berechnung der EEG-Umlage*. Berlin 2014.

Prognos, EWI, GWS (2014): *Entwicklung der Energiemärkte – Energiereferenzprognose*. Hrsg. vom Bundesminister für Wirtschaft und Technologie. Basel, Köln, Osnabrück 2014.

ÜNB (2013): *Prognose der EEG-Umlage 2014 nach AusglMechV*. Prognosekonzept und Berechnung der Übertragungsnetzbetreiber 2013.

Publications of Agora Energiewende

IN ENGLISH

12 Insights on Germany's Energiewende

An Discussion Paper Exploring Key Challenges for the Power Sector

A radically simplified EEG 2.0 in 2014

Concept for a two-step process 2014-2017

Benefits of Energy Efficiency on the German Power Sector

Final report of a study conducted by Prognos AG and IAEW

Comparing Electricity Prices for Industry

An elusive task – illustrated by the German case

Comparing the Cost of Low-Carbon Technologies: What is the Cheapest Option?

An analysis of new wind, solar, nuclear and CCS based on current support schemes in the UK and Germany

Cost Optimal Expansion of Renewables in Germany

A comparison of strategies for expanding wind and solar power in Germany

Increased Integration of the Nordic and German Electricity Systems

Modelling and Assessment of Economic and Climate Effects of Enhanced Electrical Interconnection and the Additional Deployment of Renewable Energies

Power Market Operations and System Reliability

A contribution to the market design debate in the Pentilateral Energy Forum

The Danish Experience with Integrating Variable Renewable Energy

Lessons learned and options for improvement

Understanding the Energiewende

FAQ on the ongoing transition of the German power system

IN GERMAN

12 Thesen zur Energiewende

Ein Diskussionsbeitrag zu den wichtigsten Herausforderungen im Strommarkt (Lang- und Kurzfassung)

Aktionsplan Lastmanagement

Endbericht einer Studie von Connect Energy Economics

Auf dem Weg zum neuen Strommarktdesign: Kann der Energy-only-Markt 2.0 auf Kapazitätsmechanismen verzichten?

Dokumentation der Stellungnahmen der Referenten für die Diskussionsveranstaltung am 17. September 2014

Ausschreibungen für Erneuerbare Energien

Welche Fragen sind zu prüfen?

Das deutsche Energiewende-Paradox. Ursachen und Herausforderungen

Eine Analyse des Stromsystems von 2010 bis 2030 in Bezug auf Erneuerbare Energien, Kohle, Gas, Kernkraft und CO₂-Emissionen

Die Energiewende im Stromsektor: Stand der Dinge 2014

Rückblick auf die wesentlichen Entwicklungen sowie Ausblick auf 2015

Die Entwicklung der EEG-Kosten bis 2035

Wie der Erneuerbaren-Ausbau entlang der langfristigen Ziele der Energiewende wirkt

Die Rolle des Emissionshandels in der Energiewende

Perspektiven und Grenzen der aktuellen Reformvorschläge

Publications of Agora Energiewende

Die Rolle der Kraft-Wärme-Kopplung in der Energiewende

Status quo, Perspektiven und Weichenstellungen für einen sich wandelnden Strom- und Wärmemarkt

Der Spotmarktpreis als Index für eine dynamische EEG-Umlage

Vorschlag für eine verbesserte Integration Erneuerbarer Energien durch Flexibilisierung der Nachfrage

Die Sonnenfinsternis 2015: Vorschau auf das Stromsystem 2030

Herausforderung für die Stromversorgung in System mit hohen Anteilen an Wind- und Solarenergie

Effekte regional verteilter sowie Ost-/West-ausgerichteter Solarstromanlagen

Eine Abschätzung systemischer und ökonomischer Effekte verschiedener Zubauszenarien der Photovoltaik

Ein Kraftwerkspark im Einklang mit den Klimazielen

Handlungslücke, Maßnahmen und Verteilungseffekte bis 2020

Ein robustes Stromnetz für die Zukunft

Methodenvorschlag zur Planung – Kurzfassung einer Studie von BET Aachen

Erneuerbare-Energien-Gesetz 3.0

Konzept einer strukturellen EEG-Reform auf dem Weg zu einem neuen Strommarktdesign

Energieeffizienz als Geschäftsmodell

Ein marktorientiertes Integrationsmodell für Artikel 7 der europäischen Energieeffizienzrichtlinie

Kapazitätsmarkt oder Strategische Reserve: Was ist der nächste Schritt?

Eine Übersicht über die in der Diskussion befindlichen Modelle zur Gewährleistung der Versorgungssicherheit in Deutschland

Klimafreundliche Stromerzeugung: Welche Option ist am günstigsten?

Stromerzeugungskosten neuer Wind- und Solaranlagen sowie neuer CCS- und Kernkraftwerke auf Basis der Förderkonditionen in Großbritannien und Deutschland

Kostenoptimaler Ausbau der Erneuerbaren Energien in Deutschland

Ein Vergleich möglicher Strategien für den Ausbau von Wind- und Solarenergie in Deutschland bis 2033

Negative Strompreise: Ursache und Wirkungen

Eine Analyse der aktuellen Entwicklungen – und ein Vorschlag für ein Flexibilitätsgesetz

Netzentgelte in Deutschland

Herausforderungen und Handlungsoptionen

Positive Effekte von Energieeffizienz auf den deutschen Stromsektor

Endbericht einer Studie von der Prognos AG und dem Institut für Elektrische Anlagen und Energiewirtschaft (IAEW)

Power-to-Heat zur Integration von ansonsten abgeregeltem Strom aus Erneuerbaren Energien

Handlungsvorschläge basierend auf einer Analyse von Potenzialen und energiewirtschaftlichen Effekten

Stromexport und Klimaschutz in der Energiewende

Analyse der Wechselwirkungen von Stromhandel und Emissionsentwicklung im fortgeschrittenen europäischen Strommarkt

Stromspeicher für die Energiewende

Untersuchung zum Bedarf an neuen Stromspeichern in Deutschland für den Erzeugungsausgleich, Systemdienstleistungen und im Verteilnetz

Transparenzdefizite der Netzregulierung

Bestandsaufnahme und Handlungsoptionen

All publications are available on our website: www.agora-energiewende.de

How do we accomplish the *Energiewende*?

Which legislation, initiatives, and measures do we need to make it a success? Agora Energiewende helps to prepare the ground to ensure that Germany sets the course towards a fully decarbonised power sector. As a think-&-do-tank, we work with key stakeholders to enhance the knowledge basis and facilitate convergence of views.



Agora Energiewende

Rosenstraße 2 | 10178 Berlin

T +49 (0)30 284 49 01-00

F +49 (0)30 284 49 01-29

www.agora-energiewende.de

info@agora-energiewende.de

