

**Development And Integration
Of Renewable Energy:
Lessons Learned From Germany**

Hans Poser
Jeffrey Altman
Felix ab Egg
Andreas Granata
Ross Board

DEVELOPMENT AND INTEGRATION OF RENEWABLE ENERGY: LESSONS LEARNED FROM GERMANY

July 2014

Hans Poser
Jeffrey Altman
Felix ab Egg
Andreas Granata
Ross Board

© 2014 by FAA Financial Advisory AG (Finadvice).

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or any information storage or retrieval system or method, now known or hereinafter invented or adopted, without the express prior written permission of the FAA Financial Advisory AG.

This work was prepared by FAA Financial Advisory AG (Finadvice) for the Edison Electric Institute (EEI) and Finadvice's European clients. When used as a reference, attribution to Finadvice is requested. Although every reasonable effort has been made to ensure the accuracy of this publication, Finadvice and any person acting on its behalf (a) does not make any warranty, express or implied, with respect to the accuracy, completeness or usefulness of the information, advice or recommendations contained in this work, and (b) does not assume and expressly disclaims any liability with respect to the use of, or for loss and/or damages resulting from the use of any information, advice or recommendations contained in this work.

The views and opinions expressed in this work do not necessarily reflect those of Finadvice or any person(s) acting on behalf of Finadvice. This material and its production, reproduction and distribution by Finadvice does not imply endorsement of the material.

Published by:

Finadvice
FAA Financial Advisory AG
Soodstrasse 55
CH-8134 Adliswil
Switzerland

Office: +41 43 377 1000
Fax: +41 43 377 1005
Website: www.finadvice.ch

Contents

1. EXECUTIVE SUMMARY.....	1
2. INTRODUCTION	8
2.1. Why Germany?	8
2.2. Germany’s renewable policies and support mechanisms.....	10
3. GERMANY’S RENEWABLE “SUCCESS” STORY	16
3.1. Renewable energy deployment and diversification of the power portfolio	16
3.2. Emission reductions	18
3.3. Energy independence	20
3.4. Lower wholesale prices.....	20
3.5. Job creation and expansion of Germany’s manufacturing industry.....	21
4. UNINTENDED CONSEQUENCES OF GERMANY’S RENEWABLE POLICIES	26
4.1. Enormous governmental subsidies for renewables	26
4.2. Ever increasing power prices to residential customers	30
4.3. Impact on national competitiveness	34
4.4. Financial impact to thermal generators and reliability.....	36
4.5. Impact of renewables’ variability on market operations and thermal plants	42
4.6. Expansion and additional investment in the power grid	47
4.7. Repeated redesigns and boom and bust cycles.....	50
5. CONCLUSION: TAKEAWAYS OF THE GERMAN AND EUROPEAN EXPERIENCE WITH RENEWABLES.....	58
APPENDIX A: INFLUENCE OF HIGHLY FLEXIBLE GRID DEMANDS ON AGING AND LONG TERM RELIABILITY OF LARGE TURBINE GENERATOR: AN INSIGHT FROM SIEMENS	60
APPENDIX B: A PERSPECTIVE FROM THE INSURANCE INDUSTRY ON CHANGES TO THE POWER INDUSTRY: INSIGHT FROM MARSH	65
APPENDIX C: REGULATORY INTERVENTIONS ON VARIOUS SUBSIDIES SCHEMES ACROSS SEVERAL EUROPEAN COUNTRIES.....	69
BIBLIOGRAPHY	72
References to the Finadvice and the Authors	78

1. EXECUTIVE SUMMARY

Over the last decade, well-intentioned policymakers in Germany and other European countries created renewable energy policies with generous subsidies that have slowly revealed themselves to be unsustainable, resulting in profound, unintended consequences for all industry stakeholders. While these policies have created an impressive roll-out of renewable energy resources, they have also clearly generated disequilibrium in the power markets, resulting in significant increases in energy prices to most users, as well as value destruction for all stakeholders: consumers, renewable companies, electric utilities, financial institutions, and investors.

Accordingly, the United States and other countries should carefully assess the lessons learned in Germany, with respect to generous subsidy programs and relatively rapid, large-scale deployment and integration of renewable energy into the power system. This white paper is meant to provide further insight into the German market, present an objective analysis of its renewable policies, and identify lessons learned from Germany, and to a lesser degree, other European countries.¹

The rapid growth of renewable energy in Germany and other European countries during the 2000's was due to proactive European and national policies aimed at directly increasing the share of renewable production in their energy mixes through a variety of generous subsidy programs. Two main types of subsidy programs for renewable power developed in Europe include feed-in tariffs (FITs), which very quickly became the policy of choice for Germany and many other European countries, and quota obligation systems.

FITs are incentives to increase production of renewable energy. This type of subsidy guarantees long-term (usually for 20 years) fixed tariffs per unit of renewable power produced. These fixed tariffs normally are independent of market prices and are usually set by the government, but can be structured to be reduced periodically to account for technology cost decreases. The level of

¹ The authors of this white paper would like to state that they fully support renewables as a part of the overall power portfolio. All the authors have worked with both electric utilities and purely renewable companies. Some of them have 20+ years of experience in the power sector, and a couple have direct equity interests in renewable projects.

the tariffs normally depends on the technology used and the size of the production facility. Because of their generosity, FITs proved capable of quickly increasing the share of renewable power, but since the FITs are set administratively, it is difficult to meet renewable energy goals in the most cost-effective way possible.

The quota system is the European equivalent to the Renewable Portfolio Standard used in the United States. Whereas FIT programs set the price for the resources and let the market achieve whatever level it can at that price, the quota system is a market based system that sets the desired amount of renewable resources and lets the market determine its price. Under the quota system, compliance is proven through renewable certificates that can usually be traded.

Germany used FITs to help finance its energy policy, “Energiewende” (the energy transformation), that calls for a nuclear-free and carbon-reduced economy through a vast deployment of renewable technologies.

Because FITs levels were administratively driven and slow to adapt to the evolution of the solar market, the incentive became excessively generous, which initiated an uncontrolled development of renewables, which, in turn, created unsustainable growth with a myriad of unintended consequences and lessons learned. Accordingly, this analysis will focus on Germany, whose FIT policies allowed it to realize the highest production of non-hydro renewable electricity (wind and solar) in Europe.

The most important lessons learned include:

1. **Policymakers underestimated the cost of renewable subsidies and the strain they would have on national economies.** As an example, Germany’s FIT program has cost more than \$412 billion to date (including granted and guaranteed, but not yet paid FIT). Former German Minister of the Environment Peter Altmaier recently estimated that the program costs would reach \$884 billion (€680 billion²) by 2022. He added that this figure could increase further if the market price of electricity fell, or if the rules and subsidy

² Amounts in dollars are translated from euros at 1:1.3 exchange rate.

levels were not changed.³ Moreover, it is estimated that Germany will pay \$31.1 billion in subsidies for 2014 alone.⁴ A recent analysis⁵ found that from 2008 to 2013, Germany incurred \$67.6 billion (€52 billion) in net export losses because of its high energy costs, compared to its five leading trade partners. Losses in energy intensive industries accounted for 60 percent of the total losses. This was further highlighted by a recent International Energy Agency report, which stated that the European Union (EU) is expected to lose one-third of its global market share of energy intensive exports over the next two decades due to high energy prices,⁶ expensive energy imports of gas and oil, as well as costly domestic subsidies for renewable energy.

2. **Retail prices to many electricity consumers have increased significantly**, as subsidies in Germany and the rest of Europe are generally paid by the end users through a cost-sharing procedure. Household electricity prices in Germany have more than doubled, increasing from €0.14/kilowatt hour (kWh) (\$0.18) in 2000 to more than €0.29/kWh (\$0.38) in 2013. In Spain, prices also doubled from €0.09/kWh in 2004 to €0.18/kWh in 2013 (\$0.12 to \$0.23) while Greece's prices climbed from €0.06/kWh in 2004 to €0.12/kWh in 2013 (\$0.08 to \$0.16)⁷. Comparatively, household electricity prices in the United States average \$0.13/kWh, and have remained relatively stable over the last decade.
3. **The rapid growth of renewable energy has reduced wholesale prices in Germany, with adverse consequences on markets and companies.** Large subsidies and guaranteed interconnection to the grid for renewable energy led to unexpected growth over the last 10 years in Germany and elsewhere. The merit order in Germany's wholesale markets switched as renewables, with a zero variable cost of production, take precedence over

³ Frankfurter Allgemeine, Energiewende könnte bis zu einer Billion Euro kosten, 19th February 2013; <http://www.faz.net/aktuell/politik/energiepolitik/umweltminister-altmaier-energiewende-koennte-bis-zu-einer-billion-euro-kosten-12086525.htm>

⁴ German Federal Ministry for the Environment, "Nature Conservation, Building and Nuclear Safety: Development of renewable energy sources in Germany in 2012"

⁵ Financial Times, "Germans told of billions lost to trade due to energy policy", 26th February 2014, <http://on.ft.com/1cRFiKb>

⁶ Financial Times, "Energy price gap with the US to hurt Europe for 'at least 20 years'", 29th January 2014; <http://www.ft.com/cms/s/0/80950dfe-8901-11e3-9f48-00144feab7de.html#axzz2thyHzZc8>

⁷ European Commission, Eurostat, <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=ten00115>

thermal plants. As a result, wholesale prices in Germany for base load have fallen dramatically from €90-95/megawatt hour (MWh) in 2008 to €37/MWh in 2013. This has created a large amount of load and margin destruction for utilities that built and financed thermal plants. Many new gas-fired power plants have been rendered uneconomical, leaving owners to shore up their balance sheets by undertaking large divestitures of some of their holdings, as well as by reducing their operational costs. The impact to utilities' shareholder value has been dramatic and has come on top of the impact of the global financial crises, and, in the case of Germany, the decommissioning of nuclear power. The German utilities have seen their stock plunge by nearly 45 percent since 2010. Some power plant operators in Germany and other countries, like the United Kingdom, are now calling for capacity payments to ensure that reliability is maintained and not threatened by the shutdown of various thermal power stations.

4. **The wholesale pricing model has changed** as a result of the large renewable energy penetration. In the past, wholesale prices followed the demand curve, but in Europe they now react to the weather; going down when the sun shines and the wind blows, and up when—at times of high demand—the sun does not shine and the wind does not blow. Price forecasts and power trading require more skill sets and different know-how, including weather forecasting.
5. **Fossil and nuclear plants are now facing stresses** to their operational systems as these plants are now operating under less stable conditions and are required to cycle more often to help balance renewables' variability. Investments in retrofits will be required for these plants in order to allow them to run to these new operational requirements. Moreover, renewable resources are dramatically changing thermal plants' resource planning and margins. As a result, many of these plants are now being retired or are required to receive capacity payments in order to economically be kept online.
6. **Large scale deployment of renewable capacity does not translate into a substantial displacement of thermal capacity.** Because of the variability of wind and solar, there are many hours in the year during which most generation comes from thermal power plants, which are required to provide almost complete redundant capacity to ensure the reliability

of the system. In turn, grid interventions have increased significantly as operators have to intervene and switch off or start plants that are not programmed to run following market-based dispatching. For instance, one German transmission operator saw interventions grow from two in 2002 to 1,213 in 2013. It is higher amounts of renewables with low full load hours relative to the total portfolio of power production that creates greater variability and strains on the grid. In the case of Germany, it is the large-scale deployment of both wind and solar that has impacted the entire system.

7. **Large-scale investments in the grid** are being required to expand transmission grids so they can connect offshore and onshore wind projects in the north of Germany to consumers in the south of the country. The total investment cost for the build-out of German onshore and offshore transmission systems is estimated to be around \$52 billion (€40 billion) over the next 10 years. Moreover, the grids are now being challenged to meet the dynamic flows of variable renewables and require significant additional investment to accommodate increased penetration of renewables. All of these costs will ultimately be passed on to electricity consumers. This has not gone unnoticed in Germany or in the EU. A report was released in late February 2014 by an independent expert commission mandated by the German government, which concluded that Germany's current program of incenting renewables is an uneconomic and inefficient means to reduce emissions and therefore should be stopped⁸. Moreover, the European Commission released new guidelines on April 9, 2014, with effect starting in 2017 that will correct market distortions. It will essentially ban all FIT subsidies and introduce technology agnostic auctions as the only incentives for renewables.
8. **Overgenerous and unsustainable subsidy programs resulted in numerous redesigns of the renewable support schemes, which increased regulatory uncertainty and financial risk for all stakeholders in the renewable energy industry.** As the lessons above show, some European renewable energy regulatory regimes were inappropriately structured, gamed by market players, or made obsolete by market conditions. As a result, governments and regulators corrected unsustainable regulatory regimes by reducing the

⁸ Frankfurter Allgemeine. <http://www.faz.net/aktuell/wirtschaft/wirtschaftspolitik/oekostrom-regierungsberater-wollen-eeg-abschaffen-12820227.html>

level of subsidies, sometimes retroactively, and modifying the rules of the programs. These changes often resulted in significant value destruction to various renewable players and their respective investors. This continued regulatory uncertainty across Europe is increasing the cost of capital to European renewable companies, which the rating agency Fitch just recently highlighted as the most likely sector in the European energy market to receive a downgrade in 2014.

These lessons learned are important and provide factual analyses to assist other countries' electric industry stakeholders' in creating more technically-efficient, cost-effective and sustainable ways to integrate renewable energy.

U.S. stakeholders should take into consideration the lessons learned from Germany and Europe:

Utilities should incorporate those lessons into their strategic planning, load forecasting, financial planning, trading, and regulatory affairs organizations. Decisions about current and future investments should then be made with this new analysis in mind.

Renewable companies should calculate appropriately the true costs of grid enhancements, capacity, and other important measures when submitting their plans to commissioners, investors, and other stakeholders.

Legislators and regulators should use the lessons learned from large scale integration of renewables in Germany and elsewhere in Europe to ensure a stable transition of renewables as part of the overall power portfolio while ensuring high reliability of power, stability of pricing to all users, as well as minimal value destruction to both utilities and renewable companies.

Finally, consumers must be made aware of the tradeoffs to a large portfolio of renewables and the necessary requirement for a smooth transition as part of the overall power portfolio.

In conclusion, the lessons learned in Europe prove that the large-scale integration of renewable power does not provide net savings to consumers, but rather a net increase in costs to consumers and other stakeholders. Moreover, when not properly assessed in advance, the rapid, large scale integration of renewables into the power system will ultimately lead to disequilibrium in power markets, as well as value destruction to renewable companies, utilities, and their respective

investors. The U.S. has the opportunity to incorporate these lessons learned to ensure the sustainable growth of renewable energy over the long-term, for the benefit of all customers.

2. INTRODUCTION

Over the last decade, well-intentioned policymakers in Germany and other European countries have created renewable energy policies that have slowly revealed themselves to be unsustainable, resulting in profound, unintended consequences for all industry stakeholders. While these policies have created an impressive roll-out of renewable energy resources, they have also clearly generated disequilibrium in the power markets, resulting in significant increases in energy prices to most users, as well as value destruction for all stakeholders: consumers, renewable companies, electric utilities, financial institutions, and investors.

Accordingly, the United States and other countries should carefully assess the lessons learned in Germany, with respect to generous subsidy programs and relatively rapid, large-scale deployment and integration of renewable energy into the power system. This white paper is meant to provide further insight into the German market, present an objective analysis of its renewable support policies, and identify lessons learned from Germany, and to a lesser degree, other European countries.⁹

2.1. Why Germany?

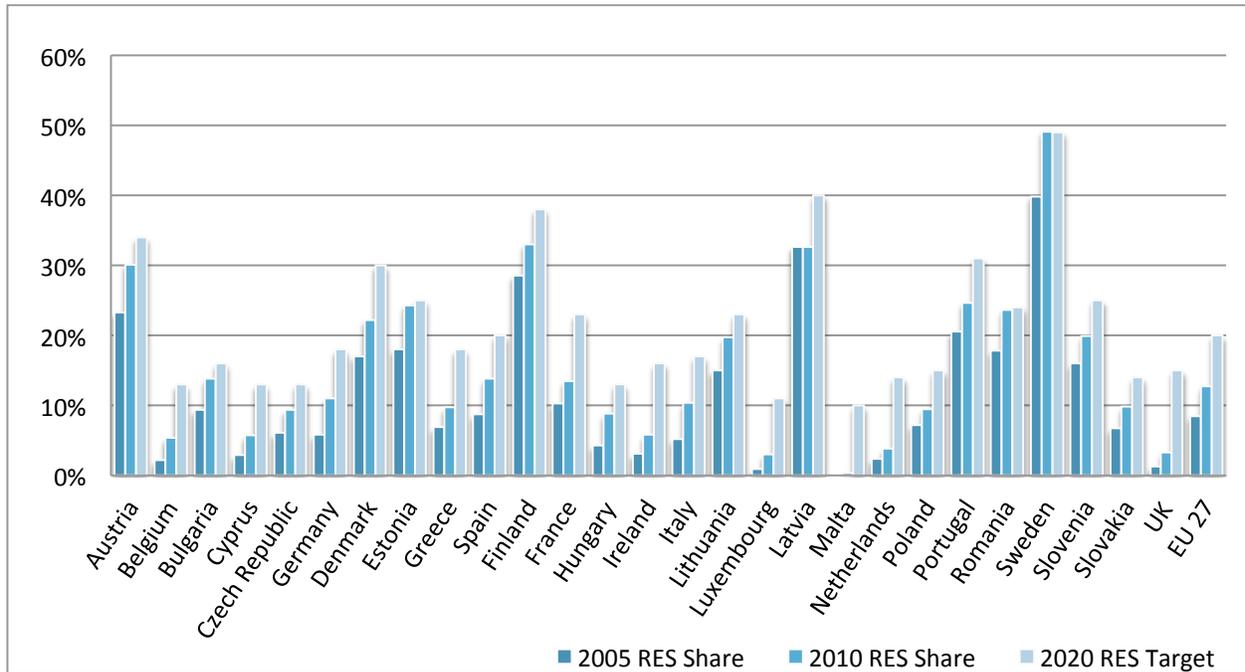
More than any other region in the world, Europe has taken a proactive stance on an extensive roll-out of renewable forms of energy. Further, Germany has been one of the most aggressive supporters of renewable power in the world, and, accordingly provides an appropriate case study of the law of unintended consequences.

As a result of aggressive policies during the last decade, the European Union (EU or Europe) has increased its gross renewable electricity generation by 50 percent, climbing from 13.6 percent in 2000 to 23.5 percent in 2012. As of 2011, the EU was the world's second largest renewable generator (following China with 18.6 percent of total production), providing 16.5 percent of the world's total renewable electricity generation (including hydropower). More interestingly, in 2010, the EU produced 70 percent of the world's electricity net generation from solar

⁹ The authors of this white paper would like to state that they fully support renewables as a part of the overall power portfolio. All the authors have worked with both electric utilities and purely renewable companies. Some of them have 20+ years of experience in the power sector, and a couple have a direct equity interests in renewable projects.

photovoltaics (PV) and 44 percent of the world’s wind generation.¹⁰ However, it must be noted, this market share is decreasing as the United States and China expand both their wind and solar PV portfolios.

Figure 1. EU 27 Member States: Trends in the share of renewable generation in gross final energy consumption (EC, 2010)¹¹



Although Germany is not the European country with the highest renewable energy penetration, it has become the most widely cited case study because of its status as the largest European producer of non-hydro renewable electricity, its economic importance in Europe, and its much-observed and replicated support mechanism for renewables, the feed-in tariff (FIT) program. After decades of experience with policies promoting renewable energy, Germany has become the focus of global attention with respect to its aggressive renewable policies and their unintended consequences.

Germany is Europe’s largest economy, the fourth largest country in the world based on GDP, and the third largest exporting country in the world. Additionally, Germany also has the single

¹⁰ EU Commission Staff Working Document, “Energy Economic Developments in Europe”, Brussels 22.1.2014. http://ec.europa.eu/energy/renewables/index_en.htm

¹¹ Eurostat European Commission

largest energy market in Europe, with a total net installed generation capacity of 168 gigawatts (GW) in 2011 and, with its interconnection to nine surrounding countries through a large interconnection network, Germany is the second largest European exporter of energy after France.

2.2. Germany's renewable policies and support mechanisms

The rapid growth of renewable energy in Germany and other European countries is due to proactive European and national policies aimed at directly increasing the share of renewable production in their energy mixes through a variety of generous subsidy programs.

2.2.1. Government support for renewable energy

The European Commission (EC) has historically concluded that more renewable energy will enable the EU to cut greenhouse gas (GHG) emissions and reduce its dependency on energy imports. It also has created mechanisms to ensure that a strong renewables industry will encourage technological innovation and job creation.¹² To achieve those goals, the EC developed the first European Directive on renewable energy in 2001, which was amended by a second directive in 2009 that established the Europe-wide goal of obtaining 20 percent of its total energy consumption, including all sectors, from renewable sources by 2020.¹³ The directive also set differentiated goals for each country, but left it up to them to decide how to achieve their national target. The EC asked each member state to develop a National Renewable Energy Action Plan (NREAP) outlining the country's overall strategy and to submit periodic progress reports.

In 2014, the EU extended climate and energy targets to 2030, requiring an aggregate 27 percent renewable energy within total energy consumption, and a 40 percent reduction of GHG emissions (from 1990 levels). This package is not prescriptive and does not require NREAPs. Instead, it offers states the opportunity to determine policy at a national level.

¹² European Commission's Directorate-General for Energy, Online Information platform about strategies for renewable energy

¹³ European Commission, Directive 2009/28/EC, 23 April 2009; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT>

According to the differentiated goals set by the renewables directive, Germany's share of energy from renewable sources in gross final consumption of energy by 2020 was set at 18 percent. In its NREAP from 2010,¹⁴ the country estimated that renewable energy would account for 19.6 percent of final energy consumption by 2020, with 38.6 percent of renewables in the electricity sector, 15.5 percent in the heating/cooling sector, and 13.2 percent in the transportation sector. At the end of 2012, Germany's total renewable generation, including hydropower, represented 23.5 percent of total electric output.¹⁵

In addition to European goals, Germany has, for many years, had its own energy policy promoting renewable energy. The so-called "Energiewende," or the energy transformation, calls for a nuclear-free and carbon-reduced economy through a vast deployment of renewable technologies. Germany's goal is to reduce carbon dioxide (CO₂) emissions by 90 percent from 1990 levels and to provide 80 percent of its electricity generation with renewables by 2050. The government has also planned the complete phase out of nuclear power by 2022.

2.2.2. Different subsidy schemes around Europe¹⁶

As a result of the European renewable directives, all European countries chose their preferred policies and support mechanisms and later implemented NREAPs to deploy renewable energy. Two main types of subsidy programs for renewable power developed in Europe include FITs, which very quickly became the policy of choice, and quota obligation systems.

FITs

FITs are incentives to increase production of renewable energy. This type of subsidy guarantees long-term (usually for 20 years) fixed tariffs per unit of renewable power produced. These fixed tariffs normally are independent of market prices and are usually set by the government. The level of the tariffs normally depends on the technology used and the size of the production

¹⁴ European Commission, Action Plans and Forecasts; http://ec.europa.eu/energy/renewables/action_plan_en.htm

¹⁵ German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: Development of renewable energy sources in Germany

¹⁶ Sources: IZES (Institut für ZunkunftsEnergieSysteme); "Das Erneuerbare-Energien-Gesetz –Erfahrungen und Ausblick" Institut der deutschen Wirtschaft Köln, 2012 - Frankfurter Allgemeine Zeitung 21.10.2013 Wirtschaft. <http://blog.insm.de/4770-quotenmodell-versus-einspeisevergutung-aus-der-praxis-lernen/>; http://www.greenpeace.de/themen/energie/nachrichten/artikel/warum_das_eeg_besser_ist_als_ein_quotenmodell/

facility. Additionally, in some cases, the tariff is scheduled to be lowered periodically by a defined percentage to account for the assumed technology cost decrease.

The advantage (and also disadvantage) of FITs is that it is independent of the market price. This mechanism allows fostering a technology that has not yet reached commercial viability, but is considered an important addition to the production portfolio. In 2004, the FIT for PV power was €457/megawatt hour (MWh), but in 2014, it was only €94.7/MWh.¹⁷ This reduction followed a decrease in the cost of technologies, as well as program redesigns that lowered the subsidy rate. Because of their generosity, FITs proved capable of quickly increasing the share of renewable power. Since FITs set the price for resources and not volume, it is difficult to set the height of the FIT such that the renewable goals are reached as economically as possible. A large FIT target results in uncontrollable development of qualifying projects, irrespective of the demand for this power. FITs remove the price risk from project developers and gives policymakers the ability to decide on the optimal allocation of resources (as opposed to the market). This ultimately leaves consumers paying for the outcome, and causes value destruction to investors in renewables and utilities who made investment decisions based upon representations of stable regulatory regimes as well as the interaction of dynamic market forces.

Like many other European countries, Germany chose FITs as the main support mechanism to support the renewables goals of the EU, and later developed a more comprehensive plan for the reduction of carbon emissions known as the Energiewende. Germany introduced the first FIT law in 1990, aimed at fostering the development of renewable energy and designed to promote rural economic development and domestic manufacturing. This law was later revised several times, including in 2000, when the German Renewable Energy Act (Erneuerbare Energien Gesetz or EEG) created the FIT program that became famous throughout the world and that still remains today. The German legislation guarantees renewable developers interconnection to the grid, priority scheduling and dispatch, and a technology differentiated FIT for 20 years. The FITs applicable to new projects decrease each year by a legal percentage (or by law amendments).

¹⁷ Erneuerbare-Energien-Gesetz (EEG) am 1. August 2004 in Kraft getreten §11, [http://www.bgbl.de/banzxaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&bk=Bundesanzeiger_BGBl&start=//%255B@attr_id=%2527bgbl104s1918.pdf%2527%255D#_bgbl_%2F%2F*\[%40attr_id%3D%27bgbl104s1918.pdf%27\]_1400074679965](http://www.bgbl.de/banzxaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&bk=Bundesanzeiger_BGBl&start=//%255B@attr_id=%2527bgbl104s1918.pdf%2527%255D#_bgbl_%2F%2F*[%40attr_id%3D%27bgbl104s1918.pdf%27]_1400074679965)

This was meant to ensure price certainty while encouraging technology innovation and cost-efficiency. This subsidy is socialized and financed mainly by residential consumers, since many exporting industrial customers are exempt from paying any costs associated with the subsidy in an effort to maintain global industrial competitiveness. It was the starting block for rapid increases in renewable energy.

German Renewable Energy Act – Erneuerbare Energien Gesetz (EEG)

The German Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG) is a law that came into force in 2000 and introduced FITs as the main mechanism to incent and finance renewable energy projects. The EEG can be seen as the starting point of a tremendous boost of renewable energy in Germany. The purpose of the EEG is to promote electricity generated from renewables (hydropower, landfill gas, mine gas, sewage gas, biomass, geothermal, wind, and solar). Due to changes in market conditions as well as the state of renewable energy in Germany, this law was reformed several times (EEG 2004, 2009, and 2012) and ongoing modifications are needed to keep the development of renewable energy up to date and improve the efficiency of its impact.

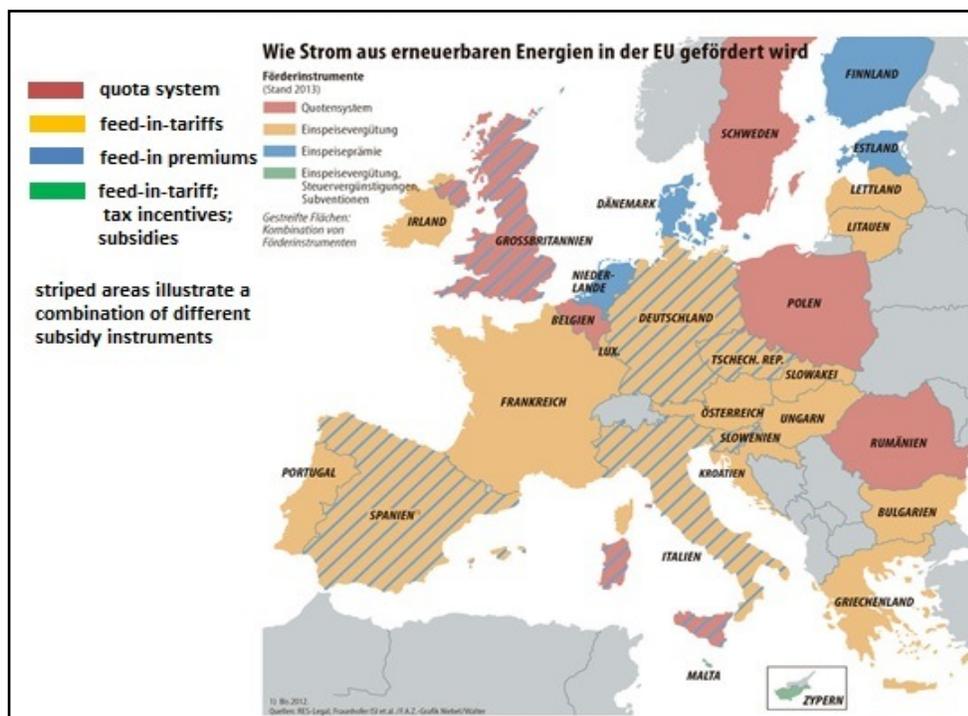
The main four provisions of the EEG are:

1. Investment protection through guaranteed feed-in tariffs (FITs). Owners of new plants receive a fixed rate, the FIT, for every kWh of renewable energy they generate. The FIT depends on the specific year a plant goes online, its size and technology, and is guaranteed for 20 years.
2. Guaranteed interconnection to the grid for renewable energy resources. Every new plant which generates renewable energy gets a preferential treatment over conventional sources by the network operator for feeding “green” electricity into the grid.
3. Decreasing FITs/degressive rates: Every year, the FIT rate decreases for new plants by a fixed percentage (degression rate). Initially, the degression intended to give renewable owners an incentive to lower the costs.
4. Socialized and financed by customers, not the government. The FIT is not paid with governmental funding, but instead is completely financed by markets and consumers. Renewable generation is sold into wholesale markets and receives the market price. The difference between the market price and the government set, predetermined FIT, is paid for by consumers as part of their electricity bills. This portion is called the EEG levy or renewable energy levy (or surcharge). The levy is not applied equally to all consumer types. Industrial consumers pay only a fraction or, in the case of energy intensive industries, are completely exempted.

Quota obligation

The quota system is the European equivalent to the Renewable Portfolio Standard used in the United States. All players, such as energy producers, retailers, and end-use consumers, have to produce and/or consume a specific amount of renewable power, which is set by the government. The price paid for the renewables is set by the market and the actual production or usage of renewable energy is proven through certificates, which are given out once power is produced from renewable energy. Since these certificates are tradable, at least within the specific country, it is possible either to produce renewable energy on one's own or to buy certificates from other producers. There are government sanctions in place in case market participants don't fulfill the quota. The quota system is used by various European countries, such as Sweden, Belgium, the UK, and the Netherlands, but the regulations and details (number of certificates per kilowatt hour (kWh), limit of quotas, etc.) vary among the nations.

Figure 2. Incentive schemes in Europe¹⁸



The quota system is a market-based system. It aims at lowering costs during the roll-out of renewable energy. It exploits the cheapest possibilities of renewable energy production available

¹⁸ Frankfurter Allgemeine Zeitung 21.10.2013

given a certain demand. This system displays much price competition between different renewable energy technologies. Sometimes, it is argued, quotas do not give sufficient investment security to producers of renewable power, which in turn increases the need for a subsidy.

Yet another subsidy mechanism is feed-in premiums, which offer a premium for the ecological value added in addition to the market price of electricity. As they are not very common in Europe they are not explained in detail in this document.

3. GERMANY'S RENEWABLE "SUCCESS" STORY

Germany's experience with renewables has often been portrayed as a success story. It undoubtedly met one of the objectives set by the EEG: the promotion of renewable generation. It remains unclear, however, how successful Germany has been in meeting the other stated goals of its renewable energy policy: mainly climate change mitigation, energy independence, reduction of fuel costs, conservation of fossil fuels, local economic development, and expansion of the domestic manufacturing base.

3.1. Renewable energy deployment and diversification of the power portfolio

Germany experienced rapid growth of renewable energy. In 2012, renewable energy generation, including hydropower, accounted for 23.5 percent of total power consumption in Germany, up from 11 percent in 2005.¹⁹ Renewable generation grew from 4.3 percent (19,000 GWh) of total power consumption in 1990 to 23.5 percent (140,000 GWh) in 2012. As the potential for additional hydropower is limited due to topographic preconditions, Germany had to resort to wind and solar, as well as biomass. All of these resources showed impressive growth rates in the last decade.

It is worth noting the difference between resources with high capacity factors, like biomass and hydropower, and those with lower capacity factors, like solar PV. Electricity from biomass, for example, has grown proportionately more than its installed capacity, whereas solar PV has required a lot more investment for a much lesser impact on the electricity mix.

¹⁹ German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: Development of renewable energy sources in Germany. <http://www.erneuerbare-energien.de/die-themen/datenservice/zeitreihenentwicklung-ab-1990>

Figure 3. Germany - Installed renewable energy capacity (MW), 1990-2012

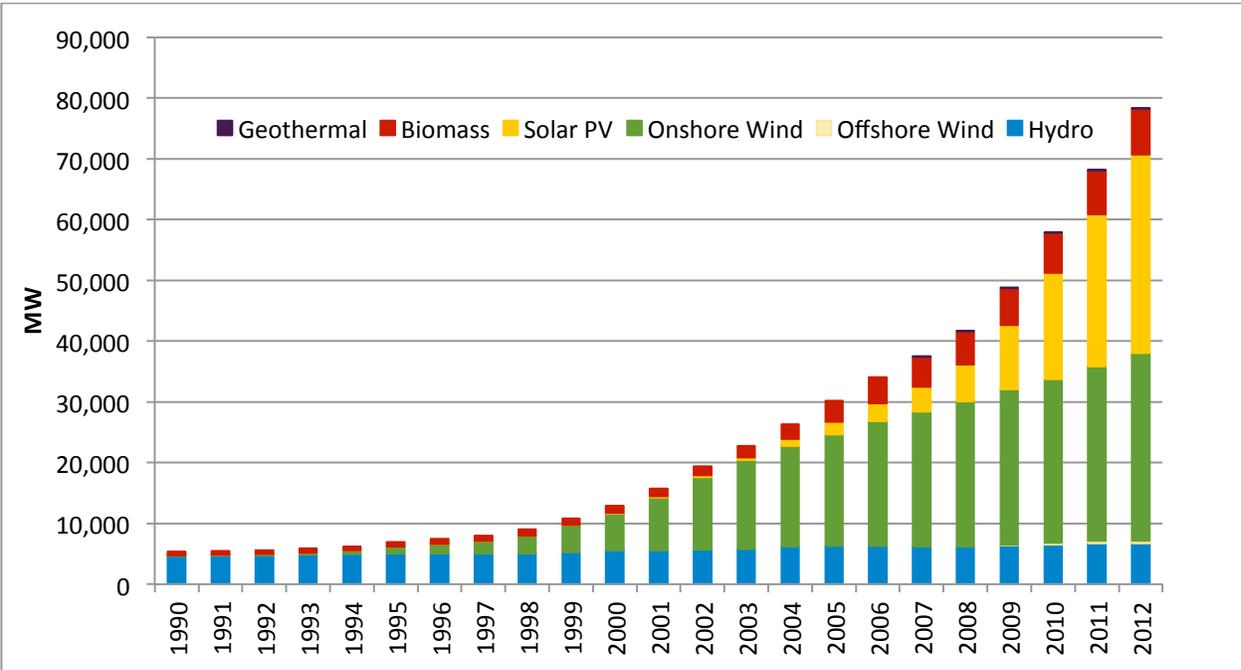
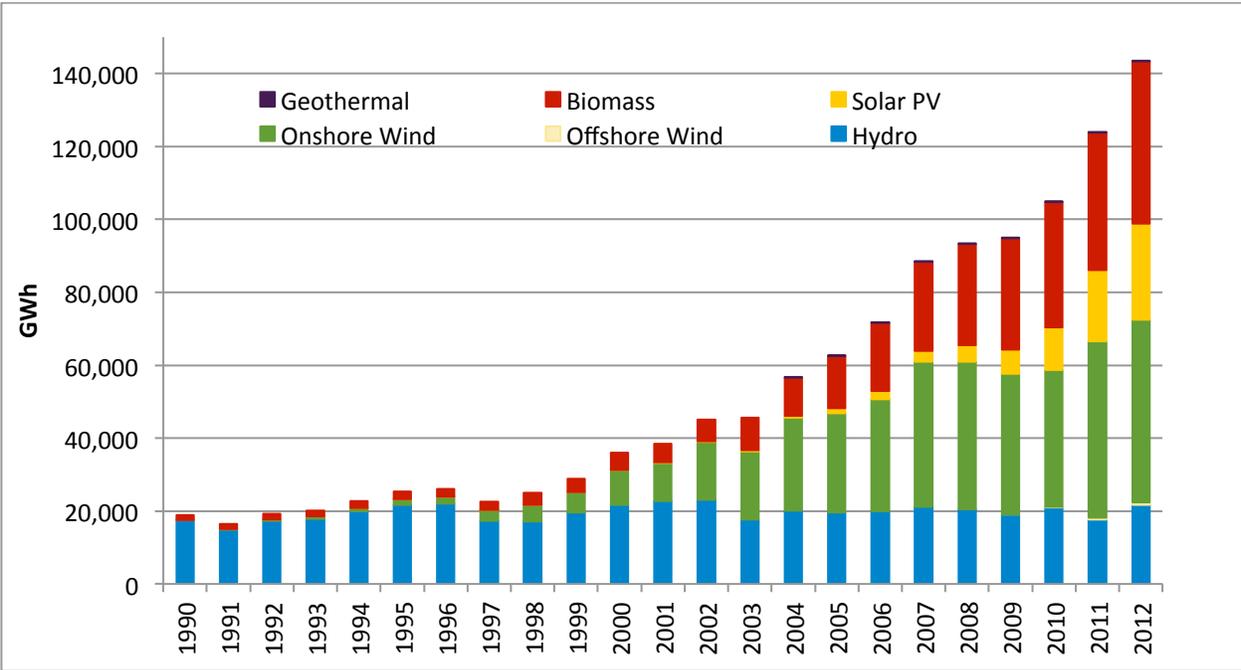


Figure 4. German renewable energy generation²⁰

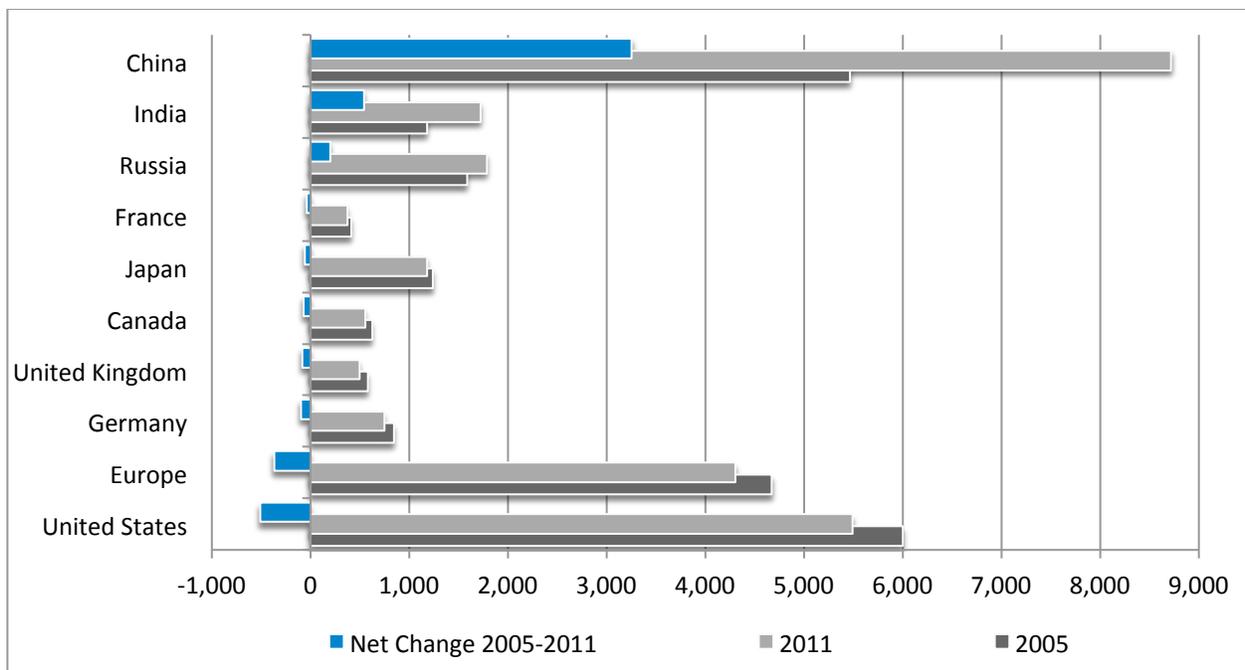


²⁰ German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: Development of renewable energy sources in Germany. <http://www.erneuerbare-energien.de/die-themen/datenservice/zeitreihen-entwicklung-ab-1990/>

3.2. Emission reductions

According to the European Renewable Energy Council, in 2009 alone, through the use of renewable energy sources in the EU, carbon dioxide (CO₂) emissions were reduced by about 340 million metric tons, or 7 percent, against 1990 levels (calculations are based on the GEMIS-model [Global Emission Model for Integrated Systems]). Given a carbon price of about €15/t in 2009, this emission reduction benefit equals around €51 billion.”²¹

Figure 5. CO₂ emissions worldwide (million metric tons)²²



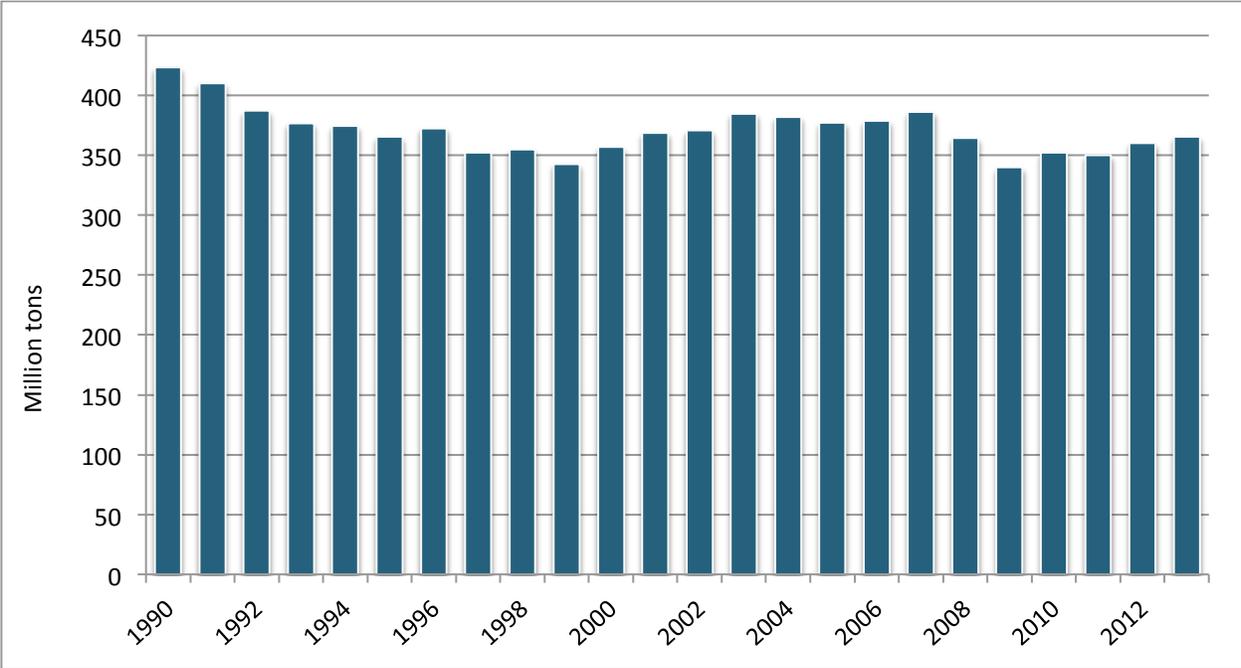
Without a doubt, renewables have helped achieve the CO₂ goals, thereby taking some of the burden from other emission sources and keeping the CO₂ certificate prices lower than they would have otherwise been. From 2005 to 2011, Germany’s CO₂ emissions declined by 99 million metric tons, or 12 percent.

²¹ European Renewable Energy Council. <http://www.erec.org/statistics/co2.html>

²² US Department of Energy, Energy Information Administration, “International Energy Statistics”, <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90&pid=44&aid=8&cid=regions,&syid=2005&eyid=2011&unit=MMTCD>

Yet, since 2009, a number of factors have led to an increase in German emissions: low prices for CO₂ certificates, low coal prices in comparison to natural gas prices, larger power generation needs due to the increase in electricity consumption in response to the economic recovery, the decommissioning of nuclear plants, and the increase in power exports. It is interesting to note that the United States is the country that has achieved the greatest reductions in CO₂ emissions, helped by significant fuel switching to natural gas.

Figure 6. CO₂ emissions from the power sector’s generation in Germany²³



While in most circumstances renewable energy contributes to reducing GHG emissions, there have been voices that have contested the suitability of FITs as a tool to reduce emissions. A 2009 report²⁴ estimated that while carbon allowances were at the time trading at around \$20/metric ton CO₂e, PV had an estimated abatement cost of \$1,050 per metric ton CO₂e, and wind had an abatement cost of around \$80 per metric ton CO₂e. These results suggest that FITs have produced unnecessarily expensive outcomes.

²³ Eionet, Central Data Repository; http://cdr.eionet.europa.eu/de/eu/ghgmm/envutt6ka/index_html?&page=2

²⁴ RWI (2009) “Economic impacts from the promotion of renewable energies: The German experience”, Essen, Germany.

3.3. Energy independence

Energy independence is desirable for every country, and certainly for Europe. Unlike the United States, which has a long-term estimated supply of 2,400 trillion cubic feet of recoverable natural gas reserves,²⁵ and 29 billion barrels of oil reserves,²⁶ the EU is the world's largest energy importer. Fifty five percent of the EU's total energy supply comes from imports. In 2012, the region imported 84 percent of its oil consumption and 64 percent of its natural gas consumption. The EU is keenly aware of its dependence on fuel sources, as was exemplified in January 2009, when 18 European countries suffered major disruptions of natural gas supplies, or in some cases, complete cutoff, during the dispute between Russia's Gazprom and Ukraine's Naftohaz Ukrayiny over prior debts, gas supplies, and prices. European countries that import gas from Russia received severe drops in pressure in their pipelines that affected countries as far as the United Kingdom. Needless to say, at the time of this writing, the EU is acutely aware of these issues, given the disputes between Russia and Ukraine with respect to Crimea, whereby the EU is considering sanctions against Russia, with the expectation that supply of natural gas from Russia may be possibly withheld.

As will be discussed later, competitiveness and energy independence are intimately related. A recent International Energy Agency report released on January 29, 2014, stated that the EU is expected to lose one-third of its global market share of energy intensive exports during the next two decades due to high energy prices, the majority of which is due to the high cost of energy imports, such as gas and oil.²⁷ Renewables help reduce the dependency on imported fossil fuels, thereby reducing the risk of possible price shocks.

3.4. Lower wholesale prices

European wholesale power prices have declined in recent years. The reasons for this include increased participation of renewables in the market (especially PV during the day, reducing high

²⁵ Speech of Gregg Kantor Chairman of American Gas Association, NARUC Winter Committee Meetings, February 11, 2014

²⁶ The Wall Street Journal, "U.S. Oil Reserves Continue to Bulge", August 1, 2013.
<http://online.wsj.com/news/articles/SB10001424127887323681904578641871449942246>

²⁷ Financial Times, "Energy price gap with the US to hurt Europe for 'at least 20 years'", 29th January 2014.
<http://www.ft.com/cms/s/0/80950dfe-8901-11e3-9f48-00144feab7de.html#axzz2thyHzZc8>

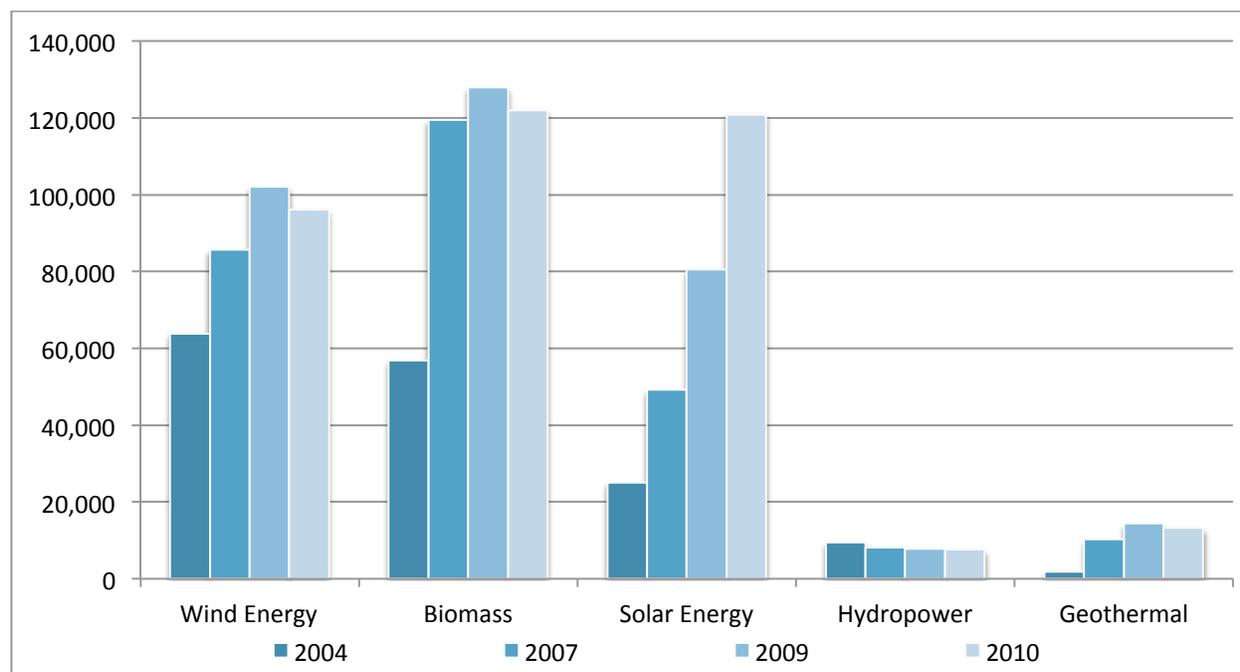
mid-day prices), abundant and cheaper coal from the United States as a result of the impact of increased development of shale gas resources on American fuel markets that make exporting coal more economical, and the global financial crisis. While lower wholesale prices are problematic for power producers who struggle to obtain adequate compensation in the market for their costs, reduced wholesale prices have helped to keep retail market prices from rising as much as they otherwise would have by providing some savings that help to offset a portion of the cost of the renewable subsidy. Given the ever-increasing large amount of subsidies, retail rates would have increased even more if wholesale prices had not declined. However, as will be explained later, sharp decreases in wholesale prices are unsustainable, as owners of generating units will be unable to keep uneconomical plants in service. In turn, many of these plants will ultimately be required to receive capacity payments in order to be online to provide back-up power for periods of power variability.

3.5. Job creation and expansion of Germany's manufacturing industry

The rapid growth of renewable energy created new jobs in the industry. In 2012, the German renewables industry employed 378,000 people,²⁸ which accounted for four times the amount of jobs in 2000. During the time of greatest growth, 2004-2010, renewable energy jobs grew around 129 percent. Although biomass is the sector that has traditionally employed the most Germans, most of the growth occurred in the solar energy sector, which went from about 25,000 jobs in 2004 to nearly 120,000 in 2010. During this timeframe, the other technologies remained relatively stable. Wind energy jobs, however, increased to 100,000 in 2009, but decreased slightly in 2010 and beyond.

²⁸ Agentur für Erneuerbare Energie - Agency of Renewable Energy Data and Figures about employment in renewable energy. <http://www.unendlich-viel-energie.de/themen/wirtschaft/arbeitsplaetze/artikel367>

Figure 7. Jobs attributable to renewable energy in Germany: 2004-2010²⁹



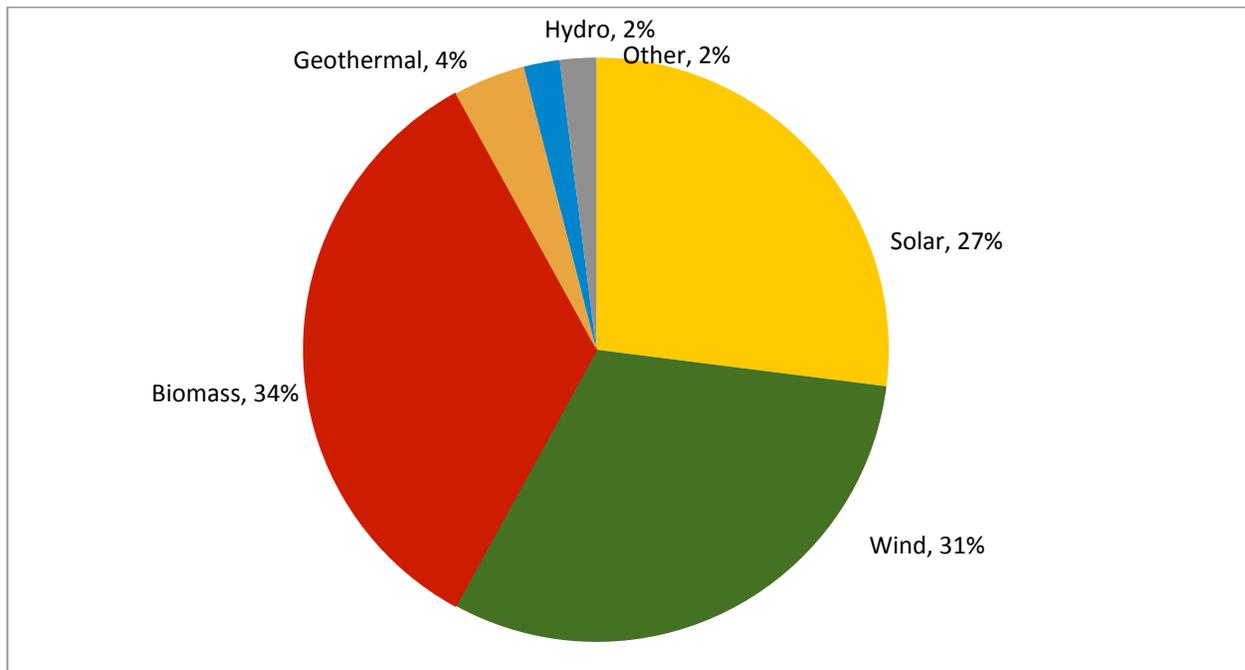
After rapid growth, 2012 saw a slight decrease in the number of renewable jobs, due, for the most part, to a reduction of employment in the solar industry. German officials, however, expect that growth in the wind and biomass industries will continue to grow strongly.³⁰

In 2012, biomass, wind, and solar shared almost equal parts of renewable energy jobs. Biomass accounted for 34 percent of the total, followed by wind (31 percent) and solar (27 percent). Geothermal, hydro, and other renewables rounded out the total. These figures are converse with respect to the overall deployment of renewables themselves, which is likely due to the capital intensity, stage of development of technologies, and economies of scale and scope.

²⁹ O'Sullivan, et al, 2011

³⁰ Agentur für Erneuerbare Energie - Agency of Renewable Energy Data and Figures about employment in renewable energy. <http://www.unendlich-viel-energie.de/themen/wirtschaft/arbeitsplaetze/artikel367>

Figure 8. Renewable energy employment in 2012³¹



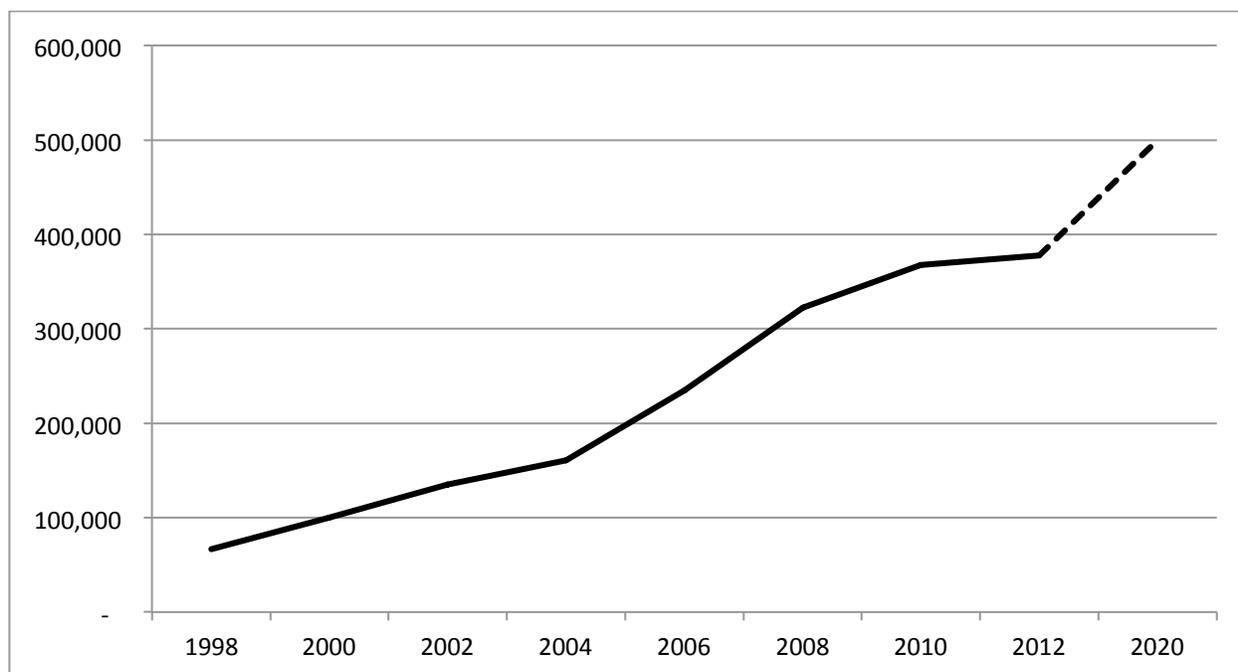
The development of renewable energy in Germany and other countries fostered growth in the German manufacturing industry. Germany is Europe's leading PV manufacturer and is the largest manufacturer of inverters in the world.³² The growth of renewable energy throughout the world has allowed Germany to expand its wind and solar manufacturing base. However, other countries have also expanded their capabilities, thereby hurting German domestic manufacturers, which have tended to be more costly than their foreign counterparts. Historically, a considerable share of PV modules installed in Germany has come from China and Japan. In 2006 and 2007, for instance, about half of PV module demand was covered by imports. Also, the boom and bust cycle that FITs created in the solar market has left some German manufacturers in a precarious situation, while Asian manufacturers have been the greatest beneficiaries of German and other European countries' programs.

Despite recent difficulties in the solar market, it is expected that new renewable energy jobs will reach 500,000 in 2020.

³¹ Agentur für Erneuerbare Energie - Agency of Renewable Energy Data and Figures about employment in renewable energy. <http://www.unendlich-viel-energie.de/themen/wirtschaft/arbeitsplaetze>

³² Id.

Figure 9. Job creation in renewable energy in Germany ³³



Yet, there is some controversy around this issue.³⁴ While there is no doubt that the growth of the renewable market led to new jobs, like in the case of emissions reductions, it is less clear if it happened in an efficient way. For example, if 380,000 jobs were created in 2012, and €14 billion were disbursed in payments to renewables that same year (total amount of EEG levy per year.), then it can be calculated that each job received a €35,000 subsidy per year.

Moreover, the total net employment is called into question when assessing the total macro-economic impact. A recently published study by the Institute on the Future of Labor states that the increasing trend of electricity prices affects jobs in other sectors. This study calculates that the increase of the EEG levy from 5.28 eurocents/kWh in 2013 to 6.24 eurocents/kWh in 2014, will lead to the loss of around 86,000 jobs, or 1.4 percent.

³³ Agentur für Erneuerbare Energie - Agency of Renewable Energy Data and Figures about employment in renewable energy. <http://www.unendlich-viel-energie.de/themen/wirtschaft/arbeitsplaetze>

³⁴ EEG- Jobmotor oder Jobkiller? www.energie-fakten.de/pdf/eeg-job-motor.pdf

On the other hand, as Germany's industrial sector is exempt from EEG's surcharge, a reversal of this support and its direct impact to industrial jobs could translate into a significant loss of jobs.³⁵ With respect to the renewable manufacturing sector, the PV industry provides a good example of what could happen to other industries when Germany reduces the subsidy. There have been several recent bankruptcies of various solar and wind manufacturers, as well as service providers. For example, in the last two years, the total number of solar cell and module production employees has fallen from 10,196 to 5,973.³⁶ The same trend applies to conventional power plants. Due to the transition to renewable energy and the need of conventional plants only as backup, many of these plants have been turned down or closed definitely. It is estimated that these actions will impact around 200,000 thermal power plant employees.³⁷

In sum, several industries in Germany have benefited from the development of renewable energy sources and, as a result, a large number of additional jobs have been created. Nevertheless, it has to be pointed out that generous subsidies are having adverse macroeconomic effects in other areas of the economy. Also, due to an increasing level of global competition in the solar market, especially due to the extraordinary cost efficiency of Chinese companies, German manufacturing companies are suffering and, as a consequence, job creation is struggling.

³⁵ Die Welt: Ende der EEG-Privilegien gefährdet eine Million Jobs 07th November 2013; Handelsblatt Online: Altmaier reist mit radikalem Ökostrom-Plan zur EU 07th November 2013

³⁶ Die Welt: Deutschlands Solarbranche löst sich auf 20th April 2013.
<http://www.welt.de/wirtschaft/energie/article121621919/Ende-der-EEG-Privilegien-gefaehrdet-eine-Million-Jobs.html>; <http://www.handelsblatt.com/politik/international/foerderung-metallindustrie-eine-million-jobs-bedroht/9039578-2.htm>

³⁷ Wirtschaftswoche: Reservekraftwerke werden Milliarden verschlingen 05th February 2014

4. UNINTENDED CONSEQUENCES OF GERMANY'S RENEWABLE POLICIES

While there have been some positive impacts from increased development of renewables in Germany, with respect to emissions reductions, diversification of the power portfolio, and energy independence, there have also been challenges and problems associated with this evolution.

Large subsidies brought about rapid deployment of renewable energy that resulted in increased costs for most types of consumers, additional investment needs for transmission lines and other integration capabilities, disequilibrium in wholesale markets with the potential of seriously affecting reliability, and unsustainable costs to the economy, resulting in repeated redesigns and realignments of renewable policies and support schemes that led to boom and bust cycles detrimental to the renewables and power industries.

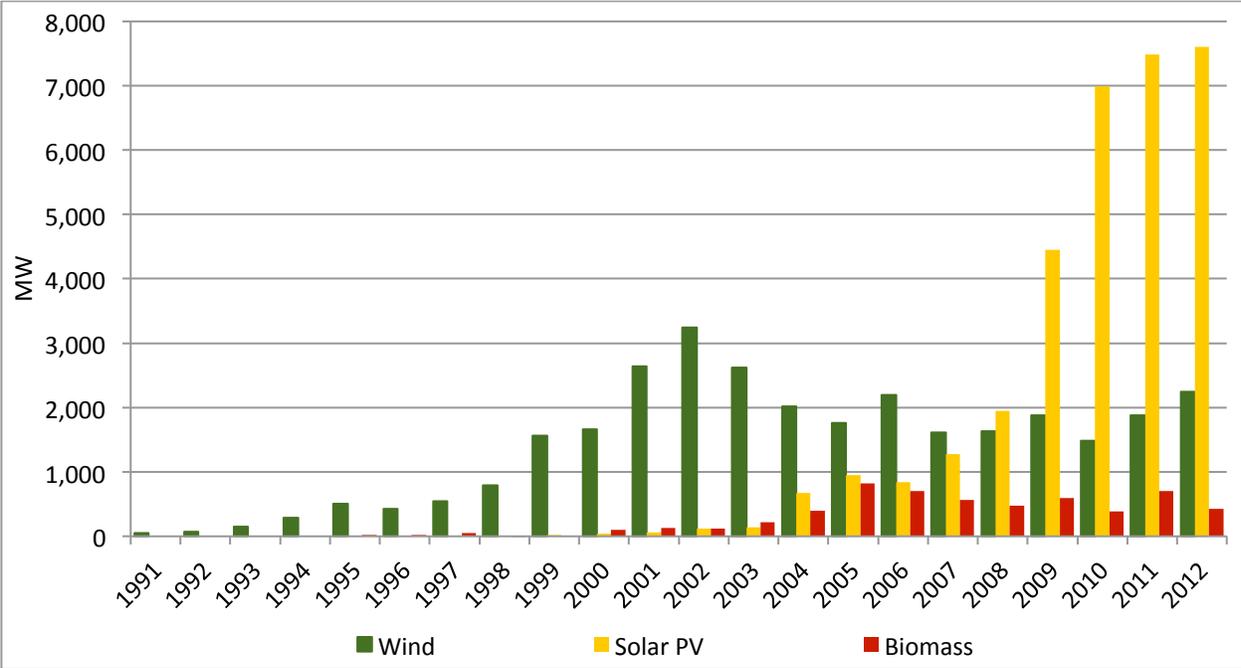
4.1. Enormous governmental subsidies for renewables

Germany's FIT program has cost more than \$412 billion to date (including granted and guaranteed, but not yet paid FIT). Former German Minister of the Environment Peter Altmaier recently estimated that the program costs could reach \$884 billion (€680 billion) by 2022. He added that this figure could increase further if the market price of electricity falls, or if the rules and subsidy levels are not changed.³⁸ It is estimated that Germany will pay \$31.1 billion in subsidies in 2014 alone.

Enormous, guaranteed FITs for PV led to very rapid, unexpected growth of PV installations during the last few years in Germany. As technology improved, costs decreased and generous subsidies made installing PV a lucrative business. While the installation of wind turbines was relatively stable at around 2 GW since 1999, the growth of PV exploded in 2009. Between 2010 and 2012, Germany built 21 GW of PV, around 7 GW a year.

³⁸ Frankfurter Allgemeine Zeitung: „Energiewende könnte bis zu einer Billion Euro kosten“ 19th February 2013. <http://www.faz.net/aktuell/politik/energiepolitik/umweltminister-altmaier-energiewende-koennte-bis-zu-einer-billion-euro-kosten-12086525.html>

Figure 10. Annual renewable energy capacity additions in Germany, 1990-2021



Given the long planning and construction periods of traditional power plants, (for example, the new nuclear plant in Olkiluoto, Finland, with 1.7 GW, is in the tenth year of construction) this rapid deployment of renewables can only be described as a macroeconomic shock. The development of 21 GW of PV in only three years blindsided the energy market. The speed of capacity additions made it impossible for the market and the generation fleet to adjust appropriately.

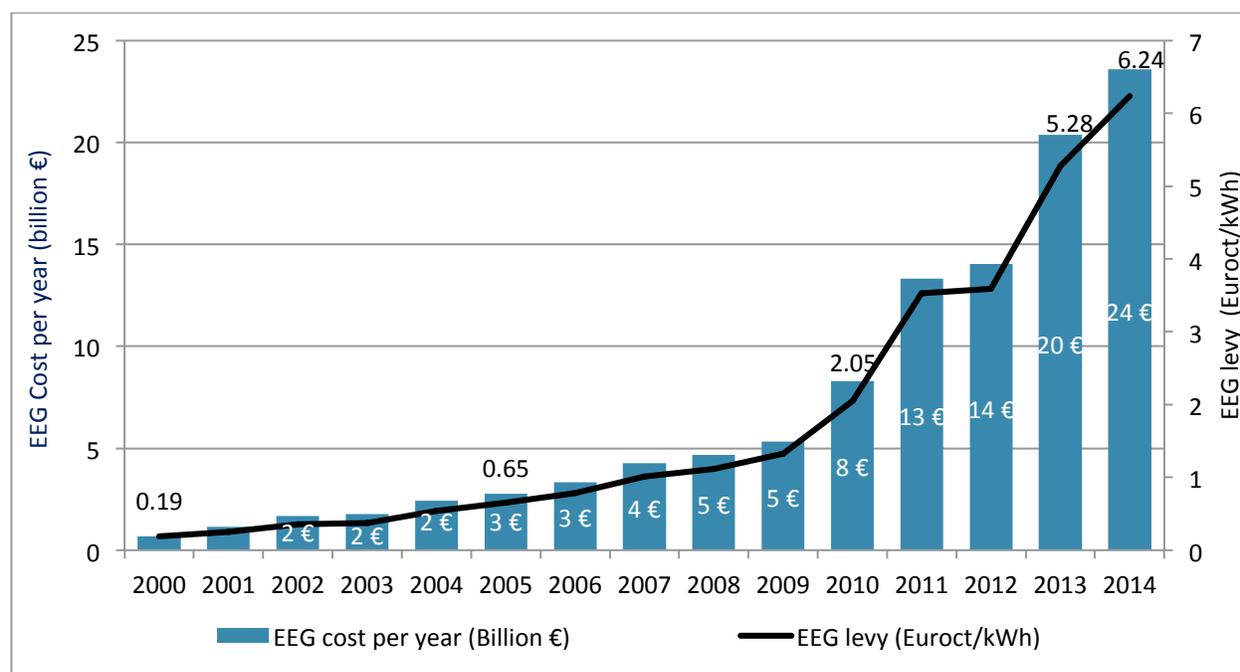
The fast growth in PV was unexpected. The system and respective market players were unable to plan the amount of capacity that was coming online. In 2012, Peter Terium, CEO of RWE, Germany’s largest power generator, said that the prices for PV modules had decreased to an extent that RWE did not consider possible. The impact has been material to RWE and other German energy companies. As an example, RWE recently reported a net loss in 2013 accounts for €2.8 billion accompanied from write-downs of approximately €4.8 billion which was attributed to the huge increase in solar and wind capacity. This is RWE’s first full year loss since the foundation of the Federal Republic of Germany in 1949.³⁹ Moreover, it was not just the

³⁹ RWE, “RWE posts first net loss in 60 years“. <http://www.rwe.com/web/cms/en/113648/rwe/press-news/press-release/?pmid=4010679>

utilities, but also research institutions that underestimated the growth of the renewables. For an industry that has long-term technical and investment lifetimes, this created system disruptions that led to value destruction.

Because of the large amount of renewable plants coming online, the EEG levy increased steadily from 0.19 eurocents/kWh in 2000 to 6.24 eurocents/kWh in 2014. Future development is unclear and experts expect a value between 5.8 and 6.8 eurocents/kWh⁴⁰ for 2015. The main drivers of the increase in the EEG levy over the years have been the rapid increase in renewable energy (especially in expensive PV), the levy exemptions for industry, and the decreasing price of renewable energy in the wholesale market.

Figure 11. Development of EEG subsidy and EEG levy⁴¹



In absolute terms, the EEG subsidy for renewable energy has increased dramatically. While in the years between 2000 and 2003 the total amount of the levy for renewable energy was around

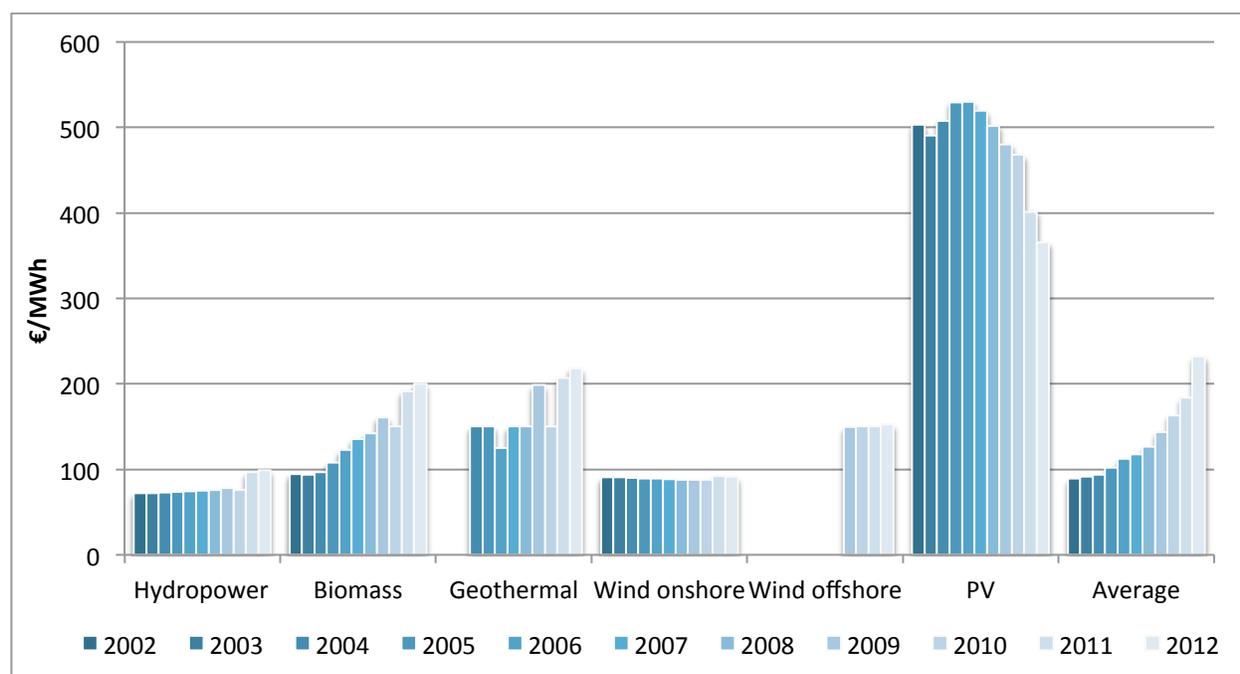
⁴⁰ Netztransparenz: German transmission system operators. <http://www.netztransparenz.de/de/Jahres-Mittelfristprognosen.htm>

⁴¹ Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Development of renewable energy sources in Germany. <http://www.erneuerbare-energien.de/die-themen/datenservice/zeitreihen-entwicklung-ab-1990/> (updated 15.10.2013)

€1 billion per year, it surpassed the €20 billion mark in 2013, and is estimated to approach €25 billion in 2014.

Taking a closer look at the EEG and the distribution of average FITs for existing renewable projects among the different technologies, figure 12 illustrates the huge differences that persist between technology types, both in the rate and its trend over the last years. The highest support is dedicated to PV, although the numbers in 2012 are only two-thirds of what they were in 2006. In total, the average FIT to plants without direct marketing increased from €89/MWh to approximately €230/MWh, as the share of high, albeit decreasing, PV FITs increased.

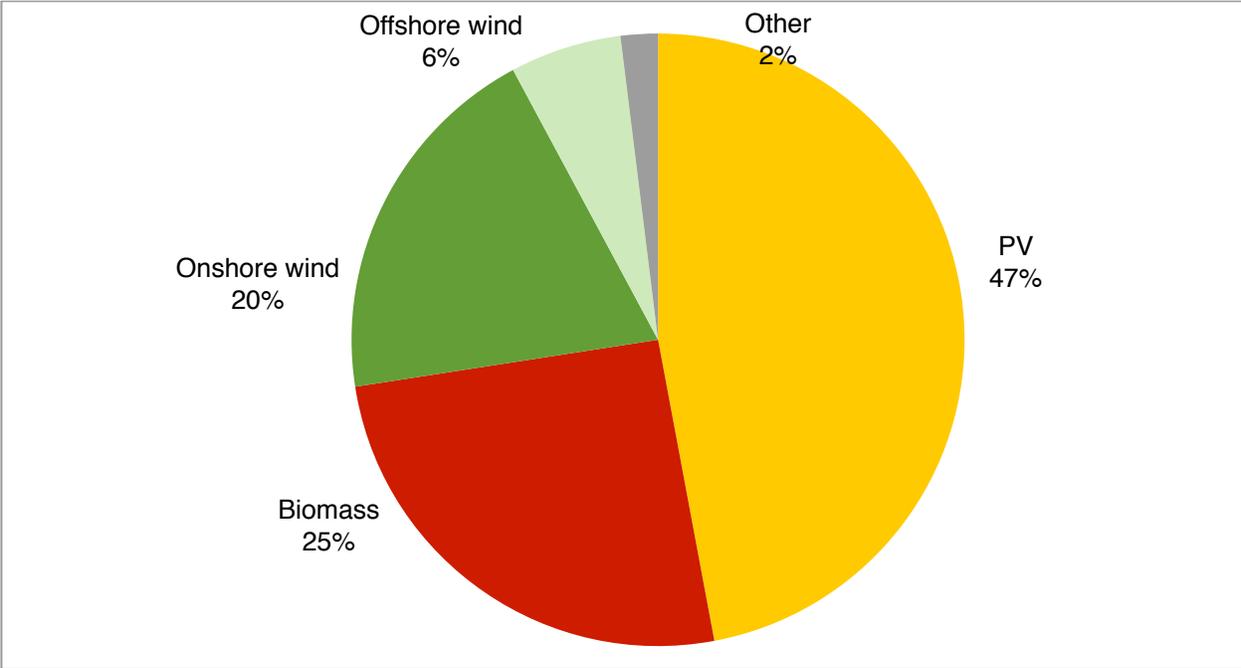
Figure 12. Development of average FIT rates paid out to all existing EEG plants divided per technology in Germany (€/MWh)⁴²



In 2014, payments to solar PV will account for almost half of the total EEG levy, followed by biomass and onshore wind.

⁴² Netztransparenz: Information platform run by the 4 German transmission system operators. <http://www.eeg-kwk.net/de/EEG-Umlage.htm>

Figure 13. Share of renewable technologies to the EEG levy, 2014⁴³



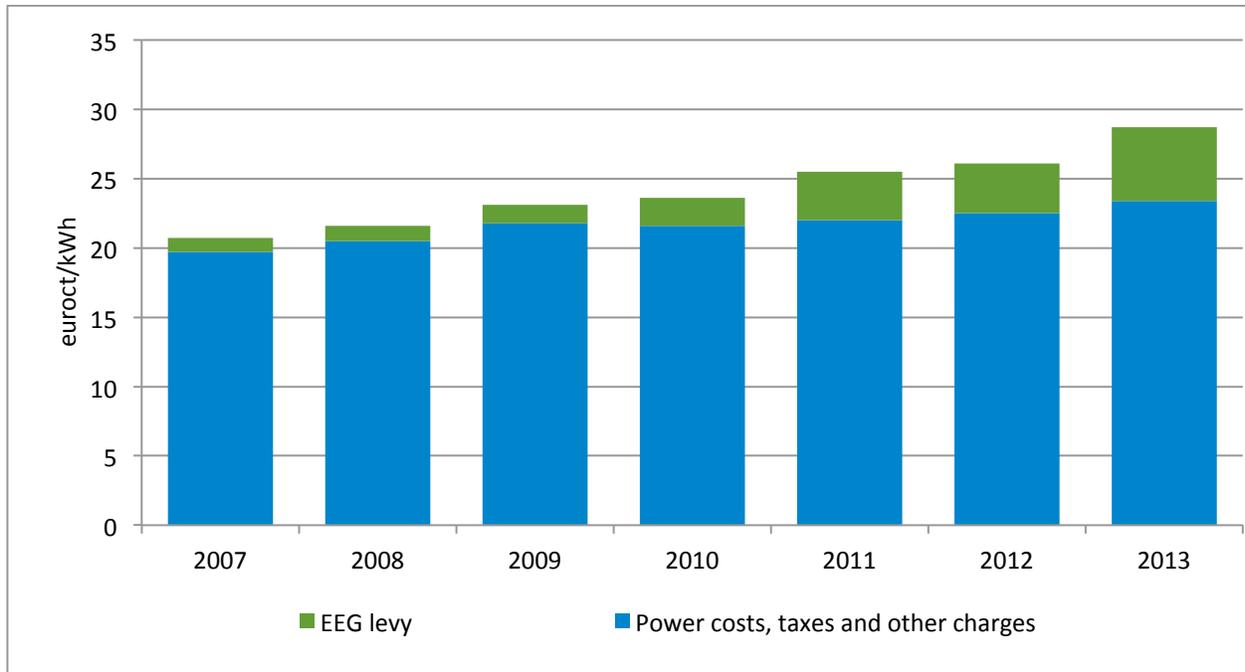
4.2. Ever increasing power prices to residential customers

Retail electricity prices have increased in Germany due in part to the generous subsidies for renewable energy. The two figures below show an increase in household electricity prices from €0.14/kWh in 2000 to €0.21 /kWh in 2007 to €0.29 /kWh in 2013. There are diverse reasons behind the increase in retail electricity rates, including the considerable growth of taxes and charges. While taxes and charges accounted for 25 percent of the total price in 1998, they were responsible for around 40 percent of the total price in 2012. Also, the price of electricity (including procurement, transmission, and distribution) has increased slightly, as a result, in part, of additional grid costs and balancing needs associated with increased renewable penetration. Finally, while the EEG levy only contributed slightly to the price of electricity in the first years of its introduction (1.4 percent in 2000), it is now one of the main factors contributing to the rise of retail electricity rates (18 percent in 2013). The EEG levy grew from €0.013/kWh in 2009 to

⁴³ PV Magazine, Germany: EEG levy increases in 2014, http://www.pv-magazine.com/news/details/beitrag/germany--eeg-levy-increases-in-2014_100013038/#axzz2vf5eJZkV

€0.053/kWh in 2013, or €240 per year per citizen, and is expected to grow to €0.062/kWh in 2014.

Figure 14. Evolution of residential power prices⁴⁴



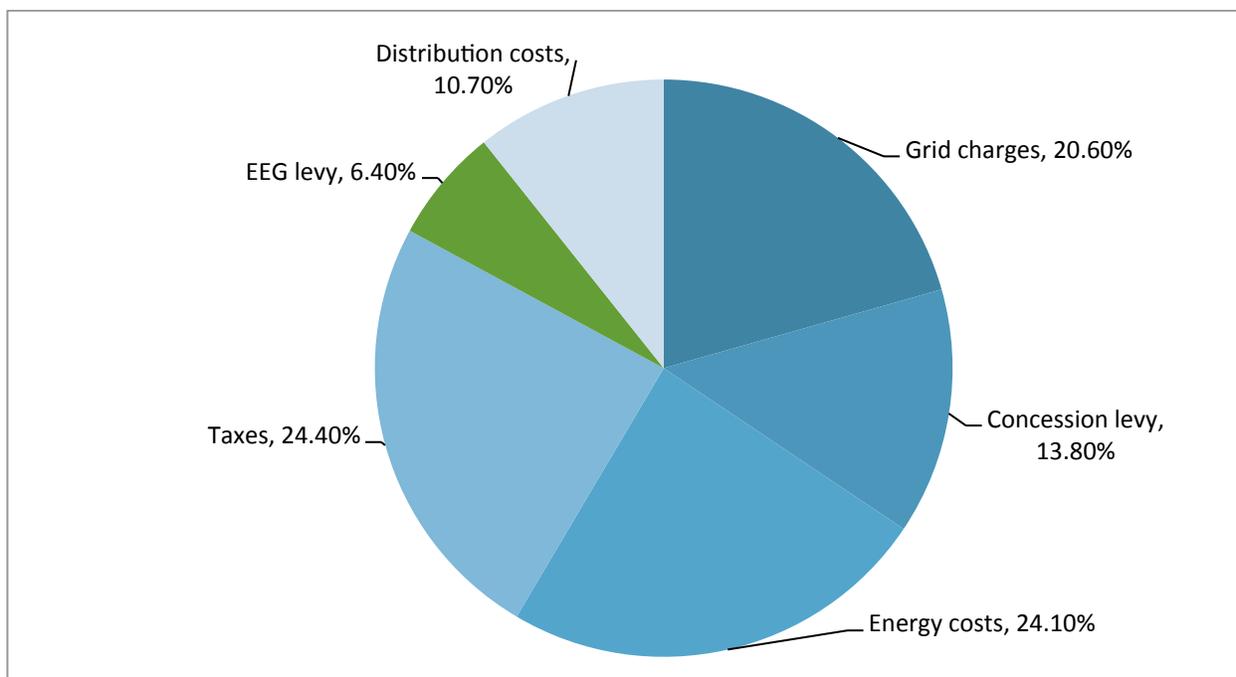
Electricity price increases went mostly uncontested in Germany because of two main factors. First, electricity expenses are only a small part, about 2.5 percent, of the overall expenditures of a regular German household. Second, there was initial strong support for the Energiewende and the readiness to bear additional costs. However, there are signs indicating that further unchecked price increases risk diminishing the popular support for the Energiewende, which is the main reason why Germany is currently working on a complete change of the existing EEG system.

Other European countries have had similar experiences with rapidly rising electricity prices. In the EU-28 area, the household electricity price rose by 11.7 percent between 2011 and 2013, while the industrial price rose by 9 percent. It is worth noting that the countries with the highest electricity prices, Denmark (€0.30/ kWh) and Germany (€0.29/kWh), also have significant levels of renewable energy; whereas the countries with the lowest prices, Bulgaria (€0.09/kWh),

⁴⁴ Agentur für Erneuerbare Energie – Agency of Renewable Energy

Romania (€0.13/ kWh), and Estonia (€0.14/kWh), have more traditional electric-generating resources.

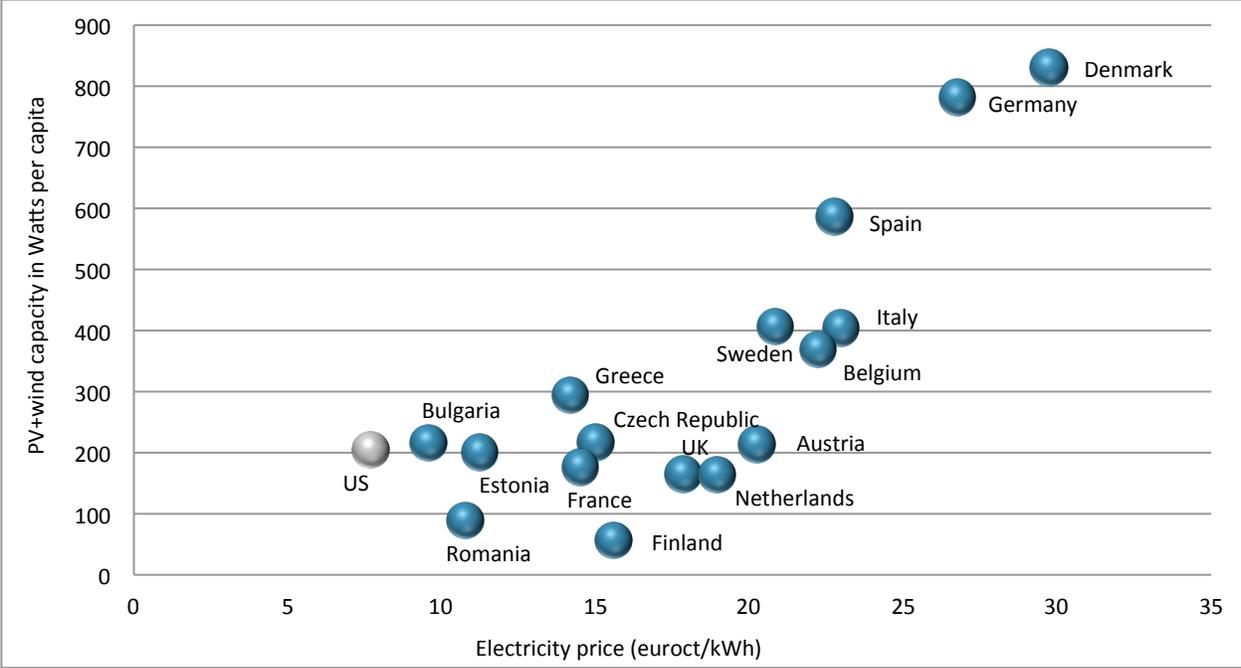
Figure 15. Breakdown of household prices in Germany, 2013⁴⁵



A further analysis confirms that a correlation exists between the amount of variable renewable energy capacity that a country has (PV and wind) and its household electricity prices including taxes, levies, and value added tax. The figure below measures the capacity of PV and wind plants in watts (W) per capita. A trend can be detected which shows that higher W per capita will result in higher electricity prices. While the majority of European countries have a low/medium level of capacity, with a level under 300 W per capita, other countries show a higher level of capacity and, accordingly, increased electricity prices. Leading countries in this analysis are Denmark and Germany, followed by Spain, Italy, and Belgium.

⁴⁵ Bundesnetzagentur: Federal Network Agency.
http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Verbraucher/PreiseUndRechnungen/WieSetztSichDerStrompreisZusammen.pdf;jsessionid=0B318530B0B7F0F3325CB5CA631C83F7?__blob=publicationFile&v=2

Figure 16. Comparison of the amount of wind and solar capacity and electricity prices, selected countries, 2012⁴⁶



The rise in electricity prices has spurred a new debate in Europe about a new energy poverty. A recent front cover of the popular German magazine *Der Spiegel* titled “Luxury Electricity: Why energy will always be more expensive and what politicians have to do against it” and showing gold-plated and diamond-encrusted power cables, succinctly summarized the mood of the German public toward high energy prices. The article discussed “Germany's aggressive and reckless expansion of wind and solar power (that) has come with a hefty price tag for consumers and the costs often fall disproportionately on the poor.”⁴⁷

According to the EU Fuel Poverty Network,⁴⁸ a portal established with the aim of bringing together energy researchers and practitioners from across the EU, energy poverty occurs “when a household is unable to afford the most basic levels of energy for adequate heating, cooking,

⁴⁶ Wikipedia, “Solar energy in the European Union”, http://en.wikipedia.org/wiki/Solar_energy_in_the_European_Union; US Department of Energy, Energy Information Administration

⁴⁷ *Germany’s Energy Poverty: How Electricity Became a Luxury Good*, *Der Spiegel*, 4 Sept. 2013

⁴⁸ The EU Fuel Poverty Network has become the leading online portal for information about EU fuel poverty and aims to bring together researchers and practitioners from across the European Union who are working in the field of fuel poverty in order to facilitate discussion, further the dialogue on across the EU and provide a platform for researchers and practitioners

lighting, and use of appliances in the home.” While this phenomenon was initially only British⁴⁹, it is now expanding to the whole EU as electricity and natural gas prices increase throughout the continent.

In November 2013, after many years of promoting FITs as an effective mechanism to support renewable energy development, the EC hinted at the need to reform or end renewable subsidies, and the need to support fossil generation that backs up renewables. The EC stated that “(i)n some cases, state intervention in energy markets may be necessary in order to ensure security of supply and to achieve climate objectives” and that “(a)s technologies mature, renewables should gradually be exposed to market prices and eventually support must be fully removed.”⁵⁰ As will be described later, the EC will ultimately remove all FIT schemes starting in 2017.

4.3. Impact on national competitiveness

Concerns about the impact of high energy prices on national competitiveness are growing. In January 2014, the EC released a communication on a policy framework for climate and energy⁵¹ that warned of the particularly high risk for “industries that have high share of energy costs and which are exposed to international competition” (p.10). At the World Economic Forum Annual Meeting in early 2014, energy prices and competitiveness was one of the biggest themes.

Participants observed the growing competitiveness gap between Europe and the United States, contrasting the United States’ “shale revolution” and abundant domestic natural gas supplies with Europe, where industrial electricity prices are much higher than in other parts of the world because of “a pell-mell push toward high-cost renewable electricity (wind and solar), which is imposing heavy costs on consumers and generating large fiscal burdens for governments.”⁵²

The rise in German power prices does not only apply to residential consumers, but also to industry consumers. In this case the main factors contributing to the end price are represented by the procurement costs. For medium-sized enterprises, the additional part is denoted by taxes and

⁴⁹ Fuel Poverty: a Framework for Future Action, Department of Energy and Climate Change, July 2013

⁵⁰ EC Communication, Guidance to Member States on state intervention in electricity markets; November 2013; http://ec.europa.eu/energy/gas_electricity/internal_market_en.htm

⁵¹ EC Communication, A policy framework for climate and energy in the period from 2020 to 2030, 22nd January 2014. http://ec.europa.eu/energy/doc/2030/com_2014_15_en.pdf

⁵² Daniel Yergin, US vs. Europe: Energy battle heats up, CNBC, <http://www.cnbc.com/id/101365772>

charges, which has gained a higher portion over the last few years, reaching about one-third of the final price in 2012.

For energy-intensive industrial consumers, such as paper, aluminum (non-iron metals), steel, and cement, electricity prices are a critical factor in economic competitiveness. These consumers represent an important part of the German economy and are therefore exempt from paying the EEG levy.⁵³ The aforementioned industries account for around 40 percent of the power consumption, although they represent only a small portion of the total number of privileged companies (10 percent).

As the next table shows, a huge number of companies benefit from privileged treatment regarding power prices, and that number is steadily increasing.

Figure 17. Exempted companies and power consumption in power-intensive industries (2012/2013)⁵⁴

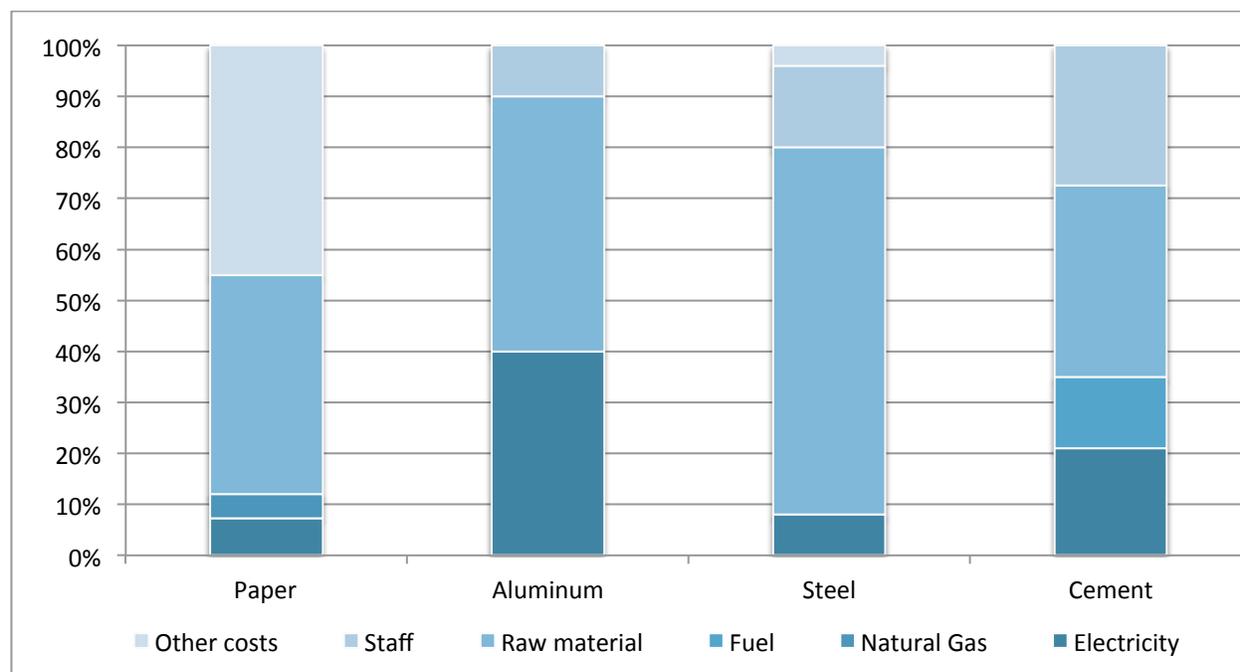
	Exempted companies	Consumption (GWh)	Ratio consumption/ companies (GWh)
Paper	107	14,062	132
Aluminum	40	10,699	267
Steel	37	11,945	323
Cement	25	3,738	150
Total: power intensive industries	209	40,464	194
Total: ALL industries	2,057	107,477	52

The share of total production costs attributable to electricity expenses varies between 7 percent in the paper industry and 40 percent in the aluminum industry, meaning electricity price increases have a great impact on total production costs.

⁵³ Forum Ökologisch-soziale Marktwirtschaft by order of Greenpeace e.V.: Strom- und Energiekosten der Industrie

⁵⁴ German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: Development of renewable energy sources in Germany. www.erneuerbare-energien.de/.../ee.../hintergrundpapier_besar_bf.pdf

Figure 18. Share of total production costs for power-intensive industries⁵⁵



For power-intensive industry companies, this special treatment is without a doubt an important benefit and enables them to stay competitive. Current calculations state that the exemptions given to German industrial companies will account for a total of €5 billion in 2014.⁵⁶

Because of the advantage that this exemption brings to large German exporting industries, these exemptions are now being challenged by the EC, which is planning to examine the special treatment that the above mentioned German companies are enjoying, and determine whether this situation violates the principle of fair competition.

4.4. Financial impact to thermal generators and reliability

Large penetration of renewable energy has not only translated into higher costs for the economy, it is also having profound effects on wholesale electricity markets that could ultimately result in a deterioration of the country's reliability. Subsidized renewables have dispatch priority over

⁵⁵ Forum Ökologisch-soziale Marktwirtschaft by order of Greenpeace e.V.: Strom- und Energiekosten der Industrie. http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/energie/2012-FOES-IZES-Verguenstigungen-Industrie.pdf

⁵⁶ Frankfurter Allgemeine Zeitung: EEG-Umlage: Welche Firmen müssen künftig zahlen? 19th February 2014. <http://www.faz.net/aktuell/wirtschaft/wirtschaftspolitik/oekostrom-eeg-umlage-welche-firmen-muessen-kuenftig-zahlen-12808022.html>

thermal generators and come first in the market's merit order, thus depressing wholesale prices to levels that are making thermal plants uneconomical. At the same time, increasing amounts of renewables require increasing amounts of back-up and balancing power that only thermal plants can provide. The implications of these developments for reliability are evident.

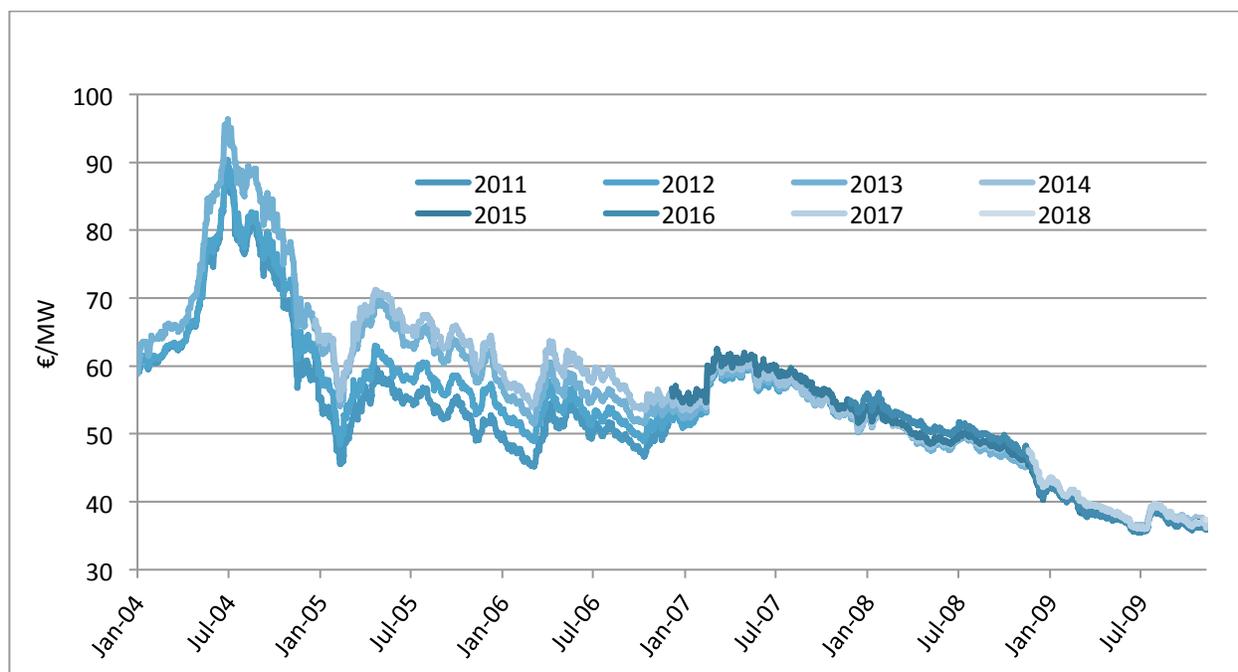
4.4.1. Impact on wholesale markets: Subsidized renewables first in merit order and low wholesale prices

While it is the total costs that determine investment decisions for power plants, it is the variable costs that determine if an existing power plant runs at any given time. Therefore the offer curve of a power market is determined by the marginal costs in ascending order of the available power sources. This is the so-called merit order. If there is an increase in demand, then plants are turned on, starting with the cheapest, until the demand is satisfied. The last plant that is turned on determines the market price for all market participants. Focusing on the difference between the long-term investment decisions and the short-term merit order is key to understanding power markets.

Renewable energy resources, like wind and solar, have very low marginal costs because they have no fuel costs. Accordingly, renewable resources are bid into the market at very low prices, thereby becoming first in the merit order. In an undistorted market, generators may offer their power at prices below their total costs. As long as the market is in equilibrium, the use of power plants with higher marginal costs ensures that other plants cover their total costs. However, the power markets today are distorted by subsidies. Renewable generation will continue to be built since it depends only on subsidies and does not react to the markets' excess power signals.

The change of the merit order and the increasing amounts of low-bid renewable energy in electricity wholesale markets have been steadily depressing wholesale prices of electricity in Germany and other European nations over the last couple of years. From values around €90/MWh in July 2008, the power price fell on the European Energy Exchange (EEX) to levels under €40/MWh at the end of 2013.

Figure 19. Wholesale price Germany - Non-peak futures prices, EEX⁵⁷



Although lower prices sound like a positive development, wholesale prices have not translated into lower prices to consumers, but instead have had a number of perverse effects.

4.4.2. Cost recovery and financial impact to utilities

Lower prices and changes in the structure of wholesale markets have had several implications for thermal generators.

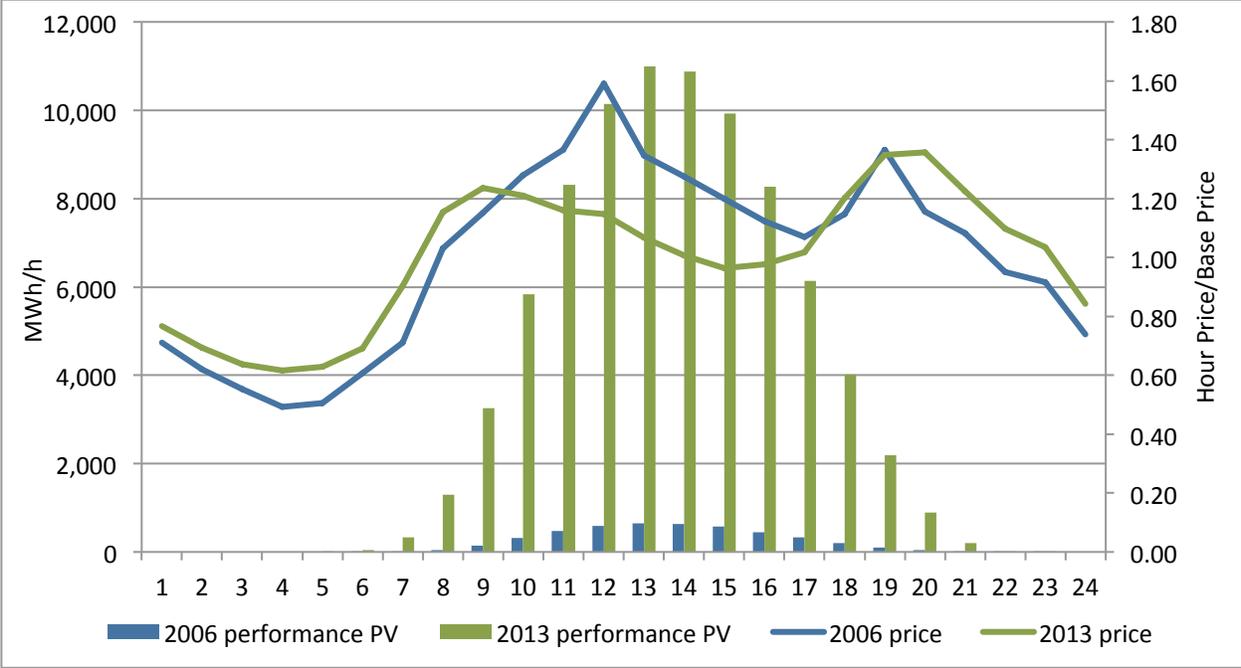
The first implication is that, at current price levels, coal and gas-fired power plants cannot cover their full costs. There are fewer hours in which the conventional power plants earn more than the marginal cost since they run fewer hours than originally planned and, in many cases, provide back-up power only.

Also, the market peak price has been reduced, further reducing the revenues of traditional thermal power plants. Given the large percentage of PV deployment, PV was able to reshape the power market. In the past, wholesale prices followed the demand curve and peak load plants earned most of their margin in the middle of the day, when high load led to high power prices.

⁵⁷ European Energy Exchange. www.eex.de

The growth in PV eroded the midday peak, which took away the high mid-day margins of the peak plants.

Figure 20. Yearly Performance of PV and Electricity Tariff (standardized)⁵⁸



This situation is making cost recovery even more difficult. This means that the owners of the plants have to write-off the money they originally invested. As discussed earlier, RWE recently announced a write down of €4.8 billion on assets, mainly power stations, and a net loss of €2.76 billion (\$3.8 billion) on total sales of €54.1 billion, its first full-year loss since 1949.⁵⁹ This situation is not unique to Germany. One of Australia’s largest utilities, Energy Australia, also announced a significant write down due, in part, to gas-fired generators becoming uneconomic because of the rapid growth of solar power and the rapid increase of electricity prices for customers.⁶⁰

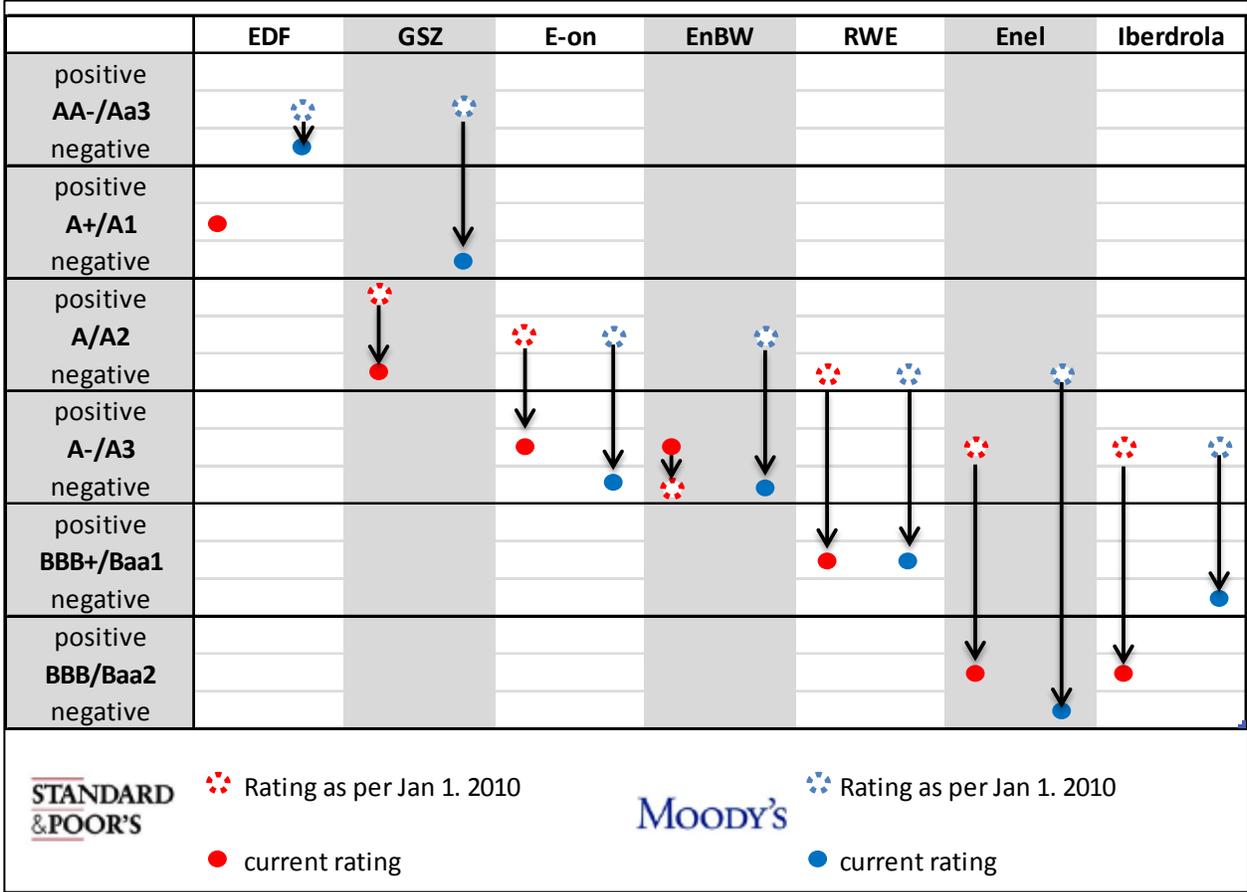
Generators’ financial difficulties have already translated into lower stock prices and credit ratings. In terms of the magnitude of share price reductions, power utilities have fared worse than

⁵⁸ European Energy Exchange. www.eex.de
⁵⁹ Bloomberg: RWE Suffers First Loss Since Founding of German Republic 4th March 2014. <http://www.bloomberg.com/news/2014-03-04/rwe-reports-first-loss-in-more-than-60-years.html>
⁶⁰ Renew Economy, Massive losses hit EnergyAustralia as demand falls, solar soars, 28 February 2014. <http://reneweconomy.com.au/2014/massive-losses-hit-energyaustralia-as-demand-falls-solar-soars-67443>

the renewable space. According to the MSCI (Morgan Stanley) European utilities share price index, the top 20 energy utilities have lost more than half a trillion dollars since their peak in September 2008.⁶¹

This is not only attributed to the large subsidies, but also to deregulation, the impact of the global financial crises, failed acquisitions, emissions controls, and investment in new efficient plants (that ultimately were closed due to renewable subsidies and permanent demand destruction), and, in the case of Germany, nuclear decommissioning. Since 2010, the European Stoxx Utilities Index is down 31 percent, while German utilities, like Eon, have seen their shares plunge 45 percent.

Figure 21. Development of ratings of major European utilities since 2010⁶²



⁶¹ The Economist October 12th, 2013. <http://www.economist.com/node/21587782/print>

⁶² Source: E.ON and own research on Bloomberg

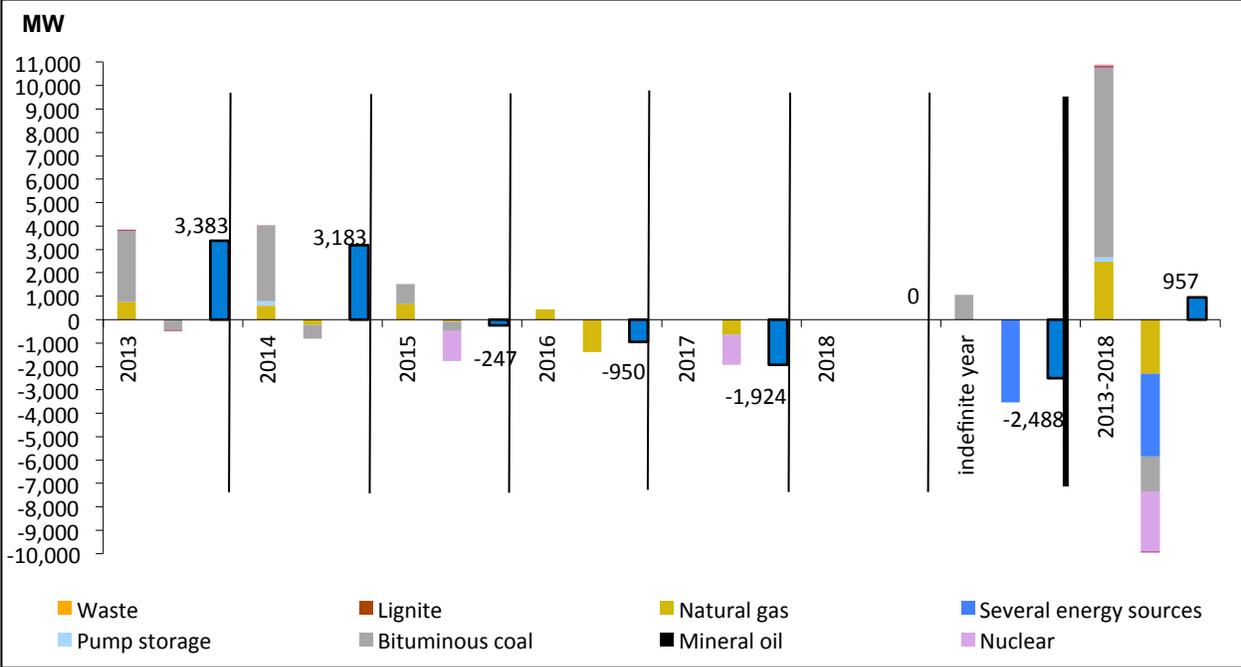
The impact to credit ratings of these institutions has also been significant. Back in 2008, the top 10 European electric companies had credit ratings of A or higher. At the time of this writing, less than half still maintain this rating.

Collectively, both renewable companies and utilities are having their costs of capital increased by both regulation and the uncertainty that is being created in the capital markets. There is no doubt that these increased costs will ultimately be passed on to consumers.

4.4.3. Evolution of the fleet and impact on reliability

A second major implication of low wholesale prices is that fewer new plants are planned. This can present reliability problems, especially as nuclear plants shut down. It can also present a challenge to integrate large amounts of renewable energy, as thermal power plants still provide back-up and balancing services.

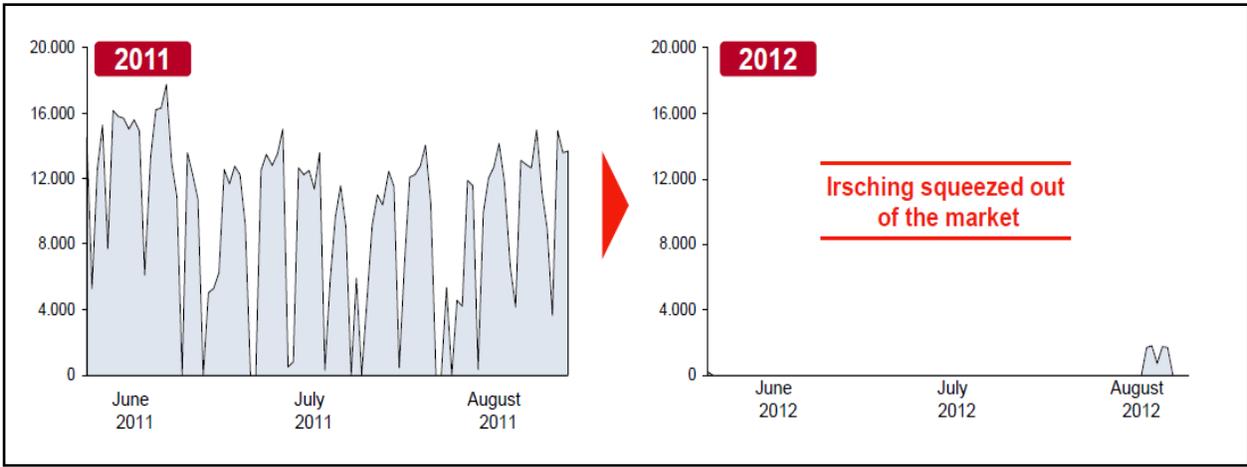
Figure 22. German-wide commissioning and decommissioning of non-intermitting power plants; National planning data 2013 - 2018⁶³



⁶³ Federal Network Agency; 08th January 2014. http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/kraftwerksliste-node.html; 08.01.2014

The effects on reliability can be seen in an agreement reached by a German grid operator and a gas-fired power plant that had threatened to close because of economic problems. In 2013, the owners of the CCGT Irsching 5 threatened to mothball the power plant for two years,⁶⁴ even though Irsching 5 had only been online since 2010, and, with an efficiency factor of 60 percent, was one of the most modern CCGT plants in Europe. The plant was kept online per decree due to its role in maintaining system stability. By agreement, the power plant committed to continued operations and, in exchange, TenneT, the grid operator, compensates Irsching’s fixed costs proportionally to the number of usages on demand of TenneT (Redispatch).

Figure 23. Electricity generation at E.ON's Irsching Gas power plant (2011 vs. 2012)⁶⁵



4.5. Impact of renewables’ variability on market operations and thermal plants

Ironically, the fast growth in renewables in general, and especially PV, is contributing to drive out of the market the very same generators that can help them grow. Because of their variability, renewables require other generators to help them integrate their power into the grid. In most cases in Germany, it is the thermal generators that used to provide baseload power that are now providing back-up and balancing services for intermittent renewables at a significant loss of technical efficiency and increased costs.

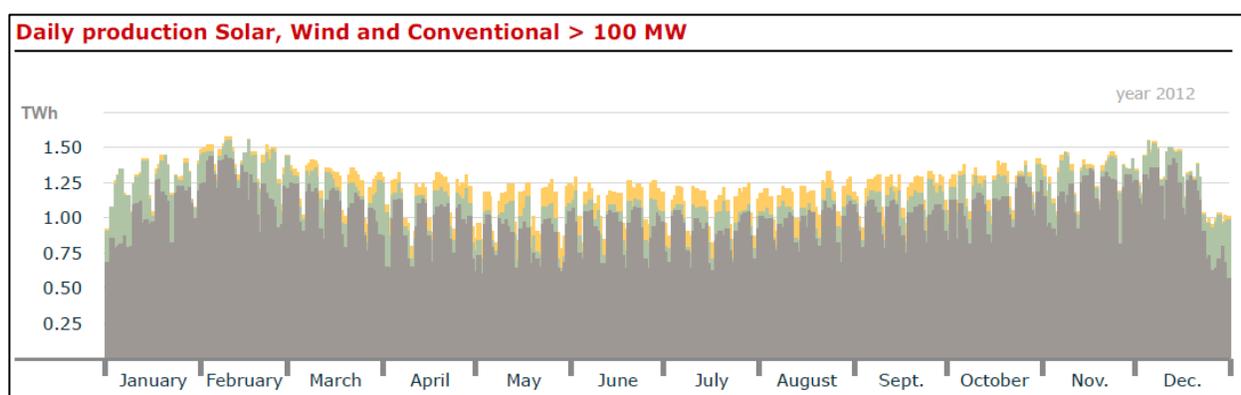
⁶⁴ TAM-News 14th. March 2013 and 29th April .2013
⁶⁵ . 01st November 2013: Speech of Thomas Barth, CEO and Chairman of the Managing Board, E.ON Energie AG: “The German Energiewende”: Shining or Warning Example for Europe? 5th Conference ELECPOR. http://www.elecpor.pt/pdf/Thomas%20Barth_ELECPOR_Nov2013.pdf.

4.5.1. Large thermal as back-up – grid interventions

The more variable renewables there are, the more the thermal power plants will serve as back-up and balancing for renewables.

Figure 24 shows the daily production of solar, wind, and conventional generation in Germany. The maximum daily solar and wind-combined production in 2012 was 530 GWh on January 5, 2012, while the minimum was only 30 GWh on December 19, 2012.

Figure 24. Daily production of Solar, Wind and Conventional in Germany 2012⁶⁶



Given the average daily power consumption of around 1,643 GWh in Germany, this means that in spite of the 13.2 percent⁶⁷ share of wind and solar power in total power generation, there must be almost complete redundant capacity of thermal plants or storage.

Wind and solar energy, by their very nature, are highly variable, with fluctuations in weather conditions causing significant variance over multiple timescales: seconds (gusts of wind and passing cloud cover), minutes (wind speed variations, briefly overcast skies), days (diurnal cycles, creating peaks of solar condition), months/quarters (seasonal cycles), and years (annual variation in environmental conditions).

At yearly and seasonal levels, both wind and solar generation can be forecasted with relative certainty. It is when considering diurnal (daily) generation profiles that variability occurs and

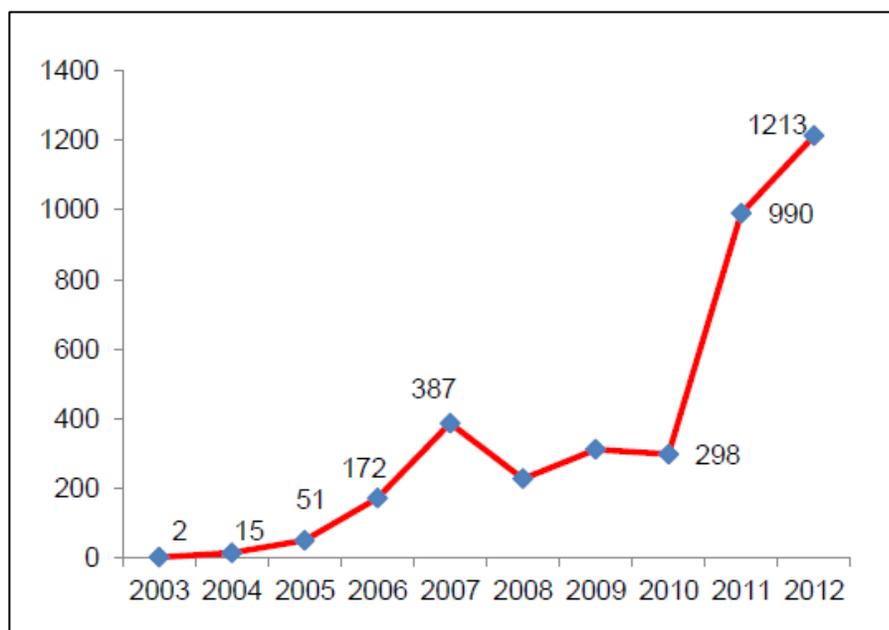
⁶⁶ FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE; Electricity production from solar and wind in Germany in 2012; February 08th, 2013

⁶⁷ German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: Development of renewable energy sources in Germany

requires system operators to intervene and make sure that supply and demand of electricity are equal at all times.

In Germany, as the percentage of renewable power increased, so did the number of times that grid operators had to intervene to rebalance the market. In 2012, there were 1,213 such interventions.

Figure 25. Grid interventions to stabilize the grid by grid operator Tennet, 2003-2012⁶⁸



For new thermal power plants to replace the currently uneconomical power plants once they reach their technical lifetime, current prices will have to rise. The effect of fewer operational hours needs to be compensated by higher prices in these hours. As a consequence, it is likely that markets will experience lower prices in times when there is sufficient renewable power and much higher prices at other times.

Renewables generate higher direct costs than traditional power production. Traditional base load wholesale power can be generated in Germany at around €65/MWh, but wind power and solar PV in Germany receive a FIT of around €90 /MWh.

⁶⁸ Tennet

Because renewables, like wind and solar, do not produce at certain times, available back-up power to the system is required. The back-up capacity must be financed even if it is used only occasionally as back-up. Therefore the little power that is produced in the back-up plants will become expensive. Data drawn from business models of Finadvice show that a CCGT can produce 3000 GWh per year at fixed costs of €11/MWh, in a power system without renewables. If renewables reduce the production of the CCGT to for example 1500 GWh, the price needed to recover fixed costs will double to €22/MWh. In a nutshell, this could mean that the cost of power in the hours with renewable power is the subsidized €90/MWh instead of conventional €65 MWh, and when there is no renewable power, the (back-up) power price will be €76/MWh (65 + 11).

How difficult it is to integrate renewable energy depends on the overall system and the specific characteristics of each national electric system. Norway, for instance, has 95 percent of hydropower, which has essentially no variable cost but acts as a nice storage/buffering mechanism for other renewables, allowing the country to integrate renewables with less impact on the overall system.

4.5.2. Impact to thermal plants operating under new conditions of high variability

Baseload thermal plants were designed to operate on a continuous base. Although some were designed to perform efficient ramping, they were all built to operate at their highest efficiencies when running 24 hours a day, seven days a week. The rapid deployment of renewable energy has meant that those same thermal plants are providing back-up and balancing services to renewables at suboptimal efficiencies.⁶⁹ The potential operational impact to owners of thermal plants for material damage and consequential business interruption could be significant and accordingly is now being closely analyzed by one of the world's top insurers.⁷⁰

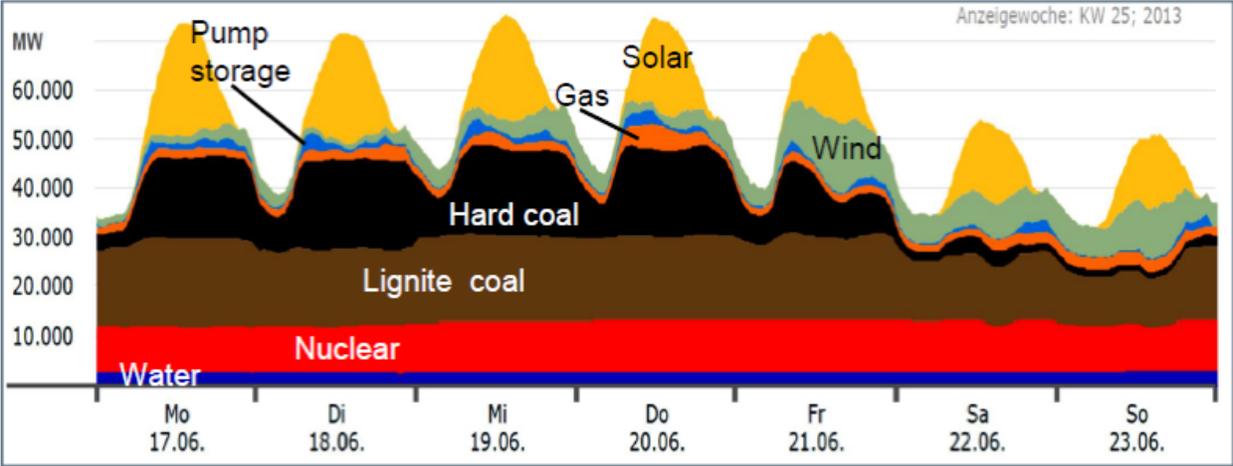
Renewable energy sources have a significant influence on the daily operations of conventional power plants since they have guaranteed access to the grid and are variable in nature. The fluctuating distribution of all kinds of power generation plants is shown in figure 26 for a one-

⁶⁹ See Appendix A for an analysis from Siemens which provides further technical related impacts,

⁷⁰ See Appendix B for an analysis from Marsh Ltd.

week time span in June 2013, in Germany. Hard coal and gas-fired units are following load and balancing renewables during peak load conditions. Typical baseload lignite coal, and even nuclear units, has to follow load during minimum load periods because of priority dispatch of renewables.

Figure 26. SIEMENS: Weather-related fluctuation of renewable energy (solar and wind power) with significant influence on operation regime of conventional power plants



The change from providing baseload power to increased cycling, load following, and providing peak load power has had profound effects on thermal generators, particularly the older, less efficient generators.

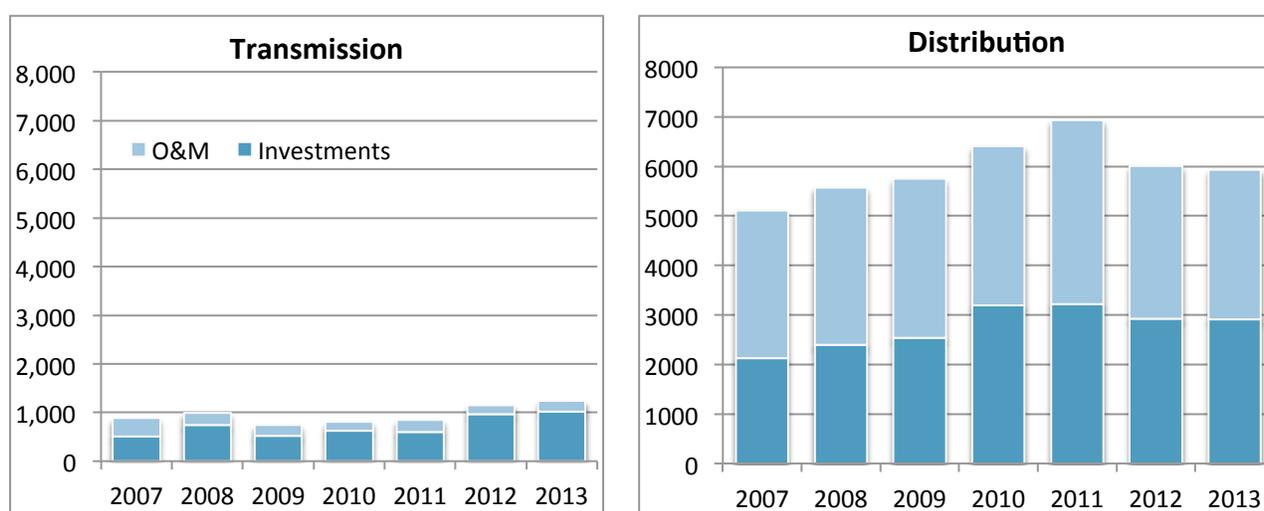
Depending on the type of generator, the new peak and medium load operation conditions with steep load ramps of up to 50 MW/min for new gas-fired units will stress a number of generator components in different ways. For example, when large, old coal-fired generators, which were designed for baseload operation, are running in peak load operation, the frequent thermal expansion and contraction of stator and rotor windings will result in accelerated wear and aging of the unit.

Adding to the costs associated with increased renewables, a condition-based maintenance, refurbishment, and replacement strategy will be needed to reduce the sudden outage risk for these older generators.

4.6. Expansion and additional investment in the power grid

The German power grid was originally designed for centralized, thermal baseload power production, but the growth of renewable energy (both centralized and distributed) in Germany requires new investments and the extension and transformation of both the transmission and distribution grids. Renewables, like offshore wind in Germany, are usually located far from power demand. Thus, adding renewables to electric systems usually requires a substantial extension of the transmission system. Resources that are close to consumption, like rooftop PV, require grid connection and grid services to back up their power when there is no sun and to ensure power quality through balancing services that control frequency and voltage.

Figure 27. New investments and operational expenditures of transmission and distribution grid operators⁷¹



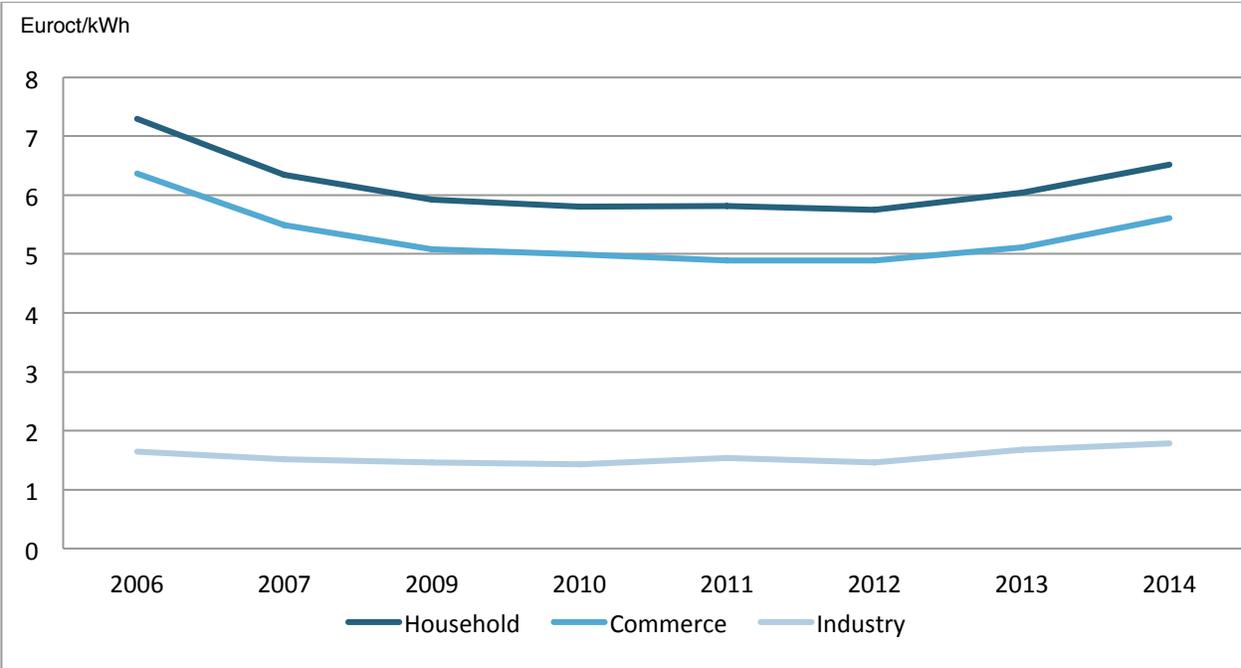
While analyzing the amounts of investments related to the grid system, it is important to distinguish between investments undertaken by the transmission system operators and those by distribution system operators. While the transmission system operators are mainly concerned with connecting new power generation plants to the existing system, it is the task of distribution system operators to work on regional and local bases and to serve private households with electricity. The investments expenditures undertaken by distribution system operators are mainly due to maintenance of the existing grid, like metering or communication systems. Since 2007,

⁷¹ Federal Network Agency

investments and operational expenditures by distribution system operators rose significantly and reached their peak in 2011 (€6,930 million), while the level of investments and operational expenditures in the transmission system remained proportionally low and quite stable with only a small rise in 2012 and 2013.

As a result of these additional investments in grid expansion and improvement, grid usage fees (fees that recover costs associated with transmission and distribution) increased in 2011,⁷² and are expected to continue to increase in the future as a result of Germany’s plan to further expand the grid to accommodate increasingly large amounts of renewable resources.

Figure 28. Development of the average grid usage fees 2006-2013⁷³



⁷² Federal Network Agency Monitoring report 2013. http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2013/131217_Monitoringbericht2013.pdf?__blob=publicationFile&v=9

⁷³ Federal Network Agency Monitoring report 2013. http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2013/131217_Monitoringbericht2013.pdf?__blob=publicationFile&v=9

The Grid Development Plan

The “Grid Development Plan” is an effort begun in 2012 by the four German grid operators (Tennet, 50Hertz, Amprion, and TransnetBW) to develop expansion plans of the current grid, including the Offshore-Grid Development Plan, which is meant to strengthen the north-south high voltage connections in order to bring power from the newly built offshore plants in the North and the Baltic Sea to the populated areas of Southern Germany.⁷⁴ The total investment in the expansion of the onshore and offshore transmission grid in the next 10 years was initially estimated at around €40 billion,⁷⁵ but was recently revised downward as the plan’s focus changed from building new lines to improving existing ones.⁷⁶ The costs will be recovered by additional grid usage fees paid by all electricity consumers.⁷⁷

Unfortunately for transmission operators and regulators, government officials of the State of Bayern lodged a protest against the build-out of the SUEDLINK on February 6, 2014, calling into question one of the cornerstones of the Energiewende.⁷⁸ The State of Bayern is not the only state to create protest, other states and municipalities are questioning the build-out of the grid mainly based upon a “not in my backyard” syndrome, as well as the high cost to be paid.

Also, critics among the scientific community have questioned the magnitude of the grid development plan and believe the plan is overdesigned, which would result in higher than necessary costs that will have to be covered by end consumers through higher grid usage fees.⁷⁹

⁷⁴ Transmission system operators: Grid development plan: second draft 17th July 2013.
http://www.netzentwicklungsplan.de/sites/default/files/pressematerial/Presse%20release_GDP_2013_second%20draft.pdf

⁷⁵ Transmission system operators_ Grid development plan.
http://www.netzentwicklungsplan.de/sites/default/files/pressematerial/Presse%20release_O-GDP_2013_second%20draft.pdf

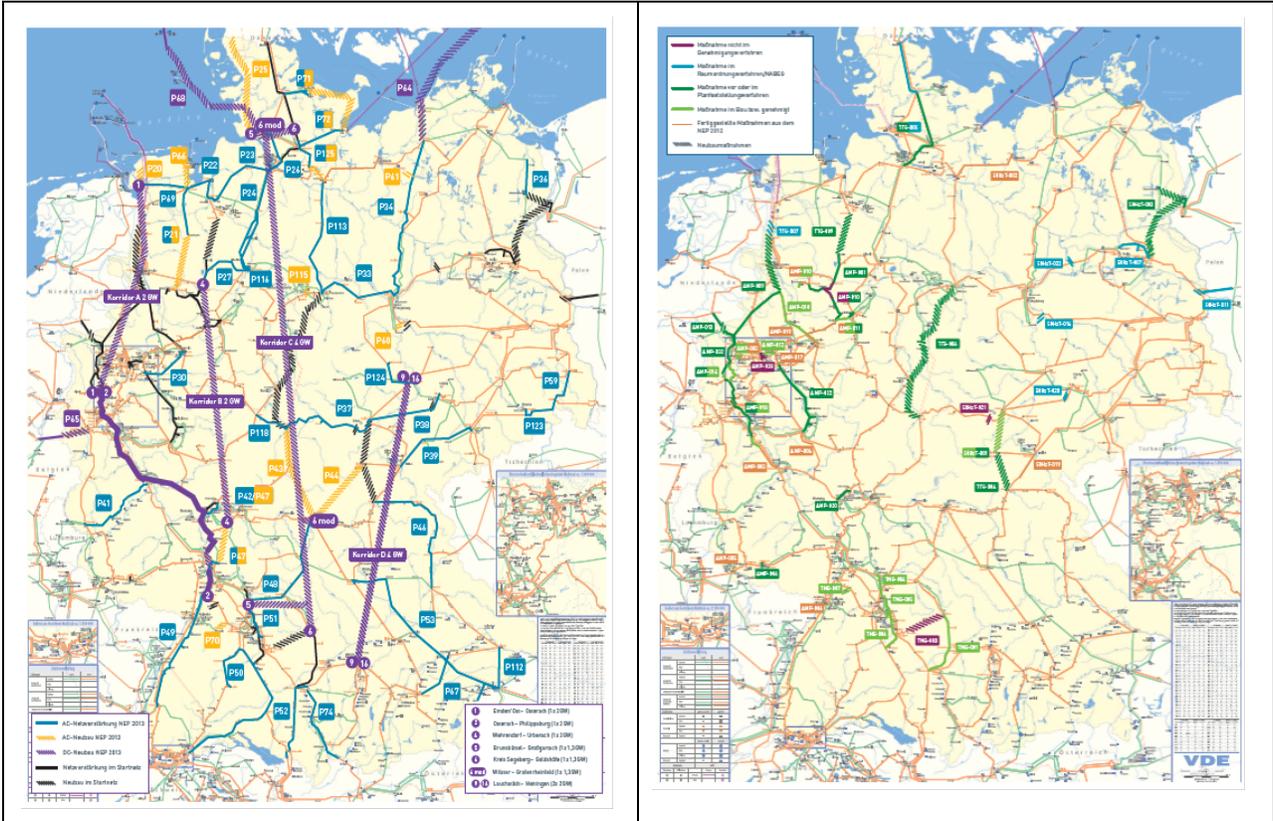
⁷⁶ Umweltdienstleister Netzentwicklungsplan bestätigt 16 January 2014 ; German Network Agency.
<http://umweltdienstleister.de/2014/01/16/netzentwicklungsplan-bestaetigt/>;
http://www.netzausbau.de/SharedDocs/Downloads/DE/II/NEP/ZFStromnetzausbau2013.pdf?__blob=publicationFile

⁷⁷ Transmission system operators: grid development plan. <http://www.netzentwicklungsplan.de/content/fragen-zur-finanzierung>

⁷⁸ Frankfurter Allgemeine Zeitung: Die Energiewende kommt die Armen teuer

⁷⁹ Solarify Netzausbauplan übertrieben: Akzeptanz der Energiewende bedroht 06th April 2013.
<http://www.solarify.eu/2013/04/06/netzausbauplan-ubertrieben-akzeptanz-der-energiewende-bedroht/>

Figure 29. Target grid network



Unequivocally, large scale deployment of renewables in Germany has increased the need to expand the grid, which will therefore lead to higher grid investments and, in turn, to higher grid usage fees for customers. The effect on the grid usage fees will be even more evident when interest rates return to pre-crisis levels.

4.7. Repeated redesigns and boom and bust cycles

European subsidy programs for renewables increased prices for European consumers, and, in many instances, became such a burden on the national economies that they resulted in numerous redesigns. Some European renewable energy regulatory regimes were inappropriately structured, gamed by market players, or made obsolete by market conditions. As a result, governments and regulators corrected unsustainable regulatory regimes by reducing the level of subsidies, sometimes retroactively, and modifying the rules of the programs. The numerous changes in the rules increased regulatory uncertainty and financial risk for the renewable industry that experienced significant value destruction.

4.7.1. Redesigning unsustainable programs

Germany set the subsidy level in €/MWh and left it to the market to react with an according quantity in installed capacity. The original FIT law had no limit to the quantity of renewables to be built, but the FIT rate was to be reduced year-by-year. This system was meant to lead to a sustainable growth of renewables. However, neither the wind nor the PV market reacted as expected by politicians. Rather, they were taken by surprise by the pace of deployment. In the solar PV industry, for example, as the cost rapidly decreased, the profitability of PV improved much faster than the FIT was reduced. This led to a boom in PV installations. The ever-increasing demand led to very high margins for producers, project developers, and installers who had an incentive to keep installing new PV systems. More systems meant more subsidy payments, but also higher costs to consumers.

By 2010, the debate over the cost of the FIT program had gained momentum in Germany as the economic crisis brought cost and industrial competitiveness back to the forefront of policy concerns, while at the same time solar PV enjoyed a rapid decline in costs. More than 100 electricity service providers announced significant price increases for 2010 (as high as 16 percent for households) claiming increased costs associated with renewable energy. In 2010, Germany's new government introduced significant changes to the FIT scheme for solar and announced its desire to undertake a major revision of its renewable energy policy in 2012. That year, further encouraged by the international economic and financial crises to attempt to restrain costs, the government modified the FIT law again. To make sure that PV installations followed a sustainable path, a "growth corridor" for solar power was established that linked the subsidy paid to PVs to the new PV capacity installed. If the yearly installed capacity exceeds 2.5–3.5 GW, the FIT decreases accordingly.⁸⁰ The FIT for solar installations above 10 MW was abandoned and the self-consumption premium (premium paid above the retail electricity price for all energy that is self-consumed and not fed into the grid) was cancelled. The new revision also announced the phase-out of the program by placing a cap on the overall FIT program of 52GW of installed solar capacity, which the government thinks will be achieved by 2020. At the end of 2013, Germany

⁸⁰ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU): Die wichtigsten Änderungen der EEG-Novelle zur Photovoltaik 2012 (PDF; 14 kB) Berlin Juni 2012, abgerufen am 29. September 2012

had almost 33 GW of installed solar PV capacity, which brings some to anticipate that the cap will be reached as early as 2016.

Other countries in Europe and around the world also had to modify, and eventually phase out, their program because of the very high costs of their renewables support mechanisms. A more detailed explanation of these regulatory interventions and redesigns can be found in Appendix C.

Spain offers the best example of a poorly designed, overgenerous subsidy program for solar PV that became so costly for the national economy that the government had to modify it several times and even take the very unpopular road of introducing retroactive cuts of the tariff, before ending the program in 2013. These changes had adverse consequences for investors in Spain, but, because of the size of the Spanish solar market, it also had the effect of contributing to the collapse of the much overheated international solar market.

In the mid-2000s, Spain was among the leading European countries in overall installed capacity of wind, solar PV, and concentrated solar power, as well as in share of renewable energy sources of total power demand, which it fueled through very generous premiums for renewable energy—PVs in particular—and a poorly designed system without caps or tariff degressions. Spain’s program, at a time of rapidly decreasing solar costs, created rapid demand for PVs which helped drive a boom cycle in the solar industry. However, by 2008 these subsidies could no longer be continued due to the impact of the global financial crisis and its impact on Spanish finances, which were further worsened by the increasing “tariff deficit” that subsidy payments were imposing on the Spanish budget.⁸¹ Accordingly, the government introduced changes to the PV FIT, which ultimately included several revisions that contributed to burst the solar market worldwide and destroyed large holdings of equity and debt investments. The FIT program ended in 2013, but the government policy changes were not able to avoid leaving the country holding €26 billion in debt that tax payers will have to honor, as well as ever-increasing electricity prices.

Almost all European nations also modified, reduced, and/or phased out their FITs programs for solar including the Czech Republic, Bulgaria, Belgium, France, Greece, Italy, and the United

⁸¹ In Spain, the cost of the FIT program is shared between rate payers and tax payers.

Kingdom. This trend was also followed outside of Europe. Canada (Ontario) and Australia (Victoria, Queensland, and New South Wales) also had to cut back their renewable energy rates.

In all cases, the introduction of such sweeping changes damaged investor confidence, increased the cost of capital to renewable companies and projects, and consequently further reduced investments in renewable energy.⁸²

All of those changes tried to moderate cost increases by limiting the growth of renewable demand. However, since the PV factories were already built, and with production orders booked, the changes led to reduced prices in PV modules and reduced margins for the producers, which provoked several manufacturers' bankruptcies. Between January 2012 and January 2013, companies producing PV modules with more than 50 employees decreased from 33 to 22.⁸³ The reduction in the level of subsidies around the globe drove some industry leaders, including the Chinese firm SunTech and American companies First Solar and SunPower, to move into the German market creating greater competition for German manufacturers who are more dependent on their domestic market and also suffer the most from the FIT revisions. Q-Cells, Soltecture, and Sovello all went bankrupt in 2012.

Ultimately, the EC recognized that European policies were leading to unintended consequences, including various market distortions across Europe. On April 9, 2014, the EC approved the new guidelines⁸⁴ for state aid on energy that included the removal of all FIT support mechanisms for renewables to apply from 2017 onwards, which, depending on the category, included some transitional measures. Effectively, all prior support mechanisms will be replaced by technology agnostic auctions (with the exception of emerging technologies and smaller scale plants) and prices will be directly linked to the wholesale market. Renewable companies will no longer receive any state support that allows them to exceed their respective market determined cost of capital. This will require renewable companies to focus on their costs and appropriate profit creating projects, whereby it is expected that these new incentive mechanisms will instill market

⁸² European Commission: "Delivering the internal electricity market and making the most of public intervention" November 5th 2013. http://ec.europa.eu/energy/gas_electricity/doc/com_2013_public_intervention_en.pdf

⁸³ Die Welt: Deutschlands Solarbranche löst sich auf 20 April 2013. <http://www.welt.de/wirtschaft/article115455341/Deutschlands-Solarbranche-loest-sich-auf.html>

⁸⁴ http://ec.europa.eu/competition/sectors/energy/legislation_en.html

competitiveness throughout the renewable sector that will essentially require them to perform as market competitive generators. It should be noted that these actions are not retroactive, however, the implications will unequivocally change the European renewable sector and hopefully assist in creating a level playing field for all energy producers.

4.7.2. Trying to make things right

Germany and other governments around the world have not only reduced the tariffs paid to renewable developers and modified program rules in an effort to achieve long term sustainable deployment of renewable energy, but they have also begun to introduce self-generation fees to ensure that the costs of maintaining and expanding the electric grid are paid for by all electric consumers, not only those without rooftop PVs.

Spain, Australia, and Germany are the first countries to have proposed changing their pricing structures and imposing a fixed fee, or back-up rate, on distributed solar installations to help pay for the electric grid.

The largest element in Germany’s average electricity bill is the “grid fee,” the fixed portion of costs associated with delivering power to consumers (transmission and distribution).

Figure 30. Retail power price and its components in Germany, euroct/kWh⁸⁵

Cost of power	12.20
Charges	16.91
Grid fee	7.00
Concession fee	1.80
EEG levv	5.30
Offshore liability levv	0.25
KWK levv	0.13
§19 power levv	0.33
Electricity tax	2.10
Total retail power price	29.11

⁸⁵ ET ENERGIE: Zur vermeintlichen „Grid Parity“ von Photovoltaik-Anlagen

In 2012, the FIT for PV in Germany was reduced and, for the first time, fell below the retail price of electricity, which created an incentive for owners of new PV systems to consume their PV generation directly instead of feeding it into the grid in exchange for the FIT payment. The EEG allows for the FIT to be applied on the net generation (total generation minus simultaneous consumption). Consumers generating and consuming their own electricity avoid paying for all fees and charges that are normally charged via power from the grid. On every kWh self-produced and consumed onsite, self-generators save €0.07 on grid fees and €0.053 on the EEG levy.

It is problematic that in the case of the grid fee, only the fee is spared but not the cost, as the owner of the PV plant still relies on the grid and grid costs arise mostly from the grid installation, irrespective of how little the grid is used. In that way, self-consumption reduces the owners' electricity bills, while increasing the electricity bills of grid users who do not have the chance for their own consumption. The savings on the EEG levy is also problematic. Why should the owner of a PV system contribute less to the Energiewende? It is not only PV owners that resort to this circumvention. This is also a common method within the German industry, using, for example, gas-fired generation for self-consumption.⁸⁶

In response to the growing trend towards self-production and consumption, and in an attempt to contain rising electricity prices, in early 2014, the German government proposed a new fee charging new owners of relatively larger PV installations (above 10 kW) for their own consumption of self-produced electricity. If approved, the new fee could enter into effect in the summer of 2014.⁸⁷ This fee would prevent companies trying to avoid the EEG levy from not contributing to the other charges. According to recent reports, 27 percent of German industry companies are building their own power plants, while another 21 percent are planning to.⁸⁸

⁸⁶ Handelsblatt Online: Der Trend zum eigenen Kraftwerk 06th. January 2014; Frankfurter Allgemeine Zeitung: Die Industrie macht ihren Strom selbst 15th October 2013; Markt und Mittelstand Nachrichten: Schutz vor EEG: Unternehmen produzieren Strom selbst 26th August 2013; Wirtschaftswoche EEG-Umlage: Gefährden Industrie-Ausnahmen die Energiewende? 12th July 2013. <http://www.handelsblatt.com/technologie/das-technologie-update/energie/industrie-der-trend-zum-eigenen-kraftwerk/9291960.html>;

<http://www.faz.net/aktuell/politik/energiepolitik/steigende-eeg-umlage-die-industrie-macht-ihren-strom-selbst-12618930.html>; <http://www.marktundmittelstand.de/nachrichten/finanzierung/schutz-vor-eeg-unternehmen-produzieren-strom-selbst/>; <http://green.wiwo.de/eeg-umlage-gefaehrden-industrie-ausnahmen-die-energiewende/>

⁸⁷ Bloomberg, Germany Tax on Own Use of Renewables Is First in Europe, 24th January 2014.

<http://www.bloomberg.com/news/2014-01-24/germany-tax-on-own-use-of-renewables-is-first-in-europe.html>

⁸⁸ Handelsblatt Online: „Der Trend zum eigenen Kraftwerk“ 06th January 2014

4.7.3. Financial impact on the renewable industry: Renewable Investment Funds

The financial impact of renewable policies on renewable investment funds is becoming increasingly negative as various European governments and regulators continue to decrease their generous subsidy programs in order to meet their fiscal requirements, or to correct the appropriate incentive mechanisms due to new innovations and/or economies of scale and scope. It is difficult to measure the total impact of these interventions across Europe due to the number of private transactions. However, while many renewable projects were bankrupted by these regulatory interventions, many other renewable players made good profits by selling early, or by not selling, and earning a respectable cash yield with a structure that had little or no debt.

A recent article in the Financial Times, titled “Private equity retreats from renewables fad,” highlighted a recent survey from Prequin that identified just 22 percent of all renewable funds earned an internal rate of return higher than 3 percent. Joseph Dear, chief investment officer of Calpers, the world’s sixth-largest pension fund, last year described clean-tech investment as a “noble way to lose money.” Calpers suffered annualized losses of 9.7 percent in the sector. “We are all familiar with the J-curve in private equity. Well, for Calpers, clean-tech investing has got an L-curve for ‘lose’” added Dear. “If it takes 12 years to get the money out, the internal rate of return is not going to be very good, even if the investment is reasonably successful.”⁸⁹

The outlook for European renewables for 2014 and going forward is negative. According to a December 2013 Fitch report:⁹⁰

“The outlook for the overall renewables sector is negative. This reflects increased political risk and the expectation that the industry will need to adapt to less favorable operating requirements and economic incentives. This is true across most jurisdictions and it results from the greater focus on the sustainability of incremental renewable capacity additions, in terms of the effect on the power industry in general and cost to consumers who ultimately foot the bill.”

Fitch rated the renewables sector as having the highest downgrade risk potential for its EMEA project finance ratings. Budgetary constraints, oversupply and distortion of power prices,

⁸⁹ Financial Times, “Private equity retreats from renewables ‘fad’” 16th February 2014.
<http://www.ft.com/cms/s/0/ef1b2248-94bb-11e3-9146-00144feab7de.html>

⁹⁰ Fitch Report: “2014 Outlook: Energy Infrastructure EMEA - Stable Except for Renewables”. December 11, 2013
www.fitchratings.com

transaction-specific operational performance, market economics (i.e. Germany proposing to cut all support for biogas), debt structures, and backlash of consumers paying higher prices were all factors contributing to regulatory intervention. Projecting past 2014, these factors are expected to continue over the next several years.

5. CONCLUSION: TAKEAWAYS OF THE GERMAN AND EUROPEAN EXPERIENCE WITH RENEWABLES

The United States and other countries have a unique opportunity to assess the lessons learned in Germany and other European-member states and achieve positive results at lower cost and risk for all stakeholders.

The large increase in market share of variable renewable generation (mainly from solar PV and wind) is changing the dynamics and operations of electricity markets, as exemplified in Germany:

- While in the past, German wholesale prices followed the demand curve, they now react to the weather, going down when the sun shines and the wind blows, and up, during times of high demand, when the sun does not shine and the wind does not blow. Accordingly, price forecasts and power trading now require new modeling and different inputs, including a much greater focus on weather forecasting.
- Power trading has become more short-term (intra-day, quarter hour, regulation, capacity) than in a conventional generation environment.
- Regulatory policies were not designed to incentivize flexible renewable power to be available where and when needed. Therefore, further regulatory interventions will be required to create a balanced system that will ultimately impact investments for both renewable companies and utilities over time as various energy markets transition to an increased portfolio of renewables.
- The power grid has to be upgraded to accept dynamic power input from many decentralized and distant variable sources.
- In the absence of energy storage, current electric systems cannot easily cope with the surplus of renewable energy, and curtailment will be required at times in order to maintain reliability.

- Intermittent renewables, like solar and wind, tend to cannibalize their own market by reducing prices when they are available. With current cost structures, if wind and solar are to produce a significant share of the power generation, they will likely require support through energy storage or additional subsidies to be profitable.

U.S. stakeholders should take into consideration the lessons learned from Germany and Europe.

Utilities should incorporate those lessons into their strategic planning, load forecasting, financial planning, trading, and regulatory affairs organizations. Decisions about current and future investments should then be made with this new analysis in mind.

Renewable companies should calculate appropriately the true costs of grid enhancements, capacity, and other important measures when submitting their plans to commissioners, investors, and other stakeholders.

Legislators and regulators should use the lessons learned from large scale integration of renewables in Germany and elsewhere in Europe to ensure a stable transition of renewables as part of the overall power portfolio while ensuring high reliability of power, stability of pricing to all users, as well as minimal value destruction to both utilities and renewable companies.

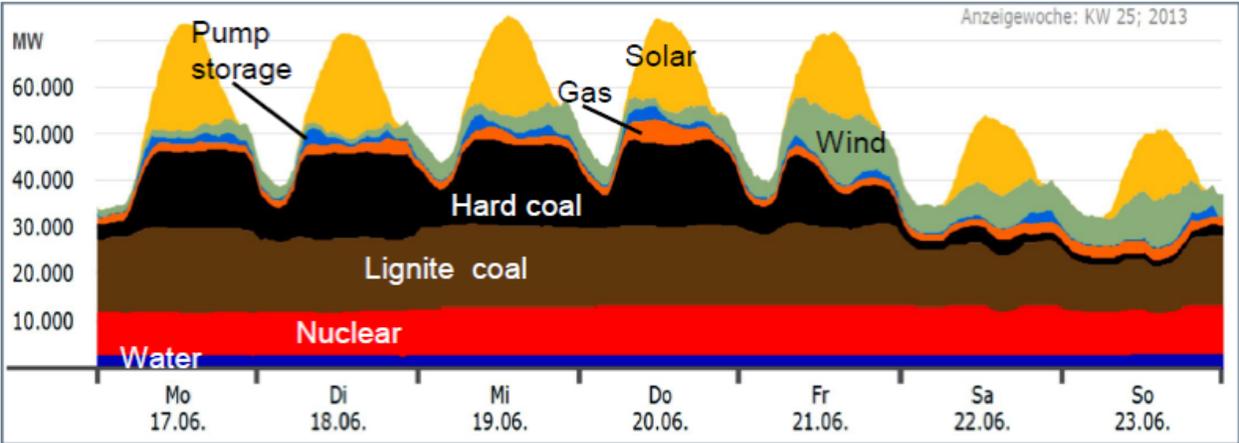
Finally, consumers must be made aware of the tradeoffs to a large portfolio of renewables and the necessary requirement for a smooth transition as part of the overall power portfolio.

In conclusion, the lessons learned in Europe prove that the large-scale integration of renewable power does not provide net savings to consumers, but rather a net increase in costs to consumers and other stakeholders. Moreover, when not properly assessed in advance, large-scale integration of renewables into the power system ultimately leads to disequilibrium in the power markets, as well as value destruction to both renewable companies and utilities, and their respective investors. The U.S. has the opportunity to incorporate these lessons learned to ensure the sustainable growth of renewable energy over the long-term, for the benefit of all customers.

**APPENDIX A:
 INFLUENCE OF HIGHLY FLEXIBLE GRID DEMANDS ON AGING AND
 LONG TERM RELIABILITY OF LARGE TURBINE GENERATOR: AN
 INSIGHT FROM SIEMENS⁹¹**

Depending on actual weather conditions, it is common practice that renewables, with their guaranteed generation dispatch preference, have a significant influence on the daily operation regime of conventional power plants. The fluctuating distribution of all kinds of power generation plants is shown in Fig. 44 for a one-week time span in June 2013 in Germany. Hard coal and gas-fired units are following load and balancing renewables during peak load conditions. Typical baseload lignite coal, and even nuclear units, have to follow load during minimum load periods because of priority dispatch of renewables.

Figure 31. SIEMENS: Weather-related fluctuation of renewable energy (solar and wind power) with significant influence on operation regime of conventional power plants

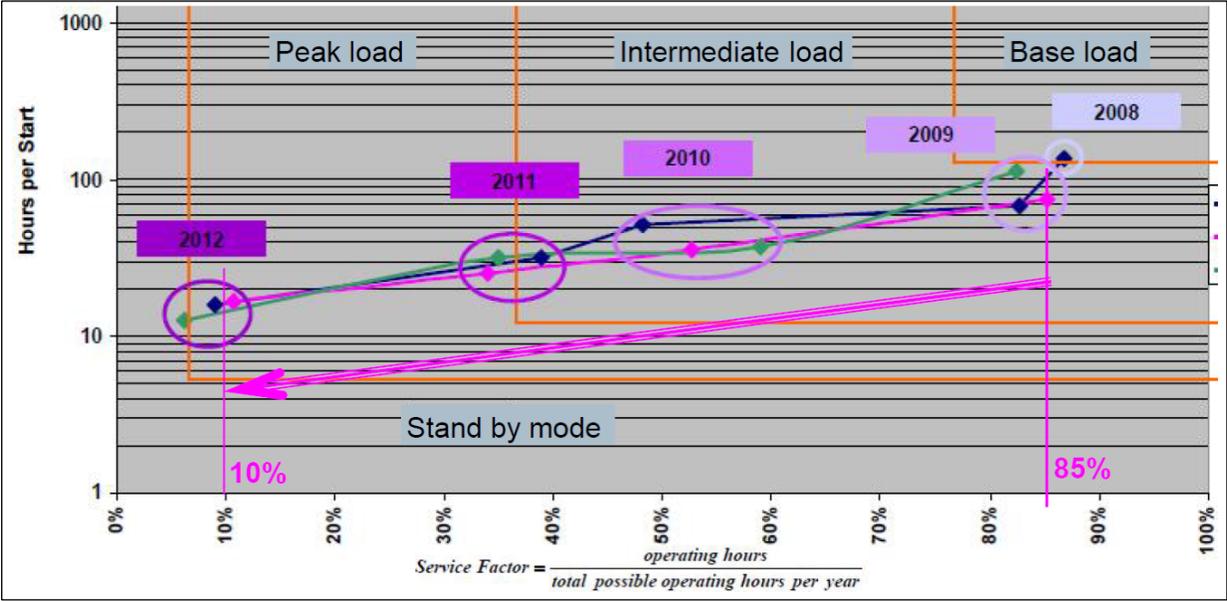


From 2008 to 2012, the increased penetration of renewables completely changed the load regime, as demonstrated in Fig. 45. As the figure shows, three 350 MVA generators in a gas-fired combined cycle power plant in Western Europe shifted from providing baseload power to peak load power. The on-load service factor decreased from 85 percent in 2008 to 10 percent in

⁹¹ Written by Jürgen Weidner, Energy Sector, Power Generation Division, Siemens AG

2012, and the on-line hours declined from 100h to 15h per start. The generators are now off-line most of the time, waiting to be needed for fast start-up during peak load conditions.

Figure 32. SIEMENS: Change of operating regime of a Combined Cycle Power Plant between 2008 and 2012



The demand for a highly flexible grid, combined with the planned new European Grid Code ENTSO-E with Requirements for Generation, will primarily stress older, less-efficient generators. The possible impact of ENTSO-E requirements on generators could be summarized as follows:

- Increased net frequency deviation (47.5 – 51.5 Hz) and higher voltage fluctuation (85 percent - 115 percent rated voltage)
 - o Risk of magnetic over-fluxing of stator core resulting in hot spots
 - o High rotor current resulting in over-heating of rotor winding a risk of turn shorts
- Frequent starts and stops of generator unit
 - o Warming up and cooling down of components
 - o Thermal cycling of windings and core resulting in increased wear and aging
- Fast load variation with high stator and rotor current gradients up to 24 percent of rated power
 - o Fast expansion and contraction of copper windings
 - o Thermo-mechanical stresses at material interfaces

- Longer short-circuit fault-ride-through times up to 250 ms connected to grid
 - o Significant higher torsional stress at turbo set shaft
 - o Risk of material cracks at rotor flange

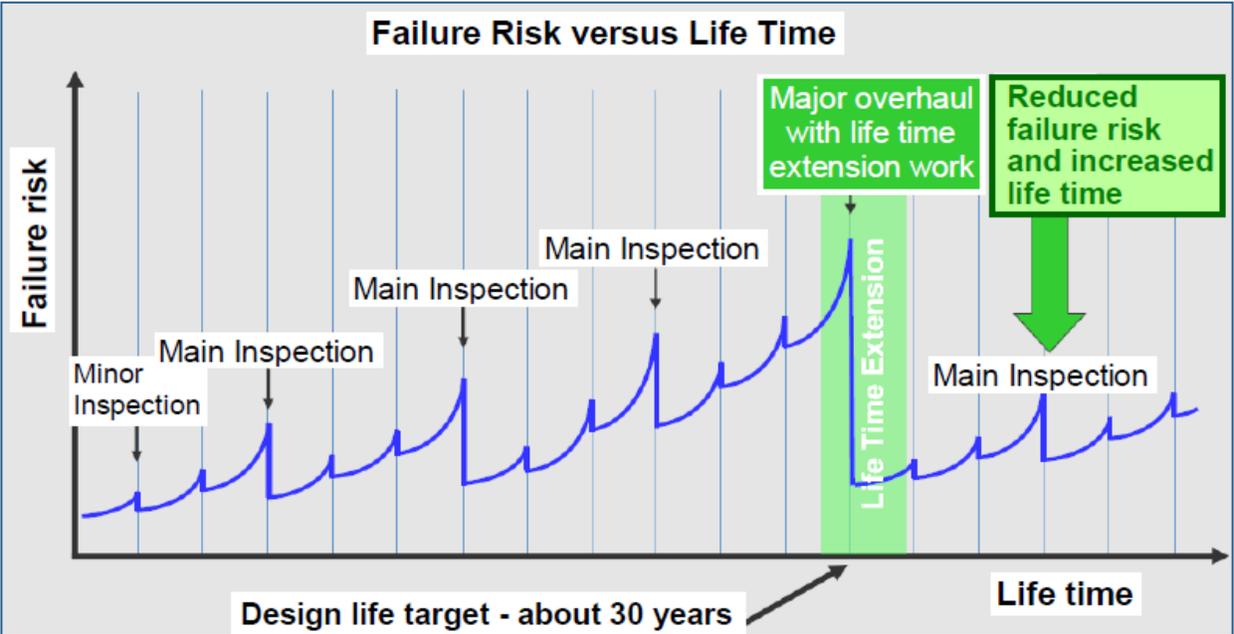
Depending on the type of generator, the new peak and medium load operation conditions with steep load ramps up to 50 MW/min for new gas-fired units will stress a number of generator components in different ways. Indirect cooled stator windings of large units will be exposed to high thermal-mechanical stress between hot copper conductor and cold iron core each time the unit has to follow fast and high load changes, while direct water cooled stator windings will mostly smoothen these stresses by direct cooling the heating-up copper conductors. When large, old coal-fired generators, which were designed for baseload operation, are running in peak load operation, the frequent thermal expansion and contraction of stator and rotor windings will result in accelerated wear and aging of the unit.

A condition-based maintenance, refurbishment, and replacement strategy is needed to reduce the sudden outage risk for these older generators. The first step should be an economic decision-making process that evaluates operation and maintenance costs against loss of availability risk and efficiency of the generator. The following influence factors should be analyzed and weighted:

- Actual and future operation regime of the unit (base - medium - peak load)
- Past and planned maintenance strategy (e.g. condition based maintenance)
- Off-line diagnosis (amount of inspections and tests during stand-still)
- Existing and planned on-line monitoring systems with use of a remote diagnostic center of OEM for risk mitigation during service period
- Knowledge of generator type dependent risk components
- Availability of strategic spare parts for fast repair
- Planned availability rate of the unit and importance within generation assets of the utility
- Available investments for short term component refurbishment and long term life time costs

Based on this amount of information, the utility, together with the OEM, could start a detailed residual life assessment study to prepare the decision for possible lifetime extension of the generator. The graph in Fig. 46 points out the increasing risk of failure versus lifetime at severely stressed generators, even if the planned minor and major inspections were performed regularly.

Figure 33. SIEMENS: Sudden outage risks of severely stressed generators and lifetime extension



To reduce a sudden outage risk when the generator gets closer to the expected life target, a major overhaul with refurbishment or component replacement could be carried out according to the results of the residual life assessment study. Refurbishment or component replacement with the new design that is fitted for higher load stresses will give the generator an increased lifetime with better performance to flexible grid demands.

Lifetime Extension management of aged and highly stressed generators can be summarized by the following five steps:

1. Prepare residual life time and technical risk assessment study -> utility together with OEM
2. Plan optimized maintenance activities based on financial risks (forced outage and amount of damage) -> Predictive maintenance

3. Make long-term refurbishment (identified components) or replacement decision based on financial asset management
4. Install online monitoring tools and a supervising remote diagnostic system for early warning of incipient damage to assist in sudden outage risk mitigation
5. Plan risk-based predictive maintenance strategy depending on operational stress factor at peak / medium / base load operation

The International Council on Large Electric Systems, the Electric Power Research Institute, and the Institute of Electrical and Electronics Engineers are all examining the increased demands on thermal generators to respond to challenges created by the increased penetration of renewables.

APPENDIX B: A PERSPECTIVE FROM THE INSURANCE INDUSTRY ON CHANGES TO THE POWER INDUSTRY: INSIGHT FROM MARSH⁹²

Industry Changes

In recent years, the greater focus on renewable generation methods has necessitated changes to operating practices. The need to balance grid supply with fuel costs and demand has required an increase in unit cycling instead of base-load generation. The outcome of such changes, with older machinery being run in a manner contrary to original design parameters, is hard to predict. While the industry fully supports renewable sources and they clearly have a part to play in future generation, issues associated with more intermittent production have to be carefully accounted for.

At the same time, wider industry changes are afoot. The increasing prevalence of shale gas, the global uncertainty with fuel infrastructure in areas of turmoil and the collapse of carbon credit pricing are sources of uncertainty for an industry that requires fixed assets and long-term stability to be profitable.

Subsidy and regulation are intended to provide some stability and certainty. However, while initiatives such as the Program of Incentives for Alternative Electricity Sources (PROFINA) in Brazil have provided a clear target of diversifying production towards renewables, the International Monetary Fund is pressuring regulators in Pakistan to cut certain subsidies. Future subsidies and regulation in the European Union are meanwhile subject to legal uncertainties concerning goals, coverage and regional enforceability. When investments in plant and machinery may run for over 20 years, investors are naturally cautious to commit to the cost of expensive equipment. With transmission and distribution equipment being, in many cases, decades old and with the demand for electricity on a continuing upward trend, the need for such investment is imperative.

⁹² Written by Caroline Woolley, Global Business Interruption Centre of Excellence, Marsh Ltd.

Insurance Trends

What is the result of all these changes?

For material damage (MD) and business interruption (BI) losses, there are urgent questions for risk managers to consider. When considering changes to how plant machinery is being run:

- A) What is the impact on the useful life of the machinery?
- B) How should maintenance schedules be altered?
- C) Will the need to manage and monitor the risks of creep fatigue, commonly associated with base-load generation, be marginalized by increasing risks of thermal-mechanical fatigue, which is more associated with shut-downs and unit cycling?
- D) Will increased unit downtime due to unit cycling increase the prevalence of stress-corrosion cracking?
- E) While new turbine designs reflect the need for fast start-up capacity, what long-term testing (more than 7,500 operating hours) has been carried out on those models?

Significant increases in equipment prices – for MD claims – and the complexity of repairing equipment with lower tolerances for error – affecting the duration of BI claims – now mean that opening a turbine case merely to investigate the possibility of damage now costs millions of US dollars. Both owners and their insurers will face new engineering challenges, both in the running of machinery and the investigation of what has actually happened to cause a loss event – and crucially, whether that loss is a covered event.

Critical Questions around BI:

- A) Increased planning and unplanned maintenance play havoc with loss periods – will theoretical repair period predictions bear any resemblance to the actual position?
- B) If damage is discovered during one of these more frequent planned outages, when does the BI claim period actually commence? When did the damage occur, and in what policy period?

- C) With such stresses on machinery, is a loss of some kind inevitable – how will that affect premium ratings and can such an event be described as sudden and foreseen?
- D) With increased frequency of outages and losses, what impact does this have on your loss distribution curve? Should you reconsider deductible levels? How will insurers compel such changes and how will they deal with such changes in general?
- E) Fluctuations in supply and demand question the security of supply itself, but also supplies. With shale gas flooding the market, is there a mismatch in requirements between the fuel and the equipment in use?
- F) What impact do the answers to these questions have on market pricing? Pricing sensitivity can affect theoretical pricing and insured values, potentially affecting the value of your claim.
- G) Taking into account capacity pricing and subsidies that vary according to individual location, how is revenue affected by a BI event? What revenue loss can be demonstrated?
- H) Actual interruption affects both insured and uninsured costs. Whilst MD and BI can be covered, market/public reputation and company branding are not. What impact will a loss have on both your suppliers and customers, and how will that impact affect industry perception and regulation?

Conclusion

While it is a time of great change for the power industry, current challenges are more formidable than ever. Risk management, risk transfer and claims will all see some impact. The intricacies of the issues and the innovation needed for satisfactory solutions require a more holistic approach. Our experts within Marsh can help you to diagnose the problems, define the issues and design solutions to help you through this difficult period of change.

The information contained herein is based on sources we believe reliable and should be understood to be general risk management and insurance information only. The information is not intended to be taken as advice with respect to any individual situation and cannot be relied upon as such.

In the United Kingdom, Marsh Ltd is authorized and regulated by the Financial Conduct Authority.

Copyright © 2014 Marsh Ltd All rights reserved

APPENDIX C: REGULATORY INTERVENTIONS ON VARIOUS SUBSIDIES SCHEMES ACROSS SEVERAL EUROPEAN COUNTRIES

Several countries, for example Spain and the Czech Republic, have implemented retroactive changes for renewable power producers.

The regulatory interventions in Spain can be divided into four different phases and are summarized in the table below.

PHASE 1:

In 2008, Spain was among the leading European countries in overall installed capacity of wind, solar, and concentrating solar power (CSP), as well as in share of renewable energy sources of total power demand. These subsidies could no longer be continued due to the impact of the global financial crises on the Spanish government, which was further worsened by the increasing annual debt of the Spanish electricity system that was being further subsidized by the government. Accordingly, decisions were made to introduce new regulations, which ultimately included eight directives that destroyed large holdings of equity and debt investments.

PHASE 2:

First, changes were related to the contract allocation mechanisms of renewable energy, which changed to a new auction-based system with high entry barriers in 2008 for PV, and further in 2009 for all other renewable technologies. At the same time, PV tariffs fell significantly in 2008-2010. Furthermore, caps were introduced in February 2010 for all existing CSP, wind, and PV projects, thereby limiting the maximum subsidy per power plant. For PV-power plants that had been planned to go online between 2011 and 2013, an even more restrictive cap was introduced.

PHASE 3:

At the beginning of 2013, a 7 percent retroactive tax on electricity sales was introduced affecting all conventional and renewable producers. The same law also eliminated the “premium option,” which enabled producers to sell electricity directly to the market and lowered the FIT

retroactively. The elimination of this premium was made retroactively from January 1, 2013, until the date the law went into effect.

In addition, at the same time the inflation index and computation methodology for renewables were changed, decreeing no inflation increase for 2013 and a 50 percent reduction afterwards. With the introduction of this law, the Royal Decree-Law 2/2013, the Spanish government expects to save a total of €600 million to €800 million per year.

PHASE 4:

The consequences caused by the introduction of these regulatory changes are extensive and touched a wide range of investors and producers in the renewable energy business. A renewable fund estimates that the impact to portfolio investments it holds in PV equates to a 40 percent-45 percent decrease in gross revenues. For its wind assets built before 2005, the fund estimates a 55 percent decrease in gross revenues.⁹³

Moreover, it can be imagined that these interventions caused a destabilization of the equilibrium of this business. This will be reflected in increased uncertainty about existing and future renewable energy projects, a high probability of legal claims against the government's actions, increased unpredictability about future investments, and higher policy and regulatory risks.

Another country that introduced changes on FIT regulations is Czech Republic in 2010. It lowered the guaranteed FIT for PV retroactively. PV investors, especially with big plants, are now required to pay a tax of 26 percent to 28 percent. Several groups of investors protested against this regulation and obtained a special legal acquittal proving that the solar tax violated the Czech constitution. Moreover, the government planned to raise charges on sites with solar plants. The Czech government undertook these measures with the aim to stop a further increase of electricity prices. In 2013, the government proposed a retroactive 10 percent tax on all solar arrays installed in the Czech Republic since 2010, which would have affected, in total, more than 1.4 GW of PV (approximately 2/3 of the total installed amount in the Czech Republic), and is estimated to have cost more than €200.000 per company. The aforementioned tax, however, results to be only an intermediate solution for the current year 2014, without a final solution yet to be implemented.

⁹³ Described renewable energy fund has requested anonymity

Other European nations known for implementing regulatory interventions include:

Bulgaria: Introduced retroactive grid access payments in September 2012 and new retroactive revenue tax up to 39 percent for solar PV operators. For other technologies, the applied fee is lower and accounts 10 percent for wind and 5 percent for hydropower. In March 2013, this fee was however revoked by the Bulgarian Supreme Administrative Court.

Belgium: New grid fee for photovoltaic projects up to 10 kW.

France: Planning 20 percent FIT reduction to all installations that are more than 100 kW.

Greece: Introduction in December 2012 of a revenue tax on all solar installations since July 1st 2012, which can reach up to 30 percent. The reasons behind these measures include too generous FITs, combined with Greek austerity measures. Further retroactive measures were announced in 2013.

Italy: In September 2011, began the contribution of €0.05/kWh of energy self-produced and incentivized under the Conto Energia IV, and introduction of an additional 6.5 percent corporate tax on all energy producers, including renewables.

In all of these cases, industry and the European Photovoltaic Industry Association, started lawsuits against the respective governments with the intention of negating such measures. The European Energy Commission presently supports the investor side with respect to receiving the agreed subsidies at the start of the installation. European laws should be “stable, long-term, transparent, predictable, and credible commitments to investors and consumers.” Retroactive amendments to correct failures in the prediction of future developments should be avoided. The introduction of these type of taxes will damage investor confidence, increase the cost of capital to renewable companies and projects (possibly other regulated entities), and consequently reduce investments in renewable energy. Moreover, these types of measures go against one of the general principles of legislation in most EU countries, the irretroactivity of laws.

BIBLIOGRAPHY

Newspapers and other media

Frankfurter Allgemeine Zeitung (FAZ)

24.02.2014: „Regierungsberater wollen EEG abschaffen“

<http://www.faz.net/aktuell/wirtschaft/wirtschaftspolitik/oekostrom-regierungsberater-wollen-eeg-abschaffen-12820227.html>

19.02.2013: „Energiewende könnte bis zu einer Billion Euro kosten“

<http://www.faz.net/aktuell/politik/energiepolitik/umweltminister-altmaier-energiewende-koennte-bis-zu-einer-billion-euro-kosten-12086525.html>

15.10.2013 Steigende EEG-Umlage Die Industrie macht ihren Strom selbst

<http://www.faz.net/aktuell/politik/energiepolitik/steigende-eeg-umlage-die-industrie-macht-ihren-strom-selbst-12618930.html>

05.02.2014 Bayern zieht Stromnetzausbau in Zweifel

<http://www.faz.net/aktuell/wirtschaft/fruehaufsteher/exklusiv-in-der-f-a-z-bayern-zieht-stromnetzausbau-in-zweifel-12590891.html>

19.02.2014 Ökostrom EEG-Umlage: Welche Firmen müssen künftig zahlen?

<http://www.faz.net/aktuell/wirtschaft/wirtschaftspolitik/oekostrom-eeg-umlage-welche-firmen-muessen-kuenftig-zahlen-12808022.html>

Handelsblatt

07.11.2013: Altmaier reist mit radikalem Ökostrom-Plan zur EU

<http://www.handelsblatt.com/politik/international/foerderung-metallindustrie-eine-million-jobs-bedroht/9039578-2.html>

06.01.2014 „Der Trend zum eigenen Kraftwerk“ <http://www.handelsblatt.com/technologie/das-technologie-update/energie/industrie-der-trend-zum-eigenen-kraftwerk/9291960.html>

<http://www.handelsblatt.com/technologie/das-technologie-update/energie/industrie-der-trend-zum-eigenen-kraftwerk/9291960.html>

24.02.2014 Industrie bangt um Stromrabatte <http://www.handelsblatt.com/technologie/das-technologie-update/energie/grossverbraucher-industrie-bangt-um-stromrabatte/9528744.html>

<http://www.handelsblatt.com/technologie/das-technologie-update/energie/grossverbraucher-industrie-bangt-um-stromrabatte/9528744.html>

Wirtschaftswoche

12.07.2013 EEG-Umlage: Gefährden Industrie-Ausnahmen die-Energiewende?

<http://green.wiwo.de/eeg-umlage-gefaehrden-industrie-ausnahmen-die-energiewende/>

05.02.2014 Reservekraftwerke werden Milliarden verschlingen

<http://www.wiwo.de/politik/deutschland/energiewende-reservekraftwerke-werden-milliarden-verschlingen/9412340.html>

Der Spiegel

18.12.2013 Ökostrom-Rabatte: EU leitet Verfahren gegen Deutschland ein – Der Spiegel Online

<http://www.spiegel.de/wirtschaft/soziales/eu-kommission-greift-deutsche-industrie-an-a-939795.html>

Die Welt:

07.11.2013 Ende der EEG-Privilegien gefährdet eine Million Jobs

<http://www.welt.de/wirtschaft/energie/article121621919/Ende-der-EEG-Privilegien-gefaehrdet-eine-Million-Jobs.html>

14.12.2013 Höhere Ökostrom-Umlage kostet 86.000 Jobs
<http://www.welt.de/wirtschaft/article122930122/Hoehere-Oekostrom-Umlage-kostet-86-000-Jobs.html>

Tagesschau

19.01.2014 Gabriel im Bericht aus Berlin "Strompreise werden nicht sinken"
<http://www.tagesschau.de/inland/bab-gabriel100.html>

Wall Street Journal

01.08.2013 U.S. Oil Reserves Continue to Bulge
<http://online.wsj.com/news/articles/SB10001424127887323681904578641871449942246>

Financial Times

29.01.2014 Energy price gap with the US to hurt Europe for 'at least 20 years'
<http://www.ft.com/cms/s/0/80950dfe-8901-11e3-9f48-00144feab7de.html#axzz2thyHzZc8>

16.02.2014: Private equity retreats from renewables 'fad' <http://www.ft.com/cms/s/0/ef1b2248-94bb-11e3-9146-00144feab7de.html>

Reuters

26.08.2013 EU's Oettinger warns against Germany cutting renewable subsidies
<http://uk.reuters.com/article/2013/08/26/uk-renewables-eu-idUKBRE97P0FS20130826>

Renewables International

01.08.2013 Spanish solar FITs revisited <http://www.renewablesinternational.net/spanish-solar-fits-revisited/150/510/71701/>

22.08.2013 Prague to implement retroactive solar tax (again)
<http://www.renewablesinternational.net/prague-to-implement-retroactive-solar-tax-again/150/452/72232/>

PV Magazine

16.12.2010 Czech President approves controversial solar tax http://www.pv-magazine.com/news/details/beitrag/czech-president-approves-controversial-solar-tax_100001824/#axzz2pp6Ajpms

19.09.2012 Bulgaria: Up to 39% retroactive grid fee for PV operators http://www.pv-magazine.com/news/details/beitrag/bulgaria--up-to-39-retroactive-grid-fee-for-pv-operators-_100008536/#ixzz2uRTtu9GB

19.12.2012 EU solar industry calls for action against retroactive subsidy changes http://www.pv-magazine.com/news/details/beitrag/eu-solar-industry-calls-for-action-against-retroactive-subsidy-changes_100009663/#axzz2pp6Ajpms

14.02.2013: Greece prepares for more retroactive PV cuts http://www.pv-magazine.com/news/details/beitrag/greece-prepares-for-more-retroactive-pv-cuts_100010212/#axzz2tI1WNo7u

26.03.2013 Bulgaria: Photovoltaic grid access fee revoked; appeals underway http://www.pv-magazine.com/news/details/beitrag/bulgaria--photovoltaic-grid-access-fee-revoked-appeals-underway_100010684/

PV Tech

26.11.2012 France retroactively cuts FiT by 20% http://www.pv-tech.org/news/france_retroactively_cuts_fit_by_20

Cleantechnica

17.02.2013 Why German Solar Is So Much Cheaper Than U.S. Solar — Updated Study
<http://cleantechnica.com/2013/02/17/why-german-solar-is-so-much-cheaper-than-u-s-solar-updated-study/>

ET Energiewirtschaftliche Tagesfragen

07/2013 Zur vermeintlichen „Grid Parity“ von Photovoltaik-Anlagen <http://et-energie-online.de/AktuellesHeft/Topthema/tabid/70/Year/2013/Month/7/NewsModule/423/NewsId/633/Zur-vermeintlichen-Grid-Parity-von-PhotovoltaikAnlagen.aspx#fn:7>

Markt und Mittelstand Nachrichten

26.08.2013 Schutz vor EEG: Unternehmen produzieren Strom selbst
<http://www.marktundmittelstand.de/nachrichten/finanzierung/schutz-vor-eeg-unternehmen-produzieren-strom-selbst/>

Umweltdienstleister

16.01.2014 Netzentwicklungsplan bestätigt
<http://umweltdienstleister.de/2014/01/16/netzentwicklungsplan-bestaetigt/>

Solarify

06.04.2013 Netzausbauplan übertrieben: Akzeptanz der Energiewende bedroht
<http://www.solarify.eu/2013/04/06/netzausbauplan-ubertrieben-akzeptanz-der-energiewende-bedroht/>

TAM-News 14.03.2013 and 29.04.2013

Instituts zur Zukunft der Arbeit (IZA)

16.12.2013 Moderater Beschäftigungsrückgang durch steigende Strompreise
<http://newsroom.iza.org/de/2013/12/16/moderater-beschaeftigungsrueckgang-durch-steigende-strompreise>

The Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia

17.01.2014 Fachministerinnen und Fachminister aus sieben Bundesländern fordern Gemeinschaftswerk in der Energie- und Klimapolitik
http://www.umwelt.nrw.de/ministerium/presse/presse_aktuell/presse140117.php

Renewable Energy World

26.08.2013 Norway Approves \$3 Billion for Wind Power Plants to Triple Capacity
<http://www.renewableenergyworld.com/rea/news/article/2013/08/norway-approves-3-billion-for-wind-power-plants-to-triple-capacity>

Research papers and studies

IZES (Instituts für ZunkunftsEnergieSysteme)

2012 “Das Erneuerbare-Energien-Gesetz –Erfahrungen und Ausblick“ Institut der deutschen Wirtschaft Köln, - “<http://blog.insm.de/4770-quotenmodell-versus-einspeisevergutung-aus-der-praxis-lernen/>)
http://www.greenpeace.de/themen/energie/nachrichten/artikel/warum_das_eeg_besser_ist_als_ein_quotenmodell/)

Forum Ökologisch-soziale Marktwirtschaft

Strom- und Energiekosten der Industrie
http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/energie/2012-FOES-IZES-Verguenstigungen-Industrie.pdf

EEG- Jobmotor oder Jobkiller? www.energie-fakten.de/pdf/eeg-job-motor.pdf

Ecofys Group

28.08.2013 Renewable energy deployment possible even with delays in transmission grid expansion – Impacts of restricted transmission grid expansion

Congressional Research Service

Europe's Energy Security: Options and Challenges to Natural Gas Supply Diversification
<http://www.fas.org/sgp/crs/row/R42405.pdf>

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

14.03.2012 Gross employment from renewable energy in Germany in 2011
http://m.germany.info/contentblob/3146650/Daten/1312974/BMU_GrosEmploymentRE2010_DD.pdf

Public Institutions

German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

development of renewable energy sources in Germany:
<http://www.erneuerbare-energien.de/die-themen/datenservice/zeitreihen-entwicklung-ab-1990>

Hintergrundinformationen zur besonderen Ausgleichsregelung 2012/2013: www.erneuerbare-energien.de/.../ee.../hintergrundpapier_besar_bf.pdf

German Federal Network Agency

How will the power price calculated?

http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Verbraucher/PreiseUndRechnungen/WieSetztSichDerStrompreisZusammen.pdf;jsessionid=0B318530B0B7F0F3325CB5CA631C83F7?__blob=publicationFile&v=2

List of power plants in Germany:

http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/kraftwerksliste-node.html

Monitoring report 2013

http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2013/131217_Monitoringbericht2013.pdf?__blob=publicationFile&v=9

Grid development 2013

http://www.netzausbau.de/SharedDocs/Downloads/DE/II/NEP/ZFStromnetzausbau2013.pdf?__blob=publicationFile

Grid development plan

<http://www.netzentwicklungsplan.de/content/wie-funktioniert-die-erstellung-des-netzentwicklungsplans>

Press release: 2013 Grid Development Plan, second draft_17.07.2013:

http://www.netzentwicklungsplan.de/sites/default/files/pressematerial/Presse%20release_GDP_2013_scond%20draft.pdf

<http://www.netzentwicklungsplan.de/content/fragen-zur-finanzierung>

Agency for renewable Energy

www.unendlich-viel-energie.de

<http://www.unendlich-viel-energie.de/themen/wirtschaft/arbeitsplaetze>

German Association of Energy and Water Industries (BDEW)

Power Price analysis May 2013

[https://www.bdew.de/internet.nsf/id/05B6EBC2BF77350DC1257AD700582730/\\$file/130527_BDEW_Strompreisanalyse_Mai%202013_presse.pdf](https://www.bdew.de/internet.nsf/id/05B6EBC2BF77350DC1257AD700582730/$file/130527_BDEW_Strompreisanalyse_Mai%202013_presse.pdf)

via KWH-Preis <http://www.kwh-preis.de/strompreis-dossier-teil-3-vergleich-strompreise-industrie-und-privathaushalt>

Netztransparenz EEG-KWK Informationsplattform der deutschen Übertragungsnetzbetreiber

Prognosekonzepte und Berechnungen der Übertragungsnetzbetreiber 2008-2014 <http://www.eeg-kwk.net/de/EEG-Umlage.htm>

FRAUNHOFER INSTITUTES FOR SOLAR ENERGY SYSTEMS ISE

08.02.2013 Electricity production from solar and wind in Germany in 2012;

<http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/news/electricity-production-from-solar-and-wind-in-germany-in-2012.pdf>

09.01.2014 Electricity production from solar and wind in Germany in 2013;

<http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/news/electricity-production-from-solar-and-wind-in-germany-in-2013.pdf>

Office of Gas and Electricity Markets (OFGEM)

<https://www.ofgem.gov.uk/publications-and-updates/understanding-energy-prices>

<https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/electricity-and-gas-supply-market-indicators>

European Commission (incl. Eurostat)

Electricity and natural gas price statistics (updated November 2013):

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Electricity_and_natural_gas_price_statistics

“Delivering the internal electricity market and making the most of public intervention” November 5th 2013 http://ec.europa.eu/energy/gas_electricity/doc/com_2013_public_intervention_en.pdf

The future role of gas. Presentation to the European Commission Directorate-General for Energy, Madrid Forum, April 18-19, 2013. http://ec.europa.eu/energy/gas_electricity/gas/doc-23/02.01_mf23_presentation_by_ec_-_future_role_of_gas_-_kitti_nyitrai.pdf

Share of renewables in electricity production (2012):

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Share_of_renewables_in_electricity_production,_2012_%28in_%25%29.png&filetimestamp=20130429062902

Legal sources on renewable energy: <http://www.res-legal.eu/search-by-country/norway/tools-list/c/norway/s/res-e/t/promotion/sum/378/lpid/379/>

European Renewable Energy Council

<http://www.erec.org/statistics/co2.html>

REN21: Renewable Energy and Policy Network for the 21st Century

About REN 21: <http://www.ren21.net/AboutREN21.aspx>

Renewables 2013 Global Status Report

http://www.ren21.net/Portals/0/documents/Resources/GSR/2013/GSR2013_lowres.pdf

EU Fuel Poverty Network

<http://fuelpoverty.eu/about/>

Fuel Poverty: a Framework for Future Action, Department of Energy and Climate Change, July 2013

Statuette - Norway's national main grid owner and operator

grid development plan 2013 -

http://www.statnett.no/Global/Dokumenter/Prosjekter/Nettutviklingsplan%202013/Statnett-Nettutviklingsplan2013-engelsk_03korr.pdf

Norwegian Ministry of Petroleum and Energy

Facts 2013: Energy and water resources in Norway

http://www.regjeringen.no/upload/OED/Faktaheftet/FACTS_energy_water.pdf

Transmission and Distribution grid <http://www.regjeringen.no/en/dep/oed/Subject/energy-in-norway/The-transmission-and-distribution-grid.html?id=444385>

Norwegian Renewable Energy <http://www.intpow.no/?categoryid=47>

Statistics Norway – Statistisk sentralbyrå www.ssb.no

Nord pool Spot <http://www.nordpoolspot.com/Market-data1/Elspot/Area-Prices/ALL1/Hourly/>

The Swedish-Norwegian Electricity Certificate Market Annual Report 2012 -

[http://www.nve.no/Global/Elsertifikater/Elcertifikat2013_Eng_TA%20\(2\).pdf](http://www.nve.no/Global/Elsertifikater/Elcertifikat2013_Eng_TA%20(2).pdf)

Other

European Energy Exchange www.eex.de

E.ON <http://www.eon-schafft-transparenz.de/>

Fitch Ratings: “ 2014 Outlook: Energy Infrastructure EMEA - Stable Except for Renewables”.

December 11, 2013 www.fitchratings.com

Tennet. www.tennet.eu

Speech of Gregg Kantor Chairman of American Gas Association, NARUC Winter Committee Meetings, February 11, 2014

Wikipedia

<http://de.wikipedia.org/wiki/Erneuerbare-Energien-Gesetz#Photovoltaik>

01.11.2013: Speech of Thomas Barth, CEO and Chairman of the Managing Board, E.ON Energie AG: “The German Energiewende”:Shining or Warning Example for Europe? 5th Conference ELECPOR http://www.elecpor.pt/pdf/Thomas%20Barth_ELECPOR_Nov2013.pdf

References to Finadvice and the Authors

Finadvice is specialized on M&A advice regarding energy and utilities

Focus on M&A advice	Focus on utilities/energy
<ul style="list-style-type: none"> • Finadvice has over 15 years experience in M&A transactions <ul style="list-style-type: none"> - Thorough understanding of technical, legal, economic, strategic and political influences and value drivers - Contacts and business relations to a large number of strategic and financial investors - Project management of M&A processes - Due Diligence for buy and sell side - Valuation models - Contract negotiations 	<ul style="list-style-type: none"> • Majority of our projects concern companies in the energy and utility industry <ul style="list-style-type: none"> - Comprehensive understanding of technical and economic details - Expertise of regulated and free markets - Knowledge of market participants and their requirements - Special knowledge in <ul style="list-style-type: none"> • Power plant operational improvement • Typical contract structures for the industry • Price escalation formulas and forecasts • Risk management in the utilities industry

M&A advice Finadvice Utilities/Energy

2 *Finadvice*

By valuing over 100 projects Finadvice gained extensive expertise in the field of renewable energies over the last 10 years

Experience in renewable energy

Experience	Number of projects in renewable energy																									
<ul style="list-style-type: none"> • Knowledge of European markets and regulation • Knowledge of key market drivers and value drivers for the different technologies • Efficiency in the examination of projects due to short preparation periods and project experience • Excellent expertise in project management through the realization of a multitude of transactions • Finadvice currently applies the gained experience for the development of two wind farms in Poland and develops additional wind farm projects for Fair Energy / Energie AG Obersterreich (>700MW under development) 																										
Contacts <ul style="list-style-type: none"> • Projects with nearly all large European utilities • Multitude of collaboration partners due to long time industry experience • Contacts and previous work for financial investors • Relations with a variety of project developers and consultants in the field of renewable energies 	<table border="1"> <caption>Number of projects in renewable energy</caption> <thead> <tr> <th>Renewable Energy Type</th> <th>plants and projects valued</th> <th>transactions concluded</th> <th>Own projects under development</th> </tr> </thead> <tbody> <tr> <td>Wind farms</td> <td>78</td> <td>22</td> <td>8</td> </tr> <tr> <td>Biogas plants (gas, heat or power production)</td> <td>31</td> <td>14</td> <td>0</td> </tr> <tr> <td>Hydro power plants</td> <td>27</td> <td>4</td> <td>0</td> </tr> <tr> <td>Solar power plants</td> <td>18</td> <td>1</td> <td>0</td> </tr> <tr> <td>Biomass and waste power and CHP plants</td> <td>9</td> <td>2</td> <td>0</td> </tr> </tbody> </table>		Renewable Energy Type	plants and projects valued	transactions concluded	Own projects under development	Wind farms	78	22	8	Biogas plants (gas, heat or power production)	31	14	0	Hydro power plants	27	4	0	Solar power plants	18	1	0	Biomass and waste power and CHP plants	9	2	0
Renewable Energy Type	plants and projects valued	transactions concluded	Own projects under development																							
Wind farms	78	22	8																							
Biogas plants (gas, heat or power production)	31	14	0																							
Hydro power plants	27	4	0																							
Solar power plants	18	1	0																							
Biomass and waste power and CHP plants	9	2	0																							

Finadvice

Authors:

Hans Poser, Managing Director, FAA Financial Advisory AG

Hans Poser is one of the founders of Finadvice. He has extensive experience in Germany, France, and Switzerland. Hans' specialist sector experience is utilities in continental Europe. Before Finadvice, Hans was Vice President of the European Utilities Team of UBS Investment Bank Zurich and provided M&A and strategic advice. Prior to that, he was a project leader in the Energy and Utilities Practice Group of BCG Frankfurt. Hans holds a Master of Engineering from the Technical University of Berlin and a DESCAF (similar to MBA) from Toulouse Business School.

Jeffrey Altman, Senior Advisor, Finadvice GmbH

Jeffrey Altman has more than 20 years of infrastructure and energy experience. Most recently, Jeffrey was Director of Investment Management at First State Investments' European Diversified Infrastructure Fund and was a member of the holding company board of Electricity North West, the electric distribution company for the City of Manchester, UK. He served 10 years in both the United States and Europe with Southern Company/Mirant Corporation. During this time, he spent five years successfully privatizing and restructuring Berlin's electric and gas utilities. While in the United States, Jeffrey initiated, negotiated, structured, and closed value-creating transactions for Southern Company, as well as developed several strategic plans, including a recommendation not to enter into the California retail energy market. Jeffrey has a Masters of Business Administration (Executive MBA Program) from the University of Southern California and a Bachelor of Science in the School of Foreign Service from Georgetown University. He is the editor of the book *Best Practice in Infrastructure Asset Management*, and has authored several articles.

Felix ab Egg, Managing Director, FAA Financial Advisory AG

Since 2005, Felix ab Egg has advised on more than 90 M&A projects (27 successful transactions) with respect to every step of the utility value chain, on behalf of Swiss and German utilities. His current primary focus is renewable energy transactions, where he has advised on more than 40 projects (11 successful transactions). Additionally, Felix advises on risk management, financings, and strategic analyses, and is also involved with Finadvice's in-house wind park development in Poland. He also worked as an author for the publisher Neue Zürcher Zeitung. Felix studied at the Universities of Lausanne and Basel and graduated with a lic. rer. pol. (MBA equivalent).

Andreas Granata, Intern, FAA Financial Advisory AG

Andreas Granata is an intern at the Finadvice Office in Zurich. He is trying to consolidate his competences and gain additional experience in the renewable energy sector, as well as corporate finance area. He is currently enrolled in the Master of Science in Management program at the Università Commerciale Luigi Bocconi in Milan, as well as the CEMS Master in Management, issued by a global alliance of 29 leading international universities.

Ross Board, Renewable Energy Investment Executive, Downing LLP

Ross Board, a Renewable Energy Investment Executive at Downing LLP, is responsible for deploying private-equity capital into utility-scale UK energy projects. Prior to joining Downing, Ross served within one of the UK's largest solar developers, working on numerous sell-side M&A transactions. Ross is currently enrolled in Warwick Business School's Global Energy MBA, focusing on financing of energy assets and international energy policy.

Finadvice

FAA Financial Advisory AG (Finadvice) is an M&A advisor specialised on the utility industry (electricity, gas and water) and renewable industry in Continental Europe with offices in Germany, Switzerland, Austria, Czech Republic, Poland and Romania as well as having partners in most other European countries.

Since 1998, Finadvice has advised utility companies, energy trading companies and renewable companies as well as those institutional and infrastructure/PE investors investing in these sectors. Finadvice provides a range of advisory services with respect to investment decisions, including valuations, due diligence, regulation and economics calculation. Finadvice is 100% management-owned and has been supporting many of its clients since the foundation of the company. Most of the partners have over 20 years of professional experience and the total group has around 300 years of experience with merger & acquisition projects and related services. Collectively, Finadvice has worked on more than 250 projects worth over Euro 52B since its foundation, which includes over 150 renewable energy assets.

For further information, please see www.finadvice.ch

Finadvice
FAA Financial Advisory AG
Soodstrasse 55
CH-8134 Adliswil
Switzerland

Office: +41 43 377 1000
Fax: +41 43 377 1005
Website: www.finadvice.ch