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Article

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Politics vs markets: how German power prices hit the floor

Martin Everts, Claus Huber and Eike Blume-Werry*

ABSTRACT

This article aims to quantify the effects of energy policy on power prices. A fundamental model is used to replicate wholesale market prices and to analyse the impact of a change in single price drivers such as coal prices or subsidies for new renewables. It is shown that approximately 50 per cent of the wholesale power price decrease in Germany of the last few years is due to market effects such as the decrease of coal and gas prices as well as the decrease in electricity demand. Only approximately 30 per cent of the price decrease can be directly associated with the subsidies for new renewable energies such as wind and solar. The first part of this article reviews the three policy objectives which guide energy strategy in Europe. In the second part two theoretic models of energy policy governance, namely the direct and multiple steering approach are introduced. Moreover, the article quantifies the impacts of the policy instruments on wholesale power prices and challenges the current energy policies. The third part briefly discusses the effect of the energy policy impact of Fukushima, before the results of the fundamental model and the market effects are analysed in the fourth chapter. The last chapter quantifies all different drivers of power prices and concludes that market effects such as coal and gas prices are at least as important as all policy effects, such as subsidizing renewables or abandoning nuclear power, combined.

1. THREE POLICY OBJECTIVES

A reliable and constant supply of electricity is commonly seen as essential for the functioning of the modern state. Selecting an appropriate electricity mix and using a variety of instruments to shape the energy policy is thus of great importance for governments. Commonly, one speaks in this context of three different policy objectives: (i) security of supply, (ii) competitiveness, (iii) sustainability. An ideal energy policy, therefore, delivers sustainable electricity at affordable prices with a high level of security of supply.

These policy objectives are, however, competing with one another and to a certain degree they appear to be mutually exclusive. Usually, a government can promote two of the three objectives at the most, at the expense of the other objective(s). This phenomenon is sometimes called 'energy trilemma'.[1]

Security of supply

One factor for governments to consider with regard to their energy policy is the availability of resources. Traditionally, countries developed an electricity mix based primarily on the availability of local resources and secondarily on the availability of resources on the international markets. The usage of locally available energy resources to generate electricity has three crucial advantages: it supports the local industries, makes the most

* Eike Blume-Werry, Energy Economics, Axpo Holding AG and International Energy, Sciences Po Paris. Email: eike.blumewerry@gmail.com.

1 World Energy Council, 'World Energy Trilemma: 2013 Energy Sustainability Index' (2013) World Energy Council, London, 5.

of a country's assets and from the security of supply perspective, most importantly, it provides a great level of independence from outside forces.

Due to the fundamental role of electricity in our modern society, it is vital for the state to ensure a stable supply of energy resources for electricity generation purposes. This is also a reason why some countries subsidize the economically non-viable production of local energy resources; Germany's support schemes for the coal industry being an example. Pedraza states:

> Coal is Germany's only major domestic fuel source and the government considers maintaining hard coal production capacity critical to the country's energy security as much as possible.[2]

However, security of supply has another dimension, which one could describe as reliability. Even though renewable electricity sources such as wind or solar do not require any fuel as such, their production heavily depends on the weather and is intermittent. Next to the above-described political aspect of the security of supply policy objective, governments have to take characteristics of different technologies into account when designing and amending their energy policy.

In order to ensure a reliable supply of electricity, it is the task of energy policy to give the market adequate incentives to provide sufficient and flexible generation capacity. This is an imperative to guarantee a high level of security of supply because fluctuating output of renewable energy sources, sudden power plant outages or unexpected high demand can otherwise cause power shortages.

Competitiveness

Regardless of whether a country imports fuels for electricity generation, subsidizes local production, provides financial incentives for the deployment of renewables, or all of the above, the competitiveness or affordability of the system takes a key position. Effectively, most countries tend to seek a middle way between what is affordable and compatible with other factors such as security of supply and sustainability. Prices of fuels can be volatile and consequently most governments aim to have a somewhat diverse electricity mix in order to reduce vulnerability to price spikes. For obvious economic and social reasons, it is important that the energy policy of any government delivers reasonable and affordable power prices for citizens and businesses. Businesses need affordable power prices to be competitive and high prices for private consumers might even lead to the so-called 'fuel poverty'.[3] Affordability is also an important aspect in regards to voting behaviour and party support among the electorate.

Economic growth is commonly accompanied with growing electricity demand and it is a significant policy objective for governments to ensure affordable prices. Many policy instruments such as carbon emission pricing or support schemes influence the competitiveness of certain technologies directly or indirectly. In this context, competiveness and affordability have also been used interchangeably as reasonable (or affordable) power prices are necessary for many businesses to stay competitive. Competitiveness has thus also been referred to as 'affordability' or simply 'costs' in the energy trilemma.

Sustainability

The sustainability of the electricity sector has become an ever more important factor in recent decades. Through their energy policies, governments strive to decarbonize the electricity sector and minimize negative externalities. Negative externalities encompass local effects, such as pollution caused by NOx emissions, as well as global effects caused by greenhouse gas emissions.

Renewable electricity sources have grown significantly and many governments subscribed to implement a certain share of renewables in their electricity sector, as agreements such as the EU 20-20-20 targets demonstrate. Next to the objectives of reducing greenhouse gas emissions and implementing more renewables, the

2 J Pedraza, *Electrical Energy Generation in Europe* (Springer International Publishing 2014) 398.

3 Fuel poverty describes a condition in which people cannot afford to keep their homes adequately heated.

aspect of sustainability also includes energy efficiency measures. Energy policy measures aiming to promote and boost energy efficiency have few if any downsides, and are thus an important energy policy instrument.

2. THEORETIC MODELS OF ENERGY POLICY GOVERNANCE

There are different means of balancing the three objectives of (i) security of supply, (ii) competitiveness and (iii) sustainability. In the following, two major theoretical approaches of (a) direct steering and (b) multiple steering are presented and discussed.[4]

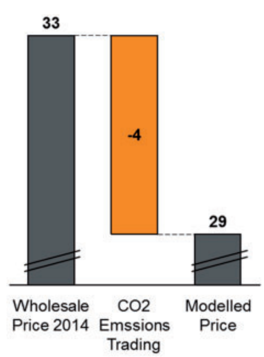
Direct steering

One approach to reach given climate targets is the so-called 'direct steering' model. The fundamental idea is to price and internalize greenhouse gas emission costs. Practically, this can be implemented by the introduction of a CO_2 tax and an emission trading system such as the European Union Emissions Trading Scheme (EU ETS).

The subsequent economic implication is a rise of wholesale power prices as a result of the CO_2 price component, presuming that the CO_2 price is sufficiently high. These high prices indirectly contribute to a higher attractiveness of low CO_2 emission technologies such as renewable electricity sources. However, high power prices also have negative effects on the competitiveness of the economy especially for energy-intensive industries operating in an international environment.

Using Germany as an example, we have calculated the effect of the CO_2 tax and emission trading system on the electricity wholesale market prices with the fundamental model Green-X.[5] In the first step, we have chosen all input data (power plant park, grid availability, subsidies, coal and gas prices, etc.) according to 2014 values and calibrated the fundamental model to match the actual electricity wholesale market prices. In the second step, we switched the CO_2 tax and emission trading system in the fundamental model off and analysed the delta between the two calculations.

It can be shown that a CO_2 tax of 6 EUR/t has a price increasing effect on German wholesale power prices of approximately 4 EUR/MWh. In other words, power prices in 2014 would have been 4 EUR/MWh lower if there had not been a price for CO_2 emissions.



4 See also Huber, C., Morthorst, P.E., 'Interactions between promotion schemes for electricity generation from renewable energy sources and CO2 reduction and their single markets: How to achieve an efficient CO2 strategy in the electricity sector', Proceedings from Internationale Energiewirtschaftstagung (2003), Vienna University of Technology, Vienna.

5 Green-X is a fundamental power model covering the EU-28 and selected other EU neighbours. It allows the investigation of the future deployments in the power and renewable sector including accompanying costs and benefits. It enables the derivation of a detailed quantitative assessment of the renewable electricity sources deployment in a real-world policy context on a national and European level for the power, heat and transport sector. It has been successfully applied for the European Commission within several tenders and research projects to assess the feasibility of '20% renewable electricity sources by 2020' and for assessments of its developments beyond that time horizon. In addition, Green-X can be used for a detailed quantitative assessment of the hourly market prices of the European power markets: C Huber and others, 'Green-X: Deriving Optimal Promotion Strategies for Increasing the Share of RES-E in Dynamic European Electricity Market' (2004) Final Report, Fifth Framework Programme of the European Commission, DG Research, Brussels.

The resulting effect on the merit order and therefore on the electricity mix is that coal fired power plants are forced out of the market as they cease to be economically viable due to the CO_2 pricing system. It is assumed that gas-fired power plants remain in the system, ensuring security of supply and setting the price as units with the highest marginal costs.

In terms of the three policy objectives, one can note that the aspect of sustainability is covered as well as preserving an appropriate level of security of supply. The resulting high power prices jeopardize the competitiveness of energy intensive businesses (unless a CO_2 tax and emission trading system is applied globally) and will also lead to higher prices for private consumers, which is why this direct steering approach fails to meet the policy objective of competitiveness.

Multiple steering

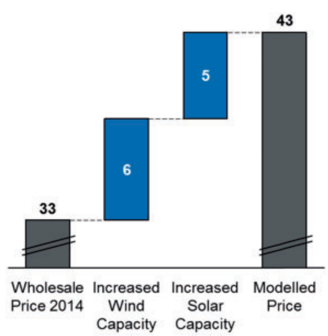
Another approach is the 'multiple steering' model. In addition to the measures introduced by the direct steering model, this approach also includes active support schemes for renewable electricity sources.

The economic effect of the additional support schemes for renewables is that electricity wholesale prices do not rise as much as they do in the direct steering model. Due to their low marginal costs, wind and solar electricity enter the merit order near the bottom of the supply curve and cause the supply curve to shift to the right, resulting in lower average power prices as higher marginal cost technologies (in this case coal-fired power plants) are no longer necessary to satisfy demand and thus forced out. This effect of renewable technologies triggering lower electricity wholesale prices has often been labelled 'merit-order effect'.[6]

A multiple steering approach can produce price neutrality as the negative consequences on competitiveness caused by the introduction of a CO_2 tax and an emission trading system are balanced with the positive effects of support schemes for renewables. Put differently, a multiple steering policy can offset the power price increase of the CO_2 tax with the power price decrease of low marginal costs renewables. Maintaining price neutrality is essential in order to avoid market distortion and is thus a crucial aspect for policymakers to consider, also to ensure compliance with EU state aid and competition legislation.

The fundamental model Green-X allows us to model and calculate the effect of the current support schemes for renewables on the electricity wholesale market prices. First, the model is used to compute power prices with input data from 2014 (such as the power plant park). In a second modelling run, we have adjusted the power plant park for wind and solar power plants to the level of 2008—before the major German Renewable Energy Act (EEG) reform in 2009. It is thereby assumed that approximately 14 GW of wind capacity and approximately 31 GW of solar capacity were built as a result of the support schemes.

The fundamental modelling shows that power prices in Germany decreased by approximately 11 EUR/MWh as a result of the expansion of renewables. In other words, one can say that German power prices would be approximately 11 EUR/MWh higher, without the renewable capacity increase of approximately 45 GW.



6 F Sensfuß, M Ragwitz and M Genoese, 'The Merit-Order Effect: A Detailed Analysis of the Price Effect of Renewable Electricity Generation on Spot Market Prices in Germany' (2008) 36 Energy Policy 3087.

In theory, the emission levy and the subsidies for renewables should force coal-fired power plants out of the market as CO_2 prices and fewer operating hours cause their production to be economically non-viable. Gas-fired power plants on the other hand should remain in the system. Their marginal costs are less affected by CO_2 prices and they are more suited to provide the flexible generation necessary for balancing intermittent renewable power generation.

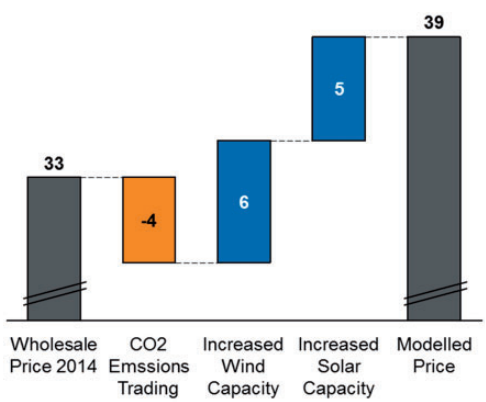
It follows that theoretically all three policy objectives can be achieved by the multiple steering model. The parallel introduction of a carbon pricing and trading system as well as support schemes for renewable electricity sources and energy efficiency measures delivers (iii) sustainable electricity without (ii) climbing prices and threatening (i) security of supply.

It comes as no surprise that policymakers favoured the multiple steering model and introduced the European Emission Trading Scheme (EU ETS) and support mechanisms such as feed-in tariffs for renewable electricity sources. However, two events, namely the Fukushima nuclear accident and the economic crisis, drastically changed the political and economic environment.

Price neutrality

In theory, the price effect of a multiple steering energy policy should be zero—or as little as possible. An increase in power prices would lead to a loss of competitiveness of the energy intensive industry. A decrease of power prices on the other hand would lead to distortions and wrong incentives for investments. If the price decreasing effect is too large, new investments in flexibility become unprofitable, threatening the security of supply.

The figures of the analysis suggest that the price neutrality is not given. The current energy policy has a price decreasing effect of approximately 6 EUR/MWh. One can conclude from this data that either the support schemes for renewables have led to an excessive deployment of renewables with a subsequent too large price decreasing effect or that the levies on emissions and the accompanying price increasing effects of the CO_2 tax are too low. As a matter of consequence, the intended price balancing effect of the multiple steering model did not occur.



The current distortions of the electricity industry confirm the theoretical analysis. Currently, power prices are too low to foster new investments in flexibility. However, intermittent renewables such as wind and solar need to be backed up by flexible generation units in order to ensure the targeted level of security of supply.

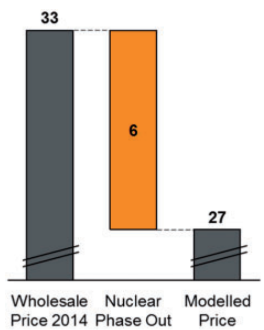
3. ENERGY POLICY AFTER FUKUSHIMA

Following the nuclear accident in Fukushima in March 2011, Germany chose to shut down eight of its nuclear power plants immediately and retire all of the remaining by 2022. Similarly, other governments, such as the Swiss decided to phase out its nuclear power plants.

Abandoning baseload nuclear power has considerable effects on the energy market. Coal-fired power plants which in the initial multiple steering model are forced out of the market, are now necessary to make up for shut down nuclear power plants. This impedes the climate targets as CO_2 emission-low nuclear power production is replaced by highly polluting coal. With coal-fired power plants back among the producing units, the political objective of sustainability falls short.

We have modelled the effect of the shutting down of the eight German nuclear power plants with the fundamental model Green-X by re-introducing them in the theoretic fundamental model and analysing the price differences between the power prices with and without the power plants.

Our analysis shows that the discontinuation of the German nuclear power plants led to a price increase of 6 EUR/MWh. Put differently, power prices in Germany would be approximately 6 EUR/MWh lower if the eight nuclear power plants with a capacity of roughly 9 GW were still running.



Hence, the nuclear phase out has a negative effect not only on CO_2 emissions but also on competitiveness and as a policy objective on its own it would be incompatible with the goals of (ii) competitiveness and (iii) sustainability.

In fact, in terms of the three policy objectives of (i) security of supply, (ii) competitiveness and (iii) sustainability, it would be very difficult to integrating the nuclear phase out into the multiple steering model. One could argue that the objective of competitiveness could be achieved by combining CO_2 levies and a nuclear phase out with support schemes for renewables. However, as mentioned the sustainability target cannot be achieved in this context due to the reintroduction of coal-fired power plants.

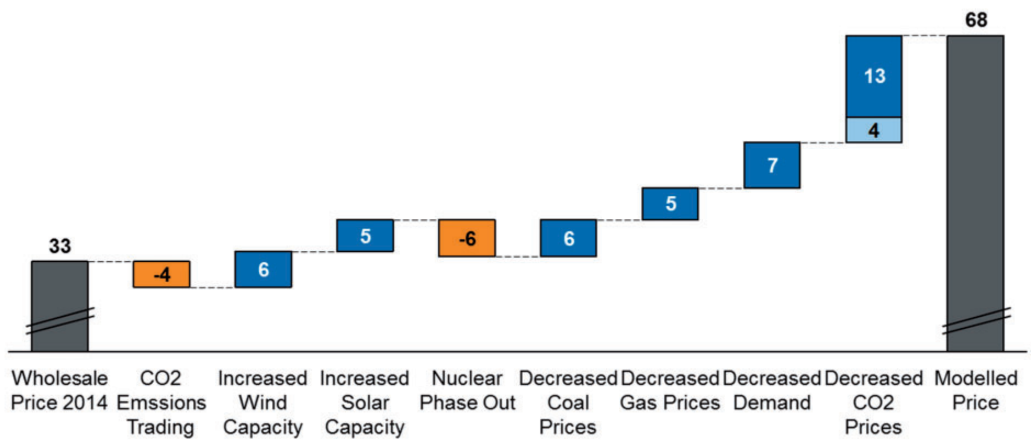
4. COMPARING POLICY AND MARKET EFFECTS

The following chapter puts the effects that followed the 2008–2009 financial crisis in relation to the mentioned energy policy instruments of CO_2 emissions trading system, support schemes renewables and the nuclear phase out. 2008 is thus picked as a reference year, not just because it reflects the pre financial crisis situation but also because it precedes the German Renewable Energy Act reform (EEG 2009), which initiated a new growth in renewable capacity (especially solar). Additionally, it is important to note that the EU ETS went into the second phase in 2008 after the first phase ended with prices close to zero in 2007. This second phase initially delivered significant CO_2 prices, reaching 30€/t in summer 2008.[7] The subsequent financial crisis and the serious economic downturn that came with it had unprecedented effects on the power market.

7 E Feess and A Seelinger, *Umweltökonomie und Umweltpolitik* (Verlag Franz Vahlen 2013) 136.

In order to analyse the market effects, the fundamental model Green-X is run several times with different input parameters. We calibrate the fundamental model and use 2014 coal and gas prices, power plant parks, network transmission capacities, fuel prices, etc. in order to calculate 2014 power prices. We then change each input variable of the fundamental model in order to evaluate its influence on power prices. To assess the effect of the economic downturn on power prices, we have chosen to set all important input variables (one by one) back to their 2008 values. This means that we are running the fundamental model Green-X first with 2014 prices (eg 2014 coal prices) in order to calculate 2014 power prices and secondly with 2008 coal prices to analyse effect of the coal price change on power prices.

The analysis is based upon the following assumption: Coal prices were approximately 7 EUR/MWh and gas prices approximately 10 EUR/MWh higher in 2008 than they were in 2014. Electricity demand was approximately 42 TW higher and CO_2 prices approximately 19 EUR/t higher in 2008 than they were in 2014. Moreover, it is assumed that the support scheme for renewables fostered 14 GW wind capacity and 31 GW solar capacity and that the nuclear phase out decreased the nuclear capacity by approximately 9 GW.



After having modelled the most relevant drivers with their 2008 values, the modelled power prices were close to the actual 2008 power prices (even though the model was calibrated for 2014). Our modelling approach shows that a coal price decrease of approximately 7 EUR/MWh leads to a power price decrease of approximately 6 EUR/MWh and a gas price decrease of approximately 10 EUR/MWh results in a power price decrease of approximately 5 EUR/MWh. The decreased demand of approximately 42 TWh does have an astonishingly large impact on power prices of 7 EUR/MWh. Hence, one can argue that approximately 50 per cent of the decrease in wholesale power prices since 2008 can be attributed to the economic downturn and its wider consequences, including the price decline of coal and gas.

Regarding CO_2 prices, we have shown that if there were no price for CO_2, power prices would be 4 EUR/MWh lower. In order to evaluate how the decrease of CO_2 prices from 2008 to 2014 affected power prices, we have to reintroduce CO_2 prices (and hence add 4 EUR/MWh) and in a second step increased the CO_2 prices by 19 EUR/t back to their 2008 value, resulting overall in an increase of power prices by 13 EUR/MWh or nearly 40 per cent.

The economic rationale behind the current low wholesale market prices is as follows: With low coal prices, hard coal and lignite power plants became economically more viable than gas-fired plants. Gas-fired power plants are thus forced out of the market and hard coal power plants became the price setting units in the merit order. The weakened electricity demand and the economic competitiveness of coal-fired power plants led to a fall of electricity wholesale prices that had positive effects on the objective of (ii) competitiveness.

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The policy objectives of (iii) sustainability and sound (i) security of supply, however, are missed. Regarding the aspect of sustainability, one can note that the coal and lignite-fired power plants jeopardize climate targets. In respect to security of supply, it is important to mention that flexible gas-fired plants which are considered necessary to balance intermittent generation from renewable sources thereby guaranteeing security of supply are forced out of the market since their continuation is no longer economically feasible.

5. CONCLUSIONS

The energy policy of multiple steering—which introduced a carbon tax, an emission trading system and support schemes for renewables—failed to deliver the expected results. The energy policy aimed to force highly polluting coal-fired power plants out of the market, thereby contributing towards climate targets. However, the additional policy objective of a nuclear phase out as well as low coal and CO_2 prices eventually caused gas-fired units to become unprofitable while coal remains the largest source of electricity in Germany. Altogether, it has been shown that the policy failure is primarily a result of the economic crisis that changed the economic framework.

The idea was to keep wholesale power prices on a reasonable level through the expansion of renewables, yet the weak demand and the somewhat unexpected strong growth of renewables caused—together with low coal and gas prices due to the economic crisis—prices to plummet which threatens investments in new capacities and the profitability of flexible hydro power plants. This impact, in combination with the shutdown of gas-fired generation capacities, puts also the long-term security of supply at risk.

As a response, Germany (as well as other European countries) has recently introduced capacity remuneration mechanisms[8] to provide market participants with more incentives for building or maintaining generation capacities in order to guarantee security of supply. Looking at these developments, one can note that capacity remuneration mechanisms are an unintended product of a failed energy policy.

This is, however, not to say that the multiple steering energy policy was poorly designed. The economic crisis and to a lesser extent the added policy objective of a nuclear phase out drastically changed the framework in which the energy policy operates. The result was a multiple steering energy policy in an economic environment that no longer fitted its design.

8 While capacity remuneration mechanisms can take different forms, they generally provide monetary payments towards generators for available generation capacity.