WISO DISKURS

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Uwe Nestle

REFORM OF THE RENEWABLE ENERGY DIRECTIVE

A Brake On The European Energy Transition?

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FOREWORD

At the end of 2016 the European Commission presented its proposals for reforming the Renewable Energy Directive, as part of the Clean Energy Package. The Package forms the third and last component of the Commission's concept for the European Energy Union, following proposals for improving security of supply and energy efficiency. As such, the Commission is fulfilling the European Council's request to develop a blueprint for a common European energy policy. But the Commission's proposal may end up hindering rather than promoting the European energy transition.

In terms of substance, the Commission's proposed reform of the Renewable Energy Directive breaks no significant new ground, and is largely oriented on the Guidelines on State Aid for Environmental Protection and Energy 2014–2020. The stated goal is to establish a uniform EU-wide system for financing the expansion of renewable energy, in the hope of improving cost-efficiency. The new system proposes replacing the feed-in remuneration until recently used by Germany and still used by other EU member states with technology-neutral cross-border competitive bidding.

In this study, Uwe Nestle concludes that the reform proposals pose a serious threat to the European energy transition. He is critical of the idea of introducing a system where technology-neutral competitive bidding would be the only permissible funding instrument. Technology-neutrality could, namely, create a situation where the volatility of solar and wind power makes it extremely expensive to guarantee security of supply – which is not the case with a proper mix of renewable energy sources. Another point of criticism is compulsory cross-border cooperation, which contradicts the successful approach of decentralised power generation applied in the energy transition, for example in Germany, and will potentially increase the cost of necessary network infrastructures. Above all, Uwe Nestle demonstrates beyond doubt that the justifications advanced for these incisive changes are anything but solid.

Instead the author recommends that the German government should argue in the upcoming negotiations for all EU member states to retain the freedom to choose their own instruments for promoting the expansion of renewable electricity. The argument that the cost of expanding renewable energy is prohibitive is misleading. The cost of generating renewable electricity has already fallen to – or even below – the range of new fossil-fuel power stations. What is required in the first place is to expand network infrastructure, improve energy efficiency and accelerate the growth of renewables. Additionally the deployment of renewable energy in transport and heating should be stepped up.

If the European energy transition is obstructed at this point in its development, it will not just become more difficult to achieve climate targets. Slowing the expansion of renewable electricity would also have serious repercussions for employment. For as well as ensuring a successful expansion of renewable energy capacities, the existing Renewable Energy Directive has created new jobs and indeed new sectors. It has paved the way for new business models and promoted the development of innovative, climate-friendly products and technologies. As such the Renewable Energy Directive contributes to the competitiveness of German and European businesses. That is also another of the objectives of the European Energy Union: to safeguard future employment and prosperity.

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SUMMARY

Through its Guidelines on State Aid for Environmental Protection and Energy 2014–2020, the European Commission is already forcing twenty-one EU member states to switch the funding of renewable electricity generation from feed-in arrangements to competitive bidding systems, at the latest when they next make major adjustments to their arrangements. The Commission now intends to cement this policy with its proposal for a new Renewable Energy Directive, which is currently being considered by the European Council and the European Parliament. The proposed changes in the new Directive would also make technology-neutral cross-border competitive bidding compulsory.

By creating these obstacles the Commission is endangering the European energy and climate targets, because implementing a one-size-fits-all competitive bidding system will threaten the ability of all member states to successfully expand renewable electricity generation. It is unfortunately likely that only a handful of member states will achieve rates of expansion comparable to those planned for Germany. As well as missing energy and climate targets, this also risks the loss of employment, local value creation and innovation.

Examination of the justifications advanced for these incisive changes reveals that they do not stand up to closer scrutiny:

– International experience demonstrates that competitive bidding systems are not per se better suited for achieving energy policy objectives than other instruments such as feed-in systems. What is decisive is how the instruments are configured.
– Renewable electricity installations that receive a premium in a feed-in system and market their electricity themselves are already extensively integrated into the electricity market. In many member states premium feed-in systems have already replaced fixed-price feed-in systems.
– Electricity from new photovoltaic installations and onshore wind turbines is already no more expensive than electricity from new conventional power stations. Restricting their expansion cannot be justified on grounds of cost. The same also applies to the restriction of renewables expansion because of network congestion: accelerated network expansion and targeted sector coupling would be the better options in overall economic terms.
– For technical reasons – and in light of the range of available sources – delivering a high proportion of renewable electricity will require a mix of different technologies. Technology-neutral financing prevents this or makes it unnecessarily expensive.
– When seeking very high shares of renewable energy – which are needed in order to fulfil the Paris Agreement – it is unrealistic to concentrate wind turbines and photovoltaic installations in the few very ideal locations in the EU. Instead of forcing cross-border competitive bidding, possibilities for member states to cooperate voluntarily should be improved.

It is thus not rationally justifiable to ban member states from using feed-in systems and compel them instead to use a competitive bidding system, including aspects of technology-neutral cross-border financing. In fact the challenges of global warming give every reason to continue to grant the individual states the freedom to use the instrument(s) best suited to their purposes. This would put national governments and parliaments in a considerably better position to implement a successful policy of rapidly expanding renewable electricity that meets the national needs and circumstances.

The German government should therefore – together with as many allies as possible – argue for freedom of choice of instruments to be restored to the situation that existed before the Guidelines on State Aid for Environmental Protection and Energy 2014–2020 were issued. That would improve the ability of all member states to press ahead with a rapid expansion of renewable electricity and as such accelerate the process across Europe as a whole. So it makes sense for the German government to press for restoration of free choice of instruments – even if it wishes to retain the competitive bidding system for Germany. It should reject a fundamental compulsion for technology-neutrality and cross-border competitive bidding, or at least ensure that it this permanently restricted to a very small share.

In the broader context the German government should initiate an open political debate over the concrete role of the market in the process of converting the EU's energy supply. This should include the questions of how and where continuing market orientation and further implementation of the internal market can actually contribute to achieving the triple goals of energy policy – cost-effectivness, environmental protection and security of supply. The debates over the Clean Energy Package could offer a good opportunity for this.

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INTRODUCTION

The Renewable Energy Directive of 2001 may well be the European Union's most successful policy initiative for climate protection. The increase in the share of renewable energy in the EU from 8.7 percent in 2005 to about 17 percent in 2015 saves greenhouse gas emissions of about 360 million tonnes annually (COM 2016a: 2; EEA 2016: 10). The European economy has also benefitted, with the creation of about 1.2 million modern jobs in renewable energy sectors across the EU (COM 2015a: 2; IRENA 2015: 9). Renewable energy contributes to security of supply, industrial development and growth, and innovation. They support the creation and preservation of competitiveness, the reduction of the EU's energy trade deficit, and the objective of lowering energy costs (COM 2015a: 2, 2014a: 6).

On the basis of these successes, almost three-quarters of the approximately six hundred actors that contributed to the Commission's official consultation process for the Renewable Energy Directive argued that the existing arrangements – including free choice of instruments – are best (COM 2016b: 2). In particular the feed-in systems in Denmark, Germany and Spain have attracted great international interest,[1] and their basic principles have been adopted by numerous other states (BMU 2007: 31; Fell 2015). Even in 2012 most EU member states were still using feed-in systems (eclareon 2012). Yet for years these have come in for heavy criticism from certain quarters – in the meantime with success. The European Commission's Guidelines on State Aid for Environmental Protection and Energy, introduced in 2014, stipulate that only competitive bidding systems are to be used (COM 2014e: note 126).

Now the Commission wishes to formalise the requirement for all EU member states to use a competitive bidding system in the Renewable Energy Directive, which is currently being revised in the scope of the Clean Energy for All Europeans package. Additionally, all competitive bidding should normally be technology-neutral and cross-border (COM 2016a: Art. 4). This compulsion to use a single standard instrument ignores the sometimes very different political, economic and ecological circumstances across the member states. Europe is very heterogeneous, so the competitive bidding system will not necessarily be the best instrument for all member states. If it becomes impossible to use the best instrument for the individual circumstances there is a danger of the expansion of renewable electricity slowing, less reduction of CO_2 emissions, loss of domestic employment, less innovation put into practice, and overall costs rising.

In view of the great success of the Renewable Energy Directive and the strong support of most actors, any fundamental changes need to be very well justified. This report therefore discusses the arguments that are advanced for this fundamental policy shift. Where and in what form is a stronger market orientation actually necessary (COM 2016a: 12)? What does it mean for renewable electricity policy if the technologies become increasingly cheap and mature, and supply an ever-growing share of the energy supply (COM 2013: 6)? Is it the case that under those circumstances only competitive bidding systems are capable of effectively and efficiently expanding renewable electricity? Or can other instruments such as feed-in systems – for particular technologies in certain member states – successfully support the triple goals of energy policy, with which the EU is working towards a cost-effective, environmentally friendly and secure energy supply?

This report concentrates principally on onshore and offshore wind and photovoltaic. For reasons of space, discussion of other important elements of the proposed Renewable Energy Directive – such as restricting priority access to the grid and abandoning binding national expansion targets – must be omitted.

Chapter 3 describes the political, economic and legal context as the basis for the subsequent analysis. Chapter 4 discusses and analyses the most important arguments advanced to support the proposed alterations to the Renewable Energy Directive. On that basis Chapter 5 draws conclusions and formulates recommendations for the German government.

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1 In the following the term "feed-in system" describes instruments where the level of remuneration for electricity from renewable sources is defined administratively. The term encompasses both fixed-price and premium systems.

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THE POLITICAL CONTEXT

3.1 THE ROLE OF EU LEGISLATION IN NATIONAL RENEWABLE ENERGY POLICY

3.1.1 RENEWABLE ENERGY DIRECTIVE

The Renewable Energy Directive of 2001 has played a decisive role in forcing the development of renewable energy for electricity generation across the entire European Union. After countries like Denmark, Spain and Germany forged the way, especially in wind power, all the member states have been obliged to join the process since 2001. A revision in 2009 expanded the Directive to include heating/cooling and transport and set the target of increasing the share of renewable energy in the EU's total final energy consumption to 20 percent by 2020 (from 8.7 percent in 2005). In order to achieve this, binding national expansion targets for renewable energy were defined for all member states, and they were required to set out how they would meet those targets in detailed National Renewable Energy Action Plans. The revised Directive also sets national indicative interim targets for 2011/12, 2013/14, 2015/16 and 2017/18 (COM 2009). As such, the Renewable Energy Directive creates a binding framework for expanding renewable energy within which all the member states – and not just individual pioneers – must engage.

The share of renewable energy has indeed grown noticeably in all EU states since 2005, representing a success for the European policy on renewable energy and climate protection. All member states bar three met their indicative interim target for 2013/14, while some have already achieved later interim targets. Denmark, Spain and Germany are no longer lonesome pioneers. If the political and economic framework for expanding renewable energy in the member states continues to improve, it could be assumed that most of them will be able to fulfil their binding targets using the instruments already introduced or planned. But because this is currently not the case in certain member states, the European Environmental Agency (EEA) expects that the EU's goal of increasing the share of renewable energy to 20 percent of total energy consumption by 2020 will be narrowly missed (EEA 2016: 19). Moreover in certain member states conditions have worsened on balance, partly through retroactive legislation. As well as worsening the concrete financing environment this also harms the credibility and security of future investment (Fouquet/Nysten 2015). If the EU target is to be met, the policy framework in certain EU states will need to be improved. That is where the new revised Directive should make a contribution.

While the binding national expansion targets required all member states to adopt corresponding policies, they have to date enjoyed great leeway to decide how to achieve their targets. They have been free to use those policy instruments that fitted best with their political, economic and geographical circumstances, with the Renewable Energy Directive laying out no specific requirements. The member states were thus free to choose between fixed-price and premium feed-in systems, quota systems, competitive bidding, investment subsidies, tax breaks or other instruments. What emerged was a kind of competition between the best instruments.

Since 2009 the Renewable Energy Directive has also enabled various measures allowing member states to work together on a voluntary basis to jointly fulfil their national expansion targets. There are also requirements for certification of origin for electricity, heating and cooling using renewable energy, and rules for priority grid access and sustainability criteria for biomass (COM 2008a).

3.1.2 CHOICE OF INSTRUMENTS

The principal instruments used for financing renewable electricity generation in the EU have been fixed-price and premium feed-in systems. Other financing instruments, including quotas and competitive bidding systems, have tended to be the exception (see Figure 2 and Table 1). Internationally more than eighty states use fixed-price and premium feed-in systems for renewable electricity. No other financing instrument is more frequently used (REN21 2016: 112). Accordingly it is with this instrument that the most experience – both good and bad – has been gathered.

THE MAIN INSTRUMENTS FOR FINANCING THE RENEWABLE ELECTRICITY EXPANSION

In the political and academic discourse specific terms – such as "feed-in system" – have emerged to describe the various instruments used to finance the expansion of renewable electricity generating capacity. This report also uses that terminology. Because the wording does not automatically convey how the instrument in question functions, brief explanations are supplied below. A distinction is drawn between price-control instruments and volume-control instruments. Under ideal market conditions both the quantity and price of a product should emerge in the market without state influence.

Price-control systems

Feed-in system with fixed remuneration (fixed-price feed-in system)

In fixed-price feed-in systems the state sets the remuneration administratively. Operators are normally reimbursed per kWh of renewable electricity supplied, and thus operate independently of short-, medium- and long-term wholesale electricity prices. The operators do not need to market their electricity.

Fixed-price feed-in represents an intervention in the market through price-control; the market then decides how many new renewable electricity plants will be built (Figure 1a).

Feed-in system with premium (premium feed-in system)

The premium feed-in system for renewable electricity also involves a remuneration set by the state, but in this case it does not cover all the electricity generation costs. Instead the operator markets the renewable electricity they generate. Only when the operator realises both components does an installation become profitable.

The premium can be sliding or fixed. A sliding premium may – as in the case of the German Renewable Energy Law (EEG) – be orientated on the medium-term average returns of a particular technology, for example onshore wind power or photovoltaic. A fixed premium is unaffected by such effects and remains constant for the entire remuneration period.

Premium feed-in also represents an intervention in the market through price-control; the market then decides how many new renewable electricity plants will be built (Figure 1a).

Systems with volume-control

Competitive bidding system

In a competitive bidding system an installed capacity or quantity of renewable electricity is advertised. The successful bidder may receive a remuneration for the installed capacity or for the supplied electricity. Where remuneration is tied to the amount of electricity supplied, it may be sliding – as in the German 2017 Renewable Energy Law (EEG 2017) – or fixed. The decisive difference to a price-control system is that the level of remuneration is determined through competitive bidding rather than set by the state.

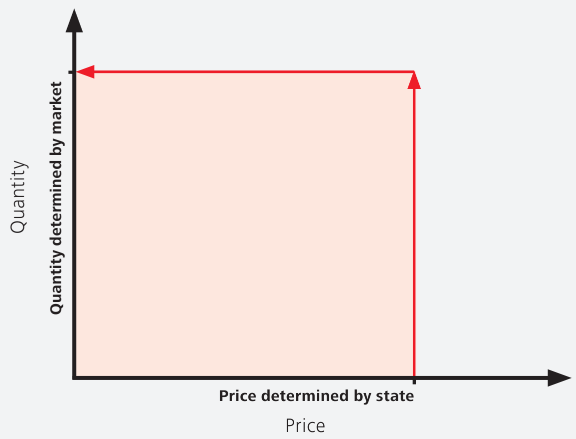
In this case the state intervenes in the market by defining a required increase in renewable electricity generation capacity or quantity, while the price is determined by the market (Figure 1b).

Quota system

In a quota system particular actors in the electricity markets (often electricity providers) are obliged to generate a specific proportion of the electricity they sell from renewable sources. Generally, this is associated with a system of tradable certificates.

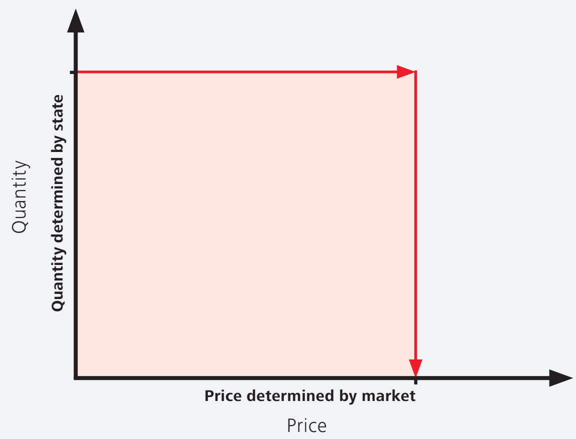
What this means is that the actors in question are not required to generate the specified amount of renewable electricity themselves, but may purchase certificates in the markets to fulfil their obligations. Here again the state intervenes in the market by controlling quantity, and the market determines the price (Figure 1b).

Figure 1a
Price-control instruments
(fixed-price and premium feed-in systems)



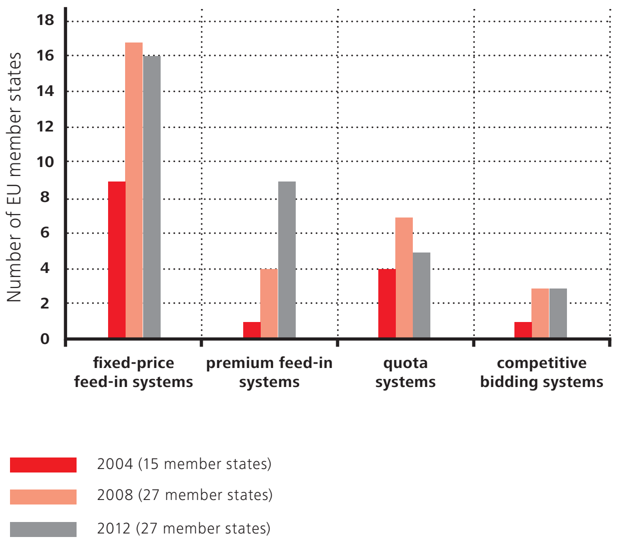
Source: Author.

Figure 1b
Volume-control instruments
(competitive bidding and quota systems)



Source: Author.

Figure 2
Main renewable electricity financing instruments in the EU
(multiple responses possible)



Source: Data from Energy Economics Group/Vienna University of Technology 2004: vi; COM 2008b: 5; eclareon 2012.

3.1.3 THE ENVIRONMENTAL AND ENERGY STATE AID GUIDELINES

The role of guidelines in the EU's legal system is to clarify the application of existing European law. One example is the Guidelines on State Aid for Environmental Protection and Energy (Environmental and Energy Aid Guidelines, EEAG), in which the European Commission indicates the conditions under which it can permit state aid on the grounds that it does not distort competition. Guidelines are issued by the Commission on its own account. Within the Commission the Directorate-General for Competition (DG Competition) is principally responsible for the EEAG, which has come to play an increasingly important role in the formulation of national legislation. Neither the European Parliament nor the European Council have any formal role in the formulation of Guidelines – unlike Directives, which must be approved jointly by Commission, Parliament and Council.

What that means concretely in this context is that support systems that clearly satisfy EEAG criteria can expect to receive rapid approval. Where it is uncertain whether a national system conforms to the EEAG (or whether it is actually subject to the EEAG at all) the likelihood of protracted legal wrangling between the member state and DG Competition is very strong, at the price of great legal uncertainty. In extremis, remunerations already received may have to be repaid. This can create great insecurity of investment. Given the great insecurity of investment that creates, there is enormous pressure on national governments to secure advance agreement with DG Competition on how their financing instruments may be configured.

Table 1
Financing systems for wind and solar electricity in EU member states in 2012[2]

WIND POWER

Financing instrument	Number of member states	Member states
Fixed-price feed-in systems	15	AT, BG, CZ, FR, DE, GR, HU, IE, LI, LT, LU, PT, SK, SI, GB
Premium feed-in systems	9	CZ, DE, DK, EE, ES, FI, IT, NL, SI
Competitive bidding systems	3	FR, IT, LT
Quota systems	5	BE, PL, RO, SE, GB

PHOTOVOLTAIC

Financing instrument	Number of member states	Member states
Fixed-price feed-in systems	15	AT, BG, CZ, FR, DE, GR, HU, LI, LT, LU, MT, PT, SK, SI, GB
Premium feed-in systems	7	CZ, DE, DK, EE, IT, NL, SI
Competitive bidding systems	3	FR, IT, LT
Quota systems	5	BE, GB, PL, RO, SE

Source: eclareon 2012.

2 In 2012 the following twenty-one EU member states used feed-in systems for electricity from wind and/or solar power: AT, BG, CZ, DE, DK, EE, FI, FR, GB, GR, HU, IE, IT, LI, LT, LU, MT, NL, PT, SK, SL (AT – Austria, BE – Belgium, BG – Bulgaria, CZ – Czech Republic, DK – Denmark, EE – Estonia, ES – Spain, FI – Finland, FR – France, DE – Germany, GB – United Kingdom, GR – Greece, HU – Hungary, IE – Ireland, IT – Italy, LI – Liechtenstein, LT – Lithuania, LU – Luxembourg , MT – Malta, NL – Netherlands, PL – Poland, PT – Portugal, RO – Romania, SE – Sweden, SK – Slovakia, SL – Slovenia).

Because state subsidies that distort trade between member states are irreconcilable with the internal market under the Treaty on the Functioning of the European Union, DG Competition plays a crucial role in financing renewable energy (EU 2012: Art. 107). The question of whether financing instruments for renewable electricity are in fact state subsidies – and as such subject to state aid rules and the requirements of the EEAG – is in fact contested. The German government believes that these rules do not apply to the German Renewable Energy Law (EEG), which finances renewable electricity generation by means of a levy paid by electricity consumers, and consequently involves no transfer of state funds (BMWi 2016a). This interpretation has to date been supported by the PreussenElektra judgment of 2001 (European Court of Justice 2001).

However, the European Commission has changed its legal interpretation, and has already classed Germany's 2012 Renewable Energy Law (EEG) as state aid and opened an infringement procedure. The German government is contesting the case, so the Commission and the German government are currently in dispute over this point (General Court of the European Union 2016). Although it remains uncertain until the decision of the European Court of Justice whether the EEAG actually applies to the EEG and other financing instruments in other member states, the Guidelines are de facto law because any attempt introduce a financing instrument without Commission approval would be subject to unforeseeable risks and legal uncertainty for any entity benefitting from it. For that reason, despite the unresolved legal dispute, every change to financing instruments is cleared in advance with DG Competition before it is adopted by a national parliament. This empowers DG Competition to overturn not only any new arrangement, but also any existing arrangement in the national financing instruments. Its leading role within the European Commission thus grants DG Competition enormous power to influence the energy and climate policy of the Union and its member states. This was fundamentally approved by the European Council, which explicitly underlined in its Conclusions on the 2030 Framework for Climate and Energy that the financing systems for renewable energy must be orientated on the EEAG (European Council 2014: 5, No. 3). But in 2016 then German Economy Minister Sigmar Gabriel wrote to the Commission explicitly rejecting the idea that such requirements could be decided out of the public eye in internal Commission guidelines or technical regulations. Instead, he said, they needed to be discussed by both the European Council and the European Parliament (Gabriel 2016: 2 f.).

Since 2014 the EEAG fundamentally require the use of a competitive bidding system for financing renewable electricity generation (although this is not covered by the current Renewable Energy Directive). In autumn 2013, the German Social Democrat and Christian Democrat parties included this change in their coalition agreement for 2013–2017. The 2017 German Renewable Energy Law (EEG 2017) implemented the EEAG requirements in German law (CDU/CSU/SPD 2013: 54; BMJV 2016: § 2, Abs. 3). Not only for Germany, but for all member states the current EEAG massively curtail the free choice of instrument that exists under the Renewable Energy Directive. The twenty-one member states that were still using feed-in systems in 2012 are required to replace them with competitive bidding systems.[3] At that point only France, Italy and Lithuania were using competitive bidding systems (eclareon 2012).

This observation is not contradicted by the exceptions applicable under the EEAG, as these apply only to small projects with installed capacity less than 1 MW (for wind power up to 6 MW or six units) (COM 2014e: note 127). According to Competition Commissioner Margrethe Vestager, that corresponds to a total output of 18 MW for one wind park, below which a project need not be financed through a competitive bidding system (Vestager 2016).

The current EEAG are valid until 2020; the political debate over a reform can be expected to begin in 2018.

3.1.4 THE PARIS CLIMATE AGREEMENT AND EU ENERGY POLICY

The 2015 Paris Climate Agreement greatly boosted the significance of climate protection and renewables for the EU's energy policy. The French government and the EU's negotiating strategy played a decisive role in the success of the Paris Conference. The Agreement tangibly raises the international community's sights. In particular the earlier goal of limiting the increase in global temperature to a maximum of 2 degrees was significantly tightened. Now measures are to be taken to limit the rise to 1.5 degrees if possible (United Nations 2015: Art. 2 (1) a). Very rapid ratification – within the space of just one year – by more than one hundred states representing 55 percent of global emissions, including Brazil, China, the EU, India, Indonesia and the United States, allowed the Agreement to come into force by November 2016. That is unusually fast for a global agreement and underlines the determination of a large part of the international community to tackle the climate crisis in earnest. In summer 2017 the number of states that have ratified passed 140 (UNFCCC 2017).

In order to achieve the Paris climate target – which is considerably more ambitious than the Kyoto Protocol – and keep ahead of global competition in renewables, the EU will need to raise its target for energy from renewable sources, which is currently at least 27 percent by 2030 (COM 2016c). The next EU Climate and Energy Package offers an outstanding opportunity to do so.

It will not be enough, however, simply to increase the target. It will be at least as important to provide the member states with optimal conditions for actually implementing the political framework for a rapid expansion of renewable electricity. This should be tied to appropriate pressure on the member states to work actively toward achieving this ambitious EU expansion target.

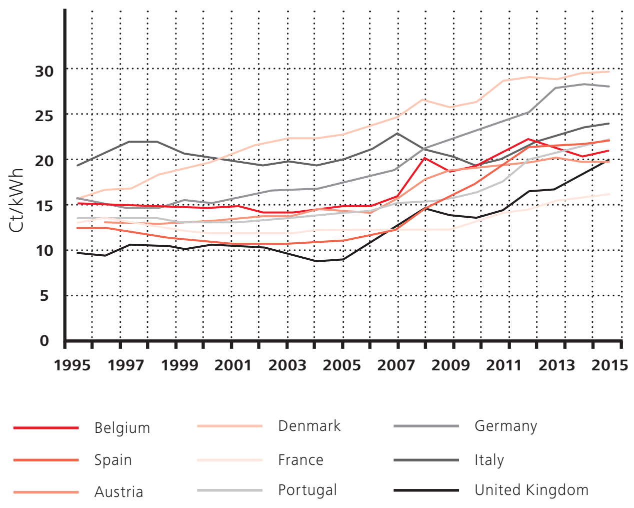
3 AT, BG, CZ, DE, DK, EE, FI, FR, GB, GR, HU, IE, IT, LI, LT, LU, MT, NL, PT, SI, SK.

3.2 THE TRIPLE GOALS AND MARKET LIBERALISATION

For many years European – and German – energy policy has been orientated on the triple goals of energy policy: economic efficiency, environmental protection and security of supply must be pursued with equal priority (COM 2015b: 2; COM 2016a: 7; Deutscher Bundestag 2015: § 1 Abs. 1). Accordingly, every energy policy instrument and every modification to such an instrument should be measured in the first place against those three criteria.

In parallel to this the EU has also required all its member states to liberalise their energy markets. This principle also applies to renewable energy. According to an earlier draft of the renewable energy directive, "common market based principles" are to be applied to support the development of renewable energy (COM 2016d). It is, however, unclear whether using "market based principles" is an objective in its own right or an instrument that should help achieving the three traditional goals of economic efficiency, environmental protection and security of supply. These goals and the market liberalisation are examined more closely in the following.

Figure 3
Domestic electricity prices in selected EU member states, 1995–2015



Source: Data from BMWi 2016b: Blatt 30a.

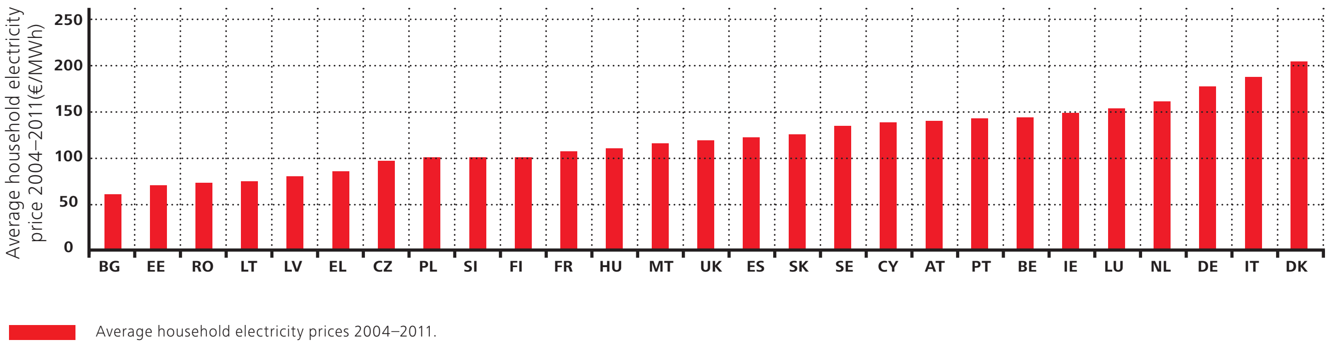
3.2.1 ECONOMIC EFFICIENCY/ELECTRICITY PRICE

Electricity price trends

Electricity prices have risen in recent years in most member states, with very large and widening differences between them. From 2004 to 2011, the annual average in the member states varied between €60 and €200 per MWh for private households and between about €60 and €140 per MWh for industry (see Figures 3, 4a and 4b). In global terms the EU's average electricity prices are relatively high (although below those of Japan and South Korea for example) (COM 2014a: 13). Price changes since 2004 also vary widely between member states (see Figure 5) (COM 2014b: 55 f.).

However, absolute electricity prices are not the only relevant factor for international competitiveness. The role played by unit energy costs is at least as important. Because European industry is comparatively energy-efficient – with very low average energy intensity – the EU has very low unit energy costs in global terms. And that enables the EU to compensate its relatively high energy prices (COM 2014a: 13, 2014b: 1, 2014c: 11, FÖS 2014).

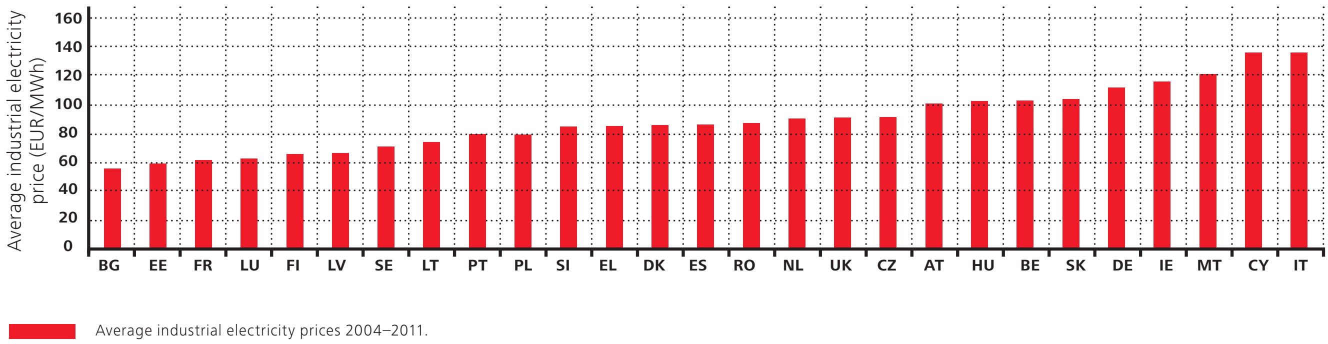
Figure 4a
Household electricity prices in the EU member states



Note: For household consumption between 2,500 and 5,000 kWh annually.

Source: COM 2014b: 57.

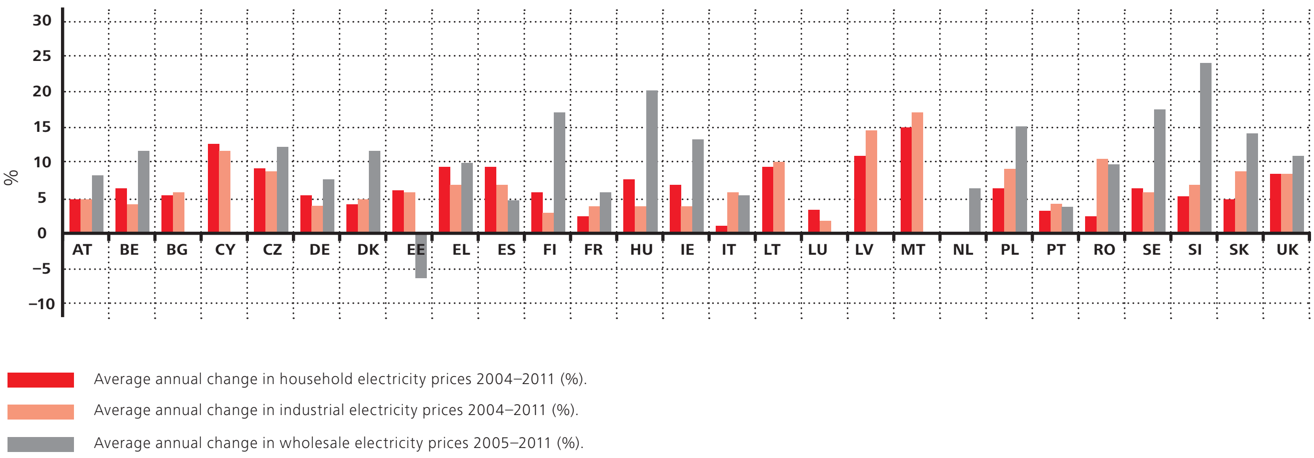
Figure 4b
Industrial electricity prices in the EU member states



Note: For industry consumption between 500 and 2,000 MWh annually.

Source: COM 2014b: 57.

Figure 5
Changes in wholesale and consumer electricity prices EU member states, 2004–2011

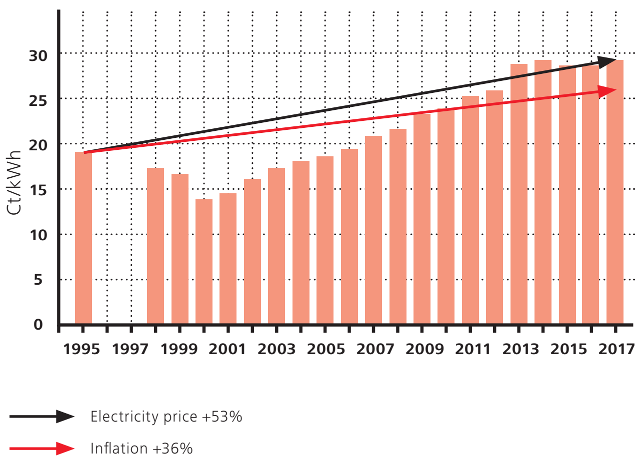


Note: For household consumption between 2,500 and 5.000 kWh annually; for industry consumption between 500 and 2,000 MWh annually.

Source: COM 2014b: 56.

As in other member states, the question of the price of electricity – and the effect of climate and energy policy upon it – is hotly debated in Germany too. The objective basis for the discussion is, however, limited. Electricity prices for private households in Germany rose by almost 53 percent between 1995 and 2017, while inflation over the same period was about 36 percent (see Figure 6) (BDEW 2016, 2017; BMWi/BMU 2006: 25; Destatis 2016; Statista 2017). In other words, in Germany there was no worryingly disproportionate rise in real electricity prices for private households during that period. The very low electricity price in 2000 is due to dumping prices associated with the beginning of electricity market liberalisation. Prices subsequently rose comparatively strongly, making the year 2000 unsuitable for comparison.

Figure 6
Average German household electricity price 1995–2017 compared to general inflation



For annual consumption 3,500 kWh.
Source: Data from BDEW 2016, 2017; BMWi/BMU 2006: 25; Destatis 2016; Statista 2017.

The rapid expansion of renewable electricity – especially photovoltaic – is often cited as the reason for the supposedly steep rise in German electricity prices. Photovoltaic expanded very strongly in Italy too in the years around 2010, at a time when it was still very expensive. In fact the share of photovoltaic in Italy in 2013 – with 6.5 percent of electricity consumption – was higher than in Germany (5.1 percent). But the household electricity price in Italy has risen by only about 27 percent since 1995. Thus an especially strong increase in real electricity costs is found neither in Italy nor in Germany, even though both very rapidly expanded photovoltaic at a point when it was still comparatively expensive. In many other member states the electricity price has risen much more strongly in both relative and absolute terms (see Figure 5) (COM 2014b: 56).

Nevertheless, many European households struggle to pay their energy bills (COM 2015b: 3). But given that European electricity prices are not fundamentally excessive, energy policy is not the arena of choice for addressing this problem. That view is shared by the Commission: "Energy poverty can only be tackled by a combination of measures, mainly in the social field [...]" (COM 2015b: 14). Instead of artificially lowering electricity prices via energy policy, social policy could channel specific support to those who actually need it. Furthermore, initiatives such as subsidising energy-saving household appliances for low-income households would help both the recipients themselves and contribute to achieving the EU's energy and climate targets. And because they would only be required by a comparatively small group of consumers, such measures would consume only a fraction of the resources required to lower the electricity price through state subsidies. Whereas reducing the electricity price in Germany by €0.03 per kWh through state intervention would cost about €10 billion annually, targeted support for the poorest 15 percent of households would only require about €150 million annually (DIW 2012: 7ff). An artificially low electricity price would also reduce the economic incentives for all consumers to invest in energy-efficient appliances and to use electricity economically. And that would contradict the EU's energy and climate goals (Strünck 2017; Müller/Bruhn 2013; EnKliP 2016a: 35 ff.).

Renewable electricity levies in the member states and the German EEG levy

In numerous EU states the cost of financing renewable electricity generation is financed by a levy on the electricity price paid by consumers (Moreno/Lopez 2011: 28). The size of the levy varies hugely between member states, ranging from 1 percent of the domestic electricity price in countries like Ireland, Poland and Sweden to about 16 percent in Germany and Spain (COM 2014a: 8). However, a larger renewable electricity levy may be at least partially compensated by a lower wholesale electricity price. This is because a large levy is normally associated with a relatively high proportion of subsidised renewable electricity. As this provides an additional wholesale supply with marginal costs close to zero, less use is made of conventional power stations with high marginal costs and the wholesale price therefore falls (COM 2014b: 64). For example in Spain the net price effect of expanding renewable electricity is found to be negative, in other words it has reduced the net price (COM 2014a: 8). In Germany the sum of electricity exchange price and EEG levy has fallen a slightly since 2013 on the basis of the same effect (BMWi 2016c: 1).

This connection between renewable electricity levy and wholesale electricity price also demonstrates why such a levy is unsuited for determining the actual costs of expanding renewable electricity. On the other hand, the European Commission declared in 2014 that its policies should be founded upon a clear understanding of the factors influencing energy costs. For only then will there be clarity as to how energy costs can be influenced through national or European policy (COM 2014c: 4).

To date such an indicator of the costs of expansion of renewable electricity has been lacking however (Nestle 2015). This is one reason why the public and political debate over the costs of the renewable electricity expansion in Germany in recent years has concentrated on the rise in the EEG levy, rather than using a suitable cost indicator. The costs of climate protection measures have also been discussed critically in other member states (COM 2014b: 64). To the extent that the debate there also revolved around renewable electricity levies like the EEG levy, it is likely that rational discussion was less than ideal, and that the political conclusions and responses were not entirely objective.

The unsuitability of the renewable electricity levy as a cost indicator is underlined by opposing trends of the German EEG levy and the average remuneration for new EEG plant. In just five years from 2010 to 2014 the EEG levy rose from about €0.02 per kWh to more than €0.06 per kWh (BMWi 2016d: 29). This strong rise in the EEG levy between 2010 and 2014 created the impression that the new EEG facilities were increasingly expensive, that the German Renewable Energy Law (EEG) was not cost-effective, and that it did not lower costs. In fact the costs attributable to new EEG plant fell by more than half during exactly this period. While the average remuneration for new EEG plant in 2010 was still more than €0.25 per kWh, it fell to about €0.12 per kWh by 2013 (see Figure 7). Accordingly the contribution of new EEG plants to the EEG levy fell massively between 2010 and 2014 – even though the plants installed in 2014 produce as much clean energy as the ones installed in 2010 (EnKliP 2014: 6). There are two main reasons for this significant increase in the cost-effectiveness of the German Renewable Energy Law (EEG): Firstly, strong cost reductions in renewable electricity technologies, especially photovoltaic. Secondly, the strong increase in the proportion of inexpensive renewable electricity technologies among the new EEG plant coming on stream. In particular the proportion of onshore wind power has increased significantly since 2010.

So the actual costs of expanding renewable electricity have fallen sharply, while the EEG levy has increased massively. The reason for this apparent contradiction is that the EEG levy – like comparable levies in other member states – is influenced not only by rising production of renewable electricity, but also by numerous other factors absolutely unconnected with the costs of the current expansion of renewable energy.

WHY RENEWABLE ELECTRICITY LEVIES ARE NOT COST INDICATORS

The calculative costs of new facilities are obscured by fluctuations in the costs of pre-existing ones. These are influenced by the following factors:

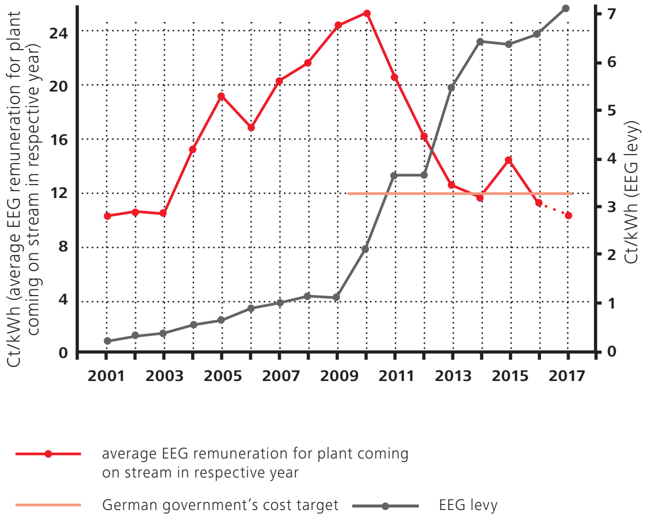
- **Wholesale electricity prices**, for example on the exchanges. The surcharge for renewable energy is often calculated by the difference between the remuneration and the electricity price on the exchange. The lower the price at the exchange, the larger the difference to the remuneration. In the case of a sliding premium system the premium rises when the wholesale price falls.
- Unavoidable **forecasting errors** (renewable generation, wholesale price, consumption etc.). These automatically create discrepancies between spending on remuneration and revenues from the levy, which are balanced on an annual basis.
- Privileges for electricity-intensive industries, which may be affected by legal changes and changes in **industry's electricity consumption**. The level of levies for other consumers often depends on the amount of electricity that is exempted.
- **Legal changes to the calculation of the levy**. In relation to the German Renewable Energy Law (EEG) this applies for example to the introduction of the redistribution mechanism in 2010, and to the introduction and modification of the liquidity reserve in 2012 and 2017 respectively.

The renewable electricity levies frequently exceed the additional costs attributable to the expansion of renewable electricity because:

- Many conventional power stations in the EU are relatively old and would have had to be shut down anyway in the foreseeable period for technical reasons. **The real additional costs of expanding renewable electricity are thus determined by the difference in cost between new conventional power stations and new renewable generating plant**. But the renewable electricity levies are calculated in terms of the difference to wholesale electricity prices, which is considerably smaller than the revenues required to refinance new conventional power stations. Construction of new conventional power stations would therefore also require additional financing. And given that they are no cheaper than the already cost efficient renewable electricity sources like onshore wind and large-scale photovoltaic, the surcharges for construction of new conventional power stations would be no cheaper than for cost-effective renewable plant.
- **The wholesale electricity price is reduced by an additional supply of renewable electricity with marginal costs of virtually zero**, because in the market economy a rising supply with constant demand automatically leads to falling prices. And falling wholesale electricity prices lead to rising calculative differential costs.
- **The cost of exempting electricity-intensive industries from the renewable electricity levies is borne by the other electricity consumers**. The entire calculative differential costs are therefore shared not by all electricity consumers, but only by those that do not benefit from any exemption. As a result the other consumers' contribution for expanding renewable electricity automatically increases.

These include catch-up effects where the levy was previously too high or too low, a falling electricity price on wholesale markets (exchanges), changes in the relief for industry and changes in the liquidity reserve and the redistribution mechanism (EnKliP 2016a: 16 f.).[4]

Figure 7
EEG levy and average remuneration for EEG plant, 2001–2017



Source: Author's calculations.

Moreover the EEG levy calculation neglects the fact that the electricity generation costs of new fossil-fuel and nuclear power stations are considerably higher than the electricity price at the exchange, which for Germany in 2017 is estimated to be just under €0.027 per kWh (50Hertz et al. 2016: 9). But it is the latter that is used for comparisons with the remuneration for EEG plant. This makes even new onshore wind turbines and photovoltaic installations appear to increase electicity costs, even though they actually are less expensive than new gas- or coal-fired power stations.

Under the German Renewable Energy Law (EEG) onshore wind turbines coming on stream in 2017 in Germany are initially remunerated with €0.077 to €0.084 per kWh, with the rate falling thereafter (BNetzA 2017a). The remuneration for ground-mounted photovoltaic is currently between €0.07 and €0.08 per kWh (BNetzA 2017b). And costs are still falling for both wind and photovoltaic. New fossil-fuel power stations, with electricity generation costs of €0.07 to €0.11 per kWh, thus lie in the same range – but their costs are tending to rise (BMWi 2014a: 3).

European power generating infrastructure would have had to be modernised anyway, regardless of the energy transition: many of Europe's fossil-fuel and nuclear power stations are obsolete, some member states have decided to phase out nuclear power, and all are affected by the needs of climate protection (Reitz et al. 2014: I; Küster et al. 2015: 1). Comparisons with the low electricity price on the exchange are therefore not appropriate. If the renewable electricity levies were calculated on the basis of the full costs of new conventional power stations rather than the exchange prices, the renewable electricity levies would be considerably cheaper and would rise little even in the event of rapid expansion of the cheaper renewable electricity technologies (EnKliP 2015a). So the German EEG levy and many of the renewable electricity levies used in other member states are inadequate and unsuitable as cost indicators. But many of them are frequently misinterpreted as just that. When the remuneration for renewable electricity generation is examined more closely, on the other hand, it becomes clear that even a more rapid expansion of the cost-effective technologies leads to only very marginal additional costs – although the development of the renewable electricity levies might suggest otherwise.

Studies comparing the respective costs of different energy scenarios are a great deal better suited for assessing the costs of expanding renewable electricity. Many such studies for Germany and other states conclude that a future electricity supply based on renewables is – both for consumers and for the economy as a whole – at least no more expensive in the medium to long term than retaining the current electricity mix. That holds even though the environmental costs are generally not incorporated into these comparisons (EWI/Prognos 2007; EWI et al. 2014; DLR et al. 2010; SRU 2011; Ademe 2016).

If the environmental costs are included, expansion of renewables comes off even better (FÖS 2015: 23). But because these costs are not itemised on electricity bills, the actual broader economic costs of conventional energy and the corresponding savings through renewables remain opaque.

3.2.2 SECURITY OF SUPPLY

Because wind and sun are strongly fluctuating energy sources, there are concerns that an electricity supply based on them could impair security of supply. To date, though, there are no signs of this occurring in the member states. Security of electricity supply in the EU is considerably better than in other major economic regions, such as the United States (see Figure 8). But it also varies very strongly across the EU. Denmark and Germany have the most reliable electricity supplies, and at the same time both have relatively high proportions of fluctuating wind and solar power. Spain and Portugal, where the proportion of these energy sources is also relatively high, lie in mid-range. Poland, on the other hand, ranks relatively poorly in European and international comparison, even though wind and solar account for less than 5 percent of its electricity supply (ZSW 2016: 36). So a secure electricity supply is plainly compatible with a high proportion of fluctuating renewable energy. And even where the share is low, examples are found where security of supply is poorer.

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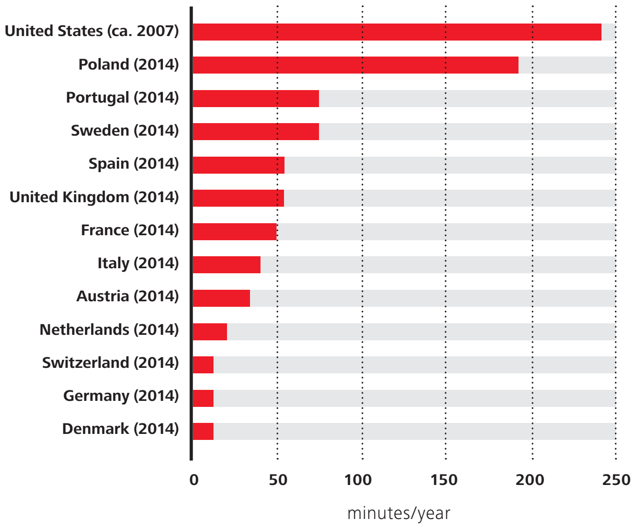
4 Under the redistribution mechanism the EEG electricity and the costs to network operators arising through the remuneration of EEG plants are shared among all electricity traders. Until 2010 they were required to physically accept the electricity financed by the EEG and pay the corresponding remuneration. Since 2010 EEG electricity has been sold on the exchange by the transmission system operators and no longer physically transmitted to the electricity traders. The latter now only have to finance their share of the EEG levy, which they pass on to their customers. The "liquidity reserve" was introduced in 2012. Its size has been altered several times since then. It creates a financial cushion to avoid transmission system operators having to borrow heavily, for example in the event of unexpectedly high EEG infeed and correspondingly high EEG remunerations or an unexpectedly low electricity price on the exchange (BEE 2012: 14).

Figure 8
Average annual power outage in selected EU states, United States, Switzerland



Source: Data from ZSW 2016: 36; FÖS 2014: 18.

With its very rapid expansion of these fluctuating renewable energy sources, Germany has gathered relevant experience. Between 2009 and 2014 almost 50 GW of such capacity were installed, two-thirds of it photovoltaic (BMWi 2016d: 12). By comparison peak load in Germany is about 80 GW. Nevertheless security of supply continues to steadily improve. Thus the average total unplanned outage fell between 2004 and 2015 from 23 to just under 13 minutes per year. Within the EU only Denmark has a slightly better figure, whereas the figure in France and the United Kingdom exceeded 50 minutes per year and in Poland was more than 190 minutes (ZSW 2016: 36). By comparison the outage figure for the United States in 2004 was about four hours (FÖS 2014: 18). Denmark and Germany demonstrate that security of supply can still be maintained even when the proportion of wind and solar electricity is high.

According to Jochen Homann, President of the German regulatory agency Bundesnetzagentur, the slight increase in outages in Germany in 2015 is attributable not to the energy transition and the expansion of renewables, but to weather events like storms and heatwaves (BNetzA 2016d). As rising global temperatures lead to more frequent and more extreme weather events (Bauchmüller 2016), the climate crisis plainly also poses a danger to security of electricity supply.

In fact Germany's electricity supply system is already capable of dealing with a magnitude of stress events caused by fluctuting renewables that will not be expected to occur regularly until many years ahead, when their proportion will be significantly higher. For example, there were no notable problems during the partial solar eclipse of March 2015, when 8 GW of photovoltaic were lost rapidly, and then 15 GW suddenly added just under an hour later (IWES 2015; Agora Energiewende 2015a).

In fact, the expansion of renewables contributes to improving security of energy supply by reducing dependency on energy imports and the associated volume and price risks. Those negative influences on energy security and the economy decline as the proportion of renewable energy increases (BMWi 2016d: 22; COM 2014c: 13, 2015: 2).

3.2.3 ENVIRONMENTAL AND CLIMATE PROTECTION

Environmental matters and particularly climate protection present enormous challenges for energy policy. As Kofi Annan, former United Nations Secretary-General, wrote in 2014 in the *Süddeutsche Zeitung*: Already today, the climate crisis "threatens the well-being of hundreds of millions of people, and in future it will be billions more. Its impacts undermine the human rights to food, water, health and shelter […]" (Annan 2014). Such conditions increase the likelihood of violent conflict. Under these circumstances many people will no longer see a perspective in their home country and be forced to leave. Many of those with access to sufficient resources will seek protection and future livelihoods in Europe.

In order to limit the impacts of the climate crisis, the international community agreed a very ambitious climate agreement in December 2015 in Paris, which came into effect in November 2016 (UNFCCC 2017) (see Chapter 3.1.4). According to the International Energy Agency average CO_2 emissions in electricity production in 2050 must not exceed 15 grams per kWh just to achieve the two degree target (IEA 2016: 11). If the rise in temperature is to be restricted more strongly, as agreed in Paris, emissions will have to fall to that level considerably more quickly. Given that emissions from fossil-fuel power stations lie between 300 g/kWh for especially efficient gas-fired facilities and more than 1,200 g/kWh for lignite (BMU 2011: 24), their future use must be strongly restricted. One option could be to use carbon capture, transport and sequestration (CCTS). But even with CCTS, coal-fired power stations still have greenhouse gas emissions of up to 260 g/kWh if mining, transport and combustion of coal; transport and sequestration of CO_2; as well as expected leakages are all taken into account. That is still too high to meet long-term climate targets (Wuppertal Institut 2010: 157).

Accordingly the European Commission decided in 2015 to phase out use of fossil fuels in the long term (COM 2015b: 2). The Paris Climate Agreement makes this objective urgent as well as important. In view of the relatively slow fall in greenhouse gas emissions in the EU, making an appropriate contribution to clearly undershooting the old two degree target appears to present a great challenge. The gap between target and reality is considerably smaller (or non-existent) in the case of the two other major goals of energy policy – economic efficiency/electricity costs and security of supply. Even if all three goals are fundamentally equal, the greatest effort should be put into the one whose achievement is plainly most remote.

Expansion of renewable energy with specific financing will be imperative for a rapid – and potentially accelerated – reduction in greenhouse gas emissions. The European Commission already stated this in 2011 in its Energy Roadmap 2050, well before the ambitious Paris Climate Agreement. According to Roadmap 2050, depending on increases in energy efficiency and the use of technologies such as CCTS, the share of renewable energy will have to reach at least 55 percent of total energy consumption and 64 to 97 percent of the electricity supply by 2050. Since the Paris Agreement is much stronger than its Kyoto predecessor, both the climate targets and the target for the share of renewables are most likely to be insufficient today (COM 2012: 8).

Another reason why specific financing for renewable energy will be vital is that the European Emissions Trading System introduced in 2005 has been unable to promote its expansion. One reason for this is that the prices for CO_2 certificates are permanently too low. Another reason is the structural effect of emissions trading systems. On the one side, higher prices for CO_2 make investments in greater energy efficiency – and thus specifically lower CO_2 emissions – in existing fossil-fuel power stations commercially viable, and if they are high enough CO_2 prices incentivise use of gas-fired power stations in place of coal. But, on the other side, they cannot incentivise investment in new renewable electricity installations to replace fossil-fuel power stations (COM 2014c: 2; Holm-Müller/Weber 2010: 8). Yet precisely that – investment in renewable energy – is vital and urgent for medium- and long-term climate protection (see Chapter 3.2.3), and efficiency improvements in fossil-fuel power stations alone will not be sufficient. Additionally any investment in existing fossil-fuel power stations increases the commercial pressure to use them as intensively as possible for as long as possible. Instead they should be used as rarely as possible and replaced as quickly as possible with renewable sources. So a Renewable Energy Directive that spurs and equips the member states to continue to advance the expansion of renewable energy will remain vital for the foreseeable future.

3.2.4 ENERGY MARKET LIBERALISATION

Alongside the climate objectives, the liberalisation of the energy markets plays an important role in European energy policy. It was initiated with the first Electricity Market Liberalisation Directive in 1996 (EP/EC 1997) and implemented in the subsequent years by the member states. Revisions were undertaken in 2003 and 2009 (EP/EC 2003, 2009). The directives regulate third-party access to transmission and distribution networks, control network usage fees and connection conditions, and unbundle responsibilities for electricity grids and generation. Altogether they set out to create equal and non-discriminatory market access for all participants.

The goals and spirit of energy market liberalisation appear to stand in a certain contradiction to the policy of renewable energy expansion and climate protection. The problematic restriction of the freedom of choice of instruments for financing renewable electricity generation through the Guidelines on State Aid for Environmental Protection and Energy and in the draft Renewable Energy Directive is also shaped by this competition.

3.3 SUCCESSES OF RENEWABLE EXPANSION IN THE EU

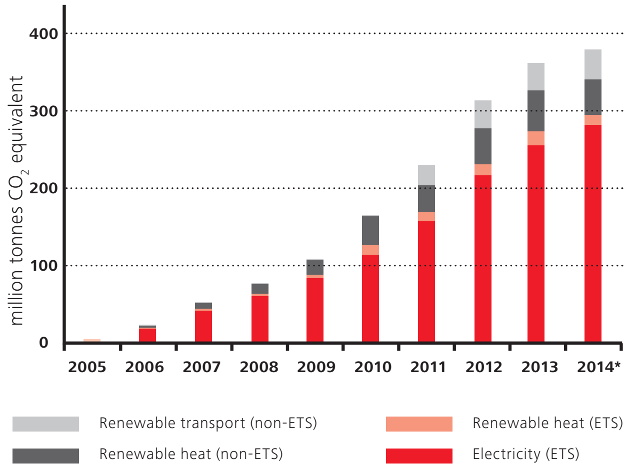
3.3.1 SUCCESSES IN EU ENERGY AND CLIMATE POLICY

Renewables contribute to achieving all the objectives of the Energy Union, especially reducing greenhouse gas emissions (COM 2015a: 2, 2014a: 6). Their expansion is therefore a long-standing official objective of the EU. The share of renewables in the energy consumption of the member states and the EU as a whole has been significantly increased in recent years, largely on the basis of the Renewable Energy Directive, rising EU-wide from 8.7 percent in 2005 to about 17 percent in 2015 (COM 2016a: 2). On the basis of this success, the European Commission determined that the share of renewables should increase to at least 27 percent by 2030. According to the Commission's Clean Energy Package this should be a binding target for the EU, without setting new binding targets at national level (COM 2016a: 2, 2016c; EEA 2016: 13; COM 2014c: 5).

The contribution of this expansion of renewables – and above all renewable electricity – to reducing greenhouse gas emissions is substantial: the increase in the proportion of renewable energy between 2005 and 2013 saves about 360 million tonnes of CO_2 emissions annually. That is equivalent to Poland's entire emissions and puts the climate effects of the Renewable Energy Directive at least on a par with those of European Emissions Trading. Without the growth in renewable energy between 2005 and 2013 the EU's total emissions today would be about 7 percent higher. Roughly 280 million tonnes of CO_2 – about 75 percent – are accounted for by additional renewable electricity, above all wind and photovoltaic (see Figure 9) (EEA 2016: 43 f.). The strong growth in renewable energy was decisively boosted by the Renewable Energy Directive of 2001 and its revision in 2009. Nonetheless it is currently uncertain whether the target of 20 percent renewable energy by 2020 can in fact be met in full. The EEA believes that the proportion achieved by 2020 will be between 18.5 and 19.7 percent (EEA 2016: 24). So member states must step up their implementation of the existing Renewable Energy Directive, and the framework for member states and investors established by the future Renewable Energy Directive must be just as good if the Union is actually to meet its binding target for 2030.

Figure 9

Estimated gross reduction in greenhouse gas emissions in the EU by energy sector since 2005

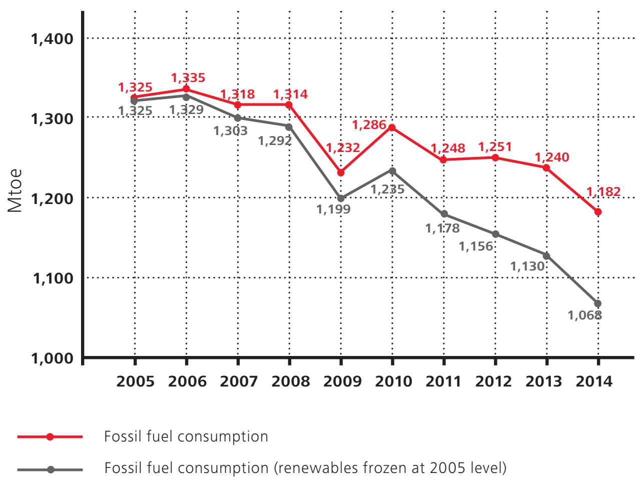


* Proxy

Source: EEA 2016: 44.

Figure 10

Effect of expansion of renewables on fossil fuel consumption in the EU, 2005–2014



Source: EEA 2016: 42.

3.3.2 ECONOMIC SUCCESSES OF EXPANSION OF RENEWABLES

Renewable energy sources and the Directive promoting them are good not only for the environment and climate protection, but also for the EU's economic development. They can contribute to achieving all the other objectives of the Energy Union: guaranteeing security of supply, economic growth and development, promoting innovation, creating and securing competitiveness and jobs for the future, reducing the EU's trade deficit in the area of energy, and lowering energy costs (COM 2015a: 2, 2014a: 6).

For example in 2013 about 1.2 million people were employed in the renewable energy sector in the EU. The trend is currently falling slightly on account of factors including efficiency gains and a slowing of expansion, especially in photovoltaic (COM 2015a: 2; IRENA 2015: 9).

The increasing use of renewable energy also reduces the consumption of fossil and nuclear fuels, which the EU currently imports to the tune of about €400 billion annually (COM 2015b: 3). More than 70 percent of the EU's imported solid fuels come from just three states: Russia, Colombia and the United States (Eurostat 2016a). Such dependency is detrimental to long-term security of energy supply. The expansion of renewable energy since 2005 saves the import of fossil fuel worth at least €30 billion annually (COM 2015a: 12). In 2010 the use of wind power alone was already reducing energy imports by more than €2 billion annually; solar electricity saved about another €0.3 billion (COM 2014b: 115). Since then – between 2010 and 2015 – wind power has more than doubled and solar electricity more than quadrupled (BMWi 2015a: 38; Eurostat 2016b). So today the import reduction attributable to these renewable sources is considerably greater (see Figure 10).

In light of this European success story the Commission is determined that the EU should regain its global leading role in renewable energy, and become the global centre for developing the next generation of advanced and competitive technologies (COM 2015b: 17). The EU is fundamentally well-equipped to do so. For example 40 percent of all patents for renewable energy technologies are registered by EU companies (COM 2015b: 3). And with over 20 percent in 2014, the EU possesses a significant share of global investment in renewable energy (EEA 2016: 55).

However, investment in renewable energy in the EU fell by about 60 percent between 2011 and 2015 – and not solely on account of falling costs (COM 2016a: 2). At the same time other major players like China are catching up; China increased its share of global investment over the same period from 7 to more than 30 percent. From that perspective the EU's aforementioned share of global investment in renewable energy is in fact an indication of how the EU has fallen behind. In 2004 the figure still exceeded 50 percent (EEA 2016: 55). The strong growth in investment in renewable energy in China and many other countries underlines the emergence of a large and growing market. It will continue to grow and offers very interesting export opportunities for European industry. In order to make the most of this export potential the corresponding basis must be created in the EU and its member states – and that includes a healthy domestic market.

3.4 THE EU'S CURRENT CLIMATE AND ENERGY POLICY

3.4.1 THE ENERGY UNION

The term "Energy Union" was first used in April 2014 by Donald Tusk, then Polish prime minister, at a time of growing concerns about the EU's security of energy supply in the context of the Russia/Ukraine crisis (Zachmann 2017: 2). Less than a year later the European Commission proposed "the goal of a resilient Energy Union with an ambitious climate policy at its core", "to give EU consumers – households and businesses – secure, sustainable, competitive and affordable energy" (COM 2015b: 2). This means the EU will "have to move away from an economy driven by fossil fuels" (COM 2015b: 2). The transition to a low-carbon economy, it says, is "unavoidable" (COM 2015b: 3). In 2016 the Commission adopted a timetable for implementing the Energy Union (see Figure 11).

3.4.2 THE CLEAN ENERGY FOR ALL EUROPEANS PACKAGE

The comprehensive package of legislative proposals, reports and communications for "Clean Energy for All Europeans", which the European Commission presented on 30 November 2016, represents a major step towards implementation of the Energy Union (see Figure 11). The proposals it contains are currently under discussion among the European Council, the Parliament and other actors and are scheduled to be adopted by 2018. The most important elements relate to the electricity market (revision of the Internal Electricity Market Directive), energy efficiency (directives for energy efficiency and buildings), eco-design, renewable energy and biomass sustainability (revision of the Renewable Energy Directive). The package also addresses other aspects ranging from the Energy Union through energy costs and prices to innovations and transport.

3.4.3 THE PROPOSED NEW RENEWABLE ENERGY DIRECTIVE

In its proposal for a new Renewable Energy Directive the European Commission confirms its position of seeking to increase the proportion of renewable energy to at least 27 percent by 2030. It proposes the target be binding for the EU as a whole, but without new binding targets at the national level (COM 2016a: 2, 2016c; EEA 2016: 13; COM 2014c: 5). Fundamentally this continues the direction set by the existing Renewable Energy Directive. In its draft the Commission also consolidates the policy of restricting the choice of instruments, which it initiated in 2014 in the EEAG under the aegis of DG Competition. That, however, was not the continuation of an existing successful policy, but a significant change in which neither the European Parliament nor the European Council had a formal say (see Chapter 3.1.3).

With the draft for the new Renewable Energy Directive the Commission is proposing that the Parliament and Council now give their formal consent to the principle that future EEAG – and thus DG Competition – explicitly determine what instruments are permissible for financing new renewable electricity capacity (COM 2016a: 69, Art. 4 Abs. 1). In so doing they would be handing far-reaching decision-making powers to the Commission, which is something then German Economy Minister Sigmar Gabriel explicitly rejected in a letter to the Commission in 2016 (Gabriel 2016: 3). In fact the proposal for the new Renewable Energy Directive itself specifies that the financing of new renewable electricity generation should use a competitive method – which would amount to a competitive bidding system (COM 2016a: 69, Art. 4 Abs. 3). The Commission also wants to make technology-neutral cross-border competitive bidding compulsory (COM 2016a: 69, Art. 5). DG Competition has in fact spoken against including any provisions concerning funding systems in the new Directive in the interests of securing itself even greater influence over national energy policy (DG Competition 2016).

The arguments used to justify these fundamental changes include renewable energy sources having in the meantime become relevant actors in the energy market (COM 2013: 6), and the energy market being close to completion (COM 2013: 6). Where the circumstances have changed to such an extent, different financing instruments need to be used and tariffs lowered (COM 2013: 6). Criticism is also expressed that because of the freedom of choice the financing instruments in many member states are not market-led and are therefore inefficient (COM 2016a: 11).

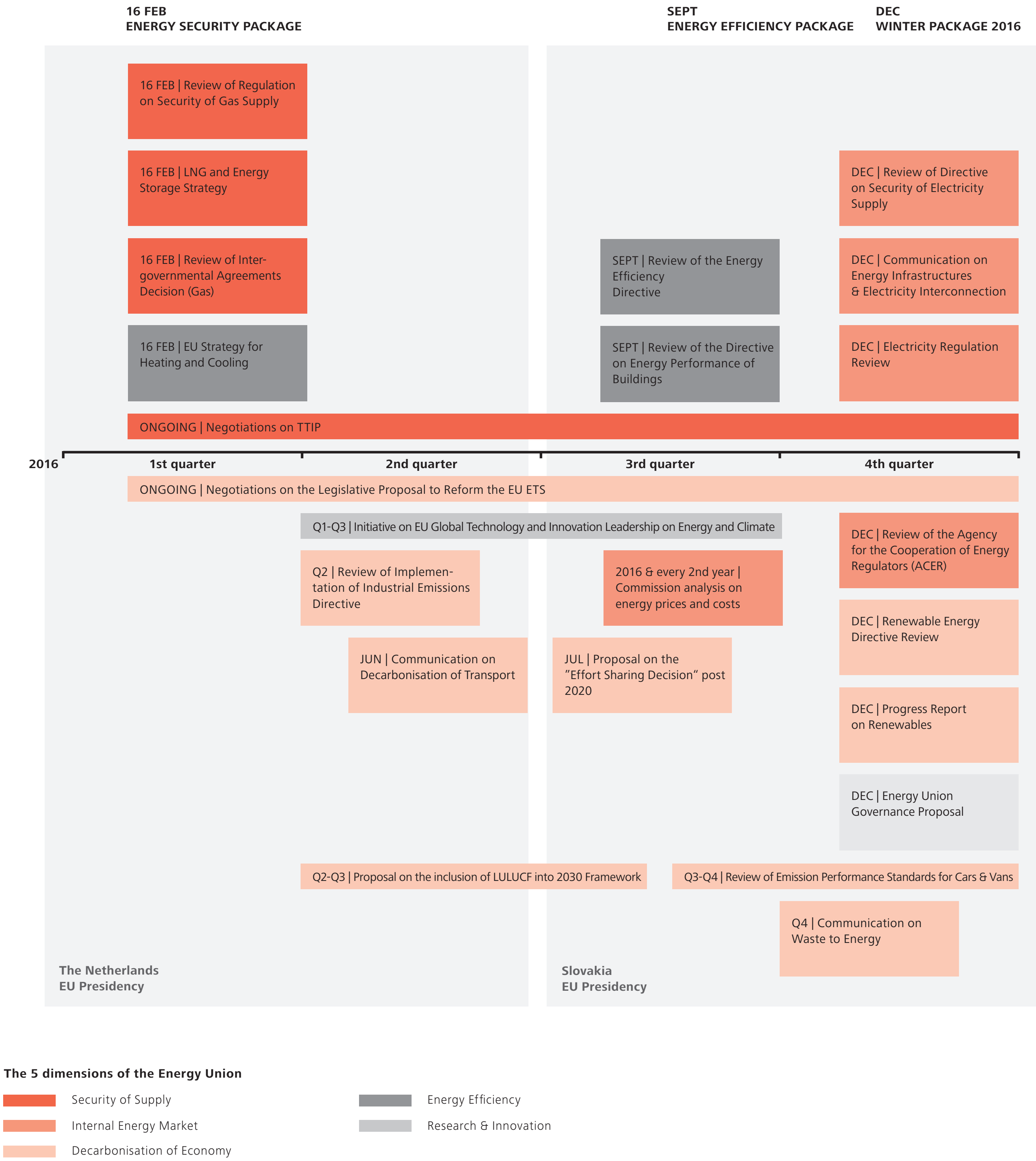
3.5 INTERIM CONCLUSION: SUCCESSFUL PROMOTION OF NATIONAL RENEWABLE ELECTRICITY POLICY BY THE EU

The expansion of renewable energy plays a central role in the Energy Union and the EU's climate, energy and economic policy. The new Renewable Energy Directive is thus an essential component of the Commission's autumn 2016 Energy Package and of the Energy Union. The Energy Union emphasises the triple goals of energy policy traditionally pursued within the EU. The goals of economic efficiency/electricity costs and security of supply are comparatively easy to implement, even with a rapid expansion of renewable energy. Fulfilling the third goal – environmental and in particular climate protection – appears to be a much greater challenge. Successful implementation of the Paris Climate Agreement of 2015 and action on the climate crisis will demand enormous efforts at the European and national levels.

The EU's energy policy as a whole has a decisive influence on national renewable energy policy. For example, binding national expansion targets meant that all member states had to install financing instruments for expanding renewable energy. The significant increase in the proportion of renewable energy in the EU and its member states suggests that this path was successful.

Since 2014 most EU states are required to convert their instruments for financing renewable electricity to a competitive bidding system by the new Guidelines on State Aid for Environmental Protection and Energy under the aegis of DG Competition. For twenty-one member states this means moving from price-control to volume-control and endangers the stability and dependability of renewable energy policy in the EU and its member states.

Figure 11
Timetable for the European Commission's 2016 dossier on implementing the Energy Union



Source: Fleishman/Hillard 2016.

In the context of the Renewable Energy Directive's success to date, the challenges of climate protection and the essential role of renewable energy in climate protection, the question whether switching to volume-control is best strategy for achieving the economic optimum needs to be considered. It must be noted that a volume-control system – such as a competitive bidding system – prevents the overfulfilment of expansion targets and introduces the risk of expansion proceeding more slowly than planned, and thus climate targets being missed. And a stuttering expansion of renewable electricity also risks jobs, endangers innovation and forgoes the benefits of increasing local value creation.

4

DISCUSSION OF THE ARGUMENTS AGAINST FREE CHOICE OF INSTRUMENTS

This Chapter discusses the most important arguments used to justify the fundamental changes proposed for the new Renewable Energy Directive (see Chapter 3.4.3), considering in particular whether and to what extent the fixed-price and premium feed-in systems most member states have used to date can still meet today's requirements. In many cases the situation in Germany is examined, as it offers extensive experience and a broad base of research.

4.1 EFFICIENCY AND EFFECTIVENESS OF THE INSTRUMENTS

Various and sometimes very different instruments have been used for financing expansion of renewable electricity in the EU and globally. By far the most prevalent are feed-in systems where the state sets fixed or variable remuneration (price-control). The market then determines the amount of additional capacity created. Noticeably fewer states use competitive bidding and quota systems where the state defines the volume of expansion and the market determines the price (volume-control) (see box on page 7). The Commission, especially DG Competition, believes that systems with volume-control are "more market-consistent". This is one of the central reasons advanced by those arguing that all member states should in future use competitive bidding systems for financing renewable electricity generation.

4.1.1 ANALYSIS

Effectiveness of instruments

With volume-control instruments the state seeks to decide how fast new renewable electricity technologies should be expanded. In fact it merely ensures that the number of new facilities does not exceed a specified volume. In the volume-control system the defined expansion can only be exceeded if no specific financing instrument is actually required for profitable construction and operation. That is not to be expected in the foreseeable future with wind turbines or ground-mounted photovoltaic in situations where no electricity can be used for self-supply (see Chapter 4.5). So specific financing instruments are required if further expansion is a political objective.

It is however quite possible that less capacity than planned will be built where a volume-control instrument is used. There are numerous examples of this occurring with both competitive bidding and quota systems (IZES 2014: 1). If this were to occur in a number of EU states the risk of missing energy and climate targets would increase.

It is obvious that the same can occur with fixed-price and premium feed-in systems too. But to date they have proven considerably more effective than volume-control instruments. In fact, many price-control instruments have overshot their political targets, in some cases very considerably. Examples include in particular Germany and Spain. While this has provoked criticisms over the cost of expanding renewable electricity, it has been very positive for climate protection. Climate protection is therefore one argument to continue to permit price-control instruments to be used. As outlined in Chapters 3.2.1 and 4.2, the cost question no longer presents an obstacle to rapid growth of inexpensive reneweable electricity technologies.

Comparison of the cost-effectiveness of various financing instruments

The question of which policy instruments for expanding renewable energy are the most cost-effective has been discussed for many years in politics and academia. Fixed-price and premium feed-in systems for renewable electricity do well in numerous scientific studies. Other financing instruments, in particular competitive bidding and quota systems, are not necessarily found to lead to lower remuneration rates. The reasons identified for this are above all the additional financing and higher transaction costs inevitably associated with competitive bidding and quota systems (Grau 2014a; IZES 2014: 1; ISI/Energy Economics Group 2010; Butler/Neuhoff 2005; EEG et al. 2004; Patlitzianas et al. 2004; Lorenzoni 2003).

The European Commission also came to a similar conclusion. In 2008 it found that in particular for onshore wind turbines and photovoltaic "well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity" (COM 2008a: 3). At that time the Commission compared the effect of different financing systems on both the expansion and the resulting remuneration, above all for fixed-price and premium feed-in systems and for quota and competitive bidding systems (COM 2008b: 3).

A recent study by the European Commission also found that the weighted average cost of capital (WACC) for renewable energy was decisively influenced by policy. The higher the capital costs, the higher both the financing costs and the minimum return demanded by investors. This makes the project correspondingly more expensive and the costs for consumers that much higher. In comparison to other EU member states, Germany until recently led the way with its (now abandoned) fixed-price/premium feed-in system; almost nowhere else were the capital costs for renewable electricity projects so low (ISI et al. 2016: 52).

There are, however, examples where the remuneration arising from competitive bidding is lower than that for feed-in systems. But the comparison is often problematic. For example wind conditions in Brazil are particularly good, and land availability is also considerably better than in many EU states (IZES 2014: 59). The latest very advantageous competitive bidding results for offshore wind power in Denmark are based on locations in very shallow waters and very close to the coast (IWR 2016). Furthermore, dumping offers can lead to prices below the actual costs.

Results of the first competitive bidding rounds in Germany

Ground-mounted photovoltaic

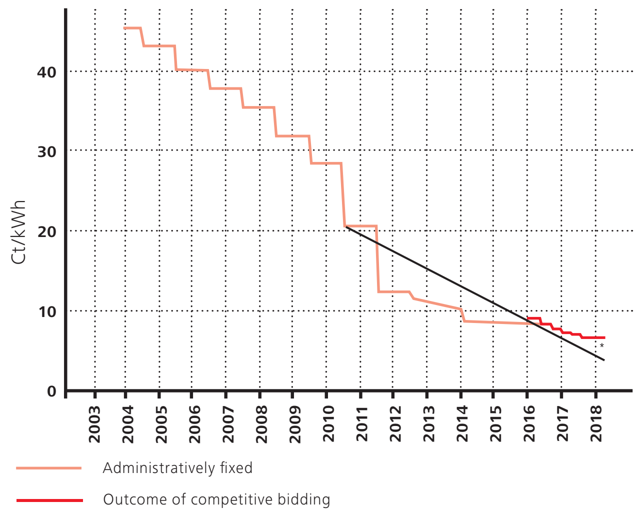
The first experience with competitive bidding for ground-mounted photovoltaic in Germany provides no indication that it would lead to lower prices or a larger reduction in remuneration than with feed-in systems. The prices and degression achieved in the seven competitive bidding rounds to date are certainly comparable with the trend for administratively set remuneration since 2004 (see Figure 12).[5]

Onshore wind power

The first competitive bidding rounds for onshore wind power in Germany concluded with what are at first glance lower prices; the first round with remuneration of €0.0558 per kWh (BNetzA 2017f). But these installations do not have to begin operation until 2021, by when continuation of the existing state-defined remuneration rules under the German 2014 Renewable Energy Law (EEG 2014) would also have led to a similarly low rate (see Figure 13). By the end of 2018 this will be just under €0.07 per kWh and will thus have fallen by about €0.008 per kWh within the space of a year. If the trend between 2014 and 2018 – and thus before the switch to competitive bidding – were to continue, the EEG remuneration would be below the level of the first competitive bidding round.

5 For this comparison the author assumed that the successful projects in a competitive bidding round come into operation on average fifteen months after acceptance.

Figure 12
EEG remuneration for ground-mounted photovoltaic before and after switch to competitive bidding



* Note: The thin black line between 2011 and 2018 shows the development assuming a linear continuation of the decline between 2011 and 2016.

Source: Data from EnKliP 2016b: 38 f.; BNetzA 2017a, 2016b.

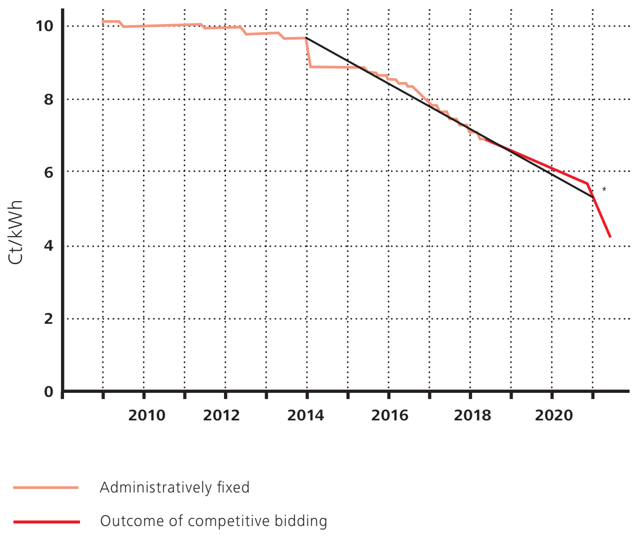
In the case of the even lower result of the second competitive bidding round it should be remembered that more than two-thirds of the awarded capacity are accounted for by just one bidder (BNetzA 2017g). Under these circumstances it cannot be excluded that strategic considerations may have played a role in the submission, possibly involving dumping prices below actual costs (Schmagold 2016). Further, in particular given the low remuneration, it cannot be said whether the selected projects will actually be realised. This competitive bidding result should therefore not be overrated.

On top of that, after the switch to a competitive bidding system there is no longer high early and low final remuneration. The final remuneration in the feed-in system is well below €0.05 per kWh. This factor alone means that the remuneration after the switch can be somewhat lower altogether. The results of the competitive bidding rounds therefore appear better than they actually are.

Offshore wind power

The first competitive bidding round for offshore wind power in Germany produced a surprisingly low price, with numerous projects doing completely without any financing apart from the returns on the electricity market (BNetzA 2017e). However there is currently no reason at all to conclude that additional financing is no longer necessary, as the bidders made plainly very optimistic assumptions in their offers. Because the installations do not come on stream until between 2021 and 2024, they assume massive cost reductions, turbine size 10–15 MW, an operating life of up to thirty years and wholesale electricity prices considerably higher than today's. Because it is uncertain whether these assumptions are realistic DONG, which won 590 MW out of the total of 1,490 MW, made it absolutely clear in a press release that its final decision on whether to go ahead with the investment will not be made until 2021 (DONG Energy 2017).

Figure 13
EEG remuneration for onshore wind power since 2009



* Note: The thin black line between 2014 and 2021 shows the development assuming a linear continuation of the decline between 2014 and 2018.

Source: Data from EnKliP 2016b, BNetzA 2017a, 2017c; BMJV 2016 ; BNetzA (15.08.2017).

Strategic considerations may also have played a role. It is therefore unclear whether these installations will be built at all (possibly later and at a different price).

Consequently the result of this bidding round for offshore wind power cannot say anything useful about the efficiency or effectiveness of competitive bidding.

Cost risks with fixed-price and premium feed-in systems

The largest risk for excessive costs in fixed-price and premium feed-in systems for renewable electricity is the remuneration being set too high, especially where it causes an expensive technology to expand considerably more quickly than planned or economically sensible. The very rapid expension of photovoltaic in Germany between 2009 and 2012 represents one prominent example where this occurred (see Chapter 3.2.1).

With cheap renewable electricity technologies on the other hand, accelerated expansion creates no relevant additional costs. For example in Germany in 2014 about 2,250 MW more onshore wind power was installed than foreseen in the German 2014 Renewable Energy Law (EEG 2014). But this only increased the EEG levy by just under €0.0009 per kWh. Yet these installations benefit the environment by reducing greenhouse gas and other emissions, generate local value creation and substitute energy imports. Additionally, with these already cheap technologies the absolute total remuneration has only a marginal effect on prices. If the remuneration for the total of 4,750 MW wind power onshore newly installed in 2014 became €0.01 per kWh – or more than 10 percent – cheaper, this would reduce the EEG levy by only €0.0003 per kWh (EnKliP 2016b: 38 f.). This would represent a saving of about one euro per year for an average household with annual electricity consumption of 3,500 kWh.

However, the speed of expansion of a renewable electricity technology can also be controlled in fixed-price and premium feed-in systems. For example, the capacity expansion of offshore wind power in Germany on the basis of premium feed-in systems is clearly capped until 2020, because only installations that possess network connection capacity or a corresponding approval are entitled to remuneration (BMWi 2015b: 2). The speed of expansion of onshore wind power is strongly dependent on the availability of suitable locations, which falls under the powers of the state (in Germany the federal states). Not least the flexible cap for photovoltaic installations in the German Renewable Energy Law (EEG) demonstrates that a provision to reduce remuneration more strongly if expansion is rapid can effectively control the process (BMWi 2017a). It has led to a gradual slowing of the expansion – about 7,500 MW between 2010 and 2012 – while avoiding a complete collapse (BMWi 2016d: 12).

There are also possibilities to improve the administrative fixing of remuneration tariffs to minimise the risk of them being set too high. For example it would be possible for the individual EU member states or the European Commission itself to acquire greater and more solid expertise allowing them to make better estimates of the actual current electricity generation costs of new renewable electricity installations. If all the experience across the EU were gathered and analysed in a structured form, this could be of great assistance to the national governments in fixing an appropriate level of remuneration.

Here the EU could assess the practical experience of the member states and their regions and local authorities. For example, photovoltaic installations are being installed on government buildings and wind turbines and ground-mounted photovoltaic systems built on disused military sites and state-owned forests. If the state had this done through its own institutions it could gain insights into the costs and apply these in the systematic analysis mentioned above (Leuphana Universität Lüneburg/Nestle 2014: 110).

Cost risks in competitive bidding systems

In competitive bidding systems, unlike feed-in systems, the level of remuneration remains unclear until the offers have been accepted. It is not even clear whether any particular project will be accepted at all, and recoup the investment in planning and participating in the bidding round. As such, competitive bidding systems generate higher equity and debt costs, leading to higher WACC than in feed-in systems. This applies above all to small and medium-sized installations, while for large projects the difference between feed-in systems and competitive bidding systems is smaller. In all project sizes the transaction costs are higher in a competitive bidding system, because the project development times are longer and development costs greater (Grau 2014b: 25). Savings can thus only be achieved by switching to a competitive bidding system if the additional costs outlined here are overcompensated through additional efficiency gains.

Both competitive bidding systems and quota models increase market concentration, because the inherent risks make it difficult or impossible for smaller investors to participate. Their experience and structure also give larger investors competitive advantages over smaller actors. Thus large companies possess departments specialised in participating in competitive bidding (Grau 2014b; EnKliP 2015b: 18). Such market concentration can reduce the intensity of competition and thus increase costs in the medium to long term. Not least, competitive bidding can curb innovation and as such also increase costs in the medium to long-term (Grau 2014b: 24). The competitive bidding rounds to date for ground-mounted photovoltaic and offshore and onshore wind power in Germany appear to confirm this (BNetzA 2016b). Thus in the second round for onshore wind power more than two-thirds of the capacity fell to just one investor (BNetzA 2017f).

The climate-driven necessity to replace fossil fuels with renewable energy as quickly as possible creates another potential cost risk in the competitive bidding system. A situation could arise where there is a political wish to put out for tender more projects than can in practice be offered by industry (for example if insufficient locations are available) (Hanke 2017). But a competitive bidding system can only reduce remunerations appropriately if there is sufficient competition (Gabriel 2014; BMWi 2015b: 2). That means that in a competitive bidding system considerably more output must be offered than has been put out for tender, also in the medium and long term. In other words, in every competitive bidding round there must also be participants that are rejected. But if political instances want faster expansion than industry is able to offer, this elementary precondition for cost-effectiveness cannot be fulfilled. The fact that smaller actors like community energy organisations find it difficult to participate on their own in a competitive bidding system exacerbates this problem. They will probably only be able to do so in close cooperation with larger partners, as illustrated by a press release from the major actor Enertrag on the first German competitive bidding round for onshore wind power in which many of the accepted projects were submitted as community energy projects (BMWi 2017b). According to the press release Enertrag alone won about 20 percent of all community energy projects accepted in this round (Enertrag 2017). This stands out even more clearly in the second round for onshore wind power. Here one single actor won two-thirds of the capacity (BNetzA 2017g). That can only be a large actor.

The risk of not receiving enough offers is especially relevant in competitive bidding for onshore wind power in densely populated states. Thus in Germany new output installed between 2000 and 2015 averaged about 2,350 MW per year. Under the German 2017 Renewable Energy Law (EEG 2017) 2,800/2,900 MW annually are to be put out for tender in the coming years (BMJV 2016: § 4 Abs. 1). That is considerably more than the long-term average expansion. Only in 2002, 2014, 2015 and 2016 were onshore wind turbines with an output of more than 2,900 MW newly connected to the grid in Germany (BMWi 2016a). It should also be noted that the strong expansion figures since 2014 are influenced by very energetic political efforts in many federal states to assign sites for onshore wind turbines following the nuclear disaster at Fukushima and the resulting support for the energy transition among all parties represented in the German Bundestag. Since then engagement has fallen off in many federal states and has in some cases reversed. Additionally, investors have been seeking to get as many facilities as possible on stream before the switch to a competitive bidding system. It is thus at least uncertain whether there will actually be more offers than requested after the switch to a competitive bidding system, and thus whether it will be possible to realise a good price (VCI 2016; Hanke 2017).

In order to avoid excessive prices, the switch to a competitive bidding system in German 2017 Renewable Energy Law (EEG 2017) sets an upper limit. Thus the state in fact not only sets the expansion target, but also puts a cap on the market price. If the maximum price is set too low, the risk increases that not enough offers will be submitted to meet the expansion target.

Cost risks in quota systems

A quota system is generally a technology-neutral instrument, characterised by the emergence of a uniform price surcharge for renewable electricity. Thus the most expensive kWh of renewable electricity required to fulfil the quota determines the price for every kWh of renewable electricity. As long as the quota can be fulfilled with technologies that exhibit similar electricity generation costs, this can represent a cost-efficient system at least in the short term. But if several technologies with different levels of costs are needed to fulfil the defined quota, windfall profits arise and increase costs for consumers (see Chapter 4.7.2).

Cost risks of changing system

Security of investment is a central factor for keeping costs low. It can be improved politically by keeping the political framework as constant as possible and ensuring that any changes are foreseeable well in advance. In Germany this has been the case in the area of renewable energy for electricity generation. This is one important reason why Germany's WACC for renewable electricity generation are the lowest of all EU member states (ISI et al. 2016: 1). Changing the financing system means uncertainty in the market, at least in the short term, which automatically increases capital costs. At least during the transitional period, this must make expansion of renewable electricity more expensive than necessary (ISI et al. 2016: 52).

Continuity of policy is thus very important for a cost-effective renewable electricity expansion. This applies both to a steady expansion and also to reliability and continuity of legislation.

4.1.2 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

The potential for improving the cost-effectiveness of renewable electricity expansion lies in particular to the choice of technology mix, which should ensure that as many cheap capacities as possible are added and comparatively few expensive ones. If this is done, the influence of the financing instruments on the cost burden on consumers is comparatively small (see Chapter 3.2.1).

Beyond this, in terms of costs, no single instrument is ideal for all technologies, member states and political objectives. For example if a member state with limited availability of sites wishes to expand onshore wind power as fast as possible, a price-control instrument would probably make sense. In a country with plenty of locations but low expansion targets, a volume-control instrument is likely useful.

Altogether, no one instrument is per se better than another. If the remuneration for expensive technologies in a feed-in arrangement is too high, this may lead to a large unplanned expansion and possibly high costs. Equally there are numerous examples where expansion targets have not been achieved. This applies to all instruments, but especially to competitive bidding and quota systems. If wrongly configured, volume-control systems can lead to very high remuneration, windfall profits and unnecessary costs for consumers. Whatever the instrument, a good configuration is decisive for achieving societal and economic goals.

Thus there is no justification for restricting the choice of instruments for reasons of cost.

4.2 LIMITING EXPANSION AND COSTS

In the case financing of renewable electricity generation, inadequate political control can lead in particular to higher costs for consumers. It is therefore understandable that the unexpectedly strong expansion of photovoltaic in Germany in 2009 to 2012 – when it was still relatively expensive – led to calls for stronger control of the expansion of renewable electricity (BMWi 2015a: 12). The fear is that uncontrolled expansion will generate high costs (see Chapter 3.2.1), as well as overloading power networks and causing power outages, costly redispatching measures[6] and shutoffs of wind power plants.

4.2.1 ANALYSIS

Cost containment by limiting the expansion of renewable electricity?

The selection of renewable electricity technologies for expansion is decisive for maximising cost-effectiveness, as illustrated by the example of renewable electricity financing in Germany. The very rapid expansion of photovoltaic around 2010 – when the EEG remuneration was still very high (up to €0.43 per kWh) – has incurred high additional costs for German consumers. This remains the case even though the remuneration was in fact low in international comparison (ISI/Energy Economics Group 2010: 28). The photovoltaic expansion of 2009 to 2012 alone accounts for about €0.014 per kWh of today's EEG levy, but supplies just 4 percent of German electricity consumption (EnKliP 2016b: 38 f.).

At that point there was a spike in photovoltaic expansion in several EU member states, including Italy. In 2011 and 2012 alone new photovoltaic installations with total output exceeding 40,000 MW were installed in the EU as a whole, more than doubling the installed output (BMWi 2015a: 44; 2016d: 39, 43). This has caused the price component "taxes and levies" for both households and industry to rise relatively strongly in Germany, Italy and a number of other EU states. At the same time the price components for networks and conventional power generation have fallen in some cases (COM 2014d). It is therefore important to ensure effective control of the speed of expansion of technologies that remain relatively expensive. This applies in particular to geothermal, biomass using cultivated biomass and slurry, and – in certain regions – offshore wind.

Today, however, onshore wind power and photovoltaic are the most relevant, and have in the meantime become cost-effective technologies. If they are now rapidly expanded this can no longer drive costs on a scale comparable with the increases around 2010 (see Chapter 3.2.1). Assuming that the remuneration for these technologies in other EU member states need not be significantly higher than in Germany, this statement also applies EU-wide.

The network and system question

Converting the electricity system to steadily increase the share of renewable energy, especially fluctuating wind and solar power, also means modifying the network. This incurs costs, because renewable electricity installations are more decentralised than conventional power stations, and wind turbines are generally located away from major settlements and industrial regions. In the case of offshore wind power, the electricity is generated far from the main consumer regions. The electricity system also needs to cope with sometimes very sudden and not entirely predictable spikes and drops in infeed from the fluctuating renewable sources (see Chapter 3.2.2). But also the implementation of the EU-wide internal market, under which all EU citizens can in principle choose which EU power station they wish to receive their electricity from, creates a not inconsiderable need for network expansion. All this generates a great need for investment in the network and incurs additional costs. To that extent not all network expansion costs are attributable to the energy transition.

Because of the rapid expansion of renewable electricity in Germany, combined with slower improvement of the power network, moreover, renewable electricity installations frequently have to be shut off, and the frequency of redispatching has increased noticeably. The associated compensation payments consequently increased strongly until 2015 (BNetz A/BKartA 2014: 17, 2015: 100; BNetzA 2016a: 7). In the political debate this has been used as an argument to restrict expansion of renewable electricity, above all in areas especially susceptible to congestion. Yet if they are shared among all electricity consumers on the "user pays principle" the costs are marginal, amounting to just under €0.002 per kWh or about €0.50 per month for an average household.

However, the volume of shutoffs and the associated costs fell noticeably in 2016 – by around one third compared to 2015 (BNetzA 2017d: 10) – for reasons including optimisation and expansion of the network. Investment by transmission system operators in network infrastructure in Germany increased by about 450 percent between 2009 and 2016 (planned). Certain federal states with particular problems are successfully forging ahead with network expansion (BNetzA/BKartA 2016: 90, 2015: 114; BWE 2016; MELUR 2015; Agora Energiewende 2016: 41).

The scope of redispatching currently seen in Germany appears manageable, especially given that the installations in question generate climate-friendly, environmentally sound

6 In relation to electricity trading in Germany and the EU, it is assumed that the electricity can be transported from the generating plant to the consumers. In fact this is not always technically possible, because the necessary network capacities are lacking. Where this is the case redispatching measures are necessary, where power stations on one side of the choke point are shut off and others on the other side started up. The operators of the affected power stations are compensated and the costs recouped via network charges. The stronger the infeed of electricity from renewable sources the more frequent the need for redispatching (BMWi 2015b: 83).

electricity for most of the year, and thus make a contribution to climate protection and targets. Additionally most of the wind turbine shutoffs in Germany are in the north of the country, where wind conditions are very good: despite shutoffs they generally record more full-load hours than those in central or southern Germany and thus have no higher electricity generation costs. Altogether a study commissioned by Agora Energiewende finds that "delaying the construction of national priority transmission lines (Bundesbedarfsplangesetz) by a few years would not be dramatic". "Further expansion of renewables need not wait for these transmission lines" (Consentec/IWES 2013: 1). In Germany there is thus no need to slow the expansion of renewable electricity because of network congestion. Instead that would be associated with risks, generating concern over the political commitment to network optimisation and expansion measures. In fact, redispatching and the associated costs drive political action. Placing restrictions on expansion could therefore lead to a situation where neither the expansion of renewable electricity nor construction of new transmission lines is implemented as rapidly as necessary. In this context an arrangement where expansion of renewable electricity cannot occur until the network capacity exists risks abuse. Simply delaying or preventing network expansion measures could at least also slow expansion of renewable electricity.

Finally, renewable energy and networks are not the only factors influencing redispatching. Renewable electricity installations are also shut off when the existing network capacity is taken up by electricity from conventional power stations. In such cases nuclear and coal-fired power stations could cut their output more strongly or shut down altogether – temporarily or permanently. At least in cases where such power stations are located in regions where network problems exist, their flexibilisation or shutoff could lead to a reduction in the corresponding costs. In Germany this applies for example to the large coal-fired power station at Moorburg (1,650 MW) and the nuclear plant at Brokdorf (1,480 MW), both on the lines south from northern Schleswig-Holstein. If the output of such power stations is reduced, more renewable electricity could be transported through the existing networks and fewer renewable electricity installations would have to be shut off (Energy Brainpool 2016). This would be highly efficient in overall economic terms, because it would cut fuel consumption, CO_2 and other emissions, and nuclear waste. The wind and photovoltaic power fed in instead consumes no fuel, causes no emissions and has marginal costs close to zero.

If network congestion persists despite reducing infeed from conventional power stations, sensible options should be sought for using renewable electricity locally. The possibilities include stepping up load management, storing electricity and moving into sector coupling. In regions with network congestion and high renewable electricity output, capacity could be diverted into the transport and heating/cooling sectors to reduce their greenhouse gas emissions and dependency on oil and gas. In view of these alternatives to shutting off renewable electricity installations, it is questionable whether restricting expansion in response to network congestion is the most economically efficient measure.

4.2.2 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

The economic effects of policy – such as the costs of the energy transition – need to be politically manageable. Controlling and limiting global warming, and securing existing and future employment in technologies such as renewable energy are also political objectives. While climate protection will remain an ongoing and highly complex challenge, the danger of excessive costs through a supposedly over-rapid expansion of renewable electricity has fallen significantly. Electricity from new onshore wind turbines and photovoltaic installations today costs less than electricity from new conventional plants. So the necessity to replace at least the most climate-damaging fossil-fuel power stations as soon as possible with more climate-friendly alternatives through faster expansion of already cost-effective renewable electricity today increases costs only fractionally. The same now also applies to offshore wind power in certain EU member states (see Chapter 3.2.1). As long as most of Europe's electricity is still generated in coal-fired power stations, strictly limiting expansion of these technologies cannot be justified in light of the climate crisis and the Paris Climate Agreement. This means that the costs of the already cheap renewable electricity technologies are no reason to switch from price- to volume-control. The climate crisis, on the other hand, supplies good arguments to choose instruments where expansion can exceed the pace set by politics. The only ones to do so are price-control instruments.

Nor can network issues be treated as a reason to restrict the expansion of renewable electricity. The principle of "network upgrade before expansion of renewables" would make it harder to achieve the goal of an environmentally-friendly electricity supply – without offering meaningful advantages for other energy policy objectives. Other possibilities for making sensible use of electricity that cannot be transported and consumed at the time of generation include local use for heating/cooling and transport, storage, and the production of hydrogen or synthetic methane. It appears questionable whether limiting the expansion of renewable electricity where network congestion exists is the most efficient approach in terms of the overall economics.

On the other hand, restricting expansion may still make sense in the case of renewable electricity technologies that remain relatively expensive. These currently include geothermal in most regions of the EU and biogas facilities using cultivated biomass. Even fixed-price and premium feed-in systems offer certain possibilities to restrict the expansion of these technologies. Germany takes such a line on offshore wind power, which has until recently remained relatively expensive. Where such options are unavailable for technologies that remain expensive, a volume-control instrument such as the competitive bidding system would appear useful.

4.3 COMPETITION

In general competition increases cost-effectiveness and ensures innovation. It forms the basis for the success of the market economy. It is especially in that context that the demand for more competition in the renewable electricity expansion arises (COM 2013: 5).

4.3.1 ANALYSIS

Competition occurs in very different areas within the electricity sector. Competition between manufacturers, operators and planners is crucial to cost-effectiveness and innovation in renewable electricity. That sphere of competition was massively incentivised by the strong – and especially from 2004 accelerated – expansion of renewable electricity in the EU. Since 2001 the Renewable Energy Directive has contributed decisively to this dynamic expansion of renewable electricity (BMWi 2015a: 38). In the European Union – and globally – the private sector has invested in renewable electricity research, development and construction. Correspondingly renewable electricity installations have become considerably more efficient and effective, and the planning of renewable electricity projects has become increasingly professional and cost-effective.

This process has massively reduced costs and significantly improved the quality of renewable electricity installations. The cost and prices of solar modules fell 76 percent between 2000 and 2013 (DGS/BSW-Solar 2015), allowing the remuneration for electricity from photovoltaic installations to be reduced massively across the EU. In Germany it fell by about 80 percent between 2004 and 2015 (BMJV 2006: § 11, 2014: § 51). Wind power has also witnessed similarly impressive technological progress: a modern wind turbine today generates nine times more electricity than the average for the mid-1990s (BWE 2015: 12). The creation of large markets with intense global competition in the various technologies has been decisive for this success.

The instruments used in the process may appear secondary at first glance; the crucial point was that the market grew. De facto in the EU it was largely fixed-price and premium feed-in systems that created this market (see Chapter 3.1.2). In terms of intensity of competition, their advantages include offering good opportunities to small actors by keeping investment risks low. It is these small actors that have been (and still are) responsible for most of the growth and for implementing most of the innovation. Thus feed-in systems have proven especially well suited for creating strong competition among plant manufacturers and project developers.

Another area where competition could occur is between the different renewable electricity technologies. This would be relevant if there were no political or technical factors influencing the technology mix. Obviously the system cannot be based largely or exclusively on photovoltaic, as that would demand enormous storage capacity. Instead a mix of different technologies such as wind, solar and biomass makes sense from a systemic perspective. Only with such a mix can security of supply be guaranteed cost-effectively. At first glance – considering only generation costs – it might appear to make sense to concentrate on just one technology, namely, the one with the lowest electricity generation costs. But if all the broader economic aspects are included – such as security of supply, energy efficiency (because storage is always associated with losses), network requirements etc. – the optimal mix will include multiple sources.

Moreover, the realistically exploitable potential of any single technology is not sufficient to realise an electricity supply based extensively on renewable energy. It is therefore a political challenge to organise the renewable electricity expansion in such a way that it is not limited to one technology.

Competition between renewable electricity technologies and conventional power stations is also unnecessary in light of the EU's political objectives. Significantly increasing the share of renewable energy and lowering greenhouse gas emissions will make further expansion of renewable electricity an absolute necessity in the short, medium and long term. This is independent of whether – and in which markets – competition between conventional and renewable generation takes place and which technology would win. Even if conventional power did, new renewable electricity installations would have to be built anyway to meet political energy and climate targets (BDEW 2013: 28).

4.3.2 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

Competition is the foundation of our market economy and ensures cheap prices, good quality and innovation. But there are areas where politics determines economic developments. This occurs especially where a development is necessary from the political perspective but cannot be adequately realised through competition and the market. One example is the political decision – which enjoys broad public backing – to steadily, substantially and permanently increase the proportion of renewable energy. This means that for the foreseeable future there is no need for competition between renewable electricity and conventional power stations. In such a situation the political decision takes precedence over the market. Fundamentally this also applies to competition between renewable electricity technologies. In medium to long term achieving energy and climate targets requires a diversity of renewable electricity technologies, even if a single technology might win in competition.

While the specific form of financing of renewable electricity in the EU member states (in Germany the Renewable Energy Law, EEG) meant there was no competition between renewable and conventional power stations, intense global competition in the area of renewable technologies has arisen over the past fifteen years. Such strong international competition among plant manufacturers and project developers in this sector has been and remains extremely helpful for implementing the EU's energy and climate targets because it generates cost reductions, quality improvements and efficiency increases in all renewable electricity technologies. Competition was initiated and encouraged through political target-setting for energy and climate protection, the Renewable Energy Directive and the national arrangements for financing renewable electricity technologies. By far the most important contribution has come from price-control instruments, concretely feed-in systems. This is because price-control has been better at expanding the market and because in these systems the investment risks are comparatively small and thus the chances of small and innovative actors are especially good.

Thus the question of competition provides no solid argument for excluding price instruments for financing renewable electricity generation. A compulsion to use competitive bidding systems, on the other hand, contains the danger of a sharp slow-down in the expansion of renewable electricity, which could reduce the intensity of competition among plant manufacturers and project developers. This would have negative consequences for cost trends, the competitiveness of European businesses and the creation and preservation of employment.

4.4 MARKET INTEGRATION

Where wind power and photovoltaic installations receive feed-in remuneration on the basis of a feed-in or competitive bidding system, it is frequently asserted that they are not integrated in the electricity market. The operators, it is argued, have no incentive to supply electricity according to the requirements of the market and system integration. Closer integration in the electricity market is therefore frequently demanded (COM 2008b: 3).

4.4.1 ANALYSIS

A distinction should be drawn between the different requirements created by the electricity system. Power plants should supply ancillary services (such as frequency and voltage stability, reactive power and black start) and should be designed and operated to supply more electricity when demand is high. At times when there is no demand for additional electricity – for example when electricity prices are negative – there should be no infeed. The operators of renewable electricity installations should also assume responsibility for reliably forecasting and reporting their infeed and providing a substitute supply in the event of an incorrect forecast. These various aspects are discussed in the following.

Ancillary services

The provision of ancillary services can be demanded of renewable electricity installations in the scope of all financing instruments. Under the German 2008 Renewable Energy Law (EEG 2008, initially a feed-in system), onshore wind turbines – and to some extent photovoltaic installations – must ensure frequency and voltage stability, provide reactive power and be able to support the restoration of supply after a power outage. Network operators have also been given the possibility to shut off EEG plants to protect security of electricity supply; facilities with output exceeding 100 kW are required to provide the technical prerequisites for remote control (Deutsche WindGuard/BioConsult 2011: 30). This arrangement within the feed-in system fulfils important prerequisites for system integration and security of electricity supply.

Systemic requirements

Fixed remuneration gives operators no real incentive to take the overall needs of the system into consideration when designing and operating their facilities. This is not the case where a premium is paid and the operators market their electricity themselves or through a third party. They are then exposed to short-term price fluctuations and correspondingly have an incentive to orientate their design and infeed accordingly. This is independent of whether the premium is sliding or fixed (EnKliP 2015c).

Such a premium system is in use today in many EU member states (see Chapter 3.1.2, Table 1 and Figure 1). Operators using a premium system have to market their electricity themselves, reliably forecasting and reporting their infeed. In the event of error they must provide a substitute supply. As such, premium systems lead to strong integration of renewable electricity generation in the electricity market (COM 2008b: 12). In Germany this system was introduced as an option in 2012. This form of direct marketing has been obligatory for new plant since 2014, and the former fixed remuneration practically abolished for new projects.[7]

A study commissioned by the Federal Environment Agency concludes that the sliding market premium creates real incentives to optimise wind and photovoltaic plants according to demand and avoiding operation when prices are negative. Future developments should therefore proceed within that framework (UBA 2015: 123). The introduction of the market premium may for example have contributed to photovoltaic installations becoming less strictly south-facing, and in some cases facing east or west. This configuration permits more modules to be installed within the same area and as such increases the total electricity yield – especially in the morning and evening, when revenues tend to be higher than in the middle of the day. At the same time the midday infeed peak is smaller, which greatly simplifies network integration (e21 2015: 4).

Independent of the switch to the market premium system in the German Renewable Energy Law (EEG), the system-compatibility of wind turbines in particular has improved considerably over the past ten years. Even before the introduction of the premium system, ever taller wind turbines were being erected with ever wider rotor diameters, whereas in comparison to the technical possibilities the increase in installed capacity remained small. Thus the average ratio between installed capacity of the generator and swept area of the rotors[8] remained almost unchanged between 1996 and 2011 in Germany while hub height increased continuously. Since 2011 the ratio has in fact fallen, while hub heights continued to increase (Deutsche WindGuard 2015: 7 f., 2017: 3). These developments contribute decisively to increasing the full load hours of new wind turbines, reducing infeed fluctuations and benefitting system integration.

However the potential of market integration to reduce the infeed fluctuation of wind and solar even further is strongly limited. Wind turbines cannot generate electricity when no wind is blowing; solar modules will never supply electricity at night. So in a system heavily reliant on renewables flexibility options, such as load management, biogas plant, gas turbines, storage etc., are crucial. In this respect different types of power stations have always fulfilled different functions. Before the energy transition and the strong growth of renewables,

7 Already in mid-2014 in Germany all offshore wind turbines, almost 90 percent of all onshore wind turbines, almost 70 percent of all biomass system and about 15 percent of installed output of photovoltaic installations were marketed directly via the market premium model (IWES et al. 2014: 4).

8 The "swept area" is the circle described by the rotor blades.

gas-fired power stations and pump storage were largely responsible for adjusting electricity production in response to short-term fluctuations in consumption. Nuclear, coal, hydro and CHP supplied the always-needed base load. There was therefore little need to adapt the output of baseload power stations to precise demand (for which many of them are not designed or suited). They generated electricity at low commercial cost, but to the detriment of the environment. Although most conventional power stations are now considerably more flexible than they were just a few years ago, reducing output to zero for short periods is still often impossible (Lambertz et al. 2012).

With a high and rising share of wind and photovoltaic the need for traditional baseload power stations falls. The more frequently infeed from these renewable installations comes close to total electricity consumption for shorter or longer periods, the more problematic inflexible baseload power stations become for security of supply. Therefore, above all, conventional generating capacity needs to be further flexibilised as the share of renewable electricity continues to grow, and new flexibility options need to be incentivised. In the future climate-friendly generation scheme, wind and photovoltaic generate the cheapest electricity, and as such replace the traditional baseload power stations. The flexibility options then have to compensate not only varying consumption, but also the fluctuating infeed from renewable technologies.

Where greater market integration is demanded it should be remembered that the potential for designing and operating wind and solar systems to better meet demand is strongly restricted. Flexibility options are needed to compensate. A series of policy instruments are available, such as adjusting network charges, markets for substitute supply, and balancing systems (UBA 2015: 136). More strongly fluctuating electricity prices should also incentivise flexibility in conventional power stations. This could occur through a dynamisation of (previously fixed) surcharges on the electricity price, for example renewable electricity levies and network charges (IWES/Energy Brainpool 2015: 45; Ecofys 2014; Frontier Economics/BET 2016).

Negative electricity prices

Should wind power and photovoltaic installations – as is often argued – stop feeding in electricity when the spot market price is negative? At least as long as negative prices occur while conventional power stations are still operating that step is controversial, because these renewable technologies generate electricity at marginal costs close to zero, while all conventional power stations have substantially higher marginal costs. Moreover, wind and photovoltaic cause almost no greenhouse gas emissions during operation, in contrast to fossil-fuel power stations (UBA 2015: 123, fn. 128; EnKliP 2015c: 39; Kopp et al. 2013: 31; IZES et al. 2013: 70). So measured against two of the three goals of energy policy – economic efficiency and environmental protection – shutting off wind and photovoltaic installations during periods of negative electricity prices is disadvantageous.

Independently of this, under the EEAG any system for financing expansion of renewable electricity can specify that renewable electricity installations can be shut off when electricity prices are negative. In the German Renewable Energy Law (EEG) that has been implemented since 2014 in the scope of the fixed-price and premium feed-in system (BMJV 2014: § 24 Abs. 1).

Cost analysis for market integration instruments for fluctuating renewables

Given that certain renewable energy sources are weather-dependent, the question of whether the objectives of the triple goals of energy policy can actually be better fulfilled through further market integration needs to be carefully considered. In particular the economic advantages for the system as a whole must outweigh the costs associated with market integration. Ultimately, market integration of the fluctuating renewable sources in the German Renewable Energy Law (EEG) on the basis of the premium system already costs €0.004 per kWh of renewable electricity fed in; for onshore wind turbines that represents more than 5 percent of total remuneration (BMJV 2014: § 37 Abs. 3).

In this connection it should also be considered whether it is more advantageous for many individual actors to prepare infeed forecasts and conduct balancing for differences, or whether it would be better in overall economic terms if this were undertaken by a central actor. That would prevent, for example, operators of photovoltaic installations having to purchase replacement power in the event of unexpected cloud cover, even in a situation where equally unexpected wind speeds boost wind power infeed. In this context, the intensity of market integration that actually generates advantages for the consumer and the economy as a whole needs to be taken into consideration (DIW 2015: 503–508; Nestle 2011).

4.4.2 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

In many EU member states the switch to premium systems has led to extensive market integration within the price-control model. This has also been acknowledged by the European Commission (COM 2013: 9). All further measures to strengthen market integration should be carefully scrutinised as to whether they can actually contribute to better fulfilment of the triple goals of energy policy. It should be ensured that they actually reduce the overall costs of the electricity system while impairing neither climate protection nor security of supply. Options for better market integration lie for example in markets for substitute supply and can be implemented in premium feed-in systems, competitive bidding and quota models.

4.5 INTERNAL MARKET

The Renewable Energy Directive and the current Guidelines on State Aid for Environmental Protection and Energy explicitly permit renewable electricity financing to use different mechanisms than those for financing conventional power stations. So according to existing EU law, member states are allowed to define specific financing instruments for renewable electricity outside the existing energy market. But this special status has been challenged. One of the arguments used to assert that renewable installations should be fully financed in the same energy market as conventional and flexibility plants is the fact that wind and photovoltaic already achieve electricity generation costs comparable with those of conventional plant. It is argued that today they are technically mature and in certain member states already contributing a significant share of the electricity supply (COM 2013: 6; COM 2015b: 17; CDU/CSU/SPD 2013: 54; Öko-Institut 2014: 53; BDEW 2013: 27). In light of this objective it is proposed for example to introduce a fixed market premium or to finance capacity rather than amount. The idea is that this will pave the way to a joint market with conventional energy sources (Öko-Institut 2014).

4.5.1 ANALYSIS

The above description of the capabilities and costs of modern renewable electricity technologies is fundamentally correct. But that does not mean that there will no longer be a need for specific financing of the fluctuating renewable sources in the foreseeable future, or that an internal market on its own could incentivise the political objective of expanding renewable electricity and meeting the political energy and climate goals.

In the analysis we must distinguish between two central functions of the electricity market:

1. Short-term operational planning and control of existing generating capacity, such that the facilities with the lowest marginal costs feed in electricity;
2. Signals on the basis of which investors can decide whether and which power stations to build or close.

If the market sends the right messages in both spheres it will ensure the short-, medium- and long-term security of the electricity supply. But – as already mentioned – a uniform market for renewable and flexibility technologies should also send signals for the expansion of renewable generation capacity.

Operational planning

The system for controlling existing power stations basically functions smoothly in the energy-only market, even with a high share of renewable electricity. If renewable electricity generation is financed through a system where operators sell their own electricity in the market – as in the premium feed-in system – they also receive a signal indicating scarcity to which they can respond.

But given that specifically financed renewable electricity installations need to receive higher remuneration than the momentary market price in order to operate economically, the market signal is distorted and its effect limited. In most cases this is unproblematic. Because wind, photovoltaic and hydro-power have marginal costs of virtually zero, they should be feeding in electricity at least as long as the spot price is not negative. This they do as a rule in all financing systems. Whether they should also operate when electricity prices are negative is a matter of controversy. But all renewable electricity financing systems can be configured to ensure that no remuneration is paid when electricity prices are negative (see Chapter 4.4.1).

Systems using cultivated biomass are a different matter, as they have relatively high marginal costs. Nonetheless in all financing instruments they continue to operate when the spot market prices are low or even slightly negative. Although a market premium system does create incentives to supply in line with demand, further measures should be adopted to reinforce the orientation of biomass plants on short-term market prices. One example of this is the flexibility bonus in the German Renewable Energy Law (EEG).

Investment decision-making

Until about twenty years ago decisions about building power stations were not left to the market. Instead the state prepared plans for the state-run electricity supply – and decided how many plants were built and what type they should be. Only since the liberalisation of electricity markets around the end of the 1990s in the European Union, the United States and other regions has this decision in general been left to the market. The energy-only market, on which the EU's and other electricity markets are oriented, was created for this purpose. It is based on trading in the quantities of electricity demanded by customers. But the relatively brief experience to date is insufficient to indicate conclusively whether this market really does send correct and adequate signals for the construction of necessary generating capacity. Most existing conventional power stations were built or at least planned before the liberalisation of the electricity markets. They still have considerable technical and commercial working life and guarantee security of electricity supply to this day.

Nonetheless, New Zealand, Chile, Colombia, United Kingdom, France, parts of the United States, and other states plainly mistrust the energy-only market. Instead, in additional capacity markets, they put out for tender what the government regards as the necessary installed capacity (or intend to introduce such a system) (Agora Energiewende 2015b: 1). Here the decision as to what generating capacity needs to be available is made by the state not the market. But not all EU member states want to follow that route. Thus the German government – with its Electricity Market 2.0 (Strommarkt 2.0) – has adapted the framework of the existing energy-only market so that the market sends the necessary signals for construction of flexibility options. It wishes to avoid the state deciding how many such facilities Germany needs (BMWi 2015c: 3, 2016e).

It remains to be seen whether this will succeed. For a string of flexibility options there are good reasons why control via a well-functioning energy-only market could be successful. Gas turbines, load management, cheap storage technologies and existing emergency generators can all come on stream with relatively low investment costs and short planning cycles. These flexibility options can relatively quickly recoup their investment costs if short-term electricity price fluctuations increase as expected in a system with a growing proportion of fluctuating renewable sources and few baseload power stations (or none at all) (BMWi 2014b: 13). Under these circumstances there could be enough investors willing to invest in these technologies.

Wind power and photovoltaic are a very different matter. They are often unable to feed in electricity when the price in the energy-only market is high, so it is highly uncertain whether they can recoup their investment costs within an appropriate period. And in the case of wind and photovoltaic those costs are comparatively high, whereas their operating costs are very low. It must therefore be assumed that even a modified energy-only market will not be capable of incentivising the construction of the right number of wind power and photovoltaic installations (IEA 2016: 12).

Additionally, as the shares of wind and photovoltaic rise, short-term electricity prices will increasingly be systematically low at the times when those technologies are able to feed in large amounts. This effect increases as the shares of fluctuating energy sources increase (Hirth/Schlandt 2016; Öko-Institut 2014: 117). If it is possible to refinance these systems at all in an energy-only market, then only with extremely high prices for coal, gas and uranium, as well as CO_2 (Höfling 2013). And it is questionable whether such high prices will transpire quickly enough to adequately incentivise the politically desired speed of growth of renewable energy. The state will therefore have to organise specific financing for the expansion of renewable electricity and will have to decide what installed capacity of these fluctuating renewable sources is needed and how many installations are required altogether for a climate-friendly and environmentally sound electricity supply. If politically desired new renewable electricity installations are actually to be built, a politically organised specific financing system will remain indispensable (Piria et al. 2013: 7; IEA 2016: 12).

Independently of this it must be assumed that during the entire transition to a completely renewable electricity supply conventional power stations cannot be finally shut down until both their capacity and their ancillary services have been reliably substituted. This leads to overcapacity, as already esists today in the EU and many member states, such as Germany. Because of this long-term overcapacity, average prices in the wholesale markets can be expected to remain consistently below the generation costs of new power stations, both conventional and renewable. That is another reason why specific financing is required for new renewable electricity capacity (IEA 2016: 12).

In relation to security of supply this does not represent a problem, because the task of guaranteeing it in the long term falls above all to the flexibility options (UBA 2015). The main task of cheap renewable electricity technologies like wind and photovoltaic, on the other hand, will be the production of electricity.

To date no proposal has been made for resolving this fundamental and systematic problem in a uniform market for fluctuating renewables and flexibility options in such a way as to automatically achieve the energy policy objectives – namely, a rapid increase in the share of renewables to the point of replacing fossil-fuel power stations, and thus a massive permanent reduction in greenhouse gas emissions (COM 2015b: 2).

4.5.2 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

In the existing energy markets wind and photovoltaic installations will remain unable to refinance themselves for the foreseeable future – and possibly will never be. To date there is no proposal for a differently structured energy market in which an internal market for fluctuating renewables and flexibility options would bring about the politically desired expansion of renewable electricity through market mechanisms without additional financing. Instead it is questionable for systemic reasons whether such a market can ever exist.

Thus the overarching goal of bringing together the renewable electricity technologies and all the other generating technologies in a uniform market makes no sense as long as expanding renewable electricity is a political objective. Modifications of the financing instruments seeking to make them fit better with existing or future markets are therefore unhelpful. Thus the introduction of a fixed premium for financing wind or photovoltaic capacity is neither necessary nor sensible, but associated with high risks (EnKliP 2015c). Instead their specific financing should be made efficient and effective in broader economic terms.

In terms of making the best economic use of existing power stations, the specific financing of wind, photovoltaic and hydro-power sends no fundamentally wrong signals. This is true irrespective of the instrument used.

4.6 EUROPEAN HARMONISATION AND CROSS-BORDER FINANCING

For many years the European Commission has been pursuing the goal of harmonising the financing of renewable electricity expansion within the Union. In the preparations for the Renewable Energy Directive of 2001 and again when it was reworked in 2009 the Commission sought to introduce a uniform European quota system. Each time this was rejected by the Parliament and the Council (see Chapter 5.1).

The draft for the new Renewable Energy Directive now demands a cross-border financing system designed to prepare the way for European Harmonisation. It proposes that by 2025 projects from other member states should be able to bid for at least 10 percent of a volume put out to tender (and by 2030 for at least 15 percent). The central motivation is that this would reduce the costs of power generation by ensuring that the most cost-effective locations are used (COM 2016a: Art. 5 (1) and (2)).

4.6.1 ANALYSIS

There are indeed regions – and entire member states – where the most important renewable electricity technologies such as wind power and photovoltaic are tangibly more expensive than elsewhere for geographical or meteorological reasons. In these cases there should be possibilities to use cheaper renewable energy sources in other European regions. But these already exist in the current Renewable Energy Directive, without cross-border financing being an explicit requirement.

It is important that many member states seek to increase the share of renewable electricity in their national energy mix. But to compel these states to fund renewable installations located in another EU state would appear to contravene the letter and spirit of Article 194 of the Treaty on the Functioning of the EU. It gives every member state the right "to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply" (EU 2012: Art. 194). That would include a member state's right to ensure that most of its electricity consumption is generated within its territory. Many member states do indeed share that preference (CE Delft et al. 2015: 22). The compulsion to admit installations in other countries to competitive bidding proposed in the current draft Renewable Energy Directive impinges upon the member states' rights under Article 194, and risks lessening their motivation to foster an increasing renewable energy share.

It is also questionable whether it is realistic to concentrate renewable electricity generation so heavily in especially high-yield locations. Ecological and political grounds suggest otherwise. In the longer term that would mean most of Europe's solar electricity supply coming from southern and south-eastern Europe and wind electricity from the North Sea, Ireland, northern France and parts of Spain, from where it would have to be distributed across the entire EU (Unteutsch/Lindenberger 2014). That in turn would make many member states strongly dependent on electricity imports.

Regions with especially good conditions would have to tolerate a very high density of solar and wind installations in order to supply large parts of the EU. And distributing the electricity would involve constructing enormous new transmission capacities between member states and through transit states. That would likely generate serious acceptance problems and take a great deal of time – which in light of the Paris targets is no longer available.

It is also likely to create acceptance problems if large parts of the EU have to import renewable electricity but cannot profit from the associated value creation. The possibilities of community energy would also be heavily constrained under such a supply structure.

4.6.2 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

Cross-border financing of renewable electricity generation is fundamentally possible regardless of instruments. Corresponding arrangements were created in the 2009 reworking of the Renewable Energy Directive (COM 2009: Art. 6–8). In some cases voluntary cooperation with other member states – especially neighbouring states – may be useful. That should remain legally and technically possible and the conditions for it should be improved. There are however a series of good reasons why many states find it unattractive to undertake a relevant portion of their financing of renewable electricity expansion through a cross-border (or completely harmonised EU-wide) financing system – and will continue to do so. To name but the most prominent: the desire to generate most of their electricity domestically, and to keep associated value creation and employment within the country.

On a broader level, a climate-friendly EU electricity supply would in theory be especially cost-effective if it concentrated on the best locations for wind, solar, hydro-power and geothermal. But given the distribution and acceptance issues such an energy scenario is unrealistic. Therefore neither the long-term goal of complete harmonisation of renewable electricity financing nor the draft Renewable Energy Directive's cross-border principle is a sensible option. This was also reflected in the public hearing on the future Renewable Energy Directive, where just 17 percent of more than 600 stakeholders supported pressing ahead with cross-border financing (COM 2016b: 3).

4.7 TECHNOLOGY NEUTRALITY

4.7.1 THE CHALLENGE

Under the current Guidelines on State Aid for Environmental Protection and Energy competitive bidding for new renewable electricity installations can only be restricted to particular technologies if open bidding would lead to a suboptimal outcome (COM 2014e: note 126). Corresponding provisions are also contained in the Commission's draft for the new Renewable Energy Directive (COM 2016a: Art. 4 (3)). The Commission believes that technology-specific renewable electricity financing only makes sense when technologies are at an early stage of development, or for small and micro installations (COM 2013: 5). Like the demand for cross-border financing, technology-neutrality is regarded as necessary to achieve cost-effectiveness.

4.7.2 ANALYSIS

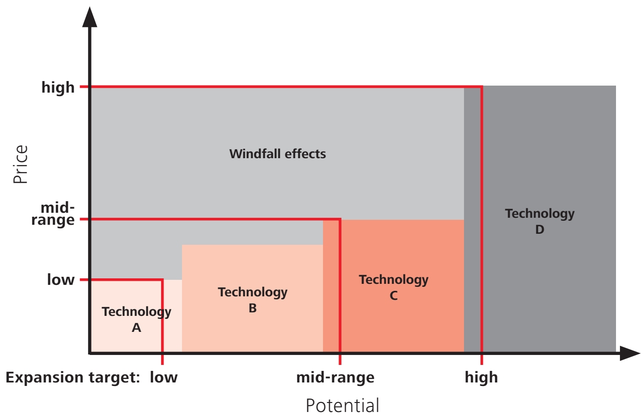
As with the question of cross-border financing, the long-term effects must be considered. For various reasons it would appear advisable to seek a good mix of technologies in an electricity supply using high proportions of renewable energy. This applies not only to the EU as a whole, but also to individual member states and potentially smaller regions too:

- In a technology mix the fluctuating renewable sources wind and sun can complement each other very well. In winter, when the sun is weak, the wind blows more strongly, while in summer it is often the other way round. At night, when photovoltaic installations produce no electricity, wind turbines can often fill the gap. Such balancing reduces the required storage capacity and associated losses, and as such also reduces the total necessary installed capacity of renewable electricity.
- Biomass systems are especially well suited for balancing demand and infeed fluctuations. If they were avoided completely more electricity storage capacity would be needed.
- There is often a lack of suitable locations for renewable electricity installations. This frequently affects onshore wind power. But building-integrated photovoltaic is unlikely to be enough either. It will often be impossible to secure the energy supply using just one of the two technologies; in fact even both together are unlikely to suffice. Offshore wind power will therefore be an essential part of the long-term energy mix.
- From the ecological perspective, but also to keep at least part of electricity production as close as possible to consumers, the use of building-integrated photovoltaic appears preferable to ground-mounted systems. It may therefore be politically desirable to prioritise the financing of building-integrated photovoltaic even if its generation costs are currently still higher.

All the aforementioned technologies – onshore and offshore wind power, building-integrated and ground mounted photovoltaic, and biomass – will probably continue to have different generation costs in the medium term. If the chosen system finances only what is currently the cheapest technology, this could block the exploitation of the medium- and long-term advantages of a technology mix.

An ambitious political expansion target for renewable electricity generation is very unlikely to be achieved using only the cheapest of the aforementioned technologies. In a technology-neutral financing system, however, the price is determined by the most expensive units required to achieve the target (see Figure 14). An unambitious expansion target can be achieved in full using the cheapest technology A. The price is low and there are no windfall effects. For a mid-range or high expansion target the more expensive technologies B, C or even D are needed. In a technology-neutral system these more expensive technologies determine the price across all technologies, leading to windfall effects and high prices. That would place a substantial additional burden on electricity consumers (Lauber/Toke 2005; Butler/Neuhoff 2005; EEG et al. 2004; ECN et al. 2005; Diekmann/Kemfert 2005).

Figure 14
Windfall effects in technology-neutral financing systems



Source: Author.

4.7.3 CONCLUSIONS FOR RENEWABLE ELECTRICITY FINANCING

Technology-neutral financing of renewable electricity expansion can achieve short- and medium-term savings – but only if the share of renewable electricity is small and just one technology is needed. If the share is higher multiple technologies are needed for technical and system-related reasons. Under these conditions technology-neutral financing leads to large windfall effects and high prices. In theory, both technology-neutral and technology-specific financing of renewable electricity generation can be implemented with feed-in, quota and competitive bidding systems.

5

CONCLUSIONS AND RECOMMENDATIONS TO THE GERMAN GOVERNMENT

5.1 THE INFLUENCE OF THE GERMAN GOVERNMENT

Unlike the Guidelines on State Aid for Environmental Protection and Energy, the new Renewable Energy Directive also requires the approval of the European Council and the European Parliament. Recent developments on issues like climate protection and the financial crisis demonstrate the kind of influence Germany wields within the EU. Acting in concert with other member states, Germany also played a decisive role in shaping the European rules for renewable energy.

This is very obvious in the question of renewable electricity financing. Both in the Renewable Energy Directive of 2001 and its reworking in 2009, the European Commission explicitly tried to introduce an obligatory EU-wide quota system (Futterlieb/Mohns 2009: 17; COM 2008a: Art. 5–10; IFIC 2016). In both cases this was rejected, and the existing system of free choice of financing instrument upheld. In both cases the German government played a crucial role. As an example, it prepared – in cooperation with the United Kingdom and Poland – a joint non-paper rejecting such a quota system and laying out alternatives (Germany et al. 2008a, 2008b). Together with Spain it also initiated the International Feed-In Cooperation (IFIC) in 2004, which Slovenia and Greece later joined. The IFIC pointed out to the other member states the potential negative consequences of a switch to a quota system. Together with other discussions and consultations this was effective, and the push by the Comission to implement a harmonised quota system found no majority in the Council. After the European Parliament added its voice, the European Commission conceded (Futterlieb/Mohns 2009: 22). Against this background, the German government should work with other member states to generate the same kind of pressure over this latest revision of the Renewable Energy Directive. This is of great importance because major changes need to be made to the Commission's proposal if – ideally – all member states are to pursue a committed expansion of renewable electricity comparable to that planned by Germany.

5.2 THE RENEWABLE ENERGY DIRECTIVE'S SUCCESS TO DATE

The EU's expansion of renewable electricity has significantly reduced greenhouse gas emissions, created jobs, reduced dependency on energy imports and stimulated innovation. The Renewable Energy Directive has been decisively responsible for all EU states undertaking political efforts to expand renewable energy sources. This meant that Germany, Denmark and Spain, which have led the way on renewables, have since then been embedded within an EU-wide expansion of renewable electricity.

The 2009 Renewable Energy Directive's target of increasing the share of renewable energy in total energy consumption to 20 percent by 2020 is largely achieved. More than almost any other policy measure, it contributes to the European climate protection target of reducing greenhouse gas emissions by 20 percent by 2020 – and if other states make matching efforts, by 30 percent. New wind power, photovoltaic and biomass power plants have made by far the largest contribution. If that success story is to continue, the new Renewable Energy Directive must guarantee political dependability and stability.

Until recently, member states enjoyed the freedom to freely choose the instruments used to finance renewable electricity generation. This has allowed them to respond to their specific national circumstances. The compulsory national expansion targets under the Renewable Energy Directive also forced member states to pursue proactive renewable electricity policies. The latter gave them additional arguments vis-à-vis political and economic stakeholders – such as the traditional energy companies – that are generally sceptical towards a rapid expansion of renewable electricity. The Commission's proposal to abolish both these principles in the new Renewable Energy Directive is likely to seriously hamper the European expansion of renewable electricity.

On the basis of free choice of instruments to finance renewable energy, price control instruments such as feed-in tariffs clearly came out on top in competition for the most effective and efficient. In recent years, ever more member states chose premium feed-in systems, where the operators market the electricity themselves. The renewable electricity they generate is thus largely integrated in the electricity market. By 2012 only six member states were using a quota system and three a competitive bidding system. Yet now the 2014 Guidelines on State Aid for Environmental Protection and Energy force all EU states to switch to competitive bidding, at the latest when a major overhaul of their corresponding legislation is undertaken.

5.3 CHANGES REQUIRED IN THE DRAFT RENEWABLE ENERGY DIRECTIVE

The Commission's proposal for the new Renewable Energy Directive enshrines the competitive bidding principle, additionally insisting that in general it be technology-neutral and cross-border. These incisive changes will impair the stability and dependability of European renewable energy policy. They endanger the European Union's renewable energy success story, climate targets, employment, innovations and further improvements in security of supply. Yet the arguments used to justify these fundamental changes are anything but solid:

– Restricting renewable electricity technologies that are already cost-effective cannot be justified in light of the increasingly noticeable climate crisis and the ambitious targets of the Paris Climate Agreement, the need to replace obsolete power stations, and further falling costs for renewable technologies.
– The generation costs of most renewable electricity technologies are no longer higher than those of new conventional power stations. Often they are cheaper.
– Nor does localised network congestion adequately justify limiting the expansion of renewable electricity. Instead affected supply should be channelled into new applications such as heating, cooling, and transport, and into electricity storage and production of hydrogen and synthetic methane. Pressing ahead with that kind of sector coupling is likely to be more efficient in overall economic terms than restricting the expansion of renewable electricity where network congestion arises. In fact, expanding renewable electricity generation increases the political pressure to accelerate network optimisation and expansion.
– Now that the costs of power produced with onshore wind and photovoltaic – and in some cases also offshore wind – are comparable to those of conventional power stations, the cost argument can no longer be used against price-control instruments. On the other hand, meeting the challenges of the climate crisis requires instruments that permit expansion to exceed the politically defined targets. Only price-control instruments can do that.
– The price-control instruments that have to date been most widely used in the EU and further afield have been responsible for the emergence of a global market in renewable energy technology. This has produced massive cost reductions and impressive quality improvements. Furthermore, the political targets for expanding renewables need to be met – and even better exceeded – even if renewable technologies would not yet be fully competitive with conventional power sources in the existing energy markets. In other words: Since there are political targets for increasing of the share of renewables to protect the climate, there is no need for competition between renewable electricity and conventional power stations for the foreseeable future. This applies irrespective of the fact that renewable electricity technologies are out of their infancy and today account for a relevant and rising proportion of electricity production.
– With the trend to premium feed-in systems, where the operators sell their electricity in the markets, many EU states have made an important step towards comprehensive market integration of renewable electricity. Any further market integration moves should be carefully assessed to ensure they contribute to fulfilling the triple goals of energy policy.
– Although electricity from wind power and photovoltaic is already often cheaper than electricity from new conventional power stations, the existing electricity markets will not in the foreseeable future be capable of refinancing them. There are also no politically realistic concepts for a common electricity market for fluctuating renewable energy sources and flexibility options. There is therefore no reason to ensure that arrangements for financing renewable electricity generation can later be completely integrated into a uniform market whose shape is currently completely unknown.
– Neither international experience nor theory suggest that volume-control instruments – such as competitive bidding or quota systems – are per se more effective or more efficient than fixed-price and premium feed-in systems.
– In a future system with a large proportion of renewable electricity it is unrealistic to expect that electricity production will be predominantly undertaken by the cheapest technologies, as this would be systemically inefficient and existing potentials would be insufficient to satisfy demand. It is therefore foreseeable that different renewable electricity technologies with a range of costs will have to be used in most member states. Under these conditions technology-neutral financing would lead to significant windfall effects and higher prices for consumers. It would therefore not appear expedient to compel states to use technology-neutral financing instruments.
– For similar reasons it is not expedient to compel states to use cross-border instruments. Generating most of the European electricity supply at the few ideal locations and then distributing it across the EU does not appear realistic.

The need to strengthen the markets – now that renewable generating technologies are cost-effective, technically mature and supply a significant proportion of the electricity supply – is frequently cited as a reason to reject price-control instruments for financing renewable generation. But "more market" is not automatically advantageous in relation to the triple goals of energy policy. Market and competition should be means to ensure a cost-effective, environmentally sound/climate-friendly, and secure electricity supply. It is not the case that every measure to intensify market integration will automatically be advantageous for society as a whole. If there is a risk of negative effects, action should be weighed very carefully before moving ahead. The triple goals of energy policy should not be subordinated to the goal of "more market" or the idea of the European market, but vice versa.

The new Renewable Energy Directive would further restrict the limited exceptions to the imperative to implement competitive bidding systems, as is already the case with the German EEG. And anyway, national governments seeking to apply exceptions become involved in long and complicated negotiations with DG Competition, with negative impacts on security of investment. The new Renewable Energy Directive should instead offer the member states maximum freedom to choose the instruments with which to finance the the EEAG's electricity expansion, with as few obstacles as possible placed in their way.

5.4 RECOMMENDATIONS TO THE GERMAN GOVERNMENT

The German government should therefore argue for the following in the European Council and vis-à-vis the Commission:

- As under the 2001 and 2009 Renewable Energy Directives, every EU member state should continue to enjoy freedom to choose the optimal financing instruments for renewable electricity generation according to their national circumstances. Because free choice improves the possibilities for rapid expansion of renewables across the entire EU, it remains advantageous for Germany even if the German government wishes to retain its recently introduced competitive bidding system. And if it were to transpire a few years from now that – due to the switch to the bidding system – Germany cannot achieve certain targets for particular technologies, free choice of instruments would also permit an alternative to competitive bidding to be introduced in those cases. The Commission's current proposal for the new Renewable Energy Directive blocks those options.
- The member states should be permitted to retain the freedom they currently enjoy to conduct technology-specific financing of renewable electricity technologies.
- Rather than compelling states to permit cross-border financing the voluntary possibilities should be improved.
- In order to gather reliable data on the real costs to consumers associated with the current renewable electricity expansion in a form that is comparable between member states, the Commission should develop appropriate cost indicators. These should be capable of taking the place of renewable electricity levies in the discussion in the member states, which have been misleading.
- Given that price-control instruments will remain an option for small renewable electricity installations anyway, the Commission should support the member states in arriving at reliable calculations of the generation costs of renewable electricity in order to be better equipped for fixing remuneration. This could be realised by offering technical support and/or defining methodological requirements for the member states concerning the calculation of remuneration tariffs.

In order to assert these points effectively at the European level the German government should seek coalitions with other member states and agree strategies at the top political level. Such an approach has been very successful in the past. More broadly, the German government should initiate an open political debate over the concrete role of the market – and the EU's internal market – in the medium- to long-term conversion of the EU energy supply. The debate over the Clean Energy Package could offer a favourable opportunity to do so. The discussion should include the question of where in the energy supply system a stronger market orientation and a further deepening of the internal market could contribute to achieving the triple goals of energy policy. The process should be especially mindful of the great challenges associated with the climate crisis and the ambitious targets of the Paris Climate Agreements.

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CCTS	Carbon Capture, Transport and Sequestration
DG	Directorate-General
EEA	European Environmental Agency
EEAG	Guidelines on State Aid for Environmental Protection and Energy 2014–2020 (Environmental and Energy Aid Guidelines)
EEG	German Renewable Energy Law (Erneuerbare-Energien-Gesetz)
EERL	Renewable Energy Directive
GHG	greenhouse gas
g/kWh	grams per kilowatt hour
IFIC	International Feed-In Cooperation
Mtoe	million tonnes of oil equivalent
WACC	weighted average cost of capital

References

50Hertz Transmission, Amprion, Tennet, TransnetBW 2016: Prognose der EE-GUmlage 2017 nach AusglMechV, https://www.netztransparenz.de/portals/1/Content/EEG-Umlage/EEG-Umlage%202017/20161014_Veroeffentlichung_EEG-Umlage_2017.pdf (25.10.2016).

Ágence de l´Environment et de la Maîtrise de l´Energie (ADEME) 2016: A 100% Renewable Electricity Mix? Analysis and Optimisation: Exploring the Boundaries of Renewable Power Generation in France by 2050, http://www.ademe.fr/sites/default/files/assets/documents/renewable-electricity-mix-finalreport-ademe-201601.pdf (12.9.2016).

Agora Energiewende 2015a: Die Sonnenfinsternis 2015: Vorschau auf das Stromsystem 2030: Herausforderungen für die Stromversorgung in Systemen mit hohen Anteilen an Wind- und Solarenergie, Berlin, http://www.agoraenergiewende.de/fileadmin/downloads/publikationen/Hintergrund/Sonnenfinsternis_2015/Agora_Sonnenfinsternis_web_16032015.pdf (6.12.2015).

Agora Energiewende 2015b: Kapazitätsmarkt oder strategische Reserve: Was ist der nächste Schritt?: Eine Übersicht über die in der Diskussion befindlichen Modelle zur Gewährleistung der Versorgungssicherheit in Deutschland, Berlin, http://www.agora-energiewende.de/fileadmin/downloads/publikationen/Hintergrund/Kapazitaetsmarkt_oder_strategische_Reserve/Agora_Hintergrund_Kapazitaetsmarkt_oder_strategische_Reserve_web.pdf (5.12.2015).

Agora Energiewende 2016: Die Energiewende im Stromsektor: Stand der Dinge 2015: Rückblick auf die wesentlichen Entwicklungen sowie Ausblick auf 2016, Berlin, www.agora-energiewende.de/fileadmin/Projekte/2016/Jahresauswertung_2016/Agora_Jahresauswertung_2015_web.pdf (8.1.2016).

Annan, Kofi 2014: Unser aller Versagen, in: Süddeutsche Zeitung, 24.1.2014, http://www.sueddeutsche.de/wissen/klimawandel-unser-aller-versagen-1.1870435 (12.2.2015).

Bauchmüller, Michael 2016: Eine Katastrophe von einem Sommer: Die Überschwemmungen in Süddeutschland waren nur Vorboten künftiger Unwetter, warnt der Wetterdienst, in: Süddeutsche Zeitung, 13.9.2016, p. 7.

Bundesministerium der Justiz und für Verbraucherschutz (BMJV) 2004: Gesetz zur Neuregelung des Rechts der Erneuerbaren Energien im Strombereich, BGBl. I 2004 (40), pp. 1.918–1.930, https://www.bgbl.de/xaver/bgbl/start.xav#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl104s1918.pdf%27%5D__1500796263312 (2.6.2017).

Bundesministerium der Justiz und für Verbraucherschutz (BMJV) 2014: Gesetz zur grundlegenden Reform des Erneuerbare-Energien-Gesetzes und zur Änderung weiterer Bestimmungen des Energiewirtschaftsrechts, BGBl. I 2014 (33), pp. 1.066–1.132, https://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&start=//*[@attr_id=%27bgbl114s1066.pdf%27]#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl114s1066.pdf %27%5D__1497513339751 (2.6.2017).

Bundesministerium der Justiz und für Verbraucherschutz (BMJV) 2016: Gesetz zur Einführung von Ausschreibungen für Strom aus erneuerbaren Energien und zu weiteren Änderungen des Rechts der erneuerbaren Energien, BGBl. I 2016 (49), pp. 2.258–2.357, https://www.bgbl.de/xaver/bgbl/start.xav?start=%2F%2F*%5B%40attr_id%3D%27bgbl116s2258.pdf%27%5D#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl116s2258. pdf%27%5D__1497513656406 (2.6.2017).

Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMU) 2007: Renewable Energy Sources Act (EEG): Progress Report 2007, Berlin, http://www.feed-in-cooperation.org/wDefault_7/content/documents/germany_documents_index_alt.php (8.7.2016).

Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMU) 2011: Erneuerbare Energien: Innovationen für eine Nachhaltige Zukunft, Berlin, http://www.ifeu.de/energie/pdf/ee_innovationen_energiezukunft_2012.pdf (6.2.2015).

Bundesministerium für Wirtschaft und Energie (BMWi) 2014a: Eckpunkte für die Reform des EEG, Berlin, http://www.bmwi.de/BMWi/Redaktion/PDF/E/eeg-reform-eckpunkte,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf (28.1.2014).

Bundesministerium für Wirtschaft und Energie (BMWi) 2014b: Ein Strommarkt für die Energiewende: Diskussionspapier des Bundesministeriums für Wirtschaft und Energie (Grünbuch), Berlin, http://www.bmwi.de/BMWi/Redaktion/PDF/G/gruenbuch-gesamt,property=pdf,bereich=bmwi2012sprache=de,rwb=true.pdf (23.1.2015).

Bundesministerium für Wirtschaft und Energie (BMWi) 2015a: Erneuerbare Energien in Zahlen: Nationale und internationale Entwicklung im Jahr 2014, Berlin, http://www.bmwi.de/BMWi/Redaktion/PDF/E/erneuerbare-energienin-zahlen-2014,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf (20.4.2016).

Bundesministerium für Wirtschaft und Energie (BMWi) 2015b: EEG Novelle 2016, Berlin, http://m.bmwi.de/BMWi/Redaktion/PDF/E/eckpunkte-eegnovelle-2016,property=pdf,bereich=bmwimobile2012,sprache=de,rwb=true.pdf (4.12.2015).

Bundesministerium für Wirtschaft und Energie (BMWi) 2015c: Ein Strommarkt für die Energiewende: Ergebnispapier des Bundeministeriums für Wirtschaft und Energie (Weißbuch), Berlin, http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/weissbuch,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf (8.12.2015).

Bundesministerium für Wirtschaft und Energie (BMWi) 2016a: Bundesregierung legt Rechtsmittel gegen Urteil des Gerichts der Europäischen Union in Sachen EEG 2012/Staatliche Beihilfen ein, Berlin, https://www.bmwi.de/Redaktion/DE/Meldung/2016/20160721-bundesregierung-legt-rechtsmittelgegen-urteil-des-gerichts-der-europaeischen-union-in-sachen-eeg-ein.html (17.11.2016).

Bundesministerium für Wirtschaft und Energie (BMWi) 2016b: Energiedaten: Gesamtausgabe, Berlin, http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/Energiedaten/gesamtausgabe,did=476134.html (25.8.2016).

Bundesministerium für Wirtschaft und Energie (BMWi) 2016c: EEG-Umlage 2017: Fakten und Hintergründe, Berlin, https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/eeg-umlage-2017-fakten-hintergruende.pdf?__blob=publicationFile&v=3 (20.10.2016).

Bundesministerium für Wirtschaft und Energie (BMWi) 2016d: Erneuerbare Energien in Deutschland: Daten zur Entwicklung im Jahr 2015, Berlin, https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=0ahUKEwj1t7LDrL_UAhVGIlAKHUyqDQkQFgg_MAM&url=https%3A%2F%2Fwww.connaissancedesenergies.org%2Fsites%2Fdefault%2Ffiles%2Fpdf-actualites%2Ferneuerbare-energien-in-zahlen-2015.pdf&usg=AFQjCNH0oaDjfCx27XGStuJnxkfcG4YbMQ (20.4.2016).

Bundesministerium für Wirtschaft und Energie (BMWi) 2016e: Strommarkt 2.0: Ein Strommarkt für die Energiewende, Berlin, http://www.bmwi.de/Redaktion/DE/Dossier/strommarkt-der-zukunft.html (10.4.2017).

Bundesministerium für Wirtschaft und Energie (BMWi) 2017a: Was ist eigentlich ein „atmender Deckel"?, in: Energiewende direkt (3), Berlin, http://www.bmwi-energiewende.de/EWD/Redaktion/Newsletter/2017/03/Meldung/direkt-erklaert.html (7.4.2017).

Bundesministerium für Wirtschaft und Energie (BMWi) 2017b: Staatssekretär Baake: Bürgerenergie großer Gewinner der ersten Ausschreibungsrunde Wind an Land, Berlin, http://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2017/20170519-baake-buergerenergie-grosser-gewinner-der-ersten-ausschreibungsrunde-wind-an-land.html (2.6.2017).

Bundesministerium für Wirtschaft und Energie (BMWi); Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMU) 2006: Energieversorgung für Deutschland: Statusbericht für den Energiegipfel am 3. April 2006, Berlin, http://www.junge-union.de/media/attachments/351507_Energieversorgung_f_r_Deutschland_-_Statusbericht_f_r_den_Energiegipfel_03042006_1_.pdf (17.9.2014).

Bundesnetzagentur (BNetzA) 2016a: 3. Quartalsbericht 2015 zu Netz- und Systemsicherheitsmaßnahmen: Viertes Quartal 2015 sowie Gesamtjahresbetrachtung 2015, Bonn, http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/Versorgungssicherheit/Stromnetze/System-_u_Netzsicherheit/Quartalsbericht_Q4_2015.pdf?__blob=publicationFile&v=1 (25.8.2016).

Bundesnetzagentur (BNetzA) 2016b: Ausschreibungen PV-Freiflächenanlagen: Beendete Ausschreibungen, http://www.bundesnetzagentur.de/cln_1421/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/PV-Freiflaechenanlagen/Beendete_Ausschreibung/Beendete_Ausschreibungen_node.html (27.10.2016).

Bundesnetzagentur (BNetzA) 2016c: Veröffentlichung der im Anlagenregister registrierten Daten, Bonn, http://www.bundesnetzagentur.de/cln_1422/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Erneuerbare Energien/Anlagenregister/Anlagenregister_Veroeffentlichung/Anlagenregister_Veroeffentlichungen_node.html#doc507892bodyText4 (18.4.2016).

Bundesnetzagentur (BNetzA) 2016d: Qualität der Stromversorgung 2015 auf konstant hohem Niveau, Bonn, http://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2016/161020_SAIDI.html (21.10.2016).

Bundesnetzagentur (BNetzA) 2017a: Bestimmung der anzulegenden Werte für Windenergie an Land für das Quartal Januar bis März 2017 (Festlegung durch EEG 2017), Bonn, https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/ErneuerbareEnergien/Anlagenregister/VOeFF_Anlagenregister/EE_Foerderung_Wind_05_2017.xlsx?__blob=publicationFile&v=2 (7.4.2017).

Bundesnetzagentur (BNetzA) 2017b: Ergebnisse der EEG-Ausschreibung für Solaranlagen vom 1. Februar 2017: Stand: 10.2.2017, Bonn, https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/ErneuerbareEnergien/EEG_Ausschreibungen_2017/Hintergrundpapiere/Hintergrundpapier_01_02_2017.pdf?__blob=publicationFile&v=3 (6.4.2017).

Bundesnetzagentur (BNetzA) 2017c: Gebotstermin 1. Mai 2017: Öffentliche Bekanntgabe der Zuschläge, Bundesnetzagentur (BNetzA), Bonn, https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/Ausschreibungen/Wind_Onshore/Gebotstermin_01_05_2017/Gebotstermin_01_05_17_node.html#doc717396bodyText1 (2.6.2017).

Bundesnetzagentur (BNetzA) 2017d: Quartalsbericht zu Netz- und Systemsicherungsmaßnahmen: Viertes Quartal und Gesamtjahr 2016, Bonn, https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2017/Quartalsbericht_Q4_Gesamt_2016.pdf?__blob=publicationFile&v=2 (2.6.2017).

Bundesnetzagentur (BNetzA) 2017e: Ergebnisse der 1. Ausschreibung vom 01.04.2017 für bestehende Projekte nach § 26 WindSeeG, https://www.bundesnetzagentur.de/DE/Service-Funktionen/Beschlusskammern/1BKGeschaeftszeichen-Datenbank/BK6-GZ/2017/2017_0001bis0999/BK6-17-001/Ergebnisse_erste_Ausschreibung.pdf?__blob=publicationFile&v=3 (14.7.2017).

Bundesnetzagentur (BNetzA) 2017f: Förderung für Windenergie an Land: Öffentliche Bekanntgabe der Zuschläge, Bonn, https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Erneuerbare Energien/Anlagenregister/Anlagenregister_Veroeffentlichung/Anlagenregister_Veroeffentlichungen_node.html#doc507892bodyText4 (27.7.2017).

Bundesnetzagentur (BNetzA) 2017g: Ergebnisse der zweiten Ausschreibung für Wind an Land. Bonn, https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Presse/Pressemitteilungen/2017/15082017_Wind.pdf;jsessionid=E89DA02C51FD82545821F155F0D01373?__blob=publicationFile&v=3 (15.8.2017).

Bundesnetzagentur (BNetzA); Bundeskartellamt (BKartA) 2014: Monitoringbericht 2014, Bonn, http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2014/Monitoring bericht_2014_BF.pdf?__blob=publicationFile&v=4 (3.2.2016).

Bundesnetzagentur (BNetzA); Bundeskartellamt (BKartA) 2015: Monitoringbericht 2015, Bonn, http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2015/Monitoring bericht_2015_BA.pdf?__blob=publicationFile&v=3 (3.2.2015).

Bundesnetzagentur (BNetzA); Bundeskartellamt (BKartA) 2016: Monitoringbericht 2016, Bonn, https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/DatenaustauschUnd Monitoring/Monitoring/Monitoringbericht2016.pdf;jsessionid=987583DDC5E6 80279CDDDABAB7671F20?__blob=publicationFile&v=2 (20.3.2017).

Bundesverband der Energie- und Wasserwirtschaft (BDEW) 2013: Vorschläge für eine grundlegende Reform des EEG, Berlin, https://www.bdew.de/internet.nsf/res/1C1C742B522CA0CEC1257BEF002F1485/$file/Anlage_2_Positions papier_Vorschl%E4ge%20f%FCr%20eine%20grundlegende%20Reform%20 des%20EEG_final_180913.pdf (7.12.2014).

Bundesverband der Energie- und Wasserwirtschaft (BDEW) 2016: Strompreisanalyse Januar 2016, Berlin, https://www.bdew.de/internet.nsf/id/DC9ABD 3F2D97604DC1257F42002E5075/$file/160122%20BDEW%20zum%20Strom preis%20der%20Haushalte%20Anhang.pdf (8.2.2016).

Bundesverband der Energie- und Wasserwirtschaft (BDEW) 2017: BDEW-Strompreisanalyse Februar 2017, Berlin, https://www.bdew.de/internet.nsf/id/BDCF F33EA21E8D9BC12580C8004CC2B8/$file/170213_AUSZUG_BDEW_Strompreis analyse_Februar2017.pdf (22.2.2017).

Bundesverband Erneuerbare Energien (BEE) 2012: BEE-Hintergrund zur EEG-Umlage 2013: Bestandteile, Entwicklung und Höhe, http://www.wasserkraft verband.de/media/materialien/BEE_Hintergrund_EEG-Umlage-2013.pdf (13.12.2015).

Bundesverband WindEnergie (BWE) 2015: A bis Z: Fakten zur Windenergie, Berlin, https://www.wind-energie.de/sites/default/files/download/publication/z-fakten-zur-windenergie/bwe_abisz_3-2015_72dpi_final.pdf (5.12.2015).

Bundesverband WindEnergie (BWE) 2016: Netzausbau in Schleswig-Holstein hat begonnen, https://www.wind-energie.de/presse/meldungen/2015/netzaus bau-schleswig-holstein-hat-begonnen (12.1.2016).

Butler, Lucy; Neuhoff, Karsten 2005: Comparison of Feed in Tariff, Quota and Auction Mechanisms to Support Wind Power Development, http://www.world futurecouncil.org/fileadmin/user_upload/Miguel/Butler_Neuhoff_Wind_Industry_Support_Mechanisms_2005.pdf (12.12.2015).

CDU/CSU/SPD 2013: Deutschlands Zukunft gestalten: Koalitionsvertrag zwischen CDU, CSU und SPD, Berlin, http://www.bundesregierung.de/Content/DE/_Anlagen/2013/2013-12-17-koalitionsvertrag.pdf;jsessionid=664DD83807D54DFD24E121 E58553D996.s2t2?__blob=publicationFile&v=2 (17.9.2014).

CE Delft et al. 2015: Mid-term Evaluation of the Renewable Energy Directive: A Study in the Context of the REFIT Programme, Delft, http://www.cedelft.eu/publicatie/mid-term_evaluation_of_the_renewable_energy_directive/1630 (11.11.2016).

Consentec; IWES (2013): Kostenoptimaler Ausbau der Erneuerbaren Energien in Deutschland: Ein Vergleich möglicher Strategien für den Ausbau von Wind- und Solarenergie in Deutschland bis 2033, prepared for Agora Energiewende, https://www.agora-energiewende.de/fileadmin/Projekte/2012/Kostenoptmaler-Ausbau-EE/Agora_Studie_Kostenoptimaler_Ausbau_der_EE_Web_optimiert.pdf (11.3.2016).

Destatis 2016: Verbraucherpreisindex (inkl. Veränderungsraten): Deutschland, Jahre, Wiesbaden, https://www-genesis.destatis.de/genesis/online/data;jsessionid=0E93C9F5D3A45CF837FDB8331190BA1A.tomcat_GO_2_1?operation=abruftabelleBearbeiten&levelindex=2&levelid=1449151740457&aus wahloperation=abruftabelleAuspraegungAuswaehlen&auswahlverzeichnis=ordnungsstruktur&auswahlziel=werteabruf&selectionname=61111-0001&aus wahltext=&werteabruf=Werteabruf (25.10.2016).

Deutsche WindGuard 2015: Status des Windenergieausbaus an Land in Deutschland: Zusätzliche Auswertungen und Daten für das Jahr 2015, Varel, http://www.windguard.de/_Resources/Persistent/f10dbf17d45804b0f-658f1a575a4f 9cb8e9bcc5c/Zusatzauswertung-Status-Windenergieausbauan-Land-Jahr-2015-20160407.pdf (18.5.2016).

Deutsche WindGuard 2017: Status des Windenergieausbaus an Land in Deutschland, https://www.wind-energie.de/sites/default/files/attachments/page/statis tiken/factsheet-status-windenergieausbau-land-2016.pdf (21.4.2017).

Deutsche WindGuard; BioConsult 2011: Vorbereitung und Begleitung der Erstellung des Erfahrungsberichtes 2011 gemäß § 65 EEG, Varel, http://www.windguard.de/_Resources/Persistent/151a451fe2a4915d3d0baebeef146eec 5b1a8dc2/eeg-eb-2011-windenergie-online.pdf (3.5.2016).

Deutscher Bundestag 2015: Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz – EnWG), http://www.gesetze-im-internet.de/bundesrecht/enwg_2005/gesamt.pdf (7.12.2015).

Deutsche Gesellschaft für Sonnenenergie (DGS); BSW-Solar 2015: Kostenentwicklung der Photovoltaik, http://www.unendlich-viel-energie.de/media/image/4394.AEE_Kostenentwicklung_Photovoltaik_1988-2013_nov13_72dpi.jpg (5.12.2015).

Deutsches Institut für Wirtschaftsforschung (DIW) 2015: Reformen bei EEG und Emissionshandel, DIW Wochenbericht 21 (2015), Berlin, http://www.diw.de/documents/publikationen/73/diw_01.c.505176.de/15-21.pdf (12.12.2015).

Deutsches Zentrum für Luft- und Raumfahrt (DLR); IWES; IFNE 2010: Langfristszenarien und Strategien für den Ausbau erneuerbarer Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global: Leitstudie 2010, http://elib.dlr.de/69139/1/Leitstudie_2010.pdf (21.7.2014).

Diekmann, Jochen; Kemfert, Claudia 2005: Erneuerbare Energien: Weitere Förderung aus Klimaschutzgründen unverzichtbar, in: Wochenbericht des DIW Berlin (29), Berlin, http://www.diw.de/documents/publikationen/73/diw_01.c.43392.de/05-29-1.pdf (15.11.2016).

Directorate-General (DG) Competition 2016: Note for the Attention of Mr D Ristori, Director General, DG ENER., Brussels, 16.11.2016..

DIW 2012: Steigende EEG-Umlage: Unerwünschte Verteilungseffekte können vermindert werden, Berlin, http://www.diw.de/documents/publikationen/73/diw_01.c.409389.de/12-41.pdf (08.02.2016).

DONG Energy 2017: DONG Energy Awarded Three German Offshore Wind Projects, Company Announcement No. 16, http://www.dongenergy.de/de/Pressekontakt/konzernmitteilungen_details?omxid=1557851 (2.6.2017).

e21 2015: e21.Newsletter vom 25.11.2015, http://www.e21.info/newsletter/index.php (5.12.2015).

eclareon 2012: Compare Support Schemes, http://www.res-legal.eu/compare support-schemes/ (17.11.2016).

Ecofys 2014: Der Spotmarktpreis als Index für eine dynamische EEG-Umlage: Vorschlag für eine verbesserte Integration Erneuerbarer Energien durch Flexibilisierung der Nachfrage, Berlin, http://www.agora-energiewende.de/fileadmin/downloads/publikationen/Studien/Dynamische-EEG_Umlage/Agora_RAP_Spotmarktpreis_als_Index_fuer_dyn_EEG-Umlage_web.pdf (8.4.2015).

Energieonderzoek Centrum Nederland (ECN) 2005: Review of International Experience With Renewable Energy Obligation Support Mechanisms, http://www.ecn.nl/docs/library/report/2005/c05025.pdf (15.11.2016).

Enertrag 2017: Ausschreibungen: Voller Erfolg der Bürgerenergiegesellschaften in Zusammenarbeit mit Enertrag, Dauerthal, https://www.enertrag.com/index.php?id=594_presse-meldung-details&no_cache=1&tx_ttnews%5Btt_news%5D=195&cHash=3cfb9d6e38ec37958bced2dea8388590 (2.6.2017).

EEG; IT Power; KEMA; RISØ; CSIC; FhG-ISI; WIENSTROM; EGL; EREC 2004: Green-X: Deriving Optimal Promotion Strategies for Increasing the Share of RES-E in a Dynamic European Electricity Market, http://www.academia.edu/15449920/Green-X._Deriving_optimal_promotion_strategies_for_increasing_the_share_of_RES-E_in_a_dynamic_European_electricity_market._Final_report_of_the_ project_Green-X-a_research_project_within_the_fifth_framework_programme_of_the_European_Commission_supportedby_DG_Research (4.5.2016).

Energie- und Klimapolitik I Beratung (EnKliP) 2014: Auf dem Weg zu 100 % Erneuerbaren Energien: Der Kostenberg ist überwunden, Kiel, www.enklip.de/projekte_25_272685380.pdf (22.10.2014).

Energie- und Klimapolitik I Beratung (EnKliP) 2015a: Auf dem Weg zum 40 %-Klimaziel: Mehr Wind an Land und Photovoltaik: Warum die Deckelung keine Kosten spart, Kiel, http://www.enklip.de/projekte_29_154031417.pdf(19.5.2015).

Energie- und Klimapolitik I Beratung (EnKliP) 2015b: Ausschreibungen für Erneuerbare Energien: Überwindbare Hemmnisse für Bürgerenergie?, Kiel, http://www.enklip.de/projekte_33_2476891162.pdf (9.9.2015).

Energie- und Klimapolitik I Beratung (EnKliP) 2015c: Ein EEG für eine effiziente Energiewende: Kritische Betrachtung von fixen und Kapazitätsprämien für Erneuerbare Energien, Kiel, http://www.enklip.de/projekte_32_2975974973.pdf (13.10.2015).

Energie- und Klimapolitik I Beratung (EnKliP) 2016a: Die Energiewende und Kosten: Kritischer Überblick und Handlungsoptionen, Kiel, http://www.enklip.de/projekte_58_2225932476.pdf (20.4.2017).

Energie- und Klimapolitik I Beratung (EnKliP) 2016b: Das Eckpunktepapier zur EEG-Novelle 2016: Der richtige Weg zu mehr Kosteneffizienz und Umweltschutz?, Kiel, http://www.enklip.de/projekte_45_2515013633.pdf (11.5.2016).

Energiewirtschaftliches Institut an der Universität zu Köln (EWI); GWS; Prognos 2014: Entwicklung der Energiemärkte: Energiereferenzprognose: Projekt Nr. 57/12 des Bundesministeriums für Wirtschaft und Technologie, Berlin, http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/entwicklung-der-energiemaerkte-energiereferenzprognose-endbericht,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf (5.10.2016).

Energy Brainpool 2016: Kurzanalyse zur Stromerzeugung bei netzbedingter Abregelung Erneuerbarer Energien, Berlin, https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/kurzanalyse_grosskraftwerke.pdf. (20.4.2017)

European Commission (COM) 2008a: Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52008PC0019&rid=4 (1.2.2018).

European Commission (COM) 2008b: The Support of Electricity from Renewable Energy Sources, Commission Staff Working Document, COM(2008) 19 final, SEC(2008) 57, Brussels, http://iet.jrc.ec.europa.eu/remea/sites/remea/files/files/documents/sec_2008_57_support_res_electricity.pdf (9.9.2015).

European Commission (COM) 2009: Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 Concerning Common Rules for the Internal Market in Electricity and Repealing Directive 2003/54/EC, in: Official Journal of the European Union L211/55, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0055:0093:EN:PDF (1.2.2018).

European Commission (COM) 2012: Energy Roadmap 2050, Luxembourg, https://www.energy.eu/publications/Energy-Roadmap-2050.pdf (15.3.2017).

European Commission (COM) 2013: European Commission Guidance for the Design of Renewables Support Schemes, Commission Staff Working Dokument, SWD(2013) 439 final, Brussels, https://ec.europa.eu/energy/sites/ener/files/com_2013_public_intervention_swd04_en.pdf (10.11.2016).

European Commission (COM) 2014a: Energy Prices and Costs in Europe, Brussels, http://ec.europa.eu/energy/sites/ener/files/documents/20140122_communication_energy_prices_1.pdf (23.3.2017).

European Commission (COM) 2014b: Energy Economic Developments in Europe, Brussels, http://ec.europa.eu/economy_finance/publications/european_economy/2014/pdf/ee1_en.pdf (18.11.2016).

European Commission (COM) 2014c: A Policy Framework for Climate and Energy in the Period from 2020 to 2030, http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN (29.10.2016).

European Commission (COM) 2014d: Progress Towards Completing the Internal Energy Market, Commission Staff Working Document, Brussels, http://ec.europa.eu/energy/sites/ener/files/documents/2014_iem_communication_annex2.pdf (5.4.2017).

European Commission (COM) 2014e: Guidelines on State aid for Environmental Protection and Energy 2014–2020, in: Official Journal of the European Union C200, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN (1.2.2018).

European Commission (COM) 2015a: Renewable Energy Progress Report, Brussels, http://eur-lex.europa.eu/resource.html?uri=cellar:4f8722ce-1347-11e5-8817-01aa75ed71a1.0001.02/DOC_1&format=PDF (11.11.2016).

European Commission (COM) 2015b: Energy Union Package: A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy, Brussels, http://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF (1.2.2018).

European Commission (COM) 2016a: Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources (recast), Brussels, http://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v7_1.pdf (23.2.2017).

European Commission (COM) 2016b: Public Consultation on the Renewable Energy Directive for the Period After 2020: Analysis of Stakeholder Views, https://ec.europa.eu/energy/sites/ener/files/documents/Summary%20RED%20II%20Consultation.pdf (10.11.2016).

European Commission (COM) 2016c: Renewable Energy: Moving Towards a Low Carbon Economy, http://ec.europa.eu/energy/en/topics/renewable-energy (5.12.2016).

European Commission (COM) 2016d: Renewable Energy: Moving Towards a Low Carbon Economy, http://ec.europa.eu/energy/en/topics/renewable-energy (5.12.2016).

European Council 2014: European Council (23 and 24 October 2014). Conclusions on 2030 Climate and Energy Policy Framework (SN 79/14), http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/145356.pdf (1.2.2018).

European Court of Justice 2001: Judgment of the Court, 13 March 2001, In Case C-379/98, http://curia.europa.eu/juris/showPdf.jsf?text=&docid=45891&pageIndex=0&doclang=en&mode=req&dir=&occ=first&part=1&cid=862809 (1.2.2018).

European Environmental Agency (EEA) 2016: Renewable Energy in Europe 2016: Recent Growth and Knock-on Effects, EEA Report (4), http://www.eea.europa.eu/publications/renewable-energy-in-europe-2016 (17.11.2016).

European Parliament and European Council (EP/EC) 1997: Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 Concerning Common Rules for the Internal Market in Electricity, in: Official Journal of the European Union L27/20, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31996L0092 (1.2.2018).

European Parliament and European Council (EP/EC) 2003: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 Establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and Amending Council Directive 96/61/EC, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02003L0087-20140430 (1.2.2018).

European Parliament and European Council (EP/EC) 2009: Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 Concerning Common Rules for the Internal Market in Electricity and Repealing Directive 2003/54/EC, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0072 (1.2.2018).

European Union (EU) 2012: Consolidated Version of the Treaty on the Functioning of the European Union, in: Official Journal of the European Union C326, p. 47, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN (1.2.2018).

Eurostat 2016a: Energy Production and Imports, http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_production_and_imports#Imports(18.11.2016).

Eurostat 2016b: File:Electricity Statistics 2013–2015 (in GWh) update.png, http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Electricity_Statistics_2013-2015_(in_GWh)_update.png (18.11.2016).

EWI; Prognos 2007: Energieszenarien für den Energiegipfel 2007, Basel/Cologne, https://www.prognos.com/uploads/tx_atwpubdb/071101_Prognos_EWI_Studie_Energieszenarien_2007.pdf (1.9.2017).

Fell, Hans-Josef 2015: Schwarz-Gelb stellt Energiewende in Frage, in: NGO Online, 1.12.2011, http://www.ngo-online.de/2011/12/1/energiewende-jetzt/ (11.12.2015).

Fleishman, Hillard 2016: Energy Union: Coming Your Way this Year, http://fleishmanhillard.eu/wp-content/uploads/sites/7/2016/02/Energy-timeline-Feb-2016.pdf (23.7.2017).

Forum Ökologisch-Soziale Marktwirtschaft (FÖS) 2014: Industriestrompreise in Deutschland und den USA: Überblick über Preisniveau, Preiszusammensetzung und Erhebungsmethodik, Berlin, http://www.bee-ev.de/fileadmin/Publikationen/Studien/2014-FOES_Industriestrompreise_Deutschland_und_USA.pdf (19.7.2016).

FÖS 2015: Was Strom wirklich kostet: Vergleich der staatlichen Förderungen und gesamtgesellschaftlichen Kosten von konventionellen und erneuerbaren Energien, http://www.foes.de/pdf/2015-01-Was-Strom-wirklich-kostet-lang.pdf (2.2.2015).

Fouquet, Dörte; Nysten, Jana 2015: Retroactive and Retrospective Changes and Moratoria to RES Support, http://www.keepontrack.eu/contents/publications biannualnationalpolicyupdatesversions/policy-briefing6-retroactive-and-retrospective-changes-and-moratoria-to-res-support.pdf (15.3.2017).

Fraunhofer Institut für System- und Innovationsforschung (ISI) et al. 2016: The Impact of Risks in Renewable Energy Investments and the Role of Smart Policies, http://www.ecofys.com/files/files/diacore-2016-impact-of-risk-inres-investments.pdf (16.2.2016).

Fraunhofer Institut für System- und Innovationsforschung (ISI); Energy Economics Group 2010: Evaluation of Different Feed-In-Tariff Design Options: Best Practice Paper for the International Feed-In Cooperation, www.feed-incooperation.org/wDefault_7/download-files/research/Best_practice_Paper_3rd_edition.pdf (5.12.2015).

Fraunhofer Institut für Windenergie und Energiesystemtechnik (IWES) 2015: Auswertung des Effekts der Sonnenfinsternis vom 20.3.2015 auf das deutsche Energieversorgungssystem, Kassel, http://www.energiesystemtechnik.iwes.fraunhofer.de/content/dam/iwes-neu/energiesystemtechnik/de/Dokumente/Presseinformationen/2015/Auswertung%20des%20Effekts%20der%20Sonnenfinsternis_v6_ys_rf_ys_rf_dj_uk_dj_ys.pdf (6.12.2015).

Fraunhofer Institut für Windenergie und Energiesystemtechnik (IWES); Fraunhofer Institut für System- und Innovationsforschung (ISI); Institut für Klimaschutz, Energie und Mobilität (IKEM); Becker, Büttner, Held (BBH) 2014: Laufende Evaluierung der Direktvermarktung von Strom aus Erneuerbaren Energien, Berlin, http://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/Berichte/direktvermarktung-quartalsbericht-10.pdf?__blob=publicationFile&v=4 (12.12.2015).

Fraunhofer Institut für Windenergie und Energiesystemtechnik (IWES); Energy Brainpool 2015: Strommarkt-Flexibilisierung: Hemmnisse und Lösungskonzepte, Bochum, http://www.bee-ev.de/fileadmin/Publikationen/Studien/Plattform/BEE-Plattform-Systemtransformation_Strommarkt_Flexibilisierung.pdf (10.2.2016).

Frontier Economics; BET 2016: Kosten und Nutzen einer Dynamisierung von Strompreiskomponenten als Mittel zur Flexibilisierung der Nachfrage: Bericht für das BMWi, http://www.bmwi.de/Redaktion/DE/Publikationen/Studien/kosten-nutzen-dynamisierung-strompreiskomponenten.pdf?__blob=publicationFile&v=4 (26.3.2017).

Futterlieb, Matthias; Mohns, Till 2009: Erneuerbare Energien-Politik in der EU: Der Politikprozess zur Richtlinie 2009/28/EG: Harmonisierung, Akteure, Einflussnahme, Berlin, http://userpage.fu-berlin.de/mtfutt/Futterlieb_Mohns_EE_Politik_EU_2009_28_EG.pdf (17.11.2016).

Gabriel, Sigmar 2014: Vorbereitung des Pilotprojektes zur Ausschreibung von PV-Freiflächenanlagen, Berlin, 31.10.2014, Schreiben an Mitglieder des Deutschen Bundestages.

Gabriel, Sigmar 2016: Schreiben BM Gabriel an EU KOM zum Energiepaket, Berlin, 24.10.2016.

General Court of the European Union 2016: Judgment in CaseT-47/15, Luxembourg, https://curia.europa.eu/jcms/upload/docs/application/pdf/2016-05/cp160049en.pdf (1.2.2018).

Germany; Poland; UK 2008a: Explanatory Note for Germany/Poland/UK Flexibility Proposal.

Germany; Poland; UK 2008b: Joint Proposal by Germany, Poland and the United Kingdom on an Alternative Renewable Flexibility Mechanism.

Grau, Thilo 2014a: Geplante Ausschreibungen für die Förderung von Strom aus erneuerbaren Energien, DIW Roundup, Berlin, https://www.diw.de/de/diw_01.c.492036.de/presse/diw_roundup/geplante_ausschreibungen_fuer_die_foerderung_von_strom_aus_erneuerbaren_energien.html (13.12.2015).

Grau, Thilo 2014b: Comparison of Feed-in Tariffs and Tenders to Remunerate Solar Power Generation, DIW Disucssion Paper, Berlin, http://www.diw.de/documents/publikationen/73/diw_01.c.437464.de/dp1363.pdf (28.10.2016).

Hanke, Steven 2017: Erste Onshore-Auktion läuft, in: Energate Messenger+, 8.3.2017.

Hirth, Lion; Schlandt, Jakob 2016: Übertragungsnetzbetreiber erwarten massiven Wertverlust für Solarstrom, http://phasenpruefer.info/uebertragungsnetzbetreiber-erwarten-massiven-wertverlust-fuer-solarstrom/(19.4.2016).

Höfling, Holger 2013: Investitionsanreize für neue Erzeugungskapazität unter wachsendem Einfluss erneuerbarer Stromerzeugung: Eine modellbasierte Szenarioanalyse des deutschen Strommarktes, Stuttgart, https://www.zsw-bw.de/uploads/media/Diskussionspapier_Investitionsanreize_2013.pdf (2.6.2017).

Holm-Müller, Karin; Weber, Michael 2010: Plädoyer für eine instrumentelle Flankierung des Emissionshandels im Elektrizitätssektor, http://www.umweltrat.de/SharedDocs/Downloads/DE/06_Hintergrundinformationen/2010_06_Emissionshandel_Strom.pdf?__blob=publicationFile(5.12.2015).

Institut für ZukunftsEnergie- und Stoffstromsysteme (IZES) 2014: Bewertung von Ausschreibungsverfahren als Finanzierungsmodell für Anlagen erneuerbarer Energienutzung, Saarbrücken, http://www.izes.de/cms/upload/publikationen/IZES_2014-05-20_BEE_EE-Ausschreibungen_Endbericht.pdf (3.11.2014).

Institut für ZukunftsEnergie- und Stoffstromsysteme (IZES); Bofinger, Peter; BET 2013: Stromsystem-Design: Das EEG 2.0 und Eckpfeiler eines zukünftigen Regenerativwirtschaftsgesetzes, Würzburg, Aachen, www.bet-aachen.de/fileadmin/redaktion/PDF/Studien_und_Gutachten/Studie__EEG_20_Stromsystem_14102013.pdf (16.2.2016).

International Energy Agency (IEA) 2016: Re-Powering Markets: Market Design and Regulation During the Transition to Low-Carbon Power Systems, Paris, http://www.iea.org/publications/freepublications/publication/REPOWERINGMARKETS.pdf (21.4.2016).

International Feed-In Cooperation (IFIC) 2016: International Feed-In Cooperation, http://feed-in-cooperation.org/wDefault_7/index.php (1.12.2016).

International Renewable Energy Agency (IRENA) 2015: Renewable Energy and Jobs: Annual Review 2015, http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Jobs_Annual_Review_2015.pdf (18.11.2016).

Internationales Wirtschaftsforum Regenerative Energien (IWR) 2016: Dänen finden Lösung für Offshore Windenergie, http://www.iwr.de/news. php?id=32579, (4.12.2016).

Küster, Robert; Zürn, Marcel; Ellersdorfer, Ingo 2015: Gesamtwirtschaftliche Auswirkungen von Modernisierungen im Kraftwerkspark der Länder der EU-25 unter einem Post-Kyoto Regime, Stuttgart, https://www.tugraz.at/fileadmin/user_upload/Events/Eninnov2006/files/kuester.pdf (29.11.2016).

Kopp, Oliver et al. 2013: Wege in ein wettbewerbliches Strommarktdesign für erneuerbare Energien, Mannheim, www.mvv-energie.de/media/media/downloads/mvv_energie_gruppe_1/nachhaltigkeit_1/MVV_Studie_EE_Marktdesign_2013.pdf (26.3.2014).

Lambertz, Johannes; Schiffer, Hans-Wilhelm; Serdarusic, Ivan; Voß, Hendrik 2012: Flexibilität von Kohle- und Gaskraftwerken zum Ausgleich von Nachfrage- und Einspeiseschwankungen, in: Energiewirtschaftliche Fragestellungen 62 (7), pp. 16–20, http://www.et-energie-online.de/Portals/0/PDF/zukunftsfragen_2012_07_lambertz.pdf (20.4.2017).

Lauber, Volkmar; Toke, David 2005: Einspeisetarife sind billiger und effizienter als Quoten-/ Zertifikatssysteme: Der Vergleich Deutschland-Großbritannien stellt frühere Erwartungen auf den Kopf, in: Zeitschrift für Neues Energierecht (2), pp. 132–139.

Leuphana Universität Lüneburg; Nestle, Uwe 2014: Marktrealität von Bürgerenergie und mögliche Ausweitungen von regulatorischen Eingriffen, Lüneburg; Kiel, http://www.enklip.de/resources/Studie_Marktrealitaet+von+Buergerenergie_Leuphana_FINAL_23042014.pdf (10.6.2014).

Lorenzoni, Arturo 2003: The Italian Green Certificates Market between Uncertainty and Opportunities, in: Energy Policy 31 (1), pp. 33–42.

Ministerium für Energiewende, Landwirtschaft, Umwelt und ländliche Räume (MELUR) 2015: Erster Planfeststellungsbeschluss für Westküstenleitung erteilt: Energiewendeminister Habeck: „Mit dem Bau kommt die Energiewende deutlich voran.“, Kiel, http://www.schleswig-holstein.de/DE/Landesregierung/V/Presse/PI/2015/0515/MELUR_150506_Planfeststellung_Abschnitt1.html (11.2.2016).

Moreno, Blanca; Lopez, Ana 2011: The Impact of Renewable Energies and Electric Market Liberalization on Electrical Prices in the European Union: An Econometric Panel Data Model, http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=72C409E82A132EB00F9E4E8DD3BA9756?doi=10.1.1.687.3270&rep=rep1&type=pdf (2.6.2017).

Müller, Klaus; Bruhn, Claudia 2013: Energiearmut als Querschnitts-Herausforderung: Impulse für eine Politische Strategie, WISO direkt, Friedrich-Ebert-Stiftung, Bonn, http://library.fes.de/pdf-files/wiso/10191.pdf (2.6.2017).

Nestle, Uwe 2011: Gleitende Marktprämie im EEG: Chance oder Risiko für die Erneuerbaren?, in: Energiewirtschaftliche Tagesfragen 61 (3), http://www.enklip.de/veroeffentlichungen_12_3196018859.pdf (12.12.2015).

Nestle, Uwe 2015: Es fehlt ein echter Kostenindikator, http://www.klimaretter.info/standpunkte/19665-qwir-brauchen-einen-echten-kostenindikatorq (30.9.2015).

Öko-Institut 2014: Erneuerbare-Energien-Gesetz 3.0: Konzept einer strukturellen EEG-Reform auf dem Weg zu einem neuen Strommarktdesign, Berlin, http://www.agora-energiewende.de/fileadmin/downloads/publikationen/Impulse/EEG_30/Agora_Energiewende_EEG_3_0_LF_web.pdf (20.10.2014).

Patlitzianas, Konstantinos; Kagiannas, Argyris; Askounis, Dimitris; Psarras, John 2004: The Policy Perspective for RES Development in the New Member States of the EU, in: Renewable Energy (30), pp. 477–492, https://www.deepdyve.com/lp/elsevier/the-policy-perspective-for-res-development-inthe-new-member-states-of-rwB5ShvWx5 (16.2.2016).

Piria, Raffaele; Lorenzoni, Arturo; Mitchell, Catherine; Timpe, Christof; Klessmann, Corinna; Resch, Gustav; Groscurth, Helmuth; Neuhoff, Karsten; Ragwitz, Mario; del Río Gonzalez, Pablo; Cowart, Richard; Leprich, Uwe 2013: Ensuring Renewable Electricity Investments: 14 Policy Principles for a Post-2020 Perspective, http://remunerating-res.eu/wp-content/uploads/2013/04/14principlespost2020.pdf (19.4.2016).

Reitz, Felix; Gerbaulet, Clemens; Kemfert, Claudia; Lorenz, Casismir; Oei, Pao-Yu; Hirschhausen, Christian von 2014: Szenarien einer nachhaltigen Kraftwerksentwicklung in Deutschland, DIW Politikberatung kompakt (90), Berlin, http://www.diw.de/documents/publikationen/73/diw_01.c.489788.de/diwkompakt_2014-090.pdf (13.12.2015).

REN21 2016: Renewables 2016: Global Status Report, Paris, http://www.ren21.net/wp-content/uploads/2016/06/GSR_2016_Full_Report1.pdf (21.7.2016).

Sachverständigenrat für Umweltfragen (SRU) 2011: Wege zur 100% erneuerbaren Stromversorgung, Sondergutachten, Berlin, http://www.umweltrat.de/SharedDocs/Downloads/DE/02_Sondergutachten/2011_07_SG_Wege_zur_100_Prozent_erneuerbaren_Stromversorgung.pdf?__blob=publicationFile (15.7.2014).

Schmagold, Philipp 2016: EEG 2017. Ausschreibung Wind an Land. Vor- und Nachteile von strategischen Geboten durch Bürgerenergiegesellschaften. In: erneuerbare energien, https://www.erneuerbareenergien.de/vor-und-nachteile-von-strategischen-geboten-durch-buergerenergiegesellschaften/150/434/97630/ (16.8.2017).

Statista 2017: Inflationsrate in Deutschland von Januar 2016 bis Januar 2017 (gegenüber Vorjahresmonat), https://de.statista.com/statistik/daten/studie/1045/umfrage/inflationsrate-in-deutschland-veraenderung-des-verbraucherpreisindexes-zum-vorjahresmonat/ (22.2.2017).

Strünck, Christoph 2017: Energiearmut bekämpfen – Instrumente, Maßnahmen und Erfolge in Europa, Gute Gesellschaft – Soziale Demokratie #2017plus, Friedrich-Ebert-Stiftung, Bonn, http://library.fes.de/pdf-files/wiso/13273-20170403.pdf (2.6.2017).

Umweltbundesamt (UBA) 2015: Strommarktdesign der Zukunft, Dessau-Roßlau, https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/climate_change_20_2015_strommarktdesign_der_zukunft_0.pdf (7.4.2017).

United Nations 2015: Adoption of the Paris Agreement: Proposal by the President, Paris, http://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf (14.12.2015).

United Nations Framework Convention on Climate Change (UNFCCC) 2017: Paris Agreement: Status of Ratification, http://unfccc.int/paris_agreement/items/9444.php (1.2.2018).

Unteutsch, Michaela; Lindenberger, Dietmar 2014: Europäische Kooperation bei der Förderung erneuerbarer Energien: Wie geht es nach 2020 weiter?, in: Energiewirtschaftliche Tagesfragen 64 (5), pp. 12–14.

Verband der Chemischen Industrie (VCI) 2016: Der Ausbau der Erneuerbaren braucht eine neue Finanzierungsgrundlage, in: chemie report 4.2016, pp. 6 f., https://www.vci.de/vci/downloads-vci/publikation/chemie-report-einzelartikel/cr-heft-04-2016-seite-6f.pdf (4.5.2016).

Vestager, Margrethe 2015: Grünstromprivileg und Ausschreibungen, Brussels, 12.2.2015, Schreiben an MdB Josef Göppel.

Vestager, Margrethe 2016: Umwelt- und Energiebeihilfen 2014–2020. Schreiben an Hermann Albers, Bundesverband WindEnergie, 6 January 2016. https://www.wind-energie.de/system/files/attachments/article/2016/ausschreibungen-eu-wettbewerbskommissarin-zum-thema-de-minimis/160106-antwortschreiben-eu-wettbewerbskommission-den-bwe.pdf (17.2.2016).

Wuppertal Institut 2010: RECCS: Regenerative Energien (RE) im Vergleich mit CO_2-Abtrennung und -Ablagerung (CCS): Update und Erweiterung der RECCS-Studie, Wuppertal, https://epub.wupperinst.org/files/3658/3658_RECCSplus_de.pdf (11.7.2014).

Zachmann, Georg 2017: Die Europäische Energieunion: Schlagwort oder wichtiger Integrationsschritt?, http://library.fes.de/pdf-files/wiso/11468.pdf (21.11.2016).

Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW) 2016: Monitoring der Energiewende in Baden-Württemberg, Stuttgart, https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/2_Presse_und_Service/Publikationen/Energie/Monitoringder-Energiewende-BW-2016.pdf (11.4.2017).

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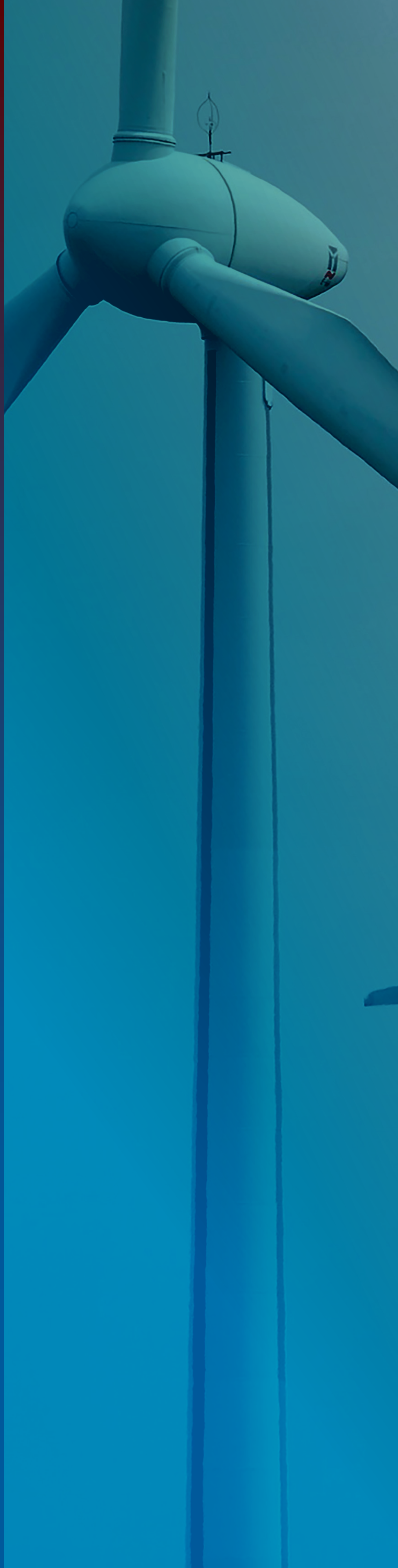

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