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RENEWABLES: THE ONLY PATH TO A SECURE, AFFORDABLE AND CLIMATE-FRIENDLY ENERGY SYSTEM BY 2030

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Renewables: The Only Path to a Secure, Affordable and Climate-friendly Energy System by 2030

Commissioned and published by the Heinrich-Böll-Stiftung, European Union

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Abstract:
Economic and environmental goals sometimes appear to require opposite paths of action. This paper demonstrates, however, that there is a single solution to Europe's threefold challenges of achieving climate protection goals while ensuring security of supply and affordable energy for a competitive economy: an expansion in the share of renewable energy. Renewables not only drastically reduce emissions; they also create jobs and offer real medium- and long-term savings to the European economy.

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EXECUTIVE SUMMARY

European energy policy is facing major challenges. In order to tackle the climate crisis, a dramatic reduction in greenhouse gas (GHG) emissions is essential, while also keeping in mind the considerations of security of supply and affordability. The energy sector is of the utmost importance in this respect, given that energy consumption is by far the largest source of GHG emissions (**Chapter 1**). A reduction of energy consumption by increasing energy efficiency is the greatest and easily accessible source of cost reduction. Furthermore, there is excellent technical potential for change within the power sector, as well as relatively small GHG reduction costs. Many conventional power plants in EU Member States are old and will need to be replaced or modernised in the coming years and decades. This will require sizeable investment, which will influence future energy prices and costs – with or without climate protection policies. This is both a challenge and a great opportunity. If the necessary modernisation of Europe's energy infrastructure, in particular power plants, electricity grids, and heating systems, is undertaken in a climate-friendly manner, additional costs can be avoided. On the other hand, conventional modernisation based on fossil and nuclear energies will lead to high environmental costs, and potentially to costly stranded investments (**Chapter 2**).

While it is clear that investment in new and environmentally sound power plants is essential, electricity markets in many Member States are failing to send the economic signals necessary for investment. Additional funds are needed if investment is to be made, whether in conventional or renewable plants (**Chapter 3**). In order to decide to facilitate new conventional power plants or renewables, the full costs of the new installations need to be compared. A number of studies show that onshore wind energy – soon to be joined by solar PV – is no more expensive than conventional power. Since the trend is for conventional energy to become more expensive and for renewables to become cheaper, it is likely that most renewables will cost less than conventional energy in the future (**Chapter 4**). This is even more true if the external costs of climate damage or insurance against the risk of nuclear accidents, for example, are factored in (**Chapter 5**). The need for back-up systems for variable renewables such as wind and solar does not change this calculation. There are a number of inexpensive technologies with huge potential, the use of which would represent only a small share of total electricity production costs (**Chapter 6**).

Often forgotten, but very much worthy of emphasis, is the fact that a rapid expansion of renewable energy sources has a number of important advantages. Besides reducing GHG emissions and other environmental and social burdens, renewables reduce energy import dependency and costs, increase energy security, strengthen local economies, and create jobs (**Chapter 7**).

The documents accompanying the White Paper on a 2030 framework for climate and energy policies presented by the European Commission at the end of January 2014 show that while energy prices will continue to rise, this increase will not be due to renewables. Nevertheless, it is important to note that the Impact Assessment of the Commission presents misleading figures that make renewables appear more expensive than they are in reality. In particular, the cost estimates for nuclear power plants featured in the impact assessment are far too low, while those for solar PV are much too high. In the event that realistic cost estimates were used, it is highly likely that a renewable strategy would prove to be much cheaper to implement than a conventional strategy (**Chapter 8**). Together with energy efficiency measures, total energy costs for European industries and citizens could even fall.

POLICY RECOMMENDATIONS

1. Nationally binding targets for renewable energy result in stable regulatory conditions that deliver investment certainty and thus contribute to decreasing the cost of renewable energy technologies. Ambitious and binding EU-wide and national 2030 targets for emission reductions, renewable energy deployment and energy efficiency are necessary to achieve ambitious climate goals and to ensure a cost-effective energy transition in Europe.

2. Support schemes and a stable framework for investments in renewables will also be necessary beyond 2020. The feed-in tariff for renewable energy sources has proven successful to support emerging and existing technologies and to bring down costs of renewable power generation. Regional differences as well as individual countries' starting points should allow for Member States to decide on their respective support scheme design, depending on the technology, size and national market conditions and their adaptability to technological and price developments. The upcoming Guidelines on Environmental and Energy State Aid should provide sufficient flexibility for Member States to decide upon the most adequate type of support instrument.

3. Member States that are committed to the transition to renewable energy should enhance mutual best practice exchange. In order to allow for the optimised use of renewable energy Member States should, on a voluntary base, make use of cooperation mechanisms and work towards interlinked support schemes in order to accelerate the transition to renewables within the internal energy market.

4. Effective macro-regional cooperation between EU Member States, including the expansion of grid distribution and transmission capacities as well as cross-border interconnections, should be enhanced in order to reduce the need for national back-up capacity, to avoid curtailing renewable power generation and to achieve a convergence to lower energy prices throughout interconnected markets.

5. Electricity grid planning should be based on long-term national targets for renewables that help identify the infrastructure needed for a transformation to a renewables-based energy system. Other forms of flexibility, beyond grids, such as demand-side management should be considered during the process of grid planning.

6. Instead of building new conventional power plants, flexible, controllable generation and demand capacity at a comparatively lower investment cost should be fostered. These back-up options include demand-side management, retrofitting generators in existing hydropower plants, biomass-fired power plants, existing emergency generators, batteries, and other new storage options. Together with renewable energy sources such as wind and solar power, they can fully substitute conventional fossil and nuclear power plants at a lower total cost.

7. External costs such as environmental damage caused by energy consumption should be fully internalised. The principal objective of the EU Emissions Trading Scheme (ETS) is to internalise the external costs of GHG pollution. However, the carbon market does not work properly. The EU therefore needs to urgently address, inter alia, the oversupply of emissions allowances in its Emissions Trading Scheme (ETS) with meaningful structural measures. Additionally, other external costs such as potential costs of nuclear accidents, air pollution and health risks should be fully internalised.

8. The transition of the energy system requires the strong integration of all energy sectors – electricity, heating/cooling and transport – in order to maximise cost-efficient solutions for a renewables-based future. In the long run, this includes the use of renewable electricity in the heating/cooling and transport sector in order to balance variable renewable energies, particularly at the local and regional level, and potentially an increase of electricity storage.

1. The Challenges Facing European Electricity Supply

The challenges of the climate crisis are gaining increasing relevance

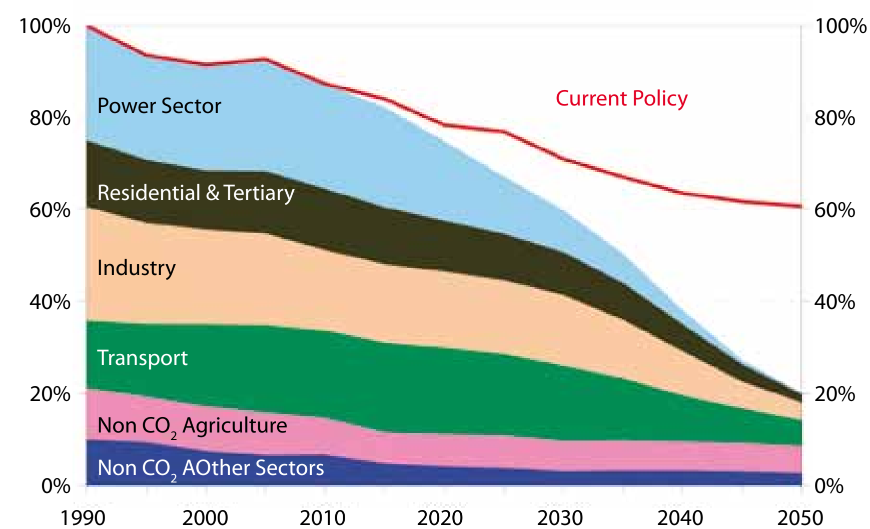
European energy policy is facing crucial challenges. Not only must it contribute to environmental protection, in particular to an ambitious climate protection policy, it must also ensure security of supply and maintain an electricity price that is affordable for industry and business as well as for private households.

The challenge of protecting the global climate now enjoys significantly greater relevance than in the past. Compared with 10 or 20 years ago, we now know much better that the lives and health of countless individuals, in particular vulnerable populations including women, children and the elderly, are threatened by the climate crisis. This is not only a worrying future scenario but is already happening today (Annan 2014). It is therefore apparent that the world, and Europe, has a lot of ground to make up in relation to climate protection.

The electricity sector is of the utmost importance

The greatest potential for cutting European Greenhouse Gas (GHG) emissions lies in the electricity sector – in particular since practically carbon-free technologies such as wind and solar power plants are already in place. Around 25% of Europe's total GHG emissions are caused by power generation, while energy consumption – including power generation, heat and transport – is responsible for around 80% of its total emissions (EC 2011). The power sector is projected to be able to achieve the largest reduction in GHG

Figure 1: Reductions in EU GHG emissions in order to achieve a domestic reduction of 80% by 2050 (100% = 1990).



Source: EC 2011

emissions (EC 2014c), and should be able to almost totally eliminate GHG emissions by 2050 at the latest. Similar reductions will be much more difficult to achieve in fields such as agriculture or transport (*see Figure 1*). Additionally, climate friendly electricity could partially replace fossil fuels in transport and heating (EC 2014). The transition of our energy system requires the strong integration of all energy markets – electricity, heating, cooling and transport.

A greater share of renewables can go hand in hand with security of supply and reasonable energy prices

Given the substantial share of GHG emissions generated by the energy sector, the transition from an energy system based on fossil and nuclear fuel consumption to one with a considerably higher percentage of renewables in the energy mix – and with significantly improved energy efficiency – is a must if climate protection is the goal.

While the transition to renewable energy will require sizeable investment over the coming decades, this paper demonstrates that, in the medium and long term, a rapid increase in the share of renewable energy is also the best strategy to ensure reasonable energy prices in Europe. Furthermore, the experience of countries such as Denmark, Germany, and Spain shows that it is possible to increase the share of renewable energy, in particular in the electricity sector, without adversely affecting security of supply. On the contrary, security of supply in Germany has in fact increased over the past six years (BNetzA & BKartA 2013). In addition to a strategy to boost renewables, a more efficient use of energy would not only reduce the environmental burden; it would also bring about cost savings, helping to maintain energy costs within a reasonable range.

2. The Need for the Renewal of the Energy Infrastructure

Sizeable investment in power plants is needed under all scenarios

Independent of climate protection policies, large investments in energy infrastructure and electricity generation will be needed over the coming decades "to ensure [the sector's] medium to long term viability and sustainability" (EC 2014c). This will have an impact on energy prices in the period up to 2030 (EC 2013). The renewal of the energy infrastructure offers an un-paralleled opportunity to opt for a climate-friendly energy system, since near-term investments will lock in certain infrastructural developments until 2030 and beyond (EC 2014c). It is essential that this future energy system be based on renewable energy. A decision to stick with the old system of conventional power plants would threaten both the environment and human security, and would entail significant (and rising) hidden costs.

The decision for a renewable future will save money

Any decision made today has consequences for the coming decades. Once built, conventional power plants can remain operational for up to five decades – or alternatively, they might end up as stranded investments. Either scenario could be very expensive. This is a strong economic argument for deciding to move towards more renewables now. The European Commission backs this line of argument: "Deep decarbonisation at the pace needed for achieving the two degrees objective requires that crucial infrastructure elements such as those on transmission lines are put in place in time […]. In many cases, particularly for infrastructure, the development often has to occur prior to their justification by demand and this will occur if there is good anticipation" (EC 2014e). A binding renewables target for 2030 is important to provide a robust indication of the future energy scenario and a clear guiding principle for grid planning.

3. The Failure of the Existing Electricity Market

The most common market design for electricity is currently the 'energy-only market',[1] according to which power producers sell electricity measured in megawatt hours (MWh). A limited number of Member States have additional capacity markets for specific segments, such as domestic coal in Spain, with certain other countries thinking about introducing such markets (Agora 2012). On capacity markets, conventional power plants are paid for offering a generation capacity to be used when needed.

The price for electricity on the European energy-only markets has been very volatile since the beginning of the liberalisation of the power sector in the European Union some 15 years ago. In recent years, prices on wholesale electricity markets have fallen considerably in Central Europe as well as in other regions – and current trends suggest that prices will decrease further. The main reasons for this are overcapacity, availability of capacity from variable renewables, and interconnection of national markets.

Existing market design is failing to stimulate investment in new power plants

In many European countries and under existing market conditions, prices are currently so low, and long-term investment certainty is lacking, that investment in either conventional or renewable power plants is not economically viable, whichever technology is employed. Regardless of the type of power generation (renewables, fossil fuels with or without Carbon Capture, Transport and Storage, or nuclear), additional support is needed if investment is considered to be politically desirable.

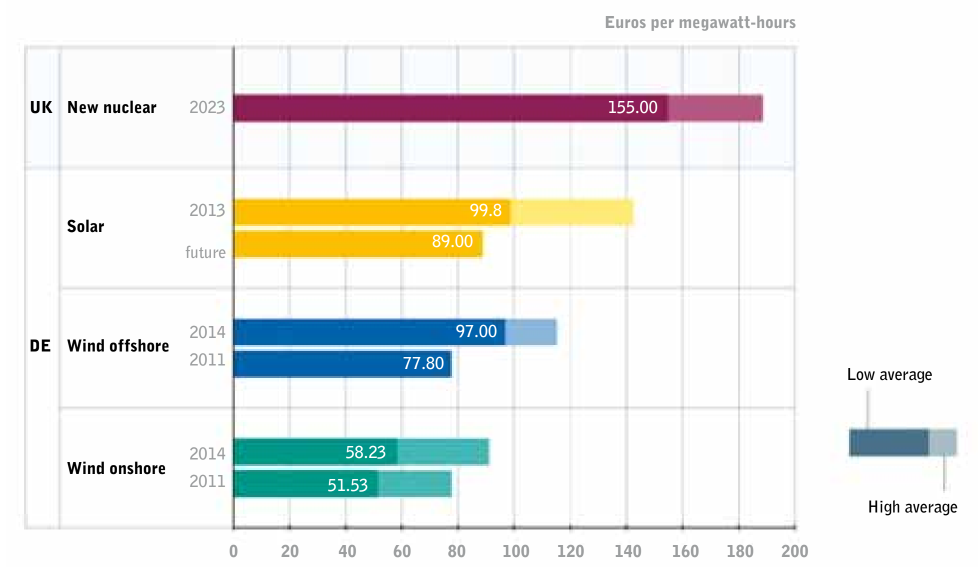
Planned nuclear power plant to receive more financial support than has ever been granted to wind energy

The contract between the British government and investors in planned nuclear power plant Hinkley Point C is a clear indication of the need for additional support, even for conventional power plants. The electricity from this nuclear power plant will be financed by a system comparable to the feed-in schemes for renewable energy used in many European Member States. The guaranteed strike price for electricity produced at this plant will be more than 10 cents per kWh (ct/kWh), to be paid for 35 years and fully indexed to inflation through the Consumer Price Index (Reuters 2013). This is much higher than the market could be expected to deliver; it is also higher than any amount ever granted to onshore wind, or that will be required by PV (*see Figure 2*).

The situation is even more starkly illustrated in Germany, where the market price for electricity is so low that even some of the existing fossil fuel power plants are unable to produce electricity profitably; their operational costs alone are too high (without even bringing investment costs into the equation). As a consequence, operators were keen to decommission certain gas-fired power plants. This was and still is of great concern as a number of these plants must remain in operation in order to ensure a safe and secure power supply. Given their flexibility, gas-fired power plants also fit well with an increase in the share of wind and solar PV. In response to this threat, the German government issued an ordinance which kept a proportion of these plants in operation (BMWi 2012), thus ensuring continued improvements in security of supply. Without this ordinance, the probability of blackouts would have been likely to increase.

1 In energy-only markets power producers only receive compensation for generated electricity and not for offering generation capacity.

Figure 2: Feed-in tariffs for current and future solar and wind in Germany with strike price for nuclear at Hinkley.



Source : Energytransition.de based on figures by Thomas Gerke, 2014

Wholesale electricity prices are not to be compared with the direct support of renewable energy

Against this background, it is clear that the electricity prices on today's energy markets are not representative of the real costs of electricity generation by conventional power plants. They therefore cannot be used as an indicator to be compared with the costs of electricity from renewable energy – even though they are often used in this way, making renewables appear much more expensive than they actually are (*see Box below*).

In order to compare the costs of renewable electricity with those of conventional electricity, the most important indicator is the actual cost of electricity generation by new plants. In including the initial capital and discount rate, the costs of continuous operation, fuel, and maintenance, and the lifespan of power plants (which can range between 20 and 50 years), the Levelized Cost of Energy (LCOE) is particularly useful when calculating the costs of generation from different sources. Externalities such as the costs of damage to the environment and increased health costs related to emissions are not included in this indicator but should also be taken into account (*see Chapter 5*).

Germany's EEG Surcharge: a Misleading Indicator

How the EEG surcharge is calculated

Under the German Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz – EEG*), grid operators are required to pay a strike price for electricity from renewable energy sources (RES-E). This totalled €22.9 billion in 2013.[2] Grid operators then sell this electricity on the stock market (EPEX – European Power Exchange), for which they received around €6.7 billion in revenue in 2013. The real costs for the grid operator can be calculated by deducting the sale price from the strike price – thus around €16.2 billion in 2013. These costs are then passed on to the consumer in the form of the EEG surcharge (Deutscher Bundestag 2013).

As energy intensive industries receive a significant reduction in the surcharge, the price paid by all other consumers is higher. This de facto subvention for industry came to €4 billion in 2013 (Deutscher Bundestag 2013). In practice, this sum is added to the EEG surcharge applied to other consumers. While it is clearly important that a small percentage of companies receive a reduction in the EEG surcharge in order to ensure competitiveness at an international level, there appears to be a broad consensus that too many companies benefit from this reduction.

The EEG surcharge is not a useful indicator of the costs of RES-E expansion

Germany's ageing conventional power plants will need to be replaced in the coming years – either by renewable energy plants or by new conventional power plants in the event of the insufficient expansion of the renewables sector. In order to ascertain whether the renewable path would lead to additional costs, it is necessary to perform a comparison between the full costs of replacing existing conventional plants with (a) new renewables plants and (b) new conventional plants.

The EEG surcharge is based on the strike price payments for renewables – that is, investment plus operational costs – from which the wholesale price of electricity is then deducted. As the latter is insufficient to cover the operational costs of many of the old conventional power plants, let alone investment costs (*see Chapter 3*), the surcharge is not a useful indicator of the additional costs of RES-E expansion and therefore cannot be used for the purpose of comparison. Instead of the wholesale price, the full costs of new conventional power plants (including investment and operating costs) should be used as a point of reference for cost calculations. Additionally and ideally, these new conventional power plants should either have the same environmental qualities – for instance negligible GHG emissions, as for wind and solar power – or the external costs should be factored into the indicator.

To illustrate this with an example, the wholesale price in Germany lies at roughly 4 ct/kWh, while the full costs of new conventional power plants are between 7 and 11 ct/kWh, and the UK's planned nuclear power plants will cost more than 10 ct/kWh (*see Chapter 4*). If the full costs of new conventional power plants were included in the calculation, the EEG surcharge would appear much lower. In the case of onshore wind it might even be negative, as wind-generated electricity is cheaper than that produced conventionally in new plants. This comparison would be a much fairer way of ascertaining the extra costs involved in RES-E expansion.

To use a household analogy, an old refrigerator might soon need to be replaced – as do many of the conventional power plants in Europe. The cost of replacement depends on the model

2 Estimated value provided by grid operators. Includes the market revenues of RES-E operators in the event that the market premium model is used.

chosen; a modern, eco-efficient refrigerator may be a little more expensive to buy than a standard one. When deciding which model to purchase, potential buyers compare the full costs of a new eco-efficient refrigerator with the full costs of a new standard model. If the calculation used for the EEG surcharge were adopted, they would instead compare the full costs of a new eco-efficient model with the operational costs of the existing refrigerator alone – failing to take into account the fact that the new standard refrigerator is not available for free, and that its full costs are therefore higher than the operational costs of the old model as investment costs must also be included. This would give the false impression that the eco-efficient refrigerator is always much more expensive than the standard model.

Employ alternative indicators to the EEG surcharge when developing renewable energy targets

The use of the wrong indicators leads to the wrong policies. In place of the EEG surcharge, the following indicators should be taken into account when deciding on renewable energy targets: the LCOE; the external costs of the different technologies; the advantages of renewable energy such as environmental protection, job creation, the reduction of energy imports and hence increasing security of supply; and the costs of balancing the variable production of electricity from wind and solar power plants. A fruitful discussion on the benefits and drawbacks of the rapid expansion of renewable energy can only be possible if misleading indicators such as the EEG surcharge are set aside and reasonable ones are used in their place. Without such a shift in the basic reference points used in the debate, the development of sound energy policies will be severely hindered.

4. Production Costs for Renewable and Conventional Power Generation

Wind energy is already cheaper than conventional energy

The German government estimates the full cost of electricity generated by fossil fuel power plants to be between seven and 11 ct/kWh (BMWi 2014). This correlates with the Levelized Cost of Energy (LCOE) for hard coal, gas and nuclear derived from a range of studies (*see Table 1*) – even if the estimations differ strongly. In the case of electricity from renewable energy sources, the support schemes in EU Member States can give additional valuable information. With investments in specific technologies made under dedicated support systems, the support provided must be sufficient; the real costs cannot be higher. In Germany, for example, investments are made in onshore wind power plants with an average strike price of around 8 ct/kWh for new installations, and in solar power plants with a strike price of between 9.5 ct/kWh for large and 13.7 ct/kWh for small installations. These strike prices remain within the range of the costs of conventional power generation. According to the studies listed in Table 1, the current costs for onshore wind are already lower than the estimates for fossil fuel and nuclear power plants. Even large solar power plants can be cheaper than new conventional power plants.

Electricity generated by onshore wind (and soon also PV) costs no more than that generated by conventional power plants.

Table 1: Costs (LCOE) of the generation of electricity from different sources, based on a range of studies and the strike prices paid by the German feed-in system (EEG).

[€ct/kWh]	Nuclear	Hard coal	Gas	Onshore wind	Offshore wind	Solar (small)	Solar (large)
Installation 2015 Prognos (2013)	-	8.2-8.6	9.3	6.6-9.6[1)]	12.0[1)]	12.1-14.2[1)]	8.7-10.7[1)]
Installation 2015 Agora (2013a)	-	8.2-10.5[3)]	7.7-11.2[2)]	6.0-8.9[1)]	-	9.8-12.2[2)]	8.1-8.9[2)]
Project start 2018[5)] DECC (2012) & Parsons Brinkerhoff (2012)	8.9[4)]	13.8-16.0	10.4	11.0-12.3	12.3-13.8	-	15.7
Installation 2013 Fraunhofer ISE (2013)		6.3-8.0	7.5-9.8	4.5-10.7	11.9-19.4	9.8-14.2	7.9-11.6
External costs[6)] FÖS (2012)	10.7-34.3	8.9	4.9	0.3	0.3	1.2	1.2
EEG strike price 2012 Installation 2014 BMUB (2013) & BNetzA (2013)				8.7-9.2 (4.7)[7)]	15.0-19.0 (3.5)[7)]	13.0-13.7	9.5-11.6

Source : own compilation

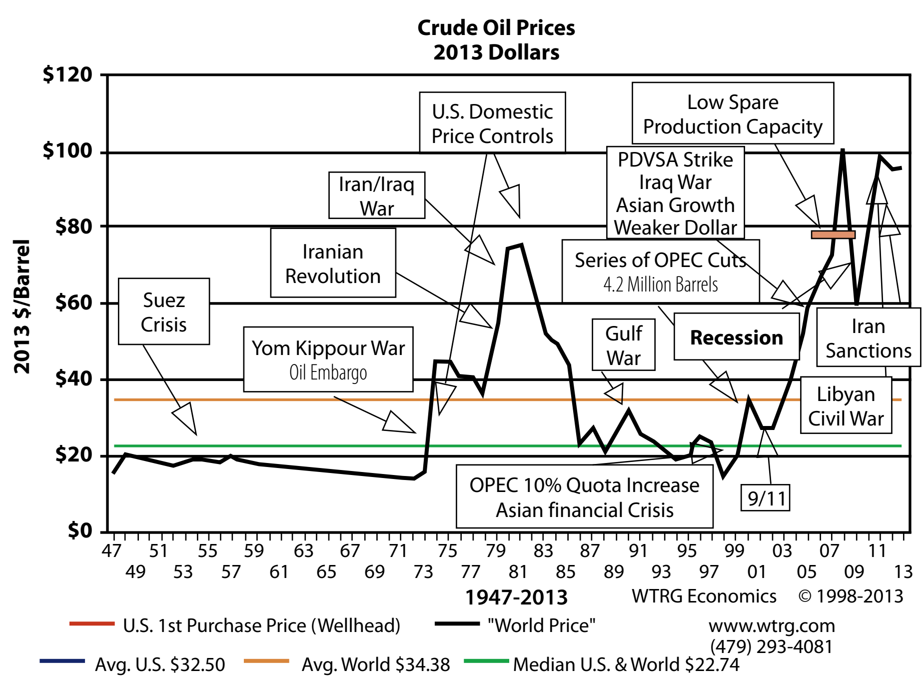
1) Lifespan 20 years. 2) Lifespan 30 years. 3) Lifespan 50 years. 4) Capital costs of between 3,660 and 5,024 €/kW installed capacity have been used. The actual cost of the Hinkley Point C nuclear power plant is between 6,000 and 8,000 €/kW. 5) Using the exchange rate of 1 GBP to 1.22 EUR (23 Jan. 2014). 6) A small percentage of the external costs are internalised by the EU ETS. 7) Lifespan 20 years. A high strike price is paid for at least the first five years, after which a lower one is introduced (given in brackets).

It should be noted that none of the estimates above include external costs, such as the environmental costs linked to the emission of greenhouse gases and the resulting climate crisis (*see Chapter 5*).

In the future, renewable energy will become even cheaper and conventional energy more expensive

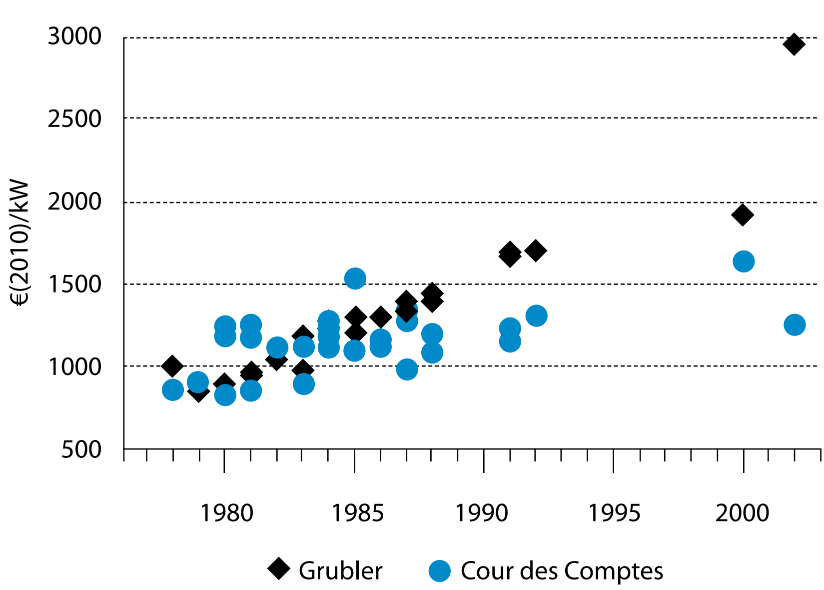
Over the long term, fossil fuels as well as nuclear power have become more expensive – and this trend will continue. This trend can be seen in the development of the price of crude oil since 1947, and in the price for nuclear power plants in France. It was impressive to see that even during the recent global economic crisis, the price of oil remained high and dropped for a short period of time only. Before the economic crisis had come to an end, crude oil prices had bounced back to about $100 (2013) per barrel, which is roughly today's price. In the 1950s, one barrel of crude oil cost about $20 (2013) per barrel (*see Figure 3*) (WTRG Economics 2014). It is also impressive to see the continuous increase in the costs of nuclear power plants in France. In the mid-1970s, the country's nuclear plants cost between €800 and €1,000 (2010) per kilowatt (kW) of installed capacity; by the early 2000s, this had risen to between €1,300 and €3,000 (2010)/kW (*see Figure 4*) (DIW 2013). The costs of the planned British nuclear power plant Hinkley Point C are estimated at between 6,000 and 8,000 €/kW (von Hirschhausen 2014). New technologies ordinarily become cheaper after their introduction onto the market, and when they move from the demonstration phase to serial and mass production. In the case of nuclear power, this has not happened – and seems unlikely to do so in the future.

Figure 3: Crude oil prices between 1947 and 2013 in $ (2013) per barrel.



Source : WTRG Economics 2014

Figure 4: Investment costs for French nuclear power plants in € (2010) per kW. Figures relate to 'second-generation' nuclear power plants.

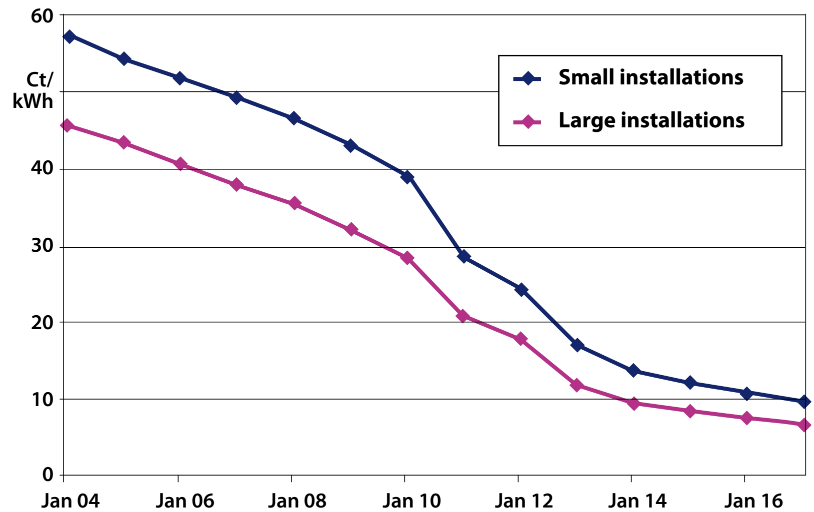


Source : Projections by Grubler and the French Court of Auditors (Cour des Comptes) (DIW 2013)

The costs of solar power and wind energy have decreased

With renewable energy, the picture is quite different. Solar power in particular has become dramatically cheaper over the past 10 years. In Germany, its strike price dropped from up to 57 ct/kWh in 2004 to between 9.5 and 13.7 ct/kWh in February 2014. If this trend continues, the strike price for all types of solar installation will sink further to below 10 ct/kWh by 2016 (*see Figure 5*). The costs of wind power have also been reduced, in spite of the fact that wind power installations now provide power system services (needed to secure grid stability) that were not offered some years ago. For electricity from offshore wind farms in Germany, the industry believes that a one-third decrease in costs is achievable over the next decade (Fichtner & Prognos 2013).

Figure 5: Nominal strike prices for solar power plants in Germany between 2004 and 2017.

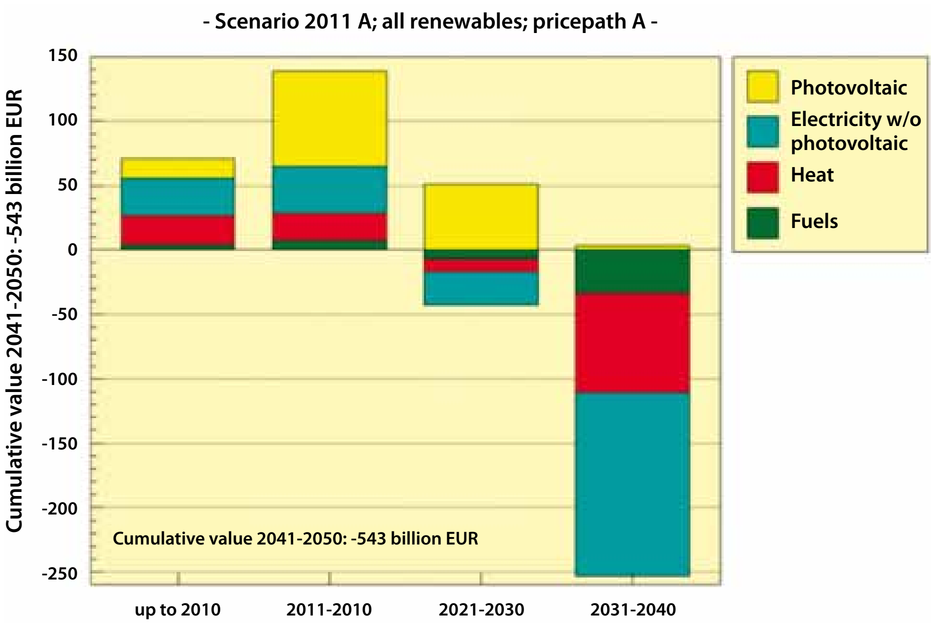


Source : Between 2004 and 2013 historical data according to the EEG (EEG 2000, EEG 2004, EEG 2008, BNetzA 2013; author's own compilation). Post-January 2014 strike prices according to the EEG effective in the event of the installation of between 2.5 and 3.5 GW per year.

Choosing the renewable path pays off in the medium and long term

It is therefore clear that the path to renewable energy is economically reasonable, particularly in the long run. A group of scientists advising the German government calculated the costs of a renewables scenario in Germany for the decades from 2000 to 2050 (*see Figure 6*). Their analysis shows that during the initial phase (up to 2020) the transition to renewable energy would be more expensive than a 'business as usual' scenario due to the high investment costs of renewable energy installations. The main share of these costs is related to the installation of a very large number of solar power plants in the years 2009 to 2012, when PV technology costs were much higher than they are today (*see Figure 5*). Under the German Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz – EEG*), the consumer will continue to finance installation costs for up to 20 years after initial operation – so until 2032. This is the reason for the size of the column for the decade from 2021 to 2030 in Figure 6. Without these solar costs, the transition to renewable energy would already be economically profitable from 2021 onwards. For the decade from 2031 to 2040, the positive economic effect of the transition to renewables will amount to more than €500 billion – far greater than the total cost of all of the preceding decades (DLR et al. 2012).

Figure 6: Cumulative differential costs of the entire energy supply in the power, heating, and transport sectors under a renewable energy scenario compared with a conventional scenario.



Source : DLR et al. 2012

High costs for new solar power plants are a thing of the past

As a result of Germany's initial investment and the technological developments introduced by its renewables policy, for which the German consumer is still footing the bill, solar power is now much cheaper than in previous years. All those wishing to increase the solar share in their power mix should therefore not be discouraged by the prospect of high initial investment costs; thanks to German investments, the sizeable sums represented by the large yellow area in Figure 6 will no longer appear in their cost calculations, even with greater solar power installation.

This shows that technology learning curves pay off. Nationally binding targets for renewable energy and support schemes result in stable regulatory conditions that deliver investment certainty and thus contribute to decrease the cost of renewable energy technologies. The most adequate support instrument depends on the technology, size and national market conditions and their adaptability to technological and price developments.

5. The Hidden Costs of Conventional Energy: Environmental Damage and Conventional Subsidies

The climate crisis threatens lives, welfare and economies

The fossil fuel-based energy system is the main driver of the climate crisis. According to Kofi Annan, the climate crisis is already threatening the welfare of hundreds millions of people; in the future, this will run to into billions. The costs of the climate crisis also threaten economies; the World Bank, the International Monetary Fund, and the International Energy Agency all warn of the risks posed by climate change (Annan 2014). In addition to the costs of the climate crisis, air pollution caused by conventional power generation is linked to health risks and environmental damage, which also lead to considerable welfare losses. The fact that the environmental costs of energy consumption are only marginally internalised in energy prices, with even the LCOE failing to include external costs, is therefore highly problematic.

With external costs internalised, renewables are much cheaper than conventional energy sources

External costs are defined as those that are not adequately reflected in energy prices, but which society as a whole must bear. If the external costs are internalised, most renewable energy sources are cheaper than conventional energy. The biggest share of the external costs of fossil fuel power plants relates to GHG emissions. In the medium term, these costs are estimated to amount to €80 per tonne of CO_2. The costs are projected to increase to €145 by 2030, and to €260 by 2050 (Umweltbundesamt 2012). In the short term, this would add about 9 ct/kWh to the current cost of electricity generated by lignite-fired power plants, and around 5 ct/kWh to electricity from gas-fired power plants (FÖS 2012). If external costs are taken into account, the total macroeconomic costs of conventional electricity are higher than the total costs of renewable energy (*see Table 1*). The rapid expansion of renewables would therefore bring substantial savings, meaning that renewables are therefore also a good investment from the economic point of view. This is even more true in the medium and long term.

The European Union Emissions Trading System (EU ETS) was once meant to internalise the external costs of GHG pollution caused by power generation and industrial production. Over recent years, however, prices for CO_2 certificates have fallen to lower than €5/tonne CO_2. This is far below actual external costs and is much too low to facilitate any change in the use of fossil fuel power plants or to influence investment decisions in favour of more climate-friendly power plants. One particularly useful change to the design of electricity markets would therefore be to internalise the external costs, e.g. by means of a functioning carbon market.

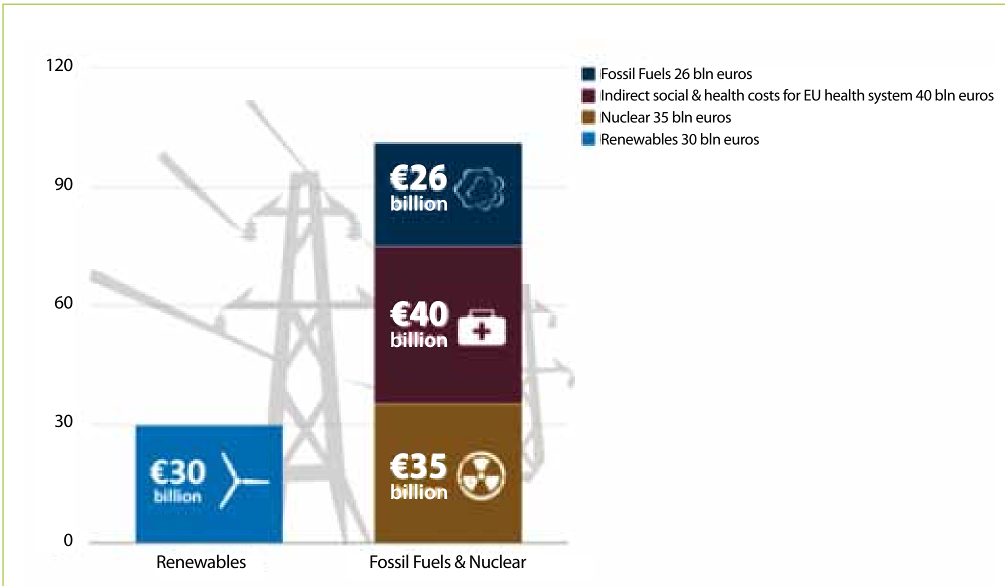
Insurance costs for nuclear power plants are highly insufficient

Furthermore, the operators of nuclear power plants do not pay all of their costs. The main reason for this is that nuclear power plants in Europe, as elsewhere, are insufficiently insured. According to experts, the Fukushima nuclear accident has to date cost more than €100 billion, not including compensation costs. However, nuclear power plants are insured for €49 million only in Bulgaria and €2.5 billion in Germany. While France's nuclear power plants are insured for €91.5 million, the costs of a nuclear accident in France were assessed to amount to €430 billion, since the plants are sometimes located very close to large cities, as in other European Member States (Gaßner et al. 2013). In this context, the key question is how much sufficient insurance would cost. Nikolaus von Bomhard, CEO of Munich RE, one of the largest reinsurance companies, stated in 2011 that they were not able to calculate that with their models (Spiegel 2013). Furthermore, there is a high level of uncertainty about the real costs for waste disposal and decommissioning (Thomas 2010).

Subsidies for conventional energy are higher than for renewables

Insufficient insurance for nuclear power plants is clearly a form of subsidy, and it is not the only one. According to the Commission's own figures, electricity from nuclear and fossil fuels in Europe benefits from an overall €100 billion of public money annually, while subsidies for renewables amount to €30 billion per year (*see Figure 7*) (SZ 2013).

Figure 7: EU Commission figures on electricity subsidies for EU countries in 2011, worth over € 130 billion in total.



Source : CAN-E 2013

6. The Additional Costs of Balancing Renewable Energy Fluctuations

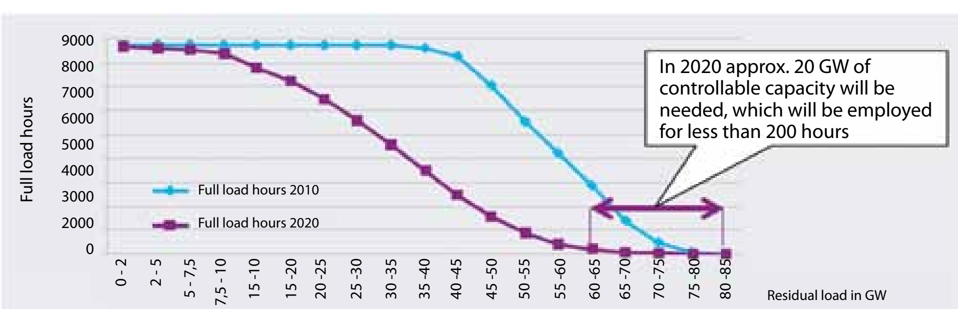
Wind and solar will be the major pillars of an electricity system based on renewables

In most European countries, wind and solar energy are the renewable technologies with both the largest potential and the lowest costs. These two technologies are therefore the two essential pillars of a future renewable electricity supply. In Germany, for example, wind and solar could have a share of 80 to 90% over the long term (Agora 2013). These technologies nevertheless depend on actual and changing weather conditions. Hence, back-up systems are needed to ensure a continuous electricity supply. It is only with such systems in place that renewable energy can really be a viable substitute for fossil fuel and nuclear power plants, to the extent that no new conventional power plants would need to be built. The LCOE fails to include these costs.

In the medium term, back-up systems will be needed for a few hours per year only

The back-up systems that will be needed over the coming years and decades must be flexible and controllable, as they will only be used for a limited number of hours per year. As the existing conventional power plants are likely to remain in operation for some years to come, they will be able to provide most of the back-up electricity needed for when little wind and solar power is available. Additional back-up capacity will mainly be needed in exceptional circumstances to cover maximum peak load, which occurs relatively rarely. As shown in *Figure 8*, approximately 20 GW of new flexible and controllable back-up capacity will be needed in Germany by 2020 as a result of the decommissioning of nuclear and old fossil power plants. While this represents almost a quarter of maximum demand, it will be needed for less than 200 hours annually, or around two per cent of a year (Agora 2013).

Figure 8: Demand for flexible and controllable back-up capacity to cover maximum peak load.



Source : Agora 2013

There are a range of different options for back-up systems

New conventional power plants, in particular coal and nuclear plants, have high investment costs. If they are to produce electricity at competitive costs, they need to remain in almost constant operation. New conventional power plants are therefore unsuitable for use as back-up systems, as these systems need to be rather flexible. There are a number of options that provide flexible, controllable capacity at a much lower cost. One of the most appealing flexibility options is demand-side management, because it reduces the maximum production capacity. Other cost-effective options include the retrofitting of generators in existing hydropower plants, biomass-fired power plants and existing power plants to increase their flexibility. Furthermore, existing emergency generators, batteries, and other new storage options can make the system more flexible (IEA 2014, TAB 2012, BET 2013).

In the short term gas turbines would be a simple and cheap option

A relatively simple and cheap way to provide back-up capacity during the transition to renewables is to make use of gas turbines. These can be fired by natural gas, as well as by biogas or synthetic gas produced with renewable electricity. Open-cycle gas turbines (OCGTs) have been used to cover rare peak load periods for many years. They have low investment costs and comparably small fixed costs – between €35 and €70 million per GW, per year (Agora 2013). Using Germany's total electricity consumption as the basis for calculation, the installation of 20 GW OCGTs would add only around 0.15 to 0.3 ct/kWh to the electricity price.[3] Since these turbines only run for a limited number of hours a year, their relatively high production costs are not relevant. This calculation was chosen for its ability to illustrate that back-up systems do not need to be expensive; it does not mean that gas turbines would be the best, the only or the cheapest option, or that this number of gas turbines would really be needed. But this default option for ensuring greater flexibility shows that the costs of the renewable electricity system are not heavily influenced by the need for back-up. Another option is the capacity of existing hydropower plants in regions such as Scandinavia and the Alpine area that could be used to store energy in longer time periods with little wind or solar power. For example, the energy stored in existing Norwegian hydro plants is equal to the electricity consumed in the entire EU27 in ten days (SRU 2011, EC 2014a). In order to take advantage of this storage potential, however, transmission capacity from the relevant EU Member States to Norway (for instance) would need to be expanded.

A mix of flexibility options would most likely be the optimal solution, and hence all of these solutions need to have a real chance to develop. In sum, the system balancing costs for the next decade will be just a few per cent of the cost of power generation by renewable or conventional power plants – and hence more or less negligible. More expensive flexible balancing solutions will only be needed in the future when the share of variable renewable energies such as wind and solar rises above about 70% (IEA 2014, TAB 2012, Fraunhofer ISE 2012, Agora 2013).

Decentralized storage has big potential to make the system more flexible

Storage technologies are rapidly developing and will become very significant in the medium- to long term, as they could – in the future – satisfy several market applications at competitive prices. The services include providing real-time system balancing (e.g. through frequency voltage regulation), providing peak and seasonal capacity and autonomy in electro-mobility. Battery storage systems and Flywheels, for instance, are already operating today in some competitive ancillary services power market – providing ten times more accurate and faster response to a power

3 Based on an electricity consumption of 500 TWh (terawatt hours) per year.

dispatcher's signals compared to power turbine generators. Thermal storage is being developed today in grid-connected Concentrated Solar Power Plants in the form of molten salt, improving its cost-performance and allowing variable renewables to become dispatchable. Other technologies, such as Compressed Air Energy Storage present affordable solutions.

Effective cooperation between EU Member States could lower prices even further

A successful back-up system would be composed of many or all of the technical options mentioned above. Member States that are committed to the transition to renewable energy should, on a voluntary basis, make use of cooperation mechanisms and work towards interlinked support schemes within the internal energy market. Effective cooperation between EU Member States, including expanding grid distribution and transmission capacities and cross-border interconnections, would reduce the back-up capacity required and make the entire system more efficient. In the short term, the cost of electricity in a system with a considerably higher share of renewables (including back-up capacity), if well designed, would thus be about the same as the cost of electricity generated with more new conventional power plants. In the medium and long term, the renewable path will be cheaper, even without taking external costs into consideration (Agora 2013).

7. Further Advantages of the Expansion of Renewables

Long list of advantages identified by the European Commission

The use and expansion of renewable energy sources brings a number of important advantages, as detailed below. According to the Impact Assessment carried out for the EC White Paper 2030, "higher efforts geared towards energy efficiency and renewable energy beyond what is needed to achieve a GHG target would result in higher benefits relating to e.g. improvements in fuel efficiency, security of supply, reduction of the negative trade balance for fossil fuels, environmental impacts and health", in addition to having a positive effect on GDP and employment (EC 2014f).

Renewables reduce energy import dependency and costs

Fossil fuel imports cost the EU nearly €400 billion per year, against a trade deficit of €150 billion (EC 2014d). By 2030, without an increase in the share of renewables, it is likely that the costs will be even higher due to increasing fossil fuel prices. Increased use of renewables would lessen this dependence on oil and gas imports and, by doing so, could reduce these costs by €370 billion per year in 2030. Greater independence from oil and gas from politically fragile regions would therefore not only increase energy security but also save money to the European economy (EREC 2013). The crisis in the Ukraine also highlights the political importance of Europe to become less dependent on fossil fuel imports.

Renewables reduce environmental costs

Renewable energy reduces greenhouse gas emissions and other air pollutants. In 2009, renewables reduced GHG emissions by 340 million tonnes, which represents about 7% of total EU GHG emissions (EREC 2013). If the EU achieves its target of a 20% share of renewables by 2020, this reduction could increase to some 600 million tonnes, or 12% of total EU GHG emissions. With environmental damage estimated to cost €80 per tonne of CO_2 (*see Chapter 5*), the use of renewables saved €27 billion in 2009; this could increase to €48 billion for the year 2020.

Renewables create jobs

The EU renewables sector employs around 1.2 million people, both directly and indirectly (IRENA 2013, EREC 2013). Around one third of these jobs are in Germany – showing that it pays to promote a rapid increase in renewables (IRENA 2013). By 2020, employment in the EU renewables sector could more than double to 2.7 million (EREC 2013). In a report for the European Commission, Cambridge Econometrics et al. calculated the effects on employment of the different scenarios featured in the EU's Energy Road Map 2050. They found that the scenario with the highest share of renewables delivered the highest number of relatively highly skilled jobs, i.e. in managerial, professional and associate professional occupations, as well as in skilled crafts and trades. About 1.2 million more people would be employed in these occupations under this scenario by 2025 than under the reference scenario (Cambridge Econometrics 2013). The Commission itself estimates that more than 800,000 additional jobs could be created under a scenario with ambitious targets for energy efficiency and renewables when compared to a reference scenario, most of them in the field of energy efficiency (EC 2014e).

Renewables generate business

In 2011, the turnover generated by renewables in the EU27 topped €137 billion – approximately 34% from biomass, 33% from solar PV, and 24% from wind power (BMUB 2013a).

8. Documents Accompanying the EC White Paper on A 2030 Framework for Climate and Energy Policies

The White Paper on a 2030 framework for climate and energy policies is primarily based on the Energy prices and costs report (EC 2014a) and the Impact Assessment (EC 2014e). The Energy prices and costs report claims to "help policy makers understand the context of recent price rises and their impact on energy consumers" and to "ensure that policy decisions rely on thorough evidence-based economic analyses" (EC 2014a). A closer look at the data does in fact reveal helpful information – but the presentation of certain aspects of the data could lead to some confusion.

According to the Commission energy prices will continue to rise – but this will not be due to renewables

The EC memo "Questions and answers on the price report" summarises one important finding: "The analysis confirms the Commission's 2050 analysis that energy prices will continue to rise in the short term – mainly due to rising fossil fuel prices as well as the need to invest in networks and in new power generation" (EC 2014b). In short, energy prices will continue to rise – but this will not be due to renewables. Furthermore, the Impact Assessment makes clear that the expansion of renewable energy brings a long list of advantages (*see Chapter 7*). It should also be noted that an increase in energy prices would have a positive impact on energy efficiency by giving increased economic impetus to such measures; if energy efficiency is implemented, total energy costs for European industries and consumers could even fall. Most importantly, a sound energy future will not be achievable without a dramatic increase in energy efficiency.

Relative numbers should not be misinterpreted

Other data can easily be misinterpreted, however. The Energy prices and costs report uses relative numbers to illustrate many developments, for instance stating that levies on electricity (e.g. for the support of renewables) increased by 30% between 2008 and 2012. This might give the impression that renewables were largely responsible for past electricity price increases. This is not the case, however, as levies generally account for only a small share of the electricity price. Hence, even a large relative increase would not make a significant difference. Another example can be found in the fact that while taxation of electricity in the EU27 increased by 120% between 2008 and 2012, the costs of network components increased by only 18-30% (EC 2014a). In absolute numbers, however, the tax increase was smaller than the network cost increase in the EU-15. The fact that the relative numbers given by the Energy prices and costs report are misleading is particularly problematic as they appear to show that policy actions and the expansion of renewables are to be blamed for price increases; this is not borne out by the data in the report itself.

The German EEG surcharge is not an indicator of the costs of electricity from renewable sources (RES-E)

A further source of possible confusion in the report is that the EEG surcharge is used to represent the additional costs involved in the expansion of renewable energy. This is incorrect. The costs are much lower, in fact; studies conducted for the German government estimate them at less than 25% of the surcharge (FÖS 2013, DLR et al. 2012).

It is very likely that comparable surcharges are used in support schemes in other Member States; these too would be misleading if used to represent the real additional costs of the expansion of renewable energy. (See p.11 for further details on the EEG surcharge and its incorrect use as an indicator of the costs of RES-E expansion.)

The extra costs of energy efficiency and renewables targets are not worthy of mention

The Impact Assessment indicates that the average total system costs of a single 40% GHG emissions reduction target for the period from 2011 to 2030 – as proposed in the White Paper – would be nearly equal to those of a 40% target combined with binding energy efficiency and renewables targets. While the first scenario (built around a single 40% GHG reduction target) would cost around €2,000 billion per year, the second (with binding energy efficiency and renewables targets) would be just €20 billion per year more expensive – an increase of only one per cent. The electricity price in the final demand sectors would even be slightly cheaper. In addition, it should be noted that a complex and controversial model, which was fed with a large number of assumptions, was used to calculate this data. As such, this small difference cannot be taken as a clear trend. In spite of these points, the Commission described its findings as follows: "Renewables and energy efficiency investment going beyond what is needed to achieve cost efficiently a certain GHG target […] would result in higher energy system costs" (EC 2014f).

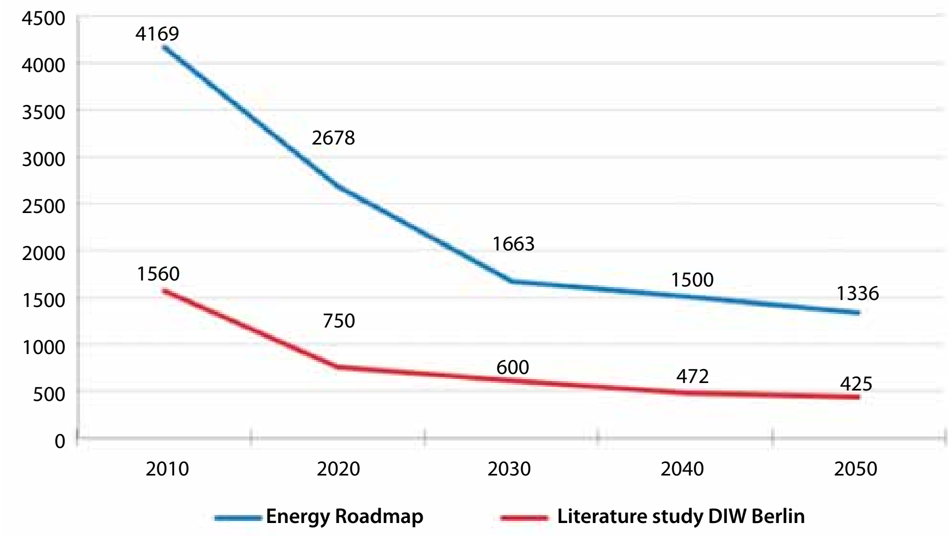
Lack of transparency in cost-related data in the Impact Assessment

In addition, there is a lack of transparency concerning the cost assumptions for nuclear, fossil fuel and renewable energy sources in the Impact Assessment. Outdated and plainly incorrect data has been used by the Commission in the past, for instance when the Energy Roadmap 2050 and the Green Paper 'A 2030 framework for climate and energy policies' were published in 2011 and 2013 respectively (DIW 2013, ZDF 2014). There is strong evidence that the same incorrect data was used for the White Paper and its Impact Assessment (von Hirschhausen 2014a).

Commission estimates on conventional energy costs are too low, while renewables estimates are too high

When calculating the investment costs of new nuclear power plants, the European Commission used the figure of €4,400 per kW capacity; actual costs are between €6,000 and €8,000 per kW (von Hirschhausen 2014). Furthermore, while the costs of nuclear power plants have increased in the past (*see Chapter 4*), the Commission projected decreasing costs for the future (DIW 2013). With renewables, conversely, the Commission estimated the costs of photovoltaic installation at €1,500 per kW capacity in 2020, although in Germany photovoltaic power plants have been set up at a cost of €1,300 per kW capacity, and costs are dropping rapidly (ZDF 2014) (*see Figure 9*).

Figure 9: Development of specific investment costs with photovoltaic power systems in Euros per kilowatt.



Source : own compilation, based on DIW 2013

According to NGO sources (EurActiv 2014), the Impact Assessment used biased projections to model cost-effective carbon reductions by 2030 with the intent to make the emissions-only approach look more attractive: On the one hand, the Commission based its modelling on the assumption that the carbon price in the Emissions Trading System (ETS) influences decisions taken across the whole economy (including non-ETS sectors) and on the other hand, it assumes unrealistically high risks for energy efficiency investments (reflected in so-called discount rates). It is highly likely that more realistic cost assumptions would produce results demonstrating that a renewable energy strategy would be significantly cheaper than a conventional strategy. Ambitious and binding EU-wide and national 2030 targets for emission reductions, renewable energy deployment and energy efficiency are necessary to achieve ambitious climate goals and to ensure a cost-effective energy transition in Europe.

LIST OF ABBREVIATIONS

CO_2	Carbon dioxide
ct	Euro Cent
EC	European Commission
EEG	Erneuerbare-Energien-Gesetz (German Renewable Energy Sources Act)
EPEX	European Power Exchange
ETS	Emissions Trading Scheme
EU	European Union
EUR, €	Euro
GDP	Gross domestic product
GHG	Greenhouse gas
kWh	Kilowatt hours
LCOE	Levelized Cost of Energy
MWh	Megawatt hours
NGO	Non-Governmental Organisation
OCGTs	Open-cycle gas turbines
PV	Photovoltaics
RES-E	Electricity from renewable energy sources
TWh	Terawatt hours
UK	United Kingdom
USD, $	United States Dollar

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European energy policy is facing major challenges. In order to tackle the climate crisis, a dramatic reduction in greenhouse gas emissions is essential. At the same time, security of supply and affordable energy for a competitive economy must be ensured. Many conventional power plants in the European Union are old and will need to be replaced or modernised in the coming years and decades. In the light of these challenges, economic and environmental goals sometimes appear to require opposite paths of action.

This paper demonstrates, however, that an expansion of renewable energy sources is the only path to a secure, affordable and climate-friendly energy system until 2030 and beyond. Renewables not only drastically reduce emissions and other environmental and social burdens; they also reduce energy import dependency and hence increase energy security, strengthen local economies, and create jobs. While fossil fuels and nuclear power will become more expensive, renewable energy will become cheaper. This is even more true if the external costs are factored in. Together with a reduction of energy consumption by increasing energy efficiency, total energy costs for European industries and citizens could even fall. Choosing the renewable path thus pays off in the medium and long term.

Ambitious and nationally binding 2030 targets for emission reductions, renewable energy deployment and energy efficiency are necessary to ensure an energy transition for a European Union for Renewable Energy.

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