THE GERMAN ENERGY TRANSITION

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STATUS, CHALLENGES AND THE FINNISH PERSPECTIVE

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- The German term *Energiewende* (energy transition) refers to a fundamental transition to a decarbonized energy system mainly based on variable renewable energy (wind, solar), with the emphasis on increased energy efficiency without the use of nuclear energy. The main focus is currently on the electricity sector and challenges relate to the support scheme, system adaptation, energy efficiency and electricity market design.

- The *Energiewende* has an effect on the EU as Germany is part of the European electricity system, which is planned to be fully integrated by 2014, with interconnectivity between regional networks increasing over time. EU energy and climate policy developments are also of relevance to Germany.

- The rising shares of variable renewable energy raise the flexibility requirements of the energy system to ensure network reliability. The extension of the electricity grid is a key factor as better cross-regional integration evens out the variability and provides greater access to dispatchable capacities and energy storage, for example.

- Nuclear energy is at odds with the flexibility requirement as it is the least flexible energy source. Large nuclear shares may ultimately limit the possible share of variable renewable energy, particularly if the sustainable biomass potential is lower than expected due to sustainability and competing usage issues.

- The issue of support costs is less dramatic than the public discussion would suggest. Structural change will incur some costs, and financing will be needed to build up the necessary low carbon energy system. But the costs of unabated climate change would be much higher.

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Introduction[1]

In the aftermath of the nuclear reactor core meltdowns in Fukushima, Japan in March 2011, the German Government presented a set of decisions known as the *Energiewende* (energy transition) in June 2011. It refers to a fundamental transition to a decarbonized energy system based mainly on variable renewable energy (RE) like wind and solar power, with the emphasis on increased energy efficiency without the use of nuclear energy. The *Energiewende* is based on an earlier 'Energy Concept'[2] that was agreed on by the same coalition government of Christian Democrats and Free Democrats[3] in September 2010, and which already laid out a long-term perspective until 2050 for the transition towards a RE-based energy system.

The main difference between the *Energiewende* and the earlier Energy Concept is the treatment of nuclear power, an energy source that has always been contentious in Germany as large parts of German society are not willing to tolerate the risks of severe accidents and nuclear waste disposal. To this end, protests have been staged against this technology since the 1970s, with demonstrations of up to 100,000 participants on occasion. To date, there has been no decision on a final nuclear waste repository site.

For these reasons, the previous coalition government of Social Democrats and Greens negotiated a step-by-step nuclear phase-out ('nuclear consensus') with the nuclear power producers in 2000/2002, with the last reactor set to go offline by 2022 at the latest. With the Energy Concept, the current government decided in autumn 2010 to prolong the phase-out by 8-14 years (depending on the reactor), but in light of the events in Fukushima, the original phase-out decision was, in essence, reinstated.

This puts Germany in a unique position. As contentious as nuclear power has always been, the country does have a tradition of using this source of energy. Between 1990 and 2006 the nuclear share of electricity generation accounted for roughly between a quarter and a third, decreasing to around a fifth thereafter.[4] The nuclear phase-out and the simultaneous shift towards renewable energy consequently poses a significant restructuring challenge to the country – being committed at the same time to greenhouse gas (GHG) reductions by 2050 (see Table 1) consistent with the 2° target.[5]

These developments are also of relevance to Finland and to the EU as a whole because Germany is the largest economy in Europe and, due to its central location, represents an energy hub that is also (indirectly) connected to the Nord Pool Nordic Electricity Market, of which Finland is a part. This relevance will increase even further as the internal market for electricity across Europe is planned to be completed by 2014.

The main prerequisite for integration is network integration, namely the extension of interconnector capacities to enable physical electricity flows between the regional networks. In other words, Germany is part of a larger system, aimed at increased integration over time. On the one hand, this is beneficial for all participants, although it requires a greater degree of coordination that may be at odds with the German increased system adaptation requirements to accommodate variable RE (see challenge 2). On the other hand, EU energy and climate policy developments are having an impact on Germany, too.

The current low prices within the EU Emissions Trading Scheme are jeopardizing the necessary

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[1] This paper has benefitted from the IASS conference "The Energiewende – is there a Nordic way?" at the Nordic Embassies in Berlin on 15-16 October 2012 as well as from a number of background conversations with stakeholders. Special thanks go to Peter Lund and Petri Hakkarainen for reviewing an earlier version of the paper and providing valuable comments. All remaining errors are the sole responsibility of the author.

[2] BMU, BMWi (2011): Das Energiekonzept der Bundesregierung 2010 und die Energiewende 2011.

[3] For information on the German party system, see Behr, T., Helwig, N. (2012): Constructing A German Europe?, FIIA Briefing Paper 99, Box p. 2, http://www.fiia.fi/en/publication/247/constructing_a_german_europe/.

[4] Tabelle zur Stromerzeugung nach Energieträgern 1990-2012, AG Energiebilanzen e.V.

[5] More precisely, to confine the increase of global average surface temperature to 2°C with respect to 1850, i.e. pre-industrial levels. See Matschoss, P. (2012): Fighting Climate Change, FIIA Briefing Paper 100, p. 3 http://www.fiia.fi/en/publication/254/fighting_climate_change/.

	2020	2030	2040	2050
GHG (wrt 1990)	-40%	-55%	-70%	-80-95%
RE share (electricity)	35%	50%	65%	80%
RE share (end-use energy)	18%	30%	45%	60%
Primary energy (wrt 2008)	-20%			-50%
El. consumption (wrt 2008)	-10%			-25%
Energy requirements in buildings (wrt 2008)	-20% (heat)			-80 % (primary energy)
Energy end-use productivity	2.1% annually			

Table 1: German climate change and energy policy targets. Source: BMU, BMWi (2011); wrt = with respect to.

structural shift within the German fossil generation mix towards flexible natural gas capacities. Furthermore, even though Germany has a first-mover tradition with rather ambitious separate emission reduction and RE deployment goals, it is easier to justify these domestically if there are similar goals at the EU level as well. Despite the decarbonization necessities in conjunction with the 2° target, however, other member states are less ambitious in terms of reduction targets in the current negotiations for the 2030 targets, and some also reject separate RE targets.

For Finland, the German developments are of further relevance because, despite the Finnish nuclear capacities under construction, rising shares of variable RE are predicted for the Nordic electricity sector as well, leading to somewhat similar integration challenges in the Nordic region. Finally, Finland and Germany have somewhat comparable electricity generation portfolios with a broad range of sources including nuclear, coal and RE.

This paper outlines the current main focus and associated challenges of the German *Energiewende* relating to RE support, system adaptation, energy efficiency and electricity market design, and continues by discussing possible points of relevance for Finland.

A renewables-based electricity supply and its main challenges

Germany's overall greenhouse gas (GHG) reduction goal (Table 1) is consistent with the industrialized countries' reduction requirements to maintain the 2° target. In addition, there are a number of supporting intermediate and sectoral climate and energy policy goals.

So far, the main focus of the *Energiewende* has been on the electricity sector. The share of renewable electricity generation has roughly tripled since 2000 and reached about 22% in 2012.[6] The long-term goal is to upscale this contribution to 80% by 2050 with intermediate goals along the way (Table 1). A large share of this is planned to come from offshore wind energy but also from better estimation and development of onshore wind energy potential, including the repowering of existing sites. Solar photovoltaic (PV) is another large contributor that has already shown rapid deployment in the past. The current intermediate goal for the RE electricity share of 35% for 2020 is likely to be exceeded and is currently under revision. However, the *Energiewende* poses a number of challenges, as outlined below.

Challenge 1: Reforming RE support – from niche to mainstream

In the feed-in tariff (FIT) scheme that is used in Germany, support costs are borne by electricity consumers as cent/kwh contributions on their electricity bills. In 2012, the contribution accounted for about 14% of the electricity prices.[7] Since a rise in the contribution for 2013 was announced in mid-October 2012, it has become a major issue in the public debate, increasing political pressure for change. Furthermore, some RE sources have left the niche and gained system relevance, posing new challenges to the support scheme.

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[6] See footnote 4.

[7] Erneuerbare Energien und das EEG: Zahlen, Fakten, Grafiken (2013) BDEW, Berlin, 31.01.13.

Germany's main instrument for supporting RE[8] is the 'Renewable Energy Law' (EEG), the first version of which was passed in 2000 and has undergone several revisions since then. The EEG is a FIT, namely a pricing mechanism that is based on three principles: (i) a fixed price per kwh of electricity produced (above market rate), usually guaranteed for 20 years and differentiated by technology that covers the investment and running cost; (ii) the grid operator's obligation to connect the installation; and (iii) an obligation to accept any electricity, whenever it is produced. The latter point is particularly important for variable energy resources like wind and PV.

The EEG has proved to be very effective in raising the share of renewable electricity. International comparisons show that in real-world policy-making this kind of technology-specific support is in most cases superior to technology-neutral instruments such as quotas, despite the theoretical advantages of the latter. The EEG has served as a role model in many countries inside and outside the EU. It results in very low project risk, and as it is the risk perceptions of investors that have led to considerable variation in policy costs in Europe, this consequently contributes in large part to the success story of the EEG.[9] In other words, the basic principles of the EEG should be maintained during the current reform.

Costs keep rising, due in part to the success of the scheme as it supports every kwh produced by RE. Further, as the RE share keeps rising, it lowers the wholesale market price (see challenge 4), thereby raising the necessary differential costs to finance the fixed price per kwh of RE produced.

However, there are several ways of *streamlining within the current design*. In general, maintaining the efficiency of the scheme calls for regularly adapting the technology-specific tariffs to follow generation-cost decreases to avoid over-compensation. However, German tariffs did not follow the unexpectedly quick drop in PV prices, leading to high compensations (and differential costs) and triggering exceptionally high deployment rates. As a result, PV tariffs had to be cut suddenly and drastically in 2012, leading to disruptions in the affected sectors.

Future cost increases from PV are now expected to be moderate due to the adjusted tariffs, but the costs of existing capacities will remain according to the EEG's guarantees. Furthermore, an estimated fifth of the electricity covered under the EEG is exempt from the payments, increasing the burden on non-privileged industry, businesses and households, and triggering state aid issues with the European Commission.[10] Cutting back the exemptions to the originally intended addressees – energy-intensive industries – to aid competitiveness would reduce the burden on the non-privileged consumers and increase acceptance.[11]

There is some scope for *somewhat more fundamental revisions within the current scheme* in order to control costs. One way is to aim for the right balance between high-cost and low-cost technologies, taking systemic effects into account (e.g. offshore wind is more expensive than onshore wind but less variable and therefore requires less backup and/or storage capacities). Furthermore, the complementarity of RE may enhance system efficiency through fewer balancing requirements.

However, when optimizing the portfolio, it needs to be borne in mind that it is the very aim of technology-specific support to provide room for the necessary learning investments of initially expensive technologies in order to drive down future costs. Other possibilities include the introduction of more competition within the scheme. One model in the context of offshore wind is to have tenders where investors have to bid for the lowest FIT in order to be allowed to make the investment. This approach could be extended to a two-stage system

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[8] On the general rationale for RE support, see footnote 5, pp. 5–7.

[9] Ragwitz, M. et al. 2012: RE-Shaping: Shaping an effective and efficient European renewable energy market. RE-Shaping D23 Final Report. Karlsruhe, February 2012.

[10] EU probes alleged misuses of Germany's green energy incentives. EurActiv.com 30.11.2012.

[11] However, from an economic point of view the whole approach is highly questionable in the first place since the decision where to locate a production site is highly multidimensional. See identical leakage discussion in the context of the European Emissions Trading Scheme: Hentrich, S., Matschoss, P., Michaelis, P. (2009): Emissions trading & competitiveness: lessons from Germany; *Climate Policy* 9, pp. 316–29.

for all technologies with a uniform (or slightly differentiated) 'basic' or 'floor' FIT combined with technology-specific tenders. Furthermore, RE producers may be asked to deal with their technologies' integration requirements themselves, directing production towards the time of need. However, this only works to a very limited degree for variable RE. Some voluntary options (e.g. premiums) were introduced in 2011 and extended in 2012, leading to around 11% of directly marketed electricity in 2011.[12]

Even more fundamental is the question of when to stop the support altogether, with the most far-reaching decision having been made for PV. Under the impact of the surprisingly high deployment rates, the tariff for new PV installations will drop to zero once the total installed PV capacity reaches 52 GW, equalling around double the installed capacity of 2011. It is expected that the technology will then be competitive. However, long-term success will also depend on the reform of the electricity market design, determining the environment in which the technologies have to finance themselves (see challenge 4).

Challenge 2: System adaptation – enhancing system balancing abilities to accommodate RE

The second major challenge is the adaptation of the energy system to accommodate rising shares of variable RE, and this is where the European dimension is particularly relevant. Some RE sources like wind and solar are variable and only partially dispatchable, while their generation profile is also uncertain to some extent. This raises the balancing needs of the system as a whole, and the flexibility requirements for other parts of the system to ensure network reliability.

These increased balancing needs may be addressed with a number of strategies that include grid extension, energy storage, increased flexibility of the remaining fossil capacities, increased flexibility on the demand side, as well as greater dispatchability of RE sources themselves to some extent. In each system, the right economic mix between the different balancing measures needs to be found.

The extension and reinforcement of the grid infrastructure is a key factor. First of all, RE sites need to be connected to the grid and power needs to be transported to the consumer. In terms of the high voltage transmission grid, the main need for extensions within Germany concerns transporting electricity from wind generation in the North to the load centres in the South. This is because wind power – especially from offshore wind parks in the North and Baltic Seas – is planned to be a major contributor to new RE capacity. However, it is southern Germany, where most people live, where the industrial centres are found and where most of the nuclear capacity is located, that will go offline by 2022.

Using high voltage direct current (HVDC) technology, these planned lines will be able to transport large quantities of electricity over long distances with few losses. Furthermore, better integration across Europe evens out variability by connecting RE over a larger geographical area, and provides greater access to balancing options.

The above-mentioned extension of interconnections between the regional networks is coordinated by the European Network of Transmission System Operators for Electricity (ENTSO-E), which sets up 10-Year Network Development Plans (TYNDP) every two years including all projects of pan-European significance. Therefore, the HVDC lines mentioned above are regarded as the origins of a pan-European overlay network, while wind farm cluster connections in the Baltic Sea, for instance, are planned as combined grid solutions with Denmark, improving access to Nord Pool at the same time. Further connections are planned with Norway (see below), Benelux, and the UK, as well as with Switzerland and Austria.

The effects of increased German Wind and PV capacity can already be felt. For example, electricity trade flows with neighbouring states (e.g. the Netherlands, Austria) have changed significantly, but at times of high oversupply this also leads to congestion problems in Eastern neighbouring countries' networks (e.g. Poland), particularly when the German network is already under high load.

Secondly, energy storage allows the storage of energy at times of excess supply and releases it when needed, but it is currently rather expensive and regarded as a longer-term option. Currently,

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[12] Informationsplattform der Deutschen Übertragungsnetzbetreiber: http://www.eeg-kwk.net/de/index.htm.

the only large-scale, long-term energy storage technology available is pumped hydro storage, with the main potential being in Scandinavia (mainly in Norway) and in the Alps. Therefore, the issue is directly linked to European grid extension and a planned sub-sea cable connection to Norway.

Thirdly, the greater balancing abilities of the network also call for increased flexibility of the fossil capacities to provide the residual load and backup at times of low wind and little sun. The discussion is ongoing whether existing capacities coupled with those currently being built or planned will suffice or not. The question also needs to be viewed in conjunction with the discussion on the new market design (see challenge 4).

Fourthly, balancing abilities can be enhanced through Demand Side Management (DSM) / load management activities, reducing energy demand during peak load and/or when RE supply is scarce, in order to stabilize the grid and lessen the need for enforcements and extensions, as well as for dispatchable capacities. On the industrial side, this essentially means an extension of the balancing energy market from power plants to industry. In other words, large industrial consumers would be compensated for shifting their energy demand on request to off-peak hours (some already do this). On the household side, DSM would require the build-up of 'smart' infrastructures (smart grids, smart meters) but it is not yet known whether the expected contribution to load management is worth the investments.

Finally, a greater future contribution to integration is expected from RE sources themselves. This is easier for dispatchable energies like biomass hydro or geothermal energy, which could also participate in the balancing market. Some incentives do exist and extensions are currently under discussion (see challenge 1).

Challenge 3: Increasing energy efficiency – in the electricity sector and beyond

The basic approach of the underlying Energy Concept for households and industry alike is to create incentives for increasing energy efficiency, and markets for energy services to tap the economic potential of energy efficiency. In order to reach the long-term GHG targets, however, it is necessary to connect the electricity with the heat sector, and the single most important heat sector is buildings, accounting for roughly forty per cent of German end-use energy consumption and a third of CO2 emissions. The aim is to have a nearly climate-neutral building stock by 2050 (see Table 1) with the remaining energy needs being renewable, requiring a doubling of the current renovation rate.

The *Energiewende* now prioritizes buildings by tightening efficiency standards, increasing subsidies for current renovation programmes and privileged appreciation rules for efficiency investments. However, the current proposal to tighten the standards is criticized for only requiring business-as-usual efficiency improvements and for requiring them only for new buildings, whereas the overwhelming share of energy consumed (and related saving potential) is in the existing stock. Furthermore, a proposal to upscale financial incentives had been blocked in the Parliament since 2011 due to disagreement on how to finance the programme. Only at the end of 2012 was an agreement struck to upscale a grant-based renovation programme by 20%.

Another crucial connection for electricity is transport, where the underlying energy concept aims at introducing electric vehicles. It also aims at tightening emission standards (including increasing biofuel shares) for vehicles, which is, however, mainly driven by EU legislation.

Challenge 4: Re-designing the electricity market – finance in a RE-dominated system

In the event of high shares of variable RE, the energy market setup also needs to provide an environment conducive to enabling dispatchable capacities to react quickly to short-term forecasts on RE's availability, for instance, and to adjust production schedules accordingly.

Furthermore, both RE and non-RE capacities may run into financing problems under the current energy market design, which trades volumes of electricity based on marginal costs (energy-only market). In the event of rising shares of RE, non-RE capacities would run fewer hours and may therefore be unable to continue to finance themselves, leading to early retirements and/or too few investments in new capacities. This is particularly true for new or recently built capacities that have to finance themselves completely in this new environment. Therefore, different models to complement the energy-only market with an additional incentive (capacity markets vs. strategic reserve) are under discussion but the necessity is yet an open question.

The insight that RE wind and solar capacities in particular may need some kind of additional incentive (capacity market or the like) as well, because their economy may not work well with the energy-only market, is much more recent. This is because their power production (i.e. marginal) costs are nearly zero and, due to their dependency on weather conditions (sunshine, wind), they sweep the market at the same time and lower the market price at the power exchange (in the absence of energy storage). However, this depends on developments like energy storage and the increasing connections of demand sectors like electricity and heat (challenge 3), which would create additional demand, associated price increases and financing contributions from the energy-only market.

The way ahead and perspectives for Finland

The developments in Germany will have an impact on Finland due to Germany's energy hub function and its (indirect) connection to Nord Pool. Furthermore, Finland (as well as the other Nord Pool members) is also committed to the 2° target with comparable long-term GHG reduction targets to Germany, and therefore model analyses of the Nordic electricity market also show rising shares of variable RE in the future.[13] In other words, in terms of integrating variable RE, Finland will be faced with somewhat similar challenges as Germany.

The two main concerns raised to date by an expert group commenting on the first monitoring report of the *Energiewende*[14], with regard to electricity and heat (building sector), relate to energy efficiency and energy security risks. Energy efficiency is considered 'one of the central prerequisites' of the *Energiewende*, and the slow pace of improvements has come in for criticism. The expert group explicitly states that the market alone will not deliver the policy targets (which is also true for transport). Here, the EU Energy Efficiency Directive may provide valuable incentives, if implemented well.

For the building sector in particular, it is claimed that the goals will not be reached without additional measures (despite the recently decided increase in the grant programme). It is also true for the Finnish building sector that an acceleration in energy improvements is a prerequisite for reaching the long-term climate change targets and that the existing building stock has the highest saving potential.[15] However, low cost and no cost potential exists[16], particularly in the event of rising energy prices. What this means is that energy efficiency measures not only represent costs but also profitable investments.

The expert group has raised concerns over energy security because they fear that too few dispatchable capacities are available, especially in Southern Germany, and it is hard to judge whether the necessary transmission lines from North to South will be in place in time. Meanwhile, in order to secure sufficient dispatchable capacities in the short term, the government has mandated power plant operators to inform the network operator of any plant closure (>10MW) twelve months in advance. If the plant is deemed system-relevant, the operator may be forced to keep it operational but will be compensated for the expense of doing so.

Furthermore, a decree has been passed that mandates large industrial consumers to participate in the balancing energy market, namely by requiring them to reduce their electricity consumption if needed to secure network stability. In order to increase balancing abilities, grid extensions are of particular importance (and challenging) to Finland and Nord Pool, too.

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[13] Nordic Energy Technology Perspectives. 2013. IEA, norden.

[14] BMWi, BMU (2012): Erster Monitoring-Bericht "Energie der Zukunft"; Löschel, A., Erdmann, G., Staiß, F., Ziesing, H.-J. (2012): Expertenkommission zum Montoring-Prozess "Energie der Zukunft".

[15] See footnote 13 ch. 6; Heiskanen et al. (2013): Literature review of key stakeholders, users and investors, D2.4. of WP2 of the Entranze Project, IEE Program http://www.entranze.eu/.

[16] IEA (2007): Energy Policies of IEA Countries. Finland 2007 Review. IEA, Paris.

On the other hand, the grid extension provides increasing export opportunities for RE-based electricity to continental Europe due to Finland's biomass resources.[17] In this context, the new HVDC transmission line to Estonia currently under construction will provide additional transmission capacity and flexibility and also decrease import dependency on non-EU sources as it 'closes the ring' around the Baltic Sea connecting Finland with continental Europe from the Northeast. Further advantages of the Nordic region in terms of balancing abilities are its endowments with large hydro storage and (dispatchable) biomass energy potential, as well as the high share of cogeneration and district heating in the Nordic system, the latter easing the local integration of variable electricity into the heating sector.

The rising Finnish nuclear capacity, however, is in contrast with the increasing flexibility requirements as it is the least flexible energy source. Adopting a nuclear strategy increases the balancing requirements for other parts of the system and for the other Nord Pool partners. Furthermore, biomass involves a number of sustainability and competing usage issues, and the size of the sustainable potential has been the subject of heated debate. In other words, a smaller than expected sustainable biomass potential, together with a strategy based on large nuclear shares, eventually limits the balancing abilities of the system and the possible share of variable RE.

However, it is variable RE that has the largest technical potential in orders of magnitude[18], in particular since PV prices have decreased so dramatically recently. What this means is that variable RE should be expected to contribute significant shares to any future energy system – also in high latitude countries such as Finland. Therefore, careful consideration should be given to whether the flexibility options in the system should be used to serve variable RE or inflexible nuclear capacities. Another issue with nuclear capacities concerns financing. This may become increasingly difficult as rising shares of variable RE supress electricity prices and the utilization of non-renewable capacities, even though nuclear capacities are the first to be utilized due to their low marginal costs. The problem will be exacerbated in the event of unexpectedly high investment cost, and because the new capacities have to be financed completely in this new environment.

When it comes to electricity prices, experts maintain that the development in Germany is less dramatic than the public discussion would suggest, and that the share of German household expenditure spent on electricity in 2011 was actually the same (2.3%) as in 1986.[19] The latest rise in the contribution announced for 2013, which sparked a lot of media attention, adds an additional €5 to the monthly electricity expenses of an average 4-person household – roughly the equivalent of a pint of beer (at German prices). In other words, the price rise is mainly a problem for low-income households and should be handled by social rather than energy policy.

At the end of January, however, the German Minister of the Environment proposed a set of measures to limit the support cost growth, dubbed the 'electricity price fuse', which culminated in a joint position paper with the Minister of the Economy just two weeks later. Representing a rare instance of agreement between the two departments – not to mention a speedy one – this development took most political observers by surprise. In order to freeze the current consumer's cent/kwh contribution for this and next year and limit the future growth, the proposal would, among other measures, lower the FIT for existing capacities ex-post. This has sparked a lot of criticism since it jeopardizes investor's trust, which is notoriously hard to regain. Consequently, it was rejected by the heads of the federal states in a meeting with both ministers as well as the chancellor in late March.

Conclusions

The *Energiewende* represents nothing less than a paradigm shift in making Germany one of the front-runners in actively restructuring its economy

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[17] Rydén, B. (ed.) (2010): Towards a Sustainable Nordic Energy System, Nordic Energy Perspectives, Stockholm, April 2010; Nordic Energy Technology Perspectives. IEA, 2013.

[18] See footnote 5, Figure 2.

[19] Neuhoff, K., Bach, S., Diekmann, J., Beznoska, M., El-Laboudy, T. (2012): Steigende EEG-Umlage: Unerwünschte Verteilungseffekte können vermieden werden, DIW-Wochenbericht 41.2012, pp. 3-12.

towards an ecological path based on renewable energy. Not surprisingly in light of such an undertaking, countless challenges and conflicts lie ahead, in particular with regard to the development of the new infrastructure and related energy security concerns. The single largest factual weakness to date has been the energy efficiency policy. The way the support cost issue was handled, however, was regarded as the antithesis of good governance by many, as it has the potential to jeopardize what lies at the heart of the success of the German support scheme: reliability and low risk.

What is needed to serve the *Energiewende* more generally is a voice of reason in the public discussion that puts costs into perspective and communicates (more effectively) that structural change does incur certain costs – despite all efforts to minimize them. Energy prices will keep rising to some extent due to the necessary learning investments in renewable energy, grids, and storage and backup capacities, but part of this price rise would occur anyway because part of the infrastructure is outdated. It cannot be overstressed, however, that the finance is being used to build up the necessary low carbon energy system, and the costs of unabated climate change would be much higher. Nevertheless, with the *Energiewende*, Germany has now risen to the dual challenge of tailoring its electricity system to variable renewable energy while simultaneously pulling out of its considerable nuclear capacity.

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