The grid expansion debate: the issues at stake

Learning from the public consultation on the German network development plan 2012

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About SEFEP

SEFEP, the Smart Energy for Europe Platform, is an independent, non-profit organisation founded by the European Climate Foundation and the Stiftung Mercator. SEFEP aims at facilitating the transition to high shares of renewables in the European power sector.

www.sefep.eu

In Germany, the Agora Energiewende has been created by the same founders in the framework of SEFEP.

www.agora-energiewende.eu

Confidential draft

The grid expansion debate: the issues at stake - Learning from the public consultation on the German network development plan 2012

Foreword

This paper analyses the arguments put by a broad range of stakeholders in the public consultation on the first German electricity transmission grid development plan (NEP – Netzentwicklungsplan) during the summer of 2012.

Why and for whom this paper has been produced

This paper has been mainly conceived with the purpose to make accessible the German grid debate to **the interested public from other countries**. This can help stakeholders engaged in the transition to renewables in other countries to benefit from the German experience, and to encourage them to get involved in their national grid planning debates. With this target public in mind, we have provided extensive background information on the German context and debate.

The reading could be interesting also for **people directly involved in the German debate**: as far as we are informed, this is the first independent analysis of a large number of the comments provided by stakeholders in the German consultation procedure.

Broadening SEFEP's perspective on the grid expansion debate

Not least through its institutional support for the Renewables Grid Initiative, **SEFEP** has actively engaged in promoting a broader acceptance in civil society for the need of expanding the transmission grids as a tool to integrate high shares of renewables. This paper enlarges the perspective, showing that we need a neutral and broader debate on power system flexibility, where grid expansion is one and not the only option to integrate renewables.

Empirical basis

The core of this work is the analysis of the comments submitted to the public consultation on the NEP draft. The planning procedure is described in chapter 2.1.

For six weeks comments could be submitted by anybody through an online platform managed by the four German transmission system operators (TSOs). 1836 individuals and 264 organisations have submitted comments, ranging from few lines to very substantial essays[1].

While preparing this paper, we have read all contributions from organisations, and circa 200 randomly chosen contribution from individuals. Circa 50 of these submissions from organisations are summarised in Chapter 3, while the analysis of the key issues emerging from the consultation (Chapter 4) also takes into account the general tone and contents of the other statements we read.

[1] The online platform is available only in German at http://www.netzentwicklungsplan.de where the TSOs have published all submissions to the public consultation, if the authors had explicitly authorised the publication.

Executive summary

At first sight, grid planning may appear as a technical debate on the location of electrical equipment. Actually, it also is a political and social debate about the future architecture of the electricity system, with strong implications for the generation mix, economic and market power, and for the environmental and social impacts related to the electricity system.

Due to its breadth and depth, the German debate on the transmission grid development plan (NEP) is a so far unique and innovative experience. Stakeholders and civil society from other countries can learn a lot from this experience.

While some German stakeholders may have an interest in slowing down the growth of renewables, none of the organisations that submitted comments to the NEP consultation has questioned the direction and the basic timetable of the *Energiewende*: nuclear phase-out by 2022, massive expansion of renewables and the fulfilment of Germany's ambitious climate targets.

Despite of this general consensus, there are many and partly contradicting views on the NEP assumptions concerning the pace of renewables deployment, as well as their geographical distribution and technical mix. The key issues are the expected shares of PV, onshore and offshore wind, as well as the possibility of reducing grid expansion requirements by favouring the location of additional renewable capacities close to consumption. The latter may include increased PV deployment in or close to urban areas, and above all a stronger deployment of wind in southern Germany, despite of the weaker wind resource in this area. This would be in line with the plans of the regional authorities: perhaps surprisingly for foreign readers, most regional authorities currently compete to host more renewables in their territory.

A large number of stakeholders criticise that the NEP proposes clearly more additional transmission capacities than really needed. EnBW sees the NEP proposal as the "upper limit for transmission grid expansion", while the public would expect the NEP should be balanced. Some stakeholders mention the conflict of interests between the two roles of TSOs as system planners and as commercial entities operating power lines.

Many stakeholders criticise that alternative flexibility options like demand response, storage or flexible generation have not been sufficiently considered in the NEP draft and in the underlying assumptions, resulting in unnecessary grid expansion requirements. A frequent related argument is that the potential for balancing renewables at the distribution grid level has not been sufficiently considered. Several stakeholders suggest integrating the current top-down grid planning approach with a bottom-up approach starting from the distribution grids. Another aspect of the same argument is the need for a better collaboration between the TSOs and the DSOs, and their request for more transparency in the data made available by the TSOs. However, no detailed proposals have been tabled on how such integrated approaches can deal with the increased complexity.

Another key point of discussion is the implicit assumption in the NEP that the transmission grid must be strong enough to avoid congestions at any hour of the

year, effectively functioning as a copperplate able to integrate any expectable mix of generation. Many stakeholders argue that much less grid expansion would be needed if the regulatory system accepts missing few hours a year of wind peaks, which would only marginally reduce the yearly wind output. On the fossil side, some research institutes and NGOs have argued that some of the proposed lines partly function as "lignite HVDC lines", because they allow carbon intensive lignite plants to run more often than today, while a weaker grid would favour more flexible gas plants located at the right side of the bottlenecks. Another aspect of this debate is the request of some institutes that against the background of ongoing discussions at the EU level the NEP should make explicit the choice of building the grid aiming at a single price zone without bottlenecks, and to justify this choice by comparing alternatives, such as several price zones or nodal prices.

The proposal of building four parallel North-South HVDC lines has been discussed by many. Numerous stakeholders welcome the HVDC lines for overcoming the main North-South congestion. Some ask to conceive them right from the beginning as a part of a future European HVDC overlay grid. However, there also are a number of critical comments pointing at their inflexibility, vulnerability and at stability risks, or arguing that they would "solidify the structure of a centrally organised power supply from large units for decades". Frequently mentioned technical solutions with the potential to reduce grid expansion requirements include new transmission technologies like high temperature conductors, temperature monitoring, lower AC frequencies and HV underground cabling.

Despite the substantial criticism expressed by many, there is broad consensus that NEP2012 is a big step forward, strongly increasing the quality and transparency of the planning procedure. Nevertheless, a number of comments have been done proposing improvements of the procedure and transparency. The key points include the call for more detailed public access to grid usage data, a full documentation of the market and of the grid models, with the possibility for independent parties to run their own calculations.

As of the way forward: many comments asked for a two-track approach, combining a smaller number of consensual high-priority measures with a revision of the methodology in future editions of the plan. In its final report to the government, the regulatory agency has not exactly followed this advice, since it accepted about three quarters of the measures proposed by the TSOs. The government has now to propose a law establishing a list of required lines. Although the methodology is likely to be improved with the next edition of the plan, many critics are now in a dilemma: should they continue making pressure for a reduction of the number of lines, thereby risking a delay of urgent projects necessary for the Energiewende? Or should they accept a larger number of projects than they consider needed? While it is clear that a significant part of the opposition is anyway local, the achievement of a broader consensus on the necessary measures would to a certain extent reduce the risk of delays due to public opposition.

Besides its possible direct impact on the next steps of procedure, many of the arguments emerged in this public consultation will to different degrees be relevant also for the discussion in other countries. Moreover, the German grid planning debate shows the considerable potential of "crowd wisdom" also in such a complex issue like power grid planning.

1 Introduction

New power lines are becoming a public issue of growing importance as the transition towards renewable power is effectively starting to transform electricity systems. All EU member states are now required to provide a ten year grid development plan, and to revise it every year in a procedure involving public consultation. It is a complex issue for public debates. Therefore, learning from experiences in other countries may be helpful for those involved.

The grid planning debate is particularly intense and interesting in Germany, due to the rapidly growing shares of renewables, the nuclear phase out, the high attention for energy policy, and thus the intense participation of highly knowledgeable civil society organisations and of a broad number of economic actors. Despite of the national specificities, many of the arguments raised in the German debate may be relevant in other EU countries in the coming years.

In the last decades, local citizens groups and nature protection organisations in Germany have often opposed new high voltage lines. But since wind energy has grown considerably, in particular in the northern and eastern parts of Germany where consumption is rather low, it has become evident that the transition of the electricity system towards renewables will require additional power lines – leading to a complex debate about how much and where supplementary lines are inevitable. Electricity companies, politicians and some national environmental organisations work to convince local opponents to accept new lines.

This paper first provides a description of the planning process and of the context of the debate in Germany (chapter 2). It then gives an overview on the positions and arguments put forward by the different stakeholder groups (chapter 3), before looking a bit more in detail at the key issues raised (chapter 4), and finally drawing some conclusions from the German Experience for the European context (chapter 5).

2 The context

2.1 The power grid planning process

Grid planning in the EU

EU institutions and policies started with energy issues: the European community for coal and steel in 1950, EURATOM followed in 1957. However, electricity remained a national domain, dominated by the influence of integrated public monopolies. A first step towards a fundamental reform was made with the first energy package in the late nineties – especially the electricity market directive adopted in 1996, aiming at a liberalisation of markets. A second package followed in 2003. The third package, adopted in 2009 aims at improving the framework for functioning liberalised markets, and was accompanied by a new directive to promote renewables, which until then did not grow as envisaged. The 20-20-20 targets (20% renewable energy, 20% reduction of greenhouse gas emissions and 20% improvement in energy efficiency until 2020) are the most known elements of this comprehensive policy package.

Since many years, it has become evident that, in order to establish an internal electricity market, the infrastructure for electricity exchange between European countries has to be improved. The Trans-European Networks for Energy (TEN-E) have been pursued since the mid-nineties.[2] The frequent opposition of local groups has been often supported by NGOs that saw such new power lines as only serving the interests of large electricity companies exchanging excess nuclear or coal power across Europe. Meanwhile, objectives and perceptions have shifted: balancing wind and solar power across borders is seen as an additional important rationale for cross-border networks. In order to strengthen such networks, the coordination of transmission grid operation and development has been considerably strengthened in the Third Energy Package of 2009. Most important is the establishment of two new institutions: the Agency for the Cooperation of Energy Regulators ACER and the European Network of Transmission System Operators for Electricity ENTSO-E[3]. Among other duties (such as the development of Network Codes) ENTSO-E has to establish every two years a non-binding Ten Year Network Development Plan TYNDP – always monitored by ACER[4]. The pilot edition was published in 2010, the second edition in July 2012[5]. While the implementation of the energy package at the EU level is fairly advanced, member states had time until March 2011 to transpose into national law the legislation requiring national Transmission System Operators (TSOs) to submit a national ten years development plan to their regulators every year.[6] ACER has to ensure the coherence between European and national plans.[7]

[2] First guidelines: Decision No 1254/96/EC of the European Parliament and of the Council of 5 June 1996
[3] Regulation EC 213/2009 and Regulation EC 214/2009.
[4] Regulation EC 214/2009 Art. 8 and 9
[5] https://www.entsoe.eu/system-development/tyndp/tyndp-2012/
[6] Directive 2009/72/EC Art. 22
[7] Regulation EC 214/2009 Art. 8 and 9

The role of the NEP in the network planning process

In Germany, the transposition into national law of the EU directive requiring the establishment of grid development plans was adopted in June 2011. In its §12 the revised Energy Law stipulates a five-step process of network planning.[8] Another important legal source influencing the grid planning process is the Power Grid Expansion Act (EnLAG) of 2009. As shown in Fig. 1 (see next page), the planning process consists of five steps.

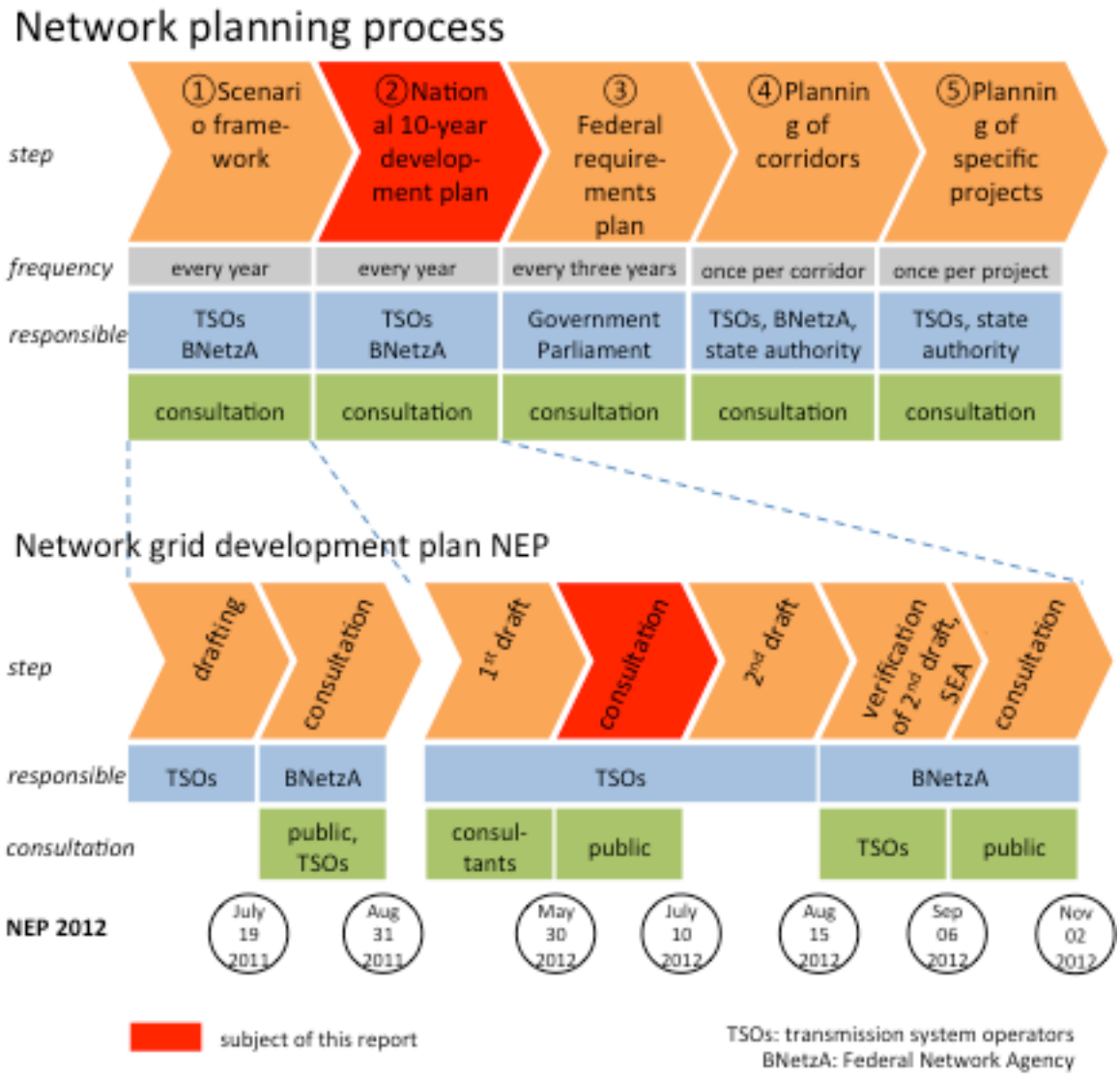

Fig. 1: Role of the grid development plan NEP in the network planning process

As the debate has shown, there are different interpretations which questions have to be clarified at which step of this seemingly straightforward process – e.g. at which stages is it still possible to claim for alternatives to transmission? The TSOs and the regulatory agency BNetzA would argue that this debate has been definitively concluded with the adoption of the framework scenario. However, as

[8] Energiewirtschaftsgesetz EnWG: http://www.gesetze-im-internet.de/enwg_2005/

will be seen below, quite a number of comments in the consultations have called for a revision of the law establishing this process. The intention of the Bundesbedarfsplan voted by Parliament (step 3) is to close the discussion on the necessity of specific connections and to speed up the permitting process of the single projects.

The figure also shows the single steps in the drafting and consultation process of the first edition of the NEP. Soon after the adoption of the revised energy law, the four German Transmission System Operators have presented a set of frame scenarios. The national regulatory authority (Bundesnetzagentur, BNetzA, i.e. Federal Network Agency), to which the draft was submitted has organised a public consultation and adopted a modified version in December 2011.[9] On this basis the TSOs have written a first draft of the national grid development plan NEP which was submitted to public consultation between May 30 and July 10, 2012. The comments from this consultation have been analysed for this report.

NEP 2012 - the first draft

The first draft of NEP 2012 – the object of the consultation we are analysing in this report – is a document of 150 pages accompanied by another 200 pages of annex.

After an introduction and an overview on the methodology, it describes the scenarios as defined in the previous step of the procedure and then the methodology and the results of their decomposition into regional consumption profiles and generation capacities. Although calculations have been made for 6.600 grid nodes, the regional resolution given in the report only corresponds to the German federal states (Bundesländer). There are four scenarios: Scenario A 2022 has been constructed so as to fulfil the energy and climate policy objectives of the government.[10] Scenario B 2022 has been based on scenario A with higher capacities of renewable and gas generation plants. Both A and B are based on previous national scenarios of the government.[11] Scenario B2022 is considered to be the "lead scenario", therefore it has been projected ten more years into the future, leading to scenario B2032. Scenario C 2022 has been calculated on the basis of (much higher) estimations of the single federal states for the future development of renewable power production on their territory – since in the consultation process of the scenario framework regional figures were estimated to be unreliable, they were uniformly reduced by 10%. The regional distribution of generation capacities in scenarios A and B is the same as in scenario C, based on the estimations given by the federal states.

The following chapter of the NEP is devoted to the model of the energy market which has been used for calculating hour by hour results for the actual generation in the target years. The overall assumption is that the present electricity market design mechanisms remains valid throughout the periods considered.

[9] See webpage of the regulatory agency: http://www.netzausbau.de/cln_1931/DE/Bedarfsermittlung/Szenariorahmen%20zum%20NEP%202012/szenarios_nep2012_node.html;jsessionid=17CB0A8F102F75207E7047F93A5F97A2

[10] Several statements in the consultation dispute this claim and argue that the objectives are misinterpreted and not fulfilled.

[11] See Szenariorahmen zum NEP 2012: http://www.netzausbau.de/SharedDocs/Downloads/DE/Szenariorahmen/Eingereichter%20Szenariorahmen%20zum%20NEP%202012.pdf?__blob=publicationFile

Chapter 5 then describes the methodologies for analysing grids and their stability: the first step consists in the definition of a so-called starting grid including all projects already planned and to be concluded until 2022. On this basis dynamic reliability tests have been carried out considering the results of the market model for the different scenarios in order to identify supplementary grid extension needs.

Chapter 6 reports the proposed grid extension measures for the different scenarios in overview maps. A description of how the overall topology of the additional measures has been created is not included. Stability analyses and a sensibility analysis for reduced consumption in all scenarios complete the description of the investigations. A key feature of the proposed grid extensions in all scenarios are four, nearly parallel HVDC (High Voltage Direct Current) lines running from the north to the south ending at former nuclear power plant sites. In the lead scenario B2022 the four HVDC corridors have an overall length of 2100 km and a capacity of 10 GW. Additionally, new AC lines with a length of 1700 km are deemed to be necessary, as well as 2800 of new lines on existing corridors. On 1300 km new wires would have to be mounted on existing power poles.

The closing chapter states that "with high probability" none of the proposed measures for scenario B will be dispensable.

The 200 pages of Annex present a short description and a rationale for each of the single point-to-point measures. The corridors indicated on the corresponding maps are rather broad, reflecting that the NEP does not yet contain any decision on specific routes.

The public consultation on the first draft of NEP 2012

Between May 30 and July 10, 2012, individuals and organisations had the opportunity to comment on the first draft of the NEP by writing to the TSOs or uploading their comment on an appropriate website established by the TSOs which contains all related documents.[12]

Comments have been published on this same website if the authors agreed to have them published. In the second draft of the NEP published on August 15, the results of the consultation have been summarised: 1836 individuals and 264 organisations have submitted comments. Both organisations and individuals mainly focus on the development of the frame conditions for the calculation of needs and the planning. Individuals discuss single corridors more often than organisations.

Moreover, the TSOs and the regulatory agency BNetzA have organised more than a dozen of public discussion workshops in different parts of Germany, with the participation of hundreds of stakeholders and interested citizens.

The website of the TSOs provides a database with all published comments as well as a list of the organisations that have participated. For the purpose of this report, we have adopted a different categorisation of organisations and issues than in this short summary given in the second draft of the NEP.

[12] http://www.netzentwicklungsplan.de/

Further development of the process

The second draft of the NEP 2012 has already been presented on August 15, six weeks after the closure of the consultation. The TSOs did not necessarily support this tight schedule, but more time was not granted. Nobody could expect important methodological improvements or considerable changes in the results within this short time. Most complaints were rejected with the argument that they were referring to earlier or later stage of the processes, and therefore not relevant at this stage.

However, the yearly exercise of establishing a NEP allows for a continuous improvement of the methodology. The draft scenario framework for the following NEP 2013 already contains some important changes, e.g. the contribution of offshore wind has been reduced considerably.

A detailed analysis of the changes in the second draft and in the following scenario framework would exceed the scope of this analysis of the first consultation.

After a formal analysis of the compliance with the legal provisions the regulatory authority has submitted the second draft to a second public consultation between September 6 and November 2, 2012. The consultation also includes a rather superficial SEA: since the corridors are still quite broad, the possible environmental impacts cannot be assessed in detail. During the consultation the regulatory authority has organised several public meetings.

On November 26 the regulatory agency, which governs the process, has delivered to the government a revised version of the NEP as well as a draft Federal Requirements Plan (Bundesbedarfsplan) confirming 51 of the 74 measures proposed by the TSOs. Three of the four proposed north-south HVDC lines have been accepted. Meanwhile, the methodology is being improved in the preparation of NEP 2013.

The revision of the NEP by the agency shows a certain influence of the consultations. However, considering the size of the extension confirmed against the background of the far-reaching methodological criticisms and the insistent call for a prioritisation of measures in the comments of the stakeholders, one can assume that many are unhappy with the decision of the regulatory agency. All those organisations that believe an effort for grid extension is urgent to enable the transition to renewables, but also think that the proposed extensions are exaggerated, not well-founded and may favour large coal power plants, are confronted with a dilemma: fighting for a further reduction of the grid extension requirements to be approved by the Parliament now[13] involves the risk of delaying the decision beyond the federal elections next autumn, i.e. of probably one year. On the other hand, accepting the list as it is might expose concrete extension projects to robust local resistance, given their weak legitimation by a plan that was heavily criticised in its basic assumptions.

[13] According to the law a new Bundesbedarfsplan has to be adopted at least every three years.

2.2 Energy policy in Germany

Development of the German power industry

In order to understand similarities and differences between Germany and other countries it is useful to have a look at how the German electricity system and its main actors have developed.

As in most European countries, the electricity system in Germany has grown out of local private or public utilities. With the diffusion of electricity, a second tier of regional utilities emerged, which covered wider areas and were able to produce and manage electricity more efficiently. A third tier was formed in the late 1920ies with high-voltage transmission lines, mostly at the level of the German states. After a short phase of competition, the large federated companies ("Verbundunternehmen") agreed to form territorial monopolies – a structure that was codified in the energy act of 1935.

Although the "Verbundunternehmen" increasingly dominated and absorbed many of the regional redistributors, the three-tier system of territorial monopolies survived until the liberalisation by the EU. Following the first energy package at the end of the 1990ies the ex-monopolies were put into competition and a power exchange was established. As a consequence, a further round of concentration reduced the large electricity companies with own transmission systems to the number of four (EON, RWE, Vattenfall, EnBW). Moreover, with the unbundling required by EU legislation, the transmission systems had to be separated from the electricity generation companies. Although the German government fiercely defended the right of the ex-monopolies to keep their own transmission system companies, the three largest ones have meanwhile been sold to independent companies – 50 Hertz (ex Vattenfall, mainly owned by the Belgian TSO Elia), Amprion (ex RWE, mainly owned by a consortium of financial investors), TenneT (ex EON, owned by the dutch TSO TenneT) – only TransnetBW is still under the roof of EnBW (which until 2010 has been under the influence of the French EDF). These four TSOs, have the overall responsibility for the functioning of the German electricity system. They have drafted the network development plan NEP discussed in this paper.

On the other hand, a large number of companies have survived in the two lower tiers of the system: Altogether there are around 900 distribution grid operators, of which many are too small for an efficient independent operation, and therefore seek cooperation with larger structures. Liberalisation has changed the working conditions also for small utilities: they are exposed to competition by larger resellers of electricity, and those with more than 100'000 clients are obliged to separate the grid from their other operations. This seemed to considerably narrow their scope and lead to considerable concentration. But the growth of distributed power generation with renewables and the growing interest for local energy policies have changed the game.

In Germany, 97 per cent of renewable power generation feeds into the distribution grids.[14] Given the lower load factors of wind and solar, this corresponds to more than half (!) of the total installed generation capacity. Distribution grid operators have to manage these rapidly increasing quantities; local utilities are dis-

[14] See e.g. the statement of VKU

covering new opportunities to provide more sophisticated services; local power production allows for new activities on electricity markets. Observers speak of a "renaissance of municipal utilities": a number of municipalities are buying back their grids from private utilities in order to gain more flexibility for local energy policy. More intend to do so in the next years, as concession contracts are expiring – however, sufficient capital is necessary for developing new strategies. Despite the requirement of unbundling, medium sized utilities have developed quite successful integrated approaches. The whole sector is in transition, and many companies have difficulties to define a long-term strategy, as the future division of roles at the distribution level is still unclear: more active management of distribution grids, load management, variable tariffs and smart interfaces with the customers require new competencies and responsibilities not provided in the present frameworks.

Energiewende – transforming the energy system

German energy policy is under particular international observation since the German Parliament decided three months after the Fukushima nuclear accident to phase out nuclear power by 2022 – Chancellor Merkel called for an "energy turnaround" or "energy revolution", the "Energiewende". However, it must be recalled that this decision was not as sudden as many are presenting it now: the term Energiewende was coined in 1980 as title of an influential book of the Öko-Institut, an organisation grown out of the grass-roots movement against nuclear power in the 1970s, and today a leading research institute on energy issues. Since then, the broad environmental, climate justice and anti-nuclear movements in Germany have promoted an intensive discussion on energy policy, which from the 1990s onwards led to policies effectively promoting renewables.

In 2000, the red-green majority stroke a deal with the utilities to slowly phase out nuclear power. That deal did not foresee a fixed deadline for phase-out, but "remaining nuclear production amounts", leaving the nuclear plant operators free to trade such production rights from one plant to another. The spirit of the deal was that these rights could be transferred from old, inefficient and more risky plants to the newer, more efficient and safer ones. All in all, the overall expected phase out schedule was not very different than the one which is now legally in force.

However, the nuclear plant operators did the opposite, i.e. started transferring production rights from the modern to the older plants, to avoid shutting the latters down. Against the spirit of the deal they had signed, they were trying to avoid shutting down the oldest plants, speculating that a new conservative government would overthrow the whole phase out decision. And this political gaming affected also the planning of the grid operators, that until very recently were owned by the nuclear power plant operators. A systematic grid planning for the nuclear phase out and for the official goals concerning high future shares of renewables did not really start in 2000, but only after Fukushima.

The political game of the utilities seemed to work out in 2010, as Mrs Merkel's coalition adopted a substantial prolongation of nuclear lifetimes, just six months before Fukushima, and less than one year before Mrs. Merkel's "Energiewende". However, even before Fukushima, the nuclear lifetime prolongation had strongly affected the popularity of Mrs. Merkel's government, and this is one reason for her rapid political turnaround afterwards.

This long and controversial debate divided public opinion and society , and it led to a relatively high pubic awareness for energy policy issues, to a high degree of expertise in a large number of research institutes and NGOs, as well as to a widespread strong personal and commercial commitment for a renewable energy future. More than a million photovoltaic installations and more than twenty thousand wind turbines have been installed, mostly by individual investors.

The German grid debate

A long history of conflicts and initiatives

Conflicts concerning the construction of new high-voltage power lines have a long history in Germany. Since the early days of the anti-nuclear and anti-coal movement, local citizen's initiatives and environmental organisations have opposed the construction of power lines, arguing that these would only serve the interests of the large electricity companies. Those promoting the new lines always accused local opponents to mainly pursue NIMBY (not in my backyard) interests. While this may be a part of the truth in many cases, it must be noted that "NIMBY" concerns can be well understandable, since the loss of property value and quality of life linked to new infrastructure of any kind are real factors, and compensation levels are often inadequate.

The situation partly changed in the last few years, as the strong growth of wind energy started requiring new lines. Environmental organisations have increasingly made efforts for establishing a dialogue with TSOs and with their local chapters and local action groups, aiming at developing a broader understanding of the electricity system and at enabling local activists to analyse their local project in a broader context.[15] However, it is not easy to convince local nature protection activists to accept additional power lines.

At the same time, more constructive activities have been started at the low-voltage end of the electricity system: some municipal utilities have been revitalised and reoriented towards distributed renewable power. Buying and managing local networks has been a key strategy for local and regional energy policy actors to gain influence. At least in these areas this has changed the public perception of (distribution) grids, thought it must be noted that the visual impact of distribution lines is much lower, involving less acceptance problems.

Growing awareness for the need of transmission grid extensions

For most of the last two decades, the solar and wind sectors, and all those promoting renewable power, focused on those grid issues that affected them directly – connection problems, missing last mile, design of and compliance with connection rules. One of the key success factors of the German feed-in-tariff laws was that renewable project developers have been protected from risks related to grid connection and curtailment, passing all these risks to the grid operators.

The wind power industry faced network stability issues earlier than the solar industry. Wind research institutes have been analysing grid usage patterns and scenarios for many years. However, the whole dimension of the integration of

[15] See for example Forum Netzintegration Erneuerbaere Energien organised by the Deutsche Umwelthilfe DUH: www.forum-netzintegration.de or Renewables Grid Initiative: http://www.renewables-grid.eu/

variable[16] renewable power was broadly realised only around 2008, when their shares were reaching substantial values, much earlier than expected

Long-term, large-scale considerations of how to deal with large shares of renewables in the European electricity system had interested researchers since years. Visions for large HVDC super-grids covering Europe and the Mediterranean area including North Africa[17] have met widespread interest in Germany and helped spreading the notion that renewable energies require additional grids.

Other concepts for dealing with variable generation, like the "renewable combined power station" (Kombikraftwerk), off-grid solutions and the role of storage both decentralised and in combination with the DESERTEC concept sharpened the attention for the interaction between transmission and other flexibility options: increasingly, it is acknowledged that the four basic flexibility sources – flexible generation, flexible consumption, storage and transmission – should be combined in an intelligent way.

The predecessors of the new planning procedures

In 2005 Germany was one of the last European countries to establish an independent energy regulator, the Bundesnetzagentur. In the same year, the German Energy Agency dena, a public-private partnership, published its first, widely and fiercely discussed grid study, calculating grid extension requirements (850 km new transmission lines and 400 km upgrading) for reaching a 20% renewable power share in 2015.[18] In the first half of 2012, Germany reached a renewable share of 25%, despite of the fact that most of these 850 km lines have not been built. This might have been one of the reasons for the tight grid stability situations in the last winter, but also strenghtened the suspicion of many NGOs and citizens that the grid expansion requirements are being exaggerated. A second study (dena Netzstudie II), published in 2010, calculated a need of 3800 km of new highest-voltage AC lines until 2020 for achieving a 39% share of renewables.[19] An alternative option with underground HVDC cable was estimated to require 3400 km of new lines and considerably higher investments. The dena studies were used as basis for government planning but were widely criticised for their lack of transparency concerning methodology and data.

Since effective grid expansion on the basis of existing legislation proceeded only slowly compared to the requirements calculated by dena, in 2009 the German parliament voted the Energy network extension law EnLAG.[20] As a kind of emergency measure, it stated by law the need for 24 specific lines, thereby shortening the legal planning procedures which had slowed down many projects. Most EnLAG projects, however, are delayed too, until July 2012 only 214 of 1834 km had

[16] Following with the terminology of the IEA, and of many pro-renewables stakeholders, we use the term "variable" renewable power. While the term "fluctuating" might express more clearly that these variations depend on natural conditions and not on human control, the widely used term "intermittent" is clearly misleading as it suggests an on/off behaviour.
[17] See: www.desertec.org/ , http://www.dii-eumena.com/
[18] English summary: http://www.dena.de/fileadmin/user_upload/Publikationen/Energiedienstleistungen/Dokumente/dena-grid_study_summary.pdf
[19] dena-Netzstudie II – Integration erneuerbarer Energien in die deutsche Stromversorgung im Zeitraum 2015 – 2020 mit Ausblick 2025. http://www.dena.de/fileadmin/user_upload/Presse/Pressemappen/netzstudie2/Ergebniszusammenfassung_dena-Netzstudie_1_.pdf.
[20] www.gesetze-im-internet.de/bundesrecht/**enlag**/gesamt.pdf,

been completed.[21] The EnLAG somehow replicates a procedure used for highway planning since decades. The Bundesbedarfsplan stipulated by the new energy law establishes a regular application of a similar approach based on a more transparent network development plan.

Reconsideration of priority feed-in and curtailment

The priority for renewable power stipulated in the German feed-in-law has for a long time been considered as a key for the success and therefore as an untouchable principle. Grid companies are obliged to provide sufficient power lines for the connection. With increasing shares of variable renewables, however, it became clear that integrating the highest peaks of renewable power generation would require considerable grid extensions used only for some hours during the year. Moreover, since renewable power is being directly traded on the power exchange, it has become evident that with nearly no variable costs, wind and solar power have always priority on the (energy only) markets. Curtailment of peaks, once a no-go for the advocates of renewable power, has therefore become a widely acceptable option. The problem, however, how to formulate conditions for limiting the feed-in of renewable power without violating their priority over fossil fuels, has not yet been solved.

Supply security

Since the Energiewende decision, mass media widely discussed the fear of a black-out as a consequence of reduced available generation capacities after shutting down several nuclear power plants, and/or by the increasingly challenging system operation due to the increasing variability linked to wind and solar. In the first "Energiewende winter" 2011-12, there have been some tight situations, widely discussed in the media, but neither a black out nor the need for controlled supply interruptions. In at least one case, many observers argued that the tight situation was due mainly to a malfunctioning and possibly a manipulation in the power exchange rather than to real physical bottlenecks. It is forecasted that tight situations might arise again until circa 2015, when some new gas power plants should start operating in Southern Germany, where capacity reserves are tighter. There is a broad agreement that a major black-our or even just large-scale controlled supply interruptions attributed to the Energiewende might jeopardise public support.

At another level of supply security, some industrial companies have been complaining about a quality reduction of power supply in the range of milliseconds, which can cause significant damage to delicate machinery and processes. Some companies announced significant investments to protect themselves from this risk. Also these interruptions are supposed to be a consequence of increasing difficulties in system operation.

A strengthening of the transmission grid is widely believed to be one of the cheapest and most effective medium and long term solutions for both risks.

Preparing innovation at the distribution level

Less in the limelight, also because of less dramatic conflicts, distribution grids and their investment needs have been analysed and discussed much less in detail. However, consumers and the large public start discussing grid issues at the

[21] http://www.netzausbau.de/cln_1911/DE/Netzausbau/EnLAG-Monitoring/enlag-monitoring_node.html

local level as their own interaction with the grid is changing. Large amounts of distributed power generation in some areas have led to the need for upgrading local grids and making them more intelligent. A considerable number of Smart grid pilot projects carried out since the middle of the last decade have not only looked at the grids themselves, but also at the opportunities for making consumption more flexible. These projects have helped to promote the understanding that distribution grids will become much more important, that the roles of different actors may change and that the consumers will be asked to participate more actively in the management of their electricity supply and consumption. Recently, this discussion has been fuelled by the fact that solar power from the own roof is now cheaper than electricity from the grid, even for commercial use. Much earlier than expected self-supply is getting economically interesting. Shifting consumption into sunshine hours increases the profitability of the own installation. What does that mean for the utilisation of the public grid? How can tariffs make sure that increasing private flexibility supports the stability of the public system? It is evident that such questions not only concern the very local level.

Regional authorities compete for more (not less) renewable deployment

Because the Bundesländer are competent for land planning, their governments have a strong influence on renewables deployment, especially onshore-wind. Until recently, hardly any wind had been built in the Southern Bundesländer, not only due to the weaker wind resource, but also due to the opposition of their conservative governments. However, short after the "Energiewende" decision, the Southern Bundesländer (not only the new green-red government in Baden-Württemberg, but also the conservative governments in Bavaria and Hesse) approved ambitious plans for permitting substantial wind capacities. Also other Bundesländer more in the North and up to Schleswig-Holstein revised their land planning, in general towards higher amounts of renewables. Perhaps surprisingly for the foreign readers, the Federal States governments are currently competing for more renewables in their territory, which reflects the widely perceived idea that renewable deployment brings more benefits than impacts not only at global, but also at regional level.

Increasing importance of grid issues in the public debate

This selection of highlights illustrates a considerably increasing importance of grid issues in the public debate over the last decade, leading also to a higher competence of the large public to understand the issues involved. More aspects could be added, such as the discussion on cross-border connections and international electricity exchange, the debate on offshore grids and links to pump storage in Scandinavia and the Alps, the discussions on technologies, landscapes and radiation. All these issues show up in the comments of stakeholders in the NEP consultation.

3 Stakeholder groups commenting on the first draft of the NEP

This chapter presents a panorama of reactions of circa 50 stakeholders. Hurried readers may just pick the sectors that are of most interest to them or directly jump to chapter 5 for a more systematic overview of the arguments.

3.1 The Power Sector: more critical than publicly perceived

Power sector business associations

The German Association of Energy and Water Industries **BDEW** as the overall representation of the German power sector has to reconcile many different interests. After welcoming the transparent NEP planning process, the BDEW starts its comment by observing that the role of the yearly NEP in the overall planning procedure is not really clear and calling for the identification of a core set of no-regret measures . On a similar tune, it suggests to adopt a more far-sighted approach by conceiving the HVDC lines right from the beginning as elements of a future European overlay grid which would also require the consideration of cross-border couplings. More fundamental then is the demand to consider more thoroughly the interrelationship of the transmission grid with the distribution grid, to involve distribution grid operators directly into the development of the NEP and to establish also grid requirement plans for the 110kV networks. The BDEW emphasises that the extension of transmission networks is only one of several options for the integration of renewables and that distribution grids will have to play an increasing role for ensuring system stability. It quotes a BDEW study having estimated a need for distribution grid extensions of 380.000 km, costing between 21 and 27 billion EUR. Moreover, the BDEW calls for examining whether transmission grid extensions cannot be avoided by finding ways to preferably locate new power generation near to consumption and loads.

This rather far-reaching criticism of the NEP methodology – wrapped up in a concluding call to take decisions on urgent projects soon – is being supported or formulated more sharply by most comments of the smaller, more specialised associations which add specific perspectives.

The Association of Municipal Utilities **VKU** is very explicit. It criticises that the network planning procedures stipulated in the revised energy law do not take into account distribution grids although the climate and energy policy goals of the government have mainly to be reached by measures in the distribution networks. It emphasises that since 2010 more generation capacity is connected to the distribution than to the transmission grids and that 97 per cent of the renewable power generation is being fed into the distribution grids. A VKU study estimates that the costs for adapting the distribution grids and making them smarter will amount to 25 bn EUR until 2030. The VKU complains that the needs of distribution grid operators have not been sufficiently considered in establishing the NEP and calls for an integrated grid planning. With the same words as the BDEW, the VKU emphasises that transmission grid extensions are only one of several options for avoiding network congestion and integrating renewables. It demands that the top-down analysis in the draft NEP be complemented by a bottom-up

planning and that also distribution grid extension, demand side management and the use of long-term storage be considered. The VKU emphasises that intelligent control and a better matching of generation and consumption on the lower voltage levels can reduce oversupply and peak loads. As the BDEW, the VKU suggests to discuss whether location signals for new generation capacities could contribute to avoid grid bottlenecks.

GEODE, a European association representing private and public electricity and gas distribution companies of which 150 in Germany, argues in the same direction. In particular it emphasises the large potential for reducing transmission grid extension brought by new technologies for balancing generation and consumption in the distribution grids – especially load management with the help of smart grids. Geode complains that storage at lower levels of the system are not being considered at all and that power-to-gas technology is dismissed on the basis of an all-or-nothing alternative. As the other associations, GEODE demands that a new edition of the NEP contain detailed flow data for the single grid nodes in order to ensure transparency of the calculations.

Compared to these conventional power industry associations, the associations representing renewable energies do not have fundamentally different views.

The most important of them is the German Wind Energy Association **BWE** which not only represents the wind turbine industry but also the wide range of wind plant owners and operators. In the introduction to its statement, the BWE emphasises that we have to do with a fundamental system transformation which involves more flexibility on all voltage levels of the electricity system and also in neighbouring sectors such as the gas system and that it will be important to develop long-term network development strategies beyond the horizon of the presently discussed plans. Concerning the methodology, the BWE calls for a more proactive consideration of upcoming technological and legislative developments, e.g. concerning storage technologies. Moreover, it considers that a much better coordination with distribution grid development would be essential for the further development of the NEP and that also coordination with the offshore and the gas grid development plans is needed. Regarding the presentation of the results of the market simulation and the grid analysis the BWE misses a documentation, which would allow for a more detailed appreciation. In particular it asks for indications concerning the duration of the "grid use cases" on which the calculations have been based, concerning the assumed "must run" socket to be provided by conventional power plants, concerning a prioritisation of the measures, and concerning coherent figures for the length of corridors and the length of electric circuits required. With regard to the volume of the envisaged investments the BWE remarks that in the last years necessary reinvestments into the networks have been omitted and asks that this gap be explicitly mentioned in the public communication on future grid development needs. Finally, the BWE complains that the six-week consultation period is too short.

Presenting a regional view, the renewable energy association of the largest federal state NorthRhine-Westfalia **LEE-NRW** admonishes that grid development has to follow the development of distributed renewable energy production. Concerning the scenarios it criticises that scenario A would not be able to fulfil the energy and climate policy targets of the federal government while scenario B and C put to strong an emphasis on off-shore wind energy. LEE-NRW asserts that it

will be difficult to convince the citizens of inland North Rhine-Westphalia to accept both higher costs of off-shore wind plants and supplementary power lines, instead of local renewable energy projects. Moreover, the organisation criticises that modern grid technologies have not been considered sufficiently: it emphasises that HVDC lines do not always need new corridors but can also replace existing highest-voltage wires on existing pylons. It also misses an appropriate consideration of the potentials of demand side management.

On the other hand, the Foundation **OFFSHORE- WINDENERGIE**, the representative organisation for offshore wind which involves a wide range of businesses as well as government representatives from the federal level and the coastal states, welcomes the NEP draft but makes a series of critical remarks. It warns that the calculations and simulations cannot be assessed by third parties, since the documentation is not sufficient. Rather fundamentally it then criticises that the NEP draft simply assumes the present technological and legal status quo and the basic assumptions in the given scenarios without investigating to which extent supplementary measures could reduce grid expansion requirements. OFFSHORE-WINDENERGIE calls for investigating the impact of such measures as: steering the location of future generation and storage; a modified use of existing storage capacities; making use of the potentials for load management; a strategic use of redispatch also for renewable power generation in an optimised combination with storage, load management and the provision of ancillary services. Being particularly interested in offshore wind, the foundation complains that the coordination with the offshore grid plan is insufficient. Concerning the maximum grid loads used for the calculations OFFSHORE-WINDENERGIE argues that the historical experience may be misleading in the future because of a different interplay between (zero marginal cost renewable) generation, power exchange prices and the potential for load management, possibly leading to lower loads in critical times. In order to discuss alternatives to the proposed grid extensions, the Foundation deems it necessary to make probabilistic investigations concerning the frequency and duration of specific generation and consumption situations. It also misses a strategy for the reduction of the conventional must-run capacities – even more as HVDC technology provides particularly interesting opportunities for providing system services, it could therefore be expected that the need for conventional must-run units would considerably decrease. Concerning HVDC, the foundation asks to investigate the opportunities to combine the lines to a meshed overlay grid – also extending to neighbouring countries - which could much more effectively stabilise the underlying AC grids and provide system services, and admonishes that the question of the system responsibility for the HVDC grid has not been addressed in the NEP.

The growing number of solar power system operators has only a rather weak specific representation. In its statement for the consultation, the Solar Energy Promotion Association **SFV** claims that grid capacities are not a major bottleneck for the development of solar power. Like several other small organisations and individuals, it points at the conflict of interest in which the authors of the NEP are caught: on one hand, the TSOs earn their revenues by building and operating transmission grids; on the other hand they are asked to tell the legislators and the public how large the grids should grow. The SFV does not think this is a good idea.

Altogether the statements of the representative associations of the power sector leave the impression that on one hand most players in the sector are very

pleased that with the NEP the discussion concerning grid development is getting a reference document which will considerably help to move the discussion forward, but that on the other hand this draft is far from being up to the challenge and that it will need considerable improvements in the methodology and revisions in the proposed measures before it can become the basis for serious planning.

Statements of single companies reflect their different interests

Many of the players in the sector that are usually present in the public debate, such as E.ON, Vattenfall, HRE, Trianel, EWE etc. have not answered the call for comments, or at least not officially. Four factors may have contributed to this: the short timeframe of the consultation, low expectations for the impact of a contribution, a high degree of consensus with the position of the association representing the relative group, or direct informal access to the TSOs.

Of the four large ex-monopolies which until recently owned the transmission grids (the "large four"), only two have issued a comment.

Energie Baden-Württemberg AG **EnBW** is effectively the only large utility which still fully owns its transmission grid (TransnetBW). EnBW is controlled by municipal owners and the state of Baden-Württemberg, who has bought back its share from EDF two years ago and is now governed by a green prime minister. EnBW's comment is rather positive but contains an interesting interpretation: "The measures identified in the NEP are understood as upper limit of grid expansion". It calls for an analysis to find the economic optimum for the integration of renewable power, independently from present legal regulations. It states that expanding the grid to cover all renewable power generation peaks is not efficient. Moreover, it argues that future editions of the NEP should better coordinate transmission grid planning with neighbouring countries, with the offshore grid, the gas grid, and also with the development of the 110kV distribution grids. EnBW also complains that the assumed future wind power generation in Southern Germany and especially in Baden-Württemberg is far too low.

The short statement of **RWE** welcomes the transparent process, basically supports the statements of the draft NEP, considers the resulting grid extension requirements as essentially comprehensible, and refers for further details to the comments of the sector association BDEW (see above).

Slightly more critical are the distribution subsidiaries of the "large four". For example, **EON Netz** demands a stronger consideration of the interrelation between distribution and transmission grids, a stronger involvement of distribution grid operators, the publication of calculation details for the single net nodes, a timetable and prioritisation of measures, and also an analysis to which extent redispatch, wind curtailment or counter trading can be economically sound alternatives to grid extension. Another example is **Rhein-Ruhr-Verteilnetz**, belonging to RWE: it mainly complains a heavy underestimation of renewable power generation in many areas, in particular in the state of Rheinland-Pfalz where it operates, and calls for a reliable and uniform methodology for establishing regional forecasts.

Much more critical is the large municipal utility **MVV Energie** (turnover 3,5 bn €), one of the most innovative players in the German energy market. In its short and strong statement it argues: "The grid extension with HVDC corridors sketched in the grid development plan solidifies the structure of a centrally or-

ganised power supply from large generation units for decades", and therefore asks for the formulation of "alternative scenarios for adapting the energy system". It calls for using all available options to avoid bottlenecks and integrating renewable energy, including also the strengthening of distribution grids, the construction of cross-border connectors, demand-side measures and increasing the flexibility of generation. It complains that distributed and regional approaches for reducing the need for transmission lines, and especially for avoiding costly HVDC lines, have been widely neglected. It also argues that more onshore wind energy in Southern Germany would be cheaper than additional offshore wind energy. It asks to compare the different options in a cost-benefit analysis.

Asking, as many others, for a thorough consideration of the interdependencies of the transmission and the distribution network, the large municipal utility of Nürnberg **N-Energy** is concerned about the proposed upgrading of many lines from high voltage to highest voltage. N-Energy argues that thiscould lead to a lesser degree of intermeshing of the high voltage grid, and therefore seriously reduce grid stability.

As the comments of the regional companies **ARGE Netz** (Schleswig-Holstein) and **WEMAG** (Mecklenburg-Vorpommern) show, not only southern but also northern utilities think that the renewable power capacities forecasted in their regions are too low.

From the wide range of small local utilities very few comments have been received. Also those who are often present in the public debate have not provided an individual comment. Six of the seven small utilities that responded are members of the Thüga nework who have sent short messages saying that they support the comment of **Thüga AG**. This company holds minority shares in more than hundred local utilities and provides joint services. Until two years ago Thüga AG was owned by EON – and the new, essentially municipal owners are changing their policy only slowly. Thügas short consultation comment is essentially satisfied with the NEP draft. However, it argues that the transmission grid cannot be planned without considering the development of the distribution grids, especially at the 110kV level. Moreover, it points to the fact that load peaks and oversupply can be in the future avoided through intelligent control of the lower levels of the grid as well as a better coordination of generation and consumption and that this would reduce the need for grid extension.

Worth mentioning is the statement of the wind plant operator **Windland** pointing at the increased vulnerability of the grid for terrorist or military attacks at the end-points of large HVDC lines due to their easy identification and key function for the envisaged grid.

A remarkable shift

We have extensively documented the reactions from the power sector because in our perception they represent a remarkable shift in views and relative influence compared to some years ago – an impression we cannot prove in this context. While the views of the large companies owning also the transmission grids used to dominate the positioning of the sector, other perspectives, representing lower tiers of the system, are now considerably gaining influence.

3.2 Industrial energy users call for a more systemic approach

The different branches of industry welcome progress in the grid planning debate. and are in general keen to see an acceleration of construction of new lines to reduce their perceived risk of power supply interruptions or power quality reductions. More over, some companies see market opportunities with grid extensions. At the same time, industry fear rising costs if excessive measures are implemented,. In order to contain costs, most industrial groups call for a more systemic approach involving all flexibility options and all levels of the grid.

The overall representation of German industry **BDI** sees the extension of grids as a key challenge for the successful implementation of the Energiewende. While calling the NEP a good step in the right direction, it makes a series of critical remarks which reflect the intense energy policy discussions within the association. The BDI warns not to misinterpret the NEP as a master plan that needs to be implemented. It emphasises that the scenarios only show the extent of grid extension necessary for complying with the present regulatory framework. Prudently it asks to include in the planning principles the call for additional incentives for more flexible demand, more flexible generation, and generation investments in the vicinity of loads. Overall, the BDI perceives that the role of distribution grids has to be more thoroughly considered – especially also with regard to the opportunities of ICT to make grids more intelligent. Moreover the BDI asks for a realistic consideration of storage – reminding that the grid development plan for gas expects input from power-to-gas technologies. It also deems necessary to make more realistic assumptions for underground cabling and to synchronise grid extension measures with the phasing out of nuclear power plants. It points to the fact that coast-near wind power is the primary cost driver in transmission grid development and asks for a more transparent attribution of costs to specific developments.

While the German Association of Chambers of Commerce and Industry **DIHK**, represents a wider range of businesses than the BDI, its short statement does not substantially differ from the BDI positions.

The Association of the German Electrical and Electronics Industry **ZVEI**, representing producers of electrical equipment at all levels of the system, welcomes the NEP as a means for the acceleration and transparent discussion of an urgently needed grid development. In order to optimise the overall costs of the system, however, the ZVEI calls for synchronising the top-down planning of the TSOs with a bottom-up approach of the distribution grid operators. In a systemic consideration of the whole grid also the optimisation potentials of smart grid technologies and all kinds of storage should be considered.

Representing the producers of power generation equipment at all levels, the power systems section of the German Engineering Association **VDMA Power Systems** in its comment to the NEP mainly complains a missing analysis of the possible positive impacts of a targeted regional allocation of future generation investments. Moreover it criticises that access to the data underlying the calculations is being granted only to a very limited circle of stakeholders and that the basis for the regional disaggregation is not transparent. Overall the VDMA has the impression that the consideration of the development of the distribution grids is insufficient.

A rather particular organisation is the Association of the Industrial Energy and Power Industry **VIK**, representing 80% of the industrial energy consumption and

90% of the utility-independent power generation in Germany. On this background, the VIK is particularly credible when complaining that the considerable potential of demand side management for grid stabilisation and avoiding grid extension has not been considered in the NEP. Representing large energy consumers, the VIK is very concerned about risks for supply reliability. VIK argues that such risks might be increased by large HVDC lines functioning as single large units not really embedded in a meshed grid. Moreover, the VIK says, large point-to-point DC lines would not be able to absorb distributed feed-in from renewable power generation in the distribution grid and would be rather inflexible confronted with possible and unforeseeable changes in the spatial patterns of power generation. In contrast, a flexible and gradual enhancement of the existing AC grid would facilitate the integration of controllable loads for stabilising the system. Considering the large uncertainties concerning future spatial patterns of power generation, also the VIK calls for setting incentives in such a way that additional generation capacities are constructed near to the loads or to good grid connections. In a general concern to maintain flexibility in a rapidly changing environment, the VIK suggests to consider and support the development of storage technologies which, in its view, will be indispensable for reaching high shares of renewables in the longer term. Finally, the organisation observes that the timing of important single measures in the NEP has not been coordinated with the shutdown dates of nuclear power plants required by law.

Among the few single companies that have filed their comments, the case of **ABB,** one of the largest producers of power generation and power transmission equipment is of particular interest. As one of the two main suppliers of HVDC technology, ABB is evidently pleased that heavy investments in lines with this technology have been proposed in the NEP draft and invites to consider that very soon new technologies will allow the construction of meshed HVDC grids while cost-effective common end-points of several lines (multi-terminals) are possible already today. Moreover, ABB suggests to take into consideration new storage technologies, since especially the cost of batteries is coming down rapidly.

Belectric, worldwide leading PV system integrator, draws the attention to the fact that already today PV power plants can deliver reactive power around the clock and that soon their ability to provide ancillary services will be augmented by plant-integrated short-time storage. This will help to reduce transmission needs, conventional must-run capacities and considerable costs.

This panorama of industry reactions indicates that growing parts of the industry in Germany have accepted the "energy turnaround" and are seeking for new business opportunities in the new context.

3.3 Political bodies : federal states for more renewables

Eight of the 16 Federal States (Bundesländer) submitted comments to NEP consultation. Their comments are generally rather positive, but some of them raise fundamental questions also brought forward by other organisations. Most of them insist to consider more seriously their own forecasts on renewable deployment, which have been the basis for scenario C. The state of **Rheinland-Pfalz** emphasises that the estimates for renewables used in scenario B are definitely too low. Moreover it demands to consider load management opportunities which could considerably reduce transmission needs and quotes the study of the Asso-

ciation for Electrical, Electronic and Information Technologies (VDE) in this respect. **Schleswig-Holstein** misses a time schedule and complains that the complexity of the presentation makes discussions difficult. It suggests to focus the first NEP on a small number of high priority lines and asks to investigate more alternatives in the next round. **Nordrhein-Westfalen** complains unrealistic scenarios not least because of an underestimation of CHP and asks to found them on regional forecasts. It suggests to examine possibilities for integrating HVDC lines into a meshed overlay grid, to consider lower frequencies (railway standard) in the AC grid as well as underground cabling. More importantly, NRW misses a systematic discussion of technology options for reducing grid extensions (also storage) and an integrated approach also considering possible interactions with the railway power, district heating and gas grids. **Lower Saxony** besides some minor well-known demands suggests to extend the HVDC offshore connections directly to the consumption centres in southern Germany thereby avoiding costly nodes on the coast. **Baden-Württemberg** welcomes the proposed HVDC lines, but points to the fact that the considerable need for additional North-South transmission capacities is due to the very strong envisaged increase of offshore and onshore wind power in Northern Germany. Baden-Württemberg asks for a detailed justification why additional wind capacities in the South (i.e. in Baden-Württemberg) could not reduce the need for additional transmission capacities. Saxony argues that the assumed figures for renewable generation are too low, also because PV is developing beyond expectations. The comments of Thuringia and Bavaria mainly concern the routing and timing of specific measures on their territory.

In a joint statement the German Association of Cities **Deutscher Städtetag** and the German Association of Towns and Municipalities **DStGB** emphasise the perspective of local communities. In their view the enhancement of distribution grids, distributed storage and the development of smart grids is of paramount importance, while improved coordination across all levels and across borders is essential for accelerating grid development. They point out that local acceptance requires early involvement of local communities and an equitable distribution of costs for grid enhancement. Concerning specifically the draft for the NEP 2012 they demand a prioritisation of measures for maintaining flexibility in the planning process

Many cities and local communities only comment specific projects in their vicinity. An example of more fundamental remarks is the statement of the county of Main-Bingen, which questions the necessity of grid extensions at the scale proposed in the NEP arguing that the development of wind and solar power in southern Germany are being heavily underestimated, and calling for the enhancement of local grid infrastructures for supporting distributed power generation in the vicinity of consumption.

3.4 Environmental and Consumer associations

The Naturschutzbund Deutschland **NABU** is the largest nature protection organisation in Germany with over half a million members. In its detailed statement, it welcomes the fact that with the NEP for the first time there is a joint development plan of the four transmission network operators and that with the public consultation required by law it is possible to discuss it publicly. At first, it lists a wide range of questions which such a plan must answer in order to explore all

alternatives to grid expansion. Concerning the draft NEP 2012, the NABU emphasises in particular that the scenarios should consider an energy mix with more PV and less offshore wind, lower electricity consumption and a curtailment of peak renewable generation which would correspond to a participation in ancillary service markets. A justification of the "initial grid" is missing, as well as an assessment of how much and where storage could reduce the need for grid extension. The NABU welcomes the construction of HVDC lines but doubts whether all lines will be needed if, as suggested, another energy mix is assumed. Moreover, the NABU heavily criticises that the assumed lifetime of conventional power plants contradict the climate policy goals and underlying scenarios of the government, and that assumed full-load hours of coal plants are well above present values. Some of the proposed grid extensions, it says, could therefore equally serve for securing a future for a supply based on conventional coal plants. Concerning the next steps in the planning procedure the NABU asks that only high priority measures be considered in the Bundesbedarfsplan (federal requirements plan, see above) which need to start route planning in 2013, and that the next NEP 2013 should include considerable improvements before proposing further measures.

The environment and nature protection organisation **BUND**, Friends of the Earth Germany, with slightly less than half a million members the second largest and probably most active environmental NGO in Germany, argues along similar lines as the NABU, using a sharper language. The BUND rejects the NEP 2012 draft as it considerably overstates the need for transmission grid extension. For the NEP 2012 the BUND requires to calculate variants with more wind in the South and less in the North, more CHP and with a curtailment of peak feed-in by 10%. It also asks to use realistic runtime hours for coal plants, to provide much more detailed data and descriptions of the calculation methods, to consider the impact of electricity savings and demand side management, and to explicitly indicate which additional lines are required by the envisaged increased international exchange. Concerning technologies, the BUND welcomes the utilisation of HVDC and asks for a detailed consideration of underground cabling. Regarding the future development of the scenario framework for NEP 2013 etc., the BUND asks to start from a regionally optimised power system structure based on distributed generation, to reduce the assumed offshore wind power contribution and to consider the opportunities of power saving and demand side management, especially in trade and industry.

The statement of **Greenpeace** emphasises the astonishingly high share of coal and especially lignite assumed in the NEP. Like other NGOs and institutes, Greenpeace points to the fact that maximum runtime hours have been assumed for lignite. Moreover it shows that the contribution of lignite – the most carbon intensive power technology – is two times as high as in the official climate and energy policy scenarios. Greenpeace also complains, as the other NGOs, the non-consideration of alternatives to grid expansion such as a shifting of additional wind capacities from the North to the South, reduced peak feed-in and demand side management. Greenpeace draws the attention to the surprising fact that the grid expansion requirements are nearly the same in all three scenarios, despite the considerable differences in the input parameters. It asks to explain in detail which measures are required for the integration of renewables and which ones for conveying conventional power, and to declare which investments would be needed anyway for modernising the grid after many years of low investments.

The NGO Deutsche Umwelthilfe **DUH**, is an influential platform for environmental organisations, politicians and business decision-makers, and is running campaigns to increase the public acceptance for new grid lines needed to integrate higher shares of renewables. The DUH welcomes the increase of transparency and public debate brought about by the NEP 2012 and the consultation of the draft. However, it argues that the TSOs in drafting the plan "have visibly followed the maxim 'as much grid extension as possible'", proposing grid extensions able to accommodate all conceivable future changes in German energy policies, including a backlash towards a more coal-based electricity supply system. The DUH deems that this is not only in contradiction to the legal mandate, but also to the very interests of the TSOs since this approach undermines the acceptance of single power-line routes and of the whole planning process. The DUH argues that a basic problem lies already in the law, which attributes a key role in the process to those (the TSOs) who have a commercial interest in expanding the grid. The DUH complains that options for reducing the grid expansion requirements have not been explored: high-temperature conductors, balancing below the transmission level of the grid system, storage at all levels of the system, selection of an average wind year instead of the extraordinary 2007, reduced peak feed-in, demand side management, use of electronic devices in renewable power plants instead of rotating masses in conventional plants for grid stabilisation, increased contribution of distribution grids to the balancing of distributed generation, as well as increased CHP. According to the DUH, the whole modelling approach has to be questioned because of the resulting questionable runtime hours for lignite and hard coal plants that are criticised by others. The organisation welcomes the use of HVDC lines but questions whether all four proposed lines will be needed in the near future. Concerning the next planning steps the DUH, as the other environmental NGOs asks to consider only a very reduced set of immediately necessary non-controversial connections.

The **WWF** raises similar criticisms and requests as the other environmental NGOs, although in a softer language. The WWF asks to clearly attribute the required grid expansion in the three scenarios to the three categories used in the European ten year network development plan TYNDP, which distinguishes three drivers for grid extension: the internal energy market (28,500 km), security of service (26,000 km) and only at the third place renewable energies (20,000 km)..

The federation of local environmental initiatives **BBU**, which played an important role in the anti-nuclear movement, refuses scenarios A and B which include the construction of additional fossil fuel plants and criticises scenario C not to assume sufficient growth in renewable power generation, especially photovoltaics. It asks for a serious consideration of storage and suggests the use of the railway power grid – which serves the larges electricity user in Germany – for enhancing the public grid.

Finally, the **AGORA-Energiewende**, a platform supporting the transition to high shares of renewables (and associated to SEFEP, the publisher of this report) through a dialogue between actors from politics, civil society, business and research, welcomes the NEP 2012 as a basis for discussions, but criticises that the draft fails to provide an analysis of alternatives to the transmission grid expansion in view of the future electricity system and therefore plans the grid of the future with the means of yesterday. As key alternatives that would need to be analysed, AGORA identifies: (1) feed-in management instead of grid extension

for the last kWh, (2) storage, (3) demand side management, (4) spatial allocation of renewable generation, (5) spatial allocation of conventional power plants, (6) technological innovations.

The German Association of **Consumer Organisations VZBV** raises similar issues as the environmental organisations. Their statement emphasises the importance of establishing a learning process, open for discussions and sufficiently transparent to effectively increase the public acceptance for single measures. A maximum transmission grid expansion, the VZBV says, should not be the guiding principle. The comment makes suggestions concerning the rhythm, transparency and comprehensibility of the process and the report, asks for an involvement of the distribution grid operators, a clear prioritisation of the measures and the identification of one HVDC pilot line, and finally, the investigation of alternatives/sensitivities such as reduction of peak feed-in, demand side management, storage – at least for 2032, optimisation of the regional allocation of generation plants.

All in all, environmental and consumer organisations, which together have several million members and often a direct contact to local action groups, have presented very similar critiques and requests. Moreover, their complaints and suggestions, although with slightly different emphasis, do not go in other directions brought forward by the power industry, the industry at large or political institutions. This is remarkable.

3.5 Research institutes

The German Institute for Economic Research **DIW**, the largest publicly funded economic research institute, has submitted a very interesting contribution, based on a power system simulation model, which unlike the NEP model assumes some responsiveness of demand to price. The DIW makes detailed calculations for 2032 starting with the grid expansions proposed in NEP scenario B 2032 and testing different alternatives. This exercise confirms that the considerable grid capacities in this scenario allow to run coal plants with a high capacity utilisation without substituting them with more flexible gas plants. Moreover, allowing for different price zones in the model, power prices in different areas would be very similar.

In a first alternative, the DIW adds reasonable amounts of storage capacities to the basic scenario and obtains even higher capacity utilisation for coal power plants and smaller price differences between zones. In a further alternative, the DIW drops the HVDC lines and shows that storage can compensate renewable power variations but that base load plants need to adapt or stop generation more frequently and that north-south bottlenecks lead to considerable price differences between northern and southern Germany. A last alternative scenario – always on the basis of the B2032 consumption and generation capacity assumptions – with only two HVDC lines from northwest to southeast result in a better north-south wind power flow, lower price differences and less gas plant use than in the scenario without HVDC, but also to a considerably lower contribution of lignite baseload plants than in the base scenario.

The DIW concludes that the HVDC grid is over-dimensioned, leads to under-utilisation of the underlying AC grid and that capacity utilisation indicates that "proposed projects partly function as 'lignite HVDC lines'". Suggesting that the HVDC projects be reduced, the DIW also remarks that a massive grid expansion as proposed by the NEP 2012 incentivises further investments in fossil power plants.

In a joint statement, the **Öko-Institut**, the **Technical University Berlin** and the **DIW**, emphasise that the NEP 2012 is based on the implicit while still controversial assumption that the transmission grid must be strong enough to avoid any bottlenecks, levelling all regional price differences and effectively functioning as a copperplate covering all the national territory. Ongoing discussions at the EU level concerning the network code "Capacity Allocation and Congestion Management" precisely regard this issue. In this context, national regulatory authorities will be asked soon to propose how (wholesale) electricity prices shall be spatially structured in the future market architecture – under discussion are a unitary price for Germany (which corresponds to the copper plate proposed by the NEP 2012), different price zones, or nodal prices (reference prices at grid nodes, which then lead to local prices depending on distance and grid capacity). The three institutes ask that the choice made in the NEP 2012 be made explicit and be justified by comparisons with the other options. Moreover, they ask for a publication of all model equations as well as input and output data, for more plausible assumptions concerning fossil fuel plants, for an integrated system approach looking also more in detail at European integration, for a motivated prioritisation of measures and a demonstration of their usefulness also in a longer-term perspective, and finally for a clear orientation of grid development towards the goal of increasing renewable power combining transmission grid development with more decentralised approaches, while guaranteeing reliability and cost effectiveness.

The **Wuppertal-Institut** for Climate, Environment and Energy (WI), also one of the top institutes working on these issues, raises some fundamental questions. It complains that the cost-minimising approach apparently used for justifying the HVDC lines neglects a series of risks that might be unacceptable, and argues that this approach should be substituted by a portfolio optimisation of risks. The possible delay of the implementation of new HVDC technologies, according to the Wuppertal Institute, constitutes an unacceptable risk for the integration of a rapidly growing share of renewable power; moreover the HVDC super-structure is characterised as a "critical infrastructure par excellence". Moreover, WI criticises that the present regime of energy-only markets may not last and should therefore not be the only basis for calculating future market developments. As many others, the authors of the comment see a key shortcoming of the utilised model in the missing consideration of other flexibility options such as demand side management, CHP, reduced need for fossil must-run capacities for ancillary services and flexible generation in biomass plants. Strongly involved in climate policy, the Wuppertal Institute doubts whether the scenarios correspond to the climate policy goals of the government, which in the NEP have not been interpreted correctly.

The Institute for electrical systems and energy economy at the University of Aachen **IAEW**, raises a series of technical questions concerning the grid model. The independent **Rainer Lemoine Institute** sees considerable potential for reducing grid extension needs through a different spatial distribution of power generation

and criticises the strict separation of generation planning and grid planning. **Flensburg University** calls for a coherent long-term perspective with 100% renewable power and a much broader variation of assumptions. The University of Applied Sciences **HTW Berlin**, finally, considers that the growth of photovoltaics has been heavily underestimated.

Essentially, the statements of the research institutes confirm the weaknesses of NEP 2012 already pointed out, with differing emphasis, by business, politics and civil society.

3.6 Agriculture: farmers ask for equal treatment than grid companies

Many farmers are directly involved in the Energiewende, as many of them invested in biogas and PV plants, or earn revenues from leasing land for wind turbines. While acknowledging the need for grid expansion, the German Farmers' Federation **DBV** is concerned about the size of the areas affected by new power lines. Seven regional farmers' associations support the DBV argumentation with own statements. The DBV calculates that the measures proposed by the NEP would require more than 10.000 supplementary pylons, an area of 27.000 ha directly spanned by cables and 76.000 ha (760 km^2) which need to be kept clean of woods. In addition 15.000 ha of ecological compensations areas would be required according to present rules. In the draft NEP the farmers' associations miss an appropriate consideration of the interests of farmers and landowners directly concerned by the projects. The farmers demand: 1: A stronger attention to maintaining productive agricultural areas and operating structures of agricultural holdings in planning the routing of new power lines. 2: A modification of the rules for ecological compensations avoiding to use supplementary agricultural areas for this purpose. 3: The introduction of regular payments for the use of agricultural areas for power lines. Concerning the last point the federation notes that since decades the expropriation laws only allow for one-off payments in the rage of 10 to 20% of the value of the affected land – and this is by large insufficient to compensate for the use restrictions over time. While this had once been justified as a necessary "sacrifice" contributing to infrastructure in the public interest, the farmers claim that the TSOs have meanwhile been privatised and earn a 9% regulated profit. They also mention that in the recent grid extension acceleration law affected municipalities have been granted high payments. The farmers therefore ask to be treated in a similar way as the grid owners and to receive an adequate yearly compensation for the use of their land for energy infrastructures. This would require a modification of the corresponding laws and raise the costs of power lines.

3.7 Individual citizens and local citizen's initiatives

In this review we have not analysed in detail the more than 1800 comments from individuals. Picking random statements from this category shows that most seem to be concerned by single power line projects in their vicinity. Astonishing, however, is the number of those who make well-founded methodological and other comments to the overall approach of the NEP 2012 draft and the planning process. None of the comments we have read fundamentally opposes the objectives of the Energiewende and the possible need for supplementary power lines.

4 The key issues

Whereas in the previous chapter the focus was on the different positions of the various groups of stakeholders, in this chapter we try to systematise the key issues raised. Inevitably, this leads to some repetitions, but should provide a comprehensive view.

A remarkable finding of our analysis is that the comments of the important actors focus with high competence on methodological questions and show a significant degree of shared understanding of the issues at stake in the transformation of the electricity system. This should not be confused, however, with a general consensus on the relative weight of arguments and the measures to be adopted – the different statements show important differences between particular interests. Concerning the key methodological problems, however, views are not so strongly diverging. This can be seen as the consequence of an intensive discussion in the last years.

4.1 Methodology leads to exaggerated transmission grid expansion requirements

While nearly all comments acknowledge that the draft NEP is a big step forward in the discussion, there is a widespread perception that the adopted methodology is not yet up to the challenge, and that this leads to exaggerated grid extension proposals.

A large number of commentators would even go beyond the statement of EnBW, one of the "large four" electricity companies, who called the propositions of the NEP the "upper limit for grid expansion".

This interesting and dynamic constellation does not follow the typical lines of conflict over planning documents with well-defined camps of opponents and defenders. It rather shows that a real learning process is going on. This might be reflected by the emerging two-track approach for the next steps in the planning process, already outlined in section 2.1. above.

In this constellation, the present chapter has a double purpose: on one hand, it systematically summarises the methodological problems jointly identified by the comments, and on the other hand it highlights the differences and the probable key conflicts of the future.

This overview therefore follows – as many statements themselves – the different steps of the elaboration of the draft NEP: from the underlying assumptions concerning generation capacities (section 4.3) over the flexibility functions attributed to the transmission grid (4.4) to the specific grid extensions proposed (4.5), ending with the main issues regarding the management of the procedure (4.6). This review of the methodology based on the comments is preceded by a summary of more fundamental remarks (next section 4.2), and followed by a summary of the

potential key future conflicts (4.7), which repeatedly show up across this overview.

4.2 Future regulatory developments not considered, technological developments insufficiently considered

By saying that "the grid of the future has been planned with the means of yesterday", one comment pinpoints a basic problem that many statements formulate in one way or the other: They criticise that the draft NEP, which is meant to plan infrastructure for many decades ahead, does not really look at future developments that will affect the function and size of transmission grids. Many comments complain that the plan takes for granted the present legal framework (e.g. hurdles for demand side management, the requirement for grids to integrate all wind and solar peaks), present technologies (e.g. storage, where a considerable price drop is expected) and already planned but not yet started projects (e.g. power lines in the start grid, conventional power plants which may be unprofitable) and that it tries to integrate variable power production only by building transmission lines. Moreover, a number of comments argue that the NEP does not even take into account current advanced business practice (e.g. concerning conventional must-run capacities or accommodation of renewable generation peaks).

Most comments demand to analyse the potential impact of technological or political developments that are being intensely discussed and may strongly affect the system in the time frame concerned. Such analyses, they argue, would not be in contradiction with the law, which requires "three scenarios which describe the range of probable developments in the framework of the medium and long-term energy policy goals of the government for the next ten years". Planning long-term investments for the future, say some comments, without considering probable short-term innovations, may lead to unnecessary costs or loss of opportunities.

4.3 Controversial extent and location of renewable power development

A first group of more specific methodological problems concerns the basic assumptions in the scenarios concerning consumption, generation capacities and their spatial distribution. Although already discussed in the consultation of the draft framework scenario in 2011, some of these assumptions are still controversial, especially those about the development of renewable generation capacities.

Controversial regional growth rates of renewable energies

Not many statements have explicitly challenged the assumed overall levels of renewable power – although there is an intense ongoing public debate on the growth rate of renewables. Many comments, however, complain about the renewable capacities attributed to single regions.

As seen above, many Federal States have recently produced much more ambitious estimates about renewables deployment in their territory than their earlier previsions. These estimates – generally reduced by 10% – had been used in the draft NEP for constructing scenario C, which, however, was not chosen to be the reference scenario. Scenario A and the "lead scenario" B, utilising lower values, were calculated on the basis of national scenarios used by the Federal government, which were then "regionalised" using the regional shares stemming from

scenario C. Many regional utilities and state governments have now criticised these figures, insisting on their original estimates or even augmenting them on the basis of the strong developments in the preceding year – notably Rheinland-Pfalz, Baden-Württemberg, Saxony, Nordrhein-Westphalen, Lower Saxony and Schleswig-Holstein.

While both coastal and inland states insist on higher values than those in the lead scenario B for their regions, the inland states, as well as southern utilities and consistent voices among industry, NGOs, and research additionally ask whether it would not be reasonable to augment capacities in the south and reduce the envisaged onshore and offshore wind capacities on the coast, which the NEP indicates as a main driver for additional north-south transmission capacities. Some, like the industry association BDI, ask to show clearly which share of the proposed grid extension is due to the transport of coastal wind power. Meanwhile, the fact that the estimates or goals of the single states add up to much more than the federal objectives has led to an initiative of the federal government to negotiate a joint vision – the outcome of these ongoing efforts is still open.

Locating new generation capacities nearer to the demand

The insistent call for revising the spatial distribution of new renewable generation capacities across all stakeholder groups comes with different requests. A number of comments explicitly ask to reduce the assumed offshore wind capacities – also considering the cost overruns, delays and additional government support for this most centralised renewable power source during the last year. More generally, a large number of comments suggest to develop instruments for incentivising the location of new generation plants (renewable and also conventional ones) in the vicinity of electricity demand, and ask to analyse the impact of such efforts on the need for additional transmission capacities.

4.4 Transmission grids as only source of flexibility

The most challenging part of the comments regards the role of the future transmission grid in the electricity system. Most statements ask to analyse more in detail whether other measures or neglected developments could not lead to lower transmission grid expansion requirements. Three main issues have been raised in this regard: other flexibility options, the interaction with the distribution grids, and the role of some proposed additional transmission capacities as enabler for a lifetime extension of inflexible coal power plants.

Other flexibility options: load management, storage, curtailment

Most statements say that additional transmission grids are an essential element of the "Energiewende" since renewable power generation is (a) often more distant from consumption than conventional generation, and (b) is variable and therefore needs flexible balancing, which can be – to a certain degree – provided by transmission. Most comments ask to analyse in detail to which extent other flexibility options could substitute transmission and reduce costs.

The most frequently mentioned alternative source of flexibility is making generation more flexible. Across all groups of stakeholders, many call for accepting curtailment of peak renewable generation as a rule, instead as an exception like today: limiting, when necessary, wind to 90% of the peak output would still allow to use around 97% of the wind electricity produced. This could be combined, as

some suggest, with locally using excess power for storage or heat production. Another frequently mentioned source of generation flexibility is an increased and more flexible utilisation of small and medium CHP plants. Several commentators, such as the DUH, also point at the fact that electronic devices in renewable energy plants or HVDC converters can increasingly take over stabilisation tasks, gradually replacing rotating masses in large conventional power plants, and thereby reducing the "must-run" capacities.

Many statements also ask to analyse much more in depth the opportunities of demand response. Referring also to recent studies, the suggestions cover all levels of consumption from large industry (statement of VIK) down to single households using smart grids, underlining that many opportunities have still to be discovered once more favourable frame conditions are in place.

To consider the impact of storage of electricity at different levels of the system is another demand of many statements in search of alternative flexibility options. Pointing out that rapid price decrease and technological progress is expected for a variety of uses of different storage technologies, they call for analysing the consequences not only for a ten-year horizon but also in a more longer-term view.

Especially distribution grid operators point to the fact that they too – and not only the transmission grid – can contribute to flexibility by exchanging electricity between different places. This leads to one of the key methodological problems identified by the comments in the consultation:

Consideration of the distribution grid and interaction of different levels

An overwhelming majority of comments is not satisfied with how the interrelationship between transmission grid and distribution grids is being dealt with in the NEP. Many point at the fact that the relationships between the different levels of the grid are changing, since about 97% of present renewable power production is feeding into distribution grids. Electricity business associations quote own studies which estimate that the investment needs for upgrading distribution grids will exceed the costs of transmission grid extension: the background is that changing and less predictable load curves, inverse electricity flows, and more frequent excess energy in whole distribution areas do not only require stronger lines but also more intelligent and flexible control equipment allowing for a more active management of the system at the distribution level. Mainly in the consultation statements from the power industry, but also from political bodies and research institutes, there is an insistent call to consider and involve the distribution level in the development of the NEP. This does not only reflect the technical needs but also a change of roles in the electricity system, where TSOs will increasingly have to share system responsibility with their counterparts on lower levels of the system.

However, practical suggestions how to treat this complex interrelationship are rare. Some point at upcoming studies concerning the distribution grid. Others, like the Association of the German Electrical and Electronics Industry ZVEI or the association of municipal utilities VKU, propose to systematically complement the top-down approach of the NEP with a bottom-up approach and then to combine both for obtaining a solid basis for long-term planning.

A congestion-free grid ensuring a future for base-load coal power?

The German institute for economic research DIW, Greenpeace, DUH, Öko-Institut and others point to the fact that the proposed grid has been dimensioned in such a way that coal plants run more hours than today, Many complain that – as a consequence of the assumption of a grid without congestions - lignite plant runtime hours have been calculated at a maximum (apparently some of them even higher than technically feasible), while runtime hours of flexible gas plants are decreasing. Greenpeace shows that in the lead scenario B lignite-based power generation – the most climate-damaging electricity source –is two times higher than in the scenario of the Federal government, and hard coal based generation increases considerably. The DIW has confirmed these results with own calculations and concludes that "the proposed projects partly function as 'lignite HVDC lines' ". This is very relevant for climate policy, since lignite is the most carbon intensive form of generation. Moreover, according to DIW, high runtime-hours of lignite plants, which are a consequence of the nearly complete elimination of bottlenecks assumed by the NEP, may lead to a shift in profitability incentivising investments into conventional power plants. Several statements ask to indicate which share of the proposed extension is really required for integrating renewable power generation, and which share helps to allow for cheaper but more climate-damaging lignite or hard-coal generation – similar to the requests to provide data on the extension required by coastal wind power.

A joint statement of three major research institutes (Öko-Institut, TU Berlin, DIW) points out that that the reason for these effects is the basic approach taken by the NEP: to calculate the use of generation capacities assuming that no grid bottlenecks exist, and then to define the grid expansion requirements to meet this assumption. In other words, the **draft NEP 2012 makes an implicit decision for a congestion-free grid,** while the European and national debates on the European network code on "Capacity Allocation and Congestion Management" are still on-going. In this debate, different market design options, such as zonal or nodal pricing are being considered. In fact, none of the comments asks for a congestion-free grid[22], some explicitly oppose this idea, and nearly all ask to reduce congestions also by other means than adding transmission capacity.

4.5 One grid pattern for all cases – no priorities and alternatives

Prioritisation of measures

Most comments call for a time-table and a prioritisation of the proposed measures as it would be required by law. Many do that against the background that they question the apparent claim of the NEP to provide a catalogue of measures that should be included in a law stating their necessity. Several voices, such as the industry association BDI, warn that the NEP should not pretend to provide a blueprint for the Energiewende and try to establish a rigid infrastructure, which would predetermine developments for many decades. In view of the many uncertainties and the considerable methodological difficulties to identify the grid required in 2022, many stakeholders ask for identifying a core set of urgent no-regret measures, leaving the rest for further discussions.

[22] The power industry association BDEW speaks of the central importance of a sufficient dimensioning of transmission grids in order to "synchronise the grid extension with the expansion of renewable power and to comply with the requirements of a widely bottleneck-free internal market".

Why the proposed grid? Are alternative patterns imaginable?

A large number of comments regard the methodology of calculating the need for additional transmission, but only very few criticise the methodology for developing the specific spatial patterns being proposed. Greenpeace points to the remarkable fact that all three scenarios, despite their substantial differences, ultimately converge into nearly the same requirements for additional transmission capacities. An interesting illustration that also other patterns are imaginable, is provided by the German Institute for Economic Research (DIW). On the basis of an own detailed calculation, the DIW has argued that some of the four proposed HVDC lines essentially serve to transmit lignite base-load power. According to DIW, two northwest-southeast HVDC lines would be a more efficient solution, better targeted at a transition towards renewables.

Underground cabling, other grid technologies

Many comments complain that new transmission technologies have not been sufficiently considered, which might reduce the need for additional lines or their impact on the environment. Such technologies would include: high temperature conductors, temperature monitoring, lower AC frequencies (as used in the railway power grid), the integration of the railway power grid into the public electricity grid, and, last but not least, underground cabling which would not only reduce the impact of power lines but also allow for another routing or easier bundling with existing infrastructures. This kind of issues might play a strong role in the procedures concerning specific corridors.

HVDC lines: grid stability, responsibility, vulnerability

A large number of comments welcome the inclusion of HVDC lines in the proposed future grid. Pointing at the fact that the law requires the NEP to include an HVDC pilot line, a number of comments asks to include one such line in a core set of urgent projects, instead of the four HVDC lines proposed without prioritising them. Most of those welcoming the HVDC lines understand them as elements of a necessary European overlay grid and ask to make this potential more explicit. Many promoters of a renewable energy future and environmental activists support HVDC lines because of their advantages, such as the ability to transport bulk amounts of electricity over long distances with less losses, their lower impact in terms of electromagnetic fields, and because they can be easily buried underground. .

Important voices from industry, utilities and NGOs, however, think that HVDC lines cannot flexibly respond to future developments and more distributed generation. Some commentators warn that the addition of single high-capacity long-distance point-to-point connections to a well-established densely meshed AC grid might increase system stability risks – which could be avoided establishing a meshed HVDC overlay grid for which, however, crucial technological elements have not yet been tested in practice. Others argue that a small number of rigid super-connections over long distances would reduce the flexibility of the grid to react to changing spatial patterns in electricity generation, consumption and storage. The statement from a large municipal utility even says: “The grid extension with HVDC corridors sketched in the grid development plan solidifies the structure of a centrally organised power supply from large generation units for decades”. Two other comments, moreover, point to security aspects and ask to

consider the vulnerability of the super-nodes at the end-points of super-important connections.

The European context

Several statements criticise that only little information is provided on the European integration of the German grid. The power sector association BDEW calls for an inclusion of cross-border links into the NEP. The joint statement of three major research institute and Scandinavian utilities ask for a better coordination of cross-border linkages, especially in view of a possibly increasing role of hydro storage in Scandinavia and the Alps. The Swiss government offered a discussion on potential synergies and an involvement of Switzerland in the planning of HVDC connections.

4.6 Transparency, procedure and governance of the planning process

Most statements filed in the consultation process welcome the NEP procedure as a considerable progress in the discussion on grid development. Many highlight that a considerable amount of data concerning grids and grid utilisation have been published for the first time, that the yearly repeated procedure of drafting a plan allows for a learning process, and that public consultations in different phases open up the debate and open the way for a slowly growing consensus on the needed power lines. Most comments however, emphasise the necessity of further improving transparency as well as the procedure.

Transparency of data, assumptions, models, results and approaches

As often mentioned throughout the preceding chapters, several commentators ask for:

- Much more detailed public accessibility of grid and grid usage data including grid nodes and possibly also the next underlying high and medium-voltage networks. Also distribution companies are asking for this transparency and do not raise security concerns
- A full documentation of the market model and its results. Some ask to provide opportunities for making own calculations with this model to verify results or test other assumptions.
- A documentation of the construction principles and the design procedure of the proposed grid patterns
- A detailed documentation of the utilised grid model and of the different scenario and sensibility runs, enabling to make own calculations
- A far better description of all the steps carried out so as to make them plausible for readers who cannot dig into the details of calculations or make their own ones

Improving the process

Many statements have asked for a more extended consultation period. It must be noted here that also the TSOs had asked for a more relaxed timeline of the consultation procedure. Contradicting suggestions have been made concerning the rhythm of establishing a NEP: some argue in favour of keeping the yearly rhythm, while others would favour a NEP every two years, thus allowing for a more in-depth discussion.

Governance of the planning process and conflicts of interest

More fundamental concerns have been raised regarding the governance of the grid planning process: several commentators, e.g. the DUH, see a problematic conflict of interests in the fact that the TSOs are responsible for drafting the NEP, while they have a direct commercial interest in influencing the future shape of the grid. This issue is likely to lead to more intense public debates in the future.

Quite a number of comments also say that the specific role and the relationship between subsequent NEPs as well as between them and the less frequent Bundesbedarfsplan (which has to be adopted by the Parliament) are not sufficiently clear.

4.7 Persisting or emerging conflicts in the debate

The systematic overview in this chapter has shown a strong support for the more transparent public debate on grid development that started with the drafting of the first NEP. At the same time, it has revealed a broad consensus concerning the need for important methodological improvements, which may have a considerable impact on the transmission grid expansion requirements.

On the other side, there are a number of specific issues on which views are diverging, and where a consensus seems difficult. The main controversial and often interlinked issues emerging from the above overview include the following:

- An open disagreement persists between northern and southern stakeholders concerning the desirable regional distribution of renewables (generally, they want more renewables in their area, not less)
- A more implicit, but important disagreement concerns the speed of the transition towards renewables
- Both are linked to different views concerning the role of off-shore wind power
- The desirability of HVDC lines depends on the perceived need for large, centrally managed structures and may become a key issue in the debate

Made explicit only in a small number of statements, but implicit in most of them, there are some more fundamental questions:

- Politics and markets: Which decisions shall be subject to market mechanisms or economic optimisation? Shall grids be a basic infrastructure, available at fixed costs? Or shall the use and construction of (scarce) grid capacities be managed with price signals? Shall the choice of generation locations continue to be free, without considering the distance to consumption and the availability of grid capacity? How shall markets be designed?
- Rigid planning versus flexibility: Do rapid developments in the energy sector still allow making long-term plans as in the past? Which investments and technologies can be flexibly adapted to different scenarios? What are no-regret measures? When do we need which decisions? How could we maintain risk-optimised portfolios of opportunities? Which kind of decisions should be avoided?
- Time pressure versus thorough discussion: How can no-regret-solutions be found in a short time? Is a good methodology needed before taking first decisions? Is it possible to define a core set of non-controversial urgent

measures? Does a call for a more thorough discussion of the NEP methodology jeopardize the Energiewende?

5 Conclusions

It is useful to distinguish our conclusions more relevant for the German context and those more relevant for the European debate.

In our view, **for the German context** the most important conclusions that can be drawn of this consultation are the following:

- The first public consultation on the NEP has seen an intensive participation of hundreds of stakeholders and of the broader public, with many comments at a high quality level.
- Even if the positions of different stakeholders on the extent of the grid expansion requirements are still significantly diverging, the whole process has stimulated an in-depth dialogue on the future of the power system and shaped a new relationship between grid planning decisions and stakeholders.
- Also in the next editions of the NEP, the debate on grid extensions will be one of the decisive venues for discussing fundamental questions concerning the future electricity system
- A systematic analysis of alternatives to the proposed grid expansion measures will be inevitable
- The dilemma between a need for rapid action and more thorough analysis requires can be solved with a two-track approach. The decision of the BNetzA (the regulatory agency) of late November 2012 has only partially gone in this direction. If the Parliament approves the lines suggested by the BNetzA, it appears certain that not all of them will be built immediately, and therefore some might be re-discussed in the next NEP round.
- In the context of the rapidly changing power sector and of a more active civil society, traditional top-down planning methods do not work anymore: a deliberately flexible, risk-conscious approach seems to be the necessary

It is therefore clear that the discussion will continue, and that all stakeholders will have a higher level of understanding.

A vast number of comments call for a more careful consideration of alternatives to transmission grid expansion. This will most probably influence the following planning procedures. Some comments also point at the fact that strategic environmental assessments legislation (SEA) requires the consideration of alternatives, which might expose to legal action grid extension projects for which alternatives have not been considered sufficiently. Even if such a formal legal requirement could be avoided by a parliamentary decision establishing the necessity of a series of grid extension projects, it would be more difficult to impose new lines against local opposition if the credibility of the underlying plan has been undermined by criticisms of important voices from the power sector, industry, politics and NGOs alike.

Looking at the considerable methodological deficits and difficulties that have shown up, a tricky question is how to reconcile the urgent need to start planning those new lines that are really needed rapidly, with the necessity for a solid justification with the support of an integrated analysis. Many feel trapped in a dilemma between the risk to support wrong solutions and the risk of jeopardising the Energiewende by blocking urgent decisions. A solution for this problem seems to lie in the suggestion to prioritise measures and to focus the formal procedure on a smaller core set of no-regret projects while continuing to work on an improved NEP methodology in the coming editions. This means to switch to a two-track strategy, and the need to rapidly develop a quick-and-dirty methodology for identifying the immediately needed core projects.

A difficult challenge is that even an improved analysis will not be able to strongly reduce the uncertainty concerning the often accelerating developments in energy technologies, markets and policies. Planning has to deal with up to ten times shorter innovation cycles, disruptive changes in markets and the entrance of many and completely new actors into the game. More flexible and risk-conscious approaches than in the past seem to be necessary.

For the European context, the most important conclusions may be:

- The German experience has demonstrated the significant potential influence of a public consultation in this field and the wide range of issues it may touch.
- With a growing share of variable renewables, grid issues become crucial, as the whole structure of the electricity system is changing.
- Grid planning issues are very complex. Civil society actors and those supporting the transition to renewables need to prepare thoroughly if they want to accompany and meaningfully comment this debate.
- Where, like in Germany, there is a broad community of competent NGOs, institutes, companies independent from the incumbent electricity industry, considerable "crowd-intelligence" can play an important role accompanying the gird expansion debate.
- The unbundled TSOs are independent from the dominant generators. However, they may have a tendency to overestimate the needs for transmission grid expansion, as they are caught in a conflict of interest between their roles as public system planners and as commercial grid operator.
- To a significant extent, the issues that will be debated in other countries will be similar to those discussed Germany. Learning from the experience of the German NEP consultation will be useful for all those wanting to engage in similar debates in other countries.

As far as we are informed, Germany has been the first EU member state to organise a public consultation of the national ten year transmission grid development plan now requested by European legislation. This study, while highlighting a series of specificities of the German case, shows that well-structured formal public consultations on a detailed document can have a strong impact both on the planning process and on the quality of the public debate.

With the growth of renewables, the grid development debate is becoming one of the central energy policy arenas. This consultation has shown an ongoing deep transformation of the power sector: the support for a transition towards a power system essentially relying on renewables is large and growing, the development

of distributed power generation has gained a momentum which has convinced important business and political forces and, as the voices from different tiers of the electricity system show, leads to shifts in the relative influence of different forces within the sector.

The growing competitiveness of distributed renewable electricity supply apparently leads to a decrease of the opportunities of central policy control. In Germany, local and regional governments and utilities are gaining more influence. The debate over more or less centralised structures in renewable power supply, however, is not over.

The strong environmental movement in Germany and the involvement of citizens since three decades has strongly contributed to a widespread awareness for energy policy issues, strong local support for renewable energy investments, as well as a dense network of highly competent civil society organisations and research institutions. This has also transformed the perspective in many industries. How this committed "crowd intelligence" helps to tackle the highly complex transformation of the energy system has again become evident in the consultation process on the first NEP described in this report. However, although the challenge of integrating large amounts of renewable power into the electricity system was known since years, proponents of a renewable energy future have only started very late to really bother about grids and market architectures. Therefore, the methodology of the NEP has been widely criticised across all sectors, but a better methodology and concrete proposals for a market architecture providing alternatives to grid extensions are still missing. This may lead to a turbulent transition phase of the system in which the political framework lags behind accelerated technological and commercial developments.

Considering the impact and the wealth of resulting arguments of the public consultation in Germany, it seems advisable for actors working for a renewable future in other EU countries to push for having similar consultations in their own country, and to prepare themselves in time. The broad technical and policy framework is the same across the EU, and so are the basic challenges of a transition from a top-down supply system with conventional generation in large plants towards a high share of variable and to a large degree distributed renewables requiring a multi-level-approach. However, there are important differences among European countries with regard to the structures of the power sector, the positions and strength of the actors involved, as well as the political context. We hope that this description of the German experience may help to prepare similar discussions elsewhere.

Glossary

Institutions

ABB	www.abb.de/
AGORA Energiewende	http://www.agora-energiewende.de/
ARGE Netz	Represents 200 wind energy operators in Schleswig-Holstein, mainly dealing with grid issues. www.arge-netz.de
BBU, Bundesverband Bürgerinitiativen Umweltschutz	Federation of local environmental initiatives. Played an important role in the anti-nuclear movement www.bbu-online.de
BDEW, Bundesverband der Energie- und Wasserwirtschaft	German Association of Energy and Water Industries. Represents 1800 companies, making up for 90% of electricity sales in Germany. https://www.bdew.de
BDI, Bundesverband der deutschen Industrie	*Federation of German Industry BDI* Represents 100.000 companies in 38 sectors employing 8 million persons http://www.bdi.eu/
Belectric Solarkraftwerke	www.belectric.com/
BSW-solar	*German Solar Industry Association* More than 800 member companies. http://www.solarwirtschaft.de
BUND, Bund für Umwelt und Naturschutz Deutschland	BUND, Friends of the Earth Germany www.bund.net/
BWE, Bundesverband Windenergie	*German Wind Energy Association* Represents the manufacturers of wind turbines etc., as well as wind plant owners and operators http://www.wind-energie.de/
DBV, Deutscher Bauernverband	*German Farmers' Federation* www.bauernverband.de/
Deutsche Umwelthilfe DUH	*German Environmental Relief* http://www.duh.de
Deutscher Städtetag	*German Association of Cities* www.staedtetag.de/

DIHK, Deutscher Industrie- und Handelskammertag	*German Association of Chambers of Commerce and Industry* http://www.dihk.de/
DIW, Deutsches Institut für Wirtschaftsforschung	*German Institute for Economic Research* The largest economic research institute in Germany. 180 collaborators. http://www.diw.de/
DStGB, Deutscher Städte- und Gemeindebund	*German Association of Towns and Municipalities* www.dstgb.de/
EnBW, Energie Baden-Württemberg AG	One of the four large utilities in Germany, supplying Baden-Württemberg and neighbouring areas. Turnover 18 bn EUR. http://www.enbw.com
GEODE	European association representing private and public electricity and gas distribution companies http://www.geode.de/
Greenpeace Deutschland	www.greenpeace.de/
HTW Berlin, Regenerative Energien	*University of Applied Sciences Berlin, Renewable Energies* http://regenerative-energien.htw-berlin.de/
IAEW, Institut für Elektrische Anlagen und Energiewirtschaft, RWTH Aachen	Institute for electrical systems and energy economy at the University of Aachen http://www.iaew.rwth-aachen.de/
LEE-NRW, Landesverband Erneuerbare Energien Nordrhein-Westfalen	Renewable energy association of NorthRhine-Westfalia
MVV Energie AG	Municipal Utility of Mannheim, owning also other municipal utilities www.mvv-energie.de/
NABU, Naturschutzbund Deutschland	*NABU, Nature and Biodiversity Conservation Union* http://www.nabu.de/
N-Energy AG	Municipal utility of Nürnberg. One of the top ten in the German electricity market. Turnover 2,5 bn EUR. www.n-ergie.de/
Rhein-Ruhr-Verteilnetz GmbH	Regional distribution grid operator, belonging to RWE. www.rr-verteilnetz.com

RLI, Reiner Lemoine Institut	Not for profit research institute of the Reiner Lemoine Stiftung, founded by one of the founders of Q-Cells http://www.reiner-lemoine-institut.de/
RWE, Rheinland-Westfälische Elektrizitätswerke	The largest utility in Germany, active also internationally: 2nd utility in NL, 3rd in UK. 17 million electricity clients, turonover 52 bn EUR. http://www.rwe.com
SFV, Solarenergie-Förderverein Deutschland e.V.	Association for Solar Energy Promotion http://www.sfv.de/
Stiftung Offshore Windenergie	Foundation offshore wind energy, "the voice of offshore wind energy in Germany" http://www.offshore-stiftung.com
Thüga AG	Network and minority owner of over 100 municipal utilities. 3,6 million electricity clients http://www.thuega.de
TU Berlin – WIP, Wirtschafts- und Infrastrukturpolitik	*Technical University Berlin, Workgroup for Infrastructure Policy* http://www.wip.tu-berlin.de/
Universität Flensburg	http://www.uni-flensburg.de/
VDMA Power Systems	Power systems section of the *German Engineering Association* www.vdma.org/powersystems
VIK, Verband der Industriellen Energie- und Kraftwirtschaft	Association of industrial energy producers and consumers http://vik.de/
VKU, Verband kommunaler Unternehmen	Association of municipally determined infrastructure undertakings and economic enterprises 1400 Members, employing 235'000 http://www.vku.de/
VZBV, Verbraucherzentrale Bundesverband	*Federation of German Consumer Organisations* 41 member organisations representing over 20 million members http://www.vzbv.de/
WEMAG Netz AG	Regional distribution grid operator in Mecklenburg-Vorpommern, 170.000 clients http://wemag-netz.de/
Windland	Small wind energy operator
Wuppertal Institut für Klima, Umwelt, Energie	*Wuppertal Institute for Climate, Environment and Energy* http://www.wupperinst.org/

WWF Deutschland	*WWF Germany* http://www.wwf.de/
ZVEI, Zentralverband	*Association of the German Electrical and Electronics Industry* http://www.zvei.org