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Recommendations for political action

PLAN

N

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Dear Sir/Madam, Dear Readers

What you see before you is the result of a unique and ambitious discussion process – **Plan N – Recommendations for political action on the future integration of renewable energy into the grids.**
Its aim is to open up the bottleneck situation in which we currently all find ourselves regarding the expansion of renewable energy in Germany. Plan N – N stands for network upgrading – is a political paper. It contains numerous suggestions on successfully achieving the essential upgrading and expansion of our energy grids, and thus better integration of fluctuating feed-in from wind and solar power sources.

Plan N is the result of discussions that lasted for almost two years between participants with differing interests and from a broad range of society. With their active involvement and expertise they sought both to analyse why our grids present a bottleneck for the integration of renewable energy, and find solutions to this problem. Together with the German environmental organisation Deutsche Umwelthilfe e. V. (DUH, German Environmental Aid), detailed proposals were drawn up regarding, for instance, the issue of how more transparency and involvement in procedures and discussions on suitable transmission technologies might lead to higher local acceptance, and therefore promote more rapid upgrading.

Responsibility for essential grid expansion can no longer lie solely with grid operators. Both politics and society must support the process. This requires – amongst other things – further broad discussion in civil society on the vital upgrading of energy systems. Moreover, it is vital to have much broader discussions within our society as a whole than we have so far had on upgrading our energy systems. Only together with all those concerned can we find acceptable regional solutions for successful grid upgrading and nature protection. The development and presentation of Plan N represents just the beginning of the dialogue process at the Forum for the Integration of Renewable Energy. It will certainly be ongoing. Whilst all the signatories support the measures presented in Plan N to the greatest possible extent, there are still some central questions where participants were unable to find a common position. Indeed, Plan N is an interim result i.e. Plan N - Version 1. All participants hope that these project issues will be resolved in further dialogue, with the aim of presenting the draft for Plan N Version 2. We are all committed to continuing fair and constructive discussions.

I would therefore like to thank all those so far involved in the discussions for their great commitment and dedication!

Dr. Peter Ahmels
Director Renewable Energy

Chapter 1

Summary

1. Summary

The expansion of renewable energy (RE) in the German energy sector is a dynamic ongoing process within the reliable framework that the German Renewable Energy Act (EEG) provides for investors. It is non-controversial within the populace and supported by all the political parties represented in the German Bundestag. At present, grid infrastructure is proving to be a bottleneck and hindrance to the further dynamic expansion of RE. During the coming years and decades, the grid needs radical upgrading and expansion to ensure security of supply at the present high standard to which we have all become accustomed. The aim will be to align the new grid to new power stations and new feed-in points.

The German Federal Government's Energy Concept presented in September 2010, focuses amongst other issues on the expansion of RE and designates grid expansion as an important prerequisite. However, in the medium and long term, upgrading and expansion of the grid can only be achieved by appropriately considering the interests of all the people who will be affected. In addition, this must also include nature and environmental protection issues as well as, in part, incorporation of new transmission technologies.

In some locations, the start of the upgrading and expansion process was not without conflict and even in future will not be free of conflict. Conflicts arise from issues around nature conservation and protection. People living alongside newly planned power line routes feel upset, disadvantaged and threatened. On the other hand, investors need to make sure that any investments they make will later be profitable. Ultimately, all these different and frequently contrary interests often lead to very long implementation times in planning and constructing new power lines. It is already clear that the integration of energy from wind and solar sources will present considerable challenges. At a regional level, this is in increasing measure already the reality of the situation.

Experience and the latest social science research findings on conflicts arising along newly planned high voltage lines, show that providing all the people who will be affected with early, readily comprehensible information on its necessity in energy-economic terms is the only way of achieving acceptance for grid expansion aimed at integrating RE.[1] Planning must be based on transparent planning processes, weighing up technical transmission technologies and giving due consideration to residents interests. Furthermore, it requires explanations of the reasoning in terms of energy-economic policy regarding the necessity of power lines, and the incorporation of regional grid expansion concepts into centralised European grid expansion concepts consistent with an Energy Concept.

Since the end of 2008, the Forum for the Integration of Renewable Energy has been a platform for intensive talks to analyse such conflicts, and to develop appropriate proposals to open up and avoid imminent bottlenecks in grid infrastructure. Over a period of almost two years, there were intensive discussions between different participants and those people affected by the changes. From the beginning, the aim was to designate and analyse divergent interests in order to find a consensus in the development of proposals to accelerate grid expansion. Plan N is the result of this discussion process initiated by the Forum for the Integration of Renewable Energy. It is a paper on strategies, showing ways of achieving greater public acceptance for grid upgrading and expansion through its recommendations for concerted political actions. However, realisation of the envisaged measures requires further support in the political arena. Amendments in the legal framework to incorporate new demands need further elaboration, and all the relevant value added processes in the energy markets must have a place in further proceedings. Actual realisation of the approaches put forward requires critical concomitant advice and support. The Forum for the Integration of Renewable Energy will take on this role in the next step.

Further, the Forum for the Integration of Renewable Energy believes that it is essential to start a broad, nationwide information campaign concurrent to implementation of the proposed measures. The aim of the campaign must be to clarify the necessity of changes in our power grid and provide appropriate answers to all concerned on, for instance, possible health risks.

The following report lists the most important measures that the signatories all believe to be significant in improving local acceptance for grid expansion in order to integrate fluctuating, regenerative energy.

[1]) FG UPSY, Jan Zoellner, Irina Rau (August 2010): „Umweltpsychologische Untersuchung der Akzeptanz von Maßnahmen zur Netzintegration Erneuerbarer Energien in der Region Wahle–Mecklar (Niedersachsen und Hessen)“; Universität Halle-Wittenberg, AG Gesundheits- und Umweltpsychologie, Gundula Hübner, Johannes Pohl (2010): Internetbefragung zur Akzeptanz des Ausbaus der Stromleitungsnetze, not yet published

It is essential to take the interests of local residents and communities as well as nature protection issues into account. At the same time, in order to attract real investment the economic framework must be firmly in place.

Taken all together, the proposals provide a road map that politicians must now urgently work on. Only then can we successfully enter the new age of regenerative energy desired by all the political parties in the German Bundestag.

Here an overview of the most important measures:

Harmonisation between European targets and German regulation *Chapter 3*

Regulations in the 3. Single Energy Market Package, in particular, the directive 2009/72/EG, should be enacted within the national legal regulatory framework by March 2011.

New role for the regulator *Chapter 4 Part A III*

Until now, it was the responsibility of the regulatory authorities to secure efficient grid operation. This will no longer suffice for the upgraded grids and integrated renewable energy. An extensive national incentive system is essential to promote innovations levelled at optimisation of RE integration and grid development. Therefore, the purpose set out in § 1 of the German Energy Act (EnWG) regarding the promotion of RE must be extended and the responsibilities of the Federal Network Agency (BNetzA) adjusted accordingly. It is imperative for the realisation of grid upgrading as described here, that the legal and regulatory framework specifically states that costs relating to grid expansion can be claimed.

Measures prior to grid expansion *Chapter 4 Part A I Part B, 4.1-4.6*

- Visible progress in the efficiency levels of energy production and usage
- Implementation of a smart grid (SG) to integrate RE and improve distribution network ability to accommodate new functions (system services):
  - Determine smart grid capability of RE production plants at high as well as medium and low voltage levels (e.g. for photovoltaic installations and micro CHP units)
  - Create incentives for grid operators to invest in the long term in smart grid innovations based in non-system solutions e.g. setting up communications infrastructure as well as appropriate measurement and meter technology in the distribution network
  - Create prerequisite conditions for the development of energy management at grid level e.g. by setting up market places in the distribution networks to optimise grid utilisation
  - Create additional incentives for energy companies in regard to load transfer for a transition period e.g. in the form of funding programmes
  - Consumer oriented, nationwide privacy policies
- Introduction of electrical CHP or hybrid power plants in all regions for RE feed-in continuity
- Development and setup of decentralised and central energy storage facilities
  - R & D innovative storage concepts (wind to methane, compressed air, H2 in caverns)
  - EU wide network (e.g. linking-up to Norwegian storage capacities)
  - Underground site planning to create sufficient storage capacity
  - Exemption from grid usage charges for energy fed in to storage
  - Creation of norms and standards for electro-mobility
  - Incentives for biogas and heat storage systems
  - Implementation of "adjusting to demand" set out in the regulation in § 64 para. 1 no. 6 German Renewable Energy Act (EEG)

Chapter 4 Part A IV Part B 4.7 5.1, 5.2 **Minimising expansion and infrastructure bundling**

Prior to grid expansion, make full use of all options to keep grid expansion to a minimum:

- Compulsory application of the priorities regulation: Grid optimisation before upgrading or expansion
- As a general rule factor in power line monitoring and high temperature lines
- Bundling of infrastructure close to residential areas, avoidance of additional burdens due to electromagnetic fields when considering bundled lines
- Recognition of costs for early cable construction work for offshore installations

Grid expansion

Chapter 5.3 5.4

In the long term, apart from the measures described above, the underground cabling option is most likely to improve acceptance levels. All the voltage levels relevant to underground cabling options need separate consideration:

Up to 60 kV:
Preferentially underground cabling; in rural areas or difficult terrain, it may still make sense to use overhead lines.

110 kV:

- Amendment of legal and regulatory framework to give precedence to underground cabling options
- Costs recognition for such measures according to § 11 and § 23 of the Incentive Regulation Ordinance (ARegV), and inclusion of these measures in the returns on equity capital incentive regulation § 14 (ARegV) and § 7 of the German Electricity Regulation on Grid Tariffs (StromNEV).
- Formulate regulatory framework and regulatory practice so that the underground cabling option for the new construction of new 110 kV lines is economically attractive to grid operators. This means, amongst other things:
    - Incentive Regulation Ordinance ARegV: Not naming a limited specific amount for extra costs for the extra costs incurred by underground cabling (110 kV) in the German Power Grid Expansion Act (EnLAG).
    - German Federal Network Agency (BNetzA): Starting a process of establishing procedures, respectively, drafting guidelines

220/380 kV:

Position A*
The German Power Grid Expansion Act (EnLAG) pilot scheme should be used for partial underground cabling.

Position B*
The German Power Grid Expansion Act (EnLAG) pilot scheme should be used for partial underground cabling. The EnLAG pilot scheme should be reviewed to see if it is suitable for full cabling.

* see list of signatories at the end of the document for each position.

- Review based on EnLAG pilot schemes and international experience whether, and to what extent, underground cabling could be an option for other projects in power line construction and of binding legislator commitments
- Full consideration of all technologies relevant to testing, planning and completion expenditures and investments in the network costs

Perspectives for transmission technology

- Testing innovative transmission technologies such as high voltage direct current transmission (HVDC)
- Review planning for an overlay HVDC grid

Regional acceptance

Chapter 6.1

- Health risks due to electromagnetic fields near high and extra high voltage overhead lines

Position A*
Improve legal protection for people in the approval procedures for new high and extra high voltage overhead lines by having regulations on safe distances together with compensation models (see for example, the regulation on safe distances for extra high voltage lines in the German Power Grid Expansion Act (EnLAG))

Position B*
Improve legal protection for people in the approval procedures for new and upgraded overhead lines by having regulations on safe distances (400 metres in urban areas / 200 metres in outer areas)

Position A*
Review and, if necessary, redefine the 26 regulation of the German Federal Immission Control Act (26 regulation BImSchV) by adding a precautionary limit for EM fields in residential areas. The precautionary limit should be based on current research and will improve legal protection for people in the approval procedures.

Position B*
Review 26 regulation of the German Federal Immission Control Act (26 regulation BImSchV) with regard to a precautionary limit for EM fields in residential areas as a preventive measure as e.g. in the Netherlands and Switzerland.

* see list of signatories at the end of the document for each position.

Planning high and extra high voltage power lines

Chapter 6.2

Early inclusion of locally affected residents in the planning procedures regarding the actual need for power line construction is an important requirement to improve regional acceptance of grid expansion. This involves transparency in

- the procedures, providing information at an early stage and encouraging participation in the regions and in planning power line routes, amongst other things, with comprehensible ecological criteria. Before proceedings are started, an informal master plan for the power line route should be drafted in an informal process with due regard for all participants.
- Regular disclosure of standardised planning data (e.g. German Federal Network Agency (BNetzA) targets) and verifiable planning explanations provided by third party experts to be included in the procedure as proof of the necessity of new power line construction in energy economic terms
- Drawing up a study on the development of distribution networks (110 kV) which will investigate the effects of regulatory measures on system optimisation based on concrete regional examples
- EU-wide coordinated basic concept for grid expansion (EU-grid expansion plan based on strategic environmental compatibility investigations) ENTSO-E 3 internal energy market package
- With cross border projects, the federal state that is most affected should lead the decision making process on the basis of standardised guidelines e.g. still to be developed planning guidelines on the standardisation of regional planning procedures and planning approval procedures of the different federal states
- Online publication of planning documents that can be accessed by anyone who is interested
- Designation of infrastructure corridors
- Options for the ecological optimisation of overhead line routes should be used to their full potential. Ecological route clearance management provides the necessary planning guidelines in this respect.

Nature protection

Chapter 6.3

- Areas of exceptional importance for nature protection must be considered on an individual basis (see Chapter 6.3.1, Table 3). If, after consultation, there are no regional planning alternatives, the power cables in these areas should be laid underground. However, there should not be any underground cabling at the extra high voltage level through sensitive ecological systems such as moorlands and wetlands.
- When restructuring or replacing pylons, all bird protection measures according to the German Federal Nature Conservation Act (BNatschG § 41) must be adhered to, and all construction regulations implemented without exception.
- At the high and extra high voltage levels, ground wires must have bird protection markers.

Summary

Chapter 2

Plan N - problem analysis and aims

2. Plan N - problem analysis and aims

In Germany, RE has for years increased more rapidly than even experts had predicted. The annual increase in RE electricity generation is currently about 1%. In 2009, the total share of RE in electricity production was already at about 16%. Presumably, the current high rate of increase for RE, amongst other things due to photovoltaic installations, might even be around 2% in 2010, and the total share could increase to 18%. We welcome this increase but it also presents a great challenge to grid expansion.

In some places, there are already bottlenecks that endanger system security and could lead to system failures. This is because wind and solar energy is not always produced at the same time it is needed. Wind and solar energy are very much dependent on weather conditions and must therefore, at times be distributed over large areas in order to avoid local overloads when demand is low. At present, storage options or smart grids are not sufficiently available and even if they are, can only provide a solution to part of the problem.

Grid expansion needs a considerable amount of planning over a period of several years. At the same time, it often encounters resistance from many regional and local residents. Gaining acceptance for grid expansion therefore means early inclusion of all the people concerned in a transparent planning process, and giving a very detailed presentation of the necessity for new grids at the different locations as well as technological alternatives. This in turn requires political discussion as it necessitates amendments to the legal framework.

Plan N for grid upgrading, provides the relevant German federal ministries and German federal state planning authorities with recommendations for changes in the legal framework necessary for grid upgrades focussed on a strongly increasing share of regenerative energy. The aim is to accelerate grid upgrading in the whole energy production system in the long term.

The recommendations in Plan N are the result of a discussion process in which grid operators, companies, electrical industry associations, RE representatives, environmental organisations and public campaign groups participated and came to a mutual understanding despite all their many and varied interests. In order to do this, we analysed technical options and potential for optimisation in the planning processes.

However, it is of central importance that the people concerned at different locations accept grid upgrading. This includes all those people personally affected by the changes who will see changes in their environments. It must also include nature protection and regional concerns – for example, regions where tourism is well established. An important prerequisite is information on the necessity of changes to the energy system and overall grid upgrading as well as on the necessity of each grid expansion project.

Chapter 3

German and European grid upgrades – a prerequisite for renewable energy expansion

3. German and European grid upgrades – a prerequisite for renewable energy expansion

More cross-border cooperation within Europe is essential for more efficient RE usage and to level out strong regional feed-in fluctuation from wind and solar energy sources depending on weather conditions. With a stronger more cooperative cross-border network, RE could be more effectively introduced into power plant planning, and make that energy more securely available. Further, new grids are needed for connection to new storage installations. These storage installations – pumped storage and caverns are possibilities – are likewise located at the periphery and mostly not in areas where demand is high. According to initial estimations, an EU-wide network would reduce the required storage volume by approximately half. Grid expansion is by far the least expensive option for RE integration. Any interim storage of energy is considerably more expensive.

In its current 10-year Network Development Plan[2], the European Network of Transmission Operators for Electricity ENTSO-E states that there is a considerable demand for new power lines. Within the EU, there is a total requirement for 42 000 km of new power lines, of which 20 000 km are for the integration of energy from RE sources. It is advisable to have 26 000 km for security of supply. Routes overlap partially. The German Energy Agency, dena, is working on estimating expansion demands for Germany. Due to its central location within Europe, it may be assumed that Germany will require several thousand kilometres of new extra high voltage lines.[3] This large volume of expansion requires thinking within a pan-European framework about which routes and which technical options for a future overlay network are best placed to augment the intermeshed European three-phase network. Other options such as planning for infrastructure corridors or using the traction power network can also contribute to expansion.

[2]) ENTSO-E Ten-Year Network Development Plan, March 2010, Download : https://www.entsoe.eu/index.php?id=42&tx_ttnews[tt_news]=36&tx_ttnews[backPid]=28&cHash=4d17d8663c

[3]) The Germany Energy Agency's Grid Study (November 2010) assumes that Germany will need about 3500 km of lines at the extra high voltage level. (http://www.dena.de/en/topics/energy-systems/projects/projekt/grid-study-ii)

Harmonisation of EU law with national legislation

Grid operators play a key role in implementing climate protection goals (EU: 20-20-20-goals of 03/2007, BRD: Federal German Government Energy Concept of 28.09.2010, p. 5: Reduction of greenhouse gas emissions by at least 80%). Consequently, there were demands for the stronger involvement of transmission and distribution grid operators in the SET-Plan[4] (11/2007) in research and development. In June 2010, the EU commission officially initiated a comprehensive research and development programme with European (including German) grid operators. Further, with the 3 energy package, grid operators were, in effect given responsibility for measures to be taken in research and development, and therefore assigned a key role in the optimisation of the power network.

However, this alone is not sufficient to ensure the continued commitment of German grid operators in the research and development sector. Further development is being hindered because the respective regulation in the 3 energy package has still not been implemented in German law. This means that the Federal Network Agency (BNetzA) still regards research and development expenditure incurred by grid operators as costs that are open to influence. Accordingly, there is no incentive for financing necessary undertakings to promote the innovation ability of grid operators in the research and development sector.

Key demand:

> *Harmonisation between European targets and German regulation: The regulations in the 3 internal energy market package, in particular directive 2009/72/EC should be implemented in German national law by March 2011.*

[4]) Strategic Energy Technology Plan: http://ec.europa.eu/energy/Technology/set_plan/set_plan_en.htm

Chapter 4

Options for system optimisation

4. Options for system optimisation

Part A: Generel theses

I Optimal integration of increasing amounts of RE into the grid requires a number of coordinated instruments. Numerous players are involved: utility companies, consumers, the public sector and many more. System optimisation is enhanced if generating plants, transmission and distribution grids and consumers are all seen and understood as part of the whole energy supply system and when the interdependency of power, heat and mobility is taken into account in planning.

Essential requirements for necessary system optimisation are:

- Improved overall and more efficient handling of energy along the value added chain from generation to consumption (Chapters 4.1, 4.5, 4.6)
- Intelligent application of a combination of de-centralised and centralised approaches for the flexible coordination of energy generation, grid control, energy storage and consumption in an energy market with continually changing demands (Chapters 4.1 to 4.6)
- Expansion of existing storage installations and the development and implementation of innovative power storage installations to enable RE feed-in that is oriented to demand and market developments (Chapter 4.4)
- Using power-led combined heat and power installations (CHP) (Chapter 4.5)
- Development of new and applied upgrading technologies (e.g. power to gas, vehicle to grid) and application of alternative infrastructures (hydrogen, mobility, heat, gas grid feed-in) (Chapters 4.3 and 4.6)
- Rapid regional, national and cross-border optimisation, upgrading and, where necessary, expansion of the power grid infrastructure and natural gas grid infrastructure (supply and storage) (Chapter 4.7)

II The energy grid must be increasingly oriented to the necessity of taking up the fluctuating feed-in of energy from wind and solar sources. Expansion that has already begun must be intensified. The goal is to achieve sustainable grid development to secure in future the full integration of ever increasing amounts of RE in the existing grid. Therefore, appropriate grid upgrading is essential to accommodate existing and new demands.

In so far as there is in reality no currently legally guaranteed optimal access, we must work towards greater clarification in the legal framework, for instance, regulations on linkage to international power lines. At the same time, absorption costing for restructuring the grids needs clear regulation.

III The German Federal Network Agency (BNetzA) is a political institution installed to increase efficiency gains in monopoly structures and enable network competition. This will not be enough in future. The focus is increasingly on facilitation and acceleration of grid expansion in the era of RE. This is leading to increasing grid costs. Cost recognition is important in the process of grid upgrading and must find expression in legislation resp. regulatory practice. Grid development needs a comprehensive and nation-wide incentives system to promote innovation for RE integration. Therefore the policy set out in § 1 of the German Energy Act (EnWG) must be extended to include the promotion of RE, and the mandate of the German Federal Network Agency must be adapted correspondingly. The authorities concerned, (in particular regulatory and planning authorities) need to be provided with sufficient financial means and staff to realise grid access that is guaranteed in law and free of discrimination. The costs involved in restructuring measures need to be socially accepted.

There must be an assurance that grid operators making necessary investments in RE integration in the best possible way are not disadvantaged.

As far as costs apportionable to consumers are concerned, the benefits resulting from the integration of energy from variable and decentralised generating plants (CHP installations) which thereby contribute to reduction of overall grid expansion must be adequately taken into account.

IV The integration of RE into the grid follows – as regulated by law – the principle "Grid optimisation before upgrading, before expansion". This principle is valid for all network levels.

V The goal is to make full comprehensive use of the ecological, compatibility and economic potential of RE in all regions of the country, including wind energy in southern Germany e.g. in the federal state of Hesse. Cost effectiveness through using regenerative energy, mainly wind, is predominantly found in the low load areas of northern Germany, but it is the high load areas in southwest Germany which will be most affected by the closure of old conventional power stations. This means that the worsening balance of the generation-load deficit cannot be stemmed without new transmission capacities.

VI The fact that some regions obtain their yearly amounts of energy solely from RE sources, or at least aim to do so, does not mean that they disconnect from the surrounding grid. In an uninterrupted grid, disconnection would make neither technical nor economic sense in terms of goal achievement. In order to secure supply, the aim should be that, if interregional grid disturbances occur then sub-networks should be able to continue operating as island networks. Politically intended and enforced separation of power generation, transmission and distribution – for reasons of competition – (unbundling) means that optimal coordination between grid operation and planning on the one hand, and energy feed-in on the other hand, no longer happens "on its own". Therefore, it is preferable to have new instruments for planning and control that will fill the resulting gap. Economic and ecological elements need to be incorporated in power station and site planning, with the aim of optimal grid utilisation.

VII Optimal network planning requires network concepts for all network levels, developed in consultation with the German federal states and the German Federal Network Agency (BNetzA). The network concepts should be based on European network planning and be oriented on politically determined goals for the expansion of RE in Germany and Europe. They should also be published. The network concepts of Mecklenburg-Western Pomerania and Brandenburg are good examples of the coordination of network studies between German federal states.5

VIII Optimised network development requires integrated network calculations for all voltage levels and for all German federal states, based on expansion goals and expansion scenarios. It is not always clearly possible to categorise network upgrading or expansion as either due to RE expansion, new fossil-fired power stations or power trading. However, wherever possible this should be done – as for instance, in the Mecklenburg-Western Pomerania network study – to create more transparency for the general public. Higher acceptance will be assured in cases where network expansion is clearly required for the integration of RE.

[5]) Mecklenburg-Western Pomerania: www.vdi.de/fileadmin/vdi_de/redakteur/bvs/bv_meck_pomm_dateien/Endbericht_Netzstudie%20M-V.pdf
Brandenburg: www.mwe.brandenburg.de/cms/media.php/gsid=lbm1.a.1312.de/Netzstudie_Schlussbericht_final.pdf

Part B: Detailed key requirements for the individual sectors

4.1 Smart Grid[6]

4.1.1 Technology

The increasing share of RE in energy production requires new and additional grid capacity. At the same time, future intelligent grids, so-called smart grids, enable a more efficient use of existing grid resources. The overall goal is to make energy production, management, storage and consumption more flexible and actively able to accommodate continually changing demands in the energy market.

A whole range of currently available technologies and data, combining both central and decentralised approaches are increasing the chances of establishing smart grids within a short time period. This includes modern measurement and control technology, the use of meteorological data and prognoses, new technologies and further application of current grid planning methods as well as grid management and operation.

Smart grids can become an important aspect in building a sustainable, environmentally friendly and secure energy supply. They form the basis of system operations that are transparent, energy and cost efficient as well as secure and reliable. We propose the following measures to achieve the progressive establishment of smart grids and the optimal integration of RE into the energy system:

Investments

Investments in smart grids, in particular, in intelligent grid management, need to be made in consultation with European initiatives such as the European Electricity Grid Initiative, within the framework of a European strategy plan for energy technologies (SET-Plan), and in accordance with national initiatives such as the E-Energy Projects.

This could happen, for instance, by increasingly equipping facilities (substations, transformers etc) e.g. with new measurement technology and optimising load capacity with the aid of prognosis-based monitoring systems to

[6]) Smart grids use current technologies and developments thereby providing further options for active and flexible adaptation of generation, grid management, storage and consumption in continually changing energy markets (Final report of the BDEW working group Intelligent Networks/SmartGrids, August 2009).

enable active distribution grid operation. Such innovative investments help to assess grid expansion measures more precisely as well as increase load capacity within certain limits, and to reduce or avoid grid expansion measures. The legislator must create incentives for these measures e.g. by directing regulatory authorities to recognise ensuing costs.

Key demand:

> *Create long-term oriented incentives so that grid operators can upgrade their grids to smart grids with non-system based solutions, which comply with minimum standards still to be defined. Such investment can include the setup of communications infrastructure as well as appropriate measurement and control technology in the distribution network.*

Usage and integration of decentralised energy installations
The integration of renewable energy installations can be promoted and added benefit secured by

- developing plug-and-play-enabled installations,
- fully exploiting potential system services in the installations,
- structuring the management of real power from decentralised installations, not always currently agreed upon, so that it is regularly available to grid operators on demand.

Key demand:

> *Smart grid-enabled renewable energy installations must be developed for extra high voltage and high voltage as well as medium and low voltage levels (e.g. for photovoltaic installations and micro CHPs). These specifications should, wherever possible be defined to the benefit of all concerned.*

Optimal load capacity in energy grids
Coordinating small decentralised and, in part, highly unpredictable producers and consumers can in combination with storage installations contribute to increasing energy efficiency and optimised load capacities since the energy could be used in close proximity to generating facilities. This would reduce grid losses. An appropriate legal framework therefore needs to be developed.

Key demand:

> *Create the right conditions for the development of energy management systems e.g. for the management of real power and reactance output at lower grid levels. One option is to set up market places in the distribution networks where these services can be requested and accessed. This would allow optimal grid load. Thus reducing grid expansion and upgrading to a minimum.*

Economic investment in energy grids
Even now, it is clear that cheaper, less expensive options will not suffice in future. Both the transport and distribution grids need fundamental upgrading and expansion. A socially acceptable consensus is needed in order to keep costs manageable and justifiable.

Key demand:

> *Using regional models draw up a study on the development of distribution networks (110 kV) to investigate the effects of regulatory measures for grid optimisation. Special emphasis should be placed on decentralised energy production installations and the participation of different market players.*

4.1.2 Players in the energy market
Energy market producers and suppliers have been in competition ever since the liberalisation of the energy market. In future, the focus will not only be on effective integration of renewable energy into the existing market. Indeed, in the long term the market itself needs restructuring. Even today, the integration of increasing amounts of renewable energy into the energy production market presents us with new challenges.

This is apparent, for instance, in increasingly frequent periods of wind energy cut-off times when the wind is very strong, and in the inadequate control options in conventional energy production. Apart from just the price of electricity, currently there are very few incentives, which the supplier can pass on to consumers. Any measures taken to stabilise resp. relieve the system are just as little rewarded as system overload is penalised. Fundamentally, there are two different incentive options – independent price-led consumption or consumption-led control/power limitation by third parties. The suppliers are the ones who can and must connect production and consumers and consumer behaviour. All those concerned must provide and make available clear price signals, preferably in an energy market place. A smart transmission grid has other feed-in and feed-out needs than downstream distribution networks. Accordingly, suppliers must align these needs with price signals from production so as to form a variable end customer tariff and thus enable cost optimised integration of RE.geahndet wird.

Key demand:

> *Grid operators must be able, for instance, to prioritise the option of creating incentives by using future energy marketplaces to place price signals for producers and consumers thereby encouraging more efficient energy rather than resorting to grid expansion.*

4.1.3 Smart Metering

The transition from demand-oriented to supply side energy systems can only be successfully managed when information and prognoses regarding production and consumption are available, and when producers and consumers are influenceable. Smart meters can function as interfaces to customers – and therefore as interfaces to households and their controllable devices – to provide consumption information and enable direct control of consumption through load resp. time variable tariffs.

The current development of smart meters as components of an intelligent future overall system (smart grid) highlights the fact that coherent, future oriented and economic solutions, which require the integration of more than one smart meter product, do not yet exist. The legislator must create incentives for these investments, for instance, by instructing the regulatory authorities to recognise relevant ensuing costs.

Key demands:

> *Policy makers must define minimum requirements for the development and use of smart meters in order to facilitate new business models and services in a liberalised energy market and make load transfer more attractive. This requires extensive standardisation of interfaces and data formats. Considering the fact that the introduction of smart meters has already started, there needs to be definition of minimum requirements as rapidly as possible.*

> *Regulatory framework should make provision for cost recognition of smart meter investments made by grid operators.*

E-Energy-Programme

An increasing number of market incentives make it more difficult for grid operators to oversee, plan and make prognoses for their grids regarding consumer behaviour. Findings from renewable energy pilot schemes in different regions should be used to launch smart meters on to the market. Grid expansion measures may become inevitable if consumer behaviour is driven only by market prices and grid capacity is not taken into consideration at an early stage.

Key demands:

> *Load transfer must take place with due consideration of grid capacities. The energy grid must be viewed as an overall system.*

> *Establishing a programme to launch smart meters on the market based on findings from the results of the E-energy pilot schemes.*

Data protection

From the perspective of consumer and data protection, it is important that only as much customer information as necessary is passed on to the energy suppliers. A lack of clear consumer-friendly data protection regulations would lead to some predictably serious acceptance problems.

Conversely, strict data protection regulations will stimulate the interest of customers in their own energy consumption, and increase their motivation to gain more control themselves. In this respect, statutory regulations, for instance, those in the German Law on Electricity and Gas Supply (EnWG) along the lines of the data protection regulations for telecommunications must be welcomed.

Key demand:

> *Rapid implementation of consumer-friendly statutory data protection regulations for smart meters and other smart grid components in, for instance, the German Law on Electricity and Gas Supply, formulated along the lines of the data protection regulations for telecommunications.*

4.2 Load transfer

In industry, large energy customers have long been used economising by shifting energy consumption to more favourable times of day. This means they avoid expensive peak load times. With increasing use of RE, a further benefit can be added - consumption can be shifted to times when weather conditions make a large and inexpensive amount of energy available.

The time-periods involved in load transfer can be up to several hours. Applications such as cooling, process heat or compressed air cannot be interrupted for any length of time. Only very well insulated cold storage warehouses can be left without cooling for a very few days. Load transfer can to a great extent smooth out the fluctuations in the power demand curve which can amount to 25000 MW during the course of the day. However, it is not suitable for longer-term storage or seasonal storage.

The transferable load in Germany in summer is about 17,000 MW and in winter about 9,500 MW. The required yearly maximum load values currently at 74,000 MW in winter and 54,000 MW in summer could be reduced by the above values. However, a substantial proportion is already being used. For economic reasons, the commercial sector already uses load transfer for many different purposes. In Germany, further load transfer potential that could be utilised is around 1,500 MW for industry and for households about 3,700 MW without energy storage (according to: Klobasa, 2007).[7]

Key demands:

Energy suppliers must be given additional incentives to use load transfer for a transition period e.g. in the form of promotional schemes until such time as sufficient experience has been gained in this field and market mechanisms provide adequate incentives.

Modification of the standard load profile: Until now, the timetable for the following day is oriented on the standard load profile i.e. the known and predictable consumption of the following day. The volatile feed-in related to variable tariffs and a thus changing consumer demand has not yet been taken into account. This requires a comprehensive field study to gather information.

[7]) Marian Klobasa (ETH Zürich 2007): Dynamische Simulation eines Lastmanagements und Integration von Windenergie in ein Elektrizitätsnetz auf Landesebene unter regelungstechnischen und Kostengesichtspunkten

Options for system optimisation

4.3 Renewable energy – combined and hybrid power stations

Increasing amounts of RE in energy production mean an increase in one's own responsibility for adaptation and consumption. In future, this will not be a task solely assigned to traditional power plant operators.

Renewable energy combined and hybrid power stations are an option to fulfil new regulation requirements and to provide balancing power needed to avoid bottlenecks in the grid. Combined power stations are RE energy installations located at different sites. They reliably provide need-based energy through the joint control of small and decentralised installations. Hybrid power stations combine different ways of producing energy. For instance, they may produce hydrogen when demand is low. Later on, this can be converted back into energy or it can be used for other purposes. This makes a point balance of CO2 emissions necessary.

The current German Renewable Energy Act (EEG) does not offer sufficient incentives for renewable energy storage. Therefore, implementation of the adopted regulation on financial incentives for upgraded grids and the market integration of RE in the current wording of the German Renewable Energy Act (§ 64 para. 1 no. 6 EEG) is essential.

The aim of the regulation should be to integrate renewable energy technologies into the grids in an optimal, need-based and reliable way from a technical and economic point of view.

The desired financial incentives, including eligibility criteria, drafting and accounting procedures, in particular for the stability of demand-based RE feed-in as well as improved grid and market integration should be oriented on the above-mentioned special nature of RE suppliers.

It is essential to create the right conditions for participation in the market for control reserve.

There should be a review of the effects of such a power to enact secondary legislation and compatibility with the mechanisms of action in the German Renewable Energy Act (EEG). Above all, there should be an avoidance of any weakening of effective upgrade mechanisms contained in the German Renewable Energy Act (EEG), especially for installations not participating in such an ordinance, so as not to put their further development at risk. Incentives should be formulated to ensure that they are only used by those installation operators whose installations or other parameters allow sustainable, safe and economic operation. Opting out of this additional requirement (i.e. out of the combined power station) must be allowed on lapse of the prerequisites. The use of storage and load management should also be considered in this context.

Key demands:

Implement the regulation in § 64 para. 1 no. 6 EEG: create incentives to stabilise feed-in

Promote technologies and/or storage installation capacities (including biogas and heat storage systems)

4.4 Energy storage installations

Storage is becoming ever more important in view of increasing amounts of RE in power plant output. Firstly it means that excess energy from inexpensive sources can be stored temporarily, and secondly, not using storage would mean a loss in the effectiveness of CO_2 reduction in regard to newly installed RE output, since ever larger amounts of excess capacity for energy conversion from RE would not be used.

Storage options are short-term storage (< 24h) and long-term storage (> 24h). Short-term storage units can flatten the demand curve during the course of a day and thereby reduce peak load times. Long-term storage or seasonal storage can compensate demand oversupply or undersupply according to the seasons.

It is advantageous to have a storage system with both short-term and long-term storage facilities. The following must be taken into account: Power lines over a wide area reduce the need for storage capacity. This is because the more extensively sufficient renewable energy capacities are connected via international power lines, the greater the amount of secure output. In this context, the term secured output means the output that can long-term and reliably be made available for operational planning. It can be factored in at any time to cover demand and reduces storage demands.

The long-term supply of RE from wind and photovoltaic facilities fluctuates during the course of the year by around 100%. Wind blows on average less in summer than in transitional periods and in winter. When there are less conventional power stations as backup, energy from large storage installations

can bridge longer periods of stagnation in summer. Currently there is not sufficient storage technology or infrastructure available.

Short-term storage

At the moment pumped storage hydropower stations are primarily used for the provision of conventional energy. However, with an increasing amount of RE they are becoming more significant since they can level out fluctuating output from RE sources at short notice during the course of a day. The pumped storage installations operating in Germany have a capacity of around 10,000 MW and can generate 0.04 TWh (Average national daily consumption in Germany is about 1.6 TWh). Germany plans to build further pumped storage hydropower stations with a capacity of around 2,000 MW. If available capacity is used up and the pumped storage installations empty then they have to be re-filled. However, because the potential in Germany and the Alps to construct new pumped storage power stations could, for various reasons, be limited, it would be beneficial to have a connection to Scandinavian pumped storage power stations. These projected installations will provide a welcome addition, but will not have the capacity to cover all future European storage needs in an energy system incorporating a high share of RE. In Germany, pumped storage power should be exempted from the newly introduced system usage charge. This is because it involves high investment costs, coordination with regulations in neighbouring countries and because it has efficiency factors of over 80% and extremely flexible applications in addition to its immense importance for secure grid operation. There is otherwise a danger that investments in Germany will stop through lack of a solid framework and investment will move to other countries. This development is already becoming apparent.

Apart from energy storage in pumped storage hydropower stations, there are numerous other more or less new storage concepts. Most of them still need to prove their economic efficiency and technical practicability in a technological and commercial context (storage in mines, pumped (hydro) storage in lakes in former mining areas etc.). Demonstration projects would be useful here.

Especially in northern Germany, compressed air reservoirs in caverns can contribute to short-time load balancing. The geological structures there are particularly suitable and at the same time, it is one of the main areas of wind energy production. Compressed air storage with a high degree of efficiency still requires substantial further technological development and demonstration projects. Regulations regarding the use of underground storage capacity are necessary to avoid imminent usage conflicts.

Long-term storage

If the future energy supply is to come from 100% RE, then besides short-time load balancing, we need to be able to compensate feed-in of fluctuating amounts of RE– possibly even down to almost negligible amounts - for the long-term stretching over weeks. One option here is underground storage of hydrogen in caverns. In comparison to compressed air, hydrogen has an energy content that is about 60 times higher per volume unit and therefore takes up less space underground. Production costs and efficiency factors must also be taken into consideration. A further approach is conversion e.g. wind energy into methane with use of the existing gas grid storage. This would not entail building new structures. Both options have the advantage that the stored energy can be used in the mobility and the heat sectors.

Required output and capacities

Currently, neither the existing short-term nor long-term storage installations suffice at all for the planned expansion of RE up to full supply. Increasing amounts of RE require an increase in energy for balancing loads. Different studies have provided initial reference points regarding requirements for increasing output and storage of energy for balancing loads if Germany is to have a 100% RE supply. An annual secure supply would need an installed output of up to 62 GW[8] and around 5 to 50 TWh[9] of energy from storage available as feed-in volume.

In the process, not all of the total demand in the short and long-term for load levelling needs to be supplied from national storages. Shifting loads to off-peak hours and other efficiency measures can also reduce demand. Equally, an EU-wide link-up can increase the share of secure output. Nevertheless, demand will remain high and all storage options, both central and decentralised, must be further developed. Building up the infrastructure for renewable energy integration will take years and therefore not all storage capacities must be in place immediately. On the other hand, development, planning and implementation of large-scale storage installations also take many years, and one reason why public discussion needs to take place now.

Storage and electro-mobility

In principle, electric vehicles can be used as small, mobile storage units. Consequently, electric vehicles would be grid-connected primarily at lower voltage levels, delivering larger capacity directly into the medium voltage grid. Decisive factors for secure grid operation would be the number of vehicles in one area, the breadth of their distribution in the grid resp. temporary local concentration, their battery capacity, the controllability of re-charging or whether, indeed, they could all be charged at the same time.

According to the national development plan, there should be about a million such vehicles in Germany by 2020. This represents a massive boost to the electric car market. Manufacture of this number of vehicles would theoretically provide an additional storage volume amounting to several gigawatts available for RE. There is also a chance of improving efficiency in energy use in the mobility sector by a factor of three. Research and development must be bi-directionally-led.

Analogue to expanding RE on the production side – there will in fact be an increasing number of mobile decentralised consumer/storage units moving around. Conversely, this requires more intelligent grids in order to make these amounts of energy available in an efficient manner, and sensibly connect grid integration of RE with storability in the electro-mobility sector.

Key demands:

- *Politicians must create a framework so that energy and eco-conscious customers have a sufficiently intelligent and innovation-friendly infrastructure in the distribution grid in a lead market. Suitable incentives must be developed to promote innovation. The incentives should be part of a current energy-economic framework.*
- *Introduce new decentralised storage concepts to the market, implement the regulation § 64 para. 1 no. 6 EEG (see chapter 4.3)*
- *Estimate total storage needs for RE integration in Germany and Europe*
- *Exemption from system usage charges for energy fed into storage installations*
- *Spatial planning for underground sites to designation sufficient cavern storage sites*
- *European network e.g. Super Grid*

8) Sollmann, Dominik 2009: 0,2% vom Paradies, Photon, 6/09, p. 64-75

9) SRU 2010: 100% erneuerbare Stromversorgung bis 2050: klimaverträglich, sicher, bezahlbar, Stellungnahme, p. 62

Research and demonstration of new storage concepts

Battery manufacturers, vehicle manufacturers, grid operators and energy suppliers must now start developing common fundamental concepts for ICT infrastructure and the charging and discharging electric cars to secure the future integration of electric vehicles and guarantee secure grid operation. This also requires the formulation of joint minimum requirements and standards.

4.5 Decentralised combined heat and power

Decentralised combined heat and power generation (CHP) is currently able to supply both electric power and reserve power. It is the ideal partner for RE with its volatile feed-in characteristics. Large scale gas and steam combined cycle power plants (GUD), are firstly, very flexible and fast in their output reduction response right down to complete cut-off when higher amounts of RE are fed-in to the system, and secondly, when e.g. there is no wind, supplying maximum capacities to the grid with full condensation operation and very high power efficiency. Medium and small CHP installations supply near site consumers and therefore counteract expansion. In future, small and medium sized CHPs will be interconnected to "virtual power plants" and participate in the markets for control reserve. The flexibility of power generation in CHPs will be supported by suitably dimensioned heat, and possibly, cold storage installations for local use or for district heating and cooling systems.

Key demands:

Meet the targets for decentralised CHP installations set out in the German CHP Act (KWKG) 2009

Appropriate concessions to offset avoided grid expansion due to an increase in CHP grid connections, in the calculation of additional costs in the incentives programme (see suggestions, OPTAN-Study[10].)

Focussing technical regulations on smooth cooperation between CHP operators and grid operators with due regard to technical safety.

[10]) IZES et al., 2008: Optimierungsstrategien Aktiver Netzbetreiber beim weiteren Ausbau erneuerbarer Energien zur Stromerzeugung (OPTAN)

Review and eventual amendment of regulations for "charges for decentralised feed-in" ("avoided grid charges") in electricity network tariff regulations so as to offer incentives for decentralised feed-in to relieve the grid at peak times.

Cooperation between grid operators and CHP operators through concluding power supply contracts within the framework of load management, and thereby avoid grid expansion.

4.6 Alternative infrastructure

The intelligent integration of different energy sectors (power, heat, mobility) and forms (solids, heat in liquid and air, natural gas, biogas and biomass) is beneficial to promoting and clearly improving the flexibility of a future energy system. The overlap between the energy, heat and mobility sectors lends itself – based on already existing storage and infrastructure systems – to optimal use resp. relief, but also to increased grid utilisation. An increased number of decentralised heat storage facilities can contribute to grid relief either locally or regionally. This is because CHPs are able to operate on an energy and demand-led basis and the generated heat can be stored temporarily. The same is true with even more flexibility for gas storage in biogas installations and for setting up decentralised cold storage installations, which deliver cooling from combined heat and power plants and thereby securing supply for larger cooling installations e.g. refrigeration warehouses.

The expansion of long-distance heating and long-distance cooling networks in addition to appropriate storage facilities, enables an energy-led operation of larger CHP installations integrated into such systems. Decoupling energy generation and heat resp. cooling delivery enables very flexible responses to load fluctuation in the grid and the balancing of volatile RE feed-in.

Biogas installation operators can use the storage facilities of the natural gas grid for processed biogas. It is less expensive to use CHP installations wherever there is a near site demand for heat because this avoids the need for complex biogas processing.

Processed biogas can be stored either centrally or decentrally before being converted to energy. Setting up biogas nets can be beneficial, and in some individual cases, be less expensive than processing it for the gas grid.

A further alternative structure option is to produce hydrogen from RE so that it can be used as interim storage. The hydrogen produced from regenerative energy can be used in the existing gas grid, or be used in the mobility sector. However, this would require setting up new infrastructure in the mobility sector (hydrogen filling stations).

Key demands:

- *Regulations for feeding processed methane and hydrogen into the natural gas grid and improvement of biogas feed-in.*
- *Incentives for decentralised biogas storage facilities*
- *Incentives to set up combined heat and cold storage facilities in CHP installations*

4.7 Conductor line monitoring/High temperature conductors

Even in the existing grid, there is a high potential for temporarily improving power line capacities in both the transmission and distribution grids. Power line capacity is higher when line temperature is monitored. The cooler or windier it is, the more power the lines can transport without exceeding the minimum safety distance of the overhead lines to the ground. So far, only a few operators have introduced line monitoring in transmission and distribution grids. It is a method of temporarily reducing bottlenecks at comparatively short notice providing that no interconnected upgrading measures need to be undertaken in the substations and reactive power provision. This form of grid optimisation must be considered when drafting grid upgrade and expansion concepts. In particular, operating conditions e.g. compliance with voltage range e.g. 400 kV +/- 5% must be heeded. Particular attention must also be paid to transient grid stability i.e. control in the event of an error. An increase in power even with monitoring and/or new high temperature conductors cannot always be allowable for technical reasons of grid protection and safety, or because of reasons relating to the German Federal Emission Regulation (BImSchV). Grid operators must be obliged to follow the rules of priority “Optimise – Upgrade – Expand” and consider the application of conductor line monitoring and other optimisation alternatives. As a rule, transmission line monitoring should be installed if it means that grid expansion can be avoided or grid capacity can be increased for an interim period. However, it does mean higher losses. The regulatory authority therefore must recognise the costs hereby incurred.

High temperature conductors are a further option for grid optimisation. Wherever there are localised “hotspots” which reduce the transmission capacity along a route, it can be a sensible option to replace conventional cabling with high temperature conductors at these points to increase permissible transmission capacity. However, there is a need to differentiate between voltage levels resp. a weighing up of interests because transmission losses increase with increasing heat in the conductors, and the danger to birds increases at high temperatures (of up to 230 degrees) (see chapters 6.3.1 and 6.3.2). Wherever grid concepts are still to be developed for German federal states, regions and communities, transmission line monitoring, and, experimentally, high temperature conductors should be taken into consideration.

Key demands:

- *Grid operators should be obligated by the legislator to act according to the priority rules “Optimisation – Upgrading – Expansion” when considering and possibly implementing transmission line monitoring and other alternative options for high and extra high voltage levels.*
- *Grid concepts that are still to be developed for German federal states, regions and communities must take transient grid stability into account, as well as options such as conductor line monitoring and experimental use of high temperature conductors.*

Chapter 5

Optimisation of grid expansion

5. Optimisation of grid expansion

5.1 Optimising, upgrading and expanding grids

The concept of "Grid upgrading – optimisation before upgrading, before expansion" taken from the German Law on Energy and Gas Supply (EnWG) and the Renewable Energy Act (EEG § 14) should have utmost priority. In addition, all the individual technically available options for upgrading and expansion must be formulated in specific terms for each separate voltage level.

Further, optimisation criteria must also be formulated in specific terms. Line conductor monitoring is one of the alternatives that could contribute to full resource utilisation. It could increase transmission capacity, at times and locally limited, to up to 50% in the north and up to 30% in the central German uplands. Upgrading transmissions routes i.e. increasing transmission capacity can be achieved by increasing voltage and/or power. Technical solutions for optimisation include: better insulation, additional cables, or well-engineered high temperature conductors. Once all these options have been exhausted, the remaining options are upgrading and expansion of transmission and distribution grids.

If grid upgrades or expansion measures only find local acceptance with technically complex solutions, then in return, the regulatory authorities should allow grid operator claims for the ensuing increase in costs incurred for all voltage levels. It must be made possible that any savings can be offset against operating costs. Further, the projected power route corridors must be identified and officially determined in order to establish who will be clearly affected by the changes and who will be entitled to compensation. This will accelerate compensation procedures and the realisation of the grid expansion measures.

In order to avoid structural bottlenecks in the transmission grid, the German Power Grid Extension Act (EnLAG) stipulates that demand planning has to be reviewed every three years. Early planning has to make allowance for prompt take up of new projects as e.g. suggested by ERGEG within the framework of European grid planning, in particular regarding the integration of RE.

Trans-regional grid upgrading and expansion scenarios are also necessary for distribution networks. Wherever possible a differentiation should be made between grid expansion to facilitate the integration of RE and other expansion measures, in particular, for connection to new fossil-fuelled power stations. This would as a rule, be the case for the 110 kV level.

Evaluation of concrete proposals must be made with due consideration for the principles of economy as well as quality (frequency and duration of interruptions). This includes, above all, effects on the active implementation time and the innovative character of the project.

To a certain extent, approval of the investment budget within the incentive scheme framework will involve an increase in operational costs. Currently, investment budgets contain only the cost of capital so that this increase in operational costs will only become relevant for the revenue cap in the following regulatory period. It could therefore make sense to close this gap by incorporating operational costs into the investment budget.

A breakdown of energy prices must be transparent and understandable (absolute and specific costs).

Decentralised production and grid expansion

The connection of decentralised power generation installations to distribution networks can lead to lasting changes in the supply function of distribution grid operators. Furthermore, the integration of decentralised power generation installations and the expansion of generating capacity in the grid can increases costs, which outweigh the mitigating effect of taking energy from the upstream grid level. Therefore, the expansion factor contained in § 10 para. 2 ARegV (regulation of incentives for energy networks) is in place to ensure that distribution grid operators can, for costs arising from a lasting change in their supply function due to the integration of decentralised installations, be taken into account when the revenue cap is set. The already implemented regulation "Number of feed-in points for decentralised energy generation installations" does not provide sufficient regulation and further suitable parameters are necessary.

Key demands:

The legislator must formulate the principle taken from the German Renewable Energy Act (EEG) "Optimisation before upgrading, before expansion" in a more detailed way.

Complete recognition and apportionment of extra costs for all voltage levels by the regulatory authorities for grid expansion deemed necessary by the German Renewable Energy Law.

Draft regional grid expansion scenarios right down to the distribution grid level

Approval of investment budgets not only for capital costs but also for operational costs and recognition as permanent non-influenceable costs

Amendments in the incentive regulation "Number of feed-in points for decentralised energy generation installation" by addition of a further parameter to calculate the expansion factor in § 10 para. 2 ARegV

5.2 Bundling existing lines/power line routes

Bundling new overhead lines along existing routes or other infrastructure facilities such as traffic routes must have preference in a nature protection context. Minimal intervention is a further precept defined in § 2 para. 12 BNatschG – German Federal Nature Conservation Act; § 2 para. 2 ROG – Regional Planning Law. However, bundling should not create additional and substantial disadvantages close to residential areas. Wherever bundling is carried out close to residential areas then pylon types must be used that ensure there is no increase in the exposure of residents to electromagnetism. If this is not possible, then re-routing must be considered (see chapter 6).

As far as underground cables are concerned, bundling is a planning option together with other infrastructure that will help to keep invasive measures in the countryside to a minimum.

For offshore production installations (wind, tide), bundling and a minimisation of invasive measures to ensure nature protection, are both particularly important in keeping the ecological burden on sensitive eco-systems such as the mud flats as low as possible. Regulatory authorities must recognise the cost for this kind of preventatively constructed cabling. They must have realistic underlying assumptions for the region. In the interests of bundling different media to minimise invasiveness in the landscape, and to ensure grid expansion requirements, already in part foreseeable, it is necessary to identify and declare national and trans-European infrastructure corridors.

Key demands:

- *Designation of infrastructure corridors*

Bundling infrastructure close to residential areas, avoidance of additional exposure to electromagnetic fields when considering bundled lines

Cost recognition by regulatory authorities for preventatively built cable structures for offshore connection

5.3 Technical implementation of grid expansion

Technically energy can be transported above ground (overhead lines) and underground (underground cables, undersea cables). In accordance with legal directives (§ 43 EnWG - German Energy Act) and based on longstanding experience, high and extra high voltage lines are generally constructed as overhead lines. European, as well as German experience, shows that underground cabling solutions have a higher regional level of acceptance than overhead line solutions for grid expansion.[11]

In Germany, energy at low voltage level is distributed mainly through underground cables and at high voltage level by overhead lines. The amount of cabling at the lower voltage level increased between 1998 and 2008 as the table below shows:

Table 1

Overhead power lines/underground cables in the German national grid, 12/2008[12]

	2008	2008	1998	1998
	km (circuit)	cables in %	km	cables in %
low voltage	1 110 057	88	968 056	80
medium voltage	499 335	74	479 120	64
high voltage	76 900	8	74 917	6
extra high voltage	35 391	0.3	39 921	0.2
Total	**1 721 683**		**1 562 014**	

[11]) Research group environmental psychology (FG-UPSY), Jan Zoellner, Irina Rau (2010): Umweltpsychologische Untersuchung der Akzeptanz von Maßnahmen zur Netzintegration Erneuerbarer Energien in der Region Wahle–Mecklar (Niedersachsen und Hessen), Abschlussbericht; Universität Halle-Wittenberg, AG Gesundheits- und Umweltpsychologie, Gundula Hübner, Johannes Pohl (2010): Internetbefragung zur Akzeptanz des Ausbaus der Stromleitungsnetze, not yet published

[12]) Data 1998 from BDEW 1998 („VDEW-Statistik 1998: Leistung und Arbeit"), Data per 31.12.2008 From the BNetzA monitoring report 2009

Due to technical and economic parameters, it is advisable and necessary to consider and present voltage levels separately and to elaborate on special background circumstances.

5.3.1 Low and medium voltage (up to 60 kV)

At the low and medium voltage levels, underground cables have long been the standard technology. In economic terms, they are comparable to overhead line construction. In densely populated areas and cities, parts of the German national grid at these voltage levels have already been laid underground. Preferably, new power lines in the distribution networks at these voltage levels should be underground. In rural grids where the terrain is difficult or topographical conditions are unfavourable, low and medium voltage overhead lines can still be a sensible technical solution.

Key demand for low and medium voltage levels (up to 60 kV):

> *Precedence for underground cabling; in rural areas or difficult areas using overhead power lines can still be a sensible option*

5.3.2 High voltage (110 kV)

At the high voltage level (110 kV), underground cabling solutions in comparatively densely populated areas, in particular, in cities are the standard technology. Regional and trans-regional transmission at 110 kV is mostly via overhead lines. Underground cabling would be equally technically possible and could speed up grid expansion measures. Underground cabling solutions at 110 kV in grid expansion have not been realised mainly due to economic reasons, but particularly due to a lack of sufficient legal and regulatory frameworks as well as obstacles in regulatory practice.

Further grid expansion requires higher acceptance. Overhead power line solutions are encountering increasing problems with acceptance within large parts of the populace, nature protection organisations and local authorities. Higher acceptance can be expected for underground cabling options. Underground cabling is also more amenable to nature protection issues.

Legal and regulatory frameworks making underground cabling solutions economically attractive are prerequisites for the full realisation of underground cable solutions at the 110 kV level.

However, despite years of effort there is still no economic equality in regulatory practice. From the point of view of grid operators, the economic framework does not provide them with an adequate rate of return. This has an immediate effect on the willingness to invest in potentially expensive technologies such as underground cabling.

In order to change this situation, it is particularly important to secure the § 14 ARegV regarding returns on capital for grid operators. The regulatory practice of BNetzA – the German Federal Network Agency – should establish procedures resp. code of practice for recognition of investments for underground cabling at the 110 kV level. An increase in the use of cables at this voltage level, necessarily involving an increase in production volume, could potentially lead to the market developments, lower production costs and prices.

Key demands for the construction of new lines at the high voltage level:

> *Adaptation of the legal and regulatory framework for precedence of underground cabling*

> *Cost recognition for these measures according to § 11 und § 23 der ARegV and inclusion of cost recognition for the same measures for returns on capital regulated in § 14 ARegV and § 7 StromNEV.*

> *Regulatory framework and regulatory practice designed to make underground cabling at the 110 kV level economically attractive for grid operators. This means amongst other things: ARegV (incentives regulation): No specification of a restrictive extra cost factor in the German Power Grid Extension Act (EnlAG) for extra costs incurred through underground cabling solutions 110 kV.*
> *German Federal Network Agency (BNetzA)-practice: Introduction of a procedure to establish resp. draft guidelines*

5.3.3 Extra high voltage (220 and 380 kV)

Laying underground extra high voltage cables is technically more complex, and is, therefore, currently more expensive. The higher cost factor for underground cabling for extra high voltage levels is higher than that for overhead lines at the 110 kV level.

Pilot projects for underground cabling at the 380 kV level are necessary to gather experience in construction and operation. The EnLAG pilot projects involving partial underground cabling should be used for this purpose. However, grid safety should not be compromised.

Experience gained from ongoing EnLAG pilot projects and international projects should be examined to determine whether, and to what extent, underground cabling could be relevant for other line construction projects. This includes investigation as to whether full underground cabling is a viable option. It is here that the legislator needs to provide binding stipulations.

Such projects must take account of minimum regulations on safe distances according to § 2 para.2 EnLAG, special nature protection issues (see chapter 6.3.1), and the entitlement to pass on extra costs according to § 2 para. 4 EnLAG. It may not be factually realistic from a nature protection standpoint to install underground cabling in some sensitive ecosystems such as moorland and wetlands. These require very intensive examination. In particular, underground cabling should not lead to deterioration of soil functions in soils especially worthy of protection or cause any lasting interference in agricultural use.

Key demands for new line construction at extra high voltage level:

Position A*

The German Power Grid Expansion Act (EnLAG) pilot scheme should be used for partial underground cabling.

Position B*

The German Power Grid Expansion Act (EnLAG) pilot scheme should be used for partial underground cabling. The EnLAG pilot scheme should be reviewed to see if it is suitable for full cabling.

* see list of signatories at the end of the document for each position.

Investigation based on EnLAG pilot projects and international project experience whether, and to what extent, underground cabling can be considered for other line construction projects, and mandatory stipulations determined by the legislator.

Complete recognition of all technologically related investigation, planning and implementation costs and investment in the grid costs.

5.4 Perspectives for transmission grids and new transmission technologies

European Overlay Network

In the short and medium term, Germany needs additional power line capacity at the extra high voltage level to transport excess RE mainly generated in the north of Germany at planned offshore installations and not required for regional demand, from there to the high demand areas in the south, southwest and west of the country. The overlay grid would be a dedicated long-range connection between large-scale projects and regions, but not replace the need for national grid expansion since transmission to inland regions, in particular, must remain secure. Long term route planning is essential for an overlay grid. This type of dedicated grid would allow the Europe-wide integration of RE and smooth out regional imbalances in power generation and consumption.

The EU has provided for cross-border planning and coordination in Art.22 of the 2009/72/EC directive regarding the drafting of a 10-year plan by transmission system operators. Apart from creating more competition and higher supply security, these grid development plans focus on RE grid integration.

The ongoing long-term planning at the association for grid operators, ENTSO-E, for a European super grid including an overlay grid to be in place by 2050, has not so far led to concrete legal provisions. These should, however, be made soon so that they can be added to the third internal energy market package.

The regulatory authority ACER and the advisory group regularly review the plans for the Europe-wide overlay grid. The results for the national planning phase should be incorporated into the EnLAG requirement plan immediately.

New transmission technologies

On the mainland, energy transmission lines mostly use three-phase alternating current (AC). However, the transmission distances for cross regional transmission using three-phase alternating current are very limited in comparison to direct current transmission if there are no compensatory installations. HVDC technology is more suitable for new systems where long distances need to be covered from the generating plant to the consumer. There has been some further development of HVDC technologies based on IGBT[13] respectively, on a

13) IGBT: insulated-gate bipolar transistor; semi-conductor module in power electronics

self-commutated basis (HVDC Light/Plus) directed at transmission capacities such as the conventional grid-led HVDC systems. HVDC is also an alternative for the connection of network systems (e.g. continental Europe/Scandinavia) and the connection to offshore wind farms.

HVDC has the following advantages:

- Low transmission losses (no conversion power loss and therefore no compensation requirement)
- Inverters in modern transistor technology can control, up to their nominal capacities of up to several 100 MVA, reactive power in the connected three-phase AC network.
- AC network decoupling (preventing short circuit transfer to several networks)
- Load flow control

HVDC has the following disadvantages:

- Inverter losses
- Transforming from one voltage level to another can only be done with three-phase AC
- High further development requirements for circuit breakers in direct currents (high currents can only be switched with alternating current – zero voltage switching)
- Embedding in an AC system makes AC/DC inverters necessary – with associated power loss.

In order to gain experience, the first German HVDC routes designed for several 1000 MW are to be realised in pilot projects as overhead lines, with the option of some partial underground cabling. 16.7 Hz alternating current (AC) technology also needs more research. Based on three-phase AC, it bridges longer distances in underground cables and can be designed as an overlay network. Via inverters, integration in 50 Hz network can take place at any point. It can enable direct feed-in into the railway power network, which works at a frequency of 16.7 Hz.

The extra costs involved as compared to conventional overhead line construction must be recognised by the German Federal Network Agency (BNetzA) and transmission grid operators must be able to pass these costs on to customers. Moreover, such projects must be government funded.

Key demands:

Assess the suitability of HVDC pilot project routes for underground cabling.

Assess the suitability of AC-16,7-Hz-pilot project routes with feed-in to the railway power network; look at and promote pilot projects in bi-polar AC technology and other technical alternatives.

Regular review of planning for pilot projects as part of an HVDC overlay network by the European regulatory authority ACER/ERGEG. Calculations must be available and transparent. Costs for construction should come largely from research funding.

HVDC routes should be included in EU network infrastructure planning according to Art.22 EU-Directive 2009/72/EC.

Chapter 6

Acceptance and environmental impacts

6. Acceptance and environmental impacts

6.1 Regional acceptance

It is important for people to understand that changes in the landscape will be unavoidable in the future, if the energy network is to be upgraded and priority given to RE in order to limit climate change, and as a result conserve the countryside as a whole. Planning and construction especially of high and extra high voltage overhead lines need to be carried out very carefully. Residents, local politicians, representatives of local initiatives and land owners must all be involved in planning at an early stage. Otherwise, there is a high risk that new lines will be rejected, and will be beset by objections and protests. This can lead to years of delay before construction takes place. Early involvement of all concerned reduces this risk.

The motives for criticism and concerns about such projects are manifold:

- Health risks due to increased electric and magnetic fields
- Spoiling the scenery with overhead lines
- Loss in value of property and land close to planned overhead lines
- Region becoming less attractive to tourists and having less recreational value especially for nature holidays
- Noise pollution in the direct vicinity and with specific weather conditions (humming, corona discharge)
- Dangers due to weather conditions – breaking ice, mast breakage, lightening

Environmentalists frequently oppose the construction of new overhead lines because of additional concerns from a nature protection standpoint. Their fears include:

- spoiling the countryside
- endangering birds if they land on the lines and receive electric shocks
- invasive measures in sensitive areas such as land clearance for route construction work
- dividing up habitats with new electric power lines; especially serious in bird reserves, national parks, biosphere reserves, nature parks and nature reserves.
- changes in the soil quality in moors and wetlands due to underground cabling

Planning, review and approval procedures are generally accomplished in two stages. The regional planning stage involves establishing one or more route corridors by the grid operator responsible for the project. The route corridors are then reviewed with regard to their compatibility with federal state planning. In a second stage, variations of all legally protected goods determined in the first regional planning stage, are considered in a public hearing upon request of those responsible for the project. Subsequently, the authorities decide on an optimised route corridor with the least possible degree of invasiveness.

However, the example of 480 km of new construction in Lower Saxony, shows that these planning procedures do not always achieve the desired level of acceptance if not all possible geographical and technical variations are considered and planning adequately justified.

Health risks due to electric and magnetic fields around high and extra high voltage overhead lines

One of the main reasons for residents campaigning against new overhead lines is their concern about health risks from electric and magnetic fields surrounding transmission lines. Planning for new lines complies with the limit value of 100 microtesla for low frequency magnetic fields stipulated in the 26 regulation of the German Federal Immission Control Act (26 regulation BImSchV). Nevertheless, despite compliance with the 26 regulation, concerns of local residents are based on more recent research findings regarding health risks, and on more stringent regulations in other countries. Since the implementation of the 26 regulation BImSchV in 1997, research has revealed an increased risk of childhood leukaemia even at a much lower permanent exposure level than stipulated. However, research has not been able to explain the biological correlations.14 The WHO classifies this as a matter of concern.

Nevertheless, in July 2010 the German Federal Administrative Court confirmed the current exposure limits stipulated in the 26 regulation BImSchV, and established that with due compliance to this limit, there is no danger to health from electric and magnetic fields.

[14]) Recommendation of the International Commission for Radiological protection (2008): Protection from electric and magnetic fields in the electric power supply and application, p. 18

[15]) German Federal Administrative Court - BVerwG 7 VR 4.10 of 07. July 2010, Download http://www.bverwg.de

Some countries have already reacted to further evidence of possible health risks and amended their applicable exposure values with preventative limits or regulations. One simple way of implementing preventative measures is with appropriate formulation in planning directives.[16]

This approach should be pursued in Germany. When weighing the interests of legally protected goods in the approval procedures, health protection for local residents should be strengthened by due consideration of prevention. Prevention requirements can most easily be met by minimum safety distance stipulations e.g. those developed for the Lower Saxony state planning programme 2007 and those contained in EnLAG

Key demands:

Position A*
Improve legal protection for people in the approval procedures for new high and extra high voltage overhead lines by having regulations on safe distances together with compensation models (see for example, the regulation on safe distances for extra high voltage lines in the German Power Grid Expansion Act (EnLAG))

Position B*
Improve legal protection for people in the approval procedures for new and upgraded overhead lines by having regulations on safe distances (400 metres in urban areas / 200 metres in outer areas)

Position A*
Review and, if necessary, redefine the 26 regulation of the German Federal Immission Control Act (26 regulation BImSchV) by adding a precautionary limit for electromagnetic fields in residential areas. The precautionary limit should be based on current research and will improve legal protection for people in the approval procedures.

Position B*
Review 26 regulation of the German Federal Immission Control Act (26 regulation BImSchV) with regard to a precautionary limit for EM fields in residential areas as a preventive measure as e.g. in the Netherlands and Switzerland.

* see list of signatories at the end of the document for each position.

[16]) cf. Overview of international precautionary regulations in: Recommendations of the International Commission on Radiological Protection: Protection from electric or magnetic fields in the energy supply and application, p. 26

Acceptance and environmental impacts

Implementation of suitable measures to minimise exposure to EM fields in consultation with the people concerned

Reduction of magnetic fields through optimal phase and system configuration and, if necessary, using appropriate pylons

Landscape

Residents and environmentalists oppose any negative impacts on the countryside and using up high amounts of land. In particular, 380 kV overhead lines have pylons 50 to 60 metres high that are visible for miles on the plains. A hilly or undulating landscape is often perceived as more attractive than flat countryside so that overhead lines are seen as more disruptive in these areas despite being much less visible.

Besides the height of the pylon, the choice of pylon is an important factor to be considered for the landscape (e.g. single level pylon). Using different pylon types must be considered in regard to how they fit into the landscape (e.g. with the help of visualisation programmes). Using higher pylons leads to substantial difficulties where stretches of water need to be crossed because they adversely affect the landscape. They are also a danger to migrating birds (see chapter 6.3). Lower pylons are always preferable for aesthetic reasons.

Bundling infrastructure measures means that there is an accumulation of different structures such as motorways, high-speed railway lines and (existing) extra high voltage overhead lines that then become a concentrated burden on a region and the people living there. This is in essence sensible, but where further projected infrastructure expansion is required, the interests of local residents must be considered to a far greater extent.

If underground cabling is not possible, regional acceptance can be increased by using optically adapted types of pylon and phase and system optimisation measures to minimise electromagnetic radiation fields. A further measure during planning may be the possible discontinuation of old routes, and thereby ensuring mitigating effects elsewhere. There must be careful examination of where, and to what extent, existing lines can be discontinued when new lines are being planned.

Key demands:

Application of the bundling principle with due consideration of mandatory national regulations on distance from the power line routes to housing in built up areas (legally binding land use plan), and in development areas for projected new homes.

Use of new routes for optimised landscaping, e.g. discontinuing 110kV lines and thus disburdening some areas/ residential districts

Loss in value of land and property near overhead power lines

Land and property owners and users are increasingly finding it unfair that with compulsory purchase of land that is needed for services such as electric power lines, compensation is one-off and only a small percentage of the market value of the properties. Where easements are in place, land used for agricultural purposes is regularly subject to loss of value that is not sufficiently offset by compensation. This is true for, amongst other things, a possible loss of market value (reduced chance of finding a buyer), restrictions on building, consequential long-term agricultural damage, the likelihood that the land will be acceptable as collateral, an increase in liability risk and less chance that it will be designated as lucrative land for development either for businesses or housing.

To compensate these disadvantages, the legislator, within the framework of its assessment mandate according to Art. 14 para. 3 of the German constitution, should review the principle governing compensation policies and adopt sector-specific new compensation policies according to § 45 EnWG or adopt new regulations in compensation laws.

Key demand:

Review current compensation regulations for future easements. These should where necessary be re-formulated within the framework of § 45a EnWG

6.2 Planning high and extra high voltage power lines

The future energy system based on RE, requires comprehensive upgrading of the grid in order to take up energy at any time and secure the necessary power supply where it is needed. Therefore, it is crucial to have an EU-wide basic concept for energy production, energy storage, and the required grid capacities for energy transport (cf. chapter 5.4). This concept must be augmented by plans made at the federal state level. Federal state level plans should be made in consultation with facility operators, and include possible regional expansion scenarios for RE along with prerequisite distribution grid expansion. In addition, energy storage options should be included. At a long-term national and European planning level, corridors should be identified and be available for power lines crossing such large areas.

Additional technical power line construction is vital in order to secure the necessary energy capacities for all the regions where it is needed. Necessary grid expansion is not self-explanatory, it requires a public campaign to clarify the interrelationship of grid expansion, the future energy system based on RE, storage and the grid. As with all infrastructure projects, disclosing planning data is not only essential for the specialised authorities, but also for public acceptance. Local residents, in particular, must have the chance to understand the plans. It is crucial to have early awareness and understanding, information exchange and involvement before the official opening of procedures. This dialogue should include all those concerned, people affected by the changes, public campaign groups and nature protection organisations. Common solutions can be found through consultation – in individual cases maybe with the help of a mediator. This kind of approach can help to incorporate and use any special knowledge that environmentalists, volunteers or even just local people often have. The more the project becomes transparent, the greater the chances for constructive and wide-ranging discussion which will greatly improve local acceptance in individual cases.

In order to guarantee legal clarity and safety, there must be no shortening of the legal process and no waiving of regional planning procedures or approval procedures. The well-proven, multi-stage planning, reviewing and approval procedures form the basis for thorough legal assessment. Consultations with all those concerned are of immense importance. This is true not only for nature protection organisations but also for local residents and citizens' action groups.

Coordinated departmental and cross-national project planning for extra high voltage routes is already indispensable at the forefront of regional planning. It should include a strategic environmental assessment and be carried out according to the § 13 ROG (German Regional Planning Act) of the regional planning regulation at the preparatory planning stage. It should name the interests and concerns of participants (grid operators, countries, public bodies, local communities, citizens etc.) and discuss alternative sites and technical solutions. The aim of this preparatory process is, within a short period, to conduct preparatory discussions on basic conditions, information requirements and planning alternatives. At the same time, the focus should be on progressively reducing problems. The results of this public process, which may, depending upon the size of the project, take 6 to 9 months, should subsequently be included in regional planning procedures and be published with application documents. The master plan should simplify the establishment of an investigative framework, reduce complexity and accelerate the preparation of application documents, as well as promote a rapid completion of procedures. Overall control for the process will lie with the planning authorities of the largest country in terms of surface area. The departments of regional planning, environment, energy and economics should all be involved. The aim is to examine and determine preferably all the interests of the different players and all concerned in a comprehensive and transparent process before actual designation of route variations. External mediation is conceivable. In Lower Saxony, this kind of cross-departmental approach has already assimilated initial experience that could provide stimulus for future procedural processes.

Additionally, Lower Saxony has had positive experience in using the internet to involve the public in regional planning. This method is being tested and refined in the regional planning process for the Wahle-Mecklar grid expansion project. The extra cost and effort is well worth the gain in ways of direct participation as well as transparency and evaluation of the views brought forward. Communities have direct interactive access to the planning areas that affect them and can give their views on planning very directly. This increases the chances that objections are more substantial. Geospatial information systems (GIS systems) are a further requirement to inform decision making.[17]

Such systems display all the relevant data on a map of the planning area. More importantly, they are always up to date. Finally, using the internet for these procedures means that large amounts of data can be processed more rapidly at several places at the same time. Implementation of planning improvements is faster as is completion of procedures.

[17]) GIS systems capture, process, organise, analyse and present geographic data. GIS systems comprise the required hardware, software, data and applications.

Planning Guidelines

The planning, review and approval procedures for new extra high voltage lines, in particular regional planning, are managed very differently in the individual German federal states. Each federal state has different requirements for procedures. Nevertheless, different kinds of management should not be allowed to make national grid planning more difficult. Model guidelines must ensure this does not happen.

The German Environmental Impact Assessment Act (EIA) is the basis for environmentally compatible project design. Planning guidelines for the optimal design of overhead lines have been developed by an EU model project for the ecological management of route corridors. This model project has integrated approach and comprises systematic methodology with the planning and choosing of design options for overhead line construction, maintenance as well as promotion of acceptance. It takes into account aspects as diverse as regional planning, route technology, nature protection and social concerns as well as conditions in the area close to the route. It is therefore an instrument with which both route operators and planning institutions can work together with all the interest groups concerned to compile suitable management options. It further enables the choice of situation-oriented management options and allows resulting conflicts of interest to be resolved in a timely manner.

These planning guidelines can be applied to both planned as well as existing overhead lines. They serve efficient grid operation according to ecological demands.

Based on the methodical process as well as on goals and guidelines, choices can be made from a pool of possible management options (biotope goals) which are based on objective data regarding suitable measures for specific route corridor situations. These choices can be assigned to planning within the framework of a transparent weighing up of priorities of interests.

Aims and guiding principles of the ecological corridor management project

Table 2

Aims	Guiding principles
• No impairment of transmission security	• Take safety-related technical standards into account
• Minimally intrusive corridor construction	• Land clearance minimisation • Time-dependent clearance • Ecologically compatible clearance measures
• Suitability for the location and sustainable development	• Location-oriented development goals • Full utilisation of natural processes (succession) and potential (biotopes)
• Protection of endangered natural environments	• Site status and species protection status • Habitat and biotope connection
• Function-oriented consideration of social goals	• Take site protection categories and woodland functions into account
• Promotion of regional development and due consideration of user-generated demands	• Route corridor management in consultation with site owners (synergy effect) • Site and time-oriented reconciliation of interests, identify and involve land users

In principle, this approach using decision models and aids based on a module system comprised of management options can be augmented and relevant to all German and European Union landscapes. The planning and approval procedures constitute the prerequisites for the integration of planning guidelines for new route corridors and improving their efficiency. Application of these planning guidelines is demonstrably less expensive than the traditional clearance of route corridors (e.g. through deforestation) and can possibly lead to higher acceptance.

Acceptance and environmental impacts

Key demands:

EU-wide coordinated basic concept for grid expansion (EU grid expansion plan based on strategic strategic impact assessment) ENTSO-E, 3 EU internal energy market package

Transparency in procedures, timely information and participation in regions as well planning routes according to, amongst other things, understandable ecological criteria. Before the official opening of procedures, draft an informal master plan dedicated to finding a route, with the participation of all concerned.

Regular disclosure of standardised planning data (e.g. according to the German Federal Network Agency, BNetzA) and verifiable justification for plans by third party experts in the procedure as evidence for the energy-economic necessity of projected line construction.

Online publication of planning documents with access for all, consistent GIS application and, if necessary, expert guidance at administrative district and community level to accelerate procedures and secure transparency

Overall responsibility for national projects should lie with the federal state that is most affected and be based on consistent guidelines e.g. projected development of master plan guidelines to standardise regional planning and approval planning of the federal states.

Sites hugely important in terms of nature protection must be treated separately (see chapter 6.3.1, Table 3). Where there are no other site planning alternatives, underground cabling is the proper solution in these areas. However, it is imperative that there is no underground cabling in sensitive areas such as moors or wetlands.

Greatest possible use of potential, to optimise overhead line routes in ecological terms. The ecological corridor management project provides the required guidelines.

Explain the necessity of grid expansion and new storage facilities for upgrading the energy system in a public information campaign.

6.3 Nature protection

6.3.1 Protection of nature and landscapes

Power lines not only endanger birds, they also always have an impact on nature and landscapes. They are therefore subject to a commitment to minimisation of adverse environmental impacts. Nevertheless, power lines always have some environmental impacts that are unavoidable. Consequently, they entail compensation demands resulting from the use of sites and impairment of the effectiveness and functional ability of ecosystems as well as impacts on the landscapes. Where sites designated in Natura 2000 are impacted by new power lines, then according to § 34 BNatSchG (German Nature Conservation Act), all effort must be concentrated in the course of a compatibility investigation to avoid this site and search for alternatives. Equally, access prohibitions relating to special species protection according to § 44 BNatSchG must be taken into account in route planning.

Apart from their impact on birds, power line routes must be critically reviewed for their impact on: stretches of water resp. inshore waters and water meadows, wetlands (especially in the sense of Ramsar), Natura 2000 sites, natural monuments and world heritage sites as well as historical and harmonious cultural landscapes. The same is true for all nature protection sites, national parks and biosphere reserves. Wherever possible none of these areas should be touched. For reasons relating to the conservation of cultural landscape uniqueness, areas of outstanding importance for nature protection should be considered on an individual basis. These are most notably sites protected according to §§ 21 to 30 in the German Nature Conservation Act (BNatSchG)[18]. Generally, power line routes can be planned in these kinds of protected areas. However, they are subject to special legal requirements and have special importance in the consideration of route or construction variations. Protected areas cannot be adversely affected by change and are regularly paramount in considerations.

[18]) BNatSchG (German Nature Conservation Act): § 21: Biotope interconnection, § 22: Declaration on the protected parts of nature and landscape; § 23 Nature protection sites; § 24 National parks, National natural monuments; § 25 Biosphere reserves; § 26 Protected landscapes; § 27 Nature parks; § 28 Natural landmarks; § 29 Protected features of landscapes; § 30 Legally protected biotopes

The following table shows which areas nature protection issues ordinarily (left-hand column) have priority or possibly (right-hand column) have priority in new overhead power line planning:

Test criteria for overhead power line planning regarding nature and landscape protection

Table 3

Legally protected natural resources	**Ordinarily** - sites where nature protection issues ordinarily have priority	**Possibly** - sites where nature protection issues possibly have priority
Animals and Plants	• Natura 2000 sites • Ramsar sites • national or nation-wide significant breeding grounds for birds • international, national or nation-wide significant bird rest sites or overwintering sites • Zones I and II in biosphere reserves • nature protection areas • national parks • natural monuments • nature preserves that are designated for bird protection	• stretches of water and inshore waters • lowlands and water meadows • wetlands • regionally significant breeding grounds for birds • regionally significant bird rest sites and overwintering sites • Zone III in biosphere reserves • natural, near-natural and naturally managed forests • legally protected biotopes (§ 30 BNatSchG) • specially protected biotopes
Landscapes and recreation	• nature preserves for the preservation of special landscapes • extensive natural landmarks	• nature preserves • nature parks • historical and harmonious cultivated landscapes and wide views • large river plains • inshore waters and water meadows
Cultural and material resources	• world heritage sites	

Essentially, planning for underground cabling involves reviewing and taking into account the same aspects and negative environmental impacts that apply to planning for overhead lines. However, as a rule there are less, or even positive environmental outcomes for the individual legally protected resources. Investigations into whether breeding or rest sites for specially protected species might be destroyed, must be particularly thorough because underground cabling construction involves disturbance of greater areas of land in comparison to overhead line construction. Further, it is fundamentally essential to bypass nature protection sites such as moors and wetlands where there are sensitive ecosystems. Planning must ensure that there are no hydraulic or hydrological changes and no negative impacts on the soil water balance at sites affected peripherally, or where stretches of water or hydraulically relevant sites need to be crossed.

From a nature protection standpoint, underground cabling is often the better solution in comparison to overhead lines. In general, the view is that impacts on nature are less serious.

However, there are some possible adverse effects on agricultural land usage especially during the construction phase, which may lead to yield losses. This is above all due to possible damage to soil structure, heavy vehicles driving on the site, mixing topsoil and subsoil, interrupting pre-flooders and drainage as well as heat produced by the cables.

Key demands:

Use the named criteria for the choice of route and do not neglect or disregard sites categorised as "ordinarily" or "possibly" in planning (see Table 3) in order to largely avoid conflicts arising from nature protection issues. This will speed up route construction.

Standardisation in all German federal states of all criteria applicable to underground cabling and overhead lines.

Establish long-term and standardised monitoring along routes; examine and document impacts on nature, landscape and soil.

Avoid damage to soil structure and functions by using methods least likely to cause damage when installing underground cables. Restoration of soil functions on completion of installation work. Keep invasive measures to a minimum during the installation phase.

6.3.2 Hazards for birds

Overhead lines are a major hazard to birds mainly because of

- landing/perching on the lines,
- electrocution from medium voltage lines and
- burns and shocks when line temperatures are > 80°C.

Most incidents involving birds happen when they collide with earth conductors installed at the top of pylons. This mostly affects migratory and resting birds with slow close-up reaction times due to poor three-dimensional eyesight. When migrating birds encounter overhead power lines they may get into critical situations due to specific topographical features (rest sites, stretches of water or streams and rivers or a higher number of birds flying closer together due to geographical relief etc) or specific weather conditions (fog, headwinds etc.). There is documentation providing evidence of not only single birds colliding with overhead lines but also of small and large flocks. Newly developed markers can reduce the collision risk. Black and white markers provide particularly effective protection and have the greatest signalling effect (e.g. for birds migrating in flocks). Further development of such measures will be provided by concomitant studies.

Protection of birds from electric shocks on medium voltage overhead power lines is regulated in the German Federal Nature Conservation Act in § 41 BNatSchG (until now § 53 BNatSchG) of 29.07.2009. According to the German Federal Nature Conservation Act, all dangerous pylons erected before 2002 must be modified by 31.12.2012. All new medium voltage pylons erected since 2002 must be constructed so that they do not endanger birds. Possible solutions are, in particular, suspended insulators, suitable positioning of insulators on the pylon to avoid short-circuiting, extending linear length of the metal extension rod and insulation of all voltage carrying parts. The situation regarding birds landing on power lines with temperatures of > 80°C is so far unclear. It is possible that the increasing corona effect (> 180 kV) at higher temperatures deters birds from landing. The connection between high temperature lines and their effect on birds has not been sufficiently researched. Better marking of the overhead earth wires counteracts the risk of collision.

- **Low voltage level (< 1 kV):**
  There is no danger of electrocution.

- **Low and medium voltage levels (> 1 kV up to 60 kV):**
  This is potentially and evidently very dangerous for large birds. They are at risk of electrocution. This is true for white storks and black storks, as well as all birds of prey, owls and corvids that perch on pylons or use them as rest and roosting places. There is a remaining danger of birds colliding with overhead lines and being burnt when line temperatures are > 80°C. These risks must not be disregarded.

Key demands:

Priority for underground cabling in new power line construction - overhead lines will always carry a potential risk for birds due to electric shocks and because they land on transmission cables (cf. 5.3.1).

Implement without exception all bird protection measures according the German Federal Nature Conservation Act (§ 41 BNatSchG), when pylons are restructured or replaced.

Transmission cables must not exceed temperatures of 80°C.

- **High voltage level (110 kV):**
  The risk of collision is high. However, there is no risk of electrocution. Birds cannot trigger earth or short circuits. There is a risk of burns at temperatures > 80°C. Small and medium sized birds like to perch on medium voltage transmission cables.

Key demands:

Preference should be given to underground cabling in all new cable construction work. Exclusion of problematic areas if there is an exception and overhead lines are built.

When construction work or cabling is carried out, fit earth conductors with bird protection markers (the best ones are black and white markers because of their proven signalling effect) according to the concept developed by bird protection associations. This is to reduce bird fatalities due to birds landing on the cables.

Initiate pilot projects to clarify whether birds are deterred from perching on transmission lines when the transmission line temperature is higher than 80°C, and whether this might be due to an increasing corona effect.

When choosing pylon types, take into account that birds collide less often with single level pylons.

- **Extra high voltage level (≥ 220 kV):**
  There is a high risk of collision and of electric shocks. Transmission cables with temperatures > 80°C carry less risk as birds appear to avoid these cables due to the strong alternating current fields. This does not apply to HVDC transmission lines.

Key demands:

Fully fit earth conductors with markers to reduce bird fatalities due to them landing on cables. The distance between the markers should be oriented to the sensitivity of each individual region. Seek alternative solutions for overhead power lines if there is increased hazard potential.

When choosing pylon types, take into account that birds collide less often with single level pylons.

HVDC power transmission lines should not exceed temperatures of 80°C so that birds do not sustain burns and die as a result. With HVDC, there are no alternating fields and therefore no corona effect. Monitoring transmission line temperature in HVDC pilot projects is necessary in order to research the effects that higher temperatures have on birds.

Chapter 7

Legal Framework

7. Legal Framework

The current legal framework would need radical changes to accommodate the solutions recommended in Plan N. New regulations are necessary for acceptable grid expansion planning in terms of regional planning and nature protection, especially in the energy policies set out in the EnWG, EEG and other subordinated regulations such as ARegV, in addition to planning, environmental and nature protection legislation. It is not the intention of Plan N to draw up a legal framework aimed at lessening conflict within society on the issue of grid expansion for the integration of RE. Nevertheless, different measures that can only be realised with concrete legal amendments have been set out in the preceding chapters. These amendments are described in chapters 3 to 6.

Besides changes in the legal framework, other measures are needed to secure and support the integration of RE in future:

Support programmes, research and other measures

- Market launch programmes for smart meters based on the results of the E-Energy Research Project
- Support programmes for electricity providers for load transfer
- Field study on the modification of the standard load profile
- Research funding programmes for innovative storage concepts
- Research projects for test routes for sections of a European overlay network based on technical innovations such as HVDC/AC-16.7 Hz, bipolar alternating current technology or other technical alternatives
- Public information campaign on the interrelationship of regenerative energy systems, grid expansion requirements and storage facilities
- Cable route monitoring to test the effects of high and extra high voltage underground cables have on nature, the landscape and the ground.
- Support for pilot projects with an associated scientific background to clarify whether the increasing corona effect in 110kV cables that have temperatures of > 80°C deters birds from landing on them.
- Monitor HVDC projects with high temperature cables to research the effects that higher temperatures have on birds.
- Mark ground wires of new high and extra high voltage power lines.

Chapter 8

Facilitating grid expansion – solutions and approaches

8. Facilitating grid expansion – solutions and approaches

Essential grid expansion touches upon very different areas of society and brings with it a need for consistent political awareness and vision along the way to a new climate friendly energy system. Further, it means that many different interests need to be taken into account, for instance, the interests of residents living close to new power lines and nature protection issues. Energy policy targets need to be brought in line with regional planning targets and any damage to interests may need to be re-examined and compensated. There are positive approaches to all these problems at all levels, regional, national and international.

Some of these groundbreaking approaches are set out here with the intention of stimulating further debate:

Example 1:

Transparent procedures and coordinated cross-departmental planning in Lower Saxony

After publication of the requirements regarding grid expansion for wind power in the dena Grid Study I and conflicts in the region along the projected routes, all the departments involved decided on a coordinated cross-departmental planning and conflict resolution, a common strategy and public information campaign. This also included joint research on grid optimisation and transmission technology as well as joint transparent outreach work, for instance, via the website www.netzausbau-niedersachsen.de. The legislative consequences of the Lower Saxony law on underground cables demonstrated the need for legislative reforms to national policy. EnLAG was unable to resolve the conflicts but could nevertheless instigate a solution-oriented process.

Within the framework of this process, technological measures for grid optimisation, for instance, the use of temperature monitoring and high temperature lines by transpower power transmission GmbH (now TenneT TSO GmbH, then E.ON Netz) were implemented with the aim of minimising grid expansion.

Example 2:

Participation and transparency

At the start of the regional planning procedure for the projected Wahle-Mecklar power route, the responsible body transpower stromuebertragungs GmbH (now TenneT TSO GmbH, then E.ON Netz) provided unrestricted access to planning documents that were formulated in an understandable way on a website specially set up for this purpose. Responses and comments could be made online. In addition, the documents were presented at eight regional information events in June 2010 in Lower Saxony and Hesse. Altogether, these measures led to a higher degree of transparency for the general public than had ever been achieved before.

Example 3:

Central planning by government-owned network operator in Denmark

Since 2008, the government-owned network operator Energinet.dk has managed an ambitious network expansion process with extensive underground cable planning. Its aim is to meet the demands required by wind power expansion whilst ensuring the countryside remains attractive for the tourist industry. Central and politically-led expansion planning stipulating transmission technology ensures a consistent, rapid and innovative expansion process which includes the interests of residents living nearby.

Example 4:

Measures to reduce EM fields in The Netherlands

In the summer of 2010, in The Netherlands close to a residential area, the transmission system operator TenneT installed pylon and power line types that reduce the EM fields of the new extra high voltage lines as part of the Wintrack project. This measure could only marginally increase regional acceptance but does take preventative health issues seriously and contributes to the protection of residents living nearby.[19]

Example 5:

Negotiations on compensation for communities and residents living nearby the planned Salzburgleitung 2 (Salzburg power line 2) in Austria

Negotiations on compensation for affected local communities and landowners were held during the planning stages of the extension of the Austrian extra high voltage network around Salzburg. Financial compensation can be appropriate in view of adverse regional effects.[20]

19) http://www.tennet.org/english/projects/wintrack/index.aspx

20) http://www.salzburgleitung.at/de/81_302.htm

Example 6:

Grid expansion measures adapted to suit local conditions increase acceptance

In regions where there is less infrastructure it may be possible to compensate adverse effects due to new extra high voltage lines by combining these with new communications infrastructure such as DSL lines as, for instance, discussed in Thuringia.

Example 7:

Successful cooperation between the town of Plettenberg and the regional network operator SEWAG in the construction of a 110-kV-underground cable

In the town of Plettenberg in the Sauerland region, a 110 kV overhead power line originally planned as an overhead line was laid underground after extensive cooperation between the regional network operator and the town authorities in consultation with scientific advisors. The expected extra costs for the underground option were actually reduced due to intensive consultation and cooperation of the participants. This involved choosing a shorter route section, putting the extensive knowledge of the local area and first-class engineering knowhow of the town civil engineering department to good use.

Example 8:

110-kV-underground cable from Altenstadt to Büdingen in the OVAG network area in Hesse

After much contention between the network operator and environmentalists, a stretch of eight kilometres of 110 kV underground cabling was laid in the OVAG network area in the summer of 2010. The extra costs for this option were divided up between the administrative district, the local authorities and the network operator. This meant that court proceedings were avoided but also led to a strengthening of bird protection in the FFH area and protection of the landscape.[21]

Example 9:

Bird protection measures according to VDE directives

Overhead power lines at the medium voltage level pose a great risk for birds. In the meantime, modification and refitting the still existing overhead lines has been adopted in German national legislation according to BNatschG provisos in VDE directives drawn up by environmentalists. This is a good example of how environmentalists should be involved in further grid expansion measures.

Example 10:

Nature protection using open countryside conservancy as an example

The conservation of the countryside along overhead power lines benefits from integrating nature protection issues into grid planning and route maintenance in an exemplary way:
In the networks operated by Amprion and RWE Rheinland-Westfalen Netz AG there have been continual improvements in the biotopes along the existing power routes since 1992. These improvements relate to stretches of woodland and are contained in the so-called biotope management plan without exception.

The 50Hertz Transmission GmbH has a concept for ecological route corridor management that was specially developed for new routes. Both approaches have the same goal.

Special species protection measures are for instance, put into practice in the RWE Rheinland-Westfalen Netz AG network area, where alterations were made to disused buildings formerly used for housing transformers to make nesting places for eagle owls. In the 50Hertz-network area measures have also been implemented to provide nesting places for storks and eagles.

Example 11:

Moderation procedure between participating interest groups

Discussions on grid upgrading to integrate fluctuating RE are only just starting. They need to have a place in all parts of society in order to raise awareness of the necessity for upgrading our energy systems and have climate friendly energy production. The Forum for the Integration of Renewable Energy have led this process in an exemplary way.

Example 12:

German government's E-Energy-Programme

The joint support programme initiated by BMWI and BMU "E-Energy: ICT-based energy system of the future" has gained international recognition. It arose from technology competition and gave new technical and ecological impulses in six model regions for a changing and increasingly decentralised resp. regenerative energy system.

[21]) http://www.ovag.de/iqshare/ovag-netz.nsf/c/Unternehmen,Presseinformation, Informationen?open&P1=1E0683CEF9CCCA21C125774C00322AAC
http://www.bund.net/fileadmin/bundnet/publikationen/klima/20100729_klima_energie_erneuerbare_energien_stellungnahme_stromspeicherung.pdf; S. 6

Chapter 9

List of signatories

Position A

EnLAG pilot projects 220/380 kV
The EnLAG pilot projects should be used for partial underground cabling.

Regulations on safe distances
More prominence of legal protection for people in approval procedures for new high and extra high voltage overhead power lines with regulations on safe distances and compensation schemes

26 regulation BImSchV
Review and, if necessary, redefine the 26 regulation BImSchV by adding a precautionary limit for EM fields in residential areas based on current research.

Position B

EnLAG pilot projects 220/380 kV
The EnLAG pilot projects should be used for partial underground cabling. The EnLAG pilot scheme should be reviewed to see if it is suitable for full cabling.

Regulations on safe distances
More prominence of legal protection for people in approval procedures for new overhead power lines and the power lines that are to be upgraded by introducing regulations on safe distances (400m within built up areas/ 200m outside built up areas).

26 regulation BImSchV
Review of the 26 regulation BImSchV with the aim of adding an EM field value as a precautionary measure for nearby residential areas according to the Swiss and Dutch models.

■ Position A
■ Position B
■ Neutral

Companies	EnLAG pilot projects 220/380 KV	Regulations on safe distances	26 regulation BImSchV
Agentur für Erneuerbare Energien, (Agency for renewable energy), Jörg Mayer	Neutral	Neutral	Neutral
Bosch & Partner GmbH, Dr. Wolfgang Peters	Position B	Position A	Position A
Cisco Systems GmbH, Dr. Frank S. Robert	Position A	Position A	Position A
Deutsche Energie-Agentur GmbH (dena), (dena, German Energy Agency), Annegret-Cl. Agricola	Position A	Position A	Position A
Elektrizitätswerke Schönau Vertriebs GmbH, (Electricity provider), Ursula Sladek	Position B	Position B	Position B
Enercon GmbH, Ruth Brand Schock	Position B	Position B	Position B
EWE NETZ GmbH, Torsten Maus	Position A	Position A	Position A
First Solar, David Wortmann	Neutral	Neutral	Neutral
Geo mbH, Wilfried Voigt	Position B	Position B	Position B
GreenMediaNet. Medienbüro für ökologisch tragfähige Entwicklungen, (Media agency for ecological developments), Dr. Corinna Hölzer	Neutral	Neutral	Neutral
Greenpeace Energy eG, Marcel Keiffenheim	Position B	Position B	Position B
juwi Holding AG, Dr. Karsten Glöser	Neutral	Neutral	Neutral

■ Position A
■ Position B
■ Neutral

	EnLAG pilot projects 220/380 kV	Regulations on safe distances	26 regulation BImSchV
OECOS GmbH, Prof. Dr. Karsten Runge	Position A	Position A	Position A
projekt21plus GmbH, Trudel Meier-Staude	Position B	Position B	Position B
ReEnergie Wendland, Dieter Schaarschmidt	Position B	Position B	Position B
SMA Solar Technology AG, Günther Cramer, Dr. Bernd Engel	Neutral	Neutral	Neutral
Vattenfall Europe Windkraft GmbH, Dorit Rößler	Position A	Position A	Position A
wpd think energy GmbH & Co. KG., Jochen Weidenhausen	Position A	Position B	Position A

Organisations, Registered Associations and Initiatives

	EnLAG pilot projects 220/380 kV	Regulations on safe distances	26 regulation BImSchV
Bioenergieregion Bodensee, (Bio-energy Lake Constance), Volker Kromrey	Neutral	Neutral	Neutral
Bodenseestiftung, (Lake Constance Foundation), Marion Hammerl	Neutral	Neutral	Neutral
Botanische Vereinigung für Naturschutz in Hessen, (Botanical association for nature protection in Hessen), Dr. Jörg Weise (subject to the veracity of the dena-I-Study)	Position B	Position B	Position B
Bundesverband Erneuerbare Energien, (German Renewable Energy Federation BEE), Harald Uphoff	Neutral	Neutral	Neutral
Bundesverband Kraft-Wärme-Kopplung e.V., (Federal registered association for combined heat and power generation), Adi Golbach	Neutral	Neutral	Neutral
Bundesverband Solarwirtschaft, (Federal registered association for the solar industry), Carsten Körnig	Position B	Position B	Position B
Bundesverband WindEnergie e.V. (BWE), (Registered Federal association for wind energy), Georg Schroth	Position B	Neutral	Neutral
Bündnis 90/Die Grünen, Kreisverband Barnim, (Green party regional association), Karl-Dietrich Laffin	Position B	Position B	Position B
BI Delligsen in der Hilsmulde e.V., (Registered action group in Delligsen), Heinz-Jürgen Siegel	Position B	Position B	Position B
BI Hochspannung tief legen, (Registered action group campaigning for underground cabling), Dr. Rainer Schneewolf, Clemens Wehr	Position B	Position B	Position B
BI Keine 380.000 Volt Freileitung im Landkreis Hersfeld-Rotenburg e.V., (Action group against 380 kV overhead power lines in the Hersfeld-Rotenburg region), Ralf Wassermann	Position B	Position B	Position B
BI Keine 380 kV-Freileitung im Schwalm-Eder-Kreis, (Action group against 380 kV overhead power lines in the Schwalm-Eder region), Bernd Kördel	Position B	Position B	Position B

■ Position A
■ Position B
■ Neutral

	EnLAG pilot projects 220/380 kV	Regulations on safe distances	26 regulation BImSchV
BI Keine 380-kV-Freileitung im Werra-Meißner-Kreis e.V., (Action group against 380 kV overhead power lines in the Werra-Meissner region), Klaus Rohmund	Position B	Position B	Position B
BI Pro Erdkabel NRW, (Action group for underground cabling in North Rhine-Westphalia), Gaby Bischop	Position B	Position B	Position B
BI Schönefeld, (Action group in Schoenefeld), Ingo Uhrmann	Position B	Position B	Position B
Deutsche Umwelthilfe e.V., (German environmental aid), Rainer Baake, Dr. Peter Ahmels	Neutral	Neutral	Neutral
Deutsche Umweltstiftung, (German environmental foundation), Jörg Sommer	Neutral	Neutral	Neutral
Deutscher Bauernverband, (German farmers' association), Dr. Helmut Born	Position A	Position A	Position A
Deutscher Verband für Landschaftspflege, (German association for landscape conservancy), Josef Göppel	Position B	Position B	Position B
Deutscher Städte- und Gemeindebund, (German town and community association), Simon Burger	Position B	Position B	Position B
Deutsches Institut für Wirtschaftsforschung, (German institute for economic research), Prof. Dr. Claudia Kemfert, Wolf-Peter Schill	Position A	Position A	Position A
Fachhochschule Erfurt, (University of applied sciences), Prof. Erik Findeisen	Position B	Position B	Position B
Fraunhofer-Anwendungszentrum für Systemtechnik, (Fraunhofer Applications Centre for Systems), Dr. Peter Bretschneider	Position A	Position A	Position A
Germanwatch, Christoph Bals	Neutral	Neutral	Neutral
GENI - Gesellschaft für Netzintegration e.V., (Registered association for grid integration), Stefan Brune	Neutral	Neutral	Neutral
GFN - Gesellschaft für Freilandökologie und Naturschutzplanung mbH, (Association for open land and nature protection), Jörg Rassmus	Position B	Position B	Position B
GNF - Global Nature Fund, Udo Gattenlöhner	Neutral	Neutral	Neutral
Heinz Sielmann Stiftung, (Heinz Sielmann Foundation), Michael Spielmann	Neutral	Neutral	Neutral
Helmut-Schmidt-University, Universität der Bundeswehr Hamburg, (Armed forces university Hamburg), Prof. Dr. Detlef Schulz	Position A	Position A	Position A
Hessische Gesellschaft für Ornithologie, (Society for Orthnithology in Hessen), Wolfram Brauneis	Position A	Position A	Position A

- Position A
- Position B
- Neutral

Signatory	EnLAG pilot projects 220/380 KV	Regulations on safe distances	26 regulation BImSchV
IG Achtung Hochspannung, (Initiative „Beware high voltage“), Peer Schulze	Neutral	Neutral	Neutral
Ingenieurbüro für Umweltplanung Schmal + Ratzbor, (Engineering consultants for environmental planning), Günter Ratzbor	Neutral	Neutral	Neutral
Klimaschutzagentur Region Hannover GmbH, (Climate Protection Agency), Udo Sahling	Position B	Position B	Position B
klimabüro küstenpower, c/o Heinrich-Böll-Stiftung, (Climate protection agency Coastal Power, c/o Heinrich Boell Foundation), Doris Lorenz	Neutral	Neutral	Neutral
Kompetenznetzwerk Dezentrale Energietechnologien (deENet e.V.), (Registered association - Expert network decentralised energy technologies), Dr. Martin Hoppe-Kilpper	Neutral	Neutral	Neutral
Länderarbeitsgemeinschaft der Vogelschutzwarten in Deutschland, (National consortium for ornithological institutes), Dr. Klaus Richarz	Position B	Position B	Position B
Naturpark Thüringer Wald e.V., Florian Meusel	Neutral	Neutral	Neutral
Offshoreforum-Windenergie GbR, (Forum offshore wind energy), Dr. Ursula Prall	Neutral	Neutral	Neutral
Staatliche Vogelschutzwarte Hessen, Rheinland-Pfalz und Saarland, (State ornithological institutefor Hessen, Rhineland-Palatinate and Saarland) Dr. Klaus Richarz	Position B	Position B	Position B
Stiftung Offshore-Windenergie, (Foundation offshore wind power), Jörg Kuhbier	Neutral	Neutral	Neutral
Soziologisches Forschungsinstitut an der Georg-August-Universität Göttingen, (Sociological research institute at the Georg August University, Goettingen), Dr. Rüdiger Mautz	Position B	Position B	Position B
Thema 1 GmbH, Guido Axmann	Neutral	Neutral	Neutral
Umweltforum für Aktion und Zusammenarbeit e.V., Berlin, (Environmental forum for action and cooperation), Cornelis F. Hemmer	Neutral	Neutral	Neutral
VDMA Power Systems, Gerd Krieger	Position A	Position A	Position A
WWF Deutschland, Christoph Heinrich	Position B	Position B	Position B
WALDKONZEPTE PartG, (Partnership - Forest concepts), Christian Stuhlmann	Neutral	Neutral	Neutral
Windenergieagentur Bremerhaven (WAB), (Wind power agency Bremerhaven), Ronny Meyer	Neutral	Neutral	Neutral
Zentrum für Regenerative Energien Sachsen-Anhalt e.V., (Registered association - Centre for regenerative enegy in Saxony-Anhalt), Prof. Dr.-Ing. Zbigniew A. Styczynski	Position A	Position A	Position A

- Position A
- Position B
- Neutral

Signatory	EnLAG pilot projects 220/380 KV	Regulations on safe distances	26 regulation BImSchV
Zukunft Biosphäre und Lebensraum Angermünde e.V. (ZUBILA e.V.), (Registered association for the future of the biosphere and environment), Dr. Anita Schwaier	Neutral	Neutral	Neutral
People			
Antonella Battaglini (PIK - Potsdam Institut für Klimafolgenforschung - PIK, Potsdam Institute for Climate Impact Research), (Smart Energy for Europe Platform GmbH, SEFEP)	Neutral	Neutral	Neutral
Andreas Fußer (Hand & Fußer)	Neutral	Neutral	Neutral
Adrian Johst (Naturstiftung David/Vorstandsmitglied Unabhängiges Institut für Umweltfragen (UfU Erfurt) – Nature Foundation David/Board Member Independent Institute for Environmental Issues)	Position A	Position A	Position A
Dr. Steffen Möller (Georg-August-University, Faculty for Geosciences and Geography, Goettingen)	Position B	Position B	Position B
Dr. Kirsten Tackmann, MdB (DIE LINKE) – (Member of Parliament, German Left Party)	Position B	Position B	Position B
Prof. Klaus Werk, (Hochschule RheinMain – College Rhein Main)	Neutral	Neutral	Neutral
Frauke Wiese, (University Flensburg)	Neutral	Neutral	Neutral

TenneT TSO GmbH | 50Hertz Transmission GmbH | EnBW Transportnetze AG

Declaration of the transmission system operators TenneT TSO GmbH, 50Hertz Transmission GmbH and EnBW Transportnetze AG regarding "Plan N – Recommendations for political action on the future integration of renewable energy in the grids"

We welcome and support the DUH initiative aimed at achieving joint awareness and understanding of the need for grid expansion to integrate renewable energy and thereby promote a politically sound consensus of all those concerned. We have clearly shown our support by actively participating in meetings at the Forum for the Integration of Renewable Energy and giving the DUH expert advice on all technical questions. As signatory transmission system operators and against this background, we wish to add and draw attention to the following points important for secure and efficient grid operation. Our undersigned standpoint is as follows:

1. Underground cabling at the voltage level ≤110 kV

Plan N addresses, amongst other things, grid issues that involve voltage levels below those in the transmission grids. As a transmission grid operator, these issues lie outside our area of responsibility and touch upon the remit of distribution network operators who are our customers. We are therefore unable to take up a position that may be to the detriment of third parties.

2. Underground cabling 380 kV

We welcome the option set out in the German Power Grid Extension Act (EnLAG) to test underground cabling at the 380-kV-level and will use this option with due regard to grid stability, approvability and economic costs. Further technical development is a prerequisite for implementing underground cabling systems at the high voltage level in a way that enables us to fulfil our responsibilities - guaranteeing system security for our zone (cf. average repair times: overhead power lines 3.34 hours – underground cables 600 hours, CIGRE 2009). Therefore, we cannot make any statements on further cabling at the extra high voltage level before the first project is completed and associated scientific results are known.

3. Electromagnetic fields

Even after decades of research we still have no scientific evidence linking illnesses or relevant health risks to electric and magnetic emissions below those set by the EU Commission "Public Reference Levels" 1999/519/EU at 5 kV/m and 100 μT (50 Hz). The 26 regulation of the German Federal Immision Control Act (26 regulation BImSchV) stipulates the above-mentioned limits based on precepts of prevention and precaution, they further satisfy scientific and medical demands relating to the protection of people. Lowering this limit or introducing additional preventative measures for emissions is neither sensible nor justifiable in view of the lack of new research findings.

4. Speeding up procedures

We welcome the initiative and commitment of the Forum for the Integration of Renewable Energy in strengthening participation rights for residents who are affected. Power line construction is not carried out without a consensus between participants and companies. There is though an urgent need for instruments to expedite procedures in procedural law especially in view of the immense expansion demand (3,600 km according to dena II) and the continually increasing amount of installed RE output in addition to faltering grid expansion (currently only 90 km of the 850 km in dena I have been constructed). The EU Commission has recognised this need and is demanding a five-year time limit on planning and approval procedures for energy infrastructure projects. Therefore, we support legal stipulation in German national law of route corridors without diminishing either the scope of review or appropriate public participation.

Bayreuth, Berlin, Stuttgart, 26.11.2010

Martin Fuchs (TenneT TSO GmbH), Boris Schucht (50Hertz Transmission GmbH), Rainer Joswig (EnBW Transportnetze AG)

Abbreviations Plan N

AC	alternating current
ACER EU	Agency for the Cooperation of Energy Regulators
ARegV	Incentive regulation ordinance
BDEW	German Energy and Water Association
26 regulation BImSchV	26 regulation of the German Federal Immision Control Act
BMWI	German Federal Ministry for Economics and Technology
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear
Safety BNatschG	German Federal Nature Conservation Act
BNetzA	German Federal Network Agency
DC	direct current
dena	German Energy Agency
RE	Renewable Energy
EEG	German Renewable Energy Act
EM fields	Electromagnetic Fields
EnLAG	German Power Grid Extension Act
ENTSO-E	European Network of Transmission System Operators for Electricity
EnWG	German Energy Act
ERGEG	European Energy Regulators
R&D	Research and Development
FFH	Fauna-Flora-Habitat
GuD-installations	CCGT Combined cycle gas turbine installations
GW	Gigawatt
HVDC	High voltage direct current
HT	High temperature lines
Hz	Hertz
IGBT	insulated gate bipolar transistor
ICT	Information and communications technology
IPlanBG	Infrastructure Planning Acceleration Act
CHP	Combined heat and power
KWKG	German Combined Heat and Power Act
kV	Kilovolt
MW	Megawatt
MVA	Megavoltampere
PS plants	pumped storage plants
SET Plan	Strategic Energy Technology Plan
SG	Smart Grid
StromNEV	German Electricity Regulation on Grid Tariffs
TWh	Terawatthour
UVPG	German Environmental Impacts Assessment Act
VDE	German Registered Association for Electrical, Electronics and Information Technologies
WHO	World Health Organization