Deutscher Rat für Landespflege e. V. & Bund Heimat und Umwelt e. V.

Requirements for the alteration and expansion of the extra high voltage grid from the perspective of nature conservation and cultural landscape management

8 Summary[1]

Introduction

In order to lessen dependence on fossil resources and reach international climate protection objectives, in both Europe and Germany the overall concept for the future energy supply has been aligned to the development of renewable energies. In Germany all nuclear power plants will additionally be switched off, increasing pressure to rapidly modify the electrical power supply.

There are very few fundamental doubts about the necessity of increased use of renewable energies among politicians and society, however time and space-related requirements for the steps needed to bring about change are disputed. Professional nature conservationists and cultural landscape managers also agree to these objectives under certain prerequisites and conditions.

Today, considerable amounts of electricity are produced in the federal Länder using wind turbine generator systems, photovoltaics and biomass, whereby the existing electrical power grid has proven a bottleneck for the transport of this supply. Due to the fact that electricity from renewable energies is produced locally and often in regions that are not yet adequately connected to the energy grid, the alteration and expansion of the electrical power grid is necessary. An additional factor is the liberalization of the power trade in Europe; for this reason alone new grid routes must be provided. Studies by the German Energy Agency (dena) furnish evidence of a need to alter and extend the grid by approx. 4,350 km by the year 2025. The Federal Government laid legal groundwork to extend the urgently needed corridor requirement and to speed up planning and implementation of further corridors. Implementation of this has been delayed, however, due to a lack of acceptance and the opposition of affected citizens and interest groups at the regional and local level and due to the complexity of federal and Land planning and approval laws.

There have been initial assessments and experiences concerning the communication of "energy grids" and in gaining acceptance

1 Übersetzung: Faith A. Gibson, Englischer Sprachdienst, Bonn.

Abb. 48: Overhead line corridors cross through forest areas (Foto: F. Obenland, TransnetBW).

for new power supply line corridors. Associations are also becoming involved by submitting recommendations for the expansion scheme to politicians.

High priority is given to the alteration and expansion of power supply line grids in the form of overhead lines or underground cables as well as the construction of storage stations to balance out fluctuations in the electrical power supply. Beyond basic agreement, nature conservationists and cultural landscape managers need to intensively grapple with the topic and input their expertise, as these measures will have a number of effects on nature conservation and the landscape appearance. They may lead to multiple burdens on the landscape and its appearance, and current planning principles may reach their limits. Many people are also concerned about detrimental effects by the planned power lines on health.

The purpose of this study is to reach the following goals:

- To compile and create a statement on the demands of nature conservation and cultural landscape management in conjunction with the alteration and expansion of the extra high voltage grid,
- to compile and evaluate previous and current standards that must be observed and taken into consideration in the power line planning and approval processes,
- to draw up summarized recommendations from the point of view of nature conservation and cultural landscape management, which will contribute to the suitable acceleration of the alteration and expansion of the electrical power grid in the future planning and approval process,
- to contribute to reciprocal acceptance (government – approval authorities – transmission grid operators – affected people) and to objectification of the debate at all levels for the sake of good governance.

Electrical power grids and the cultural landscape

The basic scientific principles of electricity generation and transport were developed in the eighteenth, nineteenth and twentieth centuries. Cities began to be supplied with electric power about 1890. Streets were illuminated and trams were built. Consumption of electricity by private homes and commercial and industrial enterprises increased constantly.

Increased consumption ("burden") had the effect that turbines, generators and power transformers were designed for increasingly greater capacities. The preferred production sites were able to directly access and utilize the required resources such as lignite or hydroelectric power. The German electrical power grid was designed as a thermal power generation system in consumer proximity based primarily on fossil fuels. This centralized consumer-proximate production system led to comparatively short transmission routes. There is an optimal voltage level for the transport of power that increases with the size of the transmitted power and the transmission distance. In large systems, the transmission or transport grid consists of wide-ranging high voltage lines. Not until the power reaches the proximity of the consumer is it transformed to lower supply voltages. The distribution grids are made up of lines at these voltage levels.

Landscapes are spaces that are shaped and perceived by humans; hence landscapes are a cultural, formative product of humans based on natural factors and evidence of human actions in their historic and present facets. The term "cultural landscape" aims to define this. Landscapes are, however, also the product of human perceptions, i.e. the result of processed sensual impressions that need not necessarily be of a visual nature.

The European Landscape Convention places this definition in a prominent position of its preamble. It emphasizes the interaction of human and natural factors and defines landscape very loosely so that the term can encompass both historic agricultural and modern industrial landscapes. Under this loose definition, elements such as power lines can be or become a part of the landscape and exhibit important relevance; they are not merely bothersome disruptive factors.

The aesthetic concept of "landscape", as well as recognition of its significance as a historic testimony and source of feelings of homeland and identity, led to the awareness – still valid today – for the targeted development, management and preservation of landscape elements and even entire landscape contexts. Interventions in the landscape in conjunction with extensive industrialization (e.g. roads, railways, industrial regions, dams and power lines) gave rise to the Heimatschutz movement, which sometimes rejected the new elements, sometimes attempted to integrate them sensitively and, for example, minimize interventions of power lines. The latter was based on the recognition that the landscape, even the historic cultural landscape, is not static, but always subject to change.

Due to the energy transition, certain parts of the landscape will, in future, be characterized by new equipment or structures such as extra high voltage lines. Historically, humans have always made interventions in nature (e.g. deforestation for firewood use, the construction of mills and dams for energy production). Today, the "remnants" of these interventions are popular among those seeking recreation and are familiar to the later generations, making erstwhile conflicts irrelevant. On the contrary they created added values, such as "romanticism" or "recreation." For more than 100 years, Germany's landscape has been criss-crossed by a grid of power lines of various voltages. Germany's "energy landscape" also contains a number of power plants, as well as the needed infrastructure, lignite collieries, biogas plants and many wind energy plants and wind farms. Since these structures of the technical cultural landscape are used intensively we, as their contemporaries, are very closely connected to them. We often lack the chronological distance that would make a later (re-) evaluation possible. Looking ahead, we can say that the challenge lies not in the basic new construction of power lines, but in the necessary expansion of the grid to extra high voltage.

To deal with extra high voltage lines, we require an insight in the changeableness of landscape. Sound information and reflection of our understanding of landscape are just as important, of perceptions and familiar sights and also the degree of familiarization. Yet the fact that change is part of the essence of the landscape is not a license for accepting all changes without reservations. The extent of the changes, their form and implementation as well as the tangible effects on the respective (collective or individual) landscape appearance with its natural and cultural historical heritage must always be analyzed and evaluated anew.

Technical requirements/components of the electrical power supply infrastructure

Extra high voltage lines serve to transport and distribute electricity over large distances. Voltages of up to about 380 kV (extra high voltage) at supply frequencies of 50 Hz are produced. Electricity can be transported via overhead lines or through underground cables.

Overhead lines consist of the following structures:

Lattice steel towers in specific intervals (approx. 400 m) and heights (50-70 m); earth wire and conductor ropes with insulators are attached to the cross beams of the towers. The prevalent types, depending on the site and topography, are two-level pylons, single-level pylons or barrel pylons; experiments are now being done with reinforced concrete pylons. Towers for extra high voltage lines usually carry a number of circuits. Lattice towers stand on concrete foundations of various designs; above the soil only a small part of the foundation is visible (pile heads). In most cases an overhead line requires a corridor of approx. 50-70 m width (width of the tower cross beam + protective strips to the right and left). Overhead line corridors are annually monitored for their function and safety by means of surveying flights and on-foot site inspections.

Underground cables consist of the following structures:

Cable systems consisting of cable trenches or tunnels, the connective structures between cable sections (also called cable joint chambers), compensation and cooling equipment as well as cable sealing terminals at each end of the cable route or at the transition to a compensation or switching station. Due to technical conditions the cable sections are approx. 700 - 800 m long. A layer of sand serves to mechanically protect the underground cables. The corridors for underground cables are in most cases narrower than those required for overhead lines. While overhead lines can be visually inspected, this is not possible for underground cables; cable corridors require a surveillance pathway.

In Germany (with the exception of Berlin) there has been no practical experience with the laying of underground cables at the extra high voltage level.

The *extra high voltage infrastructure* also consists of:

- transformer stations, switching stations and rectifier substations, which connect different voltage levels, distribute electricity to consumers or transform AC to DC voltage;
- access routes and enclosures;
- storage, storage power stations, which serve to cover peak capacities and, in the scope of grid controlling, the provision of controlling power ranges.

Legal, institutional and planning conditions

Complex legal requirements must be observed for the alteration and expansion of an inter-state extra high voltage grid – whether in the form of overhead lines or underground cables.

Various special laws (e.g. Energy Industry Act, Power Line Development Act, Grid Expansion Acceleration Act, Renewable Energy Sources Act; Soil Protection Act, Federal Water Act, Federal Nature Conservation Act, Federal Forests Act, Environmental Impact Assessment Act, Environmental Damage Prevention and Remediation Act; Preservation of Historic Monuments Acts) regulate the respective objectives/ purposes, tasks, competencies, planning/planning instruments, involvement and protection provisions.

The objectives of these special laws are often conflicting. In particular the special environmental laws lead to restrictions that could limit electrical power grid expansion. Protection provisions of varying degrees of stringency for certain regions can have obstructive or constraining effects; in some cases they demand structural or technical modifications to overhead lines (intervention minimization).

The Regional Planning Act regulates all regional planning. It is based on the general principle of sustainable regional development and creates the foundations for regional developments, which harmonize a region's social and economic demands with ecological functions – as they result from the special laws – and ensure lasting, large-scale balanced order with equal living conditions for all citizens.

A number of authorities at the federal and Länder levels (cf. the special laws cited above) as well as representatives of the transmission grid operators are involved in planning and implementing power lines. The Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway under the jurisdiction of the German Federal Ministry of Economics and Technology is responsible for the planning and approval process of extra high voltage grid expansion.

Following an extensive multi-stage procedure that included strategic environmental impact assessments and in which the public was involved at a number of phases, in November 2012 the Federal Network Agency submitted a draft demand plan for the electrical power grid to the Federal Government. It foresees wide rough corridors to serve as search areas for potential corridors. The Federal Government will enact a Federal Demand Plan Law, which will determine the energy industry necessity and the urgent demand for the projects contained in the plan. On principle, this federal planning has priority over Land plans; later, in cooperation with each of the affected Länder, a decision will be taken on the most environmentally suitable route of a corridor.

The main objection to this procedure is that the strategic environmental assessment should have been conducted far earlier, when the scenario framework was drawn up. At that time, various alternatives for extra high voltage grid expansion (alternatives of the different scenarios, zero alternatives, alternative decentralization/centralization, storage alternatives) should have been investigated, because the choice of a scenario fundamentally set the stage for future grid development and its dimensions.

Effects of the electrical power infrastructure and evaluation

Effects on humans

Many people fear detrimental health effects from electrical and magnetic fields occurring at power lines. However, the permissible thresholds are hardly met in most cases and rarely – only in the direct proximity of extra high voltage lines – exceeded.

The transmission of electrical energy via overhead lines can, under certain circumstances, be combined with noise – the so-called "corona" effect. This is also not a threat to human health.

Abb. 49: Energy needs electrical power grid expansion (Foto: Fotolia).

Effects on nature and the landscape

Soils

The temporary or permanent interventions in the soils associated with the expansion of the extra high voltage grid can limit soil functions.

In the case of overhead lines most interventions are caused by the tower foundations. Different tower foundations are required depending on the tower type, subsoil, groundwater and space circumstances. Local subsurface sealing and impairments to the soils through relocation can result. The largest parts of foundations are located below the surface of the soil and are not visible once a construction measure is completed. Construction-related soil compaction leads to temporary changes in the soil and the soil structure, which can have considerable effects on compaction-sensitive soils.

The construction and operation of underground cable systems have major impacts on the soil and vegetation. The creation of a cable trench or cable tunnel can lead to a relocation of the natural soil horizons. To mechanically protect the equipment, beds made of non-native materials are used. In addition, space is required for cable joint chambers, compensation equipment and dead-end towers. The heat emissions coming from underground cables in cable trenches alter the heat and water levels of the soil only slightly. The effects of the rise in temperature on soil life and on physicochemical degradation and transformation processes in the soil have not yet been studied. Laying cables in tunnels results in a relocation of the soil horizons combined with subsurface sealing over the entire tunnel cross section and length. Since no long-term experience with 380 kV cables has been gained, we do not know how the decomposition process of the plastic cable sheathing affects the earth. All in all, overhead lines are better suited than underground cables around moist and important soils as well as for crossing bodies of water.

Water and waters

Surface and subsurface sealing caused by overhead lines and underground cables can affect water quality and the water balance and permanently change both surface waters as well as groundwater supplies. Depending on the groundwater table, water retention measures may be required to secure the excavation trenches during the construction phase. A high groundwater table is temporarily lowered.

With overhead lines, temporary changes to the groundwater table are limited to the excavation trenches for the tower foundations. Foundation slabs cause a noteworthy degree of subsurface sealing.

When underground cables are laid in regions with a high groundwater table using an open-cut method, the groundwater level has to be lowered along the entire length of the cable trench. In addition, a change to the water balances of bodies of water must be expected where cable corridors cross a body of water or are laid along a body of water.

Also, subsurface sealing caused by the cable bed or a cable tunnel can also have negative influences on the groundwater especially in locations on slopes.

Animals, plants, biological diversity

The planned extra high voltage grid will have temporary and permanent effects on animals, plants and biological diversity including all habitats. These effects must be differentiated according to those caused by construction, by equipment and by operation.

Mainly birds are affected by the danger of flying into lines, interventions in predator-prey relations and electrocution during construction of extra high voltage overhead lines. Potential habitat impairments are also relevant to other species protected under European law, such as bats. The installation of extra high voltage underground cables in special line beds or tunnels in the soil can also cause habitat impairments for plants growing on the corridor and animals living underground through changes to their biotopes as well as the dissection of the habitats.

Extra high voltage overhead lines are obstacles in the air space of birds that are difficult for them to see, resulting in them colliding with the conductor ropes or, when manoeuvring away upwards, colliding with the thin earth wire. Species particularly affected are: large birds (herons, storks and cranes), water birds (geese, swans, ducks, loons, cormorants and crakes), shorebirds (curlews, snipes and ratites) as well as seagulls and terns.

The construction of 380 kV overhead lines is not automatically a higher collision risk for birds, however new corridors in certain regions, under certain situations and for certain species become a risk factor that is usually restricted to a few, small areas.

Expansion of the overhead line grid will increasingly devaluate, endanger or entirely obliterate habitat areas that border on corridors up to 100 m on either side (breeding and resting grounds) since some bird species demonstrate less land use intensities near power line corridors or avoid the surroundings of overhead lines altogether (e.g. common snipes, black-tailed godwits, ruffs, lapwings and redshanks).

Each new tower alters the habitat, since towers and lines offer a number of roosting possibilities and new breeding possibilities for predating and sometimes rare birds (e.g. hobbies, ospreys, crows). This leads to a shift in the predator-prey relationship since the predators are able to penetrate habitats they were not previously settled in, for example in open country, resulting in an increase in predation of meadow birds (e.g. lapwings, redshanks, European curlews). If population sizes are already critical this can lead to their extinction.

Installation of underground extra high voltage cables is comparable to the construction of gas pipelines, so that experience in this area can be used as reference.

During the construction phase the temporary elimination of existing vegetation over a width of 30–45 m is required for open-cut installation. There has been no practical experience with plough installation, but soil intervention would be limited to the soil on the immediately closed plough lane.

If endangered biotopes are affected by the corridor and the structures and if these are rare biotope types, the risk of losing area must also be taken into consideration.

During the construction phase the fauna will mainly be temporarily impacted by noise and pollutant emissions as well as visual disruptions and temporary usage of the biotope populations even in biotope populations nearby the working strips. If this disruption occurs during the breeding periods of birds, amphibians and bats this could lead to a drop in reproduction. Borders, as all-year habitats of locusts, can be affected as well as migration corridors, spawning waters, summer habitats and hibernation habitats of amphibians. The presence of humans, operation of construction equipment or installation of protective fencing can result in a temporary displacement of animals, primarily meadow breeders. Reptiles, amphibians and locusts are endangered by open excavation trenches.

The displacement of fauna during construction due to the temporary usage of the biotope populations or the impairment of the fauna due to noise, pollution and visual disruptions during construction are short term and abate after completion of the construction measure when the working strip is renewed. The breeding and resting places of underground animals such as some rodents (voles, common hamsters), moles and other soil organisms, which, with the exception of the common hamster, are not endangered species, will be irretrievably disrupted.

The construction of above- or underground structures such as cable joint chambers, compensation equipment, dead-end towers or transitional structures leads to the use of areas. Cable joint chambers should be designed so that they are adapted to the landscape and could be utilized for the attachment of nesting aids.

We can assume that rapidly renewed vegetation, such as fields or managed grasslands will suffer no permanent impairments following reconstitution and the corridor will become invisible.

"Power line corridor habitat"

Power supply line corridors also offer opportunities for developing natural and cultural landscapes. Keywords are: linear biotope linking and supplementation functions, forest aisles with ecological corridor management, development of corridor segments to compensate for interventions.

Overhead line corridors cross through various use areas (e.g. agricultural or forest areas), whereby across large stretches they remain without any specific biotope structural features. In most cases they are not single biotopes types worthy of protection, but they can serve to shape the biotope and take up nature conservation functions, for example where corridors pass through forestry monocultures or at the bases of the towers if they cross through agricultural areas. The different sized areas at the tower bases can be used as stepping stones if they are planted with grasses, shrubs, high perennials or low bushes (up to 6 m; higher vegetation is not practicable due to the maintenance of the towers), which also provide habitats for insects, small mammals and bird species.

A variety of types of vegetation populations grow on overhead line corridors in forests, for example on cleared corridors, depending on the site conditions sandy dry lawns, neglected grassland, litter meadows, common heather, lichen heather, fields of high herbaceous plants, secondary moor grass meadows, residual lime low moors, and even ruderal, neophyte and nitrophyte fields and brushwood. Such areas provide habitats for many animal species adapted to them. Forest corridors develop into coppice-like biotopes if they are covered with species capable of coppicing such as oak, hazel, willow, lime or hornbeam. If managed properly, such areas that regenerate through coppicing produce a mosaic of temporary open areas and young stands with pronounced edge effects. Coppice-like power line corridors are also suitable for extensive forms of recreation.

Ecological corridor management can contribute to the power line corridors developing into habitats for animals and plants and help to preserve and develop biological diversity.

Landscape appearance and cultural landscape

The term "cultural landscape" is used to describe landscapes of various types. The sensitivities and demands of an historic agricultural landscape are different than those of a landscape that has been marked by industry, and the abilities of these landscapes to integrate new elements are just as different. This applies to the close and far range of the viewer perspective. While in cultural landscapes that are already very technically modernized (most commonplace landscapes) new extra high voltage lines will not make much of an impact, they can compete with and lead to conflicts in previously less or hardly engineered, historically traditional landscapes and landscape appearances as well as the generally accepted ideas of "pretty" landscapes.

There are proven and participative methods for recording, mapping and typification or demarcation of (cultural) landscapes, but there are no generally binding standards.

Differentiating "landscapes" as "physical landscapes" or as "landscape appearances" leads to different assessments of effects caused by overhead lines and underground cables. When considering the landscape as a physical object, traditional protected commodities such as animals, plants, soil and water are considered. When considering the landscape as a theoretically constructed, culturally connoted and collectively remembered image of perception and as the testimony of historic processes, we must take aesthetic criteria and the views of people into consideration, whereby subjective standpoints come into play. A sceptical to mistrustful attitude towards changes is often the consequence of experiences of powerlessness and loss. In addition, a lack of factual information prevents the forming of more objective points of view. Hence, it is sometimes not the power lines as such, but the way they are planned and implemented that produces resistance, thus making it no longer an aesthetic problem.

In our perception of the landscape, the new towers will make an appearance in particular when they are erected in places that were previously empty, when aisles have to be cut through forests to make way for them, for instance, or when they tower above existing lines.

The landscape in the physical sense is mainly spanned by overhead lines. The towers are then spot structures with comparatively minor interventions in the physical landscape. The interventions of other associated structures are also comparatively small-scale from a physical point of view.

Underground cables would have more major effects on the landscape in the physical sense, but would influence the appearance of the landscape to a lesser extent.

Communicating the necessity of electrical power grid expansion and participation in the approval process

The purpose of communication is to exchange and compare information and for individuals and institutions to organize society amongst one another. It is a prerequisite for processes such as opinion forming and for political agreement. Communication can occur through direct conversations (e.g. oral presentation or conversation) or indirectly (e.g. in writing, via email, via telephone, text messaging, etc.). The variety and easy accessibility of modern technical means of communication in particular enable us to communicate with one another today at almost any time and across any physical distance. One important prerequisite for successful communication is being aware of the interpersonal needs and ideas of the communication partner in order to create links and avoid misinterpretations. Problems occur in communications in part because information is lost in the communication process due to different opinions, interpretations and priorities or because of overcomplicated processes.

Political participation is the "involvement of affected citizens in political decisions and measures." It unites "all initiatives, measures, models and methods that enable involvement in democratic decision processes" and is thus the basis of a democracy with its institutions and procedures. The opportunities offered by participation are the integration of valuable specific, regional and selected specialized and expert knowledge.

In order for successful communications to be the basis of functioning participation, the motives and concerns of the persons participating must be clarified and known, whereby the questions of gender, age, cultural background, etc, are of importance. The scope of application (local, regional, national) must also be clarified. Possible partakers in participation processes with different activities, attitudes and motives include individual affected and interested persons, representatives of citizen interests, representatives of interests and concerns that cannot represent themselves (e.g. environmental protection, cultural landscape management, urban planning affairs, etc), those whose rights are affected by the relevant processes, sponsors of the project, experts in the field, arbitrators (administration or government) and/or their agents.

Essential prerequisites for planning participation processes are timeliness combined with openness. Participation processes related to the energy transition are presently frequently suffering from preliminary decisions that deny citizens' access to contribute to the "whether" and only focus on the design, or the "how."

As for the duration of participation processes they can, on the one hand, slow down decisions due to their complex modus operandi and this is often considered a problem. Consideration ought to be given, however, to the effects of widespread resistance to plans that a lack of involvement can produce. Dissatisfaction and other potential conflicts can be lessened from the start through participation processes: they are transparent and clearly not decided in advance, create trust and increased acceptance among the population.

The term "governance" refers to linked structures that describe the governing, the steering and the coordination of political situations, but it also incorporates the connections of the state with the economic and social levels. These include not only the spectrum of political units (local, regional, national) but also associations, federations, interest groups and organizations. These connections between levels ought to cause a sort of balance of decision stages making clear that governance and regulations come not only from the state, but can also be shaped by other stakeholders.

Communication and participation play decisive roles in good governance. Good communications in particular, which are the basis of successful participation, are crucial.

Objectivity, monitoring, accompanying research and the continued enhancement of the skills of all involved are self-evident basic principles.

The potential of actively making use of participation must be desired and demanded and not seen merely as a legal obligation, but to positively shape it with experience and inventiveness.

Examples of successful dialog boards show, that people not only oppose but are interested and willing to cooperate and to contribute their knowledge to planning processes, especially when beeing seen as a serious partner..

Primary demands and recommendations

As a result of the energy transition, many traditional cultural landscapes are transforming into “energy landscapes.” Wind farms, large-scale photovoltaic plants and areas managed solely with renewable resources are increasingly characterizing the appearance of the landscape. The successes of renewable energy production are obvious, increasing amounts can be fed into the electrical power grid and more can be expected.

Although one chief aspect of energy transition, the changes to cultural landscapes, is generally largely accepted or endorsed by society, this applies to a far lesser extent to the aspect of the necessary transmission of the energy produced as a consequence of the new structure and distribution of renewable energy sources. Energy transition is moving too fast for many people; even experts agree that many activities are conducted and decisions taken in an uncoordinated and overhasty fashion without basing them on relevant experience.

Although energy transition affects nature conservationists and cultural landscape managers in the administration and implementation of their objectives and tasks, they do support it on principle. The recommendations aim to contribute to how the energy transition, and in particular the associated alteration and expansion of the extra high voltage grid, can be carried out in a qualified and efficient way.

It is important for the Deutsche Rat für Landespflege (DRL) and the Bund Heimat und Umwelt (BHU) to underscore that before grids are further expanded to a major extent, all political efforts must be taken to set priorities in saving electrical energy and using it efficiently linked with time frames of measures and economical incentives. We also point out that the Energy Industry Act requires the transmission grid operators to provide a grid that feeds in 100 percent of the renewable energy sources; perhaps through a minor reduction of this obligation to expand the grid it would be possible to markedly reduce the grid expansion.

The DRL and BHU reject any form of abandonment of European and national nature conservation and environmental protection provisions to accelerate energy transition. Such measures would neither accelerate nor promote acceptance of the grid. Nature conservationists and cultural landscape managers are clearly co-designers of an energy transition aligned to sustainability and environmental compatibility and the relevant consequences, if nothing else due to the existing and proven planning instruments. There is no evidence that nature conservation provisions would delay the planning process. The concerns of local citizens’ initiatives and of the nature conservation and environmental protection associations can certainly not be alleviated by weakening nature conservation provisions. The proven nature conservation and environmental protection instruments, such as environmental impact assessments, landscape planning, impact regulation, the conservation area systems as well as species and biotope protection, serve to steer corridor and site planning in a nature and environment compatible direction.

The federal and Länder governments ought to develop a joint master plan for energy transition and the consequences of the expansion of power transmission grids in the extra high voltage range that also takes European aspects into consideration. This plan should show the potentials of the production of various types of renewable energy that can be used sustainably and ecologically. The plan should serve as the basis for decisions on the extent to which regions wish to independently produce and utilize energy or also the extent to which they want to feed energy into the extra high voltage grids and use it economically. Technological further developments and progress as well as forecast uncertainties need to be considered at regular intervals. This would facilitate up-to-date estimations of the density of the necessary extra high voltage grid development. Also, demographic aspects should be included in such a plan.

For improved acceptance of grid expansion, the DRL and BHU propose amending the legal specifications so that in future the scenarios are first subjected to a strategic environmental impact assessment as the first step of drawing up a federal grids plan, since system alternative checks – including zero alternatives – are necessary at this early stage. This is the only way to convincingly prove that the truly most environmentally compatible and more sustainable scenario is chosen and power supply line corridors are planned on this basis. If suits are filed based on the present legal situation and the procedure taken because the scenarios were not subjected to any strategic environmental impact assessment, this will delay the planning and implementation process by a number of years.

Most of all, the involvement of nature conservation authorities in an early phase of drawing up application documents can give early indications to project agencies of nature conservation and environmental protection concerns and of the challenges of dealing with impact regulation and compensation demands.

The existing nature conservation evidence from the landscape planning of the Länder (landscape programme, landscape framework plan, regional planning at Land level) provide important information for determining sites for power corridors. This evidence and the data they are based on are significant groundwork for environmental impact assessments that also can offer information on minimizing the effects of corridors. They must be updated regularly because they then contribute considerably to accelerating the planning process and making the process transparent. They should also be communicated to the public so that they can be used in the scope of participation processes.

Restricted areas must be observed when planning extra high voltage lines. This primarily includes protected areas of various categories according to nature conservation law such as nature protection areas, national parks, national natural monuments, the core zones of biosphere reserves, FFH and bird sanctuaries, management and development zones of biosphere reserves, the inter-state biotope system, the European biotope network Natura 2000 and the German Green Belt. In addition, areas protected under the forest conservation, soil protection or monument protection laws of the Länder must be observed as well as the World Heritage regions.

From the point of view of nature conservation and cultural landscape management, the solution to transporting electricity at the extra high voltage level cannot be across-the-board “underground cables instead of overhead lines.” Instead, planners will have to deal with both alternatives depending on the respective site conditions. Both have effects on the natural balance and the landscape appearance that must be examined and evaluated with regard to the sites (appraisal of intervention intensity must also be long-term!). In addition there is a lack of practical experience in the effects underground cables on the environment. There are options for avoiding and minimizing the interventions available for both technologies. These include the reduction of the width of the construction strip to reduce losses of biotopes and habitats. Impairments to fauna can be avoided by adapting the construction times to environmental concerns (construction windows, e.g. carrying out construction measures outside the main breeding periods of meadow birds). The ecological construction supervision required of project agencies for a construction measure can minimize construction-related impairments (e.g. in determining construction access roads to tower sites).

The choice of compatible corridors (observation of habitats, bird migration routes) helps lessen collisions of birds with overhead lines. Moreover, ensuing efficiency controls and monitoring are needed. The perceptibility of overhead lines must be increased, also in the extra high voltage range, with suitable markings (combined with lessening visibility for humans). When installing underground cables at the extra high voltage level all technical means possible should be exhausted to keep heat production at a minimum. The ecological effects of underground cables in the operation phase must continue to be researched for the longer term. This research should include different bed materials, temperature sequence plots, effects on the water balance at different sites, studies of microorganisms and soil fauna (repellent or attracting effects) as well as biochemical processes (e.g. increased mineralization) and their effects on perennial plant populations.

Alteration of the cultural landscape caused by power supply line construction has not only negative consequences for nature conservation: the aisles created for overhead lines and the tower contact areas can contribute to improving biological diversity under relevant ecological expert management. They can be suitable as connection corridors in the scope of biotope network schemes in particular in dry habitats. The previous activities of the transmission network operators in this area should continue to be pursued. Corridor management schemes also take the interests of owners into account. The public as well as nature conservation and environmental protection associations should be involved in their establishment and implementation. Existing examples of corridors managed according to ecological principles can be used to gain acceptance for power supply line corridors (guided tours, corridor nature trails).

Open and objective communication between operators, government and citizens is the prerequisite for the acceptance of an expanded and altered electrical power grid; the results of public participation in the scope of the various planning levels must be transparent. The development and potentially necessary change to the cultural landscape by the energy transition must be shaped in a dialogue between representatives of government, industry, local authorities and local people. At the same time a public awareness is needed for those components that characterize the uniqueness and create the value of a cultural landscape.

Most of all, however, the trust of the citizens in the transparency of the decision process – and in particular in the neutrality of those taking the decisions – must be regained. This can be achieved by instrumentally upgrading the role of regional planning in the development process (and thereafter), as well as through the conferment of important neutrality-safeguarding tasks, primarily mediation and monitoring, to the authorities responsible for regional planning.