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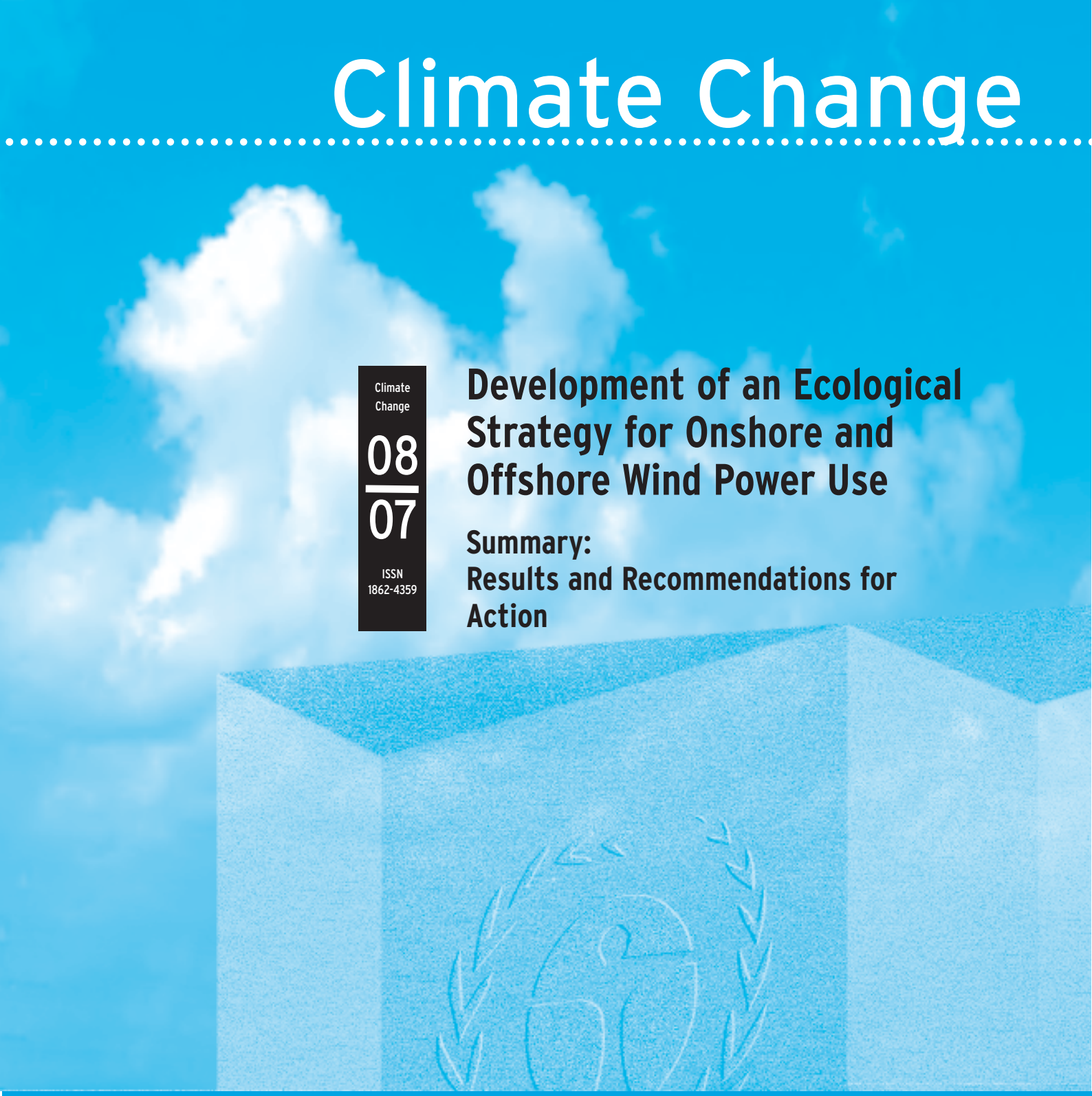

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Development of an Ecological Strategy for Onshore and Offshore Wind Power Use

Summary: Results and Recommendations for Action

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1 General

Germany is pursuing ambitious goals regarding the further development of wind energy use. The German Federal Government considers the expansion of renewable energy use as a central element of its climate conservation and energy policies. In the coalition agreement from 2005, the German Government decided to concentrate on the following topics regarding wind power: renewing old installations (repowering), offshore wind power generation, and the task of improving the conditions for wind power.

The task of repowering – i.e. replacing older systems with new, higher-capacity ones – is a major strategic goal for the further development of **onshore wind power use**. Beyond repowering, a certain growth can still be expected in the number of onshore installations. However, the windy and therefore profitable areas available for exploiting wind power are ultimately limited. The designated locations in priority and suitable regions are mostly "booked up", so that additional potential areas of a larger scale can only be developed when further positive areas are identified.

After registering an at times rapid increase in electricity generation by onshore wind turbines over the past few years, it is now a goal to exploit the **offshore wind power** on a large scale. In this respect the German Government is following up on a 2002 agreement from the (then) Federal Government on a "strategy for offshore wind power" which planned an expansion programme with a concrete time schedule. In the meantime, however, the first stages of the agreement could not be realised.

The further expansion of wind energy use should, on the one hand, be promoted as effectively as possible, and, on the other hand, proceed in the most ecological and nature-compatible way possible. It should also be designed to make economic sense and achieve a high measure of social acceptance among both the general public and those in the affected areas. A prudent **ecological strategy** is required to achieve these goals.

"Ecological Strategy"

Of itself, wind power can already be considered a fundament of an "**ecological strategy**" due to its meaning for climate conservation and resource conservation. The particular value of wind energy use must be figured in for all legislative and planning decisions. Nevertheless, it must be stated that wind energy use entails a significant intervention into the existing regional and local relationships of the environment and the surroundings which must be limited to a tolerable degree as dictated by the standards of sustainability. The intervention must be consistently designed to minimise the negative impacts, as demanded by the issues of the specific interests to be protected in each case. It may be necessary to take corrective action in those cases where evaluations judge that the negative impacts outweigh the common welfare goals pursued by the use of wind energy. A development strategy can only be an "ecological strategy" in this sense when it is holistically tailored for ecological optimisation.

The following text compiles the essential **results and recommendations for action** regarding the development of an environmental strategy for the further expansion of wind energy use.

In view of the depth of the covered topics and the extensive detail of the considerations, only those aspects will be included which are considered by the researchers to be of **strategic importance**. The explanations distinguish between the three domains “onshore wind power”, “offshore wind power”, and “onshore transmission system”.

2 Onshore Wind Power

State of the expansion development on land – more perspectives

In the last decade, enormous growth rates could be achieved for onshore wind power. This situation was triggered on the one hand by the feed-in tariffs fixed by the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz - EEG) and on the other hand by incentive regulations in the building laws (privileges for wind turbines located outside of developed urban districts, or the explicit positive designation of suitable locations in the framework of urban land use planning). However, a downward trend has been observed since 2003. The newly installed wind power capacity was only ca 1,800 MW in 2005, compared to 3,200 MW in 2002. A slight increase to about 2,200 MW could be achieved for 2006. The overall downward trend in growth will likely continue in the next years, however.

The reasons for this trend now lie in the limited availability of locations and in the only slowly emerging repowering market. The quantity of additional available windy sites is decreasing. The further expansion prospects of onshore wind power depend decisively upon the extent to which, on the one hand, **additional area potentials** for new sites can be made accessible and, on the other hand, significant capacity growth in the scope of **repowering** can be achieved.

The prevailing laws do not provide a useful basis for a systematic repowering strategy. In the building laws, the construction of replacement installations in the course of repowering projects are basically treated like new construction projects. A higher-capacity replacement plant at the same place or close nearby will therefore only be permitted if it is within an area identified positively for wind power and where enough space is available for a larger installation. The positively identified areas are however mostly “booked out”. The consequence is that the operators continue to run their relatively small systems at the old sites so that repowering fails to come about, despite the specific economic incentives given by the EEG.

“Cleaning up the Landscape” and Repowering: a Twofold Opportunity

Wind turbines cause specific changes in the landscape – just like other larger constructions. Regardless of individual aesthetic appraisal, it cannot be denied that they represent a significant landscape intervention. The magnitude of the impact will depend on the local situation – and may in some cases even be perceived as an improvement. However, especially the larger modern systems with capacities in the 3 to 6 MW range (with rotor diameters and hub heights of 80 to well over 100 metres) cannot be “hidden”. It is therefore important to select their sites carefully and to design them as aesthetically as possible from the landscape point of view.

From the urban planning and the aesthetic scenery point of view, it is a significant drawback that the scenic impression in many regions is still strongly affected by scattered wind turbines which

were not constructed within a systematic programme. In the practice, this problem applies to smaller, low-capacity systems, which were mostly installed in the 1990's and which often substantially disturb the scenery and in turn negatively affect the overall acceptance of wind power.

The negative aesthetic impression on the landscape can qualified if it is possible to dismantle existing generators in favour of constructing new systems localised in concentrated regions. In this respect, **repowering provides a twofold opportunity**: by removing lower-capacity systems from the 1990's, their replacement in the course of repowering both cleans up the landscape and at the same time achieves a significant growth in power generation capacity – admittedly at the "price" of erecting taller turbines. This "price" may be too high in some cases of urban planning. However, a much stronger positive effect is generally expected from correcting the impression of wind turbines disturbing the whole landscape.

Regulation options for eliminating scattered sites and legislative planning for repowering

The premature abandoning of sites no longer desired by urban planning can only be accomplished if **effective incentives** are created in this regard. A suitable leverage could be the prospect of higher revenues by replacing old systems with higher-capacity ones.

In certain local constellations, it is possible to develop corresponding strategies without legal changes at the communal level. In particular, the municipalities have the possibility within the framework of urban land use planning to enter into an urban planning contract with investors of new installations, or contracts under civil law with property owners, by which in return the investors are obligated to dismantle certain old installations. However, the realisation of these possibilities presupposes the mutual agreement of all parties.

A very large guiding influence would evolve from the suggestion to emulate the provisions from § 35 Para. 1 No. 5 and § 35 Para. 3 Clause 3 of the German Federal Building Code (Baugesetzbuch - BauGB) for **special privileges for repowered installations**. In practice, this would mean that replacement systems located outside of developed urban districts would be privileged, unless an urban or regional land use plan demonstrates sufficient area at another location which is specifically reserved for the replacement of old systems. Such a regulation would provide a complete basis for the planning laws to accomplish the repowering strategy strived for by the German Federal Government. In order to intensify the guidance effect towards reducing the negative consequences of wind turbines on the landscape and surroundings, the regulation could (and should) be linked to the additional expected improvement of the urban planning situation through replacing the old installations.

As a comparatively more **"mild" measure**, it would be possible to simply provide the possibility in the land use regulations to explicitly **allow** the communities to designate certain regions where only those wind turbines may be erected which replace existing (possibly even specified) installations located outside of developed urban districts. Such regions would solely serve to "accommodate" replacement systems in return for abandoned sites.

It would not be possible to activate a guidance and incentive mechanism of comparable strength to the model of § 35 Par. 1 and 3 BauGB in this manner, though, because it forgoes the interaction with a special privilege in the areas outside of developed urban districts. For the first time, however, it would provide the communities with a concrete tool to actively control the planning of

the “landscape cleaning-up” process without having to rely on the initiative or involvement of certain private investors.

Ambitious perception of inter-communal planning opportunities

The tendency to larger, higher-capacity installations increasingly requires planning at the inter-communal level. Concentration zones which only use the possibilities of a single community as an evaluation basis are often too small to access sufficient development potential for the further expansion of wind energy use in the sense of “rectifying scattered sites” and a comprehensive strategy for increasing capacity through repowering. Under the viewpoint of regional regulations, it therefore appears reasonable to make intensified use of the inter-communal regulatory possibilities. There are basically two methods available for this purpose: to specify inter-communal concentration zones through agreements between several communities regarding a joint planning of sites (inter-communal cooperation) and to compile requirements for concentration zones in the framework of regional planning.

A particular task in this context is the use of areas for wind power in **sites far from residential areas** which have not yet been incorporated in the land use planning. The modern, very large systems will likely often require the designation of new sites. Without claiming to be exhaustive, and aware of the fact that a positive designation presupposes a careful inspection of its suitability in the specific case (especially regarding the interests of nature and landscape conservation), and which means that many individual cases are likely to *not* have a positive result, the following examples of region types are listed here: cleared agricultural land, non-communal regions (state forests, military training areas, previously impacted regions like motorways, railway properties, and “phased-out industrial zones”). The planning authorities should increase their efforts towards the definition of suitable sites for eligible or priority regions in these directions.

As far as possible (if appropriate, also informally in the scope of planning or permit processes), a concerted effort should be made to influence the configuration and external design of wind turbines to not only not disfigure the landscape, but if possible to even enrich it.

Environmental interests in installation planning and licensing

There are conflicting interests regarding wind turbines at the local level:

- On the one side, the community is often interested in installing wind farms. To different extents, they claim advantages for the local economy (business tax revenues), for the regional economy (job creation), or higher-level environmental and energy policy considerations (climate conservation, supply security).
- On the other side, the projects encounter a critical or even negative stance of the people in the immediate surroundings. The criticism focuses on the issues of landscape aesthetics, concerns over noise emissions, especially close by, and light effects (shadows cast in the rhythm of the rotors, warning lights in the evening and at night).

Currently, **explicit mandatory guidelines in immission-protection law** are lacking with regard to the evaluation of shadows, navigation lights at a height, and the noise from wind turbines. Indeed. The basic obligations from § 5 Para. 1 Nos. 1 and 2 of the Federal Immission Control Act (Bundes-Immissionsschutzgesetz – BImSchG), duty to protect and prevent according to the state of the art) are applicable without restrictions to the authorisation process for wind turbines. Miss-

ing are concrete provisions within the law defining these basic obligations for the specific issues regarding wind turbines. Law enforcement agencies are therefore regularly confronted with evaluation questions which are difficult to answer. The official licensing practices are thus not consistent throughout Germany and in some states are strongly affected by restrictive clearance recommendations set by state decrees, which by themselves are not obligatory (more discussion follows).

This situation is particularly unfortunate because technical developments of recent years have already achieved significant improvements to avoid most kinds of problematic impacts (e.g. preventing rhythmic shadow effects by stopping modules, sound propagation by electronic revolution speed variation, and navigation lighting by synchronous operation, reducing the luminous intensity, and shielding). The technology can be formulated and prescribed as the mandatory "best-available technology" for wind turbines.

For these reasons it is recommended to create a regulation within the BImSchG which mandates the best-available technology for wind turbines.

Clearance issues – removing the repressive effects caused by the "wind power decrees"

The state governments in the particularly windy German states of Schleswig-Holstein, Lower Saxony, Mecklenburg-Western Pomerania, and North Rhine-Westphalia are using so-called wind power decrees to assist the offices responsible for making planning and licensing decisions, and thereby to also (at least partially) influence the content of planning and authorisation decisions. In recent years, a tendency towards more restrictive statements could be recognised. The focus of the "decrees" is mostly to prescribe **clearance recommendations**, especially for residential areas, and sometimes also for nature and landscape conservation zones and transportation routes. The clearance recommendations are particularly restrictive in Lower Saxony (1000 metres from residential buildings in the regional planning) and North Rhine-Westphalia (exemplarily formulated categorical recommendation of at least 1500 metres to public residential areas).

Indeed, at a closer look, the "decrees" should only have an **indicative or recommendation character** which, however, does not change the fact that they have a very large guidance effect since the authorising agencies often base their decisions on them in practice.

The significance of clearance requirements at the focus of the wind power decrees should not be underestimated for the further development of wind energy use, especially for repowering. General clearance requirements – i.e. not derived from individual cases – in the range of 1000 or even 1500 metres to residential areas would substantially limit the further development of wind power use and in many regions practically stall it.

If such limitations were provided based on immission protection, then there would be no objection to them from the perspective of an ecological strategy. This is however not the case. If there were mandatory regulations provided in the BImSchG to require the thorough and general application of the best-available technology with regard to noise, light, and shadow emissions, then the clearance requirements could be strongly reduced, even for particularly large installations. However, the fact that there is no generally valid concrete specification of the best-available technology in a binding legal regulation leads to the false assumption that the impacts on the immediate

surroundings caused by wind turbines can only be reduced to an acceptable level by indiscriminately generous minimum distances or strict height limitations.

For this reason, the central recommendation to eliminate these constraints is: create specific standards for the reduction of noise, shadow, and light emissions by wind turbines which are mandatory throughout Germany through a **BImSchG regulation**. In this way, legal certainty is given for the authorisation process and the best-available technology will be immediately implemented. At the same time, unreasonably strict clearance and height restrictions will lose their foundation.

On a side note – the wind power decrees undermine the **regulation of jurisdiction under constitutional law** in so far as they make recommendations which target individual permits or influence urban land use planning. The competent authorities do not posses any latitude of evaluation or judgement with regard to the individual approval process. They are thus not allowed to set any clearance requirements which go beyond those demanded by the BImSchG. The states should also refrain from influencing the urban land use planning, since the BauGB exclusively assigns the authority to structure the urban land use planning to the communities – the states are not entitled to freedoms regarding legal formulations or to actively influence communal structures.

Aspects of nature conservation

As a matter of principle, the interests of nature conservation must be satisfied during the planning and authorisation of wind power installations. There is still a certain need for investigations into specific questions regarding the impact on some specific bird species and bats. The current state of knowledge, however, does not justify challenging the strategy of expanding onshore wind power or making any essential cutbacks in this regard. The procedural requirements of the Environmental Assessment Act (Gesetz über die Umweltverträglichkeitsprüfung - UVPG) and the substantive legal specifications of the Federal Nature Conservation Act (Bundes-Naturschutzgesetz - BNatSchG) regarding the handling of impact effects in nature and landscapes provide a practical strategy to adequately approach the impacts of wind turbines on protected nature.

Therefore, the general clearance requirements from the so-called wind power decrees or from informal recommendations from other sources appear redundant and inappropriate, also with regard to nature conservation, since they do not sufficiently reflect the individual situations and can lead to solutions which excessively exceed the legal requirements for nature conservation.

Improvements to the EEG

The existing economic incentive regulation for **repowering** in the Renewable Energy Sources Act (EEG) does not extend far enough to sufficiently reduce the scenery disruptions caused by scattered installations. It is recommended to extend the regulation of the EEG § 10 Para. 2 No. 1 to *at least* also cover those installations commissioned before 1998.

In order to strengthen the landscape conservation effect of the repowering incentive, the creation of a legal formula should be considered, through which the motivation is not only coupled to the increased capacity, but also to a reduced number of systems.

3 Offshore Wind Power

Some significant changes developed during the time period after the beginning of the R&D project (end of 2003) and before the conclusion of the investigations about offshore wind power in September 2006. These changes require the considerations to be actualised and to some extent significantly influence the formulation of the ecological strategy for offshore wind power. The final report also provides a cursory reflection of further, later changes occurring until the end of 2006.

State of development in the offshore area

A characteristic for the state of development until the end of 2006 is that the preparations for potential investors in the pilot offshore wind farms are prospering and a whole series of wind farms have already been authorised. Nevertheless, the realisation of the projects has not yet begun. Apparently, the development has stagnated.

This situation can be explained by a network of several problems interacting with each other:

- Unlike other countries, Germany aims to concentrate offshore wind power in the Exclusive Economic Zone (EEZ) located far beyond the coastal regions. This location makes high technical demands on construction, operation, and safety. Although technical solutions for all problems exist, valuable practical experience is still lacking for the detailed sophisticated and comparative evaluation of project suitability and to conclusively evaluate the economic standpoint.
- Furthermore, high costs result for the grid connection – also because each and every wind farm must plan with its own connection so far. The realisation of the connections also runs into legal-administrative obstacles, because suitable land-side routes have not been set aside during land use planning and no self-contained authorisation instrument exists for cable routes.
- Credit institutions and insurance companies act restrictively in this situation, resulting in high financing costs.

The result is an unfavourable cost structure which is not adequately balanced by the compensation granted by the EEG (which for its part is lower than the revenues which can be realised in some other countries).

Further expansion perspectives

Specific goals for the expansion of offshore wind power were defined for the first time in the “German Federal Government Strategy for Offshore Wind Power” of 2002. The intention was to expand progressively, with the objective of completing the first construction stage of the “start-up phase” by 2006 with a total installed capacity of ca 500 MW. The first expansion phase should follow with a capacity of 2000 to 3000 MW installed by 2010 and subsequent phases with a capacity of 20,000 to 25,000 MW by 2030.

In view of the problems described here, the **expansion goals for 2010 can not be achieved**. A reliable adjustment of the strategic goals to the significantly changed initial situation turns out to be difficult because the further development depends decisively upon whether and within which

time periods it is possible to overcome the relevant problems and to create the necessary economic conditions. It appears that it is more important to immediately tackle the central problems and tasks than to reformulate quantitative milestones for specific years. If this succeeds, then it would be possible to achieve the goals of the 2002 expansion strategy for the start-up phase and the first expansion phase with a delay of a few years, and it would appear realistic to keep in mind the magnitude of the goals previously set for 2030.

There is no need to question the **long-term goal horizon** for offshore wind power as such in favour of a reduced development. The currently established problems appear to be solvable in principle – as far as this can be judged today. Departing from the ambitious long-term expansion goals would hinder the German climate conservation efforts, in which offshore wind power plays an important role, and at the same time reverse the progress towards securing the national energy supply.

Relatively low strategic importance has been placed so far on the plans for wind power **close to the coast**. The research consortium recognises certain additional potential here which, however, could realistically only be realised in specific cases due to nature conservation concerns – in particular regarding the use of tidal flats and existing interest constellations in the coastal regions. The focus should therefore orient on the EEZ, although it must be emphasised that it seems reasonable to also consider further individual sites within the coastal sea regions and to more closely assess their suitability.

Strategically important aspects regarding the environment and safety

The development foreseen by the German Federal Government does not raise any fundamental objections from the perspective of environmental conservation and precautions as well as marine safety.

The exhaustive regulations and declarations for **marine reserves** in the EEZ (see § 38 BNatSchG) secure the far-reaching regional protection of the species and habitats covered by the Council Directives 79/409/EEC on the conservation of wild birds and 92/43/EEC (known as the FFH Directive) on the conservation of natural habitats and of wild fauna and flora. For the record, however, it must be noted that considerable uncertainties for various species still exist both in regard to how they respond to the installations as also to their roaming and migration movements. It is therefore necessary to continue the systematic investigation of the actual impacts, and thus be able to react appropriately with measures like technical developments, improved site selection, and installation configurations. Analogous issues hold for shipping traffic safety. The safety hazards can be significantly reduced, but not completely prevented, by avoiding routes and areas with a high traffic volume.

The **progressive strategy** of the development set by the Federal Government should therefore be maintained. It is of central importance to the precautionary principle to subject the realisation of expansion stages to the most reliable findings possible about the compatibility of later expansion stages with marine conservation interests and safety.

There is still a considerable need for research and development with regard to the **technical possibilities** to reduce environmental impacts and safety hazards. Due to the lack of practical experience with high-capacity wind turbines under EEZ conditions (very deep water, salt content of the water, extreme winds, high wave wash, etc.), their various construction types (monopile,

tripod, jacket, etc.) can not be evaluated conclusively at this time with regard to both their suitability and their crash behaviour with ships (catchword: collision-friendly fundament constructions).

The **licensing regulations** for wind turbines in the EEZ anchored in the German "Seeanlagenverordnung" place a high value on the interests of marine environment and nature conservation. In some situations, however, it would be helpful if the legally binding regulations were better defined in order to unequivocally protect the different interests of environmental and nature conservation and at the same time create a higher level of legal certainty for investors (in particular by adjusting the licensing facts for marine installations to the terminology usually used in environmental and installation licensing law and by defining technical standards – catchword: "best-available technology").

With regard to site selection and specification of cable routes for connecting the wind farms, the authority granted to the Federal Government by the Federal Regional Planning Act (Raumordnungsgesetz - ROG) from 2004 for the **regional planning in the EEZ** (see § 18a ROG) provides considerably improved guidance possibilities from the environmental point of view. These possibilities should be actively employed for the balanced and comprehensive regulation of the various utilisation and conservation interests in the EEZ (if possible under international and European law). (The approach is suggested to take advantage of the guidance instrument of defining formal "suitable areas" to guide the site selections for offshore wind farms. in this way, the wind farms would be excluded from other areas in the planning region. The current and foreseeable state of knowledge, however, does not provide a sufficient basis for a complete programme of positive-negative identification of offshore wind farm sites in the EEZ. Defining "suitable areas" can therefore only be considered for delimited partial regions at the most. For the rest, the "priority area" planning category can generally be applied (without exclusion effects elsewhere). For environmental strategy purposes, the suitability or priority areas must generally fit into a systematic regional pattern.

Grouping cable routes, simplifying the authorisation of cable connections, upstream grids

A task which has not been satisfyingly solved so far is the connection of offshore wind farms with the onshore transmission grids. The land use planning does not foresee providing space for the transmission line routes in the coastal regions. In each case, several licensing processes involving different authorities must be performed, in some cases with a legally uncertain result. A sufficient legal and economical basis is lacking for the **ecologically and economically desirable grouping** of cable routes for several wind farms.

In the short term, therefore, improvements can hardly be achieved for the pilot wind farms, because the planning and licensing processes are already far advanced. However, a systematic grid infrastructure must be built up in the marine region for the later expansion phases (catchword: "**upstream grids**"). Corresponding route planning should begin immediately while consulting the neighbouring countries on the coast (and also considering the option of transboundary joint power lines). The German Federal Government should recognise the goal to provide the prerequisite grid infrastructure for connecting offshore wind farms as a planning task of national importance.

Besides the fact that ecologically acceptable preliminary decisions regarding space use must be met, a suitable legal basis for the development of upstream grids in coastal regions must also be

created. The necessary liability regarding *who* operates the grid infrastructure and *how* it will be financed must be established and regulated in the licensing regulations or elsewhere.

For the transitional period (until 2010) a first regulatory component was created (after concluding the investigations in this project) in the **§ 17 Para. 2a of the Federal Act on Energy Supply (Energiewirtschaftsgesetz - EnWG)** which was newly adopted in the course of the "Law for Accelerating Planning Processes for Infrastructure Projects" (Infrastrukturplanungsbeschleunigungsgesetz – InPBeschlG) and to which possibly (still to be verified) other perspectives could be tied in. According to this regulation, the individual wind farm operators are no longer responsible for supplying and operating the wind farm grid connection, but rather supra-regional transmission system operators. The specific costs are to be apportioned nationwide. Based on this model, it can be expected that the responsible parties will develop a proper interest in the extensive grouping of the power line routes.

On the legal level, the task arises in this context (but also independently) to create an **integrated licensing process** for stretches of cable in coastal waters and on land, to replace the current parallel, separate licensing processes. This goal could be realised without too much regulation-specific effort by extending § 43 EnWG. This regulation enables an integrated authorisation process (since late 2006) for the stretch from the coastline to the grid-connection point on land, however not for the area in the coastal waters. For this purpose, the necessary legislative procedures should be initiated as soon as possible because of the long lead times for planning. It is also a conceivable alternative to create a corresponding regulation in the context of a general revision of the authorisation instruments for marine facilities.

The **German coastal states** could contribute significantly to the realisation of this essential element of an ecological strategy for the development of offshore wind power by promoting the necessary regional planning steps for the identification of suitable transmission line routes in coastal waters and on land with sufficient capacity to also enable the later expansion phases. Furthermore, it appears advisable to create special provisions at the state level for admitting the use of the Wattenmeer (tidal flats) National Park.

Improving the instruments for licensing marine installations

From the perspective of legal clarity, for dismantling existing legal uncertainties, and - last but not least – for the purpose of empowering the guidance effect of the licensing instruments in terms of the precautionary principle in environmental policy, a fundamental **revision of the authorisation law** for marine installations is advisable. The recommendation is to pursue a completely new version of the regulations at the statutory level.

In the process, the possibility to specify / secure **progressive expansion plans** should be created (empowering authorities to limit the size of wind farms for precautionary purposes, and protecting the right of expansion for further project stages with a provisional positive global assessment).

Economic incentives

As already established above, the use of offshore wind energy is associated with substantially higher costs than those assumed within the scope of the amendment to the EEG 2004. Therefore, the pilot projects planned during the investigation period until September 2006 turned out to

be not economically feasible, despite the incentives provided by the EEG 2004. This situation was particularly true for the first “pioneering projects”.

The question thus arises of whether the incentive strategy in the EEG needs a general revision for the area of offshore wind power. However, the observations do not confirm this need. Indeed, it is obvious that the compensation foreseen by the German EEG lags relatively far behind that offered by other European countries. It therefore stands to reason that the feed-in tariffs should be newly tailored to the present circumstances and state of knowledge. The function of the feed-in system employed in Germany is recognised as fundamentally advantageous as compared to the quota-obligation systems or tendering systems applied in other countries. Switching to a quota-obligation or tendering system would significantly increase the financing risk once again. The EEG system should therefore be retained. However, it should be tailored to the changed economic situation during the proximate adjustment of the compensation provisions.

Through the insertion of §17 Para. 2a in the EnWG in late 2006, a solution to the special economic challenge entailed in the start-up financing of the first pilot projects is emerging, according to which the task of installing and operating connection lines for offshore turbines will belong to the coast-side transmission grid operators in the future. A significant reduction of the total costs for a wind farm project is expected as a result of the regulation. The extent to which the new regulation influences the profitability of individual projects cannot be authoritatively determined without performing a more specific economical investigation, possibly elsewhere, which considers various exemplary variants. However, it is certain that the regulation will considerably improve the profitability of the pilot projects.

Nevertheless, the extent to which the economic conditions need to be further improved should depend on a careful evaluation of the new regulations. A fundamental examination of the economic starting point for offshore wind power at the changed conditions is recommended within the scope of the EEG feed-in tariffs revision planned for 2008. From today’s point of view, and despite the § 17 Para. 2a EnWG, the existing technical-economical initial conditions argue more for a further increase than for a reduction of the general feed-in tariffs for offshore wind power if the objective of making offshore wind power an essential element of Germany’s power supply should be maintained.

4 Onshore Transmission System

Initial situation

Considerable obstacles to the realisation of the development strategy can result from the inadequate provisions to **assure sufficient transmission capacity** for transporting the increasing amounts of electricity generated by the wind power plants in North Germany and at sea to the centres of consumption.

Already today, individual wind farms must be temporarily disconnected when the electricity grid is overloaded so that the electricity can not be fed in. The problem will get worse in the near future since electricity generation capacities are building up faster than the grid capacities needed to transmit it are being expanded. The assurance of sufficient transmission capacity is of elemental importance, in particular for the offshore development strategy, since considerably larger amounts of electricity must be managed than from onshore systems. The integration of offshore

installations into the high-voltage and extra-high-voltage grids on land therefore requires a particular effort to plan for sufficient transmission capacity.

The study on electricity grids published in 2005 by the German Energy Agency (Deutsche Energie Agentur - dena) was criticised on some points by the researchers regarding method and content. Notwithstanding, it documents the urgent necessity to quickly begin with concrete efforts to expand the transmission capacities. In this respect, it is a considerable problem that the involved grid operators have neither a sufficient self-interest in increasing the capacity, nor can they be legally obligated to carry out particular expansion measures.

The 2005 revision of the EnWG categorically obligates the operators of transmission grids to provide sufficient transmission capacity (see § 12 Par. 3 EnWG) and amends this obligation so that the grid operators must prepare a status report on the grid expansion every two years (§ 12 Para. 3a EnWG). However, the law does not define concrete instruments for reprimanding failure to comply with the reporting obligation, nor does it provide the responsible authorities with the means to obligate the grid operators to specific grid optimisation or expansion measures.

Technical optimisation of grid use

The required actions described in the dena grid study focus unilaterally on electricity grid development measures without, however, considering the possible technical solutions for grid optimisation. Notably, the possibility to increase the transmission capacity through the so-called temperature management method is not considered. Temperature management involves controlling the grid use as a function of the wire temperature. The transmission capacity is a great deal larger at low wire temperatures (caused by the ambient temperature and cooled by wind or rain) than at high wire temperatures. Up to now, however, it is common practice to limit the line transmission capacity to that for unfavourable standard conditions – constant high ambient temperature and constant low wind speeds. In contrast, temperature management enables the transmission of considerably higher currents for periods of lower wire temperatures.

The environmental dimension: underground cables instead of overhead lines

A considerable expansion of the electricity grid will be unavoidable even after exhausting the technical potential to increase the existing capacity. An appropriate alternative to high-voltage overhead transmission lines is underground cables.

Overhead transmission lines are perceived to considerably disrupt the view of a place or landscape. Especially the 200-kV and 380-kV overhead transmission lines cause great problems with respect to landscape conservation because of their large mast heights and route widths. Scenic areas must often be widely circumvented, quantitatively increasing the demands on the landscape.

The alternative – underground cables – do not visibly impact the landscape (except for keeping the narrow routes accessible for maintenance purposes). Correspondingly, underground cables are typically widely endorsed at a local level. This is a major reason for the authorisation process for underground cables to be several years faster than for overhead transmission lines, especially because years of judicial conflicts do not need to be allowed for.

An essential disadvantage of underground cables as compared to traditional high-voltage overhead transmission lines is their higher investment costs. For the 110-kV voltage level they are

balanced by lower additional costs (e.g. for land purchases, compensation measures, authorisation process) and less voltage loss during operation. However, the extra investment costs for underground cables are higher for higher voltage ranges. The total costs for underground cables for the pertinent 380-kV range are several times higher than for overhead transmission lines. It is therefore reasonable and necessary to simplify procedures and to create suitable economic incentives in order to promote underground lines.

During the legal process for the "Law to accelerate planning procedures for infrastructure projects" late 2006, it was unfortunately not possible to create a general regulation which would allow the **additional costs** for laying underground cables to be apportioned among the grid users when residential areas or the environment / nature would thereby be protected. The law includes a corresponding regulation for extra costs only for the coastal regions up to 20 km landwards, but not however for transmission line projects located elsewhere. A result of this research project is the recommendation to begin an initiative to expand the region included in the regulation.

Guidance instruments ensure sufficient transmission capacity

Since both the EnWG and the EEG do not supply provisions for an effective guidance instrument for ensuring sufficient grid capacity, it is recommended to amend the statutory provisions in this respect.

The research consortium prefers a problem-solving approach which is strongly oriented on the idea of a higher-level, "big-solution" plan with the following elements:

- obligation for the grid operators to prepare concrete grid expansion plans,
- federal administrative specification of a demand projection based on these plans with an obligatory assessment of the expansion measures required for renewable energy,
- nation-wide apportionment of the necessary costs caused by renewable-energy-related expansion measures among transmission grid operators.

The goal of this strategy is to use the apportionment mechanism, along with constructive links to the previous demand assessment and their own grid expansion planning to create a maximal incentive for the grid operators themselves to proactively plan the measures necessary for possible capacity increases in the future. The more dedication they develop in this respect, the better their chances to realise their strategies with low friction losses (also in the authorisation procedures required for the expansion measures) and subsequently be able to partially refinance them in a nation-wide apportionment process.