SRU German Advisory Council on the Environment

Pathways towards a 100 % renewable electricity system

Chapter 10: Executive summary and recommendations

Provisional Translation

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10 Executive summary; suggested course of action

10.1 A wholly renewable electricity supply: a worthy energy policy and climate protection objective

10.1.1 Scope of this report

632 Climate policymakers are facing the challenge that greenhouse gas emissions in industrial countries need to be reduced by 80 to 95 percent in order to avert what is widely regarded as a dangerous rise in global temperature amounting to more than 2 °C relative to the pre-industrial level. The European Council officially endorsed this objective in 2009. In the view of the European Commission, only a minute proportion of the attendant reductions can be achieved through implementation of flexible mechanisms outside the EU. In Germany, there is a broad political consensus about ambitious climate protection objectives. The Federal Government has endorsed the national goal of reducing greenhouse gases by 40 percent by 2010 relative to 1990 levels and has also recognized the need to further reduce greenhouse gases by at least 80 percent by 2050.

In its current form, electricity accounts for roughly 40 percent of total German carbon emissions, thus making electricity supply a touchstone of our energy and climate policies. In order for carbon emissions to be reduced by 80 to 95 percent, German power plants would need to be virtually emission free since for technical reasons, emissions cannot be reduced sufficiently by 2050 in other sectors such as agriculture and goods transport, or the costs of such reductions would be prohibitive, whereas the requisite technological solutions are already available to electricity companies. Hence the present report addresses the issue as to whether a sustainable and climate friendly electricity supply can be achieved in Germany, without taking account of the heating or transportation sectors.

633 Germany will be facing key decisions in the coming years concerning the structure of its power supply much of whose generation capacity will need to be replaced over the next two decades since many power plants will be nearing retirement by then. The investments that are made in the coming years will have a major impact not only on the structure but also the emissions associated with the electricity sector for decades. This situation presents an opportunity to set in motion a relatively low cost but far reaching structural change of the sector.

634 We can only achieve a sustainable and climate friendly electricity supply system over the long term if it is based on renewables ***(see chapter 2, section 10.1.2)***. The vast majority of Germans support the concept of a power supply that is mainly based on renewables and this goal has also been endorsed by the current coalition government. Such a goal represents an opportunity for sustainable technological and infrastructure innovation here in Germany that will help ready our country to face future challenges in this sphere.

The present report is one in a series of recent studies that show that in Germany and Europe a complete or nearly complete shift of the power supply to renewables could be achieved. But the following issues which in our view are key, are not being given the attention they deserve:

– Is a wholly renewables based electricity supply technically feasible for and in Germany? Would such a system ensure security of supply that is on a par with today's?
– How much would a wholly renewable electricity supply and the transition thereto cost?
– What would be a realistic timeline for the transition to such an electricity supply and which measures would this transition entail?
– Which challenges would have to be met in transitioning to a renewables based electricity supply? Which political and legal frameworks would need to be taken into account for such a transition in the European context and how much leeway do they allow?
– Which political measures and instruments of policy control could be used to bring about this transformation smoothly and efficiently?

In September 2010, the German government issued an energy scenario-based energy concept containing a far reaching electricity supply roadmap that the German Advisory Council on the Environment (*Sachverständigenrat für Umweltfragen, SRU)* assessed in a separate comment. Many elements of the government's energy concept, particularly those relating to the period to 2050, the long term objectives laid down in the concept, and the proposed electricity grid expansion measures could potentially come to be regarded as exemplary at the international level. That said, the present report goes further than the government's energy concept in terms of both climate protection objectives and the envisaged energy mix, while at the same completely parting ways with the government's strategies for the transition to renewables by 2050. In our view, the prospects for this transition are far brighter than the government would have us believe; and we are far less persuaded than the government appears to be concerning the compatibility of nuclear power and renewables. But many of the recommendations and concepts in the present report are relevant regardless of whether the goal is to achieve 80 or 100 percent renewable electricity.

10.1.2 The prospects for achievement of a sustainable and climate friendly electricity supply in Germany by 2050

635 Transitioning towards a low carbon power sector is currently at the centre of the polical debate and is also a key issue for the German Advisory Council on the Environment (*Sachverständigenrat für Umweltfragen, SRU).* The only way to reduce Germany's overall carbon emissions over the long term is to completely decarbonize our country's electricity supply system. The low carbon technologies needed to do this are already available, or will be in the foreseeable future; these technologies include renewable energy such as wind, solar, biomass and geothermal energy, nuclear power, and fossil fuel power generation using carbon capture and storage technology.

That said, energy policymakers should be basing their technology decisions not just on how climate friendly a particular technology happens to be, but also on the overall statutory framework for environmental sustainability at the international level (Rio Declaration, UNFCCC), EU level, and national level (article 20a of the German Constitution; the German government's sustainability strategy). The main sustainability factors that come into play in this regard are as follows: compliance with the absolute sustainability and input limits of natural systems; taking steps to ensure intergenerational and global justice (instituting equal per-capita usage levels for common-pool resources). The Earth's climate system and biodiversity are natural systems whose ecological input limits have already been exceeded and that are urgently in need of protection. Needless to say, in order to meet the aforementioned sustainability criteria in particular (maintaining the sustainability of natural systems; achieving generational equality), it will be necessary to minimize the risk of irreversible or catastrophic events.

636 In view of the fact all energy generation technologies affect the ecobalance in one way or another, there is simply no such thing as 100 percent environmentally neutral energy generation. That said, the comparative sustainability assessment that we carried out shows that renewables constitute the only sustainable energy option.

The main goal that we need to be aiming at – fully decarbonized electricity generation – cannot be reached either through more efficient conventional coal fired power plants or carbon capture and storage (CSS) technology. Moreover, the use of coal fired power plants entails large-scale raw material extraction operations which despite improved air purity efforts result in significant air quality problems. As for CCS, its use is limited by the available storage capacity and competition from other potential uses of this capacity. Although greenhouse gas emissions from nuclear power plants are far lower than for coal fired power plants, the use of nuclear power entails the risk of accidents – an eventuality that cannot be completely ruled out and that could have consequences for large areas and for extended periods of time; plus no viable solution has been found for long term storage of nuclear waste. In our view, this is a high price to pay; and what's more, nuclear power may not be a sustainable solution in view of the limited supply of uranium. Hence in our view neither coal fired power plants nor nuclear power can be qualified as sustainable energy resources.

637 But renewables are not always without problems either, notably in that growing energy crops (a) may provoke land use changes that have a substantially negative climate warming effect; (b) may have a deleterious impact on natural capital; (c) may cause considerable environmental damage; and (d) may run afoul of the principle of equal usage rights by competing with food crop production. Other renewables and the transmission and storage capacity expansion needed for them can also provoke conflicts in terms of land or ocean use. Moreover, renewables entail the use of resources such as water and rare metals.

638 That said, in the view of the SRU, the ecological problems associated with renewables are manageable and could be minimized through policy and planning measures. The environmental problems posed by coal fired power plants and nuclear power plants are mainly of a technological nature and the same, regardless of location, whereas renewables provide some leeway in terms of localization – providing, that is, that actual energy consumption is far lower than the putative potential offered by renewables. Ecological conflicts could be largely mitigated if power plant construction was supported by regional planning.

Another key factor here is that renewable-energy power plants are normally smaller and easier to dismantle than the counterpart conventional facilities, and thus are more flexible infrastructure components. Whereas nuclear and CCS coal plants are associated with long term consequential environmental damage and risk resulting from coal mining, nuclear waste storage, and carbon storage, the environmental impact of renewable energy is generally confined to the service life of the installation. And at least for solar and wind power, their environmental impact is confined to the plant construction phase, whereas fossil and nuclear power plants necessitate sustained land and natural resource use to mine the fuels needed. Renewables are not only sustainable, but are also in line with the precautionary principle in that, in view of the present uncertainties, they can be adapted more flexibly to changing conditions and have a greater tolerance for error. Hence renewables are superior to conventional energy resources in terms of generational equity and risk avoidance, thus making renewables more sustainable. And this in turn means that renewables are the only viable sustainable solution for electricity generation.

639 When it comes to determining the way forward for implementation of an electricity system that will make a major contribution in the fight against global warming, the government needs to opt for solutions that are maximally compatible with the sustainability and precautionary principles laid down in article 20a of the German constitution . In the present report, we make the case for an energy policy that promotes anything other than renewable energy sources over the long term is at odds with the stipulations of the aforementioned constitutional clause.

640 But needless to say, transitioning to a renewables based electricity supply needs to be (a) widely accepted by the general public; and (b) consistent with the classic energy policy goal of assuring a reliable supply of affordable energy. In view of this key exigency, the present report assesses the technical, economic and political feasibility of instituting a fully renewables based electricity system in Germany.

10.1.3 A secure and affordable wholly renewable electricity supply is well within reach

641 The scenarios laid out in this report show that there are various options for institution of a wholly renewable electricity supply in Germany. These scenarios were developed at our request by the German Aerospace Centre (DLR) using the DLR's REMix model (see chapter ***3***).

Methodology of the REMix model

642 The REMix model is based on a geoinformation system which, using a high resolution grid, documents the electricity generation potential of all renewable energy sources in Germany, Europe and North Africa, and then uses the results to compute a cost optimized (i.e. lowest possible cost) energy portfolio for the defined conditions (***see section 3.3.1***).

643 Inasmuch as the model uses one hour time intervals, it can correlate annual electricity generation with electricity demand down to the hour. This in turn meets the challenges posed by an electricity system that makes increased use of wind and solar energy whose availability varies over time. An electricity supply that satisfies demand at all times must be achieved either through the use of overlapping renewable electricity resources and/or stored electricity. To this end, for the target year 2050 we modelled (a) the use of hydro power, in conjunction with wind, solar, biomass and geothermal energy as well as electricity storage technologies; and (b) cost optimized constellations of these energy technologies for each relevant instance. These calculations presupposed that learning curve effects will drive down the cost of renewable energy over the long term. The cost suppositions used by the DLR in the REMix model are the fruit of thorough research and continuous updating, but are regarded in some quarters as overly optimistic and in others as unduly pessimistic (***see section 3.3.1***). Hence the actual costs associated with renewable energy technologies going forward may turn out to be higher than those predicated here, and the actual cost-optimized portfolio of renewable energy sources may differ from the structure that was modelled for the present report.

Our scenarios are confined to those renewable energy technologies that are already well established and for which a reasonably reliable estimate of future costs can be effected. Although other renewable energy technologies such as wave and tidal energy are in the pipeline that offer additional options and leeway for implementation of a fully renewable electricity supply, these technologies were excluded from the DLR model owing to a lack of reliable data.

644 All eight of the scenarios we present here presuppose that Germany can and will implement a wholly renewable electricity supply by 2050, albeit under varying conditions in respect to grid connections with other countries and the electricity demand that will need to be met (***see Table 10-1***). We also compare the following putative models with each other:

German energy self sufficiency (scenario group 1); a regional network involving Germany and Scandinavia (scenario group 2); and a Europe-North African network (scenario group 3). Scenario group 1 can be regarded as a last-resort worst case scenario; for even if 700 TWh electricity demand in 2050 (a high estimate) can be met with domestic renewables alone, it follows that things will be much easier under less restrictive conditions. That said, scenario group 1 is not a desirable solution for economic reasons and from the standpoint of EU law.

All of the scenarios presuppose that all participating countries will jointly seek to transition to renewables and that for reasons of security of supply each such country has a vested interest in generating a minimum percentage of its energy from domestic resources. Maximum net import of 15 percent of total generated electricity was predicated for Germany.

645 All of the scenario computations are based on projected total electricity demand in Germany amounting to 500 and 700 TWh. We presume that a German electricity demand plateau of 500 TWh is achievable over the long term, even if electricity demand rises substantially in the heating and transportation sectors. But to do this, we will need to leverage the efficiency optimization potential not only for electricity use but also in the building renovation and heating and hot water provisioning domains. The scenarios based on electricity demand amounting to 700 TWh clearly show that a wholly renewable electricity supply would be within reach from a technical standpoint even if energy efficiency and savings policies are not successfully implemented and electricity demand rises far more sharply than expected.

646 However, as is always the case with long range scenario studies, the findings we present here are subject to significant uncertainty as it was necessary to make a series of suppositions concerning evolutions that are difficult to forecast. Our scenarios are intended to show that a wholly renewable electricity supply is within reach under various conditions; and (a) do not constitute a forecast of the evolutions that might come into play here; (b) do not indicate a preference on the part of our organization for a specific portfolio of renewables or for any particular cross-border energy supply network solution; and (c) are not intended as a blueprint for the transition to a wholly renewable electricity supply. Instead, our scenarios merely provide a selection of the many possible solutions that come into play here.

Table 10-1

Eight scenarios for a wholly renewable electricity supply by 2050

	German electricity demand in 2050: **500 TWh**	**German electricity demand in 2050:** **700 TWh**
Self sufficiency	Scenario 1.a: DE 100% SV-500	Scenario 1.b: DE 100% SV-700
Net self sufficiency Interchange with Denmark and Norway	Scenario 2.1.a: DE–DK–NO 100% SV-500	Scenario 2.1.b: DE–DK–NO 100% SV-700
Maximum 15% net import from Denmark and Norway	Scenario 2.2.a: DE–DK–NO 85% SV-500	Scenario 2.2.b: DE–DK–NO 85% SV-700
Maximum 15% net import from the Europe-North Africa region (EUNA)	Scenario 3.a: DE–EUNA 85% SV-500	Scenario 3.b: DE–EUNA 85% SV-700

DE: Germany; DK: Denmark; NO: Norway; EUNA: Europe and North Africa; SV: self sufficiency

SRU/SG 2011-1/Table 10-1

In a second step, the findings from the 2050 scenarios were used to determine how the available electricity generation, transmission and storage capacities would need to evolve in order to achieve the defined target state by 2050. Based on the characteristics of the existing power plant fleet, we show how conventional generation capacity could be replaced incrementally by renewable energy (***see chapter 4***).

Findings

647 Our scenario computations show that Germany could readily achieve a wholly renewable electricity supply that is both reliable and affordable. Providing that the relevant storage facilities and grids are implemented, the renewable energy potential in Germany and Europe would allow for the satisfaction of maximum posited electricity demand at all times throughout the year, using wind turbines, solar collectors, and other currently available technologies and despite fluctuations in the availability of renewable electricity. As the lowest cost energy resource in the run-up to 2050, wind energy, particularly from offshore wind turbines, plays a pivotal role in all of the scenarios discussed in the present report. On the other hand, the level of solar energy use in the various scenarios varies according to electricity demand and the amount of electricity that is imported. Biomass use in the scenarios involving transnational energy supply networks accounts for no more than 7% of electricity demand, largely owing to land use conflicts and the relatively high cost of this energy resource.

The envisaged upgrading of Germany's power plant fleet offers a golden opportunity to transition to a wholly renewable electricity supply at a relatively low cost and without engendering any discontinuities in supply structures.

648 In view of the fact that ambitious energy saving and efficiency policies would go a long way toward easing the transition to a wholly renewable electricity supply, efforts should be made to reduce and (over the long term) stabilize German energy demand. This would lower the economic and ecological costs of the system, improve its robustness, and promote rapid implementation of the necessary transformation process.

649 Although a wholly renewable domestic electricity supply without any electricity importing would be feasible, this option should definitely not be pursued in light of the evolving EU-wide internal market for energy. Although various European inter-regional networks may well be feasible, we have elected to illustrate the feasibility of only two such scenarios. A Germany-Denmark-Norway energy network would allow for the use of the enormous pump storage system capacity in Scandinavia. This option, which has been largely neglected in the energy policy debate, has been analysed by our scenarios in detail. That said, a more far flung European energy supply network with a number of EU states availing themselves of low cost response power (particularly from Norway) would help Germany to achieve a wholly renewable electricity supply – which in any case can only be achieved by expanding offshore wind power capacity and high capacity lines in the North Sea region, and through the use of pump storage systems.

650 In the view of the SRU, instituting a wholly renewable electricity supply in Germany by 2050 would entail economic advantages in addition to promoting climate protection, whereby the aggregate costs of such a system would be largely determined by the extent to which a network comprising other European countries is established. Inflation adjusted, a wholly renewable electricity supply using German resources only would be relatively cost intensive, ranging from 9 to 12 euro-cents per kWh, depending on demand. On the other hand, an inter-regional smaller-scale German-Danish-Norwegian or larger-scale Europe-North Africa network would provide electricity at a cost of only 6 to 7 euro-cents per kWh, including the cost of international grid and storage capacity expansion. Our rough estimates indicate that expanding the German grid would entail additional costs amounting to approximately 1 to 2 euro-cents per kWh.

651 Over the long term, renewable electricity will prove to be less cost intensive than conventional low carbon technologies such as CCS power plants and new nuclear power plants, whose costs will rise owing respectively to limited uranium resources and storage facilities. The price of nuclear energy will also be driven upward by the currently unforeseeable costs of long-term nuclear waste storage, whereas renewable energy costs will decline owing to the effects of learning curves and economies of scale. Whereas timely short term expansion of renewable energy resources will entail higher near-term investment and generation costs than the cost of extending the service life of existing power plants, it will nonetheless allow for long term cost savings not only in terms of direct costs but even more so in terms of social costs, and is thus a worthwhile investment in the future. In our estimation, we will begin to see such savings from a wholly renewable electricity supply between 2030 and 2040 if the attendant costs decrease as per the timeline in chapter ***4.7***, and somewhat later if these costs decline more slowly than forecast in the said chapter.

10.1.4 Transitioning to renewables would not entail either significant service life extension for existing conventional power plants or the construction of new coal fired power plants

652 A smooth and incremental transition to renewable electricity can be readily achieved by successively shutting down conventional power plants when they reach the end of their service lives and replacing these facilities with renewable electricity capacity (***see chapter 4***). Our transition scenarios presuppose that the mean service life of conventional power plants will be 35 years and that the current rate of renewable electricity expansion will be maintained (which are rather restrictive conditions). To do this the annual absolute capacity expansion rate for renewable electricity would have to increase to an average of 6 GW per year by 2020 (scenario 2.1.a), a rate that is consistent with that achieved in past years; and in the unlikely event that no electricity saving measures are instituted, this figure would be 8 GW a year, as per scenario 2.1.b. In our estimation, even this elevated expansion rate could be successfully achieved by the relevant industries. But if German and EU energy efficiency objectives are steadfastly implemented; or if the altogether realistic scenario comes true that operators of conventional fossil fuel fired power plants will want to keep their facilities in operation for longer than an average of 35 years, annual renewable energy capacity expansion clearly below 6 GW will suffice between now and 2020.

653 These scenarios (2.1.a and 2.1.b) obviate the need to extend the service life of nuclear power plants or to build new coal fired power plants with carbon capture and storage (CCS) systems. In other words, our existing fleet of conventional power plants, combined with a handful of newly built gas turbine plants, would provide a sufficient bridge for a transition to a wholly renewable electricity supply. Hence a transition scenario based on a relatively brief average service life amounting to 35 years for conventional power plants offers sufficient leeway and flexibility for the eventuality that network, storage capacity and generation capacity expansion for renewable energy will proceed more slowly than expected.

A largely renewables based system would have less of a need for base load power plants. The high volatility of renewables will necessitate a substantially higher level of flexibility on the part of all conventional power plants. The number of shutdowns required and rapid startup and shutdown procedures will rise in accordance with the increasing residual load, and will obviate the need for a permanently available and consistent base load. Hence, once renewable electricity begins accounting for approximately 30 percent of aggregate electricity capacity, the construction of new conventional power plants will become unprofitable since it will no longer be possible to operate them at a sufficiently high capacity use level. And if proportional renewable electricity use rises further still, base load power plant operation will become problematic from a technical standpoint as well. Moreover, extending nuclear power plant service life or building new coal fired power plants would entail the risk of surplus capacity over increasingly longer periods, thus necessitating renewable capacity downtime or cost intensive underuse of conventional capacity and unnecessarily ramping up the costs of the transitional phase. Hence a blanket and pronounced extension of the service life of our nuclear power plant fleet would be incompatible with our scenarios involving a transition to a wholly renewable electricity supply.

10.2 Transitioning to renewables: the challenges

10.2.1 A new balance between market forces, government planning and public participation

654 The main political challenge entailed by the transition from a non-sustainable to a sustainable energy system is overcoming the path dependency of our current electricity generation system – which, if continued will be the death knoll for achievement of the mandated climate policy objectives.

655 The German government will need to handle a host of new challenges and tasks if it wants to set in motion and coordinate the process of transitioning to a renewable electricity system. Extensive transformations of this nature can only be accomplished with strong political leadership, clearly defined goals, and the necessary political will, all of which must be wholeheartedly supported by the majority of the population. Even if regulated markets and private sector market actors continue to play the same central role that they do today, market forces alone will not suffice to drive the transition to renewables. For apart from fulfilling its classic role of establishing the requisite conditions and providing the necessary incentives for market actors, the government will also need to perform additional forward looking coordination and planning tasks so as to ensure outcomes and, above all, provide investment certainty for market actors. The government’s brief in this regard also includes making fundamental technology policy decisions that will promote a sustainable electricity supply. This in turn will necessitate considerable orchestration of capacity expansion for renewables and the attendant infrastructure projects, which require considerable planning lead time. In this sense energy and climate policy cannot be technology neutral as electricity grid expansion needs partly depend on the electricity generation technologies and generation locations that come into play. ; and thus it will be necessary to rethink the strategic role played by public planning, who should seek to avoid the mistakes provoked by the top-down approach to planning of past years and who should instead embrace successful, learning-friendly, and participatory modalities that are already in wide use. Over the long term, following a successful transitional phase, the decentralized and standalone organizational modalities promoted by market forces will regain relevance.

656 The policy thrust entailed by such a transformation has the following overarching dimensions:

- Germany's energy and climate policies are intertwined with those of the EU, in that certain key ground rules are predetermined or prescribed by EU law, particularly those concerning emissions trading and the EU energy market. Hence any attempt at transitioning to a wholly renewable electricity supply will need to intermesh with EU energy law and climate policies, which are currently in a profound state of flux. Instituting favourable conditions at the EU level could ease the task of management at the national level, whereas setting opposing policy objectives at the EU level could jeopardize German implementation of a national energy concept.
- One of the central factors for successful grid and storage capacity expansion in Germany is regional cooperation within the EU, particularly with Norway and Switzerland, but also possibly with partner states in North Africa and Eastern Europe. This would open up new possibilities for a proactive German foreign policy in the energy domain, which would need to be in keeping with the allocation of powers and responsibilities in the EU. Public-private partnerships for such projects have already recognized the supreme importance of such cooperative arrangements.
- The transition to a wholly renewable electricity supply must be fully in keeping with German Constitutional principles and will also need broad political support. In this respect, a cross-party consensus is about to emerge, at least for the transition towards a renewable power supply in the long run. And as this goal can readily be reached by 2050, it should be unstintingly enshrined in the government's policy agenda and in party platforms. Sustaining this kind of radical transformation across numerous legislative sessions will necessitate broad support among the electorate and a nonpartisan consensus; and to accomplish this, we will need a fundamental debate concerning the long term benefits of a wholly renewable electricity supply.
- This process is essential if we are to pave the way for better acceptance of the transition at the local level, since energy policy dissent at the federal level is oftentimes mirrored by local resistance to essential infrastructure investments. Hence transforming our electricity sector simply must go hand in hand with an open, frank, transparent and pluralistic public discussion of the relevant issues. Electricity infrastructure planning and investment should translate into opportunities for participatory activities at all levels. In the end, our political leaders will need to make clear decisions, which may encounter resistance at the local level. But it is crucial to clearly convey to the citizenry the supreme energy and climate policy importance of the proposed measures for implementation of the necessary overarching climate policy concept. Transforming the electricity supply system will also

require political leaders to devise policies that extend a helping hand and offer new opportunities to those members of the population who are left holding the short end of the stick as a result of the structural changes entailed by the transformation.

657 Following are a number of energy and climate policy considerations that we feel are particularly important when it comes to placing Germany's electricity system on a fully sustainable footing:

– Inasmuch as energy efficiency is the actual (so to speak) bridging technology for and to a wholly renewable electricity supply, it must be vigorously promoted.

– In order to lay the groundwork for such a transformation and create the key economic incentives necessitated by it, statutory climate protection and decarbonization objectives should be set for Germany and the EU for 2050 and translated into emissions trading policies.

– Moreover, in order to pave the way for a secure, efficient and wholly renewable electricity supply, EU and German support schemes should be developed for renewable energy.

– No new power plants should be constructed which, for technical and economic reasons, do not allow for highly flexible electricity generation and that are inconsistent with Germany's long term climate protection objectives. Moreover, the envisaged service life extensions for nuclear power plants are likewise incompatible with the flexibility requirements that need to be met for the transition to renewable energy.

– In order to have at our disposal a reliable supply of electricity, in tandem with the expansion of renewables it will also be necessary to expedite the process of adequately expanding and above all converting the electricity grid. To do this, investment incentive and grid planning modalities will have to be fundamentally altered.

– In order to move forward with the process of connecting our electricity grid with and leveraging Scandinavia's extensive and relatively low cost pump storage potential, it is in Germany's strategic energy policy interest to enter into cooperative arrangements with North Sea states.

10.2.2 New incentives for energy efficiency policies

658 The least cost intensive "bridging technology" available today for renewable electricity is scaling back electricity demand by improving energy efficiency. Leveraging available electricity savings potential could greatly help set the stage for the transition to a wholly renewable electricity supply, in view of the fact that (a) the lower the electricity demand, the less renewable electricity costs; and (b) the task of transitioning our electricity system would be eased by energy saving measures, as this would allow more time for the expansion of renewable energy capacity and the attendant grid and storage capacity. Hence the Federal

Government should institute policies aimed at putting a cap on energy demand throughout Germany.

659 To this end, the SRU recommends that an absolute electricity demand limit be set and that the government seek to stabilize electricity demand over the long term, via policy goals that would be achieved one decade at a time. For 2020, then, efforts should be made to reduce net energy demand by 10 %, i.e. to roughly 500 TWh, which would be lower than in 2008. This goal should then be adjusted for 2030 in light of the projected energy savings potential and the development of electrically powered motor vehicles. In our view, a long term energy demand plateau around 500 TWh is well within reach, even if fossil and other combustible fuels are largely replaced by electricity.

Reducing national electricity consumption to this level will necessitate (a) the institution of across the board efficiency policies that make full use of the available management and coordination instruments (***see chapter 7***); and (b) devising new policy instruments that increase the leeway for action on the part of key political actors. Taking rule of law-provisions into account (particularly the constitutional rights of those affected by the attendant measures), energy efficiency and energy saving instruments need to be optimized in such a way as to ensure sustainable and long term levelling off and reduction of electricity demand.

660 One example of such an instrument is household electricity account framework proposed by the SRU (***see section 7.3.3***), which would impose an upper limit on total household electricity consumption and takes its cue from the basic concept of White Certificates and expands it into a genuine cap and trade system, where power companies would be given certificates for specific amounts of electricity based on the number of households served by the companies. Each company would be credited with a bulk amount of electricity per household.

This system would (a) allow for the requisite flexibility via electricity trading between power companies and (b) even out electricity consumption on the part of individual customers via price mechanisms. Household electricity consumption would not be rationed, and thus the instrument would not limit consumption (and thus customers' freedom of choice in this regard) to any greater extent than prices now do.

The customer electricity account framework would be the main controlling lever for overall household electricity demand and could thus make a direct and verifiable contribution to implementation of a nationwide cap on electricity demand. In addition, this system would not only create incentives for the implementation of electricity efficiency measures, but would also promote energy savings resulting from changes in consumer behaviour – which is where the low cost savings potential actually lies.

We recommend that this model be studied and refined, particularly from a statutory standpoint.

10.2.3 Optimization of EU climate policy and the emissions trading framework

661 It is essential that renewable energy capacity expansion and the expansion of incentive and subsidy programs are keyed to statutory medium term EU climate objectives whose benchmark should be the position taken by the European Council in October 2009 and the forthcoming European Commission's Decarbonisation Roadmap 2050, according to which greenhouse gas reductions by 80 to 95 percent by 2050 compared to 1990 levels are on the EU policy agenda. This is the only reduction target that is consistent with the global reduction of greenhouse gases needed to achieve the 2 °C objective. And it provides an appropriate and necessary benchmark for technological development in this domain particularly since it would mitigate the technological lock-in effects (whose reversal is extremely cost intensive) that would arise if the requisite greenhouse gas reductions only become mandatory later on. Hence this overarching objective should be anchored more firmly in EU policy and ideally should be made mandatory.

662 Unfortunately, in terms of reaching this overarching objective, the modalities that have been defined for emissions trading for the third trading period do not go far enough, particularly since unduly high emission limits, the transferability of unused emission rights into the third trading period, and the continuation of surplus allocations in the industrial sector will result in a weak incentive effective owing to unduly low certificate prices. This situation has been exacerbated by (a) the economic crisis; (b) a glut of new certificates from the New Entrants Reserve (NER) and the flexible mechanisms called for by the Kyoto Agreement. Hence the emissions trading scheme is in desperate need of reform, notably via the following measures:

– A more stringent carbon emissions limit in conjunction with no less than a 30 percent reduction by 2020.

– A mandatory long-term emissions trading reduction goal for greenhouse gases that lays the groundwork for full decarbonization.

– Implementation of measures (in accordance with the German Constitution) to stem the tide of emission certificates. Such measures could include invalidating certificates left over from the New Entrants Reserve, auctioning industrial sector and other certificates at an earlier stage, and more stringent ex-ante benchmarks for certificate allocation rules.

– Quality assurance measures for carbon emission rights that are traded at the international level.

– Hybridization of the emissions trading framework through institution of a minimum price with a view to creating more sustainable incentives to reduce emissions.

10.2.4 Stable and efficient support for renewable energy expansion

663 By attaching a price to carbon emissions, emissions trading will indubitably make renewable electricity more profitable and will avoid what would otherwise be a significant cost increase for other mechanisms. However, while emissions trading is still an important instrument, others are urgently needed, particularly in the electricity sector. For in the context of a transition to a renewables based electricity system, emissions trading alone (even if optimized) will not lead to long term minimization of the social costs of avoiding carbon emissions. This inadequate dynamic efficiency of emissions trading is attributable to a number of factors, the most important being the lock-in effect engendered by emissions trading as a standalone instrument, i.e. one that tends to bring about incremental improvements in power plant fleets that are environmentally unfriendly over the long term, rather than promoting fundamental innovation. As a result, during the transition phase renewables would not be economically competitive even if emissions trading would send the right price signals, and would achieve this state only secondary to cost degressions engendered by broad based market penetration – for which emissions trading alone cannot hope to create the necessary level of incentives. Moreover, it is doubtful that corporations have already begun factoring into their decision making processes the kinds of emissions prices that would follow from the required long-term carbon cap. Owing to the great uncertainty as to how emissions certificate prices will evolve going forward, investors tend to favour incremental improvements for specific development pathways of conventional power plants in lieu of fundamental and radical technological innovation. And even though new conventional power plants are normally more efficient and have lower carbon emissions than their predecessors, their emission levels still remain incompatible with the goal of long term decarbonization. Moreover, pre-amortization shutdown of such power plants in compliance with stringent climate objectives would result in unnecessarily cost intensive destruction of capital. This situation is complicated by the fact that (a) in order for our highly intermeshed electricity system to achieve network effects, it will be necessary to coordinate generation technology and infrastructure development decisions at an early stage; and (b) the low marginal cost-based prices that prevail on electricity exchanges will make it necessary to refinance capital investments for wind and solar installations.

664 Germany's Renewable Energy Act (EEG) as well as EU policy will have a major influence on how expansion of renewable energy unfolds. The EU's Renewable Energy Directive (2009/28/EC) will go a long way toward keeping such expansion on track for the remainder of this decade and achieving partial convergence of renewable-energy support schemes. This policy should in any case be extended beyond 2020. A European roadmap that lays down a framework for renewable-energy expansion up to 2030 should be developed, particularly in terms of national and European infrastructure development beyond 2030. Moreover, the EU framework for renewable energy should take account of the subsidiarity principle and should be formulated in a manner that at the same time respects autonomy of EU Member States and is “community compatible”. The Renewable Energy Directive charts a viable compromise course for the foreseeable future between the goal of harmonizing internal European market ground rules and that of giving EU Member States the leeway necessary to shape their renewable energy support schemes, in that the Directive (a) favours a target of 35 percent of Europe’s electricity demand being met by renewable energy by 2020, while allowing for differences in the various Member States’ contribution to achievement of this goal; and (b) allows, and indeed encourages the Member States to enter into cooperative regional arrangements that could potentially resolve problems associated with cross-border electricity trading and joint infrastructure projects. The German government should make all-out efforts to forge such alliances.

665 The Renewable Energy Act (EEG) has proven to be an effective and relatively efficient instrument and is regarded by other nations as a shining example of a successful renewable energy support framework. The Act’s main elements – priority feed-in for renewables and guaranteed prices– should be retained at least for the intermitting renewable sources. However, in view of growing renewables shares in the electricity system new challenges have to be addressed. Especially cost efficiency of support schemes will have to become an important criterion as the rise in the proportional use of renewables will also engender higher household electricity bills. The goal here should be long term portfolio optimization of renewables with a view to achieving greater cost efficiency. Our scenarios presuppose that wind power will in any case predominate in a cost optimized electricity portfolio, although photovoltaic energy, biomass and geothermal energy will also come into play to one degree or another depending on cost and demand. The greater the proportion of German energy demand met by renewable energy, the greater the impact of other users on renewable energy markets (and thereby on renewable energy costs), the more important it will become to strive for a renewable energy portfolio that offers low costs over the long term. Germany’s Renewable Energy Act (EEG) should be amended with this goal in mind, but should also permit sufficient flexibility to fold new renewable electricity technologies into subsidy programs while avoiding further excess subsidies for photovoltaic energy. Germany’s renewable energy subsidy policies should also continue to promote a stable framework and should promote planning and investment certainty. Furthermore, Germany’s renewable energy subsidy programs need to exhibit sufficient flexibility in the face of technological advances. In the interest of taking into account the differing characteristics of the various forms of renewable energy and the impact of renewable energy expansion on the electricity market, we feel that separate support instruments should be developed for each type of renewable energy.

666 In order to ensure offshore wind energy expansion and in the interest of achieving investment certainty, the Renewable Energy Act (EEG) support scheme for offshore wind energy should be retained for the coming years. Moreover, in view of the high financial risk entailed by offshore wind farms, the possibility of instituting a government risk fund should be considered that would protect wind turbine operators against unforeseen problems that are beyond their control and would enable them to continue paying off their loans in the event of operational breakdowns. If the Renewable Energy Act's cost provisions or incentive effects continue to fail to adequately promote offshore wind energy expansion, the possibility should be considered of issuing tenders for so called fixed-cost compensation, whereby operators competing for licenses for tendered wind farm zones would bid at auction on a specific guaranteed feed-in tariff that would enable them to amortize their investment costs. The license would then be granted to the operator with the lowest tariff, and this operator would then embark upon the actual planning approval procedure. In such a case, the full feed-in tariff would apply for the 15 year minimum service life of an offshore wind farm and a reduced tariff would apply thereafter. Awarding a public contract would be subject to the condition that the operating license would be granted automatically to the operator that makes the second best offer if the zone for which the license was granted is not used within two years; in which case the operator that was originally awarded the license would not be compensated for the costs incurred and would be required to pay a penalty. Apart from ensuring that public-contract wind farm zones are actually used and that the attendant projects come to fruition, this contract award mechanism would build in the success of feed-in tariffs while at the same time pursuing the goal of strengthening the competitiveness provisions of the Renewable Energy Act (EEG) with the aim of achieving cost optimized wind power capacity expansion. Furthermore tendering will allow for more efficient coordination of grid planning and offshore wind power extension.

667 In order for wind farm zones to be tendered for auction as described above, the government would have to establish conditions that are conducive to such a procedure, the most important being the promulgation of medium and long term renewable energy expansion goals, as well as specific objectives for offshore wind power. To this end, the government should draw up an offshore wind energy expansion plan that will promote establishment of a wholly renewable electricity supply and that is consonant with a European roadmap for renewable energy. Apart from providing companies with investment certainty, such a plan would also allow for early stage planning with a view to assuring efficient and consolidated coordination of network expansion activities. Likewise a key factor in promoting investment certainty for offshore wind power is designating additional priority areas.

668 As regards biomass electricity little growth is expected in the SRU-our scenarios for cost and nature conservation reasons. Instead the following two biomass support objectives should be prioritized: (1) Residuals should be recycled in lieu of the ecologically problematic use of energy crops; and (2) better leveraging of the fact that bioenergy production is conducive to regulation for use in load following operation In the interest of providing more robust incentives for load-following operation, biogas installation support should be paid as a market price premium. Use of residual materials should be promoted via premiums rising relative to the increase of the proportion of such materials in the substrate mass. However the bonus for use of renewable raw materials (“NaWaRo” bonus) should be abolished. Residues mainly comprise liquid manure, plant waste from landscape management activities and municipal or private green areas, crop residues, and biowaste. In the interest of avoiding a situation where primarily intensive-cultivation materials are used as a supplement to low-energy residues, such as manure in particular, efforts should be made to promote the use of particularly ecologically compatible farming methods. And as financial compensation for existing installations is guaranteed, leveraging of price fluctuations should be made a more appealing option for biomass plant operators, in line with the Renewable Energy Act’s direct marketing provisions. The Act’s technology bonus, which provides targeted subsidies for innovations, should be retained as an adjunct to the aforementioned price premium with a view to promoting activities such as converting biogas to biomethane that can then be fed into the natural gas grid.

669 Photovoltaic support should be drastically reduced so as to rectify mismanagement in this domain, whose current expansion rate far exceeds that deemed necessary (according to the current state of knowledge) for achievement of a cost optimized renewable energy portfolio. The government’s decision to adjust the annual feed-in tariff reduction to market growth is, though insufficient, a step in the right direction. We also advocate an annual cap on subsidized photovoltaic capacity. The government’s defined annual expansion rate of 2,500 to 3,500 MW is far too high and could increase the costs of implementing a wholly renewable electricity supply. That said, photovoltaic capacity expansion should continue at a low but steady rate, with a view to preserving existing manual (contractor) and manufacturing expertise in the event future evolutions necessitate a rapid expansion of photovoltaic capacity.

670 Our existing onshore wind energy subsidy programs will allow for the expansion activities needed to achieve a solely renewables based electricity supply system. The main challenges here are meeting the relevant legal and policy requirements in terms of environmental protection and nature conservation, and fostering public acceptance of onshore wind farms. To this end, existing wind turbines should be repowered whenever possible, in lieu of installing them in zones not heretofore used for this purpose. Moreover, new wind turbine construction projects should strive to gain public acceptance, preferably via measures such as involving municipalities and local investors in so called citizens’ wind farms.

10.2.5 Socially acceptable and reliable phasing-out of conventional power plants

671 Emissions trading has unfortunately not deterred investments in new power plants that contribute to climate change and whose load balancing capabilities are extremely limited. This is mainly attributable to deficiencies in the current framework that provoke a weak price signal, with the result that emissions trading has only a limited impact on the transition from coal-fired to gas turbine power plants or to renewable energy (see chapter ***8.1***). Moreover, it is doubtful that corporations have already begun factoring into their long term decision making the kinds of emissions prices that would be necessary to achieve the mandated climate protection objectives (see chapter ***8.2***). In the interest of counteracting this evolution and keeping open the option of transitioning to a renewables-based electricity system, it may be necessary to institute regulatory and planning frameworks in addition to the existing emissions trading and subsidy frameworks that would allow for the management of coal fired power plant construction activities, if necessary.

In the view of the SRU, measures such as introducing national carbon emission limits for power plants – a measure currently under discussion both in Germany and abroad – would be admissible under EU law if greatly strengthening the incentive effects of emissions trading proves to be impossible.

In the Environmental Report 2004, the SRU called for a sectoral dialogue with the coal industry which aims to offer viable alternatives to affected regions and to explore ways of mitigating the negative social effects of the structural change. The economic and political conditions for the construction of new coal fired power plants have worsened in the interim, without the government having instituted such a dialogue. There is a need for a clear political signal that the construction of any power plant that does not lend itself to flexible load balancing will be realized at the company's own risk (in keeping with the relevant principles for the protection of assets and legitimate interests) and that no government subsidies will be forthcoming for such projects if the investments prove uneconomic in a changed climate policy environment and in the face of increased competition from renewables. In addition, there is a need for measures that will compensate actors that are adversely affected by the process of transitioning to a renewables-based electricity system. For example, regions that suffer from a decline in the electricity generation sector could be compensated by growth in the relevant supply sectors. This kind of development could be encouraged through industrial policies and would need to be proactively communicated. This implies that any climate policy-driven transformation process is knowledge-intensive. Therefore, the process of managing such a should be implemented from the get-go with a view to enlisting the support of the scientific community and a broad range of actors for a transparent process that strives for binding agreements.

10.2.6 Expedited grid expansion

672 A transition towards a fully renewables-based electricity system requires that the pace of expansion of our electricity grid be stepped up. In the interest of achieving security of supply, the electricity supply infrastructure will need to be able to adjust to more decentralized and more intermittent power generation. Key to reaching this goal is an extensive expansion of both domestic and international transmission capacity. And this in turn will require us to overcome the following major obstacles:

– Political and economic obstacles to investment arising from grid regulation

– Planning approval procedure delays

– Public acceptance issues

Reform of German grid regulation

673 Although transmission system operators are required by law to build electricity transmission networks that will allow for an efficient integration of renewables, it is difficult to oblige them to build a specific connection which is thought to be necessary for achieving a certain energy policy goal. Hence, in addition to existing legal obligations, it is essential to institute investment incentives that will sufficiently attract investors to build the desired sections of transmission networks. However, there are doubts whether the incentive-based regulation adopted in 2009 in Germany is able to accomplish this aim.

This regulation aims to create incentives that will scale back the cost drivers of network charges. This is done by setting a cap on transmission system operator revenues. Those operators that successfully lower their costs below the revenue cap are permitted to keep the monetary difference between this limit and their actual costs. This way they have a chance to increase their profits. Investment budgets have been introduced to ensure that sufficient capital investment is geared towards network expansion and modernization projects. The budgets are subject to approval by the Bundesnetzagentur (Federal Network Agency). Approved budgets allow for an increase in network operator revenue above the cap and are intended to attract investments in conjunction with relatively constant and secure earnings from operating electricity grids. However, operators complain that various Bundesnetzagentur deductions from the investment budgets reduce revenues to a point where grid investments are no longer sufficiently profitable. This problem is particularly acute for unbundled transmission system operators. For them, banks demand a risk margin on possible loans as these operators have a greater need for external funds owing to lower ratings from international rating agencies. The financial crisis has exacerbated this situation even further.

674 The pace of the requisite grid expansion could be stepped up by instituting a federal loan program via the Kreditanstalt für Wiederaufbau (KfW). This could bring down the higher borrowing costs which unbundled transmission system operators are currently subject to. In addition, all actors concerned should enter into a dialogue regarding an acceptable rate of return on equity. Moreover, the SRU recommends a public tendering process for the construction of high power point-to-point connections and the realization of an overlay grid.

Tendering for high-power grid connections

675 The current regulatory system fails to co-ordinate long-term the development of renewable energy and the electricity grid restructuring needs arising therefrom. This co-ordination cannot solely be left to corporate interests. Similarly to the tendering process for offshore wind farms,, the SRU considers that cost intensive domestic and cross-border point-to-point transmissions lines should be tendered via public contracts for predefined lines. Under such a system, the bidder that offers the requisite investment in conjunction with the lowest grid charges over a 20 year period would be awarded the contract.

676 This system should be based on a federal sectoral plan that defines the relevant need for transmission lines and their routes and allows a public debate concerning alternative routes (more on this below). Such a nationwide network expansion strategy would enable the government to coordinate grid expansion by tendering contracts with a required minimum capacity for lines needed. Such a process would also generate competition between bidders and thereby secure cost efficiency for the various expansion projects. Furthermore, this would obviate the need for the government to set a specific rate of return. In the end, tendering for transmission lines would also promote the development of new technologies by including qualitative criteria into the contracts.

Power grid planning and approval procedures

677 One of the central weaknesses of the current legal framework for planning and approval procedures for power transmission grids is the loss of time that results from assessments that are repeated at different stages of the approval procedure. This is mainly attributable to the fact that the tasks of land use planning on the one hand and sectoral planning on the other hand are not always clearly differentiated. Thus, the various phases of the planning and approval procedure should be clearly distinguished and thereby transparent for the authorities and interested parties.

678 To this end, it is particularly important to further develop meaningful and appropriate public participation procedures involving the general public as well as persons concerned that help to gain acceptance for the projects. For high-level decision processes in which alternative routes of power transmission lines are discussed call for a different type of participatory procedure than planning on a small scale which has direct consequences for specific pieces of real estate and may entail expropriation procedures. Unlike current practice, high-level decision making processes need to be appropriately formalized. They should allow for involvement early on of the relevant interest groups as well. For this is the only way such processes can hope to meet the measure of the problems, generate all requisite information, and promote public acceptance of the grid expansion.

679 In view of the fact that the necessary power grid expansion mostly exceeds the boundaries of individual German states and even of Germany itself, and also its extreme urgency, grid planning should be carried out at the federal level. Alternatively, stringent coordination mechanisms would be necessary between he interdependent planning processes carried out by the German states.

A far reaching reform scenario: two-stage sectoral planning

680 Against this backdrop, the SRU recommends that a federal plan titled “The electricity transmission grid for 2030” be established. It should at a high level define the relevant needs for transmission lines and the transmission line routes and should allow for a debate concerning alternative routes. This plan should take account of private sector grid planning, the requirements entailed by trans-European energy networks as well as the grid model to be elaborated by the Bundesnetzagentur (Federal Network Agency). The federal plan defines the scope of the requisite grid expansion on the basis of an open and transparent participatory procedure that includes the strategic environmental assessments (SEA) and takes account of the applicable nature conservation laws. A legally binding identification of the grid expansion required for 2030 at the highest planning level is essential for all actors. This is necessary because storage capacity expansion, load management, electricity generation management, and grid expansion activities must be coordinated. In doing so, the government assumes its responsibility to provide the requisite infrastructure. This also applies to the process of defining transmission line routes and the fundamental choice between underground cables and overhead lines.

Moreover, the planning procedure should be structured in a manner that promotes problem solving. This concerns firstly its legal design as an administrative planning procedure with final decisions being made by the federal government. This would make use of the administrative capacities as well as of the democratic legitimation of the government. In view of the close connection between the needs assessment and the large-scale transmission line routes planning, decisions in regard to both should be bundled in lieu of differentiating between statutory needs planning and executive transmission line route planning.

Another key factor here is the allocation of administrative competencies to the federal authorities. Only in this way can large scale interdependencies between the grid needs assessment and large-scale transmission line route identification be optimally realised. As experience with traffic planning has shown, in the absence of a clear normative planning competence of the federal level, the actors concerned switch to informal processes whose main drawbacks are that they do not foster the same level of accountability as a formal process and do not guarantee the broad balancing of interests that is necessary to gain acceptance.

In view of the fact that the aforementioned concept would entail statutory land use planning at the federal level, the strategic environmental assessments and the flora-fauna-habitat impact assessments should be integrated into the federal sectoral planning procedure. This would also enable a broad public participation. However, such a high-level rough-cut planning would not concern individual issues and could not be challenged by individuals in the court. Therefore, alternatives would have to be examined again in the planning approval procedure. Nonetheless, planning approval authorities could confine their efforts to the assessment of small scale alternatives, since large-scale alternatives would have already been analyzed in the preceding formal procedure, in which the variant chosen had to be justified.

The applicable law for the subsequent planning approval procedure would remain essentially unchanged.

Planning and approval for offshore cable connections

681 Most of Germany's offshore wind farms are built in the exclusive economic zone (EEZ) for reasons related to the tourist trade, nature conservation and coastal protection. Hence the requisite cable connections traverse the EEZ and then proceed through coastal waters to the onshore feed-in point. The standard planning approval procedure does not apply to cables connecting offshore wind farms in the EEZ, where virtually all offshore wind farms have been built. Instead, approval for offshore cables is governed by the Seeanlagenverordnung (Offshore Installations Ordinance). Moreover, in the interest of taking some of the financial burden off wind farm operators, article 17(2a) of the Energiewirtschaftsgesetz (Energy Industry Act, EnWG) stipulates that network connections for offshore wind farms are the responsibility of the transmission system operators.

682 The current regulatory framework guarantees sufficiently standardized and formalised planning procedures for offshore cables. But it is in need of reform, because it does not allow to sufficiently steer the process. Hence a planning approval procedure should be instituted in the near term that prioritizes networked solutions based on discretionary considerations. To this end, the SRU recommended in 2003 that management discretion with regard to the construction of wind farms and thus also to their cable connections be instituted. This would not only provide for planning discretion but also for a suitable planning procedure that entails a concentration of the procedure at one administration as well as a public participation process. It would also be preferable if a unified cable approval procedure could be instituted, although this would be difficult to achieve as the relevant competencies are divided between the federal government and state governments.

There is also a lack of coordination with regard to the offshore connections necessary for the offshore wind parks. Here too, central planning should be instituted along the lines of what we have has proposed here for onshore grid expansion. This would necessitate coordination between federal land use planning efforts for the EEZ and land use planning in the German coastal states. This could potentially be achieved via the proposed approach to tendering for public contracts for offshore wind farms (see section ***6.4.3***).

Further development of long-distance trans-European connections

683 The EU should promote the development of trans-European electricity grids and key long-distance connections and facilitate cooperation to support this objective. The EU's sphere of responsibility in this context is limited to relatively soft governance instruments, notably through selection and promotion of projects of common or European interest in the guidelines for trans-European energy networks. Grid planning and investment are still mainly the responsibility of the Member States and private enterprises. The scope of article 194 of the Treaty on the Functioning of the European Union, whose incorporation in this document was promulgated by the Lisbon Treaty, remains to be explored.

In this regard, Member State grid expansion programs should be bolstered by improved coordination, notably as regards cross-border expansion needs for renewables and high capacity long distance connections. Efforts should focus on the following in particular:

– More tightly intermeshed coordination for renewable energy expansion and grid planning for the period after 2020

– The European Commission or its subordinate authorities should conduct dedicated needs analyses, based on information from transmission network operators, concerning expansion and further development of the trans-European grid, with a view to achieving efficient quality assurance for EU energy policy objectives

– Cross-border cooperation for public contracts and notably for new cross-border high capacity long distance connections should be bolstered

– The groundwork should be laid for regional cooperation among grid operators notably in the North Sea and Mediterranean regions

Acceptance

684 While renewable energy is a technology that the general public readily embraces, the prospect of expanding transmission network grids to allow for the integration of offshore wind power provokes strong protest. One of the main effects of Germany's fast-track planning law has been to limit public participation and litigation rights. The restriction on opportunities for public input resulting from this law has also reduced the scope of nature conservation expertise that is folded into the process, and has done nothing to increase public acceptance of a renewables expansion. It is essential in this regard to solicit public input before all project related decisions have been made so that the public can still have some say about how a given project is to be carried out.

Moreover, the possibility of using underground onshore cables should be looked into more thoroughly, as the use of such cables considerably shortens the planning phase since the public accepts them more readily. A suitable instrument to this end might be a standardized assessment framework for decision making, which would be based on transparent and readily understandable criteria, as has been discussed in Switzerland.

10.2.7 Regional cooperation with Norway and neighbouring states for the use of pump storage systems as the backbone of a reliable electricity supply

685 In an electricity system with a high proportion of intermittent wind and solar energy, load balancing is one of the main challenges for achieving a reliable and low cost supply of electricity. Various load balancing methods are available: energy storage systems; large-scale networks; load dispatching; and variable output power plants. In the long term, these various options can either strengthen each other or be in competition with each other. Energy storage systems play a key role here, as they (a) allow for the storage of low cost wind and solar power, which can then be fed back into the system during peak demand periods; and (b) provide system services by ensuring grid stability.

The use of pump storage systems should be prioritized in this regard as these systems are proven, low cost, and exhibit very low energy loss. According to the estimations of the SRU, the specific storage costs for AA-CAES (advanced adiabatic compressed air energy storage) technology or other storage technologies would far exceed that of suitably localized pump storage systems, even after such technologies become commercially viable.

Inasmuch as Germany offers little in the way of suitable locations for low cost expansion of pump storage systems, such facilities would need to be expanded primarily in countries with natural areas that would allow for a very extensive expansion. The most promising locations in this regard are in Scandinavia, but also in Switzerland and Austria. In Norway in particular, numerous extensive water storage systems are available that could be converted into pump storage systems at a relatively low cost and without undue ecological impact – which in turn would mean that there would probably be relatively little public opposition to such projects.

686 Current renewable energy expansion plans, particularly in the North Sea region, and today's market design already make investments in pump storage systems and grids an appealing prospect for Norwegian hydroelectric power station and network operators – other than in Germany, where signals from the energy sector and our politicians are insufficiently clear in this regard.

What is thus needed is a clear political signal from Germany to the effect that (a) connecting the German and the Scandinavian grid and the use of pump storage systems are central to the German strategy for the expansion of renewable energy; and (b) a proactive energy foreign policy aimed at establishing the investment certainty needed by private investors is a must.

687 The North Sea wind belt extending from Scotland to Denmark could potentially play a pivotal role for the expansion of renewable energy in the EU. However this can only come to pass expeditiously if this expansion is embedded in a coordinated grid planning in the North Sea region as well as an integration of Norwegian pump storage system capacity. The German government should promote an integrated capacity and grid planning for the North Sea region by instituting clear-cut, binding policy measures. Grid operators should be encouraged to enter into cooperative arrangements that will further this aim. In the interest of promoting regional cooperation, European network planning instruments (which should be further developed) and the regional cooperation modalities called for by the Renewable Energy Directive should be used proactively.

10.2.8 The prospects for a further Europeanization of energy and climate policy

688 The climate and energy package adopted by the EU in 2008 gave Europeanization a robust boost that supports Member States' renewable energy expansion policies. Key forward looking initiatives such as the *Decarbonisation and Energy Roadmaps 2050,* to be launched by the European Commission in 2011, the envisaged pan-European high capacity long distance electricity transmission grid, and the further development of the Emissions Trading System and the Renewable Energy Directive offer further opportunities for bolstering Member States' energy policies via European climate and energy policies. A European energy strategy that places particular emphasis on climate protection and renewable energy would have numerous advantages: it would level the playing field in terms of market competition; it would provide Europe with access to cheaper energy and energy storage resources; and it would open up new markets across the entire renewable energy value chain.

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