



European Network of
Transmission System Operators
for Electricity

ENTSO-E VIEWS ON ENERGY ROADMAP 2050

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ENTSO-E Views on the Energy Roadmap 2050

1. Introduction

Looking at the discussion on a paradigm shift in the energy system in Europe, ENTSO-E welcomes the Communication from the European Commission (EC) to the Council, the European Parliament, the European Economic and Social Committee, and the Committee of the Regions on the “Energy Roadmap 2050” as well as the publication of the corresponding legislative package on Energy Infrastructure Priorities (EIP) as strategic steps towards the achievement of European Energy Policy objectives.

In the context of the conclusions of the Bucharest Energy Efficiency Forum 2009 and following the 1st European Electricity Grid Reliability Conference (European Parliament on 8 January 2009), ENTSO-E established a Working Group (WG) on 2050 Electricity Highways in 2009. The main task of this WG is to set up and coordinate a comprehensive and sustainable Electricity Highways concept and to perform consultations with the EC and other stakeholders in order to facilitate first steps in view of the 2050 time horizon.

2. Objective

The aim of this ENTSO-E paper is to identify the main elements enabling transmission system operators (TSOs) to keep up with the objective of the EC to accelerate designing and planning the future energy system looking at the 2050 horizon. The time horizon of the framework covers the period after the Ten-Year Network Development Plan (TYNDP), i.e. post 2020.

ENTSO-E is looking forward to contribute to the forthcoming debate with concrete proposals that should translate into immediate benefits.

3. Key Messages

The goal of a mostly decarbonised, efficient and secure European energy system requires particular attention to be given to energy infrastructure as a prerequisite for a competitive and greener Europe.

ENTSO-E suggests setting up an EC Master Plan for Electricity Highways Implementation as a tool to support the EC objective to accelerate designing, planning and building the Electricity Highways system.

For the society-wide acceptance of the future infrastructure projects, the communication and interaction with the public is crucial.

Ensuring appropriateness of models and plausibility of assumptions used is extremely important in order to address the needs arising out of all plausible projections for the penetration of carbon-neutral technologies in the future energy mix towards 2050.

The coherence of ENTSO-E's and the EC's approaches towards an efficient and sustainable pan-European concept regarding transmission system planning is necessary.

Information on actual technology costs and cost developments need to be clarified in order to enhance planning reliability and investment security.

ENTSO-E is in favor of establishing 2050 roadmaps as these may contribute to providing the TSOs with the needed predictability on which to base post-2020 strategies and investments. With regard to the Energy Roadmap 2050, ENTSO-E supports the scenario approach taken, outlining several different possible pathways. The conclusions drawn by the EC within the Energy Roadmap 2050 are a positive step in the right direction. ENTSO-E agrees that priority should be given to the implementation of the Energy 2020 goals and that European effort in R&D and technological innovation must be strengthened. Moreover, we believe that a 2030 perspective needs to be developed to make further contributions to investment predictability. Nevertheless, the European TSO community has a number of concerns to convey with regard to some aspects of the Energy Roadmap 2050:

3.1 Energy infrastructure as a prerequisite for a competitive and greener Europe

ENTSO-E appreciates the EC's objective to explore the challenges of the European Union's decarbonisation objective while ensuring security of energy supply and economic competitiveness. Electricity is fundamental to our economy and society and the development of an optimized energy transmission system is an important determining factor for European competitiveness as a whole.

It is necessary to carry out a thorough "competitiveness proofing" for all future EU energy policies resulting from the Energy Roadmap 2050 and all energy policies in general. ENTSO-E is in favor of building on the initiative by the Competitiveness Council, based on the EU initiative "An industrial policy for the globalisation era".

European TSOs businesses need a stable and predictable framework of regulations and investment conditions as the year 2050 is not far away in infrastructure investment terms and can have direct consequences for TSO strategies already today.

3.2 EC Master Plan for Electricity Highways Implementation

European TSOs and ENTSO-E are the most suitable entities to undertake a leadership role into defining the future electricity grid with the view to 2050. The most significant challenge for the implementation will be to reach societal consensus at EU and involved countries' (EU and non-EU) level, together with consensus among different groups of stakeholders: generators, grid operators, consumers, NGOs and other decision-making entities. This is especially true for financing, the authorization procedures, environmental priorities and local acceptance issues, which are aspects under the responsibility of the TSOs in charge of the project, and the regulatory gaps within the different national schemes. These aspects were identified as the main barriers in completing high-priority electricity infrastructure projects across Europe in the so called energy infrastructure priorities (EIP) blueprint published in November 2010 and the subsequent legislative package of October 2011 (comprising of two Regulations, namely the "Guidelines for the Implementation of European Energy Infrastructure Priorities" and the "Connecting Europe Facilities").

In line with the EIP blueprint, the tool advocated by ENTSO-E to assess how a pan-European Electricity Highways System could be built over a time horizon to 2050, is a study roadmap. This roadmap contains work packages within a modular development plan. Based on this study, the modular development plan is proposed to be developed by a study consortium consisting of ENTSO-E and its members, relevant associations, institutes, universities etc. within the **e-HIGHWAY2050** study project (start foreseen for mid-2012).

The **e-HIGHWAY2050** study project will cover the time period beyond ENTSO-E's TYNDP. It will consider the TYNDP and possibly the **North Seas offshore grid concept for 2020/30** following the Memorandum of Understanding from the North Seas Countries' Offshore Grid Initiative (NSCOGI). It must be underlined that the study project should aim at:

- ✓ developing **future-oriented novel planning approaches** allowing a comprehensive but efficient Electricity Highways discussion,
- ✓ analyzing and justifying **bulk power transmission needs** taking into account **future generation** and its spread throughout the whole transcontinental region,
- ✓ proposing **concrete implementation, operation and governance principles**¹ for needed grid investments throughout Europe and to neighboring areas,
- ✓ in the interest of security, efficiency, feasibility and sustainability, consider the **whole energy supply chain** including relevant technical/technological, economical/financial, ecological, political/sociopolitical and geopolitical/security issues,
- ✓ following a **modular approach**: 2030, 2040 and 2050, and finally,
- ✓ proposing general strategic Electricity Highways architectures including technology options.

ENTSO-E's roadmap to the 2050 electricity grid as well as the TSOs' active involvement in the SET-Plan European Electricity Grid Initiative shall be the stepping stones for elaborating and implementing the modular development plan that the EIP blueprint calls for; however, the timing for the delivery of this plan as well as the commissioning of the first parts of the "Electricity Highways" should be carefully chosen in order to ensure the streamlined fulfillment of all ENTSO-E tasks

Looking beyond the latest legislative proposal in the field of energy infrastructure ENTSO-E suggests setting up an **EC Master Plan for Electricity Highways Implementation** as a tool to

¹ Despite the aim that the identified lines should be designed as point to point (meaning specific region to specific region) with proposed technical transmission principles, no concrete geographical routing can be done within this three-years e-HIGHWAY2050 study project. This task is outside of the study project scope and will be given to the respective ENTSO-E members (Regional Groups and bilaterally at TSO level).

keep up with the ambition of the EC to accelerate designing, planning and building the Electricity Highways system. This EC Master Plan for Electricity Highways Implementation, which would build on the main inputs delivered by the **e-HIGHWAY2050** project, should:

- ✓ further **prioritize the needed Electricity Highways corridors**, as identified in the modular development plan and - for the medium-term horizon - also in the TYNDP,
- ✓ further **define special permission² rules** to assure timely Electricity Highways implementation,
- ✓ further **clarify the ground for financial incentives** for needed adequate re-financing of EH projects which will be based on breakthrough technologies and will bring new technical, regulatory or coordination challenges, and therefore show higher risks than classical transmission projects,
- ✓ support the further implementation of the SET-Plan, especially the Grid Initiative, with definition of high-performing R&D projects for efficiency of future energy infrastructure.
- ✓ further **support ACER to overcome the existing regulatory gaps** and clearly **take advantage of the key expertise of ENTSO-E and its members** in terms of EH planning, implementation, operation and ownership,
- ✓ **promote and incentivize further elaboration of concrete routing options** by ENTSO-E and its members,
- ✓ **reserve the needed corridors for the purpose of future energy infrastructure**,
- ✓ **ensure operational security** of the whole grid and system/generation adequacy on transcontinental and regional scales,
- ✓ **place regular updates on the modular development plan under the responsibility of ENTSO-E**, and finally
- ✓ develop a communication and stakeholder involvement plan for a healthy development of the needed Electricity Highways corridors by delivering the message that environmental, societal and economic factors will play an integral role in charting the path forward.

To best support investment in energy infrastructure, an appropriate regulatory framework is crucial: the stability and attractiveness of returns provided by a regulatory regime are the key factors in determining whether any investment can be financed.

The EC Master Plan shall also cover implications for non – EU member states, both in and outside Europe.

3.3 Key role of communication and interaction with the public

Given the profound changes, the planned energy transformation will imply for Europe's economy and society, and given the experience many Member States have had with public resistance to large energy infrastructure projects, resources should be foreseen to ensure an early and open communication and interaction with the European public on the possible implication of the Energy Roadmap 2050. Also the ad-hoc Advisory Group that was set up in preparation of the

² Long and uncertain permitting procedures are addressed in the blueprint on Energy Infrastructure Package. The industry as well as TSOs and regulators, see this issue as one of the main reasons for delays in the implementation of infrastructure projects, notably in electricity. The time between the start of planning and final commissioning of a power line is frequently more than 10 years. In electricity, the resulting delays are assumed to prevent about 50% of commercially viable projects from being realised by 2020. The Commission proposes a new method which includes supporting the implementation of projects of European interest through new tools, such as improved regional cooperation, permitting procedures, better methods and information for decision makers and citizens and innovative financial instruments. However, the “e-HIGHWAY2050” project will analyse possible evolutions of those priorities and ways to adapt EIP mechanisms to the future pan-European Electricity Highways system.

Energy Roadmap 2050 recommends putting more effort on transparently presenting the outcomes to the wider public to ensure full public engagement and understanding of the necessary trade-offs between the three cornerstones competitiveness, security of supply and sustainability within EU Energy policy. Moreover, since household expenditure is estimated to rise in the short and medium term, it is crucial to develop citizen's understanding of the social costs that the transformation of the energy sector will imply.

3.4 Ensuring appropriateness of models and plausibility of assumptions used

ENTSO-E appreciates that the EC has taken up calls to improve transparency of the PRIMES model and notes the effort by making the assumptions and technology costs explicit in the Impact Assessment and the attached Annexes. However, further clarification and discussion would be useful on some of the assumptions made. The technology costs used in the PRIMES model differ from those used in studies undertaken by the IEA and US DOE. The reasons behind the rather poor improvements in cost efficiency assumed in the technology cost development curves are still to be clarified. ENTSO-E would appreciate if the EC could provide more information in order to clarify these issues.

ENTSO-E also welcomes that the EC will regularly update the Energy Roadmap 2050 in order to take recent developments into account. In the context of capital costs and learning curves, we therefore recommend that a regular consultation process of Member States and industry is launched in preparation for the Energy Roadmap's revision. In this way, transparency and traceability of the cost assumptions can be effectively enhanced.

3.5 Necessity of the coherence of the planning approaches towards an efficient and sustainable pan-European concept regarding electricity

In the 2050-perspective the EU energy system will undergo a fundamental transformation. This is brought about by the production of large and intermittent wind volumes predominantly in the Northern Seas and large-scale solar in Southern Europe and possibly in Northern Africa and the Middle East along with developments in the storage and consumption of electricity and in decentralized models of electricity generation. Acknowledging this, ENTSO-E members stress the need for consistent long-term transmission planning supported by novel planning approaches based on dedicated R&D efforts. The development of the transmission grids is highly dependent on the development of electricity generation; hence TSOs will use best estimates of future generation (including locations). The EC's top-down centralized approach would benefit from alignment with the bottom-up methodology of TSOs and other stakeholders. This coherence would allow for the credible assessment of the elements of infrastructure (existing and planned) necessary to realise e.g. the EC's vision of an Electricity Highways System.

3.6 Information on actual technology costs and cost developments need to be clarified in order to enhance planning reliability and investment security.

The Energy Roadmap 2050 evaluates the investments needed for the transformation of the energy systems at about 14 % of GDP. The investment requirements to keep up with more restrictive CO²-regulation, ageing electricity grids, in particular transmission grids and generation capacity as well as the consolidation of the European market are extremely challenging for market participants. The current uncertainty in the financial market worsens the situation through increased costs of capital. ENTSO-E believes that financing models such as pooling and risk sharing (e.g. power-user investments) should be investigated further. Moreover,

it must be ensured that any legislative proposal deriving from the Energy Roadmap 2050 as well as throughout the regularly planned revisions, Europe must not be locked into specific technologies but remain technology-neutral.

3.7 Consistency of the EU's and ENTSO-E's strategic needs and visions

The consistency of the EU's and ENTSO-E's strategic needs and visions is extremely important in order to address the needs arising out of all plausible projections for the penetration of carbon-neutral technologies in the future energy mix, with production often located in very distant areas from consumption and storage areas. European TSOs and ENTSO-E are the most suitable entities to undertake a leadership role into defining the future electricity grid.

Furthermore, the successful pursuit of the core EU Energy Policy objectives of competitiveness, sustainability and security of supply call for the development of a pan-European electricity grid able to cope with the resulting future bulk power transmission needs. It also calls for a steady TSO leadership and coordination role in supporting Demand Side Management initiatives and more specifically Demand Response architectures capable of supplying System Services to the Networks, Transmission System included. In this regard, *time of use* tariffs and the strict *user pays* principle will promote more direct end-user involvement.

Reliable, sustainable and cost-efficient energy supply systems that accommodate power flows resulting from the shift to an almost carbon-free EU energy system and respond to the need to combat climate change will facilitate important objectives provided under the Lisbon Treaty. The TSOs, under the umbrella of ENTSO-E, align the EC's mid-term actions and orientation on pathways to 2050 with the vision and mission expressed by ENTSO-E. In this context, ENTSO-E members give their support to the integration of renewable energy sources and the completion of an Internal Energy Market while maintaining secure and reliable supply of electricity.

4. General remarks

4.1 Operational impact

The integration of indigenous renewable generation on the power system is considered a means to achieving energy security, environmental sustainability and economic competitiveness, simultaneously. The impact of this level of non-synchronous renewable generation on the power system will materially affect the way the electricity system is operated today.

Integrating renewable energy generation on the power system can impact on the operation of the system in a number of important ways. First, a central feature of renewable generation is that it is variable in nature; the wind blows, the sun shines, and the tides ebb and flow. The management of this variability can only be achieved through a combination of improved forecasting, increased control capability of conventional and renewable generation and new operational strategies. Second, renewable generation uses different technologies than conventional synchronous generation units. The level of penetration of these technologies can materially alter the characteristics of the power system creating challenges not only in balancing the system in real time but also in long term adequacy, system transient stability, network steady state voltage control and disturbance response. Managing these situations requires a range of system services (on the generation and demand sides of the market) to be available in multiple timeframes.

The operational challenges associated with high levels of renewable integration are only going to become more pronounced in Europe as we move toward 2050. These operational challenges need to be fully understood and any solutions need to be aligned with grid and market designs in order to provide for the necessary system services going forward. ENTSO-E are key to identifying and resolving these issues.

4.2 Grid development

The physical location of renewable plant is often at different locations to conventional generation and to load centers. Consequently, additional and upgraded grid infrastructure is required to provide access for distributed forms of renewable generation and to reinforce the system.

ENTSO-E supports the EC's view that adequate infrastructure at distribution, interconnection and long-distance transmission is a fundamental part of increasing renewable in Europe. The "extension of planning methods to a fully integrated network planning for transmission (on- and offshore), distribution, storage and electricity highways" would be of considerable benefit.

4.3 Evolution of market design

In the context of increasing RES on the power system - and all associated operational and technical implications of this development - the evolution of Electricity markets need to be structured in a way which allows sufficient generation capacity (and demand side capability) with the operational and technical characteristics that the power system needs to cover costs and make a return. It is ENTSO-E's view that there needs to be an alignment of the European electricity markets with the needs of power systems moving forward. Without such an alignment, TSOs will not have sufficient system service available to develop new system operational policies to manage the increasing complexity associated with the challenges associated with integrating large amounts of variable renewable generation. These system needs may fall outside of just "capacity" and "flexibility". A full understanding of these issues and appropriate market mechanism design are essential to achieve the balance between investment returns and the needs of the systems. ENTSO-E and its members have a central role in this emerging debate.

5. Conclusions

The consistency of the EU's and ENTSO-E's strategic needs and visions is extremely important in order to address the needs arising from all plausible projections for the penetration of carbon-neutral technologies in the future 2050 energy mix, with production often located in very distant areas from consumption and storage areas. European TSOs and ENTSO-E are the most suitable entities to undertake a leadership role into defining the future electricity grid.

Based on the experience of some Member States with regards to public resistance to large energy infrastructure projects, more resources should be allocated in the future to **ensure an early and open communication and interaction with the European public** on the possible implication of the Energy Roadmap 2050.

There is a need for coherence of planning approaches towards the Energy Roadmap 2050 and towards an efficient and sustainable pan-European concept on an Electricity Highways System. ENTSO-E's roadmap towards the **Modular Development Plan on a pan-European Electricity Highways System 2050**, the **study project e-HIGHWAY2050** as well as the TSOs' active involvement in the SET-Plan European Electricity Grid Initiative will be the stepping stones for elaborating the **modular development plan** that the EC's Communication of November 2010 calls for.

ENTSO-E is looking forward to contributing to this debate with concrete proposals and translating them into immediate benefits. In this respect ENTSO-E proposes the setting up of a **EC Master Plan for Electricity Highways Implementation** as a community tool enabling us to keep up with the objectives of the EC related to the establishment of the Electricity Highways system and to achieve the EU's energy policy targets.

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