

**Long-term Power System Planning in the
Context of Changing Policy Objectives –
Conceptual Issues and Selected Evidence from Europe**

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Abbreviations

AA-CAES	Advanced Adiabatic Compressed Air Energy Storage
CAES	Compressed Air Energy Storage
CHP	Combined Heat and Power
DSM	Demand-Side Management
DSO	Distribution System Operator
ENTSO-E	European Network of Transmission System Operators for Electricity
HVDC	High-Voltage, Direct Current
NDP	Network Development Plan
NRA	National Regulatory Authority
NREAP	National Renewable Energy Action Plan
NTC	Net Transfer Capacity
RES-E	Renewable Energy Sources for Electricity
RG	Regional Group
RTO	Regional Transmission Operator
TSO	Transmission System Operator
TYNDP	Union-wide Ten-Year Network Development Plan (Art. 8 EC/714/2009)
WG	Working Group

Executive Summary

The issue of long-term power system planning, especially in the context of changing energy policy objectives, is a relatively new one, but it is generally acknowledged that it is of central importance in many regions around the world. The European Union (EU) in particular is pursuing ambitious decarbonisation policy objectives. However, there is only limited experience, let alone successful implementation, on procedural rules to structure longer-term energy system planning processes for the coming 20–40 years. The objective of this study is to lay out a methodology that structures the planning process, and to provide selected evidence from countries that are already moving into this direction or are close to adapting their institutional framework to do so soon. The study thus identifies the “building blocks” of energy system planning (such as assumption building, dispatch, stability analysis, network adjustment, etc.), and then applies this to nine European countries: Austria, Belgium, Great Britain, Denmark, France, Germany, Italy, the Netherlands, and Switzerland. In addition to these country case studies, the study describes network planning processes on the European level and in the Western Interconnection of North America.

Drawing on the case study evidence, it is argued that aspects related to integration (i.e., linkage with generation planning) as well as stakeholder involvement and participation are important elements of network and energy system planning processes in the power system decarbonisation context. The motivation for integration is that new objectives, also with respect to generation technologies, underline the interdependence of different parts of the electricity system. The involvement of stakeholders is driven by the fact that the broadening objectives of power system planning will drive an increase in the number of relevant stakeholders.

To conclude, this study underlines the view that network planning processes are dependent from the overall power system planning objectives.

1 Introduction

This study aims at identifying a methodology for capturing both technical and institutional aspects of network planning processes, and to identify key elements of network planning processes in aligning them with energy policy objectives.

To do so, we will first examine different strands of literature in section 2. We will then develop a conceptual framework for analysing network planning processes in section 3. This framework is then applied to country case studies for: Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Switzerland, and the United Kingdom, which can be found in appendix sections A-1 to A-8. Further, appendix section A-10 details the European network planning process, and appendix section A-11 contains a description of the planning process in the Western Interconnection of North America. In the main text, we will highlight findings from the case studies in section 4, and conclude in section 5.¹

2 Different strands of literature

In this chapter we present some of the relevant literature concerning electricity network and system planning, both from technical and conceptual / institutional points of view.

2.1 Technical Aspects of Electricity Network Planning

Network planning, while generally considered an older and well-established procedure, can also however be characterised by differing levels of integration with respect to other parts of the electrical system, such as generation planning. Although specific formats of the process may vary, the general objectives remain consistent:

- “[...] the purpose of transmission system planning is to determine the timing and type of new transmission facilities required in order to provide adequate transmission network capability to cope with the future generating capacity additions and load-flow requirements.” (Gönen, 1988)
- “Power system planning [...] must develop concepts and structures which are technically and economically sound [...], in order to enable flexible and economic operation in the long as well as the short term. Power system planning also has to react to changes in technical, economic and political restrictions.” (Schlabach and Rofalski, 2008)
- “[...] (to) provide multiple paths between various generation sources and their loads,[...] (to) provide for power transfers from one geographic area to another to achieve overall system operating economies [...] (and to) interconnect the bulk power facilities of individual utilities so that they can better withstand major system disturbances without interruption of service” (Stoll, 1989)

These objectives may be reduced to two main aspects:

¹ Conceptual considerations and some findings related to the country case studies go back to a talk given in the context of a workshop on a research project on the governance of electricity network planning, which is carried out by TU Berlin.

- (1) The transmission network should provide for spatial arbitrage possibilities, i.e. to allow power generation units to be dispatched most efficiently.
- (2) The transmission network should comply with requirements for supply security, i.e. to be robust against disturbances and contingencies.

However, those objectives may be weighted and modified, especially for the level of integration of planning. With respect to integration of planning, we use the term ‘integration’ to denote the inclusion of decisions in related systems. This would involve, for example: generation planning decisions; developments in inter-connected systems; longer-term considerations; and related uncertainty both technically and politically.

2.2 Conceptual Aspects of Network Planning

The literature on conceptual aspects is scarcer and less homogenous than what is available covering technical aspects. However, the large structural reforms in the European and the US electricity sectors show a first impact, and some issues also relate to planning debates. This is mainly due to two factors: (1) New regulatory approaches led to a decrease in grid investment, which was often perceived as being too little, especially in a context of increasing wholesale competition by increasing electricity trade, and (2) generation planning was de-coupled from transmission planning (Hirst and Kirby, 2002; Oren et al., 2002; Joskow, 2005). A similar kind of debate can also be observed for China, where a reform of the electricity sector has been undertaken (Dong and Zhang, 2009).

Most of this past interest in network planning was raised by the interplay of modified sector regulation and governance, and modified objectives of the planning that were not necessarily directly reflected in the incentives of the planners. Parts of the debate therefore focused on the governance models for transmission entities to align their incentives, cf. Oren et al. (2002). By some participants of the debate, a distinction between ‘economic’ and ‘reliability’ investments was made. The former, they argued, could be delivered in a ‘market driven’ manner, i.e. with locational price signals as indicators of scarcity (Hirst and Kirby, 2002). This view was not widely shared (Joskow and Tirole, 2003; Joskow, 2005), but a recent article from Littlechild (2012) takes the view that merchant investment may be superior to regulated investment. Linking grid investment to publicly observable price signals, however, is only appealing because it makes investment needs and decisions manageable and transparent. Other approaches at making planning decisions transparent are grid-related cost-benefit analysis frameworks (Awad et al., 2004; Meeus et al., 2013). A cost-benefit analysis aims at suggesting alternatives by comparing monetary benefits and costs of different alternatives, and can be seen as a means to legitimise decisions on infrastructure.

Despite the many considerations on network planning, there are little comprehensive aspects on governance models or roles in network planning in the literature surveyed.

3 Building Blocks of Network Planning and Case Study Approach

In chapter 2 we identified some technical and conceptual aspects on network planning. Based on this, we can now derive building blocks of both the technical and the institutional aspects of network planning. This will create a framework that can serve as a means to structure analysis of case studies.

3.1 Technical Elements of the Network Planning Process

More often than not, real network planning procedures do not endogenously determine network extensions within the solution of some kind of closed optimisation problem formulation. Rather, they require some kind of discretionary action from planners to solve problems discovered by the analyses.

To identify transmission needs, one must first model flows on a network model. These flows are determined by power withdrawals and injections, the latter depending on power plant location and dispatch. Withdrawals (“load”), fuel prices, and location of power plants are in most cases represented via scenarios or fixed assumptions.

Given the identification of a transmission need, a suitable network must comply with three main technical criteria:

- (1) Thermal limits of the lines must be respected, e.g. current limits of the lines may not be exceeded. This is known as a load flow analysis.
- The network must be robust to a certain extent against network outage elements. This includes (2) the steady state (‘static stability’), and (3) the transient processes occurring during state transitions (‘dynamic stability’)

The requirements of these criteria will not be debated in this study. However, these considerations allow us to identify generic elements of network planning processes, which can be used to describe basic technical characteristics. We thus define the following elements:

- **Scenarios/Assumptions:** This covers all data and assumptions that are input to the planning process. For the case of non-integrated planning, those may, inter alia, be assumptions on future power generation units but also assumptions about load or demography.
- **Dispatch modelling:** In all electricity systems, even those not liberalised, the dispatch of power generation plants is calculated according to specific rules and algorithms. The current system in Europe is a zone pricing system that takes into account network constraints only at zonal borders, which are most often identical with country borders. The dispatch model determines the use cases of the grid, and may reflect capabilities of the grid in relation to unit dispatching problems.
- **Thermal load flow analysis:** In this step, a classical alternating current (AC) load flow study is conducted to identify thermal limitations of the network.
- **Static stability analysis:** As mentioned above, it is generally accepted that networks need to be resilient to outages of network elements or other contingencies. For the steady-state, this is evaluated by a static stability analysis. Besides the (n-1)-criterion

and its variations (e.g. common-mode failures, cf 50 Hertz et al. (2012a)), though risk-based security assessment schemes are also sometimes debated (e.g. McCalley et al., 1999).

- **Dynamic stability analysis:** Besides the steady states examined by the static stability analysis, dynamic aspects are important to be investigated as well. A dynamic analysis will show whether the system reverts to a steady state after a disturbance.
- **Network adjustment:** The steps of technical analysis covering load-flow and stability issues will identify technical requirement violations with respect to a given network configuration. To overcome these blockers, different measures can be applied. Solutions may range from topological switching, to the reconductoring of existing power lines, and even to the insertion of new connections into the network model. This network adjustment step is crucial, as decisions on the final network extension plan are made at this time. In integrated network and generation planning, this step would also include the possibility of reconfiguring generation options.

These elements blocks may be connected to show the flow of information between them. In the following example (Figure 1), a generic grid planning process is sketched out. Assumptions flow mainly into the dispatch model, which then generates use-cases for the network. According to the results of the technical analyses, the network is adjusted accordingly. Note that the dashed line implies the possibility of a dispatch model taking into account network constraints. This is especially relevant in the case of a national network planning procedure where the national power market design reflects network constraints through price zones. This can be seen in Italy (Barquín et al., 2011) and Sweden (SvK, 2011). The depiction does not necessarily imply a specific sequence of steps; often, static stability will be analysed after thermal load flow conditions are satisfied but before dynamic stability is considered.

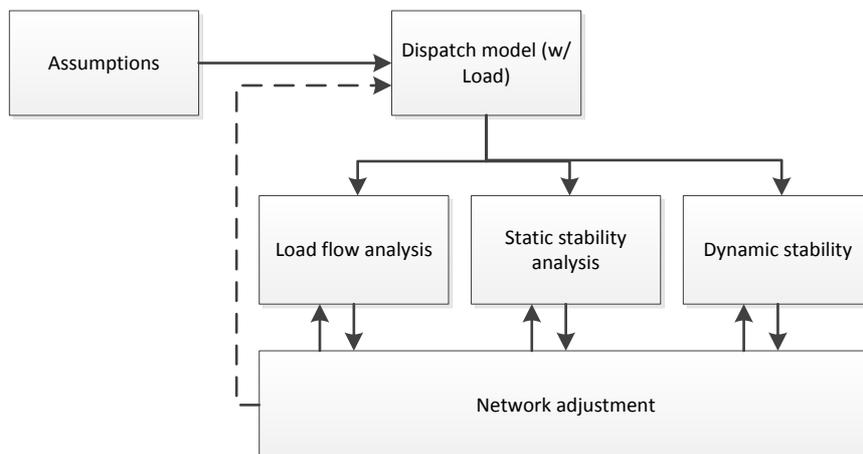


Figure 1: Generic grid planning process. Source: Own depiction.

Specific planning processes can of course not be fully captured by these blocks alone. To be put into practical analysis they need to be accompanied by a description of the tools used in each step, the general objectives of the process, the respective methods of decision-making, and the relation to steps of governance and transparency aspects.

3.2 Building Blocks of Network Planning Processes

The planning elements identified in section 3.1 may capture the technical nature of the planning process to a certain level of detail, but they do not represent institutional aspects, i.e. transparency, accountability, and roles, which were loosely referred in section 2.2. Most often, institutional arrangements relate to some kind of aggregate data/process/input/output rather than atomically providing specific rules for every smallest detail. These elements may therefore be grouped and enhanced. We propose to use an aggregate view on the process and add, where necessary, a detailed description of what happens inside the aggregate processes given. The aggregate view on network planning processes is visualised in Figure 2. On the technical level, the elements defined in section 3.1 are re-used, but grouped in order to be referenced by a governance-level view on the planning process. There, we sketch out an exemplary network planning process into three major steps: scenarios, technical planning, and final approval. This grouping might, for example, be related to the actor who has the respective leading role. In our example, the national regulatory authority (NRA) drafts and consults scenarios, and thus part of the network planning process is moved to the NRA. Then, the transmission system operator (TSO) applies its traditional process based on the scenario input generated in the previous step. The initial TSO network plan is then submitted to the regulator, who might try to reproduce the results applying the same or similar methods used by the TSO (indicated by the red dotted arrow-line). Finally, the NRA conducts a consultation on the amended version, finalises, and decides on the plan. The institutional rule of our example shall be that the NRA ultimately decides on the network plan.

For our analysis within the case studies, we define the respective building blocks of the governance view according to both the actual characteristics of the process in as much detail as needed, but also as general as possible to allow for good comparability of the processes.

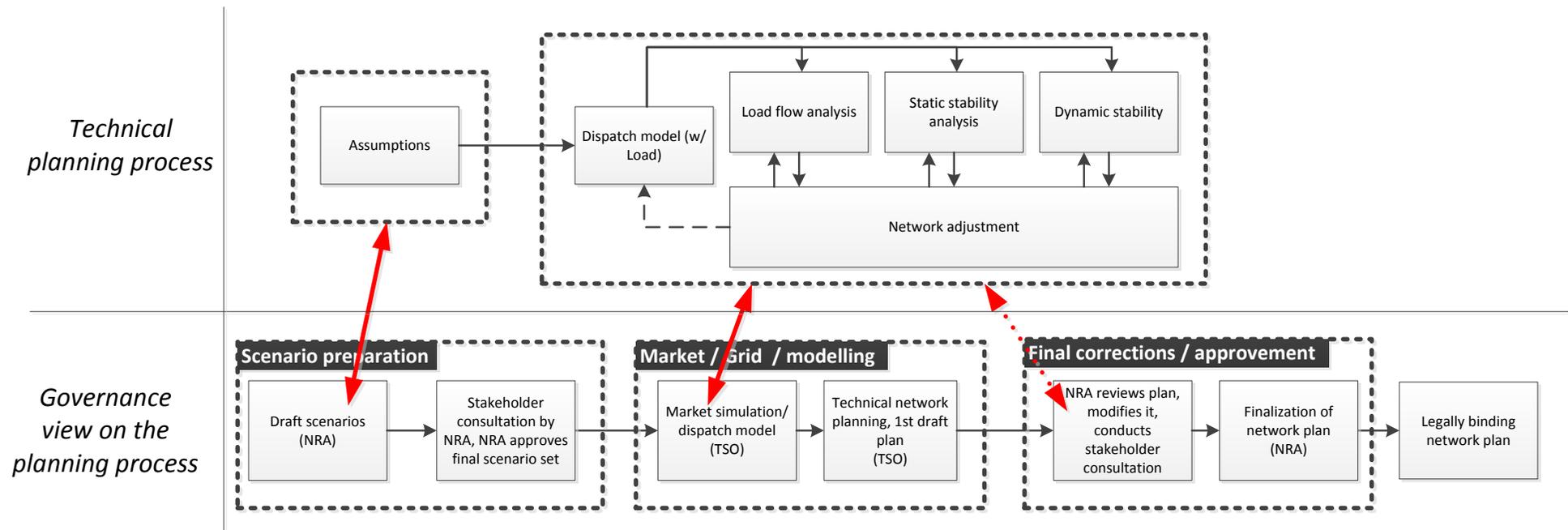


Figure 2: Technical planning elements and aggregate, governance view on the planning process. Source: Own depiction.

3.3 Approach to the Country Case Studies

Using the building blocks introduced above, the country case studies are structured as follows:

- First, a short **overview** of the overall process is given, including a chart illustrating flows of information and exercise of tasks/control.
- In the following section, the **scenario** definition part of the process is described in more detail, also referring to actual content of current national transmission planning studies.
- After the scenario definition, **market simulation** and **grid modelling** aspects are described and explained.
- Subsequent to this, the **bindingness of the planning** is analysed.
- We then **sum up** each country study using the structure presented in Table 1.

The composition of the table is based on both a planning process technical view and the conceptual aspects as discussed in section 2.2.

Transparency
Which elements of the process are transparent to whom?
Degree of public participation
Who may interfere in decisions?
Cost-benefit analysis
Integration
Fossil power generation
Renewable energy sources (RES) (e.g., timing, level, and spatial differentiation)
Coordination with neighbours
Coordination with distribution system operators (DSOs)
Coordination with Offshore-Plans
Consideration of storage + demand-side management (DSM)
Frequency of the planning process
Time horizon, long-term considerations
Cross-sectoral aspects
Consequences

What function does the planning process have? Is the plan binding?

Table 1: Classification aspects of network planning processes

4 Selected case study evidence on Network Planning Processes

This section aims at showcasing selected case study evidence from the network planning processes of the country studies undertaken. Those readers interested in the “raw material” underlying this comprehensive discussion are invited to read the country cases found in the appendix. The primary objective here is to discuss how questions of integration, especially with relation to the challenges of increasing the share of renewable energy sources in the power sector, are addressed in different countries. Whereas the question of integration focuses more on the technical aspect, the question of stakeholder involvement and transparency issues also is of importance, which forms our second topic.

The debate is centred on the nine European countries studied between the end of 2012 and the beginning of 2013. It is important to remember that these results come from a different perspective than would come from discussing, e.g., U.S. network planning arrangements (such as described in section A-11). European-relevant points include the following:

- EU Member States are expected to decarbonise their economies, with electricity being one of the most important sectors subject to these efforts.
- Transmission in Europe is generally centrally organised, with little divergence between transmission ownership and system operation, and network related effects on stakeholders are usually not externalised (such as large zonal markets, or smaller opportunities for ‘market driven’ transmission investment).
- Planning processes in European states have recently undergone or can in the near future expect to undergo changes due to community-wide legislation in the course of the Third Energy Market Package. The changes imply stronger regulatory oversight of TSOs’ planning, and establishes a framework for increased pan-European coordination. For more details see section A-10.

These observations are interesting: Although there is a widely shared paradigm of decarbonising the electricity system with generally acknowledged implications on networks - though the specifics of this are still as yet not very clear - the recent changes in planning procedure governance are focused on “market integration” and a regulatory mandate to speed-up the delivery of such a grid. Further, although the on-going and envisaged electricity sector changes are subject to a large societal debate, the European history of network planning has not led to a broad involvement of stakeholders, which is contrary to U.S. sector developments that have resulted in more institutionalised forms of stakeholder involvement.

In the next two sections we present selected case study experience on (i) integration and (ii) stakeholder involvement.

4.1 Integration: Evidence from Belgium, Germany, and Switzerland

The integrated planning of electricity systems has for a long time been central to the electricity sector and was generally broken up with the “liberalisation” of the industry (Hirst and Kirby, 2002). Power plants were in most cases able to choose their sites quite independently from network considerations, sometimes encouraged by large “copper-plate” energy market models without any locational signals. This separation led network planners towards a need to anticipate the evolution of generation, which also required the creation of new abilities for planners.

The examples of Belgium, Germany, and Switzerland are useful to illustrate possible approaches to cope with this deintegration.

In **Belgium**, a part of the pre-liberalisation planning process has been preserved: both a legally binding network plan and a generation plan are regularly issued with a ten-year horizon each. However, liberalisation has torn apart what was once a single plan, as the generation plan is now ‘indicative’ and of limited help in reducing uncertainty in binding network plans. Beyond the formalisation of assumptions on future generation, the plan is subject to political approval that can be used to ensure consistency of network planning for national energy system planning and policy.

The case is different in **Germany**, where neither a framework for network nor generation planning was in place until mid-2011. As of 2012, TSOs are obliged to draft both network and generation scenario sets, the objectives of which must be aligned with the current national energy policy. Scenarios must also include assumptions on future deployment of generation and a network development plan. Although the scenario sets are not binding in the sense that they could have a steering impact on parts of the energy system other than transmission, they undergo a public consultation and regulatory review. This forces both the underlying assumptions on generation deployment and their implications on network planning to be made subject to a societal debate. However, this does not replicate the classical ‘integrated’ planning.

As with Belgium and Germany, generation is not planned in integration with transmission in **Switzerland** either. However, the Swiss government has a long tradition of assessing the implications of its energy policy within the ‘Energieperspektiven’ studies, which contain national energy system scenarios. Compared to energy economic assessments of the other countries studies, which are available to the public, the Swiss studies suggest that governmental entities have built up detailed knowledge on the energy sector. As the results of these studies are input to the network planning process, a tight governmental and regulatory oversight over Swiss transmission planning and alignment with national energy policy seems plausible.

4.2 Stakeholder Involvement: Evidence from Denmark, Germany, and Great Britain

As discussed earlier, stakeholder involvement has less tradition in Europe, as compared to, e.g., the U.S. However, the examples of Denmark, Germany and Great Britain demonstrate that extensive stakeholder inclusion in the network planning processes can be established.

In **Denmark**, external experts are included in network planning processes, but in rounds that are generally not open to everyone: a selection of participants is made ex ante. However, Danish TSOs offer vast information on planning tools and methodologies used, possibly making the planning process better understandable to outsiders. On the other hand, the results of the planning cannot be reproduced by externals as the underlying data are not available.

The situation in **Germany** is different again as well. Both scenario assumptions and network plans are subject to public consultation and technical data of the network planning can be requested by externals. Despite that, those applying for data need to prove their expertise and to justify their interest. As already indicated in section 4.1, this broad public participation may foster the debate, but there is no codified process of how interventions by stakeholders are taken into account.

For the case of **Great Britain**, the network planning process is designed less towards the information and participation of the general public, but much more towards the inclusion of specific stakeholders, such as generators, investors, etc. This is true for the scenario development, the drafting process of the Electricity Ten Year Statement (ETYS), which includes envisaged network projects, and the approval of the plan by the UK Office of Gas and Electricity Markets (Ofgem). In contrast to Germany, participation of the general public is foreseen only in context of the regulatory approval of the plan.

5 Summary and Conclusion

Although many of the processes in EU Member States have recently or will in the near future undergo changes imposed by the Third Energy Market Package, most of their characteristics can be expected to stay untouched or respective to their legacy. The governance prescribed by European legislation puts a focus on regulatory enforcement of network development plans, and tries to push for EU-wide coordination of plans through Regional Investment Plans and a pan-European network development plan. The remaining elements of network planning processes, such as transparency, public participation, alignment with national targets, stakeholder involvement, and integration of systems linked to the transmission system (such as generation, demand side technologies, and long-term policies) are not explicitly addressed.

With respect to the objective of decarbonising the power sector, this focus on getting grids built chiefly for purposes of trade seems to be incomplete. Although network planning processes have many facets, we argue that with respect to the new objectives they may be aggregated into two main categories:

- Integration.
- Stakeholder Involvement and Participation.

The patterns observed concerning these two categories can be broken down as follows:

Integration

Full integration of network planning would mean that elements of inter-linked systems are planned simultaneously, such as with generation. This is in fact not the case for any of the processes studied, but integration can take lighter forms, such as coordination with plans for related systems. In some countries, sector legacy brings with it plans for generation systems that are taken into account for net-

work planning. On the other hand, in some countries such aspects of integrated planning have been lost. The same goes for coordination with lower-level voltage systems and coordination with spatial planning.

Stakeholder Involvement and Participation

Most network planning processes allow for public participation in the sense of public consultations, where at least a part of the network planning (e.g., scenarios) are put to consultation. However, even in more sophisticated processes with many possibilities for stakeholder involvement, data are often not available such that third parties could reproduce or verify results. On the other hand, some processes ensure the application of external knowledge by informally involving research institutes or external consultants to monitor the process. The situation is even more complicated when it comes to the “ingredients” of network planning: There is a vast array of tools which are used, but often the decision-making itself is or can be assumed to be discretionary, and not tractable by actors external to the planning process.

Outlook

In order to give specific policy recommendations, objectives and the specific points of departures need to be well understood. Although we suggest that two aspects of network planning processes - namely integration and stakeholder involvement - are key in this respect, general recommendations are likely to miss the point. We therefore encourage a focused discussion on how energy system planning processes would need to be aligned with energy policy objectives.

References

- 50Hertz, Amprion, TenneT, TransnetBW (2011):** Szenariorahmen für den Netzentwicklungsplan 2012 - Eingangsdaten der Konsultation.
- 50Hertz, Amprion, TenneT, TransnetBW (2012a):** Grundsätze für die Planung des deutschen Übertragungsnetzes.
- 50Hertz, Amprion, TenneT, TransnetBW (2012b):** Szenariorahmen für den Netzentwicklungsplan Strom 2013 - Entwurf.
- 50Hertz, Amprion, TenneT, TransnetBW (2012c):** Netzentwicklungsplan Strom 2012, 2. überarbeiteter Entwurf der Übertragungsnetzbetreiber.
- 50Hertz, Amprion, TenneT, TransnetBW (2012d):** Kraftwerksliste zum Netzentwicklungsplan Strom 2012.
- 50Hertz, Amprion, TenneT, TransnetBW (2012e):** Kraftwerksliste Szenariorahmen NEP 2013.
- Austrian Power Grid AG (2009):** Masterplan 2020, 4th edition.
- Austrian Power Grid AG (2011):** Netzentwicklungsplan 2011.
- Awad, M., Broad, S., Casey, K.E., Chen, J., Geevarghese, A., Miller, J., Sheffrin, A., Zhang, M., Toolson, E., Drayton, G., Hobbs, B.F. (2004):** The California ISO transmission economic assessment methodology. Presented at the Carnegie-Mellon Conference on Electricity, Pittsburgh PA.
- Barquín, J., Rouco, L., Rivero, E. (2011):** Current designs and expected evolutions of Day-ahead, Intra-day and balancing markets/mechanisms in Europe (OPTIMATE project report.).
- BFE (2007):** Die Energieperspektiven 2035 – Band 1: Synthese.
- BFE (2012):** Strategie Stromnetze; Entwurf Detailkonzept im Rahmen der Energiestrategie 2050.
- BFE, Bundesamt für Raumentwicklung (2001):** Sachplan Übertragungsleitungen (SÜL).

- Bundesnetzagentur (2011):** Genehmigung des Szenariorahmens zum NEP 2012. Bundesnetzagentur, Bonn.
- Bundesnetzagentur (2012a):** Bestätigung Netzentwicklungsplan Strom 2012 durch die Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen. Bundesnetzagentur, Bonn.
- Bundesnetzagentur (2012b):** Begleitdokument zur Konsultation des überarbeiteten Netzentwicklungsplans Strom 2012 der Übertragungsnetzbetreiber durch die Bundesnetzagentur mit dem derzeitigen Stand der Prüfung. Bundesnetzagentur, Bonn.
- Bundesversammlung der Schweizerischen Eidgenossenschaft (1999):** Energiegesetz (EnG).
- Conseil d'Etat Belgique (2007):** Arrêté royal relatif à la procédure d'élaboration, d'approbation et de publication du plan de développement du réseau de transport d'électricité. [WWW Document]. URL http://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=fr&la=F&cn=2007122098&table_name=loi
- CRE (2011):** Investissements [WWW Document]. URL <http://www.cre.fr/reseaux/reseaux-publics-d-electricite/investissements>
- CRE (2012a):** Public consultation of the French Energy Regulatory Commission dated April 10th 2012 on the ten-year development plan drawn up by RTE for the electricity transmission network in France.
- CRE (2012b):** Deliberation by the Energy Regulation Commission on the 19th of July 2012 examining the ten-year network development plan drawn up by RTE and submitted in 2012.
- CREG (2010):** Avis relatif au projet de plan de développement 2010 – 2020 de la S.A. ELIA SYSTEM OPERATOR.
- David, P.A. (1994):** Why are institutions the “carriers of history”? Path dependence and the evolution of conventions, organizations and institutions. *Structural Change and Economic Dynamics* 5, 205–220.
- Direction générale de l’Energie (2011):** Déclaration de la Direction générale de l’Energie en vue de l’approbation du plan par le Ministre fédéral de l’Energie.
- Dong, J., Zhang, J. (2009):** Transmission Planning in China. *The Electricity Journal* 22, 77–85.
- EC (2009a):** Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.
- EC (2009b):** Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003.
- Elia (2011):** Plan de développement fédéral 2010-2020.
- Elinfrastrukturudvalget (2008a):** Technical report on the future expansion and undergrounding of the electricity transmission grid - Summary.
- Elinfrastrukturudvalget (2008b):** Teknisk redegørelse om fremtidig udbygning og kabellægning i el-transmissionsnettet.
- Energinet.dk (2006):** Systemplan 2006 - English version.
- Energinet.dk (2007a):** Scenariereport, fase 1 - arbejdspapir.
- Energinet.dk (2007b):** Systemplan 2007 - English version.
- Energinet.dk (2008):** Energinet.dk Netdimensioneringsregler.
- Energinet.dk (2009):** Kabelhandlingsplan 132-150 kV – Marts 2009.
- Energinet.dk (2010):** A Brief Description of Energinet.dk’s Market Model MARS.
- Energinet.dk (2011a):** Systemplan 2011.
- Energinet.dk (2011b):** 2030 - Scenarier for Energinet.dk.
- ENTSO-E (2011):** Scenario Outlook and System Adequacy Forecast 2011-2025. ENTSO-E, Brussels.

- ENTSO-E (2012a):** Scenario Outlook & Adequacy Forecast 2012-2030. ENTSO-E, Brussels.
- ENTSO-E (2012b):** 10-Year Network Development Plan 2012. ENTSO-E, Brüssel.
- ENTSO-E (2012c):** Regional Investment Plan Baltic Sea. ENTSO-E, Brüssel.
- ENTSO-E (2012d):** Regional Investment Plan Continental South East. ENTSO-E, Brüssel.
- ENTSO-E (2012e):** Regional Investment Plan Continental Central East. ENTSO-E, Brüssel.
- ENTSO-E (2012f):** Regional Investment Plan Continental South West. ENTSO-E, Brüssel.
- ENTSO-E (2012g):** Regional Investment Plan Continental Central South. ENTSO-E, Brüssel.
- ENTSO-E (2012h):** Regional Investment Plan North Sea. ENTSO-E, Brüssel.
- ENTSO-E (2012i):** An Overview of System Adequacy: Winter Outlook Report 2012/2013 and Summer Review 2012. ENTSO-E, Brüssel.
- ENTSO-E (2012):** System Adequacy and Market Modeling [WWW Document]. URL <https://www.entsoe.eu/system-development/system-adequacy-and-market-modeling/>
- ENTSO-E (2012j):** The Ten-Year Network Development Plan and Regional Investment Plans [WWW Document]. URL <https://www.entsoe.eu/system-development/tyndp/>
- FERC (1996a):** [Dockets No. RM95-8-000, Docket No. RM94-7-001] ORDER NO. 888.
- FERC (1996b):** [Docket No. RM95-9-000] Open Access Same-Time Information System (formerly Real-Time Information Networks) and Standards of Conduct ORDER NO. 889.
- FERC (2000):** [Docket No. RM99-2-001; Order No. 2000-A] Regional Transmission Organizations.
- FERC (2007a):** (Docket Nos. RM05-17-000 and RM05-25-000; Order No. 890) Preventing Undue Discrimination and Preference in Transmission Service.
- FERC (2007b):** (Docket Nos. RM05-17-000 and RM05-25-000) Order No. 890 Fact Sheet.
- FERC (2011):** [Docket No. RM10-23-000; Order No. 1000] Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities.
- Frontier Economics, Consentec (2011):** Bedeutung von etablierten nationalen Gebotszonen für die Integration des europäischen Strommarkts - ein Ansatz zur wohlfahrtsorientierten Beurteilung. Ein Bericht für die Bundesnetzagentur.
- Gönen, T. (1988):** Electric power transmission system engineering. Wiley, New York.
- Hirst, E., Kirby, B. (2002):** Transmission Planning and the Need for New Capacity, in: U.S. Department of Energy (Ed.), National Transmission Grid Study - Issue Papers.
- Joskow, P., Tirole, J. (2003):** Merchant Transmission Investment. National Bureau of Economic Research Working Paper Series No. 9534.
- Joskow, P.L. (2005):** Patterns of Transmission Investment (No. 0527), Cambridge Working Papers in Economics. Faculty of Economics, University of Cambridge.
- Littlechild, S. (2012):** Merchant and regulated transmission: theory, evidence and policy. *J Regul Econ* 42, 308–335.
- Maire, F. (2012):** TYNDP 2014: First insights.
- McCalley, J.D., Vittal, V., Abi-Samra, N. (1999):** An overview of risk based security assessment, in: Power Engineering Society Summer Meeting, 1999. IEEE. Presented at the Power Engineering Society Summer Meeting, 1999. IEEE, pp. 173–178 vol.1.
- Meeus, L., von der Fehr, N.-H., Azevedo, I., He, X., Olmos, L., Glachant, J.-M. (2013):** Cost Benefit Analysis in the Context of the Energy Infrastructure Package.
- Mirbach, T. (2009):** Marktsimulationsverfahren zur Untersuchung der Preisentwicklung im europäischen Strommarkt.
- Moselle, B., Brown, T. (2007):** International Review of Transmission Planning Arrangements (A report for the Australian Energy Market Commission). Brattle Group, Brussels.
- National Grid (2012a):** UK Future Energy Scenarios.
- National Grid (2012b):** Network Development Policy Update.

- National Grid (2012c):** National Electricity Transmission System Security and Quality of Supply Standard - v. 2.2.
- National Grid (2012d):** Electricity Ten Year Statement.
- NERC (2012):** NERC Interconnections [WWW Document]. URL http://www.nerc.com/fileUploads/File/AboutNERC/maps/NERC_Interconnections_Color_072512.jpg
- NERC (2012):** Regional Entities [WWW Document]. URL <http://www.nerc.com/page.php?cid=1|9|119>
- O'Donnell, P. (2011):** Introduction to Market Modeling in ENTSO-E.
- Ofgem (2010):** Handbook for implementing the RIIO model.
- Oren, S., Gross, G., Alvarado, F. (2002):** Alternative Business Models for Transmission Investment and Operation, in: U.S. Department of Energy (Ed.), National Transmission Grid Study - Issue Papers.
- Parlement fédéral belge (1999):** Loi relative à l'organisation du marché de l'électricité.
- Reich, K., Gutsch, C., Nischler, G., Nacht, T., Stigler, H. (2012):** Szenarioanalysen für den Masterplan 2030 der Austrian Power Grid AG.
- République Française (2012):** Code de l'énergie [WWW Document]. URL <http://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000023983208&dateTexte=20120406>
- RTE (2011a):** The French electricity report 2010.
- RTE (2011b):** Generation adequacy report on the electricity supply-demand balance in France.
- RTE (2012):** Schéma décennal 2012 de développement du réseau de transport d'électricité - version 21 novembre 2012.
- RTE (2012):** ASSESS [WWW Document]. URL <http://www.rte-france.com/fr/nos-activites/notre-expertise/les-offres-de-logiciels/assess>
- Scheepers, M.J.J., Seebregts, A.J., Hanschke, C.B., Nieuwenhout, F.J.D. (2007):** Invloed van innovatieve technologie op de toekomstige elektriciteitsinfrastructuur.
- Schlabbach, J., Rofalski, K.-H. (2008):** Power system engineering planning, design, and operation of power systems and equipment. Wiley-VCH, Weinheim.
- Service public fédéral Economie, BFP (2009):** Etude sur les perspectives d'approvisionnement en électricité 2008-2017.
- Statnett, Energinet.dk, SvK, Fingrid (2012):** Nordic Grid Development Plan.
- Stoll, H.G. (1989):** Least-cost electric utility planning. Wiley, New York.
- SvK (2011):** Idag införs elområden - Svenska Kraftnät [WWW Document]. URL <http://svk.se/Press/Nyheter/Nyheter-pressmeddelanden/Allmant/Idag-infors-elomraden/>
- TenneT (2010a):** Quality and Capacity Plan 2010-2016, Part I.
- TenneT (2010b):** Quality and Capacity Plan 2010-2016, Part II A.
- TenneT (2011):** Vision 2030.
- TERNA S.p.A. (2007):** Grid Code, Chapter 2.
- TERNA S.p.A. (2012a):** Piano di Sviluppo 2012.
- TERNA S.p.A. (2012b):** Presentation: Piano di Sviluppo della Rete di Trasmissione Nazionale 2012.
- Transport- og Energiministeriet, Danish Energy Authority (2007):** A visionary Danish energy policy 2025.
- WECC (2010):** White Paper: WECC 10-Year Regional Transmission Plan -- Framework, Components, and Process.
- Whitfield, A., Nieto, A., Fraser, H. (2012):** Planning Arrangements for Electricity Transmission Networks: An International Review (A report for the Australian Energy Market Commission). NE-RA Economic Consulting, Sydney.

A-1 Austria

A-1.1 Governance of the Planning Process

The Austrian transmission grid is operated and to a large extent owned by Austrian Power Grid AG (APG), a subsidiary company of Verbund AG, of which the Austrian state holds a majority interest (51%). Since 2012, APG has also operated the Vorarlberger Übertragungsnetz GmbH grid, and the Tiroler Wasserkraft AG (TIWAG) grid since end of 2010. Those are regional transmission grids in the Vorarlberg and Tyrolean region, and these transmission grids are not owned by APG. APG is required by Austrian federal law to operate and expand the transmission grid safely, anticipatory, and reliably (cf. § 40 EIWOG 2010).

In 2009, APG published its Masterplan 2020 for grid expansion, to present their views on the developments in the Austrian energy sector with a time horizon to 2020 (Austrian Power Grid AG, 2009). Within the Masterplan 2020, APG developed different scenarios with the assistance of a research institute at the University of Vienna, and also carried out market simulation and grid modelling for the transmission grid. Results were reviewed and evaluated by a research institute at the University of Graz (Austrian Power Grid AG, 2009). The necessary expansion projects are highlighted in the Masterplan 2020, and the plan is still subject for periodic reviews and adjustments by APG.

The Austrian Electricity Act (“Elektrizitätswirtschafts- und -organisationsgesetz 2010”, EIWOG 2010) requires APG in their role as the national TSO to draw up an annual plan (“Netzentwicklungsplan”, NDP) on grid expansion (cf. § 37 EIWOG 2010). The NDP has a ten year horizon for information regarding necessary grid expansion and includes all planned grid expansion projects that are to be realised within the next three years. The grid expansion projects were in the recent NDP presented with their technical data, their reasoning for necessity, and their operational utility (Austrian Power Grid AG, 2011). Grid expansion projects were divided into two basic categories:

- **Projects of national or European interest:** These projects were taken from the Masterplan 2020.
- **Power and network connection projects:** These projects are initiated by local and regional requirements, such as overload in lower voltage-level grids or connection of power plants.

All market participants are by law required to provide the relevant data for network planning to the TSO upon request, such as consumption forecasts, recent or planned changes of the grid configuration, recorded measurement data, and other documents for planned grid expansion or production capacity. Additionally, the TSO is allowed to request further data from market participants (cf. § 37 (7) EIWOG).

Before the NDP is submitted to the NRA, in this case E-Control, APG must implement a consultation with relevant market participants (cf. § 37 (5) EIWOG 2010) and consider the results of the consultation procedure in the NDP. After submission, the NRA conducts another consultation with special interest groups (cf. § 38 (2) EIWOG 2010). The NDP must be approved by the NRA. For the 2011 NDP, the notes of the special interest groups were released within the official notification by the NRA (E-Control, 2011). Once the NRA has decided on the NDP, the investment projects are legally binding.

The governance of the Austrian grid planning process is depicted in Figure 3.

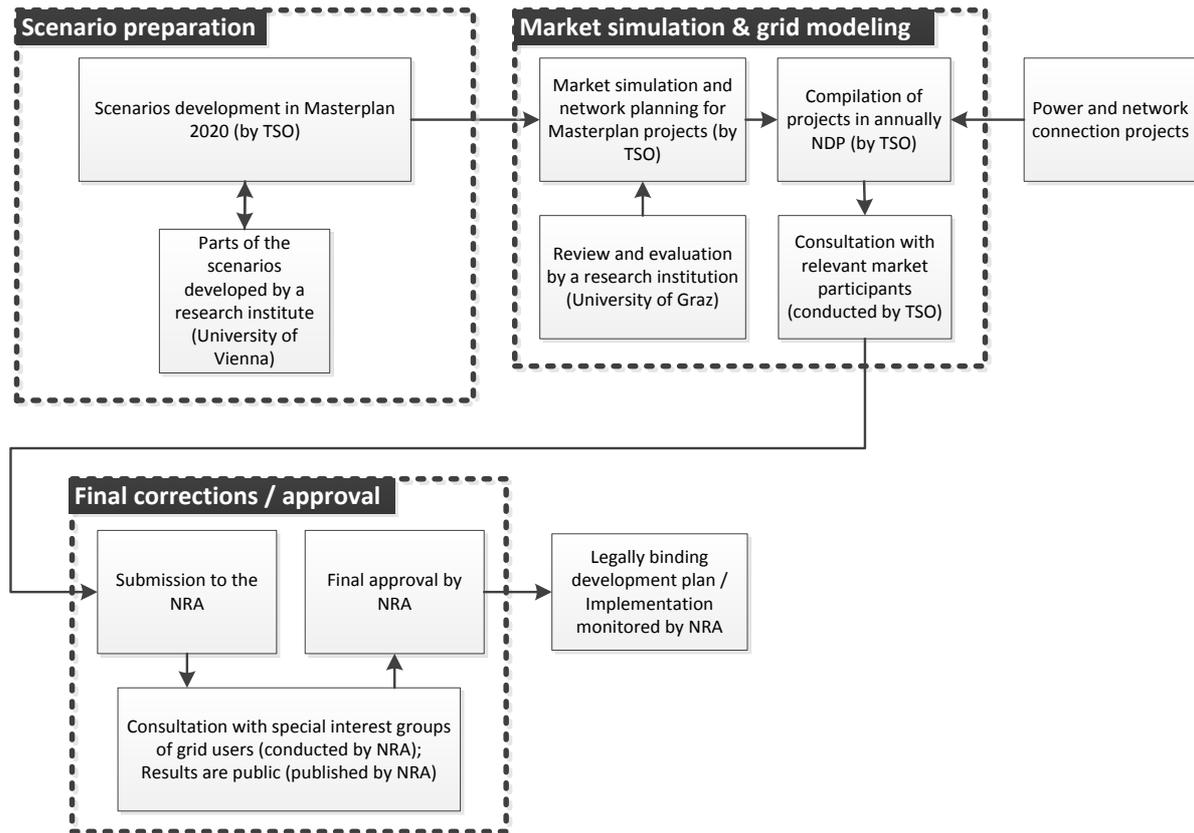


Figure 3: Governance of the Austrian planning process

A-1.2 Scenario definition

A-1.2.1 Legal Foundations

The legal requirements are stated in § 37 EIWOG. Adapted from § 37 (4) EIWOG, the TSO is required to make suitable assumptions on the development of production capacity, the energy supply, energy consumption, and exchange with other countries. The TSO is also required to consider the investment plans for regional grids (§ 37 (4) EIWOG).

A-1.2.2 Contents of the Current Scenarios

As mentioned before, APG draws up different scenarios within their Masterplan 2020 considering the development of the electricity consumption, the exchange with neighbouring countries, and the national production capacity. The development of renewable energy sources is considered pursuant the “Ökostromgesetz” (Austrian renewable law), and the extension of hydro power according to the Austrian “Masterplan Wasserkraft” (Masterplan hydro power). Within the Masterplan 2020 scenarios, pump storages were considered (Austrian Power Grid AG, 2009). Current regional investment plans were not considered within the scenarios. To incorporate the investment plans for regional grids, APG plans to refine its Masterplan and would like to create more detailed Masterplan scenarios in coordination with regional grid operators (Austrian Power Grid AG, 2009).

For the analysis of the development of the production capacity, APG accessed the know-how of a research institute at the University of Vienna. The analysis included the results of European research, development of the pan-EU Green-X project, PRIMES modelling scenarios and calculations, and other specific country studies (Austrian Power Grid AG, 2009).

A-1.2.3 Transparency/Governance

The underlying scenario assumptions and content for the Masterplan 2020 were not made public. However, the University of Graz published a description of the planned APG Masterplan 2030 scenarios (Reich et al., 2012), which are the “Best Estimate”, the “Energiewende”, and the “Green” scenarios.

A-1.3 Market Simulation/Grid Modelling/Planning Process

A-1.3.1 Planning Process

On the basis of the developed scenarios, APG conducted load flow calculation for the existing Austrian grid (2011) and forecasted scenarios for the years 2015, 2017 and 2020. For the future load flow calculations, APG assumed that some of the already planned necessary grid expansion projects would be realised.

Based on the load flow calculations, grid expansions until 2020 were proposed. To validate the results, the grid was tested against static and dynamic stability criteria (Austrian Power Grid AG, 2009). The grid modelling - including the stability analyses - was reviewed externally by a department at the University of Graz.

A-1.4 Models and Methodologies

The models and methodologies used in the APG Masterplan 2020 were not described. For the Masterplan 2030, the calculations will be based on the ATLANTIS model (Reich et al., 2012).

A-1.4.1 Transparency/Governance

Within the Masterplan 2020, only the results of the market simulation, load flow calculations, and derived grid expansion projects were published. The underlying methods and detailed assumptions were not made public. APG argued that some information, particularly data relating to power plant projects, could not be made public due to reasons of data privacy (Austrian Power Grid AG, 2009).

E-Control, the NRA, must evaluate the NDP on the basis of the public information within the Masterplan 2020, the NDP itself, and on additional information regarding cost estimates and related financial risks for the planned grid expansion projects.

Based on the public information in the Masterplan 2020 and the NDP itself, a detailed evaluation for third parties is not possible.

A-1.5 Bindingness of the Planning

Once approved by the NRA, the NDP is legally binding. In case of noncompliance regarding the planned grid expansion projects with a time horizon of three years, the NRA is authorised to compel

APG to undertake the expansion projects, to tender the project to third parties, or to oblige APG to increase its capital (cf. § 39 EIWOG 2010).

A-1.6 Overview

Following the points above, the Austrian network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, and (3) consequences of the plan.

Transparency	
Which elements of the process are transparent to whom?	Only aggregated information on the scenarios, the market simulation, and the grid modelling is published in the Masterplan 2020 and the annual NDP.
Degree of public participation	One consultation is held with relevant market participants before the submission, and another consultation with special interest groups (those listed in the official notification of the NRA) before the final approval.
Who may interfere in decisions?	The NDP must be approved by the NRA, E-Control.
Cost-benefit analysis	No cost-benefit analysis included. Verbal descriptions of the benefit for network operation given for each project in the NDP.
Integration	
Fossil generation	No integrated planning, i.e. exogenous assumptions on fossil generation.
Renewables (timing, level, and spatial differentiation)	The development of renewables is considered pursuant of the “Ökostromgesetz” (Austrian renewable law) and the extension of hydro power accordingly through the Austrian “Masterplan Wasserkraft” (Masterplan hydro power).
Coordination with neighbours	The development in other countries is considered in the scenarios.
Coordination with DSOs	During the scenario development the TSO is required to consider the investment plans for regional grids.
Coordination with Offshore-Plans	Not applicable.
Consideration of Storage + DSM	Integration of pump storages.
Frequency of the planning process	Yearly

Time horizon, long-term considerations	Both the Masterplan 2020 and the NDP have a time horizon of 10 years. Currently, as of Autumn2012, the Masterplan 2030 is prepared.
Cross-sectoral aspects	No information available.
Consequences	
What function does the planning process have? Is the plan binding?	The planning process identifies necessary grid expansions projects and incorporates them into the NDP. After the approval by the NRA, the NDP is legally binding.

A-1.7 Fact Sheet Austria: Actors of the network planning process

TSO: The electricity network in Austria is operated by the Austrian Power Grid AG (APG), a subsidiary company of the Verbund AG (<http://www.verbund.com/at/de/>), which is majority owned (51%) by the Austrian state. Since 2012 the APG has also operated the grids of the Vorarlberger Übertragungsnetz GmbH. (<http://www.apg.at/de>).

Regulatory Authority: The Austrian energy market is regulated by the “Energie-Control Austria für die Regulierung der Elektrizitäts- und Erdgaswirtschaft” (E-Control). Since March 2011, E-Control is an institution under public law and therefore not subordinated to a ministry or the government. (http://www.e-control.at/en/home_en)

Research Institutes:

- Mr Reinhard Haas is professor at the "Institute of Energy Systems and Electric Drives" at Vienna University of Technology. (http://www.eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/staff/staff_detail.php?id=12)
- Mr Herwig Renner is professor at the “Institute of Electrical Power Systems“ at the University of Technology Graz (<http://www.ifea.tugraz.at/institut/profil/?lang=en>)

A-2 Belgium

A-2.1 Governance of the Planning Process

Belgian TSO Elia is responsible for planning the Belgian electricity network. The planning process takes place in cooperation with two public authorities – the Direction générale de l’Energie and the Bureau fédéral du Plan, as well as with involvement from the ministry of naval questions, who is responsible for offshore technology (Conseil d’Etat Belgique, 2007). After approval by the Department of Energy of the different versions of the NDP, the network development plans take effect for a period of ten years and are published by the TSO, although the plans are subject to adaptation every three years (Conseil d’Etat Belgique, 2007). The first system planning within a legal framework took place before liberalisation in 1999. Due to this historical background, the actual planning process is well-documented but also quite complex.

An overview over the procedure is presented in Figure 5. Scenarios are first drafted by the TSO, which is coordinated with the Direction générale de l’Energie and the Bureau fédéral du Plan (Conseil d’Etat Belgique, 2007). Generation assumptions are based on the generation plan, which is the system plan for the Belgian energy generation. The resulting scenarios then serve as input to the market simulation and grid modelling, which is undertaken by the TSO.

This first draft of the NDP is then submitted to the national regulator, the Commission de Régulation de l’Électricité et du Gaz (CREG). CREG then conducts a consultation with relevant stakeholders, the ministry of naval questions for concerns about the modalities of grid connection with offshore wind parks, and the regional regulatory authorities relating to renewable energies (CREG, 2010; Elia, 2011). Requests for modifications are then forwarded to the TSO, who is required to amend the NDP draft accordingly. After adoption, Elia evaluates the environmental impacts of the NDP. This sub-evaluation process includes consultation with the ministry of environmental development to address concerns about the geographically affected regions, as well as with the committee for environmental incidences (SEA) and the advisory board for sustainable development (CDFF). After modification, the NDP is submitted to CREG and a public consultation takes place (CREG, 2010). Finally the NDP is approved by CREG and the Direction générale (Elia, 2011).

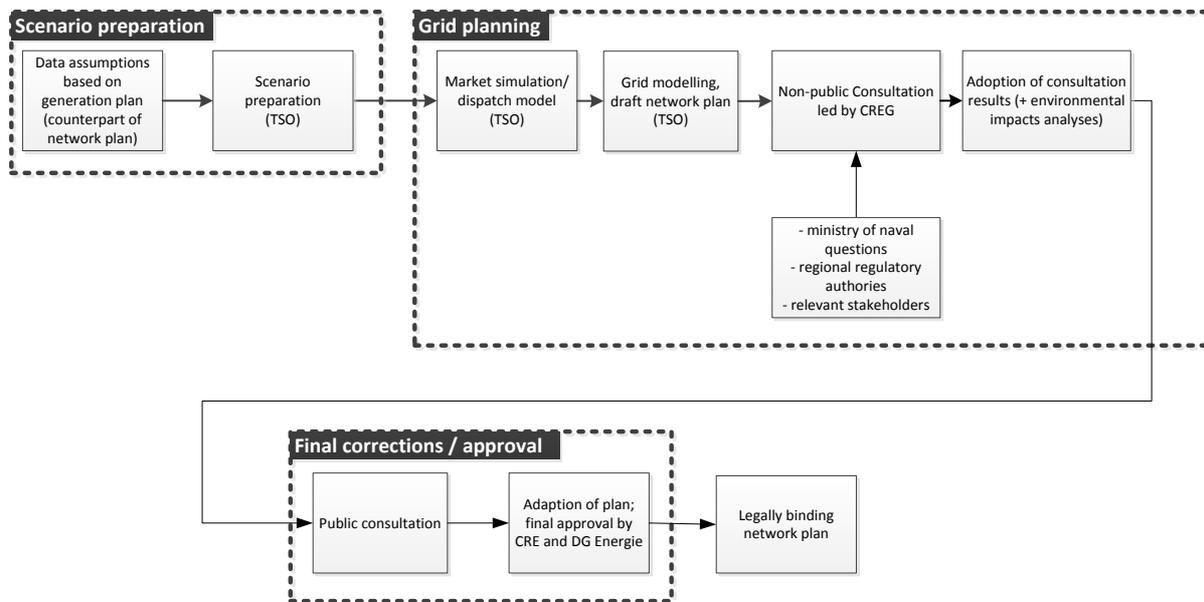


Figure 4: Roles and governance of the Belgian network development process.
 Source: Own depiction.

A-2.2 Scenario definition

Energy system planning in Belgium has a long tradition. Before the 1999 liberalisation, a legal framework for planning energy production as well as the transmission grid had already been in place in the form of “*le plan d’équipement*”. The management of all Belgian electricity production and transportation companies fell under a single committee responsible for the Belgian electrical system planning. (Service public fédéral Economie and BFP, 2009). The *plan d’équipement* was developed twice, each plan lasting for a period of ten years, first from 1988-1998 and also 1995-2005 (1988-1998; 1995-2005, cf. Service public fédéral Economie and BFP, 2009).

In the course of liberalisation system planning was separated into two single planning processes. For energy generation planning, “*l’Etude sur les perspectives d’approvisionnement en électricité*” and then “*le programme indicatif des moyens de production d’électricité*” were implemented. Grid planning was designated under, “*le plan de développement du réseau de transport d’électricité*” (Service public fédéral Economie and BFP, 2009). Despite the separation, it is legally required that the grid plan (also known as the system plan) refers to the energy generation plan (Conseil d’Etat Belgique, 2007).

A-2.2.1 Legal Foundations

The legal requirements concerning scenarios are stated in Loi du 29 avril 1999 (“Loi Electricite”) and Arrêté royale 2007 (Parlement fédéral belge, 1999; Conseil d’Etat Belgique, 2007)

- Scenarios must reflect certain developments:
 - Development of the electricity consumption: high scenario and low scenario
 - Development of central fossil energy generation: commissioning of new power plants (five different scenarios) and the shutdown of old plants
 - Development of nuclear phase-out (Elia, 2011).
- Scenarios based on the assumptions made in the energy generation plan.

A-2.2.2 Contents of the Current Scenarios

As already mentioned, the system plan must refer to the most recent version of the energy generation plan. Additionally, the NDP is based on the targets defined by the EU climate and energy package. Most importantly, the NDP uses established targets for shares of renewables in energy consumption (Elia, 2011). Concerning the level of renewables in the system by 2020, the data of the recent National Renewable Energy Action Plan (NREAP) for Belgium were assumed (Elia, 2011).

In its most recent system plan covering the period of 2010-2020, Elia based its scenarios on the assumptions made at the time of the most recent generation plan, covering the period of 2008-2017.

The scenario definitions are as follows:

Consumption	Assumption made concerning the planned nuclear-phase out	Central fossil energy generation - commissioning of new power plants
Low scenario	Nuclear phase-out as decided in the recent legislation	No additional units
		3 additional Combined Cycle Gas Turbine (CCGT) plants 5 additional CCGTs
		All power plant projects with status "reserved capacity"
	Extension of a period of 10 years (Doel 1, Doel 2 and Tihange 1)	No additional units 3 additional CCGTs 5 additional CCGTs
High scenario	Nuclear phase out as decided in recent legislation	All power plant projects with status "reserved capacity" 3 additional CCGTs
		5 additional CCGTs All power plant projects with status "reserved capacity" All power plant projects with at least status "detailed planning process"
		Extension of a period of 10 years (Doel 1, Doel 2 and Tihange 1)

		All power plant projects with at least status “detailed planning process”
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Table 2: Scenarios of the Belgian NDP. Source: (Elia, 2011)

A-2.2.3 Transparency/Governance

Although the energy generation plan serves as input to the network planning process, no specific consultations on the scenarios are conducted.

A-2.3 Market Simulation/Grid Modelling/Planning Process

A-2.3.1 Grid Modelling, Planning Process, Models and Methodologies

Concerning the NDP, no notice is given on the market and grid modelling tools used. The NDP contains a verbal description about how new lines are selected. From a technical point of view, it is explained that static and dynamic stability criteria need to be met, but no reference to the modelling tools is given. However, concerning grid modelling aspects it is noted that the current procedure is deterministic and focuses on critical use cases of the grid, particularly specific load flow situations. Elia has indicated, however, that it is currently investigating probabilistic approaches to system planning. Further, in the NDP Elia describes that they might conduct some type of cost-benefit analysis. In the case that a long-term development problem under consideration might be solved by different investments, costs are compared (Elia, 2011, pp. 68). One further aspect on integration is that Elia is responsible for system planning down to the voltage level of 70 kilovolts (kV), a level that is often not part of the transmission network planning process (Service public fédéral Economie and BFP, 2009).

The output of the grid planning resembles a grouping of projects into two time periods: short-term projects are grouped (in recent planning, between the years 2010-2014) as are mid-term/long-term projects (recent plans cover 2015-2020) (cf. Elia, 2011).

A-2.3.2 Transparency

As mentioned above, no specific information on the technical aspects of the market simulation or grid modelling steps is made public. Therefore, the results of the network planning cannot be verified by third parties. However, a public consultation on the plan is conducted at a later stage.

A-2.4 Bindingness of the Planning

The NDP is approved by CREG and the Direction générale (Direction générale de l’Energie, 2011). Although the plan is then deemed legally binding, no information on the consequences of non-delivery was available. Due to its holistic impact, the NDP needs to be fragmented according to the regions where it is to be applied (see section “investment plans for Flanders, Wallonia and Brussels-Capital”, Elia, 2011).

A-2.5 Overview

Following the discussion above, a sum up of the Belgian network planning process can be made with respect to three different aspects: (1) transparency, (2) integration, and (3) consequences of the plan.

Transparency	
Which elements of the process are transparent to whom?	Only aggregated transparency, no information about models or network data is made available.
Degree of public participation	One public consultation is made on the plan according to Law 2006-02-13/41.
Who may interfere in decisions?	Five public authorities affected by the consultation may input: the committee for environmental incidences (SEA), the advisory board for sustainable development (CDFF), and the three regions affected. Furthermore the regulator, the Department of environment, and the Department of naval questions are involved (Direction générale de l'Energie, 2011).
Cost-benefit analysis	Elia claims to conduct a techno-economic comparison of different expansion alternatives in their NDP (Elia, 2011, pp. 73).
Integration	
Fossil generation	Fossil integration is based on the assumptions and results made in the production system plan (Conseil d'Etat Belgique, 2007).
Renewables (timing, level and spatial differentiation)	Renewables integration are based on the assumptions and results made in the production system plan (Conseil d'Etat Belgique, 2007), and consistency with the NREAP is ensured.
Coordination with neighbours	No explicit coordination efforts are undertaken. Consultation with neighbouring countries on the plan is possible (Direction générale de l'Energie, 2011).
Coordination with DSOs	The TSO operates the entire power grid from 30 kV to 380 kV. The technical planning for lower voltages is conducted jointly with local network operators (Plan 2010-2020).
Coordination with Offshore-Plans	The TSO is required to take into account offshore plans by submitting the draft of NDP to the ministry responsible for offshore planning (Conseil d'Etat Belgique, 2007).
Consideration of Storage + DSM	No information available.
Frequency of the planning process	5 years for the federal development plan, shorter intervals for the regional adaptation plans.
Time horizon, long-term consid-	The NDP has two time horizons: the first phase is under short-

erations	term consideration (2010-2014), and the second phase describes the network development for long-term (2015-2020) (Direction générale de l’Energie, 2011). The generation plan also has a time-horizon up to 2020 (CREG, BFP, 2009).
Cross-sectoral aspects	No information available.
Consequences	
What function does the planning process have? Is the plan binding?	Legal determination of the need for system planning with the adoption of the NDP by the ministry every three years (Conseil d’Etat Belgique, 2007).

A-2.6 Fact Sheet Belgium: Actors of the network planning process

TSO: In Belgium, the electricity transmission network is operated by only one TSO, Elia. Elia holds a license that is valid for 20 years and can be renewed (Elia System Operator SA-NV; www.elia.be/).

Regulatory Authority: The TSO is regulated by the federal NRA CREG (Commission de Régulation de l'Electricité et du Gaz; <http://www.creg.be/fr/index.html>). The three regional NRAs, also responsible for the energy policy, are: VREG for the Flemish Region (<http://www.vreg.be/>) ; CWaPE for the Walloon Region (<http://www.cwape.be/>) ; BRUGEL for the Brussels-Capital Region (<http://www.brugel.be/>).

Further parties taking part in the process are the numerous stakeholders participating in the consultation process. Among them are the ministry responsible for offshore technology, the ministry of environment, NGOs, and individuals.

Additionally, the Direction générale de l'Energie (<http://economie.fgov.be/fr/>) and the Bureau federal du plan (<http://www.plan.be/index.php?lang=fr&TM=30&IS=61>) are involved in the network development process.

A-3 Denmark

A-3.1 Governance of the Planning Process

The Danish TSO Energinet.dk is responsible for planning the Danish electricity network (Energinet.dk, 2006). Network expansion projects are published by Energinet.dk in the yearly system plans (“Systemplan”) (e.g. Energinet.dk, 2011).

Despite the fact that there is apparently no detailed legal framework that would prescribe a specific yearly cycle for preparation of plans or detailed rules regarding governance, a very general governance process can be described, shown in Figure 5. Scenarios used in the grid planning process have been developed by Energinet.dk with the collaboration of external experts in the field (Energinet.dk, 2007a). Based on these scenarios, market simulation and internal grid modelling is conducted by Energinet.dk internally (Energinet.dk, 2007b). Modelling and simulation results inform an expansion plan comprising the future expansion projects. This expansion plan must be submitted to the Danish Ministry of Climate, Energy and Buildings (MoCEB) for review. In general, projects do not need an approval by the MoCEB, but project implementation cannot start until 6 weeks after plans have been submitted. The MoCEB can, however, by individual decision mandate project approval by the MoCEB. For legal details see section A-3.2.1.

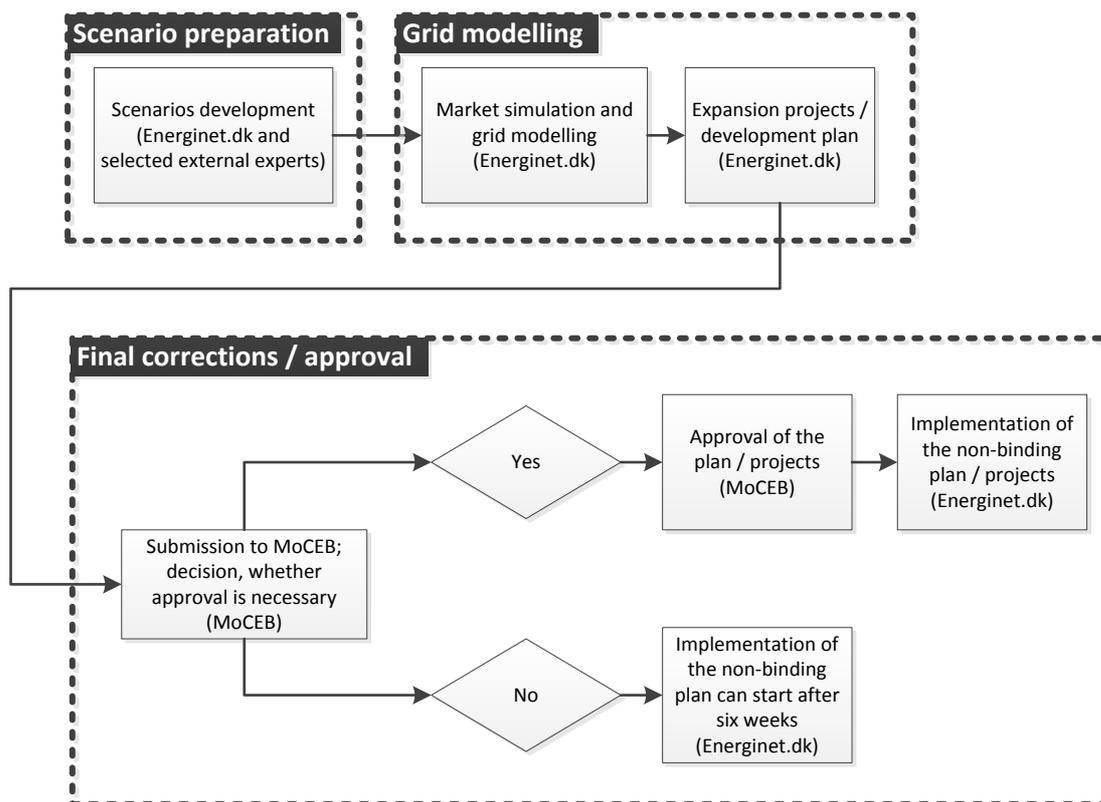


Figure 5: Roles and governance of the Danish network development process.

Source: Own depiction.

Apart from this general procedure of system planning, there has been one example of a joint action by national authorities and Energinet.dk to constitute an “Electricity Infrastructure Committee”. This committee, appointed by the former Danish transport and energy minister, issued a long-term (2030) non-

binding technical report in 2008 titled “Technical report on the future expansion and undergrounding of the electricity transmission grid” (Energinet.dk, 2006; Elinfrastrukturudvalget, 2008a).

Following the technical report, grid modelling for lower voltages has been conducted jointly with regional network operators (Energinet.dk, 2009).

Further, TSOs in Nordic countries coordinate by jointly analysing system adequacy in the “Nordic Grid Development Plans” on a regular basis (Statnett et al., 2012).

In the following sections, the “standard procedure” of the system plans as well as the long-term technical report will be described.

A-3.2 Scenario Definition

The Electricity Infrastructure Committee:

In January 2007, the Danish government announced renewable energy targets for the year 2025. These targets included a decrease in the use of fossil fuels by at least 15% and an increase of renewable energy to at least 30% of overall energy consumption (Transport- og Energiministeriet and Danish Energy Authority, 2007). Based on these targets, the former minister for transport and energy (and currently the minister for climate, energy and buildings) established a committee (“elinfrastrukturudvalget”) headed by TSO Energinet.dk. The committee’s goal was to assess and quantify “the total need for expansion and the tasks to be solved by the electricity infrastructure” caused by the integration of renewable energy and local generation (Energinet.dk, 2007b). The other members of the committee were the Danish Ministry of Transport and Energy, the Ministry of Finance, the Ministry of the Environment, the National Association of Local Authorities in Denmark, and the Danish Energy Authority. Based on analysis, the committee was tasked to develop multiple expansion prototypes covering different options for future network design within the range of “no grid expansion” to “complete undergrounding” of the transmission network (Energinet.dk, 2007b; Elinfrastrukturudvalget, 2008a).

Regarding the time frame of 2006-2030, four scenarios were developed in various meetings by Energinet.dk and “selected individuals” and experts outside of the company (Energinet.dk, 2007a). These four scenarios were to cover the range of ambitious vs. moderate environmental policy, and an international vs. a national focus regarding energy markets (Energinet.dk, 2007a). According to the Electricity Infrastructure Committee, the scenarios fell in-line with renewable energy targets set by the Danish government (Elinfrastrukturudvalget, 2008a). However, detailed data regarding the scenarios has not been published.

System plan:

In its most recent system plan for the year 2011, Energinet.dk based its scenarios on the October 2011 government programme “a Denmark that stands together” (Energinet.dk, 2011a). Detailed data has recently been published on Energinet.dk’s website.

A-3.2.1 Legal Foundations

The Electricity Infrastructure Committee:

As already mentioned, the Electricity Infrastructure Committee was established by the minister for climate, energy and buildings. So far, this has been the only case of such joint action. There is also no legal foundation for future committees. Since Energinet.dk is owned by the MoCEB, which is also in charge of national energy policy, the Danish government may also have intentionally opted for rules with less governance.

System plan:

Two important laws set rules for the expansion of the Danish electricity network: the Danish Electricity Act (“lov om elforsyning”) and the Law on Energinet.dk (“lov om Energinet.dk”).

Article 20, paragraph 1 of the Danish Energy Act states that the general obligation for system operators is to “maintain and expand the network as necessary”. In addition, article 21, paragraph 1 states that all network expansion projects conducted by system operators other than Energinet.dk in the transmission network (above 100kV) must be approved by the ministry for climate, energy and buildings. Further, article 22, paragraph 11 adds that DSM and decentralised power generation must be checked as alternatives to network expansion.

According to § 4 of the Law on Energinet.dk, Energinet.dk must submit a plan to the ministry for climate, energy and buildings for all expansion projects before it can initiate expansion. The expansion must also not be initiated before a period of six weeks after plan submission. The plan itself does not necessarily require an approval by the state authorities, though the MoCEB can demand that an approval by the ministry itself is necessary.

MoCEB can also impose its own plan upon Energinet.dk to build, expand, and maintain electricity networks on small islands.

A-3.2.2 Contents of the Current Scenarios

The Electricity Infrastructure Committee:

As mentioned above, four “environmental” scenarios were developed by Energinet.dk and selected experts as the basis for the technical report issued by the Electricity Infrastructure Committee (Energinet.dk, 2007a; Elinfrastrukturudvalget, 2008b). The four scenarios differ not only on renewable energy assumptions, but also on assumptions of whether a national or international focus for the energy sector is being considered. These scenarios are depicted in Table 3.

	Ambitious renewable scenarios	Moderate renewable scenarios
International focus	Greenville	Blueville
National focus	Grønnevang	Blåvang

Table 3: The 4 scenarios for the technical report in Denmark; Own depiction based on (Energinet.dk, 2007a).

Different renewable targets and assumptions regarding economic development were allocated to each of these four scenarios, as shown in Table 4.

	Greenville	Blueville	Blåvang	Grønnevang
Renewable scenarios	High proportion of offshore wind Some CHP (gas and biomass) 100% of electricity consumption based on RES	Thermal capacity (coal + gas) Offshore wind turbines and wind turbines Less CHP (gas and biomass) 50% of electricity consumption based on RES	Local CHP (natural gas, biomass, and biogas) Larger facilities (offshore wind, coal-fired CHP) 50% of the electricity consumption from RES	High proportion of small and medium plants (natural gas and biogas) Larger plants in the form of offshore wind 80% of the electricity consumption from RES
Economic development	Progress and Growth Low interest rates and inflation	Progress and Growth Low interest rates and inflation	Relatively low growth High interest rates and inflation	Growth at reasonable levels Moderate interest rates and inflation

Table 4: Assumptions in all four Danish scenarios; Translation based on (Energinet.dk, 2007a).

Systemplan 2011

As mentioned above, the system plan 2011 takes into account the October 2011 renewable energy targets from the government programme “A Denmark that stands together”. According to these targets, overall energy supply should be based on 100% renewable energy in 2050. Electricity and heat supply should already be based on 100% renewable energy in 2035 (Energinet.dk, 2011a).

In 2011 Energinet.dk also added a reference scenario and published the assumptions regarding the shares of electricity generation from different primary energy sources (Energinet.dk, 2008).

A-3.2.3 Transparency/Governance

The Electricity Infrastructure Committee:

Concerning transparency, only selected experts took part in the discussions on the scenarios (Energinet.dk, 2007a).

Regarding governance, after scenario development, all state authority members of the committee could have had an impact on scenarios. However, the actual interaction between Energinet.dk and other members of the committee remains unclear.

Systemplan 2011:

Transparency: Only highly aggregated data is available (Energinet.dk, 2011b).

Governance: The ministry for climate, energy and buildings can have an impact on the plans submitted by Energinet.dk.

A-3.3 Market Simulation/Dispatch Model

In the case of the system plans as well as in the case of the Electricity Infrastructure Committee, market simulation was conducted internally by Energinet.dk (Energinet.dk, 2007b, 2011a; Elinfrastrukturudvalget, 2008a).

For market simulation, Energinet.dk uses MARS, a tool developed internally by the company (Source: Website Energinet.dk).

A-3.3.1 Modelling Aspects

MARS:

MARS is a market model, developed by Energinet.dk, which covers the Nordic Pool Area. Modelling the market on an hourly basis, MARS takes elastic demand and market power into account. The objective function states a welfare maximisation problem, and the producers' behaviour (i.e., market power) is modelled using game theory and a Nash equilibrium approach (Energinet.dk, 2010). A 14 page description of the model is published on Energinet.dk's website.

A-3.3.2 Transparency

Energinet.dk publishes brief information on all models, which are currently found on its website. Important models developed by Energinet.dk (such as MARS) are also presented in separate documents in more detail.

Since Energinet.dk does not publish detailed data, the results cannot be reproduced by third parties.

A-3.4 Grid Modelling

The Electricity Infrastructure Committee

In its technical report, the electricity infrastructure committee analysed six prototype expansion solutions covering different options for future network design. These options ranged from “no grid expansion” to “complete undergrounding” (Elinfrastrukturudvalget, 2008b).

In the cases of the system plans as well as in the case of the Electricity Infrastructure Committee, the process of technical simulation was conducted by Energinet.dk internally (Energinet.dk, 2007b, 2011a; Elinfrastrukturudvalget, 2008a).

Energinet.dk uses a variety of tools for the Grid modelling process, among others Samlast and PowerFactory. (Website: Energinet.dk)

In addition, Energinet.dk's “network dimensioning rules” also consider the fault of multiple components caused by the same event. Solutions within the grid modelling process must allow for system stability even in such cases (Energinet.dk, 2008).

A-3.4.1 Models and Methodologies

Samlast

Samlast is a tool at Energinet.dk based on “Samkøringsmodellen” hydro generation modelling. Samlast combines calculations of Samkøringsmodellen with the network calculation tool Optlast. This provides detailed results about losses and possible overloads of the transmission system. Samlast contains an analysis of the transmission network for Denmark, Finland, Norway, and Sweden for voltage levels of 132 kV and above. It is maintained by Fingrid, Svenska Kraftnät, Statnett, and Energinet.dk.

The model is developed by the SINTEF research group in Norway and commercially performed by Powell IT (Website: Energinet.dk).

PowerFactory

The simulation tool Power Factory, from German manufacturer DlgSILENT GmbH, is used for analysis of the dynamic stability of the Danish transmission system. Energinet.dk has a complete model of the transmission system and has detailed site-specific models of the Danish power stations, high-voltage, direct current (HVDC) connections, and offshore wind farms (Website: Energinet.dk).

A-3.4.2 Transparency

As with market models, Energinet.dk publishes brief information on its website over all models that are currently used. Since Energinet.dk does not publish detailed data, the results cannot be reproduced by third parties. In addition, Energinet.dk publishes further principles in its “network dimensioning rules” (Energinet.dk, 2008).

A-3.5 Bindingness of the Planning

Projects become binding depending on the MoCEB’s decision. First, the decision determines whether it requires a formal approval of the project. If not, realisation of the project can start six weeks after the project was submitted to the MoCEB. If formal approval is required, the MoCEB initiates an approval procedure, which may render the project binding.

A-3.6 Overview

Following the discussion above, the Danish network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, and (3) consequences of the plan.

Transparency	
Which elements of the process are transparent to whom?	Only aggregated data for the scenarios and expansion principles is available.
Degree of public participation	Only public authorities are allowed to participate.
Who may interfere in decisions?	The ministry for climate, energy and buildings (MoCEB) can approve plans submitted by Energinet.dk or subject them to further review. In some cases, the ministry can impose its own plans on Energinet.dk.
Cost-benefit analysis	No information available.
Integration	
Fossil generation	Fossil generation per technology varies across the four scenarios.

Renewables (timing, level and spatial differentiation)	The level of renewables varies in the four scenarios, but the official target is 100% renewable energy in the electricity sector by 2035. Concerning spatial differentiation, no detailed information could be found.
Coordination with neighbours	Apart from TYNDP and ENTSO-E SO&AF, the Nordic Grid Development Plan applies for all Nordic countries.
Coordination with DSOs	Grid modelling for lower voltages is conducted jointly with DSOs (Energinet.dk, 2009).
Coordination with Offshore-Plans	No information available.
Consideration of Storage + DSM	Energinet.dk is legally obliged to consider DSM as a substitute for grid expansion.
Frequency of the planning process	No information available.
Time horizon, long-term considerations	Considerations are at least until 2030 for the electricity infrastructure committee. There are no binding requirement for the system plan.
Cross-sectoral aspects	Energinet.dk is also the natural gas TSO in Denmark.
Consequences	
What function does the planning process have? Is the plan binding?	Public information on the one hand (system plan) and potential necessity for approval (plan submission) on the other hand. The system plans and the technical report are non-binding (Elinfrastrukturudvalget, 2008b).

A-3.7 Fact Sheet Denmark: Actors of the network planning process

TSO: The only TSO in Denmark is the publicly owned Energinet.dk. Energinet.dk falls under the supervision of the ministry for climate, energy, and buildings (MoCEB). Energinet.dk is not only responsible for the electricity transmission network, but also for lower-voltage level electricity grids and for gas transmission. (<http://www.energinet.dk/EN/OM-OS/Om-virksomheden/Ejer-og-bestyrelse/Sider/default.aspx>)

Regulatory Authority: The Danish Energy Regulatory Authority (DERA; “Energitilsynet”) regulates the Danish electricity, gas, and district heating industries. (<http://www.dera.dk/>)

Ministry: The ministry for climate, energy, and buildings is the owner of Energinet.dk. It is the most important ministry regarding network expansion in particular and the Danish energy sector in general. (<http://www.kemin.dk/da-dk/sider/forside.aspx>)

Danish Energy Agency: As an agency of the MoCEB, the DEA (“Energistyrelsen”) plays an important role regarding energy policy and legislation. (<http://www.ens.dk/da-dk/Sider/forside.aspx>)

A-4 France

A-4.1 Governance of the Planning Process

Réseau de Transport d'Electricité S.A. (RTE) is the French TSO, a wholly owned subsidiary of the French utility EdF and the largest network operator in Europe. In its role, RTE is responsible for the operation, maintenance, and development of the French transmission grid (RTE, 2011a).

According to article L. 321-6 of the French energy code, RTE must provide a yearly ten-year network development plan based on existing and projected supply, as well as on existing and projected demand (République Française, 2012). The general objective of the plan is to aggregate the information of market participants with regards to main infrastructure building or upgrade projects over the coming ten years. Additionally, the plan must include a complete list of projects for the coming three years (CRE, 2012a).

The generation assumptions that form the basis of the NDP result from generation adequacy forecast reporting, which is prepared every two years by RTE and the NRA, the Energy Regulatory Commission (CRE). The generation adequacy report reflects the multi-year planning of generation investments, and additionally take into account regional plans concerning the connection of renewable energy to the electricity network (SRCAE and S3REnR). After the assumptions have been determined, the TSO drafts a first version of the NDP that is put to consultation with the members of the Comité des clients utilisateurs du Réseau de Transport d'Electricité (CURTE), the transmission system users' committee.

After the consultation is concluded, the revised draft is submitted to the NRA (CRE, 2012a). The NRA verifies the plan and conducts a public consultation. RTE is obliged to adopt the proposals in the NDP.

According to L. 321-6 of the French energy code, the NRA is responsible for ensuring that the plan covers all requirements in terms of investment as well as coherence with the European TYNDP. L. 321-6 mandates that the TSO must submit the plan to the ministry of Energy in a maximum time interval of four years (République Française, 2012).

The investments described in the three-year section of the NDP are binding. For implementation, the TSO must develop a yearly investment plan to be submitted to the NRA for approval. After approval, the three-year section of the NDP is binding (CRE, 2011).

The structure of the governance of the French planning process is depicted in Figure 6.

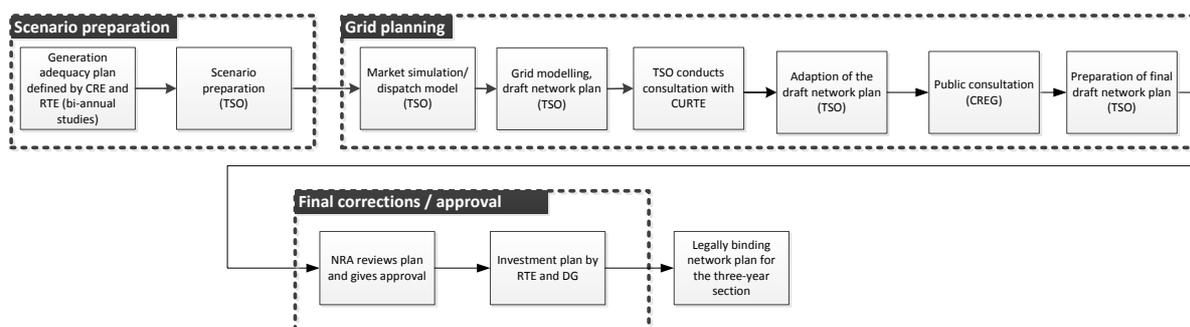


Figure 6: Roles and governance of the French network development process.

Source: Own depiction.

The network development plan for the period 2012-2021 is the second of its kind. The first version was published in December 2011. The second edition was published and submitted to CRE for consultation in November 2012 (CRE, 2012a; RTE, 2012).

A-4.2 Scenario Definition

A-4.2.1 Legal Foundations

As mentioned, every two years RTE and CRE are obliged (by Law of 10 February 2000) to draw up an analysis of trends in the electricity supply-demand balance. This “generation adequacy report” covers trends in national electricity consumption, generation installations, and exchanges with neighbouring countries (RTE, 2011b).

A-4.2.2 Contents of the Current Scenarios

The assumptions on generation and consumption found in the recent scenarios are taken from the generation adequacy report of 2011.

Additionally, the future NDP is expected to consider data concerning the implementation of renewable energies collected by the regional plans for connecting renewable energies to the network (S3REnR and SRCEA) (CRE, 2012a). This data has not been included in the recent NDP, due to the fact that S3REnR and SRCEA are not accomplished yet (RTE, 2012).

Besides the assumptions based on the adequacy generation plan and S3REnR/SRCEA, the NDP does not specify additional generation development assumptions considered for network development.

Based on the general assumptions (Table 5), four scenarios for 2030 are prepared (Table 6).

Main assumption/ scenario	High consumption	Week growth	Median	New mix
Economic growth	High	Low	Moderate	Moderate
Demographics	High	Low	Moderate	Moderate

Energy efficiency	Low	Moderate	Moderate	High
Nuclear power	High	Moderate	Moderate	Low
Renewable energy	Moderate	Low	Moderate	High
Interconnectors	High	Moderate	Moderate	High

Table 5: General assumptions for the French NDP. Source: (RTE, 2012)

2030	High consumption	Week growth	Median	New mix
Consumption	589.5 TWh	468.4 TWh	540.3 TWh	516.4 TWh
Nuclear power production	65 GW	56 GW		40 GW
CCGT	6.9 GW			8.9 GW
Coal	1.7 GW			
Peak load	14.5 GW	5 GW	16 GW	15 GW
Hydro	25.2 GW (actual park)			28.2 GW
Marine	1.5 GW	0 GW	1.5 GW	3 GW
Onshore/ offshore	24.5 GW/ 5.5 GW	18.5 GW/ 1.5 GW	24.5 GW/ 5.5 GW	28 GW/ 12 GW
Photovoltaic	20 GW	12 GW	20 GW	30 GW
Decentralised thermic	7.1 GW	7.1 GW	7.1 GW	10.8 GW
Export	52.1 TWh	70.1 TWh	42 TWh	35.1 TWh
Interconnection capacity	28 GW	21 GW	21 GW	28 GW

Table 6: Scenarios on the French NDP. Source: (RTE, 2012).

A-4.2.3 Transparency

The scenario assumptions are made public from within the NDP itself, but not before its publication. However, the generation adequacy report is made public (RTE, 2011b).

A-4.3 Market simulation/Grid modelling/Planning process

A-4.3.1 Grid modelling, Planning process, Models and methodologies

RTE gives no information on the models or data they use for grid simulation and planning. However, RTE has expertise in developing network planning models and they maintain the following tools (RTE, 2012):

- METRIX and TROPIC, for optimal power flow simulation
- ASTRE, for analysing voltage stability. The model also includes tools to simulate load flow and security margins.
- EUROSTAG, for simulating the transient state of a system over the long- and short-term).

Although no technical information about the actual network planning process is given, RTE claims that they conduct a cost-benefit analysis. Three kinds of benefits are compared against the cost of the projects: (1) saved congestion costs (i.e., costs of re-dispatch), (2) values of (avoided) lost load, and (3) a decrease in network losses (RTE, 2012, pp. 202-203).

A-4.3.2 Transparency

According to the public consultation process requirements, the NRA is obliged to publish a summary of the consultation and its analysis of the NDP (CRE, 2012b). Additionally, in the 2012 edition of the NDP a new category was created that deals with the remarks and questions made during the first consultation on the 2011 edition (RTE, 2012). As set out above, , an internal stakeholder consultation with the TSO's user group CURTE takes place.

Concerning the market and grid modelling, the TSO does not publish any technical information in its NDP. Furthermore, the results published are on a line project level only.

A-4.4 Bindingness of the Planning

The investments described in the three-year section of the TYNDP are binding. For implementation, the TSO must develop a yearly investment plan to be submitted to the NRA for approval. After approval, the three-year section of the TYNDP is binding (CRE, 2011).

The course of action in the case of unrealised but necessary investments (with a delay of three years) is codified in point II in article L. 321-6 of the French energy code: first CRE requests RTE to fulfil the investments. If the request is unfulfilled three months after request, CRE moves to a public tendering (CRE, 2012b; République Française, 2012).

A-4.5 Overview

Following the discussion above, the French network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, and (3) consequences of the plan.

Which elements of the process are transparent to whom?	Only highly aggregated scenario data is published in the NDP.
Degree of public participation	Public consultation on the plan takes place according to L. 321-6 of the French energy code (République Française, 2012).
Who may interfere in decisions?	The plan must be approved by the NRA (République Française, 2012).
Cost-benefit analysis	A cost-benefit analysis is carried out, ranking the importance of different expansion projects with a focus on the highest economic welfare (RTE, 2012).
Integration	
Fossil generation	Fossil integration is based on the results of the generation adequacy report, made every second year (CRE, 2012a).
Renewables (timing, level and spatial differentiation)	Renewable integration is based on the regional plans, SRCAE and S3REnR (RTE, 2012).
Coordination with neighbours	No explicit coordination.
Coordination with DSOs	After the approval of NDP, the TSO must develop regional plans in cooperation with the DSO eRDF (République Française, 2012).
Coordination with Offshore-Plans	Coordination is based on regional plans SRCAE and S3REnR (RTE, 2012).
Consideration of Storage + DSM	Only large-scale pump storages are considered (RTE, 2012).
Frequency of the planning process	Yearly
Time horizon, long-term considerations	The time horizon is given ten year focus with two sections: (1) three-year development (binding), (2) ten-year development (RTE, 2012).
Cross-sectoral aspects	No information available.
Consequences	
What function does the planning process have? Is the plan binding?	The (investment) plan for the three-year horizon is legally binding. In case of noncompliance, the NRA has different opportunities to ensure the implementation of the plan. (République Fran-

ing?	çaise, 2012)
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A-4.6 Fact Sheet France: Actors of the network planning process

TSO: In France, the electricity transmission network is operated by only one TSO, Réseau de Transport d'Electricité S.A. (RTE). RTE is a wholly owned subsidiary of the French utility EdF and the largest network operator in Europe. <http://www.rte-france.com/fr/>.

Regulatory Authority: The TSO is regulated by the Commission de Régulation de l'Energie (CRE). <http://www.cre.fr/>.

One important stakeholder group for the French network planning process is RTE's user group the Comité des Clients Utilisateurs du Réseau de Transport d'Electricité (CURTE). http://clients.rte-france.com/lang/an/visiteurs/accueil/espace_CURTE_presentation.jsp) CURTE may participate in a closed consultation with the NDP. Other stakeholders for consultation are public.

The NDP is approved by the Ministry of Sustainable Development (Ministère du Développement durable; <http://www.developpement-durable.gouv.fr/>)

A-5 Germany

A-5.1 Governance of the Planning Process

In Germany, the transmission system is owned and operated by four TSOs, which emerged from four large utilities. They are 50Hertz, Amprion, TransnetBW, and TenneT. Transmission network planning has traditionally been in their hands, but since the 2011 amendment of the “Energiewirtschaftsgesetz” (EnWG), a new transmission network planning process has been established. This new process defines a new procedure both in terms of requirements and project planning. In this description, we will focus on the requirements planning part.

From a governance point of view, the requirements planning process is split into two parts: A scenario definition, where main assumptions to be used in the later analysis are defined, and a more technical part, where the network development plan (“Netzentwicklungsplan”) is prepared. In both steps all four German TSOs develop the initial draft, which is then published for consultation with stakeholders, including the general public.

The whole process is repeated yearly (§12a I, S. 1 and §12b I, S1 EnWG). At the end of the process the national regulator, Bundesnetzagentur, submits the requirement plan to the federal government, which puts it forward to the parliament in order to transpose it into federal law.

An overview of the procedure is presented in Figure 7. Scenarios are first drafted by the TSOs, which are then submitted to the national regulator. The NRA conducts a consultation and creates a final version of the scenarios. These scenarios then serve as input to the technical network development process, which is mainly carried out by the TSOs again. The preliminary result of this TSO-internal process is a network development plan that is put to consultation. After this first consultation has ended, the TSOs compile a second draft that is then submitted to the NRA. The NRA may comment or change the plan, and again puts the plan to consultation. The resulting final network development plan is eventually, every three years, submitted to the federal government, where it is given to the parliament for adoption. As a side aspect, TSOs are by law required to take into account existing offshore-network plans² and European network plans.

² As of writing this study, no offshore plans were yet drafted.

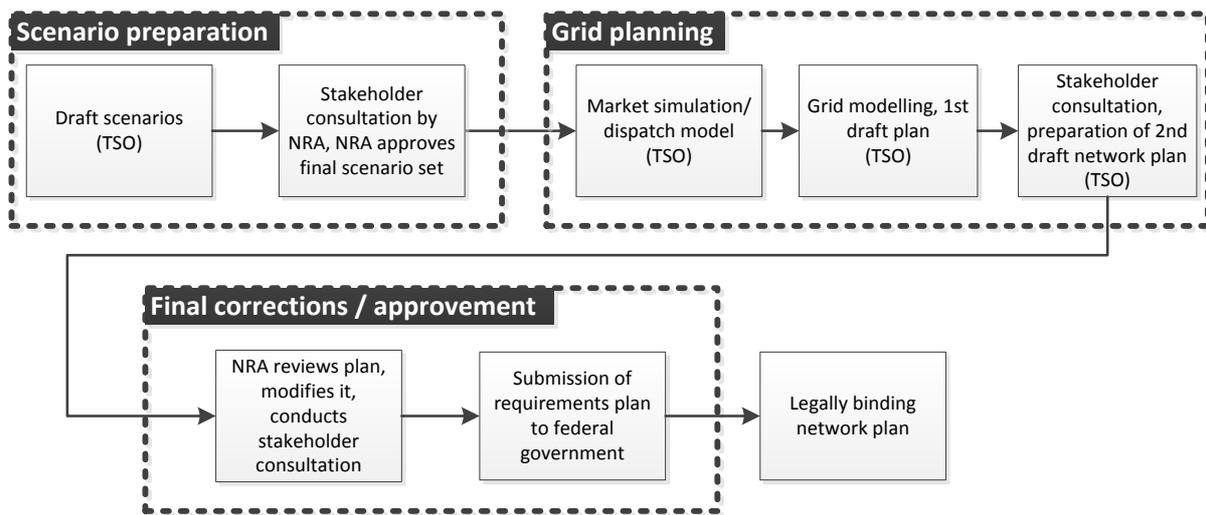


Figure 7: Roles and governance of the German network development process.

Source: Own depiction.

From a technical point of view, the concept pursued by the German network planning process is a national standard, or “copper plate”, in that the grid should allow for basically all flows that occur given the stochastic in-feed of renewables, the market-based dispatch of conventional units, and the commercial exchanges with other countries (Bundesnetzagentur, 2011). This also implies that a cost-benefit analysis is not foreseen, as a trade-off between the provision of transmission capacity and unit re-dispatch is not considered (Frontier Economics and Consentec, 2011)³.

A-5.2 Scenario Definition

A-5.2.1 Legal Foundations

The legal requirements are stated in §12 EnWG:

- At least three scenarios for the next 10 years, with one ‘expected’ scenario. This ‘expected’ scenario is required to additionally cover the next 20 years.
- Scenarios must reflect developments ‘within the energy policy objectives of the federal government’, i.e., the whole planning is based on the assumption that political objectives can be met.
- Scenarios include assumptions on generation, consumption, and exchanges.

A-5.2.2 Contents of the Current Scenarios

Currently two scenario sets exist, one for the 2012 NDP and one for the 2013 NDP, drafted by the TSOs.

The first version of 2011 (50Hertz et al., 2011) proposed prices for fuel and carbon certificates, expected capacity, and location (federal state-wise) of renewable generation, yearly national power consumption, peak load, and capacities of conventional generation capacity. For modelling the other Eu-

³ The study cited here was prepared for the German Regulator to analyse costs and benefits of (i) keeping the uncongested national bidding area, and (ii) of splitting it.

European countries, the draft scenarios referred to data from ENTSO-E's (2011, 2012a) System Outlook & Adequacy Forecast for generation and load. The assumptions on both conventional and renewable generation capacity and yearly consumption differ for each of the three scenarios, whereas the other assumptions on fuel prices are constant. For the determination of future power plant investments, TSOs also use information from gas TSOs. The scenarios can be characterised as follows:

Scenario	Description
A 2022	Low annex of RES-E, average conventional capacity.
B 2022	Moderate annex of RES-E, above-average conventional capacity.
B 2032	Forward projection of B 2022.
C 2022	Peak load not covered by domestic generation capacity, high RES-E capacity.

Table 7: Scenarios of the German NDP.

The second version (50Hertz et al., 2012b) mainly followed its predecessor but uses more recent data and takes into account the amendments required by the NRA's first scenario draft decision (cf. section A-5.2.3)

In both draft scenarios, storage was only considered within conventional technologies. Small-scale and Advanced Adiabatic Compressed Air Energy Storage (AA-CAES) were not considered. Similarly, demand-side management (DSM) was not explicitly modelled, but in its decision the NRA requested sensitivities on the load level to be calculated. The spatial distribution of renewables was conducted following the German federal states' renewable targets (50Hertz et al., 2012b).

A-5.2.3 Transparency/Governance:

After TSOs have drafted the scenarios and submit them to the NRA, the NRA conducts a consultation and will finally approve the (possibly amended) scenario set. Consultation is open to everyone, and all assumptions of the scenarios themselves are made public. However, some implicit assumptions necessary for market simulation and grid modelling were added later in the process and therefore not subject to public consultation (specifically, technical availability of power plants).

The NRA's letter of approval of the first scenario set (for NDP 2012) was a thorough analysis of the approach, and the NDP's assumptions on generation capacities were amended for all three scenarios. Further, the TSOs were obliged to consider the impact that a 10% reduction of the yearly energy consumption would have on network investment needs (Bundesnetzagentur, 2011).

A-5.3 Market Simulation / Dispatch Model

A-5.3.1 Modelling Aspects

The dispatch model used is the Institute of Power Systems and Power Economics (IAEW) model (Mirbach, 2009). The IAEW model solves the unit commitment problem for all 35 countries of the ENTSO-E members, with exchange capacities modelled as net transfer capacities (NTCs). Inter-temporal con-

straints of the unit-commitment are considered over all 8760 hours of a year. The objective function of the model is cost-minimisation, which is equivalent to welfare maximisation under the assumption of inelastic demand made here.

According to the requirements of a “copper-plate” power market design, the modelling did not take into account national network constraints, and therefore network modifications do not have any impact on the unit commitment. Within the same line of reasoning, only the active reduction of intermittent in-feed takes place, when such must-run type production exceeds total inelastic demand and maximum storage injection. Additional must-run generation results from combined heat and power (CHP) generation, which were considered fully heat-led if their electric output was at most 300 megawatts (MW) (50Hertz et al., 2012c, p. 59). DSO data was used to allocate prospective RES-E feed-in to network nodes. TSOs further stated that they want to deepen collaboration with DSOs (50Hertz et al., 2012c).

Load modelling (50Hertz et al., 2012c) was done by scaling measured vertical network load time series data from 2007.

A-5.3.2 Transparency

The list of power plants in the modelling is public (50Hertz et al., 2012d, 2012e). However, the market model itself and the underlying data were not made public.

A-5.4 Grid Modelling

A-5.4.1 Grid Modelling Process

The detailed grid modelling process is described in the NDP. Figure 8 lays out the respective steps of the process. First, relevant transmissions use cases are selected from the nodal time series of load and in-feed from the dispatch model. Then, to create a functioning grid model scenarios B2032 and C2022 are taken as a starting point to identify long-distance transmission corridors. The TSOs base this on the claim that it ensures a sustainable network planning approach (50Hertz et al., 2012c, p. 100). Next, for each of the scenarios a load flow analysis is conducted and the network is modified according to the thermal limits. To validate the results the network is back-tested through modelling of all 8760 hours of the year. After that, static and dynamic stability analyses are conducted, and the network is modified until the relevant requirements are fulfilled.

A-5.4.2 Models and Methodologies

The static load flow study is done with INTEGRAL analysis. No information on the software used for the transient analysis is indicated by the TSOs.

The insertion of transmission options is done manually. The concrete process of manually inserting transmission lines is obscure. However, the TSOs (50Hertz et al., 2012a) claim that they apply the “NOVA” principle, which ranks network optimisation before network reinforcement on the same existing lines, and considers network expansion such as building new lines as the ultimate measure..

A-5.4.3 Transparency/Governance

§12 f EnWG allows eligible parties to receive nodal time series data and technical data of the transmission network, particularly topology, line, and transformer impedances. This allows third parties to

relate to the result, but given the discretionary level of decision making within the technical network planning process, not to reproduce the result.

A-5.5 Bindingness of the Planning

The TSOs put the draft NDP to public consultation (§12 b III S. 2 EnWG). The statements received are then used to compile a second draft version, including a comprehensive justification on how responses were taken into account (§12 b IV EnWG). After that, the regulator receives the NDP for review and approval. The NRA is required to check that the plan is in-line with legal requirements, and may access related data from TSOs. As of writing this document, the NRA has finished validating the measures (specifically new lines) identified in the 2012 NDP. 51 out of 75 projects were identified as confirmable, and the rest not found to be necessary (Bundesnetzagentur, 2012a). In their assessment, the NRA focused on checking the (n-1) criterion (Bundesnetzagentur, 2012b).

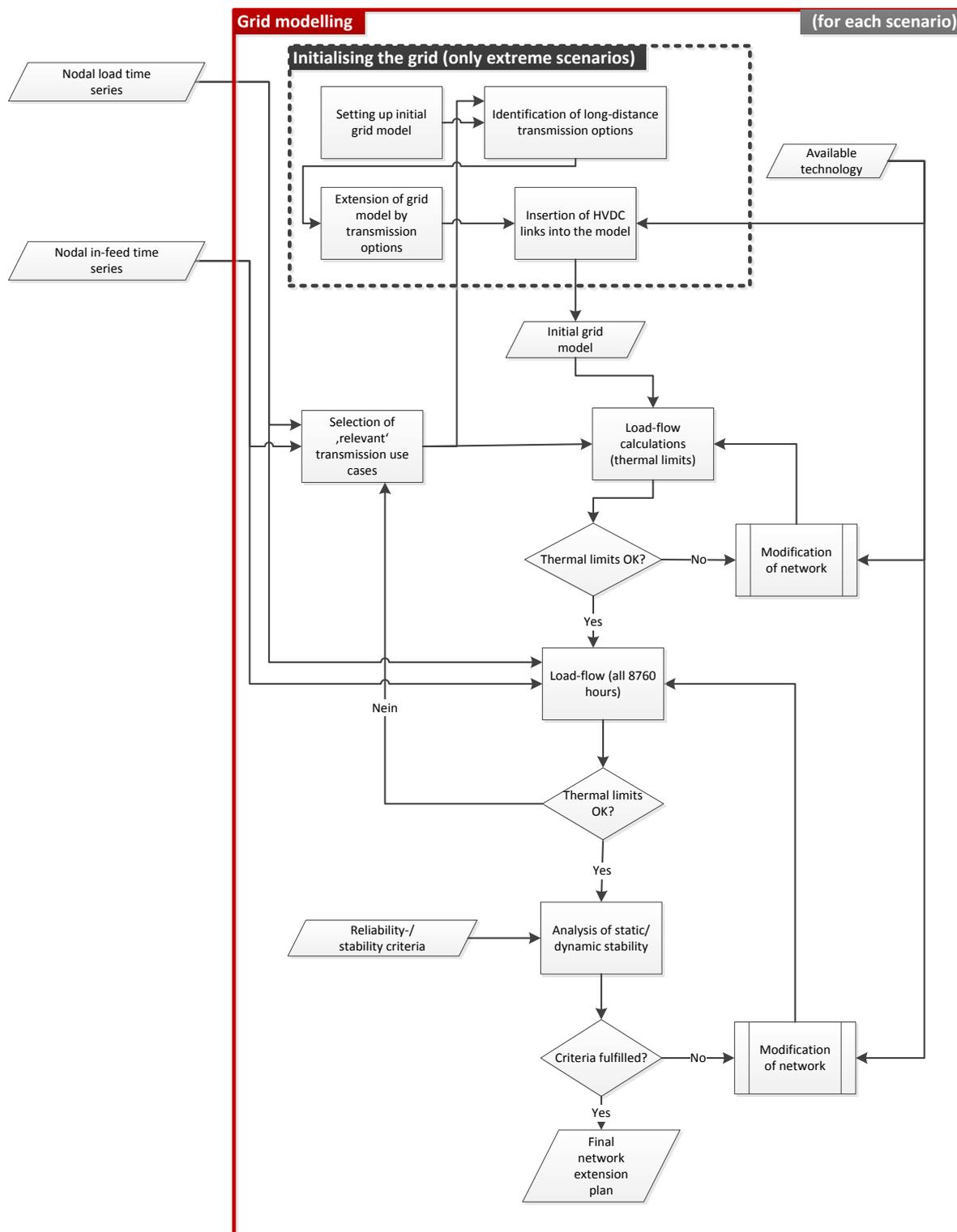


Figure 8: Grid modelling process in Germany. Source: Own depiction, based on (50Hertz et al., 2012c).

A-5.6 Overview

Following the discussion above, the German network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, (3) consequences of the plan.

Transparency	
Which elements of the process are transparent to whom?	Only aggregated transparency, but some additional data is available for a limited user group.
Degree of public participation	1 public consultation on the scenarios, 2 on the NDP.
Who may interfere in decisions?	The legal determination of investment needs is both in the hands of the regulator and of the federal parliament.
Cost-benefit analysis	Costs and benefits are not evaluated since the transmission demand is considered inelastic (“copper plate”).
Integration	
Fossil generation	Fossil generation is not planned, but only taken into account via scenario assumptions.
Renewables (timing, level and spatial differentiation)	The timing of renewables installations is reflected only by the respective scenario years, i.e., 2022 and 2032 for the 2012 NDP. Renewables are spatially distributed by using the renewables targets of the federal states. For the distribution down to network nodes, DSO expertise and studies are used.
Coordination with neighbours	There is no explicit coordination. The TYNDP and ENTSO-E's Scenario Outlook & Adequacy Forecast (SO&AF) are the only sources of coordination.
Coordination with DSOs	TSOs aim to deepen collaboration with DSOs, especially with respect to network models and scenarios.
Coordination with Offshore-Plans	TSOs are required to take into account offshore plans if available.
Consideration of Storage + DSM, RES feed-in	Only large-scale storage considered. DSM is not explicitly considered but sensitivities on a 10% load shift are calculated. RES supplies are treated as inelastic, following the legal framework.
Frequency of the planning process	Yearly. Public participation processes are necessary in between. At the moment, only changes to the network planning must be made subject to public consultation.
Time horizon, long-term considerations	§12a,b EnWG requires a horizon of 10 years to be analysed for all scenarios, and 20 years for the “most likely” scenario.

Cross-sectoral aspects	Some data-exchange occurs with the gas NDP on the planning status of power plants.
Consequences	
What function does the planning process have? Is the plan binding?	With the adoption of the NDP by the parliament every three years, the need is 'legally determined' and is therefore not examined in later permitting steps

A-5.7 Fact Sheet Germany: Actors of the network planning process

In Germany the electricity transmission network is owned and operated by four TSOs. They are private companies responsible for geographically distinct areas (see **Error! Not a valid bookmark self-reference.**). They are:

- 50Hertz Transmission GmbH, Berlin
<http://www.50hertz.com>
- Amprion GmbH, Dortmund
<http://amprion.de>
- TenneT TSO GmbH, Bayreuth
<http://www.tennetso.de>
- TransnetBW GmbH, Stuttgart
<http://transnetbw.de>



Figure 9: Spatial distribution of the German TSOs. Source: 50 Hertz et al. (2012)

The TSOs share a common information website on the network development plan, where all the TSOs' documents are available.

This site can be found at: www.netzentwicklungsplan.de

All German TSOs are regulated by the NRA ("Bundesnetzagentur"), which also has a role in validating the network development plans. For network development issues, the regulator offers relevant data at www.netzausbau.de. Moreover, the Bundesnetzagentur is consulted by the Institute of Electrical Power Systems at the Graz University of Technology for evaluation of projects proposed by the network plan (<http://www.ifea.tugraz.at>).

Other parties taking part in the process are the numerous stakeholders participating in the consultation process, among them: nature conservation groups, NGOs with different political objectives, individuals (both affected and not), and academia.

A-6 Italy

A-6.1 Governance of the Planning Process

The privatised TSO TERNA S.p.A., which is also listed in the Italian stock exchange, is in charge of grid planning in Italy. The Italian Ministry of Economic Development (MoED), “Ministero dello Sviluppo Economico”, and Italian NRA the Regulatory Authority for Electricity and Gas, “Autorità per l'energia elettrica e il gas”, also play an important role. A general overview of the grid planning process will be described in this section.

According to article 36 paragraph 12 of the Legislative Decree 93/2011, TERNA is legally obliged to devise yearly development plans covering a time period of ten years. TERNA develops one or multiple scenarios regarding future load and generation based on information and data provided by other system operators, the Italian railway, own assumptions, and studies conducted by independent companies or research institutions on behalf of TERNA (TERNA S.p.A., 2007, 2012a). Based on the scenario(s) and in-house grid modelling, TERNA devises a preliminary network development plan. After approval by the TERNA board of directors, the preliminary plan is submitted to the MoED, which consults those regions geographically affected by the plan (article 36 paragraph 12, 93/2011). The MoED also forwards the plan to the NRA, which conducts a public consultation (article 36 paragraph 13, 93/2011) and reports the results of the consultation and its own evaluation back to the MoED. The MoED takes the NRA assessment into account and decides on approval of the plan. Upon approval, the plan is legally binding for both for TERNA and transmission asset owners affected (article 36 paragraphs 9 and 14, 93/2011). The implementation of the plan is monitored by the NRA (article 36 paragraph 14, 93/2011), who can impose a fine on TERNA in cases for failure to comply with the plan, unless TERNNA can prove that the lack of compliance was for reasons beyond its control (article 36 paragraph 14, 93/2011).

The governance of the Italian planning process is depicted in Figure 10.

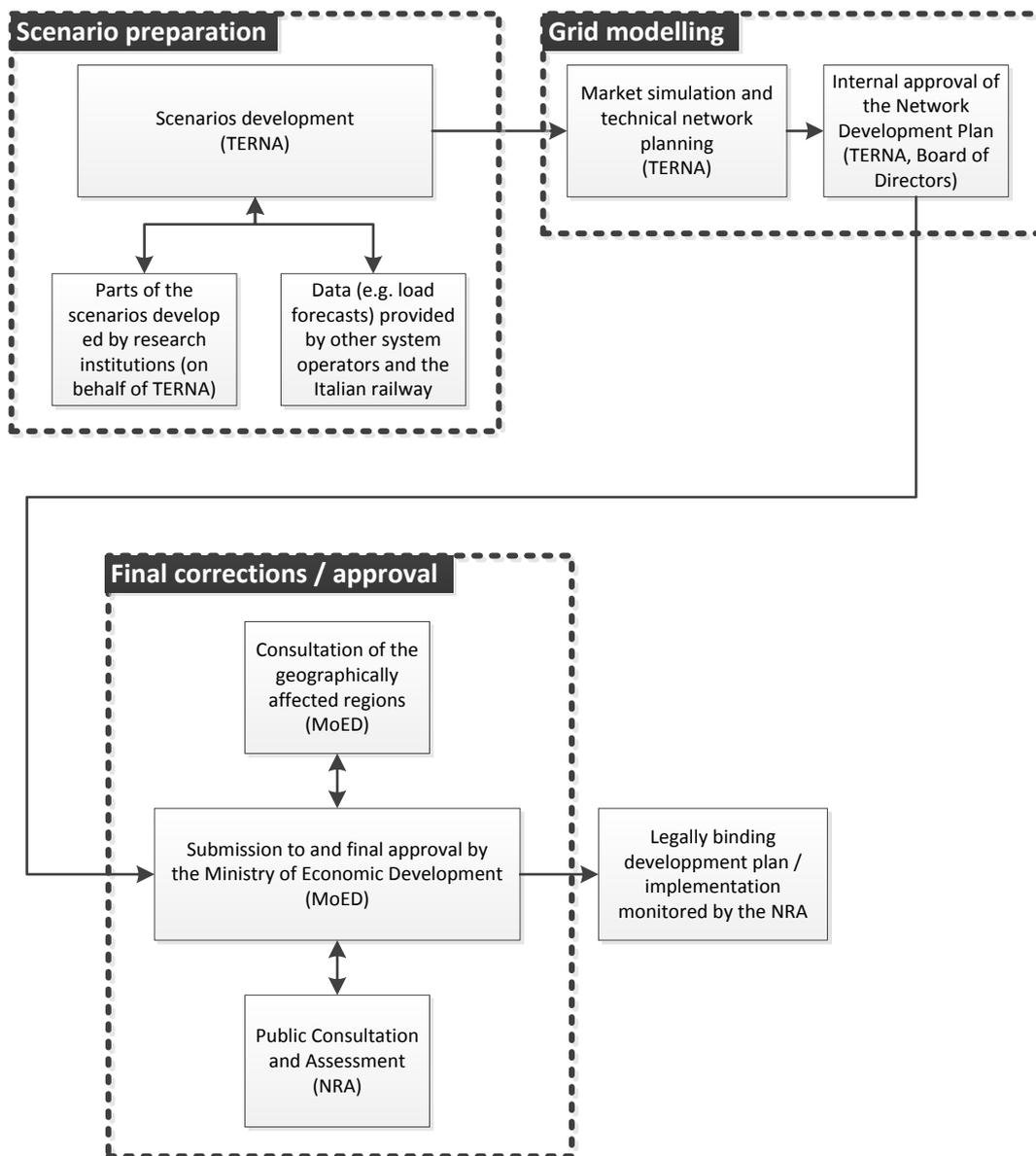


Figure 10: Governance in the Italian grid planning process. Source: Own depiction.

A-6.2 Scenario Definition

In general, Italian law does not impose specific restrictions on the process of scenario development. However, other system operators are required to provide TERNA with all relevant information regarding scenario definitions (article 36 paragraph 9 a), 93/2011). TERNA specifies further details on scenario development in Chapter 2 of its grid code (TERNA S.p.A., 2007).

The development plans cover a time span of ten years, and can be based on one or multiple scenarios (TERNA S.p.A., 2007, p. 4). Demand forecasts are generated by dividing Italy into different macro-economic areas. For these areas, economic progress (measured by GDP forecasts, employment, investment, and consumption) and growth in energy demand are analysed, mainly by companies specialised in “periodic updates [to] the macroeconomic picture” (TERNA S.p.A., 2007, p. 8).

TERNA further develops scenarios regarding installed generation capacity as well as import and export power forecasts (TERNA S.p.A., 2007, pp. 9, 23).

A-6.2.1 Contents of the Current Scenarios

In its most recent development plan, from 2012, TERNA gathers macroeconomic assessments and field studies conducted by external companies (TERNA S.p.A., 2012, p. 52) and creates two scenarios, from which only one - the more likely one - is selected as a reference scenario for further steps of the planning process.

The two scenarios, the “Development” scenario and the “Baseline” scenario, both forecast demand from 2012 to 2021. The “Development” scenario (high demand), is based on an increase in the total electricity demand for the entire country, equal to an average rate of about + 0.9 % per year. The “Baseline” scenario models low demand, and considers a decrease in electricity demand of 0.2 % per year from a higher degree of energy savings. For the steps following this process, only the “Development” scenario is chosen as a reference scenario. TERNA explains this by stating that the aim of the development plan is system adequacy, and therefore the high demand scenario would need to be chosen (TERNA S.p.A., 2012, p. 53).

Concerning generation from renewable energy sources, the scenario is in-line with the renewable energy targets set out by the MoED. In its National Action Plan, the MoED sets a goal of 17% of total energy consumption coming from renewable energy by 2020 (TERNA S.p.A., 2012, p. 64). The Baseline scenario forecasts an additional 9.6 gigawatts (GW) of wind and another 23 GW of photovoltaic (PV) generation capacity to be installed in near-to-medium future (TERNA S.p.A., 2012a, p. 59)

A-6.2.2 Transparency

TERNA publishes aggregated scenario data both in the development plan and on its website, providing a certain degree of public transparency.

The governance aspect of the scenario development process is not entirely clear. There is no legal obligation for scenario approval by any state authority. However, the entire plan must be approved by the MoED. This can also be interpreted as a governance aspect for the scenario development process.

A-6.3 Market Simulation/Grid Modelling/Planning Process

A-6.3.1 Grid modelling, Planning process, Models and methodologies

According to Chapter 2 of TERNAs grid code, the goal of the development process is the “security, reliability, efficiency, continuity of supply of electrical energy, and cost reduction of transmission and of supplies” (TERNA S.p.A., 2007, p. 3). Moreover, the existence of some sort of dispatch modelling based on, eg. cost and efficiency of the respective plant, is mentioned (p. 4).

The grid code also refers to static stability (n-1) and dynamic security as part of the security criteria. The goal is that “in typical load situations for the forecasting grid, with related foreseeable production programmes and with all elements of the system in service (fully operational grid), supplies at all points of withdrawal are guaranteed without violating the normal operating limits (current and voltage) of the grid elements in continuous operating conditions” (TERNA S.p.A., 2007, p 5).

In addition to these security criteria, the plan also compares the estimated investment costs of the expansion project with the resulting benefits, in the form of a reduction of overall system costs. This includes “production, transmission and distribution costs that are passed to users of the national electricity system” (TERNA S.p.A., 2007, p 5).

According to Art. 9 of the Decree of the Ministry of Economic Development from 15 December 2010, the plan must contain a “cost-benefit analysis of interventions and the identification of priority actions, which are able to give the maximum contribution to the security of the system, the development of foreign exchange and the reduction of congestion”. The cost-benefit analysis carried out by TERNA reflects a total welfare approach and lists as particular benefits the reduction of CO₂ emissions, removing the constraints from renewable energy feed-in, and a reduced risk of interrupted electricity supply (TERNA S.p.A., 2012b, pp. 73-75).

A-6.3.2 Transparency

There appears to be almost no information concerning the modelling aspects of the Italian development plan and no model descriptions appear to be published.

It is uncertain whether the MoED or the NRA evaluates the modelling aspects of the development plan. Based on the information provided in the plan itself, an evaluation of these aspects is not possible. However, the resulting plan is put to public consultation by the NRA.

A-6.4 Bindingness of the Planning

Once approved by the MoED, the development plan is legally binding. Implementation is monitored by the NRA and TERNA can be fined in cases of noncompliance (article 36 paragraph 14, 93/2011). The progress on projects of previous development plans is also covered in the second section of each development plan (e.g. TERNA S.p.A., 2012a).

A-6.5 Overview

Following the discussion above, the Italian network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, and (3) consequences of the plan.

Transparency	
Which elements of the process are transparent to whom?	Aggregated scenario data is published in the development plan and on the TERNA website. There is a public consultation of the preliminary development plan carried out by the NRA. Local authorities (the regions), the Ministry of Economic Development, and the NRA assess the plan.
Degree of public participation	A public consultation is conducted by the NRA (with access available upon online registration).

Who may interfere in decisions?	The plan must be approved by the Ministry of Economic Development.
Cost-benefit analysis	A cost-benefit analysis is carried out to rank the importance of different expansion projects.
Integration	
Fossil generation	Fossil generation is not planned.
Renewables (timing, level and spatial differentiation)	There is a target of 17% of total energy consumption by 2020, in line with the national renewable energy targets. Information on the spatial differentiation is obtained from sources such as DSOs.
Coordination with neighbours	Direct coordination only takes place on a bilateral basis. There is also coordination through the TYNDP and ENTSO-E SO&AF.
Coordination with DSOs	DSOs are legally obliged to provide data input to TERNA.
Coordination with Offshore-Plans	No information available.
Consideration of Storage + DSM	No information available.
Frequency	Yearly
Time horizon, long-term considerations	Ten year focus
Cross-sectoral aspects	No information available.
Consequences	
What function does the planning process have? Is the plan binding?	The planning is legally binding, and a fine can be imposed on the TSO in case of noncompliance.

A-6.6 Fact Sheet Italy: Actors of the network planning process

TSO: The only TSO in Italy is TERNA S.p.A.. TERNA has been listed in the Italian stock exchange since 2004. The majority shareholder is currently the Italian Cassa Depositi e Prestiti bank, holding 29.85%.

[http://www.terna.it/default/home_en/the_company/about_terna.aspx]

Regulatory Authority: The Italian Authority for electricity and gas, l'Autorità per l'energia elettrica e il gas, regulates the electricity and gas infrastructure. Its assessment of the network development plan is taken into consideration by the Ministry of Economic Development. (Website of the regulatory authority and the section A-4.6)

Ministry: The Ministry of Economic Development is the most important ministry regarding network expansion. Its approval of the network development plan is necessary for the plan to be implemented. (See section A-4.6 for further details)

Other system operators: The Italian railway and other system operators must provide information and data to TERNA that are necessary for system planning (e.g., load forecasts) (TERNA S.p.A., 2007).

A-7 The Netherlands

TenneT B.V. owns and operates the Dutch transmission grid, including the 380 kV and 220 kV high-voltage grids as well as the 150 kV grid in South Holland. Owned by the Dutch government, TenneT is responsible for the safe and reliable transmission of electricity in the Netherlands.

Through the Dutch electricity act (“Act of 2 July 1998 Providing Rules in Relation to the Production, Transmission and Supply of Electricity”, section 21) TenneT as grid manager must provide the “most accurate possible estimates of the total capacity required for the transmission of the electricity” once every two years. This estimate is submitted to the NRA, the Dutch Competition Authority (“Nederlandse Mededingingsautoriteit”, NMa) (Section 21 (1), Electricity Act 1998). The grid managing entity must also justify the way that it intends to provide for the total capacity required for the transmission of the electricity over the grids (Section 21, Dutch Electricity Act 1998, and Ministerial order).

TenneT has created a Vision 2030 report, which sets out their view on the future of the Dutch electricity transmission grid between 380 kV and 110 kV and highlights possible related future developments for the transmission grid until 2030. Beside this, TenneT publishes a quality and capacity plan to fulfil the mentioned legal requirements. The quality and capacity plan is published once every two years with a time horizon of seven years and is approved by NMa with regard to terms of quality of supply and network reliability.

On the basis of scenarios, market simulation and grid modelling in the Vision 2030 study, and the quality and capacity plan, the Dutch government decide those projects that will be pursued and incorporated in its national Electricity Supply Structure Plan (“Structuurschema Elektriciteitsvoorziening”, SEV).

The structure of the governance of the Dutch planning process is depicted in Figure 11.

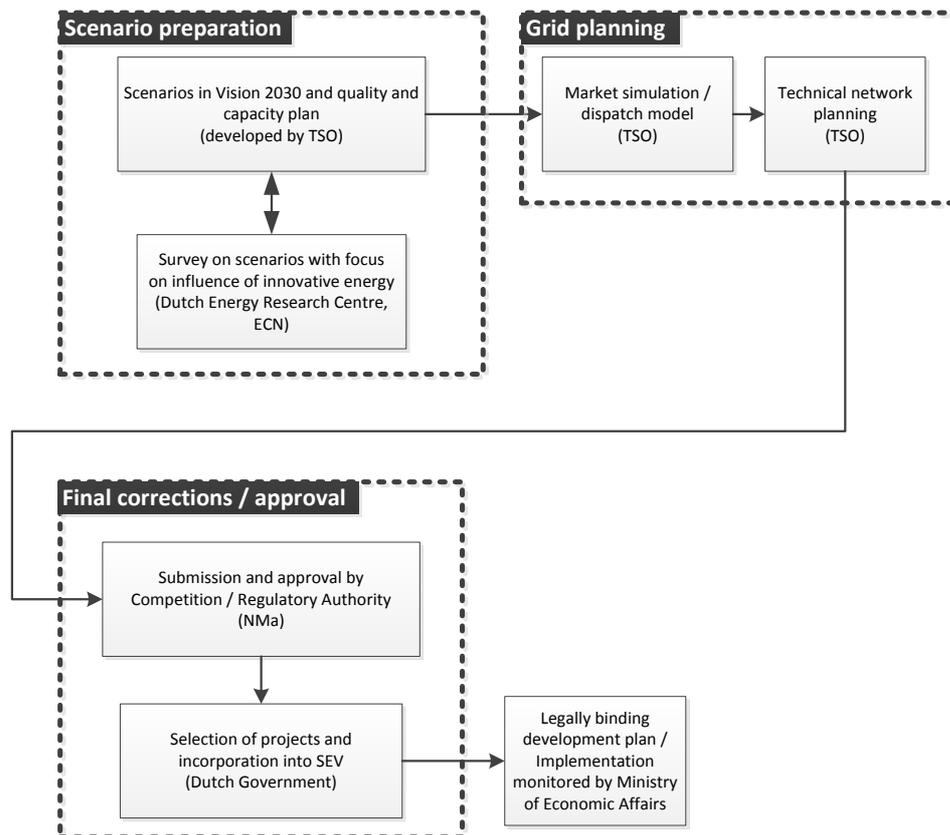


Figure 11: Governance of the Dutch grid planning process. Source: Own depiction.

A-7.1 Scenario definition

A-7.1.1 Legal foundations

As mentioned above, the Dutch electricity Act, Section 21, and additional Ministerial Orders provide guidelines for the planning process, but there are no rules for the scenario definition by law.

A-7.1.2 Contents of the current scenarios

In the Vision 2030 report TenneT attempts to anticipate general developments with implications for the electricity system. These are, inter alia, economic growth, development of renewables (particular wind), production locations in the Netherlands (inland/coastal locations), and global demand for fossil fuels. Considering these developments, a set of four scenarios has been drafted by TenneT. The four trend scenarios are developed as a basis for forward analysis up to 2030. As stated in Table 8, the four scenarios are characterised by different renewable power penetration levels (environmental dimensions) and different degrees of regulatory constraint on market force (market dimensions) (TenneT, 2011).

	Strict regulation and regional focus	Completely free global market
Renewable oriented	Sustainable Transition	Green Revolution

Fossil oriented	New Strongholds	Money Rules
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Table 8: Four scenarios in the Vision 2030. Source: (TenneT, 2011).

Different renewable targets and assumptions regarding economic development were assigned to each of these four scenarios and are shown in Table 9.

	Green Revolution	Sustainable Transition	Money Rules	New Strongholds
Load growth (per year)	2 %	1 %	3 %	0 %
Production capacity (period 2010 – 2030)	Increase by 10,000 MW (mainly renewables)	Increase by 4,000 MW (mainly renewables)	Increase by 10,000 MW (conventional thermal power) and import of 6,000 MW	Export demand of 5,000 MW (coal-fired and nuclear plants)
Energy storages	In 2020: two 600 MW CAES facilities In 2030: 2,000 MW energy island	Two 600 MW CAES facilities	No energy storages assumed	No energy storages assumed
Cross-border interconnector capacity	Governed by market forces Further interconnectors will be conducted	Additional interconnectors with Scandinavia	Further interconnector capacity (with Germany, Norway, and the UK)	No further interconnectors
Extreme situation	(1) Windy, cloudy day (2) Windless, sunny summer day	(1) Windy, cloudy winter day (2) Windless, sunny summer day	Windy day	Windy day

Table 9: Selected Assumptions in the Vision 2030 scenarios. Source: (TenneT, 2011).

The spatial distribution of photovoltaics and micro-CHPs is assumed to be proportional across the Netherlands, whereas the regional distribution of onshore wind is assumed to reflect the objectives set out in the Governance Agreement for the National Development of Wind Power (BLOW) (TenneT, 2011, p. 26).

At TenneT’s request, the Energy Research Centre of the Netherlands (ECN) carried out a study evaluating the quantitative estimates of peak load and electricity generation capacity, taking into account possible application of heat pumps, air conditioning, plug-in hybrid electric vehicles, and (for the evolution of generation capacity), wind energy (onshore and offshore), photovoltaic, biomass and micro-CHP. Additionally, an assessment of different alternatives for demand and supply adjustments was

made (Scheepers et al., 2007). In the new stronghold, sustainable transition and money rules scenarios the differences calculated by ECN were sufficiently small, so that from TenneT's point of view for these scenarios there was no need for a revision of the grid concept. In the green revolution scenario, ECN concluded that innovative technology (on the basis of the available potentials and anticipated market developments) could have a substantial impact. Installed renewable energy production capacity could be 30% higher than TenneT's green revolution scenario anticipates. Therefore, TenneT assumes that the difference between the calculations of TenneT and ECN do not have any implication for the basic structure of the transmission grid, but could influence speed and direction of grid development (TenneT, 2011).

The Vision 2030 scenarios are developed as a basis for anticipating future electricity grid transmission requirements. In preparation for the quality and capacity plan, TenneT carried out a market survey with a focus on the reasons for the substantial increase of the number of new production capacity plans. The survey revealed that market parties assume not all of the planned projects will actually be realised, but that there was uncertainty about which projects are likely to be cancelled. Because of this uncertainty, TenneT considered direct translation of the Vision 2030 scenarios into future perspectives for the Quality and Capacity Plan not possible (TenneT, 2010a). Instead, TenneT developed two additional scenarios within the quality and capacity plan, and four variants for one of the scenarios concerning different future developments in the power production sector. The first scenario is the import-scenario, which presumes that 2,500 MW is imported from Belgium and Germany for all years under review of the current quality and capacity plan. The second scenario is the export-scenario: Here TenneT presumes that electricity is exported to Belgium and Germany increasing from 2,000 MW in 2010 to 6,000 MW in 2016. Within the export-scenario three variants have been developed that specifically examine how production facilities in different regions of the Netherlands may be deployed. A fourth variant was developed to analyse the effects of the feed-in of offshore wind farms into the Dutch transmission grid (TenneT, 2010a).

Within the two scenarios, TenneT considers the development of electricity consumption, electric transport, electric heat pumps for space heating, large scale production capacity, expected (maximum) growth of renewables (biomass, wind onshore / offshore, photovoltaic), small-scale CHP capacity, and exchanges with Belgium, Denmark, Germany, Norway, and the UK (TenneT, 2010a).

A-7.1.3 Transparency/governance

TenneT publishes the developed scenarios in their Vision 2030 document as well as the quality and capacity plans, but there is no public consultation on the assumptions made for the scenarios. External consultation does take place, as mentioned above, with ECN reviewing the four Vision 2030 trend scenarios with regard to the influence of innovative energy technology.

A-7.2 Market simulation / dispatch model

A-7.2.1 Modelling aspects

TenneT translated the quantitative information from the scenario description into input data for the market simulation. The market simulation was conducted by TenneT internally.

A-7.2.2 Transparency

TenneT only publishes basic assumptions for the models. The list of large scale thermal power plants, development of electricity demand growth, and exchange with neighbours assumed is public. The market model itself and the underlying data are not available to the public.

A-7.3 Grid modelling

A-7.3.1 Technical planning process

To analyse the existing grid, load flow calculations are performed for each of the Vision 2030 trend scenarios. TenneT provides the results of the network analysis for each scenario, indicating the main capacity problems and proposals for a grid extension concept for each scenario. On this basis, TenneT developed a number of possible future transmission grid configurations to address the capacity problems of all four scenarios. Effects on lower-level grids have not been considered in the Vision 2030, but will be considered for calculations in the quality and capacity plans (TenneT, 2011).

In the quality and capacity planning, TenneT conducted load flow calculations for the import and export-scenario covering the years 2010, 2013, and 2016, depicted the utilisation rate of 380 kV connections. Extrapolating from the discovered capacity problems, TenneT mapped the required grid expansion for each scenario in the 380 kV grid (TenneT, 2010b).

The grid resilience was tested by assessing its stability under normal conditions (n-0), in an event of a single failure (n-1), and in the event of a single failure during maintenance (n-2) (TenneT, 2011).

A-7.3.2 Models and methodologies

No information about the models and methodologies used for the technical planning process were made public.

A-7.3.3 Transparency

TenneT does not publish detailed data of the grid modelling. Only the results of the load flow calculation, finding of capacity problems, and the required grid expansion for each scenario were made public.

A-7.4 Bindingness of the planning

The NRA NMa approves the quality and capacity plan in terms of the quality of supply and the network reliability. The Dutch government selects projects and incorporates them into the Stichting Experimenten Volkshuisvesting (SEV) programme, so that they become legally binding in the national Electricity Supply Structure Plan.

TenneT, in their role as the grid manager of the Dutch transmission grid, must report changes regarding the implementation to the Director of the NRA. The plan implementation is monitored by the Minister of Economic Affairs, who is authorised to impose administrative penalties (Electricity Act 1998, Section 22).

A-7.5 Overview

Following the discussion above, the Dutch network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, and (3) consequences of the plan.

Transparency	
Which elements of the process are transparent to whom?	Aggregated transparency: the assumptions and results are public, but not the methods and data used for calculations.
Degree of public participation	There is no public participation except via a market survey in preparation of the 2010 Quality and Capacity Plan.
Who may interfere in decisions?	NRA must give approval, and the Dutch government selects and incorporation projects into its Electricity Supply Structure Plan.
Cost-benefit analysis	No information available.
Integration	
Fossil generation	There is no integrated fossil planning. Assumptions in the scenarios are towards production locations.
Renewables (timing, level and spatial differentiation)	The spatial distribution of photovoltaics and micro-CHPs is assumed to be proportionally across the Netherlands, whereas the regional distribution of onshore wind is assumed to reflect the objectives set out in the Governance Agreement for the National Development of Wind Power (BLOW).
Coordination with neighbours	There is consideration of development with other countries, for example Belgium, Germany, France, and Norway.
Coordination with DSOs	There is no coordination in the Vision 2030 view, but effects for the subordinate grids will be considered in the quality and capacity plan.
Coordination with Offshore-Plans	TenneT takes into account offshore plans and “landing points” in their grid planning process.
Consideration of Storage + DSM	In two of the four Vision 2030 scenarios is there consideration of distributed and three large-scale storages. DSM is taken into account within the ECN study.
Frequency	Every two years
Time horizon, long-term considerations	The Vision 2030 time horizon is 20 years. The quality and capacity plan is published once every two years with a horizon of sev-

	en years.
Cross-sectoral aspects	No information available.
Consequences	
What function does the planning process have? Is the plan binding?	From the NDP, the NRA selects certain grid expansion projects for inclusion in the Electricity Supply Structure Plan, which then become legally binding.

A-7.6 Fact Sheet Netherlands: Actors of the network planning process

TSO: The electricity transmission network is owned and operated by the publicly owned Tennet B.V. As grid manager, TenneT is the first cross border transmission system operator in Europe, also undertaking operations in parts of Germany. (<http://www.tennet.org/english/tennet/index.aspx>)

Regulatory Authority: The Netherlands Competition Authority (NMa) fights cartels, assess concentrations, and prevents abuses of dominant positioning in all industries of the Dutch economy. They are therefore the NRA for the transport and energy market. (http://www.nma.nl/en/our_work/default.aspx)

Ministry: The ministry of Economic Affairs (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties) is the appropriate ministry regarding grid expansion and the Dutch energy sector in general. (<http://www.government.nl/ministries/ez>)

Energy Research Centre of the Netherlands (ECN): The ECN is one of the largest energy research institutes in Europe. Their offices in the Netherlands are located in Amsterdam, Eindhoven, Petten, and Wieringermeer. (<http://www.ecn.nl/corp/>)

A-8 Switzerland

A-8.1 Governance of the Planning Process

The Swiss Electricity supply act requires the national TSO to draft multi-annual plans on grid operation (Art 8 S. 2 StromVG) and to provide “required reserve transmission capacity” (Art 8 S. 1 c StromVG).

In case the secure and affordable supply of electricity is endangered, the Swiss Federal Council, the Bundesrat, may inter alia take actions to enforce electricity grid service (Art. 9 StromVG)

The above rules are coherent with the often mentioned Article 4 of the Swiss Energy Law (EnG, Bundesversammlung der Schweizerischen Eidgenossenschaft, 1999), which states that “the energy industry is responsible for the supply with energy. Federal Government and Cantons provide a suitable framework for them so they can optimally fulfil this task”.

In line with this, there are currently no comprehensive rules for network planning (BFE, 2012). Although the Swiss Government regularly updates its energy strategy (“Energiestrategie”) approximately every five years by preparing “energy perspectives” studies (“Energieperspektiven”), these outcomes are not directly binding for the network planning process (ibid.).

Still, the current process is subject to some governance rules:

- The national TSO is obliged to prepare “multi-annual plans”, also covering network development (Art 8 S. 2 StromVG).
- These plans enter into the “Sachplan Übertragungsleitungen” (SÜL), which evaluates transmission line projects and includes a pre-emptive conflict analysis. The SÜL study is prepared by the Bundesamt für Energie (BFE), the federal energy authority, in cooperation with the Bundesamt für Raumplanung (ARE), the federal spatial planning authority. Transmission line projects are evaluated according to superordinate political objectives, which are partly codified in laws and partly from reports and studies (BFE and Bundesamt für Raumentwicklung, 2001, S. 34 ff).
- Line projects adopted in the SÜL are submitted to the Swiss federal Bundesrat for approval.

The structure of the process explained above can roughly be represented by Figure 12.

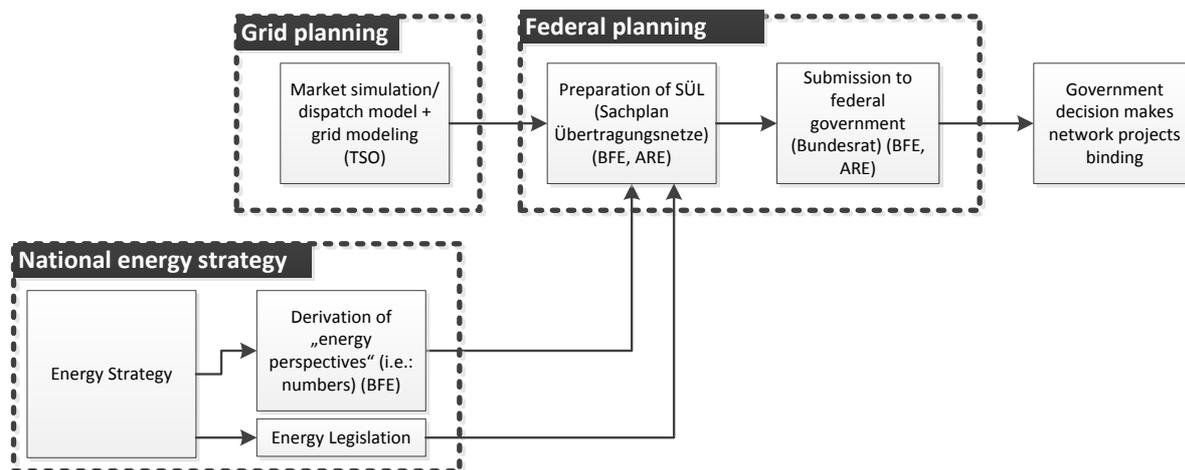


Figure 12: Current governance structure of the Swiss Network Planning process. Source: Own depiction.

As of writing this study (Spring 2013), a modification of the process is envisaged by the Swiss government. In the course of preparing its “Energy Strategy 2050”, which will feature a Swiss nuclear phase-out, the government also intends to modify the network planning process (BFE, 2012). The currently proposed but not yet agreed modifications will most notably include the introduction of a politically legitimated scenario set (“Szenariorahmen”) as an input to the planning process. The scenarios are proposed to be subject to a public consultation. Further, the government is planning to issue binding guidelines to steer the development of electricity networks. Finally, the planning is foreseen to be updated annually (BFE, 2012).

However, for the moment grid planning remains in the hands of the TSO, and is only indirectly monitored by the NRA, EICom. The network development plan itself is not planned to be publicly consulted, but is solely intended to be made public after the NRA has decided on the certain projects (BFE, 2012).

Further, plans are being made to detach the need determination from the SÜL. Therefore, once the regulator has decided on specific projects the investment requirements are not discussed at later stages.

The structure of the currently proposed new process is displayed in Figure 13.

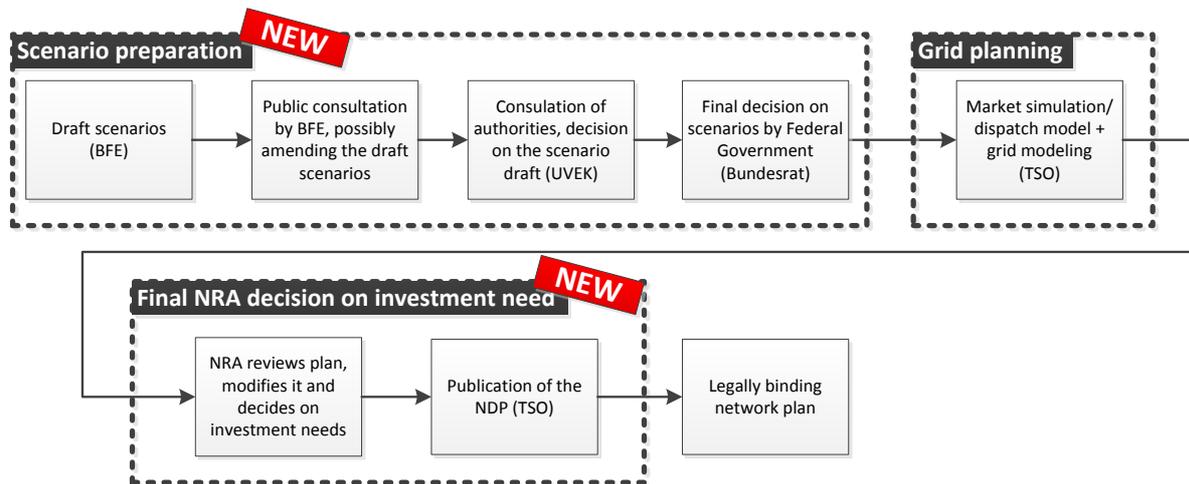


Figure 13: Structure of the proposed amendment of the Swiss network planning process. Source: Own depiction.

A-8.2 Scenario Definition

As there is no explicitly codified process on the network planning itself, the following descriptions will focus on the currently valid “Energy Perspectives”, which are part of the non-codified framework of need determination process that the SÜL must obey (BFE and Bundesamt für Raumentwicklung, 2001, p. 25). The scenarios are a high-level analysis of political objectives, related policies, and technological and economic development.

A-8.2.1 Contents of the Current Scenarios

The energy perspectives 2035 contain four main scenarios, which cover three main areas: energy supply, energy demand, and CO₂ emissions. Each scenario is accompanied by a respective policy alternative. The four scenarios are split in two parts: two scenarios take a set of policy measures as given, and two scenarios analyse policies that could be used to reach objectives set *a priori* (BFE, 2007). The scenarios are briefly outlined in Table 10.

Scenario	Description
Current policy	Policy-measures oriented: Moderate energy efficiency measures, delayed adoption of measures with regards to efficiency gains/energy price changes.
Increased co-operation	Policy-measures oriented: Target agreements between state and private sector, moderate strengthening of climate and efficiency regulations.
New priorities	Objective oriented: Priorities on climate protection, energy efficiency and saving resources.

Forward to the 2000-Watts-society	Objective oriented: Reduction of CO ₂ emissions and per-capita (total) energy consumption from 2000 to 2035 by 35%.
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Table 10: Scenarios of the Swiss “Energieperspektiven 2035” (BFE, 2007).

All scenarios identify an electricity generation gap as of (earliest) 2018 (BFE, 2007, p. Z-2). The scenarios themselves do not provide a technical solution for this gap but analyse how different technologies could be extended given seven different “supply alternatives”, which range from nuclear to renewables to electricity imports.

A-8.2.2 Transparency/Governance:

The underlying assumptions of the network planning process by the national TSO are not made public, but the “energy perspectives” are regularly published on BFE’s web page.

A-8.2.3 Contents of the Proposed Scenario framework of the New Network Planning Process

The current proposal on the amendment of the Swiss network planning process (BFE, 2012) only roughly defines the content of the scenarios. Presumably non-exclusively, the proposal lists installed generation capacity per technology, yearly electricity consumption, annual peak-load, and cross-border electricity exchanges. Information on the siting of new generation should be incorporated, especially by using information on the cantons-level.

A-8.3 Market Simulation / Grid Modelling / Planning Process

As the multi-annual plans themselves are not public, related information on the actual market simulation and grid modelling processes are also not publicly available.

A-8.4 Bindingness of the Planning

As set out in A-8.1, both processes end with a legal determination of required transmission projects. In the old process, the federal government takes the final decision on the need for new lines.

A-8.5 Overview

Following the discussion above, the Swiss network planning process can be summed up with respect to three different aspects: (1) transparency, (2) integration, (3) consequences of the plan.

Transparency	Current process	Draft new process
Which elements of the process are transparent to whom?	Projects are published when included in the SÜL.	Scenarios Network development plan (after adoption by the NRA)
Degree of public par-	First public consultation during	Public consultation on scenarios (but not

icipation	spatial planning / permitting	on the network development plan)
Who may interfere in decisions?	The SÜL provides an opinion on specific projects. The final decision is made by the federal government.	The NRA is responsible for the final need determination.
Cost-benefit analysis	In the spatial planning process.	No information available.
Integration		
Fossil generation	No integrated planning. Exogenous assumptions used.	
Renewables (timing, level and spatial differentiation)		
Coordination with neighbours	Unknown	Mandate for the national grid operator to coordinate within European Network of TSOs for Electricity (ENTSO-E) members (BFE, 2012, p. 12).
Coordination with DSOs	Unknown	The national TSO coordinates the requirements planning of the railway system electricity network, the DSO networks, and the transmission grid (BFE, 2012, p 13).
Coordination with Off-shore-Plans	Not applicable.	Not applicable.
Consideration of Storage + DSM	Unknown	No information available.
Frequency of the planning process	No fixed cycle, with occasional updates of the SÜL.	Annual updates.
Time horizon, long-term considerations	Current multi-annual plans do not have a certain time-horizon. It is unclear what time horizon the internal planning by TSO Swissgrid covers.	10-year planning. It is unclear what time horizon the internal planning by TSO Swissgrid covers.
Cross-sectoral as-	Integration of railway system electricity network planning into	Integration of railway system electricity

pects	SÜL, but not a need determination base.	network planning.
Consequences		
What function does the planning process have? Is the plan binding?	Approved need after conclusion of the SÜL-process and approval by the federal government.	Approved need after NRA-decision by EICom.

A-8.6 Fact Sheet Switzerland: Actors of the network planning process

Swiss legislation requires the transmission system to be in the hands of a single national transmission company (Art 18 StromVG). The majority of shares and votes must be owned by Swiss cantons and municipalities. Further, the shares may not be exchanged or traded. Art. 20 StromVG assigns responsibility for planning of the transmission grid to the national transmission company. The national transmission company is current Swissgrid (<http://www.swissgrid.ch>).

From an administrative point of view, the highest authority concerned with national energy system planning is the Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK), currently headed by Ms Doris Leuthard. The UVEK can be considered similar to a ‘ministry’ due to its responsibilities. There are 4 authorities below the UVEK that have relevance for the network planning process:

- The Swiss NRA is EICom, (Eidgenössische Elektrizitätskommission), <http://www.elcom.admin.ch/>
- The Eidgenössisches Starkstrominspektorat (ESTI) <http://www.esti.admin.ch>
- The Bundesamt für Energie (BFE) <http://www.bfe.admin.ch>
- The Bundesamt für Raumentwicklung (ARE)

A-9 United Kingdom

This section will deal with aspects of the grid planning process applied in the UK. Despite the fact that Northern Ireland is a part of the UK, this study will focus on the network planning process in Great Britain, which is governed by the regulation through the Office of Gas and Electricity Markets (Ofgem).

A-9.1 Governance of the planning process

As part of the current regulatory regime for network operators in Great Britain, the three transmission owners (the National Grid Electricity Transmission, the Scottish Power Transmission Limited, and the Scottish Hydro-Electric Transmission Limited) are required to submit well-justified business plans to Ofgem prior to each regulatory period (Ofgem, 2010). The business plans include non-binding network expansion plans as well as depictions of the general methodology and stakeholder processes applied during the creation of the business plan (Ofgem, 2010).

Since the GB transmission system is operated by National Grid, this section will analyse National Grid's network development process in detail (source: Ofgem and National grid websites).

As shown in Figure 14, National Grid develops and publishes multiple scenarios each year (e.g. National Grid, 2012a). These scenarios are then subject to annual stakeholder consultation, carried out in bilateral meetings, workshops, and questionnaires (National Grid, 2012b, p. 6). After scenario development, market simulation and grid planning is conducted by National grid internally, and respective network development results are then published as an element of National Grid's "Electricity Ten Year Statement" (ETYS). The ETYS is again subject to stakeholder consultation (National Grid, 2012b, p. 32). This entire process is carried out annually. If a year's ETYS coincides with a Revenue Incentives Innovation Outputs (RIIO) price control, the results of the ETYS will form the basis for National Grid's RIIO business plan, which will be submitted to Ofgem. Ofgem assesses the results of the business plan as well as the network development process and methodology applied by National Grid, and also performs a stakeholder consultation and alters or directly approves the methodology and results of the legally non-binding business plan. See section A-9.4 for further details.

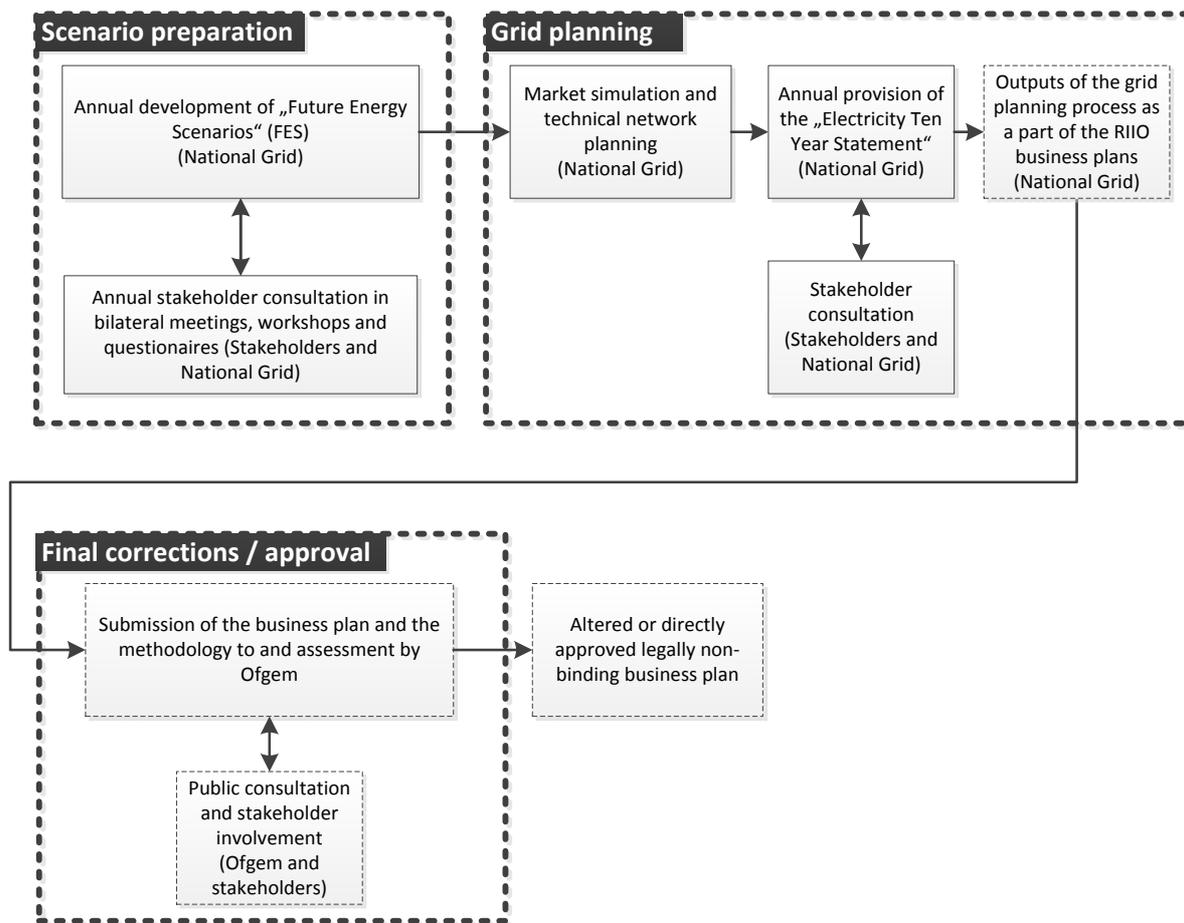


Figure 14: Governance in the grid planning process in the UK. Source: Own depiction.

A-9.2 Scenario definition

National Grid develops multiple scenarios each year. The scenarios are intended to reflect a broad range of potential outcomes (National Grid, 2012b, p. 10).

In order to increase the scenario range on a regional/local level and to consider local variations, National Grid applies “sensitivities” regarding spatial distribution of generation and demand. The sensitivities are applied within a respective scenario while keeping the overall scope of the scenario constant using a “one in one out” rule. If sensitivities are applied regarding generation, for instance, a plant in one area will be dropped out whereas a plant of similar capacity and fuel type in another area will be added, thus keeping the installed capacity of that fuel type in the scenario consistent (National Grid, 2012b, p. 18).

The regional strategies as a part of the ETYS contain information on whether sensitivities have been applied regarding specific planning results (National Grid, 2012b, p. 18).

Demand information in the scenarios is based on the annual submissions made by transmission system users (National Grid, 2012b, p. 18). Stakeholders are consulted on the scenarios and feedback steers the production of future scenarios (National Grid, 2012b, p. 11).

In general, the scenarios extend in detail at least to the year 2030, and at a higher level of perspective to the year 2050 (National Grid, 2012b, p. 11).

A-9.2.1 Legal foundations

Outwardly, there is no legal framework considering the content of the scenarios.

However, the Climate Change Act of 2008 set a legally binding target to decrease greenhouse gas emissions by at least 80% below the 1990 baseline towards 2050. An interim target was also introduced to cut emissions by at least 34% by 2020. The Climate Change Act also sets ‘carbon budgets’ to ensure targets are met. The budgets embody legally binding limits on total greenhouse gas emissions in the UK for a given five-year period. The fourth period (up to 2027) should provide that emissions will be decreased by around 60% by 2030 (National Grid, 2012a, p. 13). As described in section A-9.2.2, the “baseline scenario” each year is in-line with these emission targets.

There is, however, a legal foundation regarding the process of scenario development. As part of the RIIO business plans, the scenario development process must be in-line with stakeholder consultation rules provided by Ofgem (Ofgem, 2010).

A-9.2.2 Contents of the current scenarios

In the current version of the Future Energy Scenarios, National Grid (2012a) developed three different synopses in order to capture a broad range of future developments. These include detailed information from present to 2030, and rather high level perspective to 2050. The “Slow Progression”, “Gone Green”, and “Accelerated Growth” scenarios differ regarding various parameters such as economic development, electricity demand, generation from (non-)renewable energy sources, and whether carbon emission targets can be met (National Grid, 2012a). The Slow Progression scenario assumes a much slower deployment of installed renewable generation capacity, whereas the Gone Green scenario is compatible with renewable energy targets. The Accelerated Growth scenario even exceeds targets (National Grid, 2012b, p. 17). An overview regarding scenario assumptions for selected parameters is shown in Table 11.

	Slow Progression	Gone Green	Accelerated Growth
Renewable energy targets	Pressure grows for the abandonment of EU 2020 renewable targets and UK 2050 carbon targets.	Targets met. Scenario based on meeting targets. Balanced approach across all market sectors, no trading. No change to EU and UK policies.	2020 targets met early.
Economy / Economic forecasts	Economic hardship across Europe, scarcity of finance, impact on consumer bills. Affordability of meeting targets compels change. Low GDP assumptions.	Modest GDP assumptions in medium term, historical average from 2017 onwards.	Sustained economic growth across Europe. High GDP assumptions.
Nuclear power	Delayed until mid-2020s. An average additional 10-year life extensions for advanced	Slight delay, byearly 2020s. Average additional 7-	Slight delay, but met by 2020, and then strong deployment. Average additional 5-year AGR

	gas-cooled reactors (AGR).	year AGR life extensions	life extensions.
Demand	Annual energy consumption declines at a slower rate than Gone Green due to slower development in embedded generation and energy efficiency. Annual consumption continues to decline towards 2030. Peak demand broadly flat to 2020, with gradual decline thereafter.	Gradual decline in annual consumption due to increasing level of embedded generation and energy efficiency gains. Energy consumption starts to increase from the middle of next decade. Peak demand broadly flat out to 2020, with gradual increase thereafter.	Higher decline in annual consumption due to higher development in embedded generation, energy efficiency and the impact of time of use (TOU) tariffs. Energy consumption picks up again towards the middle of the next decade due to increase charging from electric vehicles (EVs) and heat pumps. Peak demand broadly flat out to 2020, then higher due to EVs and heat pumps.

Table 11: Selected Assumptions in the Future Energy Scenarios 2012; source: (National Grid, 2012a, pp. 91 ff.)

A-9.2.3 Transparency/governance

Scenario data is only published at an aggregated level. However, extensive explanations concerning assumptions on the impact of various sectors on electricity demand and generation are presented (National Grid, 2012a).

A-9.3 Market simulation /rid modelling / Planning process

A-9.3.1 Grid modelling, planning process, Models and methodologies

The security standards comprise two criteria, the “security criterion” and the “economy criterion”.

The security criterion states that demand must be met without generation from intermittent resources or imports from interconnectors (National Grid, 2012b, pp. 19 f.; 2012c, appendices C and D).

The economy criterion involves a “pseudo cost-benefit study” to ensure that sufficient transmission capacity is built to enable the transmission of intermittent generation to main load centres (National Grid, 2012b, p. 20). In these analyses, nuclear as well as intermittent generation and generation from pumped storages and plants fitted with carbon capture and storage (CCS) are set to specific contributory levels. “Other contributory generation is scaled to meet the required demand level” (National Grid, 2012b, p. 20; 2012c, appendix E).

As potential results of the grid planning process, multiple options apart from circuit expansion are considered. These options range from “low-cost investments” (e.g., fast switching reactive compensation), to “operational” (e.g., availability contracts, reactive demand reduction) and “investment solutions” (e.g., building new lines but also hot-wiring overhead lines) (National Grid, 2012b, pp. 20-21).

From these possible options, multiple suitable solutions are chosen. The solutions must “be sufficiently wide and include both small-scale reinforcements with short lead-times as well as larger-scale alternative reinforcements which are likely to have longer lead-times” (National Grid, 2012b, p. 21).

In order to perform a cost-benefit analysis for these suitable solutions, factors such as output, impact of the solution on congestion, lead-time, cost, and the progress of the solution through the development and delivery process are identified (National Grid, 2012b, p. 22).

Based on these factors for each potential solution and as part of the cost-benefit analysis, a full life-time cost-analysis is conducted that “includes forecast transmission investment costs, constraint costs and the cost of transmission losses” (National Grid, 2012b, p. 24).

A preferred solution is selected from the set of potential solutions using a “least regret analysis”. For each of the scenarios, the regret of a potential solution is defined as “the difference in cost between the [solution] and the best possible transmission strategy for that scenario” (National Grid, 2012b, p. 27). In this process, a regret value is computed for every solution and each scenario. The sum of regrets of a solution over all scenarios is defined as the “worst regret”, and the potential solution with the lowest “worst regret” is then selected as the preferred solution (National Grid, 2012b, pp. 27 - 28).

The resulting preferred solutions are aggregated to “Regional Strategies”, which describe information on the previous decision process including all the solutions identified, a summary of the cost-benefit analysis, and information on the work that will be undertaken in the following year as well as within the next ten years (National Grid, 2012b, p. 30).

A summary of the Regional Strategies is published each November as part of the ETYS. Stakeholders are invited to provide feedback on the Regional Strategies as well as the entire grid planning process (National Grid, 2012b, p. 31).

A-9.3.2 Transparency

National Grid provides a free Excel tool, the Electricity Scenarios Illustrator (ESI), which reproduces the cost-benefit analysis results in order to help increase transparency (National Grid, 2012b, pp. 23 ff.). For the rest of the modelling, transparency can be considered limited.

A-9.4 Legal consequences / Bindingness

Neither the ETYS nor the projects in the RIIO business plan are legally binding.

The purpose of the ETYS is to “provide clarity and transparency on the potential development of the National Electricity Transmission Systems” (National Grid, 2012d, p. 3).

Concerning the bindingness of the RIIO business plans, Ofgem states that adjustment of development plans is expected as further information regarding future development becomes available. They further state that they “recognise that circumstances change and [they] will not hold companies to the specifics of their business plans. Indeed, Ofgem expects network companies to update their decisions on how to deliver during the price control period as new information becomes available” (Ofgem, 2010, p. 50).

A-9.5 Overview

Transparency	
Which elements of the process are transparent to whom?	Aggregated scenario data is publicly published. National Grid publicly provides a free Excel tool to increase the transparency of the cost-benefit analysis process.
Degree of public participation	Stakeholder consultations over scenario and methodology of grid planning processes assumptions are conducted.
Who may interfere in decisions?	Ofgem may interfere with the legally non-binding RIIO business plans. More importantly, Ofgem can interfere in the entire grid planning process (including methodology), rather than individual process.
Cost-benefit-analysis	National Grid performs a full lifetime cost and “least regret” analyses to select preferred solutions.
Integration	
Fossil generation	Concerning spatial distribution of fossil fuel generation, scenario sensitivities can be applied.
Renewables (timing, Renewables (level and spatial differentiation)	The current scenarios differ in the shares of renewable energy sources at each point in time, in order to reflect potential future developments. One scenario falls below and one above the UK RES targets for 2030. Concerning spatial distribution of renewable generation, scenario sensitivities can be applied.
Coordination with neighbours	No information apart from the TYNDP could be found.
Coordination with DSOs	No information available.
Coordination with Offshore-Plans	No information available.
Frequency of the planning process	Annually, for the ETYS.
Consideration of Storage + DSM	National Grid considers reactive demand reduction as an alternative to network expansion in the grid planning process.
Time horizon, long-term considerations	The scenarios are detailed until 2030 and broadly described to 2050.

Cross-sectoral aspects	No information available.
Consequences	
What function does the planning process have? Is the plan binding?	The plan is explicitly non-binding. The ETYS is published to increase transparency.

A-9.6 Fact Sheet United Kingdom: Actors of the network planning process

TSO: The transmission system in UK is operated by National Grid (<http://www.nationalgrid.com>). However, ownership of transmission assets is in the hand of three transmission owners: National Grid, Scottish Power Transmission Limited (<http://www.spenergynetworks.co.uk/>), and Scottish Hydro-Electric Transmission Ltd (Group site: <http://www.ssepd.co.uk/>).

Regulatory Authority: The national regulatory authority of the United Kingdom is the Office of Gas and Electricity Markets (Ofgem; <http://www.ofgem.gov.uk>).

A-10 Europe

A-10.1 Overview

The third package of legislative proposals adopted by the European Commissions for an internal EU gas and electricity market stipulates pan-European, regional, and national network planning processes. The supra-national rules are given by the Regulation EC/714/2009, whereas rules on the national planning processes are given by Directive 2009/72/EC (EC, 2009a, 2009b). For the supra-national rules, the acting TSO is the European Network of Transmission System Operators for Electricity (ENTSO-E), and the corresponding supra-national regulatory authority is the Agency for the Cooperation of Energy Regulators (ACER). The TSO and NRA collaborate to produce the union-wide ten-year network development plan (TYNDP), which is complementary to the national development plans (NDPs). Regulation EC/714/2009 also envisages regional investment plans (RegIPs), which will be described in more detail later.

The plans are inter-related, with the union-wide network-development plan always denoted as ‘non-binding’ and national plans falling under compliance requirements of the union-wide plan. On a national level, TSOs are required to draft ten-year plans every year, which are then submitted to respective NRAs, put to consultation (which is generally not public), and finally checked for completeness and consistency with the European TYNDP. NDPs become binding by the requirement that NRAs must monitor and evaluate the adoption of the national plans and are required to interfere if projects are not undertaken in time. Therefore, the procedure for national plans can be considered as the minimum requirement for the Member States’ national network planning processes. Between the union-wide and the national levels, Article 12 of Regulation EC/714/2009 requires that TSOs establish regional cooperation, inter alia contributing to the network planning. These regional groups must deliver a RegIP every two years. Thus, the inter-relation of the different network planning levels covers a further requirement, namely that the TYNDP is expected to be built both on NDPs and RegIPs, and must be consistent with the content of existing NDPs and RegIPs.

The TYNDP must be drafted every two years by ENTSO-E and be put to stakeholder consultation. After consultation and possible amendments, the TYNDP is submitted to ACER, which mainly checks that the plan is consistent with national plans. ACER may require national plans to be amended in case they do not comply with the TYNDP. Finally, the NDPs need to take into account the RegIPs and the TYNDP requirements. The rough structure of the planning process is depicted in Figure 15.

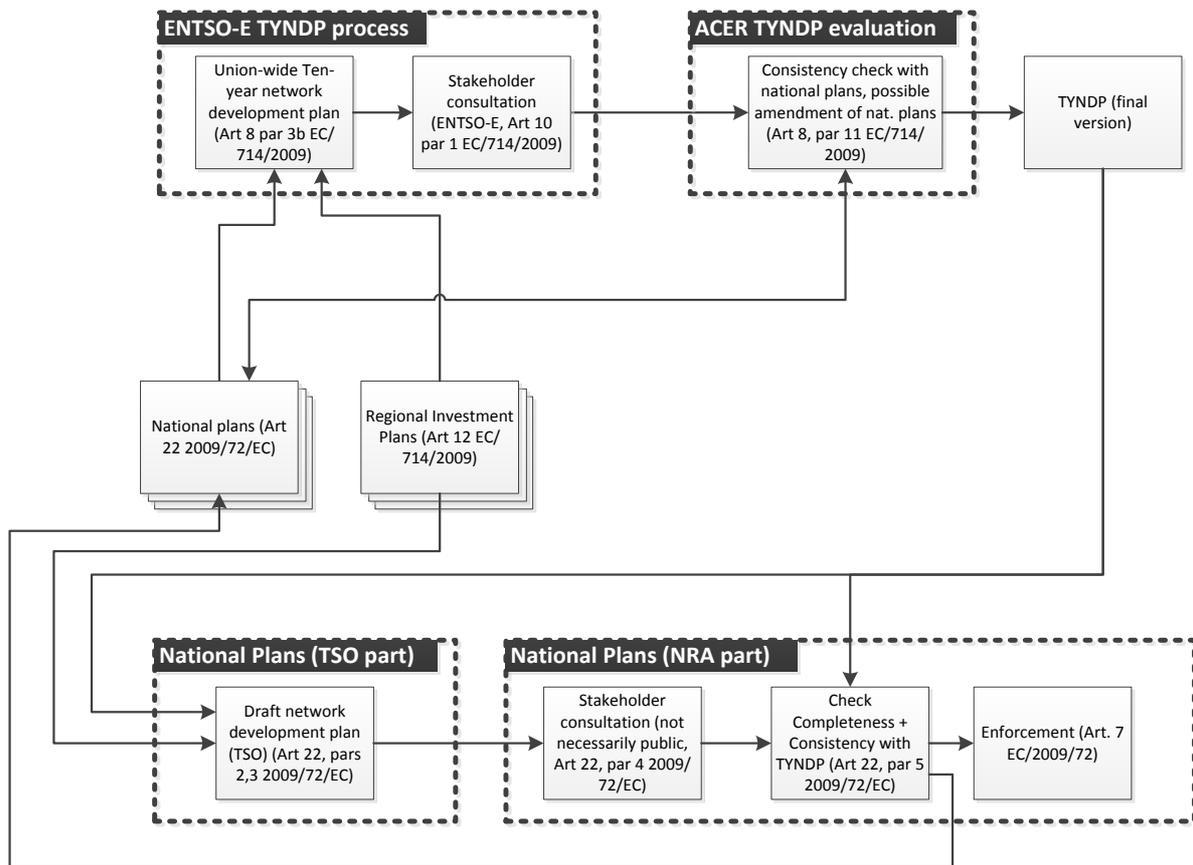


Figure 15: National, regional and union-wide network development / investment plans. Source: Own depiction.

A-10.2 TYNDP

In its current form, the TYNDP (ENTSO-E, 2012b) provides a framework but mainly uses RegIP outputs. The scenarios used are those defined in the ENTSO-E Scenario Outlook & Adequacy Forecast (SO&AF) 2012-2030 (SO&AF; ENTSO-E, 2012a). The SO&AF defines three scenarios, but only two of them are used for the TYNDP:

- Scenario A: “Bottom-up scenario”, solely considering the new generation investment needed to maintain security of supply (not used for TYNDP).
- Scenario B, “Best Estimate Scenario”, which is based on TSO expectations about the future developments. However, investment is considered to be market-driven. Load is considered to be the same as in Scenario A.
- Scenario C, “EU2020 Scenario”, which builds on the expectation that the EU 20-20-20 targets are met. Renewable deployment is constructed from National Renewable Energy Action Plans (NREAPs), or respectively equivalent governmental plans.

The scenarios were consulted on as with the preparation of the SO&AF, which is part of the TYNDP package (Art. 8 par 3b EC/714/2009). Therefore, the consultation requirement also applies to the SO&AF.

A-10.3 Regional investment plans

The six regional groups (RGs) with the respective countries covered are listed in Table 12.

Regional Group	Countries
Baltic Sea (BS)	NO, SE, DK, FI, EE, LV, LT, PL, DE
Continental South East (CSE)	HU, SI, RO, RS, BG, MK, ME, BA, HR, IT, EL
Continental Central East (CCE)	AT, HR, CZ, DE, HU, PL, RO, SK, SI
Continental South West (CSW)	FR, PT, ES
Continental Central South (CCS)	FR, DE, CH, AT, IT, SI
North Sea (NS)	IE, NI, GB, NO, DK, NL, BE, LU, DE, FR

Table 12: Regional groups of the union-wide network planning process

The regional groups are pure TSO groups that conduct regional network planning. This means that common modelling is used, but other countries are partially included so as not to optimise regional electrical islands.

The scenarios of the regional groups equal the TYNDP scenarios (Scenario B Best Estimate and Scenario C EU2020, from the SO&AF 2012). All RGs calculate sensitivity, taking into account a full nuclear phase-out in Germany to 2020. RG Baltic Sea introduced a robustness check on carbon prices by swapping the two scenarios' carbon prices.

The models used differ by each regional group, with some using different models for the same type of analyses (e.g., the Continental Central South), and some giving no notice about their models. An overview is presented in Table 13

RG	Market modelling tool(s)	Grid modelling tool(s)	Non-RG countries included in the modelling
BS	EMPS, MAPS, SAMLAST	SAMLAST, PSS/E	UK, RUS, EST, LV, LT, UA, BG, PL, SK, CZ, AT, IT, DE, CH, NL, BE, FR, ES
CSE	Only qualitative description, no names.	Only qualitative description, no names.	AL, TR
CCE	PowrSym3 (Operation Simulation Associates)	Only qualitative description, no names.	All European countries except Albania and Montenegro.
CSW	ANTARES, RESERVAS, MAREA	CONVERGENCE (RTE), PSS/E, UPLAN	GB, BE, CH, DE, IT, NL

CCS	ANTARES, PROMED (Terna/CESI)	Only qualitative description, no names.	ES, UK, NO, SE, DK, PL, CZ, HU, SI, NL, BE
NS	Not provided.	Not provided.	Not provided.

Table 13: Modelling tools and (non RG) countries included in the modelling.

Source: (ENTSO-E, 2012c, 2012d, 2012e, 2012f, 2012g, 2012h).

A-10.4 The role of ENTSO-E

ENTSO-E was set up following the requirement of Art 5 EC/714/2009. Inter alia, it is required to draft network codes and to prepare the TYNDP (cf. section A-10.1). Its general structure is made up of four committees: System Development, System Operations, Market, and Research & Development. These committees are headed by a board and a general assembly. Each committee consists of at least several working groups (WGs). Further to the working groups, RGs and “drafting teams” also belong to most of the committees: For the cases of network planning within the System Development Committee, the RGs are the network planning RGs. Drafting times are mandated with drafting network codes.

As set out above, network planning activities are related to the System Development Committee (SDC). Within the SDC, the TYNDP WG coordinates the creation of the TYNDP package. The RegIPs are created by the respective RGs.

The WG System Adequacy & Market modelling prepares the SO&AF, which is the source of scenarios for the TYNDP, as well as the Winter and Summer Outlook Reports. The Winter and Summer Outlook Reports discuss regional energy balances for the period under consideration. However, this is not done on the basis of a market simulation, but rather on TSO data submitted to the ENTSO-E via questionnaires (ENTSO-E, 2012i, p. 10). Further, the WG maintains a “pan-European Market Database” (ENTSO-E, 2012). This database contains data on fuel prices, location of power plants, and demand data (O’Donnel, 2011; ENTSO-E, 2012c).

Network models used by RGs and the TYNDP are prepared by the WG Network Modelling and Data (ENTSO-E, 2012j).

The “European Planning Standards” WG supports the preparation of the TYNDP and RegIPs by developing guidelines on both selecting network planning cases and assessing impacts of projects for the RegIPs and the TYNDP (ENTSO-E, 2012j).

A-10.5 Changes for the 2014 TYNDP

For the coming 2014 TYNDP, some changes are foreseen (Maire, 2012):

- The planning horizon will be extended to 2030. In-line with this, the scenarios are also enlarged to 2030 (preparation of the “ENTSO-E 2030 visions”).
- Pan-European market studies are planned to be introduced. As of now, market studies are taking place within the RGs. For that purpose a Pan-European Expert group is intended to be formed.

- A cost-benefit analysis will be conducted for each of the projects. However, as of the writing of this report, it is not exactly clear how this procedure will work and how it will be applied.
- To increase the stakeholder involvement, a long-term network development stakeholder group will be assembled.

A-11 Regional planning co-ordination in the US

A-11.1 Actors and structure of the governance of electricity networks and planning in the US

A-11.1.1 The US transmission system (electrical)

The US transmission system, similar to the European system, consists of several synchronous areas. Those areas, interconnected via direct current (DC)-couplings, are:

- the Western Interconnection
- the Eastern Interconnection
- the Texas Interconnection

These areas span geographic regions as depicted in Figure 16.

A-11.1.2 The US transmission system (actors)

Electricity transmission in the US is overseen by state regulators known as public utility commissions, or by the Federal Energy Regulatory Commission (FERC). FERC regulation dominates for questions related to interstate commerce, whereas state regulation is focused on in-state activities. Transmission is to a large extent regulated by FERC (Whitfield et al., 2012, p. 9).

Independent System Operators (ISOs) and Regional Transmission Operators (RTOs) are generally subject to FERC and state utility commissions' regulation for transmission planning. These two similar but different groupings are defined by FERC Orders 888/889 (FERC, 1996a, 1996b; for ISOs) and Order 2000 (FERC, 2000; for RTOs). Whitfield et al. (2012) has stated that the difference between ISOs and RTOs are generally small. Both ISOs and RTOs operate the grid under their control and are responsible for planning and expanding the network (Whitfield et al., 2012; p. 84). Network planning requirements emerge mainly from FERC Orders 890/1000 (FERC, 2007a, 2011). The 2007 FERC Order 890 defines requirements for regional transmission planning, specifically within the region of an RTO or ISO (Moselle and Brown, 2007). Building upon Order 890, FERC Order 1000 introduced stronger requirements for interregional planning, specifically planning between RTO and ISO regions (Whitfield et al., 2012).

A central element of Order 890 was the introduction of nine planning principles that transmission providers' **regional planning processes** must comply with. This includes not only RTOs and ISOs, but also their subordinated transmission companies (FERC, 2007b, p. 3; Moselle and Brown, 2007, p. 16-17). The nine principles are as follows:

1) Coordination:

Transmission providers should coordinate with their interconnected adjacent systems and transmission customers in such a way that a non-discriminatory transmission plan is produced.

2) Openness:

The process must generally be open to all.

- 3) Transparency:
Transmission providers are required to disclose data, assumptions, and criteria that underlie their planning process.
- 4) Information exchange:
Transmission customers are required to provide information on their demand for transmission.
- 5) Comparability:
Transmission customers' demands must be considered on a non-discriminatory basis.
- 6) Dispute resolution:
The network planning process must provide a procedure for conflict resolution.
- 7) Regional participation:
Regional sharing of transmission plans should be ensured.
- 8) Economic planning studies:
Transmission investments must be evaluated both on a reliability and an economic basis.
- 9) Cost allocation for new projects:
The transmission planning process must define a cost-sharing method for projects that are not funded by an existing scheme, e.g., regional projects involving several transmission owners.

After issuing Order 890 in 2007, FERC Order 1000 became effective in 2011. Concerning planning processes, the focus was on inter-regional planning processes: transmission providers were now required to engage in inter-regional transmission planning agreements. In contrast to the regional planning process, transmission providers do not need to create an inter-regional transmission plan. However, important aspects to be coordinated are (i) the impact of a project within one region for other regions, and (ii) the identification of inter-regional projects that address transmission needs “efficiently and cost effectively” (Whitfield et al., 2012).

Besides the regulatory oversight of the planning process, an important role is taken by the North American Electric Reliability Cooperation (NERC), which was appointed by FERC in 2006 to take on the role of the national Electric Reliability Organization (ERO), a concept introduced by the Energy Policy Act of 2006. NERC develops standards for system operation, adequacy assessment, and transmission planning. NERC also monitors and enforces compliance with the standards set. FERC has delegated parts of its tasks to regional entities. See Figure 16 and Table 14 for an overview.

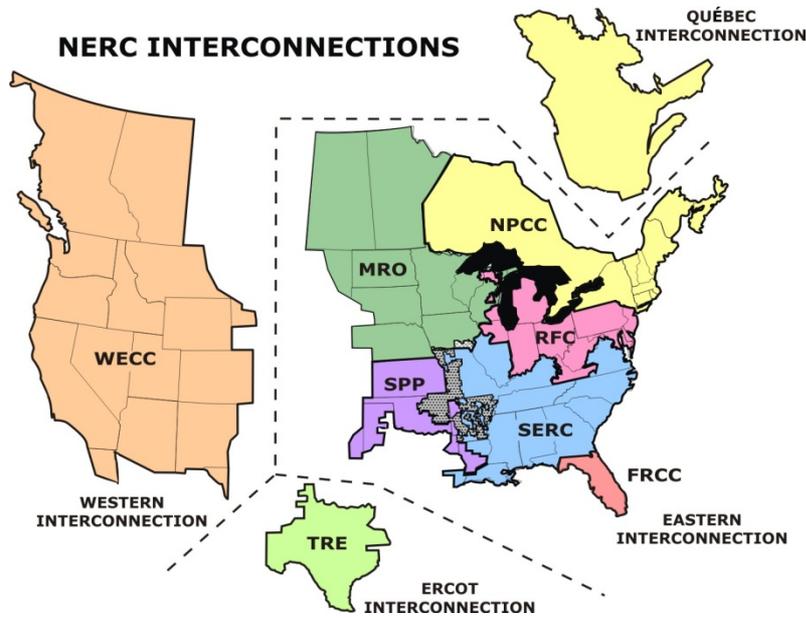


Figure 16: NERC Interconnections and Regional Entities. Source: (NERC, 2012).

Western Interconnector	
WECC	Western Electricity Coordinating Council
Eastern Interconnector	
FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RFC	ReliabilityFirst Corporation
SERC	SERC Reliability Corporation
SPP	Southwest Power Pool
ERCOT Interconnection	
TRE	Texas Reliability Entity

Table 14: NERC Regional Entities, abbreviations and full names. Source: (NERC, 2012).

A-11.2 Planning in the Western Interconnection

Planning in the Western Interconnection is facilitated both on an ISO/RTO level and on an interregional level governed by the Western Electricity Coordinating Council (WECC). In the remainder of this section, we describe the current processes and governance of the interregional planning in the Western Interconnection. The background of this current inter-regional arrangement is both FERC Orders 890/1000 and project funding for WECC by the US Department of Energy (DoE). One note about wording: although planning the area of a whole interconnection can well be regard as “inter-regional”, the WECC denotes its planning procedure as “regional” and therefore also commits itself to the stricter Order 890 (in comparison to Order 1000).

A-11.2.1 Actors of the Planning Process

The main actors of the Western Interconnection are depicted in Figure 17. On one hand, the Transmission Expansion Planning Policy Committee (TEPPC) process is supported by regular WECC groups, specifically the WECC Planning Coordination Committee (PCC) and the related subcommittees on Loads and Resources (LRS) and Variable Generation (VGS). On the other hand, there is an organisational structure dedicated to the process internal to the TEPPC. There is a Technical Advisory Subcommittee (TAS) and three WGs on Studies (SWG), Modelling (MWG), and Data (DWG). In parallel to that, the TEPPC organisation contains several groups that especially serve the purpose of including the various stakeholders (governmental, transmission providers, utilities, etc.) into the planning process. These groups are a State Provincial Steering Committee (SPSC), a Scenario Planning Steering Group (SPSG), and Subregional Planning Groups (SPGs). These groups are coordinated by an SPG Coordination Group (SCG).

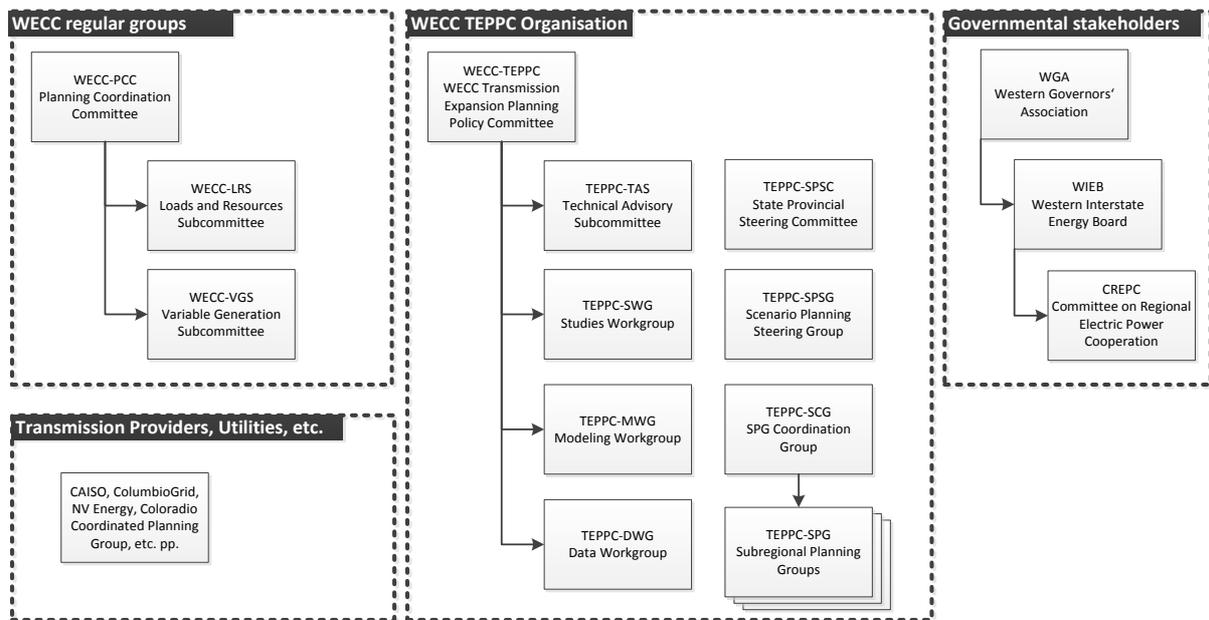


Figure 17: Actors of the Western Interconnection planning process. Source: Own depiction, adapted from descriptions in (WECC, 2010)

A-11.2.2 Structure of the Planning Process

Current planning is documented in two representations: (i) a governance-level description where the actions of stakeholders are related to aggregated planning steps, and (ii) a more technical description of the contents of planning. The former is depicted in Figure 18. First, “Study Requests” by stakeholders are fed into the process. These study requests may either relate to an addition of resources, e.g., changes of assumptions or scenarios, or specific transmission projects that stakeholders wish to submit to the planning process. After that, a study programme is defined for the current years’ planning cycle. The study programme may be a combination of a number of studies. Then, analysis is performed, and a transmission plan is eventually created.

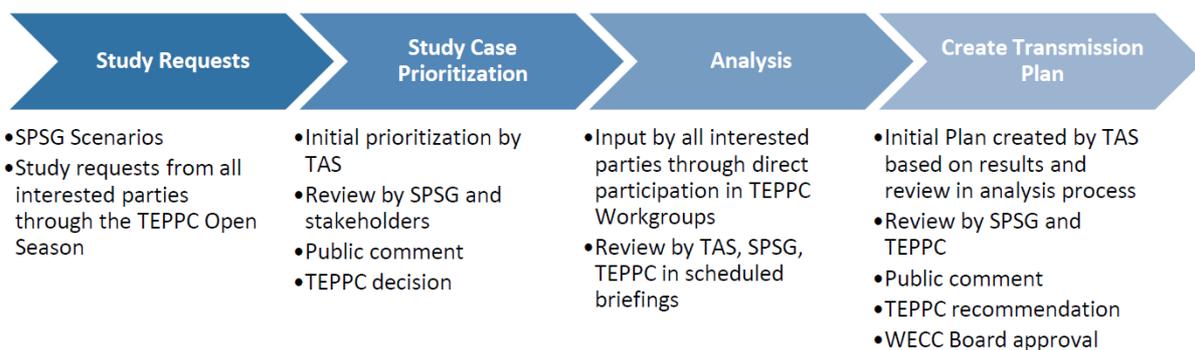


Figure 18: “Governance-level” description of the Western Interconnection Planning Procedure. Source: WECC (2010, p. 12).

On the technical side of the planning process, the usual preparations concerning loads, generation, and characteristics and evolution of the transmission system are made. Further, specific study cases of the study programme are associated with “key questions”, which may lead to a refinement of the respective study case. The analysis itself is carried out based on a simple production cost model soft-

ware tool called Promod, by Ventyx. This model is used to simulate every hour of the study year. To identify transmission needs, the different study case simulation results, including base case and historical measurements, are compared. From these models patterns of congestion are identified. The observed congestion situations are then grouped into different categories, mainly trying to relate them to reasons for their congestion (e.g., contingency on the construction of a future plant). Following this, findings are then used to identify transmission needs and potential solutions. In a subsequent step, an evaluation of the potential solutions concerning costs, contribution to reliability criteria, environmental aspects, and consistency with public policy objectives is carried out. The final step is the formation of recommendations. In this step, the objective is to deliver a “set of actionable information” that not only includes the proposed projects themselves, but also advice on “public policy, opportunities for collaboration”, etc.

The final plan is, however, not binding: It is informational and WECC has no authority to order that lines be built. WECC states that “it is up to the decision-makers at all levels (utilities, developers, regulators, siting agencies, and financiers) to determine what transmission and other infrastructure are built” (WECC, 2010, p. 8).

A-11.2.3 Conclusion of the Western Interconnection’s Planning Process

In the context of this study, the regional planning process of the Western Interconnection are most closely related to the EU-wide TYNDP procedure, as it tries to consolidate multiple plans of actually independent network planning actors. However, the Western Interconnection process seems to be more open to various stakeholders than the EU process. The committees, WGs, and teams of the European process are generally restricted to only TSOs, with little in-process connection to representatives of public policy, environmental stakeholders, generation and load-serving entities, etc. Nevertheless, every institutional form is, to a certain extent a “carrier of history” (David, 1994) and the current type of planning organisation in the US is certainly and to a large extent owing to the heterogeneity of actors in the US electricity sector.