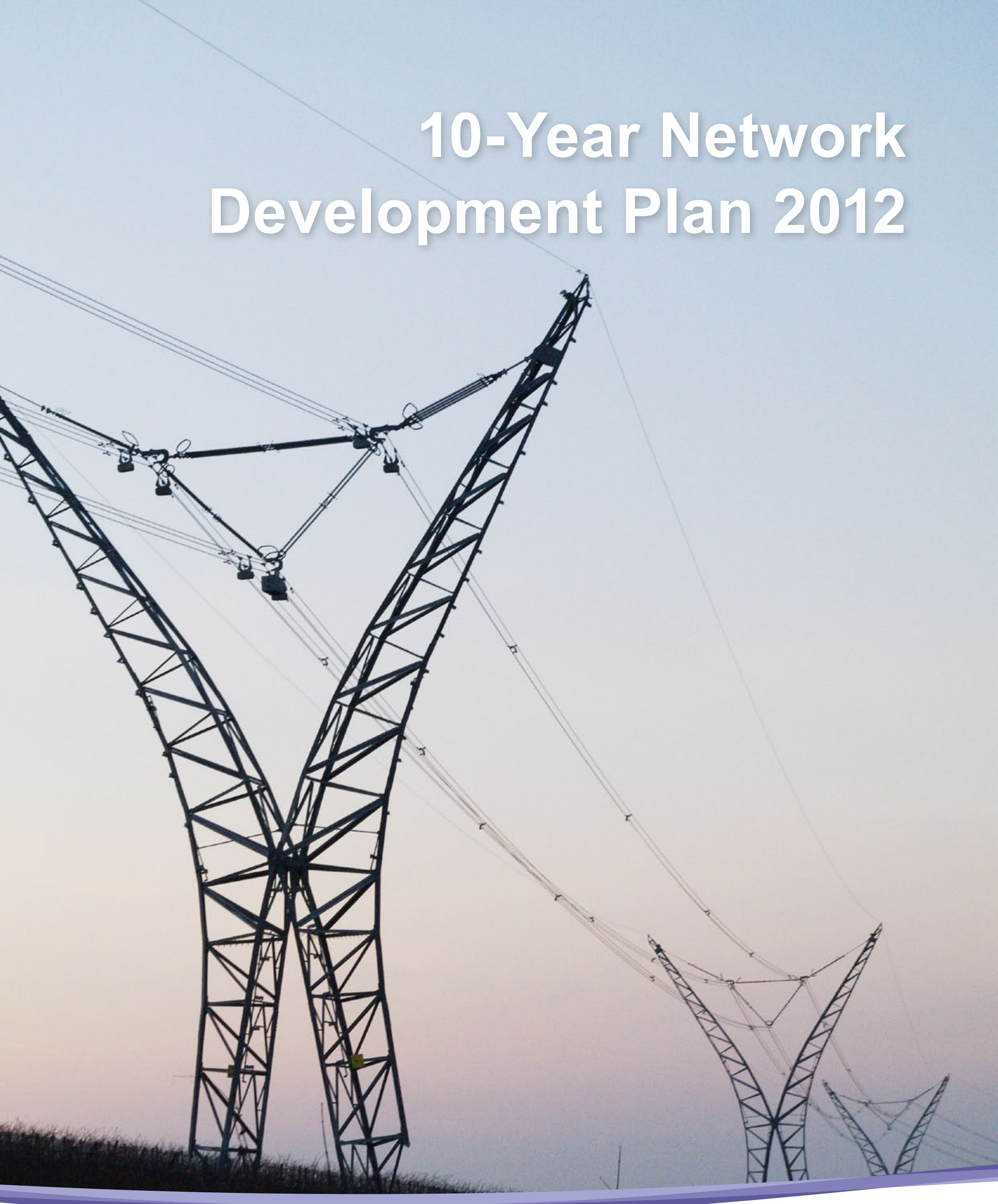
10-Year Network Development Plan 2012



European Network of
Transmission System Operators
for Electricity

entsoe

10-Year Network Development Plan 2012

5 July 2012

Content

1 Executive Summary

1.1 ENTSO-E Delivers the TYNDP 2012 Package

The European Network of Transmission System Operators for Electricity (ENTSO-E)[1)] provides herewith the 2012 release of the Community-wide Ten-Year Network Development Plan (TYNDP).

The present report is part of an 8-document suite also comprising the Scenario Outlook and Adequacy Forecast and 6 Regional Investment Plans. Together they form the **TYNDP 2012 Package**. Complying with present regulations (especially Reg. (EC) 714/2009) and anticipating the implementation of the future Energy Infrastructure package, these 8 reports jointly deliver a structured, systematic and comprehensive vision for grid development in the coming 10 years in Europe. They describe significant investments in the European power, which are required to achieve European energy policy goals.

NB: the final version published in July 2012 accounts for the feedback received during the 8-weeks consultation process in Spring 2012. Most stakeholders welcomed the TYNDP, their comments mostly targeting future issues of the report. The TYNDP package has also been updated with the most recent information related to the German national development plan in consultation. (Provisional data was introduced in the projects submitted for consultation and the final TYNDP needed only to be marginally adapted.)

1.2 What is New Compared to TYNDP 2010?

In a volatile environment, the TYNDP and its methodology are bound to evolve. ENTSO-E targets a delivery every two years of an enhanced product, introducing methodology improvements so as to ensure timely and consistent results, achieving efficiency rather than awaiting perfection.

---

1) See www.entsoe.eu

The first Ten-Year Network Development Plan was published by ENTSO-E on a voluntary basis in spring 2010, in anticipation of the entry into application of Regulation (EC) 714/2009. The 2012 release builds on this experience and the **feedback received from stakeholders.** In the last two years, ENTSO-E especially organized two consultations, nine workshops and stakeholders' meetings in order

- to discuss scenarios, methodologies, study process, project valuation, and initial results,
- to jointly develop more harmonized methodologies and
- to agree on the expected outcomes of a transparent process.
  (For the preparation of the next TYNDP, ENTSOE will set up a stakeholders' group to ensure even tighter exchanges with stakeholders.)

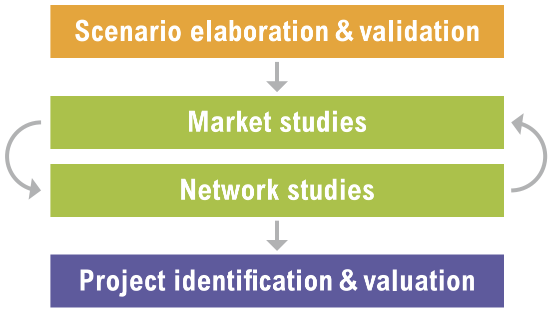


Figure 1.1:
Overview of the general methodology

New common top-down-defined and run processes have thus been developed:

- **20-year, Europe-wide scenarios**,
  each displaying a valid generation adequacy assessment, encompassing jointly all foreseeable futures and matching European 20-20-20 objectives (see SO&AF 2012),
- generic **planning standards** and
- an **integrated market and network modeling**
  combining market and network studies in an iterative process.

In order to streamline efforts and ensure consistency, **regional and pan-European perspectives are built together in an integrated process**.

Projects of pan-European significance – i.e. candidate Projects of Common interest – have been defined (see Appendix 2) and 3rd parties, i.e. **non-ENTSO-E members, had the possibility to submit candidate projects** by complying with a public procedure advertised at the beginning of the process.

Finally, the presentation of projects in the TYNDP 2012 has been reshuffled to display both a synthetic technical description of every investment item and the cost benefit analysis of every project, through a **multi-criteria assessment** scale (see Appendix 3).

1.3 What are the Scenarios for the Coming Decade?

Grid development requires the anticipation and consideration of the long-term. Notwithstanding the Electricity Highways 2050 works ongoing, ENTSO-E developed **4 visions up to 2030** to examine the challenges and opportunities for TSOs development of longer-term scenarios. Within these visions, **2 scenarios**[1] have been used as a basis for the TYNDP 2012:

- The Scenario EU 2020 has been built top-down, based on the European 20-20-20 objectives and the NREAPs[2] (it is the reference scenario).
- The Scenario SAF-B extrapolates information from market players' present investments perspectives in a bottom-up approach.

Both scenarios however match the **European 20-20-20 objectives**:

- Power demand evolution results from contradicting effects of, downward, the present economic crisis, strong energy efficiency measures, and, upwards, the switch by end-uses from fossil fuel to electricity (heat pumps, electric vehicles …) and development of electronic devices. At the perimeter of the ENTSO-E system, the peak load in January continues growing by 8 % in Scenario EU 2020 over the coming decade.
- Renewable energies boom, mostly wind and photovoltaic, providing by 2020 as much as 38 % of the electricity demand in Scenario EU 2020.
- Depending on the share of gas and coal-fired units in the mix in the coming ten years, CO_2 emissions of the power sector also sink from 26 % to 57 % in Scenario EU 2020.

Scenarios have been validated in a public consultation early 2011. The restated decisions of German government regarding nuclear phase-out plans led ENTSO-E to test a sensitivity with respect to the presence/absence of nuclear units in this country in order to ensure robustness of the results.

1) Visions and scenarios for this TYNDP 2012 are depicted in SOAF 2012.

2) National Renewable Energy Action Plans:
each EU Member State published their roadmap towards the European 20-20-20 objectives.

1.4 Where are the Major Investment Needs?

In the coming decade, the net generating capacity will increase by about 250 GW, i.e. 26 % of the present total. Almost all the increase can be explained by RES development (about 220 GW). The figure however hides the important decommissioning by 2016 of obsolete fossil-fuel-fired units not compliant with the emissions thresholds set by the Large Combustion Plant Directive, partly substituted by the commissioning of new conventional power plants (mostly gas, but also coal and nuclear).

All in all, about a third of the present net generating capacity will be built in the coming decade. New generating capacity is almost fully located farther from load centres, RES including: wind generation develops mostly as large wind farms, also offshore. **The major shift in the generation mix will therefore induce a massive relocation of generation means and, with large wind and solar capacities, more volatile flows, requiring the grid to adapt.**

Market studies can appraise the resulting gross commercial exchange patterns by 2020. As shown in Figure 1.2, Italy, the UK, Poland and Baltic states remain major importing countries. France and Scandinavia are the larger exporters, as is the case today, however, exchanged volumes are higher. Germany, Spain and Portugal experience high exchange volumes but for both imports and exports, which results in an overall balance. Rather logically, the highest volumes are exchanged in the heart of Europe.

Market studies basically show **larger, more volatile power flows, over larger distance across Europe**, mostly north south from Scandinavia to Italy, between mainland Europe and the Iberian Peninsula, Ireland and UK or east to south and west in the Balkan Peninsula. Investment on grid is needed to avoid present congestion worsening and new congestion appearing.

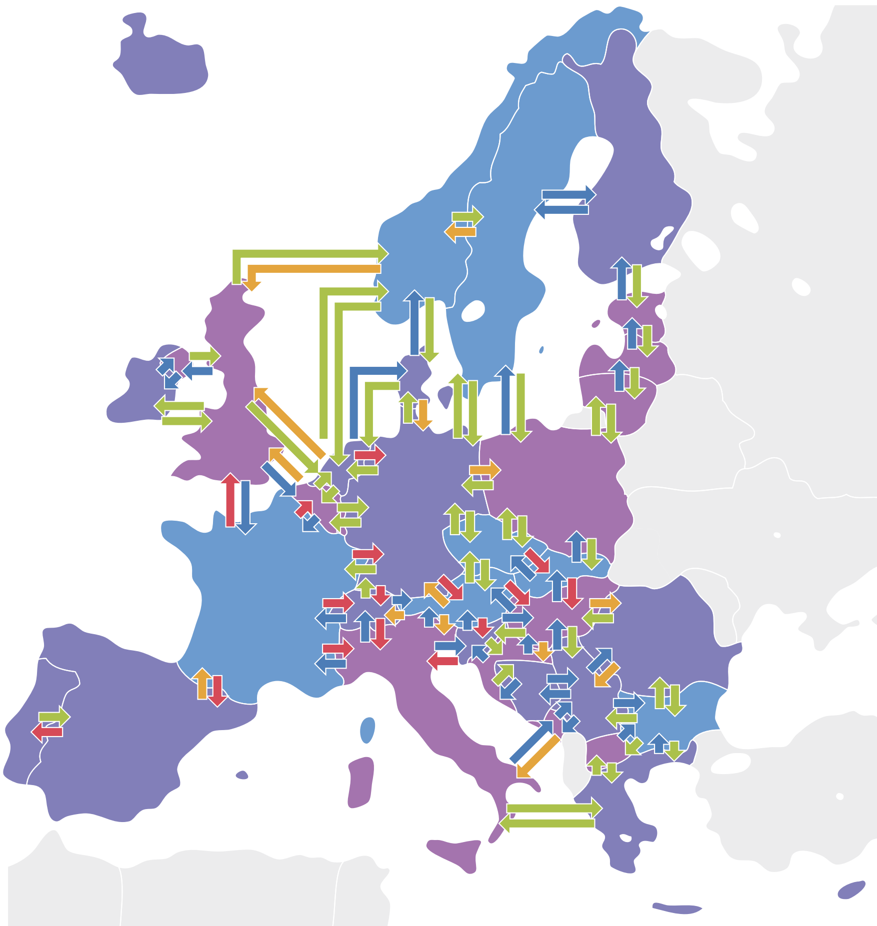


Figure 1.2:
Power exchanges patterns[1] in 2020 between ENTSO-E countries

About 100 bottlenecks can be identified on the European network by the end of the decade, as displayed in Figure 1.3. About 60 % of the concerns are primarily related to market integration (either between price zones, or intra-price zones), about 30 % primarily related to generation connection and 10 % primarily related to security of supply. However **80 % of the bottlenecks are related to RES integration**, either because direct connection of RES is at stake, or because the network section or corridor is a keyhole between RES and load centers. The north-south internal corridors in Germany are typical examples of the latter.

[1] The annual power flows shown on the map do not reflect actual physical power flow on the grid but simplified expected commercial exchanges.

Figure 1.3:
100 main bottlenecks in Europe in 2020

1.5 What are the Grid Investments for the Coming Decade?

Over 100 transmission projects of pan-European significance have been identified to address and solve the above-mentioned concerns in the coming decade (among them, 40 % are interconnectors).

About 76 % of the investment items in the TYNDP 2012 package were previously included in the TYNDP 2010[1] and are hence confirmed. 24 % are new ones, which is a bit more than what the regular turnover of the TYNDP process could be expected to be. These figures show both the robustness of the TYNDP 2010, and that the TYNDP is a living process. Overall, there has been material delay to the delivery of one third of the investments, mostly because of social resistance and **longer than initially anticipated permitting procedure**s, possibly leading to project reengineering.

As displayed in Figure 1.4, projects of pan-European significance total about 52,300 km of new or refurbished Extra High Voltage routes, split rather equally between the two 5-year sub-periods. It represents a 25 % increase compared to TYNDP 2010, especially with individually long-stretching new investments:

– + 3,000 km of subsea routes are envisaged, developing in total 10,000 km of offshore grid key-assets and
– **+ 7,000 km of routes are considered inland, mostly to bring to load centers the power generated on the outskirts of the European territory**.

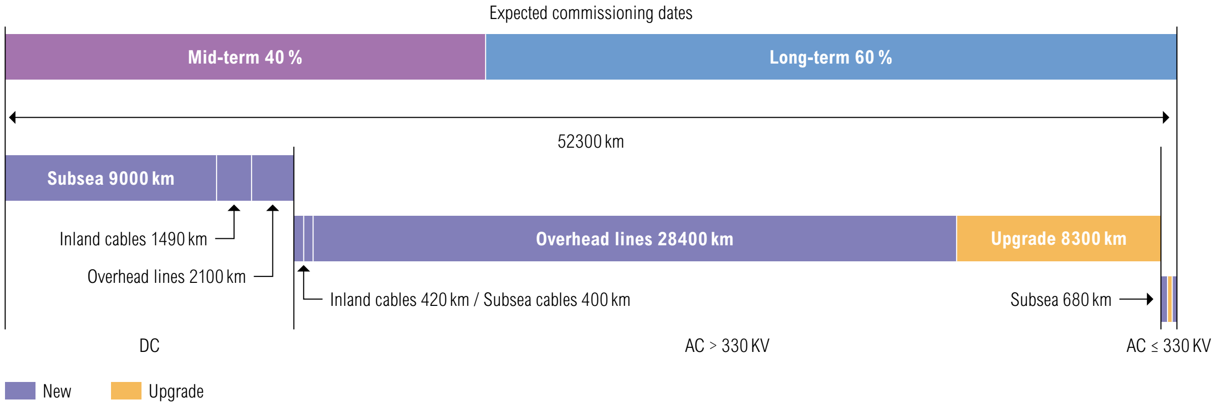


Figure 1.4:
Projects of pan-European significance – volumes

1) 51 of the 495 investments items contained in the TYNDP 2010 have been commissioned to date (12 have been partly commissioned, 25 are expected to be commissioned in 2012).

Figure 1.5:
Grid Transfer Capability increases

Projects of pan-European significance are very diverse, adapting to the very specific geography they are inserted in. They develop grid transfer capability (GTC) ranging from a few hundreds of MW to more than 4 GW. Globally, increases to GTC are basically developed where higher power exchanges are expected, as displayed Figure 1.5.

The planned projects directly support the EU energy policy (see Figure 1.6).

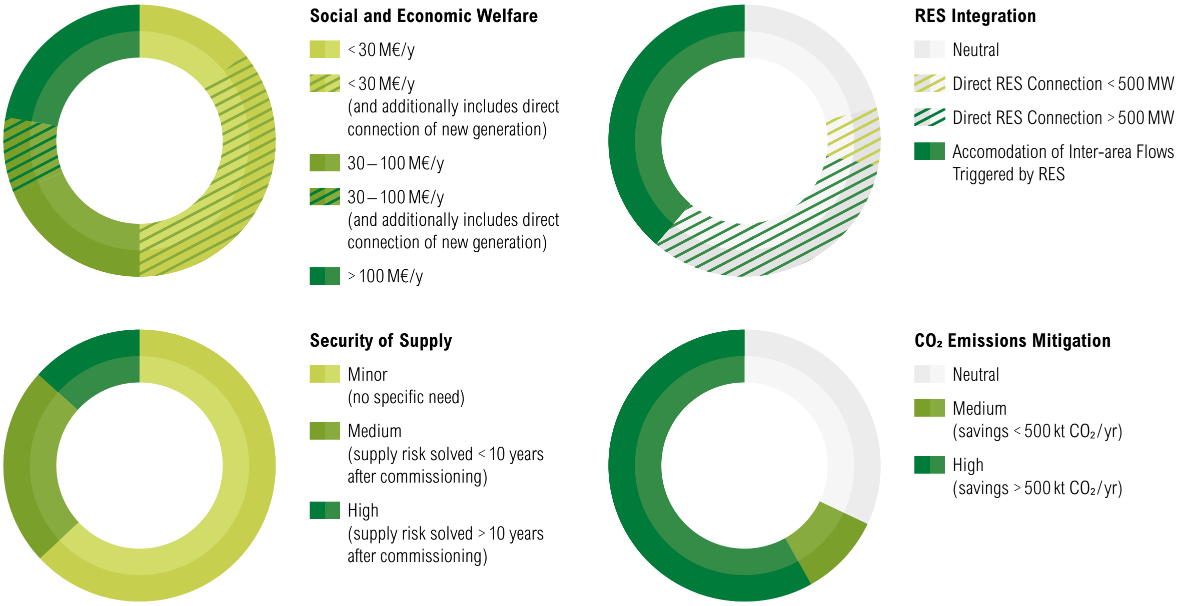


Figure 1.6:
Projects of pan-European significance – contribution to EU energy policies

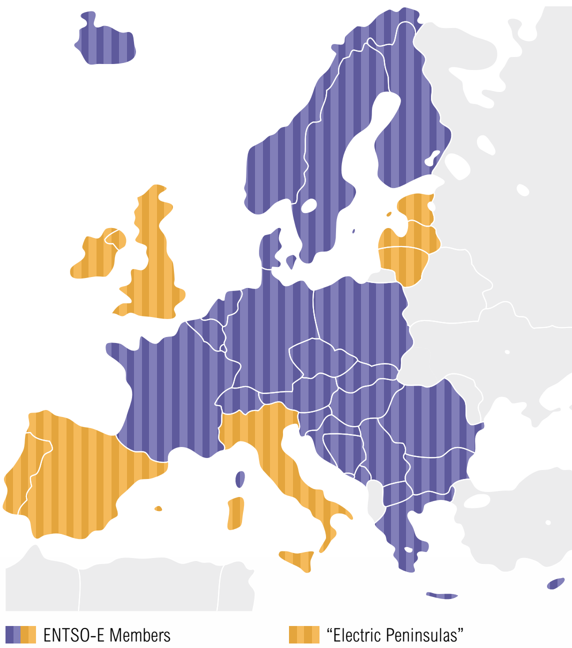


Figure 1.7:
"Electric peninsulas" in Europe by 2020

80 % of the projects contribute to RES integration (either for direct connection or serving RES energy movements across Europe): **transmission grid development at the European level is required for about 125 GW of new RES**, i.e. half of the expected RES development in Europe.

47 %[1)] contribute significantly to market integration, enabling each generation costs savings of at least 30 M€/yr, which equates to greater than 100 M€/yr including the benefit of the integration of the four regions currently with the weakest integration to the European system namely: Italy, the Iberian Peninsula, Ireland and the UK and Baltic states (see Figure 1.7).

1) Not accounting projects that directly connects new generation (another 40 %).

Globally, comparing the situation before and after grid reinforcement, the analyses show that **transmission projects of pan-European significance will help alleviate total generation operational costs by about 5 %**. Most savings are expected in the above-mentioned countries.

33 %[1)] of the projects are required to integrate isolated systems such as the Baltic States, secure large load centres (in particular capital cities), or even countries with negative generation adequacy forecast in the coming years.

All projects contribute to significantly mitigating CO_2 emissions in Europe (with the exception of the few direct connections of fossil-fuel-fired power plants).

All the projects also display high technical performances (see Figure 1.8). A project's technical resilience and flexibility can be substantially influenced by TSOs and consequently projects of pan-European significance typically show robust design. On the other hand, other characteristics such as losses are influenced greatly by other exogenous factors, and there the project's benefits in such areas are diverse:
- Positive effect on losses for those merely improving grid meshing/interconnection,
- negative when connection of new remote generation is at stake and
- undetermined when the appraisal is more complex.

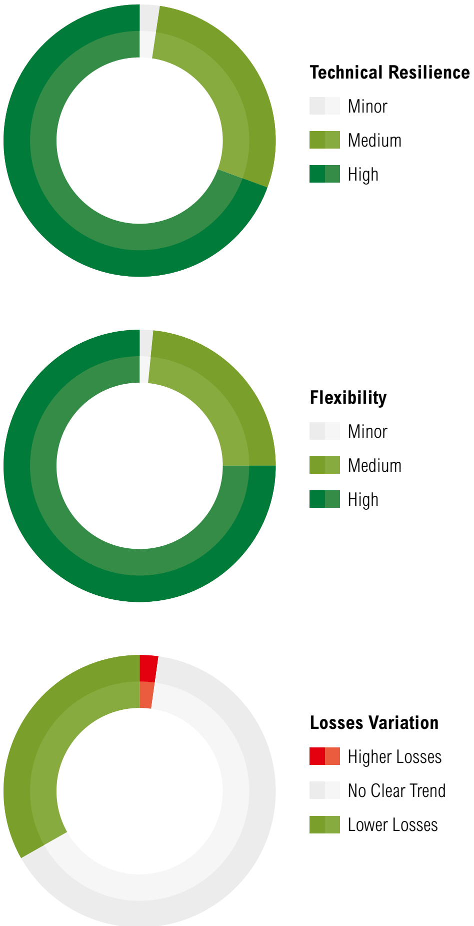


Figure 1.8:
Projects of pan-European significance – technical assessment

Total investments costs for projects of pan-European significance amount to **€ 104 billion, of which € 23 billion is for subsea cables**. The figures are in line with the previous analysis of the TYNDP 2010 and the overall € 100 billion envisaged by the European Commission in their communication on the Energy Infrastructure Package on 17th November 2011.

This effort is significant for TSOs financial means. It equates however to about 1.5 – 2 €/MWh of power consumption in Europe over the 10-year period, i.e. **only around 2 % of the bulk power prices or less than 1 % of the total end-users' electricity bill**.

1) Other projects enhance grid meshing and thus the overall security of supply, but are discarded from the analysis; in their regard, the initial situation locally shows acceptable risk.

1.6 What is the Resilience of the Proposed Investments?

Thousands of market situations, which consider all hazards that may affect the power system have been simulated and processed for this TYNDP 2012. Frequent situations, or rare ones but resulting in particularly extreme flow patterns, have then been identified for further analysis, in order to test the grid's ability to withstand them and to define if necessary the required measures. Such typical situations are at peak load in winter or summer, with extreme but probable low or high wind/solar generation. Thus, TSOs **can ensure the proposed investments are adaptable, valuable and robust**.

The following map (see Figure 1.9) shows that most identified concerns are solved with the proposed investments. It answers questions such as: "beyond the investment proposed in the Plans, are there any measures still required related to grid development?" For the coming decade, the results are supplied for every analyzed boundary; beyond the coming decade, farther important issues for grid development are sketched and will be further investigated in the next release of the TYNDP.

The map shows that most identified concerns are solved with the proposed investments:

- Every generation connection or security of supply issue is rather well limited; easily addressed and most are marked light purple.
- Projects also match requirements of market integration in the foreseen scenarios, except possibly for rare situations. Sizing investments to match these would not prove profitable. Most of the corresponding boundaries are marked medium purple for these rather open and interacting concerns.
- Grid development will be needed beyond the investment listed in the Plans to meet challenges coming by 2030 and beyond: grid development to integrate offshore wind, the Mediterranean solar plan, further interconnection with the East, etc.

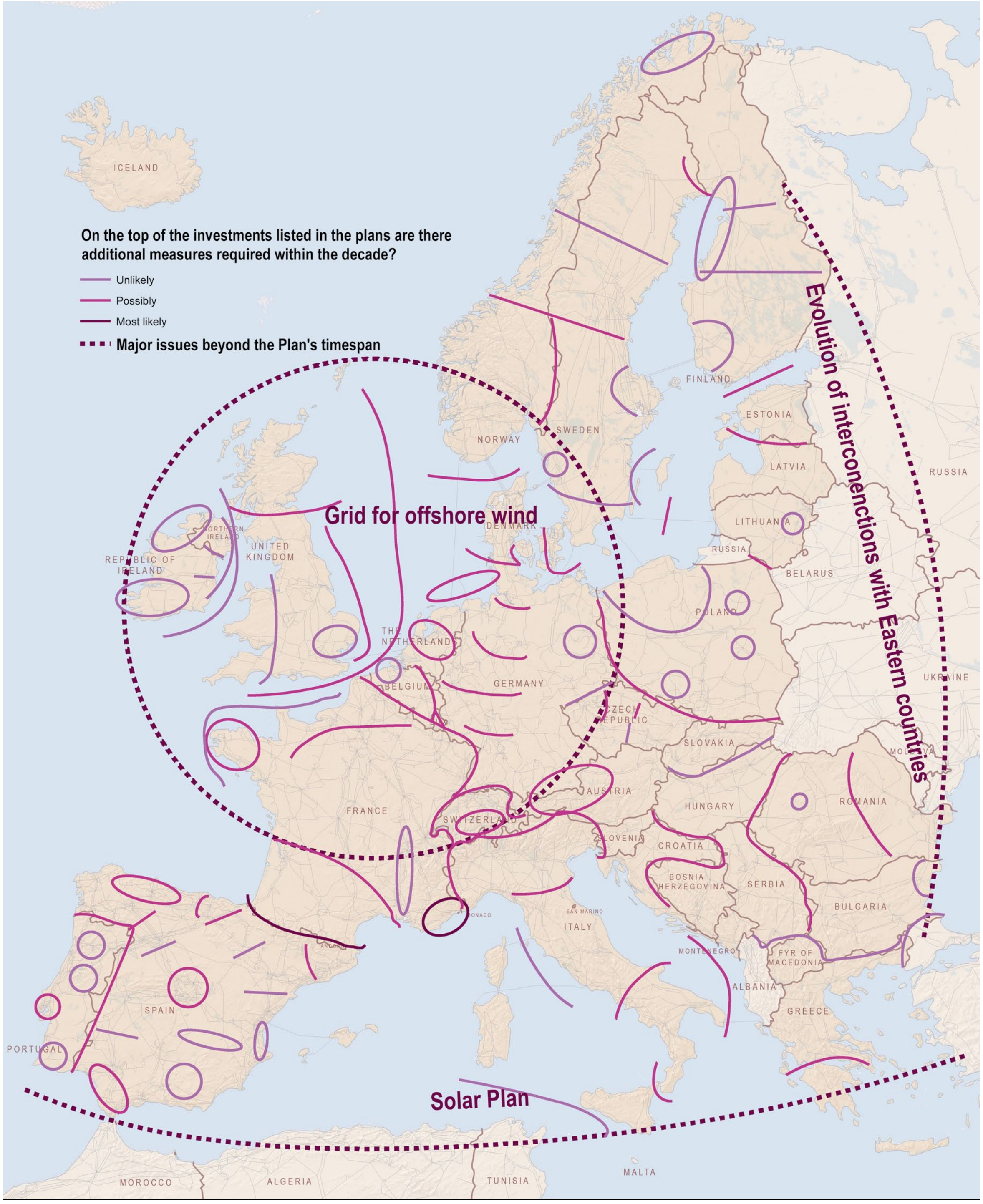


Figure 1.9:
Transmission adequacy

Resilience is also ensured by the fact that TYNDP 2012 **project designs use cutting edge technologies**. Some of them are new technology demonstrators and world premieres: largest DC VSC equipment, longest AC cable route, DC and AC parallel operation … Aside from the proposed extra high voltage investments, TSOs also contribute to the development of smart grids[1]: latest electronic tools and IT systems help optimizing the operation of existing assets, and especially monitor, forecast and control distributed RES and load management.

Visions for 2030 are a step toward 2050, where the EU advocates 100 % RES power generation. 2050 scenarios and analyses are still ongoing, in the framework of the Electricity Highways 2050 consortium led by ENTSO-E. Even before this work is complete, it emphasizes that **the trends depicted in the present TYNDP report will continue developing in the coming decades**:

- Generation moving to the periphery of the European area, mostly with offshore RES and coastal large conventional units.
- Hence, larger, more volatile power flows over larger distances in Europe.
- As a result, grid development is primarily triggered by generation development.

ENTSO-E thus believes that **the pan-European TYNDP constitutes a solid and robust synthesis of the required development of the European grid**.

A major challenge is that the grid development may not be in time if the RES targets are met as planned by 2020. Permit-granting procedures are lengthy, and often cause commissioning delays. If energy and climate objectives have to be achieved, it is of upmost importance to smooth the authorization processes. In this respect, ENTSO-E welcomes the proposals made by the European Commission with the draft **Energy Infrastructure Package**, as there are many positive elements in the permitting section that will facilitate the fast tracking of transmission infrastructure projects including the proposal of a one-stop shop and defined time lines. More thorough analyses are, however, required so as to ensure the measure can be successfully implemented, particularly in relation to whether the timelines proposed are achievable, and particularly in the context of the public participation process and the potential for legal delays. One must also notice that the supporting schemes are limited to the so-called Projects of Common Interest (PCIs) whereas there are many significant national transmission projects that are crucial to the achievement of Europe's targets for climate change, renewable and market integration.

[1] See the ENTSO-E R&D Plan (www.entsoe.eu/resources/key-documents)

1.7 What are the Next Steps?

The quality of the integrated market and network modelling relies on the knowledge of all specific parameters of each local power system in Europe as well as the resulting ability to master and cut aptly through numerous uncertain parameters. The aim is to properly model every grid concern in a limited timeframe and therefore correctly valuate just over 100 projects from right across Europe.

ENTSO-E hence devised a specific **top-down coordination, both relying on common standards and subsidiarity to take advantage of TSOs' local expertise and workforce**. This organization will be improved to address new challenges but must continue to rely on this combination of top-down lead and decentralized expertise.

The TYNDP 2012 enabled ENTSO-E to implement for the first time a **cost benefit analysis**, articulating market and network studies. ENTSO-E believes that the developed methodology is a good basis in the perspective of the future Energy Infrastructure Package. The **valuation of projects** and the integrated realization of both the pan-European and regional reports are intended to **efficiently support the selection of Projects of Common Interest** in the Regional Groups. Scenarios in the **SOAF are released every year** to accommodate every required update.

ENTSO-E works with **stakeholders' feedback** and the present text accounts for the feedback received during the 8-weeks consultation process in spring 2012. Most stakeholders welcomed the TYNDP. Most comments received targeted future issues of the report, and asked especially for greater stakeholders' involvement, in particular for the definition of scenarios and inclusion of 3rd Party projects. ENTSOE will set up an ad'hoc stakeholders' group to ensure tighter exchanges with stakeholders. (More details can be found in the report on received comments on the web site). The preparation of the TYNDP 2014 has already started!

Beyond the coming decade, ENTSO-E also anticipates longer-run needs:

- ENTSO-E Regional Group North Sea directly contributes to **the North Seas offshore grid concept for 2020/2030** following the Memorandum of Understanding for the North Seas Countries' Offshore Grid Initiative (NSCOGI).
- Also, ENTSO-E leads a consortium in charge of the "**e-Highway 2050**" study, which seeks to develop a strategic plan that will provide a vision for a pan-European power system, built around the Electricity Highways concept developed in sequence over the time horizon to 2050.

2 Introduction

2.1 ENTSO-E Supplies a Vision for Grid Development in the Coming 10 Years in Europe: the TYNDP Package 2012

The European Network of Transmission System Operators for Electricity (ENTSO-E)[1] provides herewith the 2012 release of the community-wide Ten-Year Network Development Plan (TYNDP).

The objectives of the TYNDP are to ensure transparency regarding the electricity transmission network and to support decision-making processes at regional and European level. This pan-European report and the appended Regional Investment Plans are the most comprehensive and up-to-date European-wide reference for the transmission network. They point to significant investments in the European power grid in order to help achieve European energy policy goals.

2.1.1 Complying with European Regulations

The present publication complies with the requirements of Regulation EC 714/2009, in force since March 2011 whereby (According to Art. 8.3-b) "ENTSO-E shall adopt a non-binding Community-wide 10 year network development plan, including a European generation adequacy outlook, every two years".[2]

The Regulation set forth that the TYNDP must "build upon national investment plans" (the consistency to which is monitored by the Agency for the Cooperation of Energy Regulators, ACER), "and if appropriate the guidelines for trans-European energy networks". Also, it must "build on the reasonable needs of different system users". Finally, the TYNDP must "identify investment gaps, notably with respect to cross-border capacities".

---

1) See in Appendix § A2.1 and for more information www.entsoe.eu

2) Legal requirements set for the TYNDP by Regulation 714/2009 are summed up in Appendix § A2.1.

2.1.2 A Structured, both Synthetic and Comprehensive, Material

Stakeholders require for grid development synthetic and detailed perspectives at the same time. ENTSO-E faces the challenge by supplying the "TYNDP package 2012", a suite of documents consisting of:

- the present Community-wide TYNDP report 2012,
- the 6 Regional Investment Plans 2012 and
- the Scenario Outlook and Adequacy Forecast 2012.

All these documents present information of European importance. They complete each other, with limited repetition of information from one document to another only when necessary to make everyone of them sufficiently self-supported:

- Scenarios are comprehensively depicted in the SOAF,
- investments needs and projects of European importance are comprehensively depicted in the Regional Investment Plans and
- the present Community-wide TYNDP report hence only sums up synthetic information for concerns and projects of pan-European significance.

Every document is designed to be between 50 and 100 pages long, not accounting for appendices. Generic information presented in the TYNDP 2010, especially section 2 and 3 regarding the organization of the European power system and the challenges for grid development is not recalled in the present edition.

The TYNDP 2012 package was consulted in Spring 2012 in order to be finalized in June 2012.

2.2 A Top-down, Open and Constantly Improving Process

The first Ten-Year Network Development Plan was published by ENTSO-E on a voluntary basis in Spring 2010, in anticipation of the Directive and the Regulation. The 2012 release builds on this experience and the feedback received from stakeholders.

In the last two years, ENTSO-E organized in this respect two consultations, regarding the TYNDP 2010 in Spring 2010, and the scenarios for the TYNDP 2012 in Winter 2011 as well as nine workshops, in Brussels or regionally, about scenarios, methodologies, study process, projects valuation, and first results[1]. The Florence forums, conferences, dedicated meetings with DG Energy, ACER and market players also contributed to sharing concerns, jointly developing more and more harmonized methodologies and agreeing on the expected outcomes of the process.

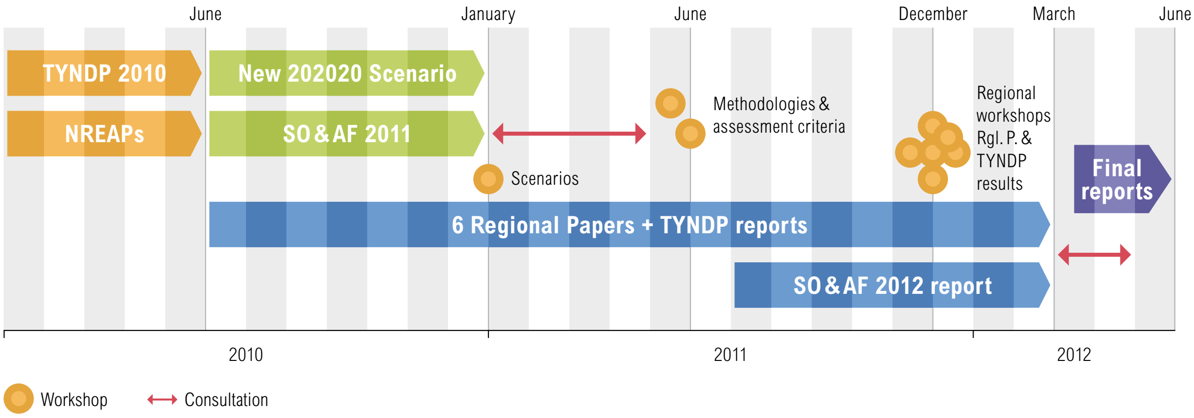


Figure 2.1:
TYNDP 2012 elaboration schedule

What's new with the TYNDP 2012 package?

ENTSO-E have proposed, submitted to stakeholders and implemented the following improvements since 2010:

A new organization framework:

- ENTSO-E designed and ran top-down for the present TYNDP submission new common study procedures:
  - Common top-down-defined and consulted scenarios (see SOAF 2012),
  - generic planning standards (see Appendix 3) and
  - specific study protocols for joint studies bases of TYNDP 2012.
- In order to streamline efforts and ensure consistency, regional and pan-European perspectives are built together in an integrated process, considering six regions relevant to addressing grid development issues in Europe (see Figure 2.2). (Regions are overlapping to ensure overall consistency of the Regional Investment Plans.)
- The possibility for 3rd parties (non-ENTSO-E members) to submit candidate projects by complying with a public procedure.[2]

Improved outcomes, directly answering stakeholders request when consulted about TYNDP 2010:

- Identification of main future congestions issues on the grid and assessment of Bulk Power Flows across these,
- explicit definition of projects of pan-European significance (see §A2.5 in appendix),
- higher-level presentation of projects, showing connections between investments to develop additional grid transfer capability,
- valuation of every project benefits assessment to enable cost benefit analysis and
- synthetic assessment of the transmission adequacy expected with the planned investments.

1) See workshop and consultation material on www.entsoe.eu

2) www.entsoe.eu/fileadmin/user_upload/_library/SDC/TYNDP/2012/3rd_parties_projects_guidance.pdf

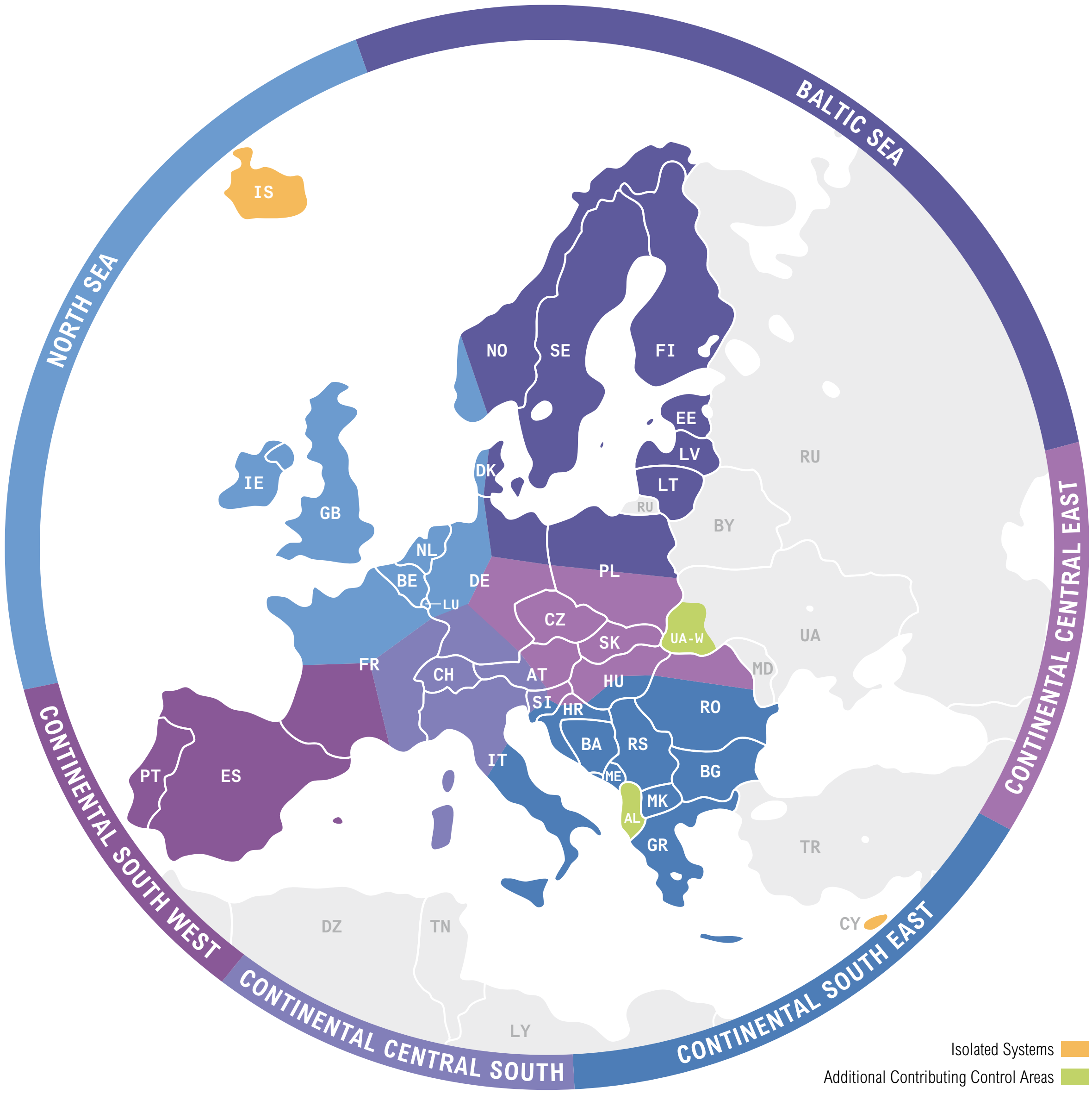


Figure 2.2:
ENTSO-E System Development Regions

In a volatile environment, the TYNDP and its methodology are bound to evolve. ENTSO-E targets a regular delivery every two years of an enhanced product, introducing methodology improvements so as to ensure timely and consistent results, thus achieving efficiency rather than aiming at perfection.

Figure 2.3 sums up the overall process: basically open to stakeholders; constantly improving; integrating efficiently both pan-European and regional exercises (see Chapter 4 for more details).

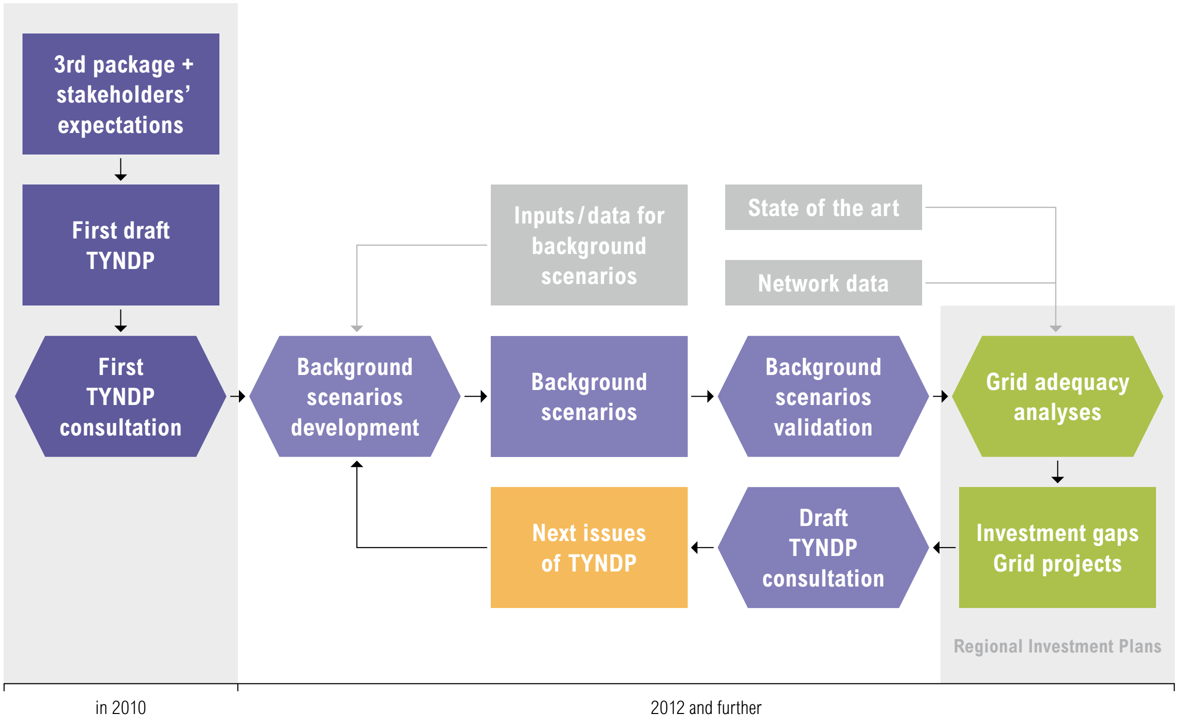


Figure 2.3:
Building-up process of the TYNDP

2.3 How to Read the TYNDP 2012 Report?

The document is structured in the following way:

– **Chapter 3, Assessment of TYNDP 2010**
  points out the main changes that have occurred with respect to the investments presented in the TYNDP 2010 submission.

– **Chapter 4, Methodology**
  describes the overall process and specific methods used to elaborate the TYNDP 2012 package. (Regional parameters used to apply the methodology, as the case may be, or specific regional outlooks are presented in the Regional Investment Plans.)

– **Chapter 5, Scenarios**
  gives only a synthetic overview of the basic scenarios underlying the present TYNDP. (The detailed description of the scenarios and the generation adequacy forecast are in the SOAF 2012 report.)

- **Chapter 6, Investment**
  needs exposes the evolution of the European grid capacity from the present situation, highlighting the drivers of grid development, location of grid bottlenecks in ten-year time and Bulk Power Flows across these bottlenecks.
- **Chapter 7, Projects**
  presents a synthetic overview of all planned projects of pan-European significance. (The technical details of the projects are in Appendix 1; see also the Regional Investment Plans.)
- **Chapter 8, Transmission Adequacy**
  sums up the improved situation in ten-year time with all projects of pan-European significance implemented.
- **Chapter 9, Environmental Concerns**
  sums up the environmental impact of the planned projects.[1)]
- **Chapter 10, Assessment of Resilience**
  resets the planned projects in larger and farther-looking perspective.
- **Chapter 11, Conclusion**
- **Chapter 12, Appendices**
  - **Appendix 1**
    displays the Table of Projects, summing up all the information regarding projects of pan-European significance.
  - **Appendix 2**
    supplies the definition of key-concepts and a glossary.
  - **Appendix 3**
    describes the planning standards.
  - **Appendix 4**
    focuses on measures to improve social acceptance of grid investments.
  - **Appendix 5**
    sums up the state of the art regarding transmissions technologies.
  - **Appendix 6**
    supplies additional results.

NB: the final version published in June 2012 accounts for the feedback received during the 8-weeks consultation process in Spring 2012. Most stakeholders welcomed the TYNDP, their comments mostly targeting future issues of the report. The TYNDP package has also been updated with the most recent information related to the German national development plan in consultation. (Provisional data was introduced in the project submitted to consultation and the final TYNDP needed only to be marginally adapted.)

1) The Strategic Environmental Assessment of projects is available at national level and is not recalled here.

3 Assessment of TYNDP 2010

This chapter deals with the evolution of projects planned in TYNDP 2010. It compares the evolution of the table of project in Appendix 1 of the TYNDP 2010 and TYNDP 2012 reports.

3.1 Robustness of the TYNDP 2010 Investment Portfolio

The structure of the table of projects has evolved compared to the TYNDP 2010, especially based on stakeholders' feedback:

- The investments items are now clustered into larger projects to display both a synthetic technical description of every investment item and the cost benefit analysis of every project.
- The labeling build on the investment items' references supplied in the TYNDP 2010 report. Additional investment items are labeled "Axxx".
- A specific column monitors the evolution of every investment item from TYNDP 2010 to 2012.

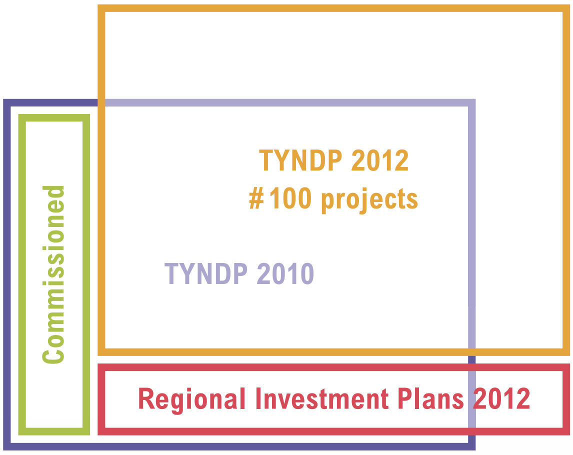


Figure 3.1:
Evolution of projects from TYNDP 2010 to TYNDP 2012

Figure 3.1 illustrates the evolution of the TYNDP Project table between the 2010 and 2012 publications.

Out of 495 investments items presented in the TYNDP 2010

- about 75% are present in the pan-European TYNDP 2012 report,
- 51 have been commissioned to date (12 have been partly commissioned, 25 are expected to be commissioned in 2012),
- 126, expected to be commissioned after 2012, are now presented in the Regional Investment Plans 2012[1] and
- 12 have evolved in their design or have been entirely substituted (the correspondence can be monitored in the table of project "status evolution from 2010 to 2012")

27% of the investments in the pan-European TYNDP report 2012 have been newly introduced. This figure compares to the 16% of the investment planned in the TYNDP 2010 that are now completed or about to be completed. This is a relatively normal turn-over although a bit high, but matching the evolutions of investment needs in Chapter 6. These figures show both the robustness of the TYNDP 2010 which is here confirmed and that the TYNDP is a living process.

[1] 25 new investment items have been introduced in addition in the Regional Investment Plans 2012.

In total, 503 investment items are now clustered into a few more than 100 projects of pan-European significance (see Chapter 7 and Appendix 1 for more details).

3.2 Monitoring of Projects of TYNDP

51 investment items have been completed. The following chart shows the progression of all the projects detailed in the TYNDP 2010 that are still to be commissioned, in order to illustrate whether the stated delivery timescales for the investments have been met.

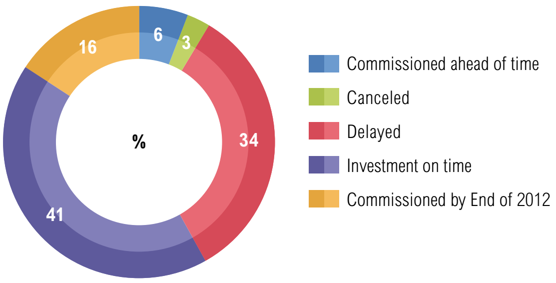


Figure 3.2:
Monitoring of projects of TYNDP 2010

6 % of the investments are ahead of schedule. This is mostly the case of investments where consensus among stakeholders has been reached earlier than expected: the business plan has hence been validated earlier enabling to entering the permitting phase.

More than 55 % remain on track. It can be generally concluded that good progress has been made as the delivery timescales for the projects move from the long-term to the mid-term.

That withstanding, there has been **material delay to the delivery of one third of the investments, mostly because of social resistance and longer than initially expected permitting procedures**, possibly leading to project reengineering. For example, some sections of new proposed overhead power line routes have had to be substituted with the use of underground cables. The phenomenon is not specific to certain countries or regions. On average, delayed investments are delayed a bit longer than 2 years.

4 Methodology for TYNDP 2012

4.1 Market and Network Integrated Modelling

ENTSO-E developed for the present TYNDP 2012 the target-methodology introduced in Chapter 8 of the TYNDP 2010.

As summed up in the figure below, the top-down target methodology breaks down into 4 steps, detailed hereafter:

The present chapter deals with the specific methodological features developed for the TYNDP 2012. Generic planning standards are presented in Appendix 3.

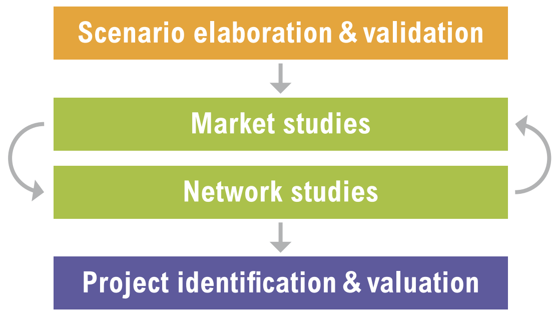


Figure 4.1:
Overview of the general methodology

4.1.1 Scenarios to Encompass Possible Futures

The first step is the construction of scenarios (see definition in Appendix, § A2.3). Each scenario must show intrinsic logic and consistency, especially a valid generation adequacy[1] and all scenarios must encompass all foreseeable futures. Scenarios are built for the entire Europe to ensure global consistency. They comply with visions until 2030 in order to provide longer-run perspective. They have been publicly consulted.

The reference scenario for the TYNDP 2012 is the Scenario EU 2020, and all results are presented by default for this scenario. It is a top-down scenario, deriving from the policy goals the EC and Member States[2] set themselves for 2020. The other basic scenario, Scenario B, derives from a bottom-up approach, based especially from presently known intentions of market players. The scenarios eventually rather converge, showing shared consensus regarding the achievement of the European 20-20-20 objectives.

Variants of these scenarios may have been analyzed additionally, to accommodate specific local options whenever needed. Especially, sensitivity to the shut-down nuclear power plants has been considered.

Scenarios are synthetically presented in Chapter 5 and detailed in the SOAF 2012.

1) A generation adequacy study answers the question "is there going to be enough capacity in the future to cover the demand?", basically regardless of price issues.

2) National Renewable Energy Action Plans

4.1.2 Market Studies to Derive Economic Balances

For every scenario, a market study answers the question "which generation (location/type) is going to serve which demand (location) in any future instant?". Their outcome is market balances in every country/price zone and especially generation, and exchange patterns ("Bulk Power Flows").

To perform a market study, the demand must be modeled, and usually as dependent on weather conditions. Additionally, generation connected to the distribution level, and thus seen as negative demand from TSOs, or smart grids may lead to the need to enrich this model. At the same time, the generation features (especially a cost function) must be modeled, and these depend on several parameters such as raw material prices, financial situation, geopolitical evolutions, meteorological conditions etc. Systems experiencing energy constraints, as for example those with significant part of hydro storage capacities, need to adopt annual or pluri-annual scopes in order to take into account time of production optimization.

The modelling of all market components' behavior is thus huge. Most market study tools rely on probabilistic modelling. Conversely, the modelling of the transmission grid itself must rely in most cases on a 1-node-per-country (or price zone) principle with simplified transmission capacity limitation modelling between the nodes. Because of computation limitations, available tools show different trade-off with more or less detailed modelling of every market item versus network feature. They have been developed to match specific characteristics of hydro-systems here or delicate thermal unit commitment there.

ENTSO-E thus organized for the elaboration of the TYNDP 2012 the possibility to run in parallel several market study tools at regional levels, in order to better adapt to specifics of every region on the one hand, and mutually challenge the models to derive more robust results. The variety of outcomes of market studies are presented in Regional Investment Plans. All the simulations however are derived from a single database depicting the scenarios to ensure consistency between all six European regions.

4.1.3 Network Studies to Assess Grid Transfer Capability

Network studies answer the question "will the dispatch of generation and load given in every case generated by the market study result in power flows that endanger the safe operation of the system (accounting especially for the well-known N-1 rule)?" If yes, then transmission projects are designed, tested and evaluated for all relevant cases. Studied cases explore a variety of dispatch situations: frequent ones, or rare ones but resulting in particularly extreme flow patterns. A limited set is chosen to map the whole range of situations identified in the market studies.

Inputs to common network studies are default pan-European Power Systems Models (PSMs), where the specific generation and load dispatch stemming from the market studies is blended. PSMs are datasets, depicting transmission assets, with default topology and an "example case". ENTSO-E regularly organizes data collection to update and make available to all TSOs these basic datasets.

The methodology for network studies is depicted in Appendix 3, Guidelines for Grid Development. Basically, network studies help assessing the grid transfer capability, and its increase enabled by transmission projects. This output of the network studies can be retrofitted in market studies to assess improvement brought by the enhanced grid to the market.

Market studies (assessment of all cases with simplified grid description) and network studies (extensive grid description for one particular case) are thus duals. They are wisely articulated in a two-step, iterative process in order to ensure consistency and efficiency (every concern being properly addressed with the appropriate modelling) and to avoid too complex all-in-one black-box models either too complex to run or lacking detailed enough modelling of some aspects.

4.1.4 An Explicit and Practical Valuation of Projects

The network value develops from the combined action of all grid assets interacting with each other. Stakeholders wished to get a better idea of how the proposed investments interact. Isolating objectively the specific impact of every investment is, however, very complex because of the network effect.[1)]

The presentation of projects in the TYNDP 2012 has hence been reshuffled to display both a synthetic technical description of every project item and the cost benefit analysis of every project.

Transmission projects are valuated against the following multi-criteria scale developed by ENTSO-E (**see Appendix 3 for the definitions**).

Grid transfer capacity increase:	**+ … MW**
Socio-economic welfare:	
RES integration:	
Improved security of supply:	
Losses variation:	
CO_2 emissions mitigation:	
Technical resilience:	
Flexibility:	
Social and environmental impact:	
Project costs:	

Table 4.1:
Principles of multi-criteria assessment of projects of pan-European significance

Projects basically improve the grid transfer capability and an assessment of the grid transfer capability increase is provided for every project. All other dimensions are assessed via 3-level indicators:

- The social and economic welfare indicator, the RES integration indicator and improved security of supply values the benefits of the projects in the 3 dimensions of the EU energy policy:
  - Market integration,
  - RES development and
  - Security of supply.
- The RES integration, losses variations and CO_2 emissions variation indicators value the benefits with respect to the three pillars of the 20-20-20 policy.
- The technical resilience and flexibility indicators refer to the technical performance of the assets in the grid.
- The social & environmental impact completes the costs, date of commissioning and the status of the project as well as show risks attached to the project completion.

1) Schematically, the added value of all assets is greater than the sum of their individual values, ceteris paribus.

The assessment of the benefits compares the situation with and without the projects, ceteris paribus.

4.2 A specific, Top-down, Europe-wide Coordination

This new top-down methodology represents a great improvement compared to the previous release of the TYNDP. The whole process has been implemented for the first time, by ENTSO-E and all 41 TSOs members to deliver the TYNDP 2012 package, involving huge amounts of data and new models.

ENTSO-E is already building on the gathered feedback to strengthen all the involved procedures and further improve the methodology implementation. The goal is threefold:

1. To accelerate and strengthen data collection, consistency checks and processing,
2. to facilitate common model calibration and
3. to coordinate regional groups, articulate pan-European and regional assessment and merge all results consistently.

The quality of the integrated market and network modeling described supra relies on the knowledge of all specific features of every local power system in Europe as well as the resulting ability to master and cut aptly through numerous uncertain parameters. The aim is to model properly every grid concern in a limited timeframe of 2 years, and hence valuate correctly more than 100 projects all over Europe.

ENTSO-E hence devised specific top-down coordination, both relying on common standards and subsidiarity to take advantage of TSOs' local expertise and workforce:

- 1 working group coordinating the TYNDP 2012 delivery and 3 working groups of key-experts to set up methodologies and organize data framework, for planning standards, scenarios and market studies, power system models.
- 6 regional groups, gathering TSOs experts, jointly performing regional analyses, sharing views, mutually challenging and jointly building solutions, each group able to focus on the specific concerns of their area.

As a result, about 200 people in Europe contributed to the TYNDP 2012 package. Be they all thanked for their commitment

5 Scenarios

This chapter deals with the assumptions used to develop the results presented in the TYNDP 2012 package. The presented material gives the main conclusions of the SOAF 2012 report and the market studies that have been carried out in the Regional Investment Plans.

5.1 Long-term Visions and Scenarios

The development of the transmission grid requires a long-term vision that is robust for relevant developments that determine the future use of the grid. In the **SOAF 2012 report** the pan-European **ENTSO-E energy visions** for 2030 are presented. In these four visions, four credible, coherent and consistent energy projections until the year 2030 are described. Although 2030 is beyond the scope of this TYNDP, these visions are the background against which the ENTSO-E scenarios will look at in the future.

The SOAF 2012 report presents an update of the scenarios that were developed in SOAF 2011, have been publicly consulted and commented on in the first semester of 2011, and used as bases of the analyses. The re-stated decision of German government regarding nuclear phase-out plans led ENTSO-E to test a sensitivity to the presence/absence of nuclear units in this country in order to ensure robustness of the results.

Two pan-European scenarios were established to assess the system adequacy in this TYNDP. The two scenarios, being Scenario EU 2020 and Scenario B, describe different paths of relevant parameters until the year 2020.

- In the Scenario EU 2020, the European 20-20-20 objectives and the NREAPs[1)] were the starting point and the necessary evolution towards this target has been filled in (top-down). The Scenario EU 2020 is used as the reference scenario and reported by default.
- For Scenario B the present situation is taken as a starting point and the future developments are extrapolated until 2020 based on the best estimate (bottom-up).

1) National Renewable Energy Action Plans,
each EU member state published the roadmap towards the European 20-20-20 objectives.

Toward a sustainable future

As the European Commission is preparing a directive to make a further step in improving energy efficiency in a context where energy represents around 80% of the greenhouse gas emissions, TSOs are enlarging their approach to better contribute to energy efficiency. TSOs cannot directly control the use of energy by end-users: however, they can contribute by enabling the use of new technologies or concepts such as efficient generation, demand side management, smart grids and energy storage.

TSOs support energy efficiency, considering the following criteria to qualify the efficiency of energy:

- Environmental footprint (CO_2, renewability)
- Affordability
- Reliability and availability
- Losses

Thus, with their efforts to develop their transmission network in order to enable renewable energy sources to evacuate their power, TSOs play an active and positive role in realizing environmental neutral generation. The market-focused tools developed by TSOs make it possible to lower the use of expensive electricity generation when the consumption decreases, which participates in the economic aspect of energy efficiency. By developing their network, TSOs enable the use of new power plants, which in major cases generate electricity with a better efficiency than older ones. By this, more efficient and affordable generation becomes available to a larger market.

Of course, TSOs have been fighting to control their energy losses for long, for these weigh directly on TSOs' energy efficiency as well. It seems useful to remember at this stage, that with constant levels of transit (generation and consumption remaining equal), network development (new lines) implies less losses (though a low effect), thus a higher energy efficiency…
However, the current main driver for new corridors is usually the need for more transit, with connected losses. The transmission of electrical energy introduces losses that increase with the magnitude of the flow and the distance of the transport. TSOs have been spending much effort to reduce the losses as much as possible by using extra high voltage.

As the TYNDP includes numerous projects either dedicated to connecting new renewable energy sources, or more energy-efficient power plants, or bound to transporting this efficient energy t owards consumption areas, grid development projects play a major role on the way to the 20% energy-saving target.

The evolution of new generation in the top-down scenario is interpolated between the current situation and the end vision: therefore information about the location of new generation must be also assumed top-down, whereas in the bottom-up scenario the evolution of the system derives from market players' known intentions, and the location of new generation match them.

5.2 Renewable Energy Boom by 2020

In the SOAF 2012 report, a projection of the evolution of load and generation are presented. In Figure 5.1 the generation mix for 2012 and 2020 is displayed.

The total of installed capacity will increase by 250 GW, i.e. by 26 %, to reach 1214 GW. This increase is mainly due to wind and solar generation which will be developed by 220 GW by 2020. These generation technologies are by nature not controlled and the power system will have to adapt to greater RES outputs. Scenario B also shows a significant RES development, but about 22 GW lower than Scenario EU 2020. The installed capacity of fossil fuel units increases by 14 GW in Scenario B, while in Scenario EU 2020, it slightly decreases (2 GW).

In parallel, the total system peak load will continue to increase, between 2012 and 2020, by about 30 GW and will reach 567 GW in the reference scenario. New conventional generation develops in pace with the load growth. The overall generation adequacy is therefore assumed to be ensured by the end of the coming decade. (More details are available in the SOAF 2012 report.)

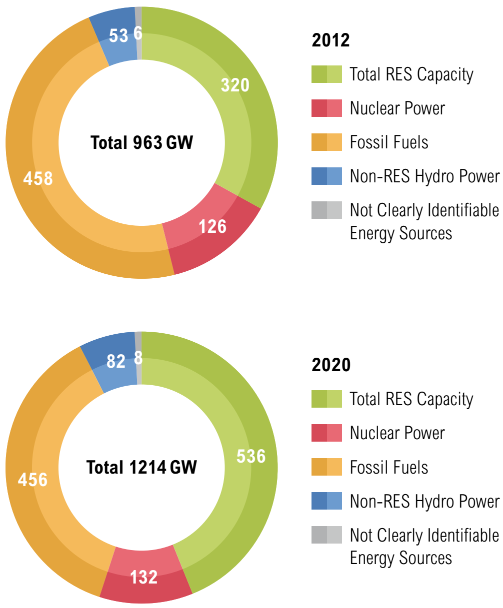


Figure 5.1:
Evolution of the generation mix, Scenario EU 2020

5.3 European Power Exchanges by 2020

Market studies have been conducted to simulate the behavior of the power system by 2020 (see Chapter 4). All situations likely to occur during the 8,760 h of the year have been analyzed. The following map synthesizes the results, displaying for every border the magnitude of the energy exchanged in every direction; and for every country the magnitude of the net yearly energy balance.

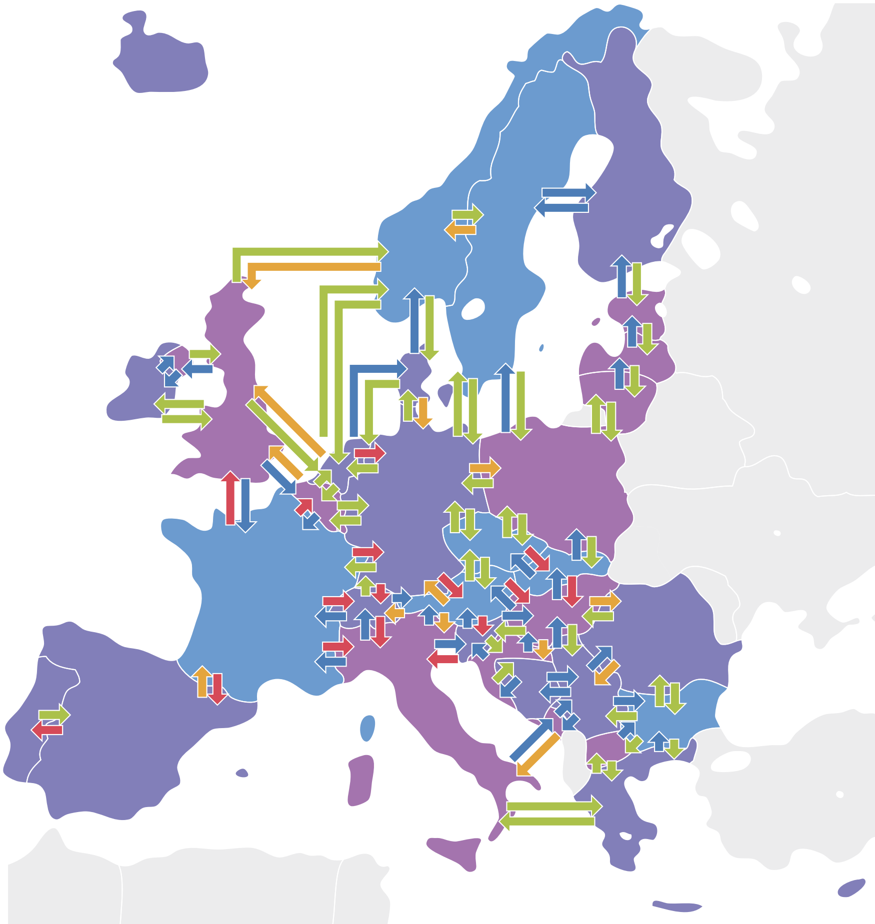


Figure 5.2:
Power exchanges patterns[1)] in 2020 between ENTSO-E countries

France and Scandinavia are the biggest exporters and the United Kingdom, Italy, Poland, Belgium and the Baltic States have a clear import position. Other countries such as Spain or Germany show a rather balanced position on average, but can experience significant bidirectional flows to neighboring countries due to the intermittency of RES.

1) The annual power flows shown on the map do not reflect actual physical power flow on the grid but simplified expected commercial exchanges.

6 Investment Needs

Once scenarios have been defined, the next phase in network planning consists of characterizing the **Investment needs**, i.e. every concern ahead on the regional grid and of European significance, and which are likely to trigger extra-high voltage grid investment in order to restore the grid ability to fulfil the duties and services expected from this infrastructure.

Investment needs are described in the present Chapter 6, before solutions to accommodate them are summed up in the next Chapter 7.

6.1 Present Situation

Figure 6.1 depicts cross-border transfer capacities nowadays.[1)]

The map shows diverse level of Net Transfer Capacities (NTC) in Europe. These discrepancies basically match the geography and demography of Europe: highest NTC levels (and highest grid density generally) are met in the central part of the continent where there is also the highest population density (and hence higher consumption, and installed generation), from London to Milan. Southeast Europe also shows a consistent pattern with similar interconnection capabilities all across the area, but at a globally lower level than in more densely populated areas.

1) Source: www.entsoe.net

Figure 6.1:
Illustration of Net Transfer Capacities in Europe (summer 2010/11)

6.2 Drivers of Power System Evolution

Drivers for grid development directly derive from the three pillars of EU energy policy goals:

- Security of supply,
- Renewable energy integration and
- Internal Market integration.

Figure 6.2 shows the main primary drivers[1] for grid development in Europe in the coming decade (see definition in Appendix 2, §A2.4):

- Large amount of RES spread all over Europe, with concentration in Iberian Peninsula, in the south of Italy, and North Seas neighboring countries. About 220 GW of new RES generation are foreseen (see SOAF 2012 report).

- Power plant decommissioning[2]: about 25 GW of nuclear capacity is scheduled to be shut down from 2010 to 2020, especially in Germany (16 GW) and the UK (7 GW). Obsolete coal-fired power plants are also scheduled to be shut down in order to meet environmental standards, especially in the UK (9 GW). The decommissioned power plants were mostly located relatively close to the most populated areas in Europe, possibly resulting in security of supply issues.

- In total, about twenty large areas (shown by amber dots) with specific supply are at risk unless transmission capabilities are improved or local generation develops.

- The relatively low interconnection of Baltic States regarding neighboring EU states.

- Cyprus and Iceland are island systems. No interconnectors with other ENTSO-E countries have been considered in the TYNDP package 2012.

---

1) As the case may be, any other investment needs (ageing of equipment, reliable grid operation, decommissioning of smaller units, etc.) are shown in Regional Investment Plans.

2) To clarify the picture, only decommissioning of power plants larger than 1 GW that are not replaced on site by new generation – and changing hence the power flow patterns – are described.

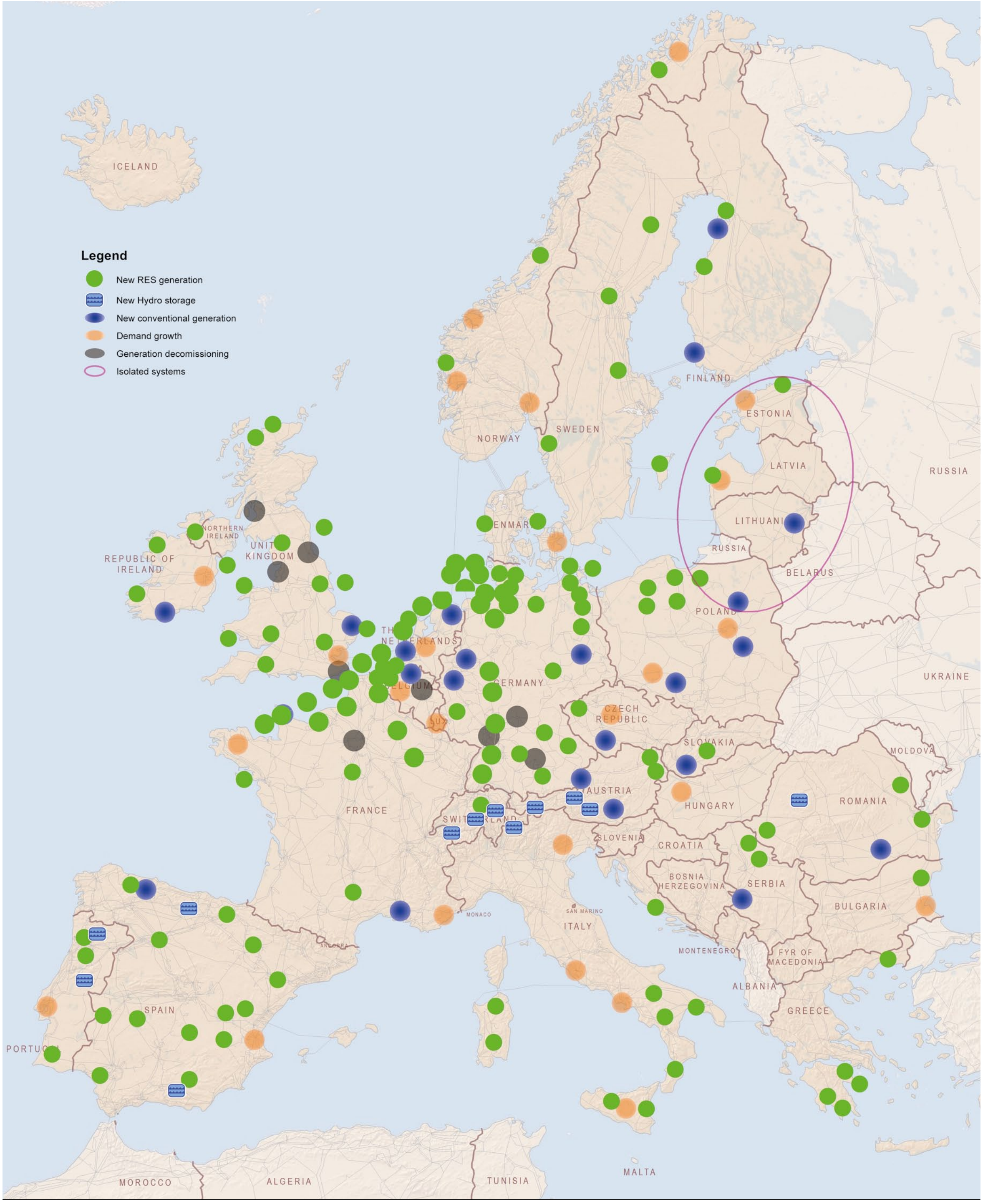


Figure 6.2:
Grid development drivers

6.3 Main Bottlenecks Possibly Developing in the Coming Decade

As a result of the market and network study process, almost 100 possible bottlenecks have been identified in Europe in the coming decade (unless new transmission assets are developed).

Figure 6.3 shows their location, i.e. the grid sections (the "boundaries"), the transfer capability of which may not be large enough to accommodate the likely power flows that will need to cross them unless new transmission assets are developed.

In order to ease the understanding, the likely bottlenecks have been sorted according to three types of concerns:

1. Security of supply when some specific area may not be supplied according to expected quality standards and no other issue is at stake,
2. generation direct connection and
3. market integration, if inter-area balancing is at stake, distinguishing what is internal to a price zone and what is between price zones (cross-border).

NB: when a boundary can be flagged with more than one concern, then, somewhat arbitrarily, Market integration prevails over Generation connection and security of supply.

- About 60 % the boundaries are primarily related to market integration issues, 40 % cross-border and 20 % internal. Most present cross-border congestions can be recognized on the map, as they would just develop unless new grid assets are implemented.
- About 30 % are primarily related to generation direct connection.
- About 10 % are primarily related to security of supply issues.

Figure 6.3:
100 main bottlenecks in Europe in 2020

6.4 Expected Bulk Power Flows by 2020

A **Bulk Power Flow** is the typical power flow triggering grid development across a boundary. They are quantified in the following sections for every concern. Bulk Power Flows range from about 500 MW to more than 10,000 MW.

6.4.1 Generation Connection

The map of generation integration (Figure 6.4) shows the boundaries that are related to direct connection of renewable or conventional facilities to the grid. It highlights

- higher Bulk Power Flows (amber and red) where there are big concentration of new generation
  - developing in a limited area, especially offshore wind in the North Sea or
  - adding up to already large concentration of generation (Scotland, Wales, Alps, Rhone Valley),
- lower Bulk Power Flows (blue and green) where large amounts of RES develop where relatively little generation was installed – in Ireland, Portugal, Spain, southern Italy, Greece, Bulgaria and Romania, Poland, and Nordic countries – and
- lower Bulk Power Flows (blue) where large power plants are planned in Germany, Poland, Lithuania, and Finland.

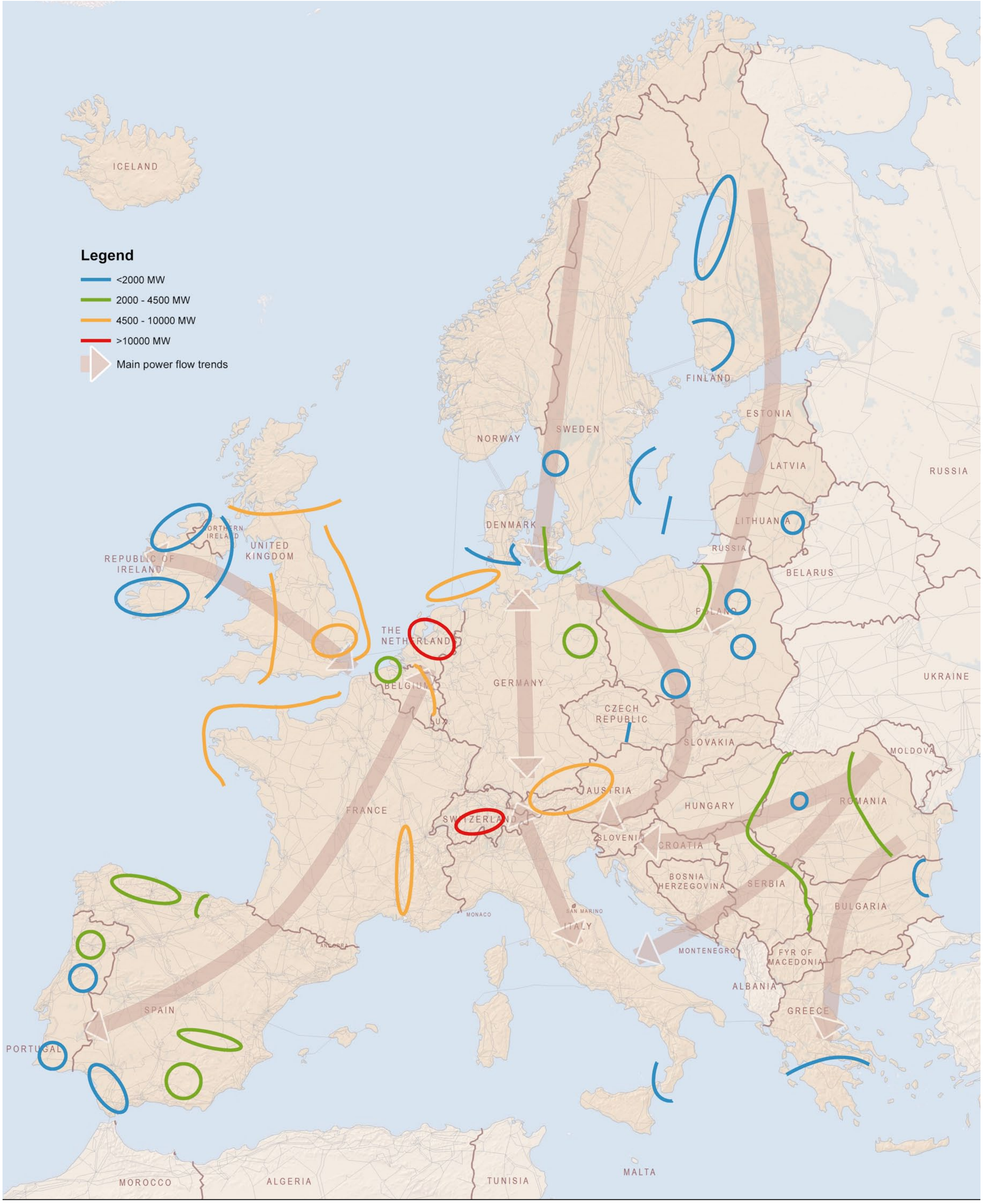


Figure 6.4:
Bulk Power Flows related to generation connection

6.4.2 Market Integration

Figure 6.5 displays market integration concerns.

The map shows:

- Relatively larger Bulk Power Flows in the heart of Europe than on the periphery of the continent. This is a rather mechanical result: the area spreading from Benelux to the Alp region is denser, and geographically located at the crossroad of the European power system compared to other countries.
- Compared to other peripheral areas, Ireland and the UK show remarkably higher Bulk Power Flows (amber rather than green or blue). The generating fleet will experience a deep renewal, and obsolete nuclear and coal-fired power plants will be substituted especially by wind generation. As all wind turbines in the area show very correlated output profiles, large surpluses or deficits are likely and hence more variable exchange patterns with mainland Europe.
- The largest Bulk Power Flows related to market integration are located in the central part of Europe, and are oriented north south between
  - generation concentration along and off the North Seas shores and high RES development in southern Italy,
  - large consumption areas (Benelux, Paris area, south of Germany, North and Central Italy, Mediterranean Sea shores from Spain to Italy) with relatively low installed generation (and even lower with unit decommissioning) and
  - hydro storage in Scandinavia and the Alps, with pumping capacity.
- From north to south, the power system alternatively shows generation and consumptions areas. As a result, the power flows are large, but also more volatile than today: for instance, in summer the southern part of Germany will show surpluses every day and deficits every night.
- On a parallel corridor, there are much larger north-south flows in Baltic States, Poland and Central-East Europe than the present transfer capability of the grid allows for.
- There are much larger east to west and south flows in southeastern Europe than the present transfer capability of the grid allows for.

Figure 6.5:
Bulk Power Flows related to market integration

6.4.3 Security of Supply of Large Areas

Figure 6.6 locates and quantifies all security of supply concerns.

The analysis shows very different issues:

- Supply of large cities or urbanized areas (Lisbon, Catalonia, French Riviera …),
- countries with a negative generation adequacy forecast (Belgium, Luxembourg) requiring additional cross-border transmission capacity[1],
- regions within countries with a negative generation adequacy forecast (south of Germany, Brittany, Northwest Hungary, northern Norway) requiring additional transmission capacity and
- Baltic States requiring a higher interconnection with EU countries to ensure their supplies.

---

[1] See SOAF 2012. Conversely, when the generation adequacy forecast of a country is acceptable without accounting for import capacity, no security of supply issue is marked on the map. The country may however require imports to mitigate electricity prices. Italy is an example of such situation.

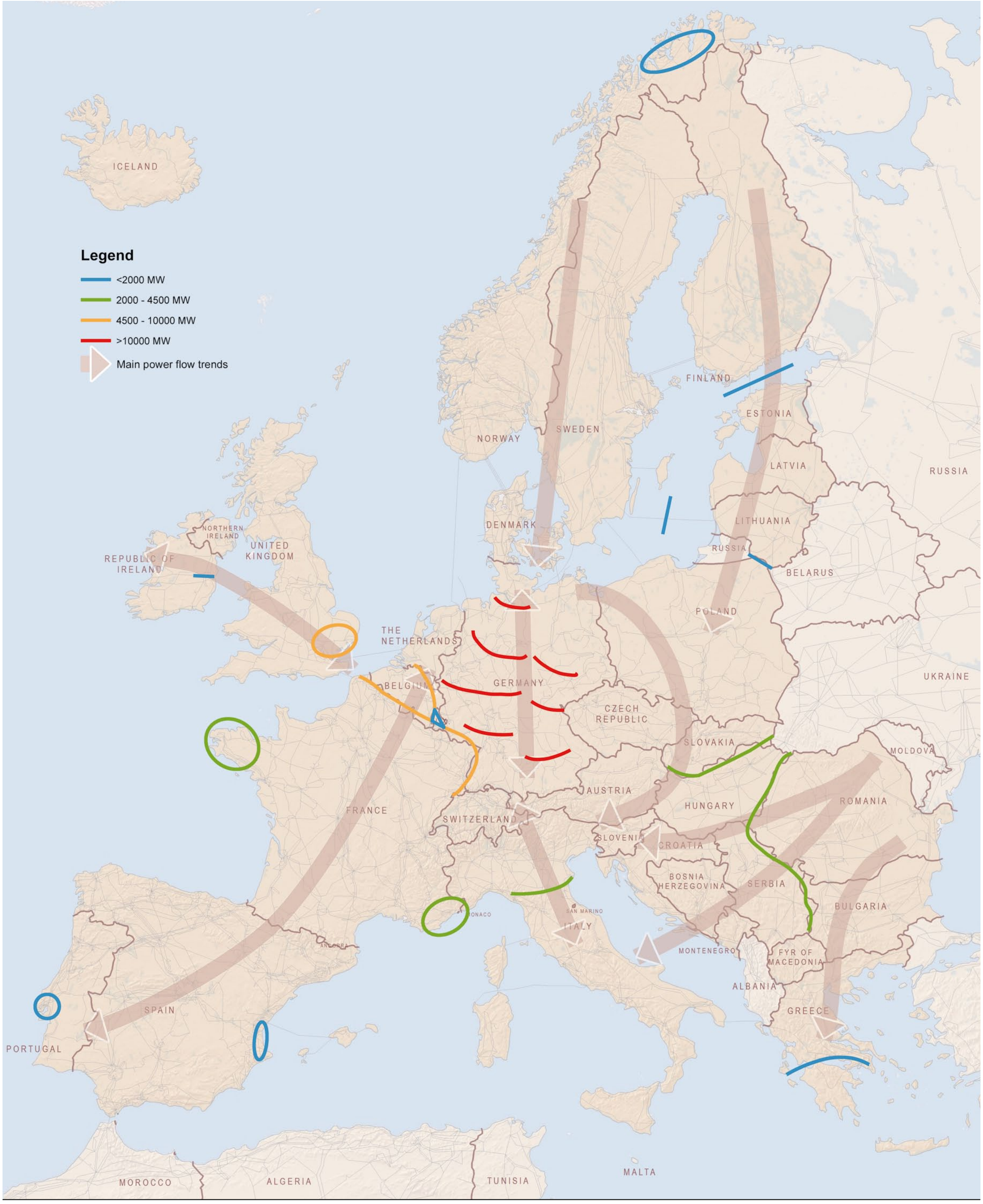


Figure 6.6:
Bulk Power Flows related to security of supply

6.5 RES Integration as the Major Concern

The breakdown into security of supply, generation connection and market integration in chapter 6.4 is useful for better understanding and comparisons of every single concern.

However 80 % of the bottlenecks are directly related to RES integration (see Figure 6.7), either because direct connection of RES is at stake or because the network section or corridor is a key-hole between RES and load centres. The north-south internal corridors in Germany are typical example of the latter. The Map displays the overall picture, with, in lighter green the boundaries related to the accommodation of inter-area transits triggered by RES and in darker green the boundaries related to direct connection of RES generation (or to both concerns as the case may be).

The massive development of RES is the main driver for larger, more volatile power flows, over larger distance across Europe, mostly north – south from Scandinavia to Italy, between mainland Europe and the Iberian Peninsula, Ireland and the UK or east to south and west in the Balkan Peninsula.

The next Chapter 7 deals with grid investments that are hence needed to avoid present congestion to worsen and new congestion to appear.

Figure 6.7:
RES Integration is the major concern for grid development

7 Projects of pan-European Significance

To solve all investment needs identified for the coming decade in Europe, the European TSOs evaluated in collaboration numerous grid reinforcements.

The pan-European TYNDP report focuses on **projects of pan-European significance** (see definition in Appendix 2, § A2.5). Projects with more regional (resp. national) focus are presented in the ENTSO-E Regional Investment Plans (resp. National Development Plans).

Every project of pan-European significance is listed, described and valuated in Appendix 1. The present Chapter provides an overall view about the projects, their costs and benefits.

Projects promoted by 3rd parties

In order to deliver the most comprehensive and up-to-date outlook of the electricity grid by 2020 and beyond, ENTSO-E, based on the stakeholders' feedback to the TYDNP 2010, elaborated and made publicly available in February 2011 as part of the TYNDP development process, a procedure for the inclusion of the third party projects in the 2012 release of the TYNDP:
www.entsoe.eu/system-development/tyndp/tyndp-2012/

ENTSO-E received five submissions, analyzed in every relevant Regional Group. The candidate projects however did not demonstrate evidence of a transmission license or an exemption for such license granted by the relevant national regulatory authorities and the EC, in accordance with the TYNDP procedure. The non-discrimination principle (especially with regard to similar projects that may not have applied for inclusion for this reason), makes it inappropriate for these five projects to be incorporated in the table of projects of the TYNDP 2012 package.

Some stakeholders commented in the consultation process that the procedure was too stringent and therefore the 3rd party procedure will be modified for the next TYNDP 2014, consistently with the procedure proposed by the EC to identify future Projects of Common Interest.

7.1 Grid Development Projects of pan-European Significance are Needed all over Europe

The following two maps geographically display all investments item composing the projects of Pan-European Significance.

The first map (Figure 7.1) shows all projects commissioned mid-term, i.e. in the first five-year period of the TYNDP, from 2012 to 2016.

The second map (Figure 7.2) shows all projects commissioned in the longer run, i.e. from 2017.

The maps show basic information regarding location, routes and technology (AC or DC, voltage level). When the precise location of an investment is not yet known, the area where the investment is likely to occur is colored. The investment labels ease the correspondence with the table of projects in Appendix 1.

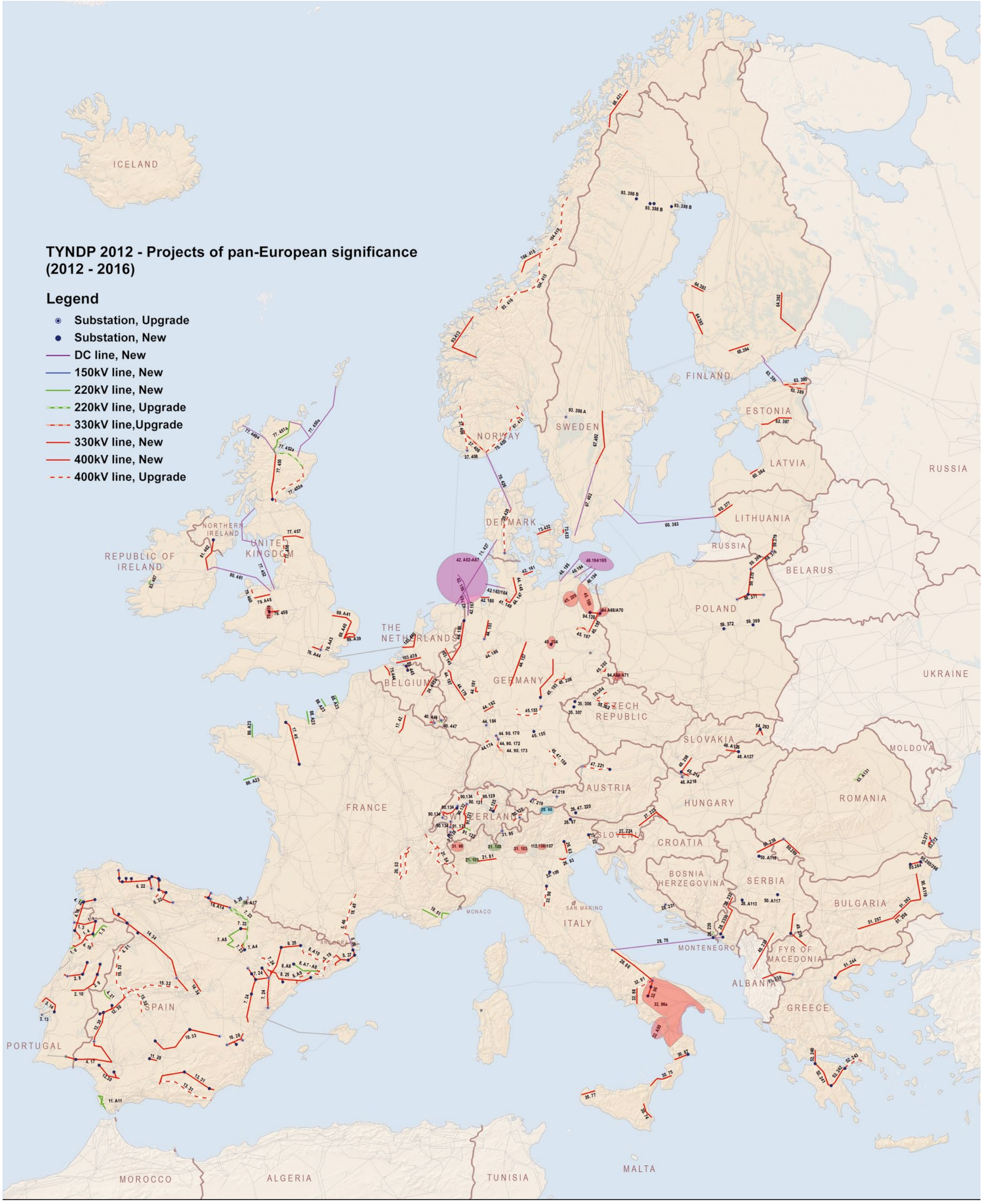


Figure 7.1:
Projects of pan-European significance mid-term (until 2016)
(a larger print of this map is inserted at the end of this report)

The maps show **projects of pan-European significance basically planned all over Europe**, with a relative balance between long-term or mid-term. Projects are rather well defined for the coming five years. Longer-run projects may still be in planning or design & permitting phases: they may not be precisely designed and located yet, and several options might still be envisaged for some of them.

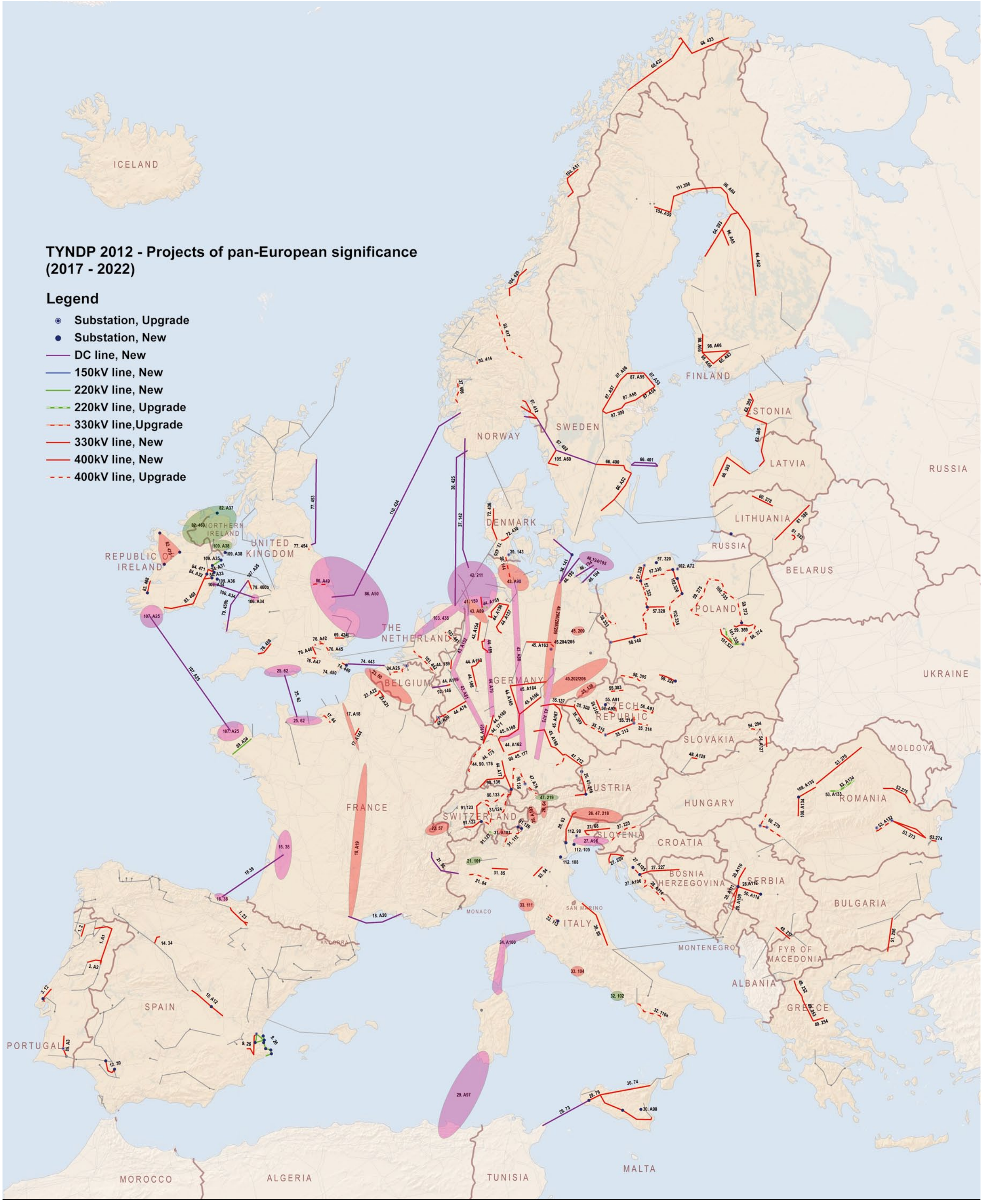


Figure 7.2:
Projects of pan-European significance long-term(as of 2017)
(a larger print of this map is inserted at the end of this report)

NB: compared to the version submitted to consultation, the final version of the TYNDP 2012 report has also been updated with the most recent information related to the German national development plan in consultation. (Provisional data was introduced in the project submitted to consultation and the final TYNDP needed only to be marginally adapted.)

7.2 Over 50,000 km for Grid to Build or Refurbish in the Coming 10 Years

Over 100 transmission projects of pan-European significance have been identified to address and solve the above-mentioned concerns in the coming decade. (Among them, 40 % interconnectors).

As displayed in Figure 7.3, projects of pan-European significance total about 52,300 km of new or refurbished Extra High Voltage routes.[1] The expected commissioning dates are split rather equally between the two 5-year subperiods.

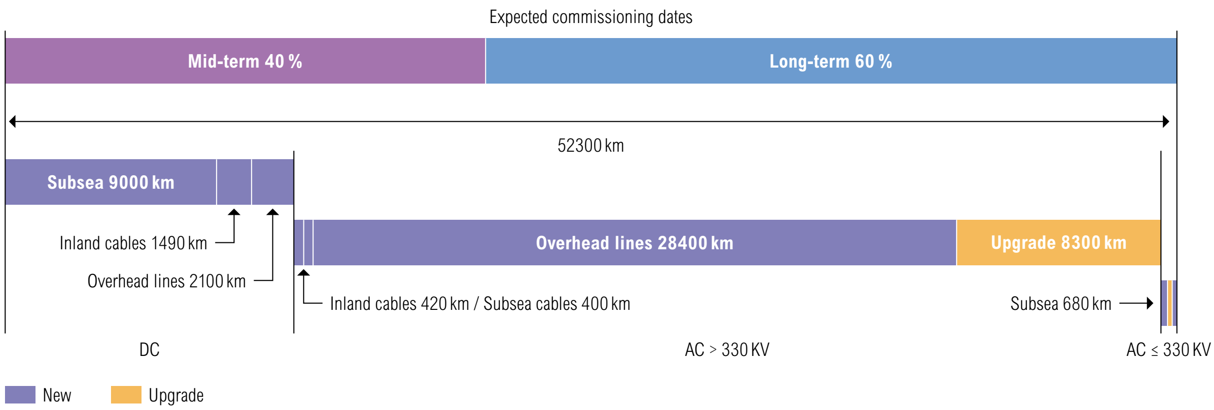


Figure 7.3:
Projects of pan-European significance – volumes

The TYNDP 2012 figures represent a 25 % increase compared to TYNDP 2010, with especially **individually long-stretching new investments**:

- +3,000 km of subsea routes are envisaged,
  developing in total 10,000 km of **offshore grid key-assets**.
- +7000 km of routes are considered inland,
  mostly to bring to load centers the power generated on the outskirts of the European territory.

The vast majority of project (around 39,000 km) use the common HVAC technique. This is the common technical standard in Europe for electricity transmission and is a well-established technology. In addition, about 12,600 km of HVDC links are planned. Most relate to subsea investments where AC technology is no option. Several HVDC interconnection projects are however considered inland with parallel operation with HVAC lines.

[1] Compared to the existing grid length of about 305,000 km.

1,080 km of HVAC subsea cables, at 150 kV or 220 kV are also planned, mostly for offshore wind connection.

Over 82 % of the investments correspond to new equipment/routes and 18 % to refurbishment or upgrade of existing assets.

7.3 Grid Transfer Capability Increase by 2020

As developed in Chapter 6, the challenge of the coming decade is to face larger and more volatile power flows across larger distance in Europe. The proposed grid reinforcements hence focus on Grid Transfer Capability (GTC) increase.

The GTC increase enabled by every project is presented in Appendix 1. Figure 7.5 synthesizes the outcome across all boundaries in Europe. The values of gained GTC are oriented by needs and cover a huge range of transmission capacity increase efforts: projects of pan-European significance are very diverse, adapting to the very specific geography they are inserted in. They develop GTC ranging from a few hundreds of MW to more than 4 GW. Globally, greater GTC increases are developed basically where higher power exchanges are expected.

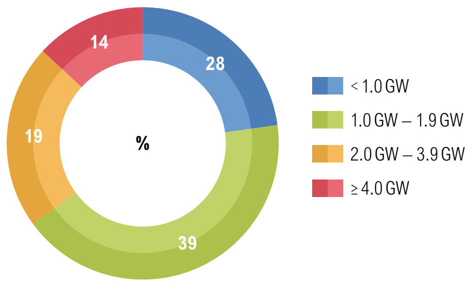


Figure 7.4:
Grid Transfer Capability increases breakdown

Larger GTC increases correspond to situations where parallel investments combine their effort across a large boundary where large Bulk Power Flows are expected (for instance, between Ireland and the UK and mainland Europe). Lower amounts correspond to more specific situations (new power plant connection for instance).

Figure 7.5:
Grid Transfer Capability increases

7.4 Projects Benefits

The projects' impacts were assessed by the multi-criteria assessment developed by ENTSO-E (see Appendix 3) to show the benefits of each project.

7.4.1 A Direct Support to the EU Energy Policy

The charts shown (see Figure 7.6) illustrate the magnitude of support given by the projects to the EU energy policy. The corresponding benefit is considered in terms of four criteria:

1. Social and Economic Welfare,
2. RES Integration,
3. security of supply and
4. CO_2 Emissions Mitigation.

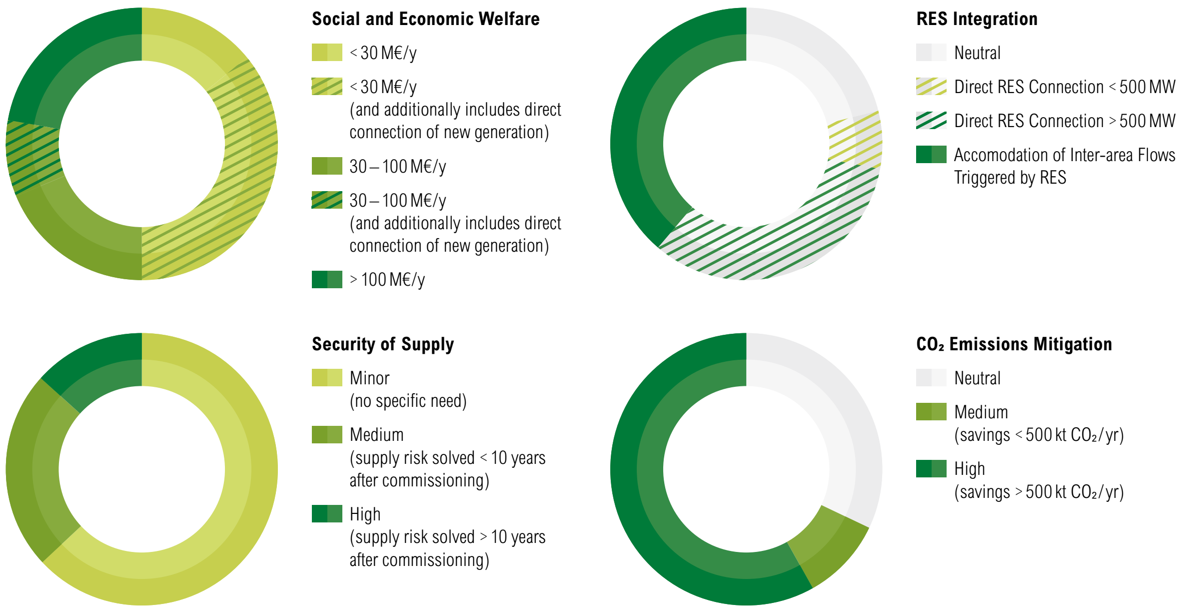


Figure 7.6:
Projects of pan-European significance – contribution to EU energy policies

As a result of the strict criteria applied[1)], the **Socio-Economic Welfare** (SEW) indicator has a very strong correlation with market integration. High-marked projects correspond mostly to additional interconnectors with four network peninsulas: Ireland and Great Britain, Spain and Portugal, the Baltic States, and Italy.

80 % of the projects show high benefits for RES integration, half by directly connecting RES, and half by accommodating inter-area unbalances triggered by RES. Projects still marked low with respect to RES integration either contribute specifically to connecting nuclear or conventional generation or for securing the supply of load areas at risk.

With respect to the **security of supply,** 13 % of projects are classified as High, meaning the project will secure an area for at least ten years after commissioning. 24 % are classified as Medium, meaning the project will contribute to securing a specific area but for less than ten years after commissioning. (If more than one project is required to secure an area for more than ten years, then none can be individually classified as High. This is the case for projects securing Belgium and the Baltic States.)

All **projects reduce the CO_2 emissions** with the exception of a small number of projects that are solely for the integration of new fossil-fuel-fired power plants.

1) Warning: Low-rated projects regarding the social and economic welfare indicator also merge here key-projects for generation connection, thus triggering the social and economic welfare of the generation project itself.

7.4.2 High Technical Performance Standards

All the projects also display high technical performances (see Figure 7.7).

The charts for Flexibility and Technical Resilience illustrate that for such technical factors, for which a TSO has a wide degree of freedom to influence, very high performance can be achieved. This is in contrast to other objectives which are strongly affected by factors which cannot be significantly controlled by a TSO such as the location of generation.

In this latter respect, losses for instance depend on exogenous factors, and projects benefits in this respect are diverse (as explained in the insert next page):

- Positive for those merely improving the grid meshing,
- negative when connection of new remote generation is at stake and
- undetermined when the appraisal is more complex.

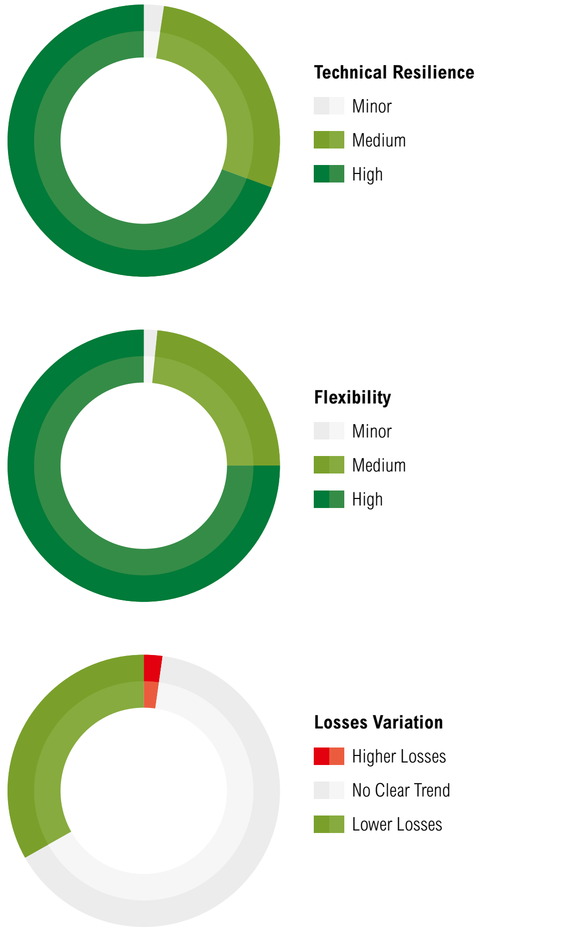


Figure 7.7:
Projects of pan-European significance – technical assessment

Grid losses variation

Transmitting electrical energy causes electrical losses, the more distance and the higher the energy, the higher the losses.

An efficient way to reduce losses is to operate the grid at higher voltage and thus reducing the electrical current. However, equipment for higher voltage is more costly and therefore an economic equilibrium between (investment) costs and benefit (reduction of losses) is chosen at the design of the extra-high voltage grid. Typically in Europe voltages of 400 kV and 220 kV are used to transport electrical energy over large distances. In itself the extra-high voltage grid is already designed to be as efficient as possible to minimize the overall costs.

The effect on overall losses of a single transmission line is fairly small; it should not be expected that the losses indicator in the TYNDP will reveal a major step in efficiency of the grid, the big step has already been made with the introduction of the extra high voltages. Some projects however can have a substantial positive effect on electrical losses.

The Assessment Alternatives

The assessment of the losses of a single project is not straightforward.
There are various perspectives and ways to assess the losses in the grid, all with other outcomes:

1. The project can be assessed by itself. This means that the amount of loss on the lines in the project can be evaluated. The effect on the other parts of the interconnected grid is neglected which would give a very narrow view on the effect of losses. The outcome of this indicator using this method for assessing would be that new projects will have losses, more or less depending on the project design; voltage upgrades of existing lines could reduce the losses.
2. The project can be assessed as a part of the European Transmission Grid. A comparison between the European grid with and without the project can be made without modifying the load and generation profile. In general this would mean that for a grid extension project the overall impedance would decrease and the losses would reduce; in case of decommissioning the losses would also generally increase.
3. The project can be assessed, taking into account its effect on GTC. In case a project increases the GTC on a specific corridor, more energy can potentially be transmitted along that corridor. This would potentially mean a different running arrangement for generators; an increase of generation in the congested area, and a decrease of generation in the non-congested area. A different GTC results in a different running arrangement of generators over the hours in the whole year. The two configurations are not easily comparable anymore. Therefore a planning case by planning case assessment of efficiency is not meaningful and year-round comparisons should be made. For instance, connecting offshore wind farms that would substitute fossil-fuel-fired units closer to load centres would result in higher losses on the total grid – in general only a marginal drawback compared to the total increase of social and economic welfare.

The assessment of the grid losses variation derives for every project from the most suitable approach considering its specific features.

7.4.3 A Difficult Social Acceptance of Projects

The social & environmental index measures the risk that a project might not be completed at the expected commissioning date. Results are displayed in Figure 7.8.

This indicator reflects the perception of risk, which may vary depending on every national context. Project promoters of course indicate low risk when the target date is still to be more accurately defined, in the long run; or when projects are under construction, and close to being completed. Conversely, projects in the permitting phase are almost all classified as Medium or High-risk.

See Appendix 4 for more details about social acceptance issues.

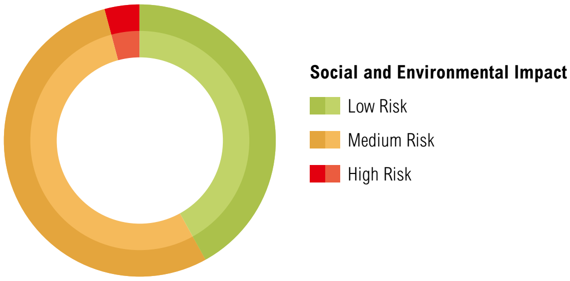


Figure 7.8:
Projects of pan-European significance – social and environmental impact

7.4.4 5 % of Savings in Generation Operating Costs

Comparing the power system costs to, on the one hand, present, limited, NTCs , and on the other hand future NTCs[1] once projects of pan-European significance are implemented, shows that long-term cross-border **transmission projects of pan-European significance will help alleviate total annual generation operational costs by about 5 %**. For higher generation costs that can be expected by 2020, this represents about € 5 billion.

Most of the savings are expected from the integration of the four regions showing presently the weakest integration to the European system: Italy, the Iberian Peninsula, Ireland and the UK, and the Baltic states (see Figure 7.9).

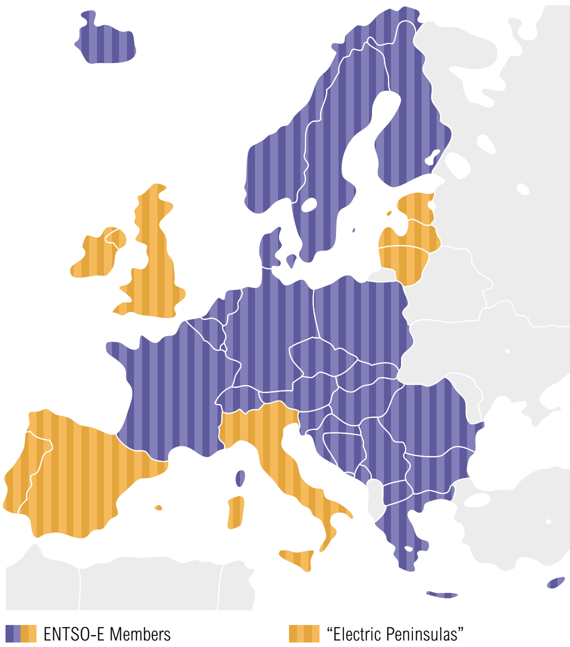


Figure 7.9:
"Electric peninsulas" in Europe by 2020

[1] Only benefits of increased NTCs are measured here. Investment costs for the corresponding long-term cross-border projects amount to about € 20 billion.

7.5 About € 100 Billion Investments in the Coming 10 Years

Project costs show a very wide range, corresponding to the diversity of the projects' designs (see Appendix 1), from less than €50 million to more than €1 billion: 40 % of the projects display costs lower than €300 million and 23 % greater than €1 billion.

Austria	1.1	Ireland	3.9
Belgium	1.9	Latvia	0.4
Bosnia & Herzegovina	0.0	Lithuania	0.7
Bulgaria	0.2	Luxembourg	0.3
Croatia	0.2	Montenegro	0.4
Czech Republic	1.7	Netherlands	3.3
Cyprus	0.0	Norway	6.5
Denmark	1.4	Poland	2.9
Estonia	0.3	Portugal	1.5
Finland	0.8	Romania	0.7
France	8.8	Serbia	0.2
FYROM	0.1	Slovakia	0.3
Germany	30.1	Slovenia	0.3
Greece	0.3	Spain	4.8
Hungary	0.1	Sweden	2.0
Iceland	0.0	Switzerland	1.7
Italy	7.1[3]	United Kingdom	19.0
		Total ENTSO-E perimeter	104.0

Table 7.1:
Investment costs breakdown in billion €

Table 7.1 figures out the total expected investments cost per country[1] for all projects of pan-European significance.[2]

Total investments costs amount to **€ 104 billion, of which € 23 billion is for subsea cables**. The figures are is in line with the previous analysis of the TYNDP 2010 and of the overall € 100 billion envisaged by the European Commission in their communication on Energy Infrastructure Package on 17th November 2011.

Total investment costs per country correlate relatively with land size and population. Still there are noticeable deviations. Ireland thus foresees as much as € 4 billion (due mostly to HVDC long-distance cables), an important effort compared to the population size. With big evolutions with respect to generation location on the German ground, Germany considers by far the highest investments, with € 30.1 billion.

The investment efforts are significant for TSOs financial means. It represents however about 1.5 – 2 €/MWh of power consumption in Europe over the 10-year period, i.e. **about 2 % of the bulk power prices or less than 1 % of the total electricity bill**.

1) This is the best available information to date. Figures however keep adjusting for every project and the information is subject to changes for every country.

2) TSOs invest beyond projects of pan-European significance at regional or national level.

3) Figure corresponds to the investments solely born by the TSO of the country; in other words, investments possibly made by others investors are then not reported for that country.

8 Transmission Adequacy

Transmission Adequacy shows how adequate the transmission system is in the future in the analyzed scenarios, considering the presented project commissioned. It answers the question: "Is the problem fully solved after the projects are built?"

Three categories have been considered in the transmission adequacy showing that needs are solved in every situation, in almost every situation or that the need is not completely solved:

- Light purple: **unlikely** that with all projects in the plans, in the span of scenarios considered in the plans, further measure is reported related to the boundary.
- Purple: **possibly,** with all projects in the plans, in the span of scenarios considered in the plans, certain rare developments could trigger further measures on the boundary although sufficient transmission capability is provided for the vast majority of the situations.
- Dark purple: **most likely** that in the span of scenarios considered in the plans, additional measures are needed on top of all projects in the plans to cope with congestion on the boundary.

Figure 8.1 (next page) shows that most identified concerns are solved with the proposed investments:

- Every generation connection or security of supply issue is rather well limited; easily addressed and most are marked light purple.
- Projects also match requirements of market integration in the foreseen scenarios, except possibly for rare situations. Sizing investments to match these would not prove profitable. Most of the corresponding boundaries are marked medium purple for these rather open and interacting concerns.
- For the pan-European system two boundaries have been marked as dark purple in the time span of the scenarios. One is related with the France-Spain interconnection. With all projects included in this Plan it is still expected that the interconnection will have congestions more than 50% of the time. However, from the TSO's point of view, the projects have to be implemented step by step, and they are complex enough so that it is not possible to commission more than one project in a timeframe of 6 years. The other one is in Southern France where due to the local load growth there is need for both transmission capacity and demand side management, so the indicator shows that additional actions with respect to demand side management are needed still after the transmission lines have been commissioned.

Grid development will be needed beyond the investment listed in the Plans to meet challenges coming by 2030 and beyond: grid development to integrate offshore wind, the Mediterranean solar plan, further interconnection with the East, etc.

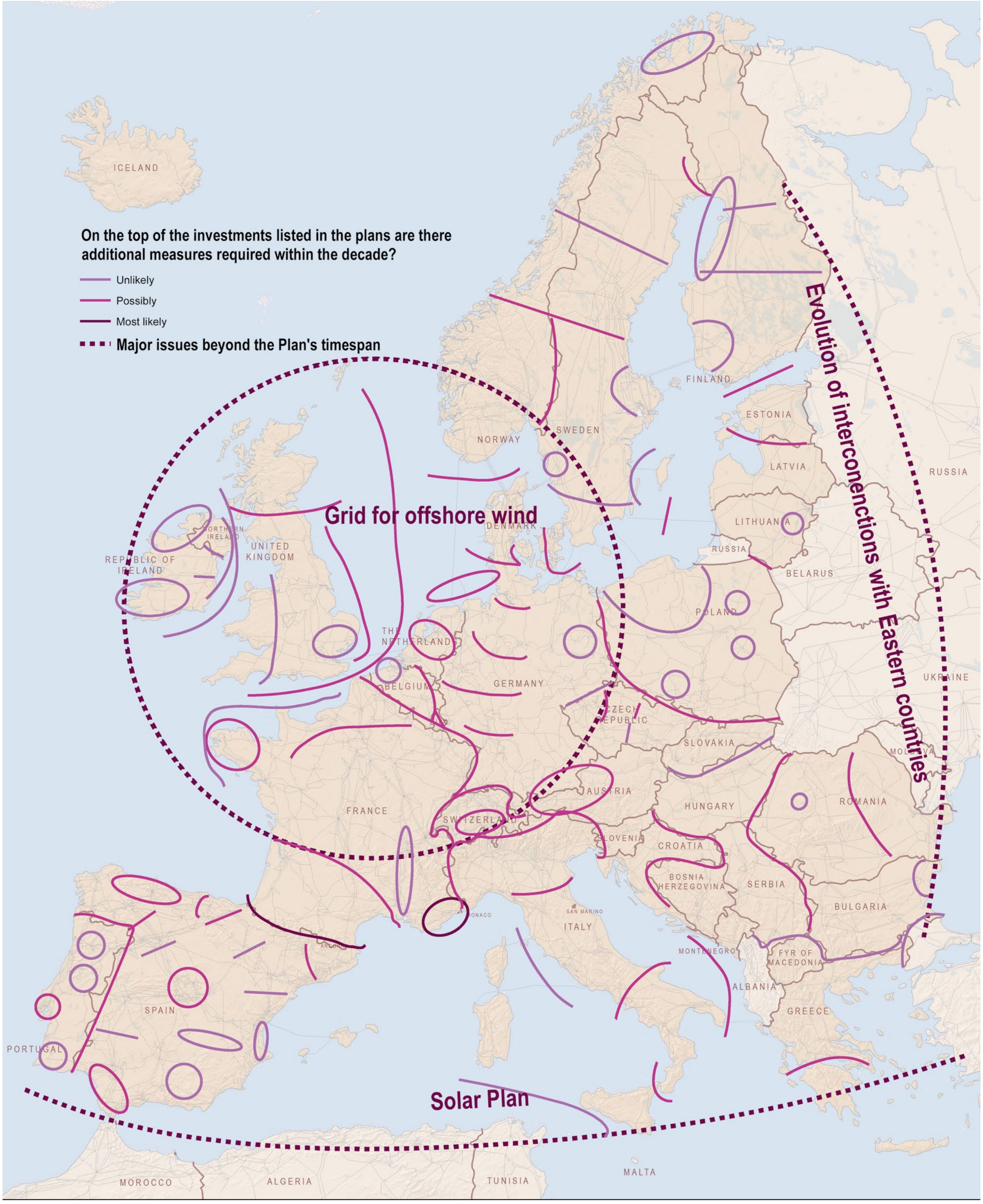


Figure 8.1:
Transmission adequacy by 2020

8.1 Detailed Focuses

The TYNDP 2010 recognized some seven main clusters of investment needs related to renewable integration, East-West and North-South flows in the South-East and Central South regions, Baltic States integration, connection of new conventional power plants and supply of some European cities and regions, and market integration.

Checking against those needs one can state that the direct renewable connection needs are solved almost in all the cases except in the parts of Northern Spain. However, a lot of transmission needs stem from the fact that the RES are located away from the consumption centers, which shows on the North-South transmission needs.

There are more uncertainties linked in the transmission adequacy for North-South flows in Northern, Central and Southern Europe. German nuclear phase-out has created some uncertainty for the transmission adequacy of the proposed projects inside Germany. The TYNDP package reflects results as far as available in January 2012.

In South-East Europe there are uncertainties for the East-West transmission adequacy linked with the possible new undersea DC tie lines between Balkan and Italy, the connection of Ukraine and Turkey to the rest of the Europe and a huge potential of RES in the overall region that could, with new transits from Ukraine, Turkey, Romania and Bulgaria, make congestions on the above mentioned directions.

Baltic States will surely be integrated more tightly to the rest of the European electricity system but according to the studies there will be some situations where the transmission capacity might not be enough for the market needs.

To summarize, there are only a few cases where additional measures are certain to be needed on top of the proposed projects in the plan. However, there is a level of uncertainty for residual congestion in some rare conditions or a need for further investigations in some areas. This can of course change if the assumptions behind the analysis change, for example, with more ambitious renewable targets or other sudden large changes in the system, like the decision on nuclear phase-out in Germany has shown.

9 High Environmental Standards

Presently, the European transmission network consists of approximately 305,000 km of routes. Completing the projects of pan-European significance will lead to refurbishing about 9,000 km of existing assets and building 43,200 km of new assets, increasing the total length of the network by 17 % over the coming ten years (of which 76 % are overhead, and 24 % underground or subsea).

A relatively limited network growth despite a major shift in generation mix

An equivalent of about one third of the present net generating capacity will be built in the coming decade. New generating capacities are almost all located farther to load centers, RES especially (wind generation develops mostly as large wind farms, also offshore). The major shift in the generation mix will hence induce a massive relocation of generation means and, with large wind and solar capacities, more volatile flows, requiring the grid to adapt. This represents for the adaptation of the generation fleet a rate of 3 %/yr.

On the other hand climate change mitigation will require energy-efficiency measures (including in the power sector) but also transfer from fossil-fuel based end-uses to CO_2-free energy sources. European power peak load is thus expected to grow slightly in all scenarios by 7 to 8 % over the next ten years (see SOAF 2012). This represents 0.7 %/yr for the load growth.

The major driver for grid development is therefore generation. In comparison to the 3 %/yr for the generation adaptation rate, the grid's growth rate looks relatively modest, with 1.3 %/yr. This illustrates once more the "network effect", where the output developed by all elements together is greater than the summed output of every individual element.

A strong support to EU energy policies, with efficient resources commitment

By nature, projects of pan-European significance aim at supporting EU energy policies. Figure 9.1 shows how many out of the 52,300 km of either upgraded or new assets contribute to all of the three pillars of the EU energy policy.

It should be noted that, if summated, the total volumes of circuit kilometers for each pillar (85,400 km) would be greater than the total physically constructed (52,300 km) as it is possible for a single project to fulfil several requirements at the same time. This again illustrates that network development proves to be a productive and efficient way to invest and reach several high-level goals at once, while reducing environmental impacts greatly by sparing resources.

The commissioning of projects of pan-European significance will result in **CO_2 savings of 170 Mt**, of which 150 Mt CO_2 results from the connection of renewable generation technology and 20 Mt CO_2 which stem from saving following further market integration (mostly "electric peninsulas").

The projects of pan-European significance allow around 125 GW of renewable generation to be integrated in the power system and are thus **required for about half of the expected RES development in Europe** (about 220 GW).

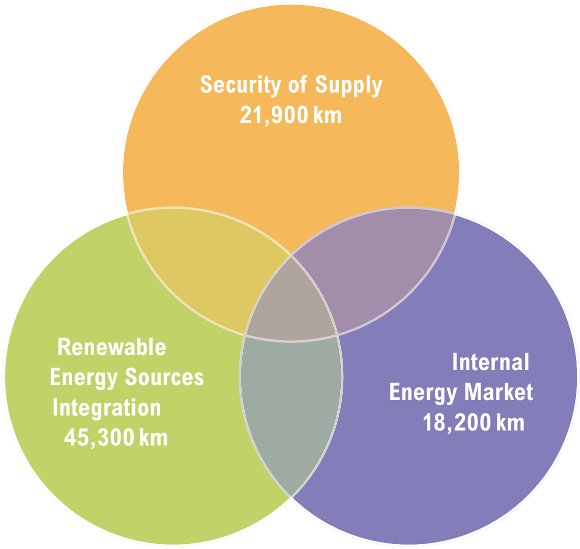


Figure 9.1:
Projects of pan-European significance – volume breakdown per EU Energy policy pillar

10 Resilience Assessment

The main objective of transmission system planning is to ensure, with respect to the mid- and long-term horizon, the development of an adequate transmission system which contributes to:

- **Security of supply**
  Transmission grid ensures safe system operation and provides a high level of security of supply.
- **Sustainability**
  Transmission grid allows for the integration of renewable energy sources.
- **Competitiveness**
  Transmission grid facilitates grid access to all market participants and contributes to social welfare through internal market integration and harmonization.

This chapter will firstly describe how the plan answers to the technical and economical assessment and then describes the technological development and long-run issues.

The more detailed description of the planning standards can be found in Appendix 3.

10.1 A Plan Robust to all Reasonably Likely Situations

The transmission grid is designed for future needs. It needs to cope with the situation that will be there, not just fix problems encountered today. For this aim several future scenarios or sensitivity cases are needed for the basis of the plan. The new infrastructure should fit in with the existing infrastructure, and also should not hinder any long-term future development.

TSOs perform complex system and grid studies to check the system behavior under extreme conditions.

There are two commonly agreed main background scenarios: Scenario EU 2020 and Scenario B. Sensitivity to the shut-down nuclear power plants has been considered. Regional analyses have been done for these in an all-year-round analysis. Thousands of market situations, considering all hazards that may affect the power system have been simulated and processed for this TYNDP 2012.

Regionally most restrictive cases based on the possible future situations have been studied in grid studies in order to check the secure functioning of the grid after the projects are commissioned. High-load cases, low-load cases, high/low renewable production cases, different hydro years in the Nordic system and other regionally constrained cases have been studied.

The detailed results of the studies can be found in the Regional Investment Plans .

The system has been verified both for the capacity that the proposed projects will give and for the technical functioning against the common ENTSO-E planning standards, see Appendix 3.

10.2 A Profitable Investment Plan for Europe

Investments should positively address social welfare.

Socio-economic assessment of a project is carried out in order to evaluate its economic viability and overall impact. TSOs systematically undertake such studies. In general, the assessment takes into account the foreseen investment costs and benefits of the new projects. The investment costs are subject to uncertainties concerning the permitting processes or other supply chain considerations, and include capital/operational cost etc. On the other hand, benefit evaluation is a more demanding exercise since for example some technical improvements (for security of supply) or pursuing policy objectives (integration of renewable sources) are difficult to quantify.

Grid investments help so that bottlenecks are removed and so renewable generation is not bottled somewhere in the grid. This also includes how the benefits should be looked at on a wider pan-European level.

The total benefit in generation savings for the long-term projects regarding the market integration in this Plan (in total about €20 billion investment) has been analyzed to be €5 billion/year; therefore, there is definitely a positive economic value of the projects notwithstanding the other benefits that have not been changed into monetary value.

10.3 Implementation of Edge Technologies

The challenge of grid development must be met by use of cost effective solutions and without any disturbance for the whole reliability of the European transmission. The technologies employed to date in the transmission grids are efficient, reliable, well-engineered and are widely available techniques for transferring energy in high-voltage grids. The ongoing technology progression, predominantly driven by special applications, has led to new techniques that may have the potential to be employed in the future transmission grid. Of course, it is not possible to give a comprehensive description of all the research done about grid operation and development in the present report. Appendix 5 supplies a more detailed perspective. For further information, the reader is invited to refer to the ENTSO-E R&D Plan.[1)]

New 400 kV AC OHL projects are in technical, economic, and ecological terms the most efficient solution for long-distance electricity transmission. Indeed, such reinforcements integrate straightforwardly into the existing grid since this technology has been the standard for a long time. In addition, other solutions are implemented to accommodate specific situations when necessary.

This chapter deals with novel techniques as well as unconventional techniques, i.e. known technologies that have not been widely used for various reasons. Basically technologies can be sorted into four categories depending on their maturity: mature (PST), in large-scale testing phase (real-time thermal rating, low sag conductors), in the development phase (FACTS) and in the research phase (superconductors, nanotechnology).

---

1) See the ENTSO-E R&D Plan (www.entsoe.eu/resources/key-documents/).

Some illustrations on the more novel and unconventional technologies that have been selected for the projects in this plan:

- **Underground Cables**
  There are examples in the plan where an AC cable has been deemed as an appropriate technology selection. These are mostly short connections in the order of some tens of kilometers.
- **High Temperature Conductors (HTCs)**
  This technical choice has been made for several projects of the TYNDP: the 260 km long 400 kV overhead line between France and Italy, 275 km in the French Rhône Valley, an ongoing upgrade of a 220 kV line in Poland …
- **High Voltage Direct Current (HVDC)**
  More than 40 HVDC links representing some 13,000 km of routes, mostly undersea and located in North, West, Central and South Europe, are described in the TYNDP 2012. Nevertheless, some cables are to be installed onshore, e.g. between France and Spain or Belgium and Germany.
- **Underground and submarine XLPE (Cross-Linked Poly-Ethylene) cables**
  Some above-mentioned HVDC projects consider the use or will use XLPE cables.
- **HVDC combined with AC**
  Some projects combine HVDC and HVAC solutions, like the southwest link in Sweden and Norway.
- **Combined Grid Solution**
  Krieger's' Flak could be mentioned as a project combining offshore wind integration with interconnectors between Denmark and Germany.
- **Gas Insulated Line (GIL)**
  Pilot project in the Brenner Tunnel being currently under consideration between Italy and Austria, constituted of a 65 km long double circuit 400 kV Gas Insulated Line.
- **Phase Shifting Transformers (PSTs)**
  Help better controlled active power through preventive or curative strategies. There are several projects including PST devices, for example a dozen of Phase Shifting Transformers are to be installed in Europe in the coming ten years, like in Zandvliet (4th PST on the Belgian north border).
- **Flexible Alternating Current Transmission System (FACTS)**
  Several projects in the Plan includes FACTs devices, such as SVC's.

Several novel technologies can be mentioned that can be considered as a possible help in operations, but do not appear as a full part of the TYNDP list of investments:

- **Real-Time Thermal Rating (RTTR) monitored cables/lines or Dynamic Line Rating**
  They are on their way to become a mature technology based on the real-time control of the thermal rating of a line or a cable.
- **Fault Current Limiters (FCLs)**
  Comprise technologies with different degrees of maturity.
- **Wide Area Monitoring System (WAMS)**
  An information platform with monitoring purposes. Based on Phasor Measurement Units (PMUs), WAMS allow monitoring transmission system conditions over large areas in view of detecting and further counteracting grid instabilities. This early warning system contributes to increasing system reliability
  by avoiding the spreading of large area disturbances, and optimizing the use of assets.
- **Electric Storage**
  As for now, there are around 15 projects in Europe, which are limited to the connection of hydro pump power plants, mainly in Switzerland, Austria, Romania, Spain and Portugal. As for storage demonstration projects, the TWENTIES project involving several ENTSO-E members, responding to the ENERGY 2009.7.1.1 call (optimization of the electricity grid with large-scale RES and storage) can be quoted, as well as the Almacena project in Spain.
- **Smart grids**
  The term „smart grids“ usually refers to distribution rather than transmission systems. From the technical point of view, many "smart" features which the Distribution System Operator (DSO) of the future will be able to employ are already available to and implemented by the Transmission System Operators (TSOs) nowadays. Among these features are
  - massive communication in real time
    between virtually all nodes in the system,
  - active and reactive power flow control
    based on real-time measurements,
  - loss optimization
    via optimal power flow algorithms and
  - legal provisions
    for redispatch, countertrading, market interruptions, cross-border remedial actions etc.

Storage capacity development in Europe

Recent evolution of the renewable energy source in most of the European countries, supported by favorable incentive schemes, by quick permitting procedures and by network reinforcement, suggests the TSOs to bring up a few additional issues for the forthcoming years.

In order to comply with the third energy package the further development of the electricity systems should be carried out in the most efficient way, reducing the bottlenecks on the transmission grid and developing new technologies for the management of the intermittent production.

Beyond grid reinforcements, which aim to increase the transmission capacity by avoiding the wind curtailment, storage systems might prove efficient and profitable facilities to cope with the future increase of the wind and photovoltaic sources (see Figures 10.1 and 10.2).

The boom of RES installations has been sustained thanks to the TSO effort to follow the investment needs; therefore most of the new capacity has been connected either to the new transmission grid or to an upgraded portion. Moreover, the intermittent generation, having a priority access to the network, put out of the market the thermal generation decreasing the availability of reserve. Therefore, electricity systems with high penetration of RES are exposed to the risk of a difficult management of the margin reserve, in particular during the off-peak load period.

In order to reduce constraints to full access of RES generation, new power capacity is first required. Meanwhile, a more flexible management of the energy produced by RES is strongly required taking into account the capacity to be installed within 2020 in compliance with the national action plans. Such a process needs the involvement of all the users to develop the electricity system, starting with the TSOs to develop the grid; quick permitting procedures of new lines/substations/transformation, are therefore very important to speed up the authorization process. System needs are in the meanwhile development of other facilities, characterized by an easy construction.

As a conclusion, storage facilities might be a complement, and not an alternative way, to the grid development in order to allow
– resolution of grid congestions,
– peak shaving,
– reserve for the electricity system and
– primary frequency regulation.

Depending on their location, storage systems might need coordination of TSOs and DSOs to supply connection to the grid and take full advantage of the solution.

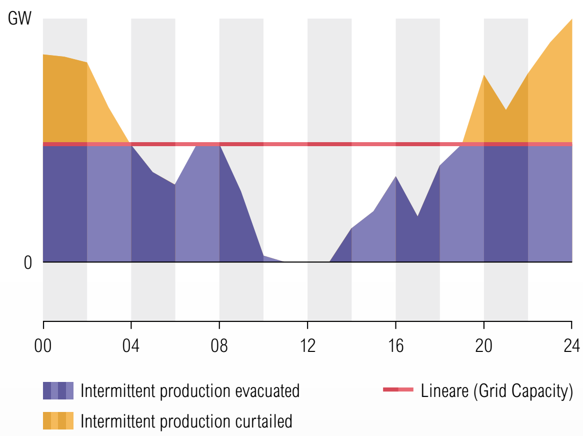


Figure 10.1:
Reduction of energy curtailment without storage

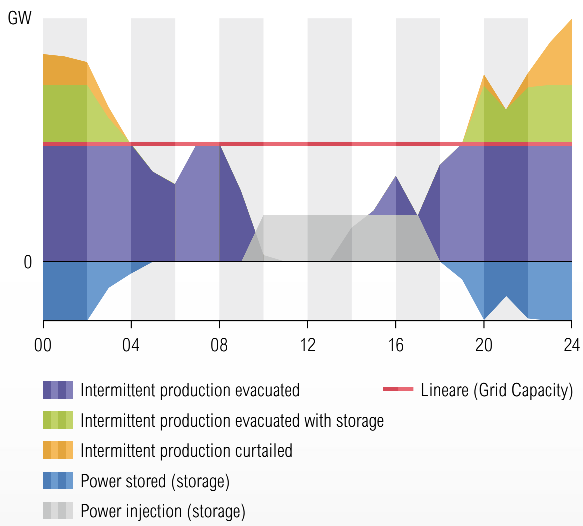


Figure 10.2:
Reduction of energy curtailment with storage

Network development as tackled in the TYNDP is indirectly concerned with the ongoing development of the distribution systems. The more active role of the networks themselves as well as the expected more active participation of loads and generation embedded in the distribution systems will impact on the forecast of the load as well as, in the long run, the design of the market models used to simulate the behavior of the system participants. ENTSO-E is actively involved in the design of the network codes necessary to accommodate smart distribution grids and will continue to tune the tools used in the elaboration of the TYNDP accordingly.

TSOs strive to make the best use of existing assets implementing technologies such as PST, HTLS, and FACTS, in order to achieve an efficient grid development or as an interim measure where grid extension cannot be realized in a timely manner. When grid extension is needed, proven new technologies are widely resorted to fulfilling transmission tasks. TSOs also anticipate future challenges with live-texting of promising new technologies through pilot projects.

Some of the technologies are still in a premature state and a large-scale integration of these technologies in the transmission grid is not possible due to reliability constraints. As the TSO's have the responsibility for the whole electrical system in their control zone, precaution is needed with respect to the introduction of new technologies.

As a matter of fact, none of the examined technology is a universal solution. Each project has to be considered in a dedicated study assessing the best fitting technologies.

For that reason, some technologies will play a real role in the European TSOs' transmission projects in the next ten years, and some other technologies do not appear yet, for their level of maturity and reliability are not satisfying yet within this timeframe.

10.4 A Milestone towards Electricity Highways 2050

First step toward Electricity Highways 2050

Most of the grid we have today, will still be there for a long time. In addition the grid that we build today will be there for at least the next 40 – 60 years. The existing grid and the future grid should be compatible with each other.

TYNDP and the projects in the plan are the first step toward the Electricity Highways 2050.

In the 2050-perspective the EU energy system is expected to undergo a fundamental transformation. This is brought about by the production of large and intermittent wind volumes predominantly in the northern Seas and large-scale solar in southern Europe and possibly in northern Africa and the Middle East along with the developments in storing and consuming electricity and in decentralized models of electricity generation (see Figure 10.3).

The consistency of the EU's and ENTSO-E's strategic visions and needs is extremely important in order to address the necessities arising according to all projections for the penetration of carbon-neutral technologies in the future energy mix, with production often located in very distant areas from consumption and storage areas.

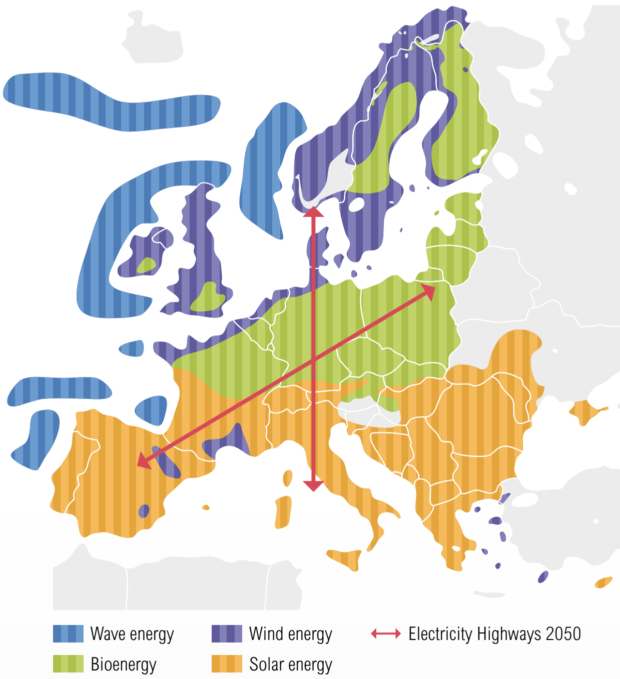


Figure 10.3:
RES development by 2050

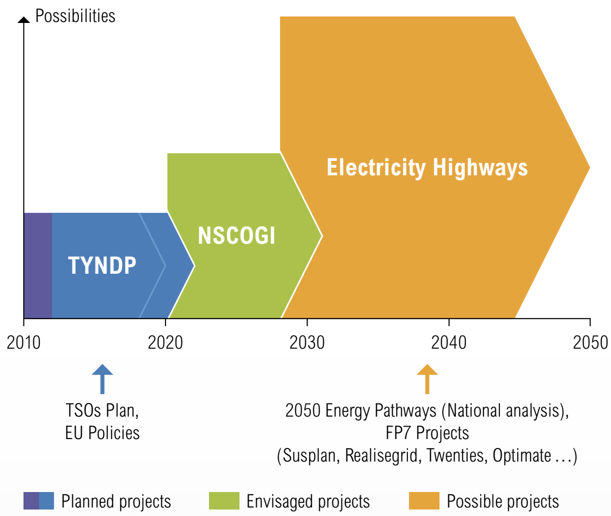


Figure 10.4:
Towards 2050

In a context of a full decarbonized energy future, the question will be raised on how to solve the RES generation fluctuation (see Figure 10.4), and how to transform yesterday's "generation follows load" into a tomorrow's "load follows generation" principle.

Acknowledging this, ENTSO-E has stressed the importance of consistent long-term transmission planning, supported by novel planning approaches based on dedicated R&D efforts.

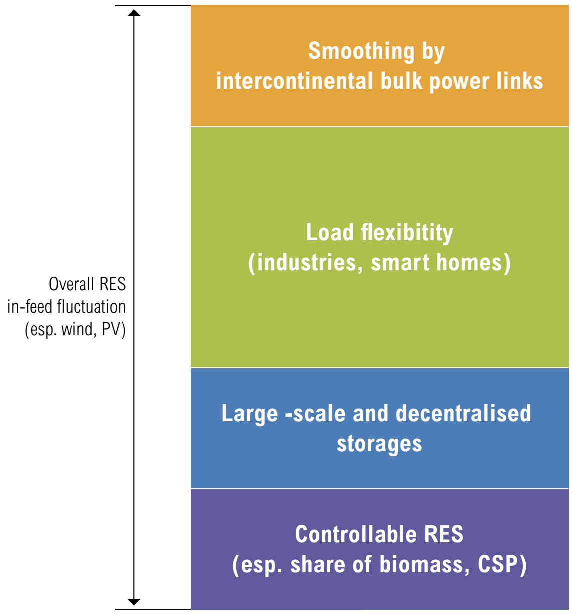


Figure 10.5:
Challenges of a fully renewable energy sources based electricity system in 2050

In line with the proposal for an Energy Infrastructure Package (comprising of two regulations, namely the "Guidelines for the Implementation of European Energy Infrastructure Priorities" and the "Connecting Europe Facilities"), as published in October 2011, ENTSO-E tries to assess how a pan-European Electricity Highways System should be built over a time horizon to 2050. A study roadmap was provided in 2011, in order to frame a Modular Development Plan on a pan-European Electricity Highways System (MoDPEHS) for 2050.

Based on this study, the modular development plan shall now be developed by a study consortium consisting of ENTSO-E and its members, relevant professional associations, Research Institutes, Universities, etc. within the "**e-Highway 2050**" study project, which should start in the course of 2012.

The "**e-Highway 2050**" study seeks to develop a strategic plan that will provide a vision for a pan-European power system, built around the Electricity Highways concept developed sequentially over a time horizon to 2050.

The approach will start from the pan-European transmission network by 2020, which is assumed to be known and in line with the Scenario EU 2020 energy targets. Thus, the project aims at covering the time period beyond ENTSO-E's Ten-Year Network Development Plan. It will consider two important first steps: The TYNDP as a basis, and also the North Seas offshore grid concept for 2020/30, following the Memorandum of Understanding for North Seas Countries' Offshore Grid Initiative (NSCOGI).

The "e-Highway 2050" study project aims at

– developing future-oriented novel planning approaches, allowing a comprehensive but efficient Electricity Highways discussion,

– analyzing and justifying bulk power transmission needs, taking into account future generation and its spread throughout the whole transcontinental region,

– proposing concrete implementation, operation and governance principles for needed grid investments throughout Europe and to neighboring areas,

– in the interest of security, efficiency, feasibility and sustainability, considering the whole energy supply chain including relevant technical/technological, economical/financial, ecological political/sociopolitical and geopolitical/security issues,

– following a modular approach: 2030, 2040, 2050, and finally

– proposing general strategic Electricity Highways architectures including technology options.

The modular long-term planning roadmap will be provided by using two parallel approaches, based on the same macro-scale scenarios:

– A scenario approach using linear power flow approximations for the network modeling and semi-quantitative cost benefit analysis techniques to propose an expansion plan for 2020 – 2050 and

– improvements for the above expansion plan, taking into account critical issues using novel planning techniques (correlated uncertainties in energy and power scenarios, voltage problems and stability considerations, black-out risks) in order to make the above expansion plan more robust.

Both planning approaches will consider the whole energy supply chain, including all the relevant technical/technological, economical/financial and regulatory/socio-political dimensions needed to develop efficient, yet sustainable, grid architecture options meeting future energy supply requirements. Scenarios on generation, storage capacities and consumption patterns will be detailed based on stakeholder consultations and in-depth work with professional associations.

As part of the "e-Highway 2050" dissemination process, respective progress reports along the three-year study project will support the TYNDP 2014 process, as the starting point for sketching intermediary steps reflecting the increase of decarbonization of the electricity systems.

11 Conclusion

RES integration is the major challenge for grid development in the coming decade

The TYNDP 2012 studies show basically **larger, more volatile power flows, over greater distances across Europe**. About 100 bottlenecks can be identified on the European network by the end of the decade. About half of the concerns are primarily related to market integration (either between price zones, or intra-price zones), one third primarily to generation connection and 20 % primarily to security of supply. However **80 % of the bottlenecks are related to RES integration**, either because the direct connection of RES is at stake, or because the network section or corridor is a keyhole between RES and load centres. The north-south internal corridors in Germany are typical example of the latter.

Requirement to build or refurbish over 50,000 km of network for around €100 billion

A bit more than 100 transmission projects of pan-European significance have been identified to address the above-mentioned concerns in the coming decade. About 76 % of the investment items of the TYNDP 2012 package were already present in the TYNDP 2010[1)] and are hence confirmed. 24 % are new ones, which is a little greater than what could be anticipated from the inherent, regular turnover of the TYNDP process. These figures show both the robustness of the TYNDP 2010; and that the TYNDP is a living process.

Projects of pan-European significance total about 52,300 km of new or refurbished Extra High Voltage routes, split rather equally between the two 5-year sub-periods. This figure represents a 25 % increase compared to TYNDP 2010, which in the main stems from new investments of very long circuits:

- +3,000 km of subsea routes are envisaged,
  developing in total 10,000 km of offshore grid key-assets and
- **+7,000 km of onshore routes are being considered, mostly to bring to load centers the power generated on the outskirts of the European territory.**

1) 51 investments items have been commissioned, to date.
(12 have been partly commissioned, 25 are expected to be commissioned in 2012).

It should be noted that the planned projects are in direct support of the EU energy policy:

- 80 % of the projects contribute to RES integration (either for direct connection or serving RES energy movements across Europe): **transmission grid development at European level is required for about 125 GW of new RES**, i.e. half of the expected RES development in Europe.
- 47 %[1] contribute significantly to market integration, enabling each generation costs savings of at least 30 M€/yr, which increases to more than 100 M€/yr when the integration of the 4 regions with the weakest current integration with the European system are considered: Italy, Iberian Peninsula, Ireland, the UK and Baltic states.
  Globally comparing the situation before and after grid reinforcement, the analyses show that long-term cross-border **transmission projects of pan-European significance will help alleviate total generation operational costs by about 5 %**. Most savings are expected from the above-mentioned countries.
- 33 %[2] of the projects are required to integrate isolated systems such as the Baltic States, secure large load centers (in particular capital cities), or even countries with negative generation adequacy forecast in the coming years (ex: Belgium).
- All projects contribute to significantly mitigating CO_2 emissions in Europe (but the few directly connecting fossil-fuel-fired power plants).

Total investment costs sum up to **€ 104 billion, of which € 23 billion is for subsea cables**. The figures are in line with the previous analysis of the TYNDP 2010 and the overall € 100 billion envisaged by the European Commission in their communication on the Energy Infrastructure Package on 17th November 2011. This effort is significant for TSOs financial means. It represents however about 1.5 – 2 €/MWh of power consumption in Europe over the 10-year period, i.e. **only around 2 % of the bulk power prices or less than 1 % of the total electricity bill**.

---

1) Not accounting projects that directly connects new generation (another 40 %).

2) Other projects enhance grid meshing and thus the overall security of supply, but are discarded from the analysis as in their regard, the initial situation locally shows acceptable risk.

ENTSO-E provides strong support for EU energy policies

The quality of the integrated market and network modelling relies on the knowledge of all specific features of every local power system in Europe; as well as the resulting ability to master and cut aptly through numerous uncertain parameters. The aim is to model properly every grid concern in a limited timeframe, and hence valuate correctly slightly more than 100 projects all over Europe. ENTSO-E hence devised a specific **top-down coordination, both relying on common standards and subsidiarity to take advantage of TSOs' local expertise and workforce**. This organization will be improved to address new challenges but must continue to rely on this combination of top-down lead and decentralized expertise.

The TYNDP 2012 enabled ENTSO-E to implement for the first time a cost benefit analysis, articulating market and network studies. ENTSO-E believes that the developed methodology is a good basis in the perspective of the future Energy Infrastructure Package. The **valuation of projects** and the integrated realization of both the pan-European and regional reports are intended to efficiently **support the selection of Projects of Common Interest** in the Regional Groups. **Visions to 2030** give the framework for the future definition of scenarios and cases bases for ENTSO-E datasets and studies. Scenarios in the **SOAF are released every year** to accommodate every required updates. ENTSO-E works with **stakeholders' feedback** and the present text accounts for the feedback received during the 8-weeks consultation process in Spring 2012. Most stakeholders welcomed the TYNDP. Most comments received targeted future issues of the report, and asked especially for greater stakeholders' involvement, in particular for the definition of scenarios and inclusion of 3rd Party projects. ENTSOE will set up an ad'hoc stakeholders' group to ensure tighter exchanges with stakeholders. (More details can be found in the report on received comments on the web site). The preparation of the TYNDP 2014 has already started!

A major challenge is that the grid development may not be in time if the RES targets are met as planned by 2020. Permit granting procedures are lengthy, and often cause commissioning delays. If energy and climate objectives have to be achieved, it is of upmost importance to smooth the authorization processes. In this respect, ENTSO-E welcomes the proposals made by the European Commission with the draft Energy Infrastructure Package, as there are many positive elements in the permitting section that will facilitate the fast tracking of transmission infrastructure projects including the proposal of a one-stop shop and defined time lines. More thorough analyses are however required so as to ensure the measure can be successfully implemented, particularly in relation to whether the timelines proposed are achievable, and particularly in the context of the public participation process and the potential for legal delays. One must also notice that the supporting schemes are limited to the Project of Common Interest whereas there are many significant national transmission projects that are crucial to the achievement of Europe's targets for climate change, renewable and market integration.

12 Appendices

12.1 Appendix 1: Table of Projects of pan-European Significance

The following tables show some synthetic information about the projects mentioned in Chapter 7 of the main document. They give a synthetic description of each project with some factual information as well as the expected projects impacts and commissioning information.

Projects develop grid transfer capability across the boundaries as displayed on the following map (see Figure 12.1). The numbers attached to every boundary on the following map correspond to the projects' indices relieving the constraints across that boundary:

Project & investment items

A **project** in the TYNDP package 2012 can cluster several **investment items**.

Every row of the table in Appendix 1 to the TYNDP or Regional Investment Plan report corresponds to one investment item.

The basic rule for the clustering is that **an investment item belongs to a project if this item is required to develop the grid transfer capability increase associated with the project**.

A project can be limited to one investment item only.
An investment item can contribute to two projects;
in this case it is depicted only once in the table of projects,
in one of the projects (and only referred to in the other project: no technical description, status etc. are repeated).

Labeling

Projects of pan-European significance are numbered from 1 to 112. Investment items' labels have the following structure: project_index.investment_index. They are displayed on the projects maps in chapter 7 and in the tables of projects.

Investment items which were present in the TYNDP 2010 have the same index in the TYNDP 2012 package.

Indices of investments items which were not present in the TYNDP 2010 start with "Axxx".

Examples:

- **79.459**
  designates an investment item, already present in TYNDP 2010 (under the label 459), contributing to project 79.
- **42.A86**
  designates a new investment item, not present in TYNDP 2010, contributing to project 42.

Figure 12.1:
Projects – boundaries correspondence

For each project, the following information is displayed:

Column 1	**Project number**	
Column 2	**Investment number**	shows the label under which the investment item is referred to in the TYNDP 2012 package, especially the projects maps shown in Chapter 7.
Column 3+4	**Substation 1 & Substation 2**	show both ends of the investment item. The code of the country concerned is given between brackets.
Column 5	**Brief technical description**	gives a summary of the technical features (e.g. new line / upgrading of existing circuit, underground cable / OHL, double circuit / single circuit, voltage, route length …).
Column 6	**Grid transfer capability increase**	shows in MW the order of magnitude or a range for the additional grid transfer capability brought by the project.
Column 7	**Social and economic welfare**	can show 5 different displays distinguishing 1. the SEW gained via better accommodation of inter-area transits and 2. the SEW gained if the project supplies access to the grid for new generation: < 30 M€/yr < 30 M€/yr and additionally gives direct grid access for new generation ≥ 30 M€/yr and ≤ 100 M€/yr ≥ 30 M€/yr and ≤ 100 M€/yr and additionally gives direct grid access for new generation > 100 M€/yr
Column 8	**RES integration**	can show 4 different displays distinguishing the direct connection of RES (< or > 500 MW) and the accommodation of inter-area flows triggered by large amount of RES (> 500 MW): Neutral Direct access to the grid for less than 500 MW of new RES (medium, connection) Direct access to the grid for more than 500 MW of new RES (high, connection) Increasing the capacity between an area with excess of RES generation to share this with other areas[1] (in order to facilitate at least 500 MW of RES penetration)
Column 9	**Improved security of supply**	shows 3 levels of concern, and specifies the area at risk as the case may be: Minor (no specific need) Medium (supply risk solved for less than 10 years after commissioning) High (supply risk solved for more than 10 years after commissioning)
Column 10	**Losses variation**	Higher losses No clear trend Lower losses

For each project, the following information is displayed:

Column 11	**CO_2 emissions mitigation**	Neutral Medium (savings < 500 kt CO_2/yr) High (savings > 500 kt CO_2/yr)
Column 12	**Technical resilience**	Minor Medium High
Column 13	**Flexibility**	Minor Medium High
Column 14	**Social and environmental impact**	Low risk Medium risk High risk
Column 15	**Project costs**	> 1,000 M€ ≥ 300 and ≤ 1,000 M€ < 300 M€
Column 16	**Present status**	describes the progress of the project, with respect to the main typical phases of grid projects: – Under consideration, – planned, – design & permitting, – under construction and – commissioned.
Column 17	**Expected commissioning date**	gives the year by which the investment should be commissioned)
Column 18	**Evolution compared to the TYNDP 2010 situation**	explains the reasons for any adaptation of the technical consistency, evolution of the commissioning date and status of the investment.
Column 19	**Investment comment**	displays any additional information that could be of interest for every investment.
Column 20	**Project comment**	displays any additional information that could be of interest for every project.

Project identification					Project assessment									
Project number	**Investment number**	**Substation 1**	**Substation 2**	**Brief technical description**	**Grid transfer capacity increase**	**Socio-economic welfare**	**RES integration**	**Improved security of supply**	**Losses variation**	**CO_2 mitigation**	**Technical resilience**	**Flexibility**	**Social and environmental impact**	**Project costs**
1	1.1	Frades B (PT)	Pedralva 1 & 2 (PT)	Creation of a new 400 kV station in Frades B connected to Pedralva by means of two new 400 kV, 40 km lines. The realization of this two connections can take advantage of some already existing 150 kV single lines, which will be reconstructed as double circuit lines 400 + 150 kV line and partially sharing towers with those 400 kV circuits.	3,800 MW			Tras -os Montes and the Alto Duore area						
	1.2	Pedralva (PT)	Alfena (PT)	New 50 km double circuit Pedralva – Alfena 400 kV OHL (only one circuit installed in a first step). This line is going to use partially a corridor of a existing single 150 OHL.										
	1.3	Pedralva (PT)	Vila Fria (PT)	New 55 km double circuit Pedralva – Vila Fria 400 kV OHL (one circuit installed), with needed extension of existing Vila Fria substation to include 400 kV facilities.										
	1.4	Frades B – Ribeira de Pena – Feira (PT)		New 160 km double circuit 400 kV OHL Frades B – Ribeira de Pena – Feira (one circuit operated at 220 kV between R. Pena and Feira) with a new 400/60 kV substation in R. Pena. In a first step, only the 130 km section R. Pena – Feira will be constructed and operated at 220 kV as Vila Pouca Aguiar – Carrapatelo – Estarreja (see investment 1.6). In a second step, one circuit of this line will be operated at 400 kV.										
	1.5	Macedo de Cavaleiros (PT)	Vila Pouca de Aguiar (PT)	New 75 km double circuit 400 + 220 kV OHL Macedo de Cavaleiros – Valpaços – Vila Pouca de Aguiar.										
	1.6	V. P. Aguiar – Carrapatelo – Estarreja (PT)		New 400 + 220 kV double circuit OHL (initially only used at 220 kV) Vila Pouca Aguiar – (Rib. Pena) – Carrapatelo – Estarreja. Total length of line: 2 × (90 + 49) km.										
	1.A1	Ribeira de Pena – Guarda (PT)		New 192 km double / single circuit 400 kV OHL Ribeira de Pena – Guarda. In a first step, only the 75 km section R. Pena – Guarda will be constructed and operated at 220 kV between Vila Pouca de Aguiar and Macedo de Cavaleiros (see investment 1.5), in a second step one circuit of this line will be operated at 400 kV. Between Macedo de Cavaleiros zone and Pocinho zone a single line will be constructed, between Pocinho zone and Chafariz zone a double circuit 400 kV OHL will be constructed (only one circuit installed in a first step), this last line will use one circuit of the line V. Chã B – Guarda (see investment 2.A2) to establish the line R. Pena – Guarda.										
2	2.8	V. Chã B – Arganil / Góis – Penela – Paraimo / Batalha (PT)		New single circuit 400 kV OHL Vila Chã B – Arganil / Gois – Penela (90 km) plus new double circuit 400 kV OHL (15 km) to connect Penela substation to Paraimo – Batalha line. Two new 400/60 kV substations at Vila Chã B and Arg. / Góis are needed, as well as the expansion of the existing Penela substation to include 400 kV facilities.	1,800 MW									
	2.9	Guarda – Ferro B – (Castelo Branco) – Falagueira (PT)		New double circuit 400 + 220 kV OHL Guarda – Ferro B – “Castelo Branco zone” (between Guarda and Ferro B only the 400 kV circuit will be installed) plus new double circuit 400 + 150 kV OHL “Castelo Branco zone” – Falagueira. New 400/60 kV substations in Guarda and Ferro B. Total length of line: 135 km										
	2.10	Falagueira (PT)	Pego (PT)	New 40 km double circuit 400 + 150 kV OHL substituting for an existing 150 kV line.										
	2.A2	V. Chã B – Guarda (PT)		New double circuit 400 kV OHL Vila Chã B-Guarda (55 km)										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2014	Adjustment resulting from the new date of the hydro power plant.		This project integrates new amounts of hydro power plants in the northern region of Portugal (3,200 MW of which 2,700 MW with pumping) and creates better conditions to evacuate wind power already existent and new with authorization for connection. These new amounts of power will increase the flows in the region, and it is estimated that the flows could reach 3,800 MW, which must be evacuated to the littoral strip and south Portugal through three new independent routes. Part of these flows will interfere and accumulate with the already existent flows entering in Portugal through the international interconnections with Spain on the north, the Alto Lindoso – Riba de Ave – Recarei and Lagoaça – Aldeadávila axis, which induces additional needs for reinforcement of this axis in a coordinated way.
planned	2017	Adjustment resulting from the new date of the hydro power plant.		
design & permitting	2014 / 2015	Delays due to authorization process.		
design & permitting	2015 / 2016	Progresses as planned.		
partly under construction, design & permitting	2011 / 2012	Delays due to authorization process. A section of the line Macedo de Cavaleiro – Vila Pouca de Aguiar between Macedo de Cavaleiros and Valpaços (53 km) was commissioned at the end of 2011.	This investment allows the connection of RES (mainly wind) and increases the trasnmission capacity in the Douro area.	
design & permitting	2013	Delays due to authorization process.	This investment allows the connection of the RES (mainly wind) and new load in the area.	
design & permitting	2015 / 2016	Progresses as planned.		This project integrates new hydro power plants (590 MW with pumping) and evacuates the existent and new wind generation in the inner central region of Portugal (it is expected to connect more 800 MW of new wind, but the wind target in this region overcomes surmounts of more than 2,000 MW). The existing network of 220 kV and 150 kV is no more adequate to integrate these new amounts of power, and a new 400 kV axis should be launched in this region in two major routes: – one to the littoral strip (Penela / Paraimo / Batalha) and – another by the interior, establishing a connection to Falagueira substation, where there is an inter-connection with Spain (Falagueira – Cedillo).
design & permitting	2015 / 2016	Adjustment resulting from the new date of the renewables project.		
design & permitting	2014	Progresses as planned.		
planned	2020	New investment in TYNDP. This investment supports the integration of new hydro and wind power plant in northern Portugal.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs
3	3.12	Rio Maior – Alm. Bispo – Fanhões (PT)		New 71 km double circuit 400 kV OHL feeding Lisbon area from north with creation of a 400/220/60 kV substation in Almargem do Bispo. A section of this reinforcement (between Rio Maior and Carvoeira zone) will be finished earlier included on a 400/220 kV double circuit line linking Rio Maior and Carregado substations.	1,880 MW			Lisboa and Setúbal Peninsula						
	3.13	Palmela – F. Ferro – Ribatejo (PT)		Expansion of Fernão Ferro substation to include 400 kV facilities and connection to the existent Palmela – Ribatejo single circuit line by a new 25 km double circuit 400 kV OHL.										
	3.14	Marateca – Pegões – Fanhões (PT)		New 400/60 kV substations in Pegoes. New 90 km double circuit 400 kV OHL. This new line will be connected to already existing line Palmela – Sines 2, so making a direct link Sines – Pegões – Fanhões substations.										
4	4.16	Aldeadávila (ES)	Lagoaça (PT) – Armamar (PT) – Recarei (PT)	New Duero Interconnection 400 kV. New 400 kV OHL interconnection line Aldeadávila (ES) – Lagoaça (PT), including new Lagoaça substation. Also associated, the lines Lagoaça – Armamar – Recarei 400 kV in PT and the Armamar 400/220 kV substation. On a first phase (2009) a new 400/220 kV substation (Lagoaça) will be created with only 220 kV level installed and there will be some rearrangements and reinforcements on the local 220 kV network structure. On river crossing a new 220 kV double line with separated circuits, firstly Aldeadavila (ES) – Lagoaça (PT) 1 & 2 and changing later to Aldeadavila – Pocinho (PT) 1 & 2, will substitute the existing two 220 kV lines Aldeadavila – Bemposta (PT) and Aldeadavila – Pocinho (PT). Total length: 1 km (ES) + 105 km (PT)	PT – ES 1,700 MW / ES – PT 1,400 MW									
	4.17	Guillena (ES) – Puebla de Guzman (ES)	Tavira (PT) – Portimao (PT)	New southern interconnection. New 400 kV OHL double circuit line between Guillena (ES) – Puebla de Guzman (ES) – Tavira (PT) – Portimão (PT), including new Tavira and P. Guzman 400 kV substations. On the interconnection section P. Guzman – Tavira, initially only one circuit will be placed. Total length: 25 km (ES) + 110 km(PT)										
	4.18	Boboras (ES) – O Covelo (ES)	Vila Fría (PT) – Vila Conde (PT) – Recarei (PT)	New northern interconnection. New double circuit 400 kV OHL between Boboras (ES) – O Covelo (ES) – Vila Fria (PT) – Vila do Conde (PT) – Recarei (PT), including new 400 kV substations O Covelo, Boboras, Vila Fria and Vila do Conde. On the section O Covelo – Vila do Conde, only one circuit will be placed. Total length: 50 km (ES) + 112 km (PT)										
	4.21	Aldeadavila (ES) JM Oriol (ES)	Villarino (ES) Caceres (ES)	Uprating the existing Aldeadávila – Villarino 400 kV OHL in order to increase its capacity from 1,350 MVA to 1,690 MVA. Uprating the existing line JM Oriol – Caceres 220 kV										
	4.21	JM Oriol (ES)	Arenales – Caceres (ES)	New 220 kV JM Oriol – Arenales, and new Arenales substation.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	2016 / 2019	Progresses as planned.		This project reinforces the security of supply of Lisbon and Setubal region (north and south Tagus river) by creating a strong semi-ring of 400 kV, with two new 400 kV substations that can guarantee the load growth in the region in a safe, secure and quality way. Currently there are only 3 400 / VHV substations (Alto de Mira, Fanhões and Palmela), and two of them are quite far from the main load. This new project will create two new 400 kV substations near the main loads.
under construction	2012	Progresses as planned. Line Palmela – F. Ferro – Ribatejo was commisined at the end of 2011. The expansion of Fernão Ferro substation to include the 400 kV will be concluded only in 2012.		
under construction	2012	Progresses as planned.		
partly commissioned, design & permitting	Aldeadavila – Lagoaça 400 kV (cros border), Aldeadavila (ES) – Pocinho (PT) 1 & 2 220 kV, Lagoaça 400/220 kV Substation, Armamar (PT) – Lagoaça (PT) 400 kV commissioned in 2010. Armamar (PT) – Recarei (PT) expected in 2012.	Aldeadavila – Lagoaça 400 kV (cross-border), Aldeadavila (ES) – Pocinho (PT) 1 & 2 220 kV, Lagoaça 400/220 kV Substation, Armamar (PT) – Lagoaça (PT) 400 kV completed. Portuguese section Armamar (PT) – Recarei (PT) delayed in authorization process.		This project increases the capacity between PT and ES. Larger and more volatile flows are expected between both countries due to the huge increase of volatile sources and the market interchanges. The project includes two interconnection routes, besides the internal reinforcements required, one in the north and other in the south, due to the important loop flows between the two countries and, consequently, only both interconnections allow to reach a reasonable import / export capacities that will reach the "3.2 GW".
partly under construction, design & permitting	2013	Portuguese section commissioned. P. Guzman – Guillena (ES) built and operating at 220 kV. Difficulties in the authorization process in the Spanish section P. Guzman – border and connection to Guillena 400 kV.		
design & permitting	2014	Progresses as planned. Changes in route and connecting point in Spain due to environmental constraints.		
under construction	2013	Progress as planned, although there are difficulties to find a suitable period for a planned outage to carry on the project.		
design & permitting	2014	Delays due to authorization process.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
5	5.19	Vic (ES)	Pierola (ES)	Upgrading (uprating) the existing 75 km single circuit Vic – Pierola 400 kV line in order to increase its capacity from 1,360 MVA to 1,710 MVA.	1,200 – 1,400 MW in both directions			Perpignan, Gerona						
	5.20	Arkale (ES)	Hernani (ES)	Upgrading the existing single circuit Arkale – Hernani n° 2 220 kV OHL in order to increase its capacity up to 640 MVA.										
	5.36	Sta.Llogaia (ES)	Baixas (FR)	New HVDC (VSC) bipolar interconnection in the eastern part of the border, via 320 kV DC underground cable using existing infrastructures corridors and converters in both ending points.										
	5.37	Santa Llogaia (ES)	Bescanó (ES)	New double circuit Sta. Llogaia – Ramis – Bescano – Vic / Senmenat 400 kV OHL (single circuit in some sections) New 400 kV substations in Bescano, Ramis and Sta.Llogaia, with 400/220 kV transformers in Ramis and Bescano.										
	5.46	Baixas (FR)	Gaudière (FR)	Reconductoring of existing 70 km double circuit 400 kV OHL to increase its capacity.										
6	6.22	Boimente (ES)	Grado (ES)	North axis Project between Galicia and the Basque Country. Part of the project is considered as the Asturias Ring. – New double circuit Boimente – Pesoz – El Palo – Salas Grado 400 kV OHL. – Change of voltage level of the existing Soto – Tabiella single circuit from 220 kV to 400 kV, and connection as input / output in Grado. – New single circuit Soto – Penagos 400 kV OHL. – New double circuit Aguayo / Penagos – Udalla – Abanto 400 kV OHL – New double circuit Zierbena – Abanto – Gueñes 400 kV OHL. – New double circuit Gueñes – Ichaso OHL. – New double circuit Gozón – Reboria – Sama – Lada 400 kV OHL. – New double circuit Sama – Velilla 400 kV OHL. – Uprating the single circuit Lada – Robla 400 kV OHL in order to increase its capacity by around 300 MVA. – It includes new 400 kV substations Pesoz, El Palo,Salas, Grado, Gozón, Sama, Reboria , Costa Verde, Penagos, Solorzano, Udalla, Abanto and several transformers to 220 kV.	2,000 – 4,200 MW									
	6.22	Soto – Grado – Gozon-Reboria (ES)	Costaverde – Sama (ES)											
	6.22	Soto (ES)	Penagos (ES)											
	6.22	Sama (ES)	Velilla (ES)											
	6.22	Lada (ES)	Robla (ES											
	6.22	Penagos / Aguayo (ES)	Abanto (ES)											
	6.22	Zierbena (ES)	Abanto (ES)											
	6.22	Abanto / Gueñes (ES)	Ichaso (ES)											
7	7.23	Ichaso (ES)	Castejón (ES)	Northern part of the new Cantabric – Mediterranean axis. New double circuit Castejón – Muruarte – Dicastillo – Ichaso 400 kV OHL, with new 400 kV substations in Muruarte and Dicastillo with 400/220 kV transformers. Section Castejón – Muruarte 400 kV already in service	1,320 – 4,280 MW									
	7.23	La Serna (ES)	Magallón (ES)	New double circuit La Serna – Magallón 400 kV OHL.										
	7.A4	Tudela (ES)	Magallón (ES)	New CCRS (Combination of Reactors step by step) in Magalló 220 kV.										
	7.A5	Dicastillo (ES)	Moncayo (ES)	New double circuit Dicastillo – El Sequero – Santa Engracia – Magaña – Moncayo 220 kV OHL.										
	7.23	Aragón (ES) Tudela (ES) La Serna (ES)	Peñaflor (ES) Magallón (ES) Ichaso (ES)"	Uprating the existing Aragón – Peñaflor 400 kV OHL, Tudela – Magallón 220 kV and La Serna – Ichaso 220 kV.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2012	Delays due to authorization process.		Mid term interconnection project between France and Spain ("2.8 GW") . It includes cross border lines and internal lines required to assure NTC.
design & permitting	2014	Delays due to authorization process.		
partly under construction, design & permitting	2014	Progresses as planned.		
under construction	2011 – 2013	Bescano-Vic / Senmenat 400 kV commissioned. Difficulties in the authorization process of the section Bescano – Sta Llogaia 400 kV		
design & permitting	end 2013	Progresses as planned.		
partly commissioned, design & permitting	2012 – 2014	Section Pesoz – Salas commissioned. El Palo connection is in progress. Difficulties in the authorization process of the section Boimente – Pesoz and Salas – Grado.		Larger and more volatile west – east power flows from Galicia to the Basque Country, triggered especially by the development of new generation sources in the north and northwestern part of the country (mainly wind, a new pumping hydro power plant, and some CCGT that will replace former coal power plants) and the need to feed the high industrial and demanding regions of the north and northeastern part of Spain.
design & permitting	2015	Changes in the definition of the investment: – Substation Valle del Nalón 400 kV is not required as the link can not take advantage of existing 132 kV due to technical and environmental problems, – connection Gozón – Carrio 400 kV can not use existing corridor of lower voltage lines and requires therefore a new substation Reboria 400 kV.		
commissioned	commissioned	commissioned		
design & permitting	2015	Delays due to authorization process.		
commissioned	commissioned	commissioned		
partly commissioned, design & permitting	2012	From Penagos / Aguayo to Udalla commissioned. The connection from Udalla to Abanto has delays in authorisation process.		
commissioned	commissioned	commissioned		
design & permitting	2016	Delays due to authorization process.		
partly commissioned, design & permitting	2017	Castejón – Muruarte section has been commisioned. Muruarte – Dicastillo – Ichaso has difficulties in the authorisation process which led to change the route and connection (Ichaso substitutes Vitoria).		Larger and more volatile Cantabric – Mediterranean power flows in Spain, triggered by the development of local RES but also influenced by transits flows caused by the generation / demand situations in the north and Levante areas.
design & permitting	2014	Delays due to authorization process.		
design & permitting	2013	New investment in the TYNDP, as it is required to ensure the GTC increase for the entire project.		
design & permitting	2013 – 2017	New investment in the TYNDP. Ensures the GTC increase of the project while helping to evacuate the generation in Soria and Aragón.		
design & permitting	2013 – 2014	New investment in the TYNDP. Difficulties in the authorization process.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	7.24	Fuendetodos / Mudejar (ES)	Eliana / Godelleta(ES)	Southern part of the new Cantabric – Mediterranean axis. – New double circuit Fuendetodos – Muniesa – Mezquita – Platea – Godelleta 400 kV OHL. – New double circuit Teruel – Mudejar – Morella – la Plana / Godelleta 400 kV OHL. – The new Godelleta substation will be equipped with a 400/220 kV transformer and connected to the existing 400 kV lines Cofrentes – La Eliana, and Catadau – Requena 400 kV lines. – New 400 kV substations Mezquita, Platea, Muniesa, Mudejar and Godelleta with 400/220 kV transformer units.	1,320 – 4,280 MW									
8	8.25	Aragón (ES)	Isona (ES)	New double circuit Aragón / Peñalba – Arnero – Isona 400 kV OHL with new 400 kV substations Arnero and Isona, and a 400/220 kV transformer in Arnero.	3,870 MW									
	8.25	Escatron (ES)	La Secuita (ES)	New single circuit Escatrón – Els Aubals – La Secuita 400 kV OHL with new 400 kV substation in Els Aubals and La Secuita with 400/220 kV transformer.										
	8.A6	Torres del Segre (ES)	Mequinenza (ES)	New SSSC (Static Synchronous Series Compensator) in Torres del Segre / Mequinenza 220 kV.										
	8.A7	Mangraners (ES)	Begues (ES)	New Double circuit Mangraners – Espluga – Begues and Mangraners – Juneda – Secuita – Perafort – Begues 220 kV.										
	8.A8	Espluga (ES)	Penedes (ES)	Uprate 116 km single circuit 220 kV OHL.										
	8.A9	Garraf (ES)	Vandellos (ES)	Uprate 108 km single circuit 400 kV OHL.										
	8.A10	Isona (ES)	Calders (ES)	Uprate 79 km single circuit 400 kV OHL.										
9	9.26	Catadau (ES)	Benajama (ES)	New double circuit Catadau – Jijona-Benejama 400 kV OHL. A new 400 kV substation will be created at Jijona and transformers installed in Jijona and Catadau.	1,840 MW			Costablanca area						
	9.26	Catadau (ES)	Jijona (ES)	220 kV lines from Catadau to Jijona in the coast of Costablanca using partially the 132 kV lines										
10	10.28	Cofrentes (ES)	Ayora (ES)	New single circuit Cofrentes – Ayora 400 kV OHL.	3,380 – 4,270 MW									
	10.28	Ayora (ES)	Pinilla (ES)	New single circuit Cofrentes – Ayora – Campanario – Pinilla 400 kV OHL. This project also includes a new 400 kV substation in Campanario.										
	10.33	Romica (ES)	Manzanares (ES)	Transmanchega project. New double circuit line Romica – Manzanares 400 kV OHL. New substation Manzanares with a 400/220 kV transformer unit.										
	10.33	Manzanares (ES)	Brazatortas (ES)	Transmanchega project. New double circuit line Manzanares – Brazatortas 400 kV OHL. The new 400 kV substation Brazatortas will be connected to the existing line Guadame – Valdecaballeros.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2012 – 2015	Turis substation is substituted by Godelleta due to environmental reasons. Uprate Eliana – La Plana and new circuit is rejected due to environmental reason. As alternative a double circuit connection Morella – Godelleta / La plana. These issues delay the project up to 2015.		Larger and more volatile Cantabric – Mediterranean power flows in Spain, triggered by the development of local RES but also influenced by transits flows caused by the generation / demand situations in the north and Levante areas.
design & permitting	2014	Delays due to authorization process. In addition, Monzón substation is substituted by Arnero		Larger and more volatile south – northeastern power flows from Aragón to Catalunya, triggered especially by the development of new RES in the south of Catalunya and Aragón, that joined to the existing generation sources (RES and conventional) in this area and further in the south causes higher flows, that would naturally flow to the large consumption areas in Catalunya.
design & permitting	2015	Delays due to authorization process.		
design & permitting	2013	New investment in the TYNDP. Ensures the GTC increase of the project while alleviating present and the future congestion in the parallel 220 kV axis.		
design & permitting	2013	New investment in the TYNDP. Ensures the GTC increase of the project while alleviating present and the future congestion in the parallel 220 kV axis.		
design & permitting	2011 – 2013	New investment in the TYNDP. Ensures the GTC increase of the project while alleviating present and the future congestion in the parallel 220 kV axis.		
design & permitting	2015	New investment in the TYNDP. Ensures the GTC increase of the project while alleviating present and the future congestion in the parallel 220 kV axis.		
design & permitting	2015	New investment in the TYNDP. Ensures the GTC increase of the project while alleviating present and the future congestion in the parallel 220 kV axis.		
design & permitting	2017	Delays due to authorization process.		Security of supply of the Costablanca area in Levante Mediterranean coast.
design & permitting	2016 – 2019	New investment in the TYNDP complementing the previous one to alleviate congestion in the 132 kV lines that supplies Casabanca area. 132 kV lines will be upgraded to 220 kV.		
design & permitting	2015	Delays due to authorization process, forcing to reschedule the investment.		Larger and more volatile east – west flows triggered mainly due to new RES generation development in Valencia, Albacete and Ciudad Real.
design & permitting	2012 – 2013	Progresses globally as planned.		
design & permitting	2016	Postponed in new National Master Plan as need is not imminent.		
design & permitting	2013	Progresses as planned.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
11	11.29	Cartuja (ES)	Guadame (ES)	New double circuit Cartuja – Arcos de la Frontera – La Roda – Cabra – Cordoba – Guadame 400 kV OHL (partly already commissioned). It includes new 400 kV substations Cartuja and Cordoba, with 400/220 kV transformers.	1,270 MW									
	11.A11	Cartuja – Pto. Sta Maria (ES)	Facinas (ES)	New 52 km single circuit 220 kV OHL Puerto Sta Maria – Pto. Real – Parralejo – Facinas.										
12	12.30	Don Rodrigo (ES)	Aznalcollar (ES)	New double circuit 400 kV OHL Aznalcollar – Guadaira – Don Rodrigo. Aznalcollar substation will also have a new input / output in Guillena-Palos 400 kV. This project also includes new 400 kV substations in Aznalcollar and Guadaira with 400/220 kV transformerss.	2,150 – 1,600 MW									
	12.30	Guillena (ES)	Almaraz (ES)	New double circuit 400 kV OHL Guillena – Brovales – Arroyo S. Servan – Carmonita – Almaraz. This project also includes new 400 kV substations in Arroyo S. Servan, Carmonita with 400/220 kV transformers.										
13	13.31	Caparacena (ES)	La Ribina (ES)	New double circuit Caparacena – Baza – La Ribina 400 kV OHL, with two new 400 kV substations in Baza and La Ribina (these substations will be also connected to Carril – Litoral 400 kV line).	1,950 – 3,400 MW									
	13.31	Caparacena (ES)	Litoral (ES)	The existing single circuit Litoral – Tabernas – Hueneja – Caparacena 400 kV line will be uprated in order to increase its capacity.										
14	14.34	Trives (ES)	Tordesillas (ES)	New line Trives – Aparecida – Arbillera – Tordesillas 400 kV OHL and Trives – Conso – Valparaiso – Tordesillas 220 kV OHL. New 400 kV substations in Aparecida.	600 + 3,000 MW									
	14.34	Tordesillas (ES)	La Cereal / Moraleja (ES)	New double circuit Tordesillas – Segovia – Galapagar 400 kV OHL.										
	14.34	Segovia (ES) – PST Galapagar	Moraleja (ES)	New input / output of Moraleja in Segovia – Galapagar 400 kV OHL and new PST in the 400 kV line Galapagar – Moraleja.										
	14.34	Loeches (ES)	SSReyes (ES)	Upgrade of the existing 21 km single circuit Loeches – SS Reyes 220 kV OHL to 400 kV in order to increase its capacity.										
	14.34	Fuencarral (ES)	Galapagar (ES)	Uprate Galapagar – Fuencarral 400 kV.										
	14.34	Mudarra (ES)	Tordesillas (ES)	New double circuit 400 kV Mudarra – Tordesillas OHL and upgrade of the existing single circuit Mudarra – Tordesillas 400 kV line in order to increase its capacity.										
15	15.A12	Olmedilla (ES)	Valdemingomez (ES)	New double circuit Olmedilla – Villares – Morata – Valdemingomez 400 kV OHL, and new substation Villares and Valdemingomez 400 kV, with 400/220 kV transformers in T. Velasco	8,700 MW									
	15.32	(Castilla) (ES)	(Madrid) (ES)	Uprate – Cofrentes – Minglanilla – Belinchon – Morata 400 kV, – double circuit Trillo – Villanueva Escuderos – Olmedilla – Belinchon 400 kV, – double circuit Valdecaballeros – Arañuelo 400 kV, – double circuit Morata – Villamiel – Almaraz 400 kV, – double circuit Villaviciosa – Almaraz 400 kV, – double circuit Aldeadavila – Arañuelo and Aldeadavila – Hinojosa – Almaraz 400 kV, – Picon – Aceca – Los Pradillos-Torrejon de Velasco and – Añover – Torrejón de Velasco – Pinto Ayuden – El Hornillo – Villaverde 220 kV										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
partly commissioned, design & permitting	2011 / 2014	Arcos – Cabra – Guadame section commissioned. Cordoba connection postponed in new National Master Plan as need for demand is not imminent. Cartuja – Arcos faces difficulties in the authorization process.		Larger and more volatile south – north power flows, triggered especially by the development of new RES in Cadiz, that joined to the existing generation sources (RES and conventional) in the area causes higher flows, that would naturally flow to the large consumption areas in the north.
design & permitting	2012 / 2013	New investment in the TYNDP, contributing also to evacuate the generation in the coast of Cadiz.		
design & permitting	2017	Delays due to authorization process which led that Guillena – Guadaira connection is substituted by Aznalcollar – Guadaira with a new topology.		Larger and more volatile southwestern – northwestern power flows, triggered especially by the development of new generation sources in Sevilla and Huelva (mainly wind and solar), but also in Extremadura, that joined to the existing generation sources in the area causes higher flows, that would naturally flow to the large consumption areas in the south (Sevilla) or in the north (towards Madrid), depending on the demand / generation situation.
design & permitting	2012	Alcuescar substation substited by Carmonita. Progresses as planned otherwise.		
design & permitting	2016	Delays due to authorization process.		The project aims at ensuring the connection to the transmission network of new RES (wind, solar and pumping hydro) and ensuring the possibility of more volatile power flows between the Almeria and Granada.
under construction	2012	Final phase of permitting. Progress as planned although there are difficulties to find a suitable period for a planned outages to carry out the work.		
under construction	2011 – 2012	Progress as planned. Trives – Tordesillas 400 kV axis shares towers with the Trives – Tordesilla 220 kV line. Final phase of permitting.		Larger and more volatile northwestern – centre power flows , triggered especially by the development of new RES in Galicia and Castilla-León, that joined to the existing generation sources (RES and conventional) in the area and further in the north causes higher flows, that would naturally flow to the large consumption areas in the centre of Spain, mainly Madrid.
under construction	2012 – 2013	Partly commissioned. Progresses as planned.		
design & permitting	2013 – 2015	Delays due to authorization process.		
design & permitting	2015	Delays due to authorization process.		
design & permitting	2014	New investment in TYNDP.		
partly under construction, design & permitting	2018	Uprate fostered because of necessity. New line postponed in new Master Plan.		
design & permitting	2016 / 2017	New investment in TYNDP.		Larger and more volatile south – centre power flows, triggered especially by the development of new RES in Cuenca, that would naturally flow to the large consumption area of Madrid but also influenced by transits flows caused by higher flows coming from the south of Spain.
partly under construction, design & permitting	2011 / 2018	Some of the investments progressed as planned. Other have problems either in permitting process or finding a suitable period for a planned outage to carry out the works.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
16	16.38	Gatica (ES)	Aquitaine (FR)	New HVDC interconnection in the western part of the border via DC subsea cable in the Biscay Gulf.	FR – ES 1,200 MW ES – FR 2,000 MW			Biarritz, Basque country						
	16.A14	Amorebieta (ES) Garraf (ES) Adrall (ES) Orcoyen (ES)	Gueñes (ES) Secuita (ES) La Pobla (ES) Elgea (ES)	Uprates required in Basque country and Catalonia in order to use fully the benefit of the long-term ES – FR interconnection.										
	16.A17	Arkale (ES)		New PST on Arkale – Argia 220 kV interconnection line.										
17	17.42	Lonny (FR)	Vesle (FR)	Reconstruction of the existing 70 km single circuit 400 kV OHL as double circuit OHL.	9,000 MW			Reims, Paris area						
	17.44	Havre (FR)	Rougemontier (FR)	Reconductoring of existing 54 km double circuit 400 kV OHL to increase its capacity.										
	17.A18	tbd (FR)	tbd (FR)	New network reinforcement between Haute Normandie and the south of Paris area. Length about 160 km.										
	17.45	Taute (FR)	Oudon (FR)	“Cotentin – Maine” Project: New 163 km double circuit 400 kV OHL connected to existing network via two new substations in Cotentin and Maine regions.										
	17.A144	Cergy (FR)	Terrier (FR)	MORP project: New single circuit 400 kV line between existing 400 kV substations.										
18	18.48	Gaudière (FR)	Rueyres (FR)	Reconductoring with ACCS limiting section (10 km) of existing single circuit 400 kV OHL.	>1,000 MW			Provence area						
	18.A19	tbd (FR)	tbd (FR)	Restructuration of whole EHV grid in Massif Central area.										
	18. 20. A20	(Provence) (FR)	(Midi) (FR)	New subsea HVDC link between Marseille area and Languedoc.										
19	19.51	Boutre (FR)	La Bocca (FR)	PACA “Filet de sécurité” project: Construction of 3 new AC 220 kV underground cables – Boutre – Trans (65 km), – Bianҫon – Fréjus (26 km) and – Bianҫon – La Bocca (17 km). Installation of reactive power compensation devices in 220 kV Boutre and Trans substations.	500 MW			French riviera						
20	20.53	Coulange (FR)	Le Chaffard (FR)	Reconductoring (with ACCS / ACCR) of two existing double circuit 400 kV OHL (Coulange – Pivoz-Cordier – Le Chaffard and Coulange – Beaumont-Monteux – Le Chaffard). Total length of both lines: 275 km	2,400 MW			Southeast France						
	20. 18, A20													

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under consideration	approx. 2020	New investment in TYNDP, defined since last release, aiming 4 GW capacity between France and Spain.		Long-term interconnection project between France and Spain ("4 GW"). It includes cross border lines and internal lines required to assure NTC.
under consideration	2016	New investment in TYNDP meant to solve congestion in this area.		
design & permitting	2016	New investment enabling to take full advantage of the transfer capacity.		
design & permitting	2016	Progresses as planned.		Project needed to cope with larger and more volatile power flows from Normandy to Champagne, triggered especially by the development of new generation sources (along the Channel coasts, from Picardie to Champagne and further north abroad) that would naturally flow to large consumption areas: Paris area, but also more broadly from Britanny to Reims.
under construction	2018	As the pace of generation installation is lower than expected, the investment has been postponed.	This investment is needed for integrating new generation in Le Havre area. As the pace of generation installation is lower than assumed earlier, the investment has been postponed from 2015 to 2018	
under consideration	long term	New investment in TYNDP, defined since last release.	Either existing assets uprate or new HVDC, actual needs still being evaluated, depending on uncertainties on generation location.	
under construction	2013	Delays due to authorization process.		
planned	2018	New investment in TYNDP, defined since last release, triggered by larger and more volatile power flows between generation developing north of Paris and Paris area.		
under construction	end 2012	Progresses as planned.		Larger and more volatile north – south power flows in southwestern France, triggered by the development of local RES generation but also influenced by transits flows with neighboring countries.
under consideration	long term	New investment in TYNDP, defined since last release, triggered by larger and more volatile power flows in Southwest France.		
design & permitting	2018	New investment in TYNDP, defined since last release, triggered by larger and more volatile power flows in Southwest France.		
design & permitting	2015	Progresses as planned.		Security of supply of the French Riviera.
under construction	2016	Progresses as planned.	Construction over 4 years because the works are only possible during limited periods every years on this strategic corridor.	The project aims at ensuring the reliable grid operation to cope with new generation development along the Rhone Valley and more volatile power flows between the Alps and southwestern France.
			The investment contributes both to project 18 and project 20. For the technical description see project 18.	

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
21	21.54	Cornier (FR)	Piossasco (IT)	Replacement of conductors (by ACCS) on Albertville (FR) – Montagny (FR) – Cornier (FR) and Albertville (FR) – La Coche (FR) – La Praz (FR) – Villarodin (FR) – Venaus (IT) – Piossasco (IT) single circuit 400 kV OHLs. In addition, change of conductors and operation at 400 kV of an existing single circuit OHL between Grande Ile and Albertville currently operated at lower voltage, and associated works in Albertville 400 kV substation. Total length of lines: 257 km	FR – IT 1,800 MW (600 MW in the MT)									
	21.55	Grande Ile (FR)	Piossasco (IT)	"Savoie – Piémont" Project: New 190 km HVDC (VSC) interconnection FR – IT via underground cable and converter stations at both ends (two poles, each of them with 600 MW capacity). The cables will be laid in the security gallery of the Frejus motorway tunnel and possibly also along the existing motorways' right-of-way.										
	21.81	Trino (IT)	Lacchiarella (IT)	A new 380 kV double circuit OHL between the existing 380 kV substations of Trino and Lacchiarella in Northwest Italy area. Total line length: 95 km Voltage upgrade of the existing Magenta 220/132 kV substation up to 380 kV.										
	21.84	Casanova (IT)	Vignole (IT)	Voltage upgrade of the existing 100 km Casanova – Vignole 220 kV OHL to 400 kV and new 400/220/150 kV substation in Asti area.										
	21.101	Turin (IT)		Restructuring of the 220 kV network in the urban area of Turin. Some new 220 kV cables, some new 220/132 kV substations and some reinforcements of existing assets are planned. Total length: 63 km										
22	22.57	under consideration (FR)	under consideration (CH)	Reinforcement of the interconnection in the area of Geneva's lake.	FR – CH 1,000 MW CH – FR <1,500 MW									
23	23.60	under consideration (FR)	under consideration (BE)	To be determined.	1,800 – 3,000 MW			Lille, Ruien area						
	23.A21	Avelin (FR)	Mastaing (FR)	Operation at 400 kV of existing line currently operated at 220 kV.										
	23.A22	Avelin (FR)	Gavrelle (FR)	Substitution of a new double circuit 400 kV OHL to an existing 400 kV single circuit OHL										
24	24.60a	Lillo (BE)	Mercator (BE)	Brabo Project: Doubling of the axis Zandvliet – Mercator via Lillo. First part: erecting a new 22 km double circuit 380 kV OHL with 1,500 MVA capacity Lillo and Mercator.	1,500 MW			Antwerp area						
	24.445	Zandvliet (BE)	Lillo (BE)	Brabo Project: Doubling of the axis Zandvliet – Mercator via Lillo. Second part: erecting a new 22 km double circuit 380 kV OHL with 1,500 MVA capacity Lillo and Zandvliet and a new 400 kV substation in Lillo.										
	24.445a	Gramme (BE)	Van Eyck (BE)	Doubling of 108 km 380 kV axis Gramme – Van Eyck + high performance conductors + new 380 kV substation (Van Eyck).										
	24.A26	Horta (BE)	Doel / Mercator (BE)	Upgrade with high performance conductors.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2012–2013	Mainly progresses as planned although the works on existing lines take slightly longer than initially thought.		Planned France–Italy interconnection development.
design & permitting	2017–2018	Progresses as planned.		
under construction	2013	Authorization process ended, construction phase on going.		
design & permitting	long term	Delays due to authorization process.		
design & permitting	long term	Progresses as planned.		
under consideration	long term	Progresses as planned. Several technical options (route, technologies) have been designed and are being investigated.	The very uncertain environment, regarding commissioning and decommissioning of generation in particular makes the assessment complex.	France–Switzerland interconnection development under consideration.
under consideration	2018–2020	Project entered a feasibility study phase.		France–Belgium interconnection development: internal French grid reinforcements, that are prerequisite to maintain the present NTC and further interconnection development under consideration. This project enhances security of supply in Belgium and allows intra and inter countries RES integration.
design & permitting	2017	New investment in the TYNDP.	Upgrade of all grid assets in northern France at the same standard	
design & permitting	2017	New investment in the TYNDP.		
design & permitting	2017	New date of operation advanced to 2017 due to new generation projects.	Brabo Project	The project aims at ensuring the reliable grid operation to cope with new generation development in the northern part of Belgium and more volatile north–south flows. It also enhances the security of supply in Antwerp harbour.
design & permitting	2017	Permits cancelled by national authority. New permitting procedure has started.	Brabo Project	
design & permitting	2014	Permitting phase has started.		
design & permitting	2016–2020	New investment in the TYNDP. The grid simulations performed by Regional Group North Sea showed higher north–south physical flows on northern Belgian boundary. This project avoid a NTC reduction due to higher loop flows.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	24.A27	Zandvliet (BE)		New PST in Zandvliet substation.	1,500 MW			Antwerp area						
25	25.62	under consideration (FR)	under consideration (GB)	IFA2: New subsea HVDC link between the UK and France. Capacity is still to be determined. (Possibly 1000 MW)	1,000 MW									
26	26.63	Lienz (AT)	Veneto region (IT)	The project foresees the reconstruction of the existing 220 kV interconnection line as 380 kV line on an optimized route to minimize the environmental impact. Total length should be in the range of 100 – 150 km.	750 MW									
	26.47.220	Lienz (AT)		Erection of a new 220/220 kV PST in the substation Lienz (AT).										
	26.47.216													
	26.64	Bressanone (IT)	new substation near Innsbruck (AT)	New double circuit 400 kV interconnection through the pilot tunnel of the planned Brenner Base Tunnel. Total line length: 65 km.										
	26.66	Prati di Vizze (IT)	Steinach (AT)	Upgrade of the existing 44 km Prati di Vizze (IT) – Steinach (AT) single circuit 110/132 kV OHL, currently operated at medium voltage and installing a 110/132 kV PST.										
	26.83	Volpago (IT)	North Venezia (IT)	Realization of a new 380 kV line between the existing substation of North Venezia and the future 380 kV substation of Volpago, connected in and out to the 380 kV “Sandrigo – Cordignano”. Total line length: 31 km										
	26.93	Dolo (IT)	Camin (IT)	New 15 km double circuit 400 kV OHL between existing Dolo and Camin 400 kV substations, to be built in parallel with the existing line.										
	26.97	Polpet (IT)		Voltage upgrade of the existing Polpet 150 kV / medium voltage substation up to 220 kV, complying with 400 kV standards. The substation will be connected by two shorts links to the existing Soverzene – Lienz 220 kV line.										
	26.47.218	Obersielach (AT)	Lienz (AT)	New 190 km 380 kV OHL connecting the substations Lienz (AT) and Obersielach (AT) to close the Austrian 380 kV ring in the southern grid area. Line length: 190 km										
	26.A102	new interconnection between Italy and Austria		New possible interconnection line between Italy and Austria.										
27	27.68	Okroglo (SI)	Udine (IT)	New 120 km double circuit 400 kV OHL with installation of a PST in Okroglo. The thermal rating will be 1,870 MVA per circuit.	>1,800 MW									
	27.92	West Udine (IT)	Redipuglia (IT)	New 40 km double circuit 400 kV OHL between the existing substations of West Udine and Redipuglia, providing in and out connection to the future 400 kV substation of South Udine.										
	27.A96	new interconnection between Italy and Slovenia		New interconnection between Italy and Slovenia.										
	27.223	Cirkovce (SI)	Heviz (HU) Zerjavenec (HR)	The existing substation of Cirkovce (SI) will be connected to one circuit of the existing Heviz (HU) – Zerjavinec (HR) double circuit 400 kV OHL by erecting a new 80 km double circuit 400 kV OHL in Slovenia. The project will result in two new cross-border circuits: Heviz (HU) – Cirkovce (SI) and Cirkovce (SI) – Žerjavenec (HR).										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	2016 – 2020	New investment in the TYNDP. The grid simulations performed by Regional Group North Sea showed higher north – south physical flows on northern Belgian boundary. This project avoid a NTC reduction due to higher loop flows.	4th PST on the Belgian north border.	The project aims at ensuring the reliable grid operation to cope with new generation development in the northern part of Belgium and more volatile north – south flows. It also enhances the security of supply in Antwerp harbour.
under consideration	2020	Further investigations during the feasibility phase have led to reassess the expected commissioning date for "IFA2".		France – UK interconnection development under consideration.
planned	long term	Progresses as planned.		Reinforcement of the interconnection between Italy and Austria. Also the support the interaction between the RES in mainly Italy with the pump storage in the Austrian Alps.
under construction	2012	Project is in errection and expected to be commissioned 2012 according to the schedule.	The investment contributes also to project 47.	
			The investment contributes both to project 26 and project 47. For the technical description see project 47.	
under consideration	>2022	Progresses as planned.		
design & permitting	mid term	Investment delayed with 2 years due to the permitting process.		
design & permitting	2015	Delays due to authorization process.		
under construction	2014	Authorization process ended, construction phase ongoing.		
design & permitting	2015	Authorization process started, project phase ongoing.		
under consideration	long term	Progresses as planned.	The investment contributes also to project 47.	
under consideration	long term	This investment replaces investment n° 65 mentioned on TYNDP 2010. The previous investment evolved so much that it is substituted by a new project. Feasibility studies ongoing including internal reinforcements.		
planned	long term	Progresses as planned.		This project increases the capacity between Slovenia – Italy and Slovenia – Hungary. Project will remove congestion and strengthen connection on north-south and east-west axis.
design & permitting	2015	The investment is delayed due to longer than expected authorization procedures.		
under consideration	long term	Feasibility studies ongoing including the internal reinforcements.	Need for strengthening the connection between Slovenia and Italy and increasing of power exchange capability.	
design & permitting	2016	Presently in the authorization process. This investment was delayed due to permitting process.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs
	27.224	Krsko (SI)	Bericevo (SI)	New 400 kV double circuit OHL. This project will strengthen connection between East and Central part of Slovenia and connect an internal loop. Line length: 80 km	>1,800 MW									
	27.225	Divaca (SI)	Cirkovce (SI)	Upgrading 220 kV lines to 400 kV in corridor Divaca – Klece – Bericevo – Podlog – Cirkovce. Line length: 193 km										
	27.A105	Lika(HR)	Brinje (HR)	New 55 km single circuit 400 kV OHL replacing aging 220 kV overhead line.										
	27.A106	Lika (HR)	Velebit (HR)	New 60 km single circuit 400 kV OHL replacing aging 220 kV overhead line.										
	27.A107	Lika (HR)		New 400/110 kV substation, 2 × 300 MVA.										
	27.A108	Brinje (HR)		New 400/220 kV substation, 1 × 400 MVA.										
	27.229	Plomin (HR)	Melina (HR)	New 90 km double circuit OHL, with two connecting substations and transformer 400/220 kV, 400 MVA.										
	27.227	Banja Luka (BA)	Lika (HR)	New 400 kV interconnection line between BA and HR.										
28	28.70	Villanova (IT)	Lastva (ME)	New 1,000 MW HVDC interconnection line between Italy and Montenegro via 375 km 500 kV DC subsea cable and converter stations at both ending points.	1,000 MW									
	28.86	Foggia (IT)	Villanova (IT)	New 178 km double circuit 400 kV OHL between existing Foggia and Villanova 400 kV substations, also connected in and out to the Larino and Gissi substations. A PST will be installed on the new 400 kV line.										
	28.89	Fano (IT)	Teramo (IT)	New 200 km single circuit 400 kV OHL between the existing 400 kV substations of Fano and Teramo, providing the connection in and out to the future substation to be built in Macerata area.										
	28.232	Visegrad (BA)	Pljevlja (ME)	New 70 km single circuit 400 kV OHL between Visegrad and Pljevlja.										
	28.233a	Lastva (ME)		A new substation will be connected to the existing line 400 kV Podgorica 2 (ME) – Trebinje(BA), with two transformers 2 × 300 MVA 400/110 kV, and convertor station for the DC cable Lastva (Tivat) – Villanova (see 70).										
	28.233b	Lastva (ME)	Pljevlja (ME)	New 160 km double circuit 400 kV OHL existing substation Pljevlja and new substation Tivat.										
	28.A109	Bajina Basta (RS)	Visegrad (BA)	New 400 kV interconnection OHL between RS and BA, and reconstruction of existing two OHL 220 kV between BA and Serbia.										
	28.A110	Bajina Basta (RS)	TPP Obrenovac (RS)	New double circuit 400 kV OHL between new substation Bajina Basta (see infra), and substation Obrenovac.										
	28.A111	Bajina Basta (RS)	Pljevlja (ME)	New 86 km single circuit 400 kV OHL connecting existing substation Pljevlja (ME) and substation Bajina Basta (RS).										
	28.A112	Bajina Basta (RS)		New 400/110 kV substation in Bajina Basta, upgrading an existing 220/110 kV substation.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2015	Authorization process ended, construction phase is on going. This investment was delayed due to permitting process.		This project increases the capacity between Slovenia – Italy and Slovenia – Hungary. Project will remove congestion and strengthen connection on north-south and east-west axis.
planned	long term	Progresses as planned.		
planned	2020	Strengthening of the 400 kV corridor across the Adriatic coast in Croatia in LT period and removal of regional congestion at north-south axis , also to accommodate power transfers from Croatia and Bosnia & Herzegovina to Italy through new IT – ME DC link (Investment 70).		
planned	2020			
planned	2017			
planned	2020			
design & permitting	>2016	Project moved to long term, due to postponed commissioning date of thermal power plant Plomin.		
under consideration	2020	End points of OHL and commissioning date defined after bilateral HR – BA agreement.		
under construction	2015	Authorization process ended, construction phase ongoing. The substations on the ME side has been changed.		It contributes significantly to the increase of GTC between the West Balkans and IT such contributing to market integration; complements the ME – IT cable.
design & permitting	2015	Progresses as planned.		
design & permitting	long term	The investment is delayed due to longer than expected authorization procedures.		
planned	2015	Feasibility study for 400 kV interconnections RS – ME – BA proposed under Infrastructure Projects Facility for western Balkans.		
design & permitting	2015	Feasibility study covering the aspects of route planning, substation location, environmental and social issues and equipment selection is due to end in second half of 2011.		
design & permitting	2016	Feasibility study covering the aspects of route planning, substation location, environmental and social issues and equipment selection is due to end in second half of 2011.		
planned	>2016	New investment in TYNDP.	New 400 kV overhead line between RS and BA. It will eliminate constraints in the region for electric energy transits and exchange.	
design & permitting	>2016	New investment in TYNDP.	Obrenovac is the "strongest" 400 kV node in Serbia, thus providing significant upgrade for evacuation and energy transfer from north to south, and further down in Montenegro, through the new line between Bajina Basta and Pljevlja (ME).	
planned	>2016	New investment in TYNDP.		
planned	>2016	New investment in TYNDP.		

		Project identification			Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	28.A113	Bistrica (RS)		New 220/110 kV substation.	1,000 MW									
	28.A114	Konjsko(HR)	Velebit (HR)	New 100 km single circuit 400 kV OHL replacing ageing 220 kV overhead line.										
	28.231	Konjsko (HR)		Installation of a 150 MVAr reactive power device.										
	28.A115	Plat (HR)		New 220/110 kV substation.										
	28.228	Trebinhe (BA)	Plat (HR)	Re-establishment of two previously existing 220 kV single circuit interconnection Trebinje (BA) – Plat (HR). Total length: 10 km										
29	29.73	El Aouaria (TU)	Partanna (IT)	New 350 km 1000 MW HVDC line between Tunisia and Italy via Sicily with 400 kV DC subsea cable and converters stations at both ends.	1,500 MW									
	29.76	Partanna (IT)	Ciminna (IT)	New 65 km single circuit 400 kV OHL in Sicily between existing Partanna and Ciminna substations.										
	29.A97	unknown (IT)	unknown (AL)	New interconnection between Italy and Algeria – new DC submarine cable.										
30	30.74	Chiaramonte Gulfi (IT)	Sorgente (IT)	Realization of 380 kV ring grid, trough the construction of 3 new 380 kV lines: Chiaramonte Gulfi – Ciminna, Sorgente – Ciminna and Paternò – Priolo. It will be realized a new 380/150 kV substation in Caltanissetta area and the voltage upgrade of the existing Ciminna substation up to 380 kV. Total line length: 365 km New 380/150 kV substation in Sorgente area will be temporaly connected in and out to the existing 400 kV line Paterno – Sorgente and to the local 220 kV and 150 kV network.	1,000 MW			Palermo, Catania, Agrigento and Messina area						
	30.75	Sorgente (IT)	Rizziconi (IT)	New 90 km double circuit 400 kV line, partly via subsea cable and partly via OHL. This line is part of a larger project that foresees the creation of the future 400 kV ring grid of Sicily.										
	30.77	Partinico (IT)	Fulgatore (IT)	New 45 km single circuit 400 kV OHL between Partinico and Fulgatore in western Sicily.										
	30.87	Feroleto (IT)	Maida (IT)	New 400 kV OHL across Calabria between the existing substation of Feroleto and the future substation of Maida, while restructuring the existing grid in North Calabria.										
	30.A98	Mineo (IT)		New 380/150 kV substation in Mineo area connected in and out to the existing 400 kV line Chiaramonte Gulfi – Paterno and to the local HV network.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2015	New investment in TYNDP.	After a topology change in the area, the investment will eliminate firm connection in "Vardiste" (secure and stable operation in Serbian network and systems of Bosnia & Herzegovina and Montenegro), to eliminate constraints in the region for electric energy transits and exchange.	It contributes significantly to the increase of GTC between the West Balkans and IT such contributing to market integration; complements the ME – IT cable.
planned	2020	Strengthening of the 400 kV corridor across the Adriatic coast in Croatia in LT period and removal of regional congestion at north-south axis, also to accommodate power transfers from Croatia and Bosnia & Herzegovina to Italy through new IT – ME DC link (Investment 70).		
design & permitting	2014	Investment postponed 1 year due to permitting process.		
under construction	2013	New investment in TYNDP, contributing to mesh the network surrounding HVDC link IT – ME and to increase the reliability of the EHV system.		
planned	2014	Progresses as planned.		
design & permitting	long term	The investment is delayed due to longer than expected authorization procedures.	This project will be realized in 2 steps. In the previous TYNDP just the first part of the investment was mentioned (500 MW).	Interconnection between Italy and North Africa. Other interconnection projects between North Africa and Italy are still under investigation and under study.
planned	long term	Progresses as planned.		
under consideration	long term	New investment in TYNDP.	Need for a new interconnection between Algeria and Italy and increasing of power exchange capability with North Africa frontier. Feasibility study ongoing.	
planned	2016 / long term	Feasibility studies carried out have led to adapt the schedule.		Sicilian 400 kV transmission ring.
under construction	2014	Delays on construction phase.		
planned	2016	Feasibility studies carried out have led to adapt the schedule.		
design & permitting	mid term	Delays due to authorization process.		
planned	long term	New investment in TYNDP.	Need to overcome the expected congestions on the central-east HV network of Sicily affected by the flows of consistent production from renewable plants.	

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
31	31.85	Pavia area (IT)	Piacenza area (IT)	New 45 km double circuit 400 kV OHL between 2 substations in the Pavia area and Piacenza.	>1,000 MW									
	31.95	Mese (IT)		Voltage upgrade of the existing 220/132 kV Mese substation up to 400 kV.										
	31.99	Avise (IT)	Chatillon (IT)	Voltage upgrade of the existing 40 km Avise – Villeneuve – Chatillon single circuit 220 kV OHL up to 400 kV.										
	31.100	Milan (IT)		Restructuring of the 220 kV network in the urban area of Milan. Some new 220 kV cables (33 km), a new 220 kV substation (Musocco) and some reinforcements of existing assets (35 km) are planned.										
	31.103	Brescia (IT)		New 400/132 kV substation in southeast area of Brescia, connected in and out to the existing Flero – Nave 400 kV OHL, while restructuring the 132 kV network.										
	31.112	Tirano (IT)	Verderio(IT)	New 140 km single circuit 400 kV OHL between Tirano and Verderio substations connecting also the new 400 kV substation Grosio / Piateda.										
	31.124	Mettlen (CH)	Airolo (CH)	Upgrade of existing 225 kV OHL into 400 kV. Line length: 90 km										
	31.A101	new inter-connections between Italy and Switzerland		Up to 4 interconnection projects are under discussion, one or two probably will be implemented.										
32	32.88	Montecorvino (IT)	Benevento (IT)	New 70 km double circuit 400 kV OHL between the existing 400 kV substations of Montecorvino and Benevento II, providing in and out connection to the future substation to be build in Avellino North area, which will be also connected to the existing Matera – S. Sofia 400 kV line.	1,900 MW			Naple urban area, Sorrento Penninsul, minor Campania islands and Tirrenic South coast Italy						
	32.91	Foggia (IT)	Benevento II (IT)	Upgrade of the existing 85 km Foggia – Benevento II 400 kV OHL and installation of a PST on this line.										
	32.96	Deliceto (IT)	Bisaccia (IT)	New 30 km single circuit 400 kV OHL between the future substations of Deliceto and Bisaccia, in the Candela area.										
	32.96a	several new 380 kV substations in Central/South of Italy for RES (IT)		It will be realized few new 380/150 kV substations. The new substations will be connected to the wind power plants in order to avoid the congestions on the 150 kV network and to dispatch the renewable energy produced.										
	32.102	Naples (IT)		Restructuring of the 220 kV network in the urban area of Naples. Some new 220 kV cables and some reinforcements of existing assets are planned. Total length: 36 km										
	32.110a	Aliano (IT)	Montecorvino (IT)	New connection OHL 400 kV between north Basilicata and Campania region.										
	32.A99	restructuring of North Calabria (IT)		New 400 kV OHL between the existing substations of Laino and Altomonte in Calabria and a new 380/150 kV substation in Aliano connected in and out to the existing 400 kV line Matera – Laino and to the local HV network. Related to this project will be acted a great restructuring of the local HV network, downgrading the existing 220 kV lines to 150 kV level and the demolition of great part of existing 150 kV lines inside the Pollino Park.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	long term	Initial design partially changed, with new reinforcements and rearrangements activities on the neighboring areas resulting from further studies.		Increase interconnection capability between IT and CH.
design & permitting	2014	Delays due to authorization process.		
design & permitting	2014	Delays due to authorization process.		
design & permitting	mid term	The cables in the Milan area are in operation, the appropriate substations are under construction and the reinforcements are under design and permitting.		
planned	mid term	Progresses as planned.		
planned	long term	Progresses as planned.		
under consideration	2020	Progresses as planned.		
under consideration	long term	This investment replaces investment n° 120 mentioned on TYNDP 2010. The previous investment evolved so much that it is substituted by a new project. Feasibility studies ongoing including the internal reinforcements.		
design & permitting	mid term	The Avelino substation is under construction, the line is in delay due to authorization process.		Reinforcement between south and central-south of Italy to accommodate increasing market flows.
under construction	2013–2014	Authorization process ended, construction phase ongoing.		
design & permitting	mid term	The 2 substations are in operation from 2011. The connecting line is still in design and permitting. This delay is due to authorization process.		
under construction	mid term	The realization of the substations is delayed. These investments are highly sensitive to the construction of the wind / solar plants that are meant to connect.		
design & permitting	long term	Progresses as planned.		
planned	long term	Progresses as planned.		
partly under construction, design & permitting	2012 / mid term	New investment in TYNDP (initial design partially changed, evolution including new reinforcements and rearrangements activities on the neighbouring areas resulting from further studies).		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
33	33.90	Calenzano (IT)	Colunga (IT)	Voltage upgrade of the existing 80 km Calenzano – Colunga 220 kV OHL to 400 kV, providing in and out connection to the existing 220/150 kV substation of S. Benedetto del Querceto (which already complies with 400 kV standards).	500 MW			central part of Italy						
	33.94	Mantova area (IT)	Modena area (IT)	New 35 km 400 kV OHL between the 2 substations in Modena and Mantova area.										
	33.104	Rome (IT)		Restructuring of the network in the Rome area. The work consists of – a new 380/150 kV substation in southwest area of Rome, connected in and out to the existing 380 kV line Rome West – Rome South, – a voltage upgrade of the existing Flaminia substation up to 380 kV to be connected in and out to the foreseen 380 kV lineRome West – Rome North and – a restructuring of the 150 kV network.										
	33.109	North Bologna (IT)		New 400/132 kV substation in North Bologna area connected in and out to the existing Sermide – Martignone 400 kV line.										
	33.111	Lucca (IT)		New 380/132 kV substation in Lucca area connected in and out to the existing 380 kV line La Spezia – Acciaiolo.										
	33.113	Monte S. Savino (IT)		New 400/220/132 kV substation in Monte S. Savino area connected to the existing S. Barbara 400 kV substation by upgrading an existing 220 kV line.										
34	34.A100	Codrongianos (IT)	Suvereto (IT)	Repowering of existing HVDC interconnection between Sardinia, Corse and mainland Italy via 220 kV DC subsea cable (358 km). The first connection is in operation since 1970. Total capacity of the bipolar link: 500 MW	500 MW									
35	35.137	Vitkov (CZ)	Mechlenreuth (DE)	New 400 kV single circuit tie-line between new (CZ) substation and existing (DE) substation. Length: 70 km	500 MW									
	35.138	tbd (CZ)	tbd (DE) – southeastern part of 50Hertz Transmission control area (Röhrsdorf)	Possible increase of interconnection capacity between CEPS and 50Hertz Transmission is under consideration: – Either a new 400 kV tie-line (OHL on new route) or – a reinforcement of the existing 400 kV tie-line Hradec (CEPS) – Röhrsdorf (50Hertz Transmission).										
	35.306	Vitkov (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA.										
	35.307	Vernerov (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA.										
	35.308	Vernerov (CZ)	Vitkov (CZ)	New 400 kV double circuit OHL, 1,385 MVA.										
	35.309	Vitkov (CZ)	Prestice (CZ)	New 400 kV double circuit OHL, 1,385 MVA.										
	35.311	Kocin (CZ)		Upgrade of the existing substation 400/110 kV; upgrade transformers 2 × 350 MVA.										
	35.312	Mirovka (CZ)		Upgrade of the existing substation 400/110 kV with two transformers 2 × 350 MVA.										
	35.313	Kocin (CZ)	Mirovka (CZ)	Connection of 2 existing 400 kV substations with double circuit OHL having 120.5 km length and a capacity of 2 × 1,385 MVA.										
	35.314	Mirovka (CZ)	V413 (CZ)	New double circuit OHL with a capacity of 2 × 1,385 MVA and 26.5 km length.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	mid term	Delays due to authorization process.		Reinforcement between northern and central part of Italy to accommodate increasing market flows.
planned	long term	During the preliminary consultation process the substations have became uncertain.		
design & permitting	2013 / long term	Progresses as planned.		
design & permitting	mid term	Delays due to authorization process.		
planned	long term	Progresses as planned.		
design & permitting	2015 / long term	Delays due to authorization process.		
planned	long term	New investment in TYNDP.		Reinforcement between Sardinia, Corse and mainland Italy.
under consideration	long term	Progresses as planned.		This project is required to enable power flows between west and east, enhance the transfer capability between CZ and DE and supports the future generation evacuation.
under consideration	long term	Progresses as planned.		
planned	2017 / 2018	It is closely dependent on construction of line investment n°308.		
planned	2013 / 2016	Commissioning date has been divided into two phases: – 1st phase – temporary connection of wind plant 180 MW – 2nd phase – finalization of substation construction including connection to the distribution grid (consumption)		
planned	long term	Permitting procedure complications are foreseen (line crosses protected area).		
under consideration	long term	Permitting procedure complications are foreseen (line crosses protected area).		
design & permitting	long term	Schedule harmonization with market participants.		
planned	long term	Schedule harmonization decided with market participants.		
planned	long term	Schedule harmonization decided with market participants.		
planned	long term	Schedule harmonization decided with market participants.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	35.315	Kocin (CZ)	Prestice (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 115.8 km. Target capacity: 2 × 1,385 MVA	500 MW									
	35.316	Mirovka (CZ)	Cebin (CZ)	Adding second circuit to existing single circuit line (88.5 km, 2 × 1,385 MVA).										
	35.317	Hradec (CZ)	Reporyje (CZ)	Upgrade of existing 400 kV single circuit OHL with length of 116.9 km. Target capacity: 1,385 MVA										
36	36.141	Ishøj / Bjæverskov (DK)	Bentwisch / Güstrow (DE)	The Kriegers Flak Combined Grid Solution is the new offshore multiterminal connection between Denmark and Germany used for both grid connection of offshore wind farms Kriegers Flak and interconnection. Technical features still have to be determined.	600 MW									
37	37.142	Tonstad (NO)	Wilster (DE)	Nord.Link / NorGer: a new HVDC connection between southern Norway and northern Germany. Estimated subsea cable length: 520 – 600 km Capacity: 1,000 MW	up to 1,400 MW									
	37.408	Kristiansand, Feda (NO)		Reactive compensation due to HVDC links NorNed and Skagerak 4. Reactive power devices in 400 kV substations.										
	37.406	(southern part of Norway) (NO)		Voltage uprating of existing 300 kV line Sauda / Saurdal – Lyse – Tonstad – Feda – 1 & 2, Feda – Kristiansand; Sauda-Samnanger in long term. Voltage upgrading of existing single circuit 400 kV OHL Tonstad – Solhom – Arendal. Reactive power devices in 400 kV substations.										
38	38.425	Feda (NO)	tbd (NL)	NorNed 2: a second HVDC connection between Norway and The Netherlands via 570 km 450 kV DC subsea cable with 700 – 1,400 MW capacity.	700 MW									
39	39.428	Kassø (DK)	Tjele (DK)	Rebuilding of a 400 kV OHL of 173 km from a single circuit to a double circuit . This increases the transfer capacity with approx. 1,000 MW.	1,000 – 1,550 MW									
	39.144	Audorf (DE)	Kassö (DK)	Step 3 in the Danish-German agreement to upgrade the Jutland – DE transfer capacity. It consists of partially an upgrade of existing 400 kV line and partially a new 400 kV route in Denmark. In Germany new 400 kV line mainly in the trace of a existing 220 kV line. The total length of this OHL is 114 km.										
40	40.446	Bascharage (LU)	Aubange (BE)	As a first step(2016) a PST could be placed in the existing 225 kV line between LU and BE. In a second stage, two solutions are currently investigated (4 TSOs – Elia, Amprion, CREOS, RTE are involved). Solutions 1 would be a new interconnection between CREOS grid in LU and ELIA grid in BE via a 16 km double circuit 225 kV underground cable with a capacity of 1,000 MVA. Solution 2 would be the interconnection between CREOS grid in LU and ELIA grid in BE via a new 380 kV double circuit. The current study will investigate the impact of this new interconnection on other boundaries (impact of loop flow) and on internal grids . The potential reinforcements of the other boundaries and the internal grids will also be taken into account in the evaluation.	380 – 900 MW			Luxemburg area						

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	long term	Schedule harmonization decided with market participants.		This project is required to enable power flows between west and east, enhance the transfer capability between CZ and DE and supports the future generation evacuation.
under consideration	long term	Schedule harmonization decided with market participants.		
commissioned	commissioned	Commissioned.		
planned	long term	Permission for Danish wind farm KF 3 is in pending. Connection to Sweden is withdrawn at present, but can come on a later stage.		The Kriegers Flak Combined Grid Solution is the new offshore multiterminal connection between Denmark and Germany used for both grid connection of offshore wind farms Kriegers Flak and interconnection.
design & permitting	2018/2021	Revised capacity and progress postponed, due to more demanding system operations and time needed to obtain necessary government permits for reinforcing the national grid.		The purpose is: Market integration with the continent and facilitating RES integration in southern and western Norway. Will also improve security of supply in southern Norway.
design & permitting	2012/2014	Feda is in the planning and permitting stage. Kristiansand is under construction(commissioned expected as planned 2012)		
design & permitting	2016 (2013–2018)	Revised progress. Due to more demanding system operations and time needed to obtain necessary government permits for reinforcing the national grid. The investment now embed former TYNDP 2010's investments 407 and 409 and the technical description has been updated accordingly.		
under consideration	long term	NorNed 2 is now not likely be realized during this planning period but is included in the TYNDP calculations and therefore on the project list. NorNed 2 is not included in the current Norwegian national grid development plan.		Additional interconnection between NO and NL under consideration.
design & permitting	2012/2014	Progresses as planned.		Step 3 in the Danish-German agreement to upgrade the Jutland–DE transfer capacity.
under consideration	2017	Progresses as planned.		
under consideration	2016/2020	The comissioning date and status changed as the study to determine the best investment is still ongoing.		Increase the transfer capability between LU,DE, BE and FR.

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	40.A29	Bascharage (LU)	tbd (BE, DE and / or FR)	New interconnection with neighbor(s) either 220 kV or 400 kV	380 – 900 MW			Luxembourg area						
	40.447	Heisdorf (LU)	Berchem (LU)	New 20 km double circuit mixed (underground cable + OHL) 225 kV project with 1,000 MVA capacity including substations for infeed in lower voltage levels.										
	40.A30	Bascharage (LU)	Niederstedem (DE) or tbd (DE)	Upgrading and new construction of an interconnector to DE, in conjunction with the interconnector in the south of LU. Partial upgrading of existing 220 kV lines and partial new construction of lines. With power transformer station in LU.										
41	41.149	Dollern (DE)	Stade (DE)	New 400 kV double circuit OHL Dollern – Stade including new 400 kV switchgear in Stade. Length: 14 km	>3,000 MW									
	41.150	Conneforde (DE)	Maade (DE)	New 400 kV double circuit (underground cable + OHL) Conneforde – Maade including new 400 kV switchgear Maade. Length: 37 km										
	41.A74	north of Control Area 50Hertz Transmission (DE)		Construction of new substations / lines for integration of newly build power plants in northern part of 50Hertz Transmission control area.										
42	42.152	Dörpen / West (DE)		New substation for connection of offshore wind farms.	>8,000 MW									
	42.159	Cluster BorWin1 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 400 MW										
	42.160	offshore wind park Nordergründe (DE)	Inhausen (DE)	New AC-cable connection with a total length of 35 km.										
	42.161	offshore wind park GEOFreE (DE)	Göhl (DE)	New AC-cable connection with a total length of 32 km.										
	42.163	Cluster HelWin1 (DE)	Büttel (DE)	New HVDC transmission systm consisting of offshore platform, cable and converters with a total length of 145 km. Line capacity: approx. 690 MW This Project includes also a new substation Büttel and connection of this new substation with the existing OHL Brünsbüttel – Wilster.										
	42.164	Cluster SylWin1 (DE)	Büttel (DE)	New line consisting of underground + subsea cable with a total length of 210 km. Line capacity: approx. 864 MW										
	42.165	Cluster DolWin1 (DE)	Dörpen / West (DE)	New line consisting of underground + subsea cable with a total length of 155 km. Line capacity: 800 MW										
	42.166	offshore wind park Riffgat (DE)	Emden / Borßum(DE)	New AC-cable connection with a total length of 80 km.										
	42.167	Cluster BorWin2 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 800 MW										
	42.A82	Cluster DolWin2 (DE)	Dörpen / West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW										
	42.A83	Cluster DolWin3 (DE)	Dörpen / West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under consideration	2020	New investment in TYNDP.	An ongoing network study (4 TSOs involved) investigates the robustness of the planned 220 kV connection between LU and BE and the potentially need for an upgrading to a 400 kV interconnector in the south.	Increase the transfer capability between LU,DE, BE and FR.
design & permitting	2012 / 2017	Progresses as planned.		
under consideration	2020	New investment in TYNDP.		
design & permitting	mid term	This investment depends on the commissioning of a conventional power plant in the area. The additional reason for delay is the long permitting procedure associated with this investment.		Evacuation of the new conventional generation in the 50Hertz and TenneT area.
design & permitting	long term	Progresses as planned.		
planned	long term	New investment in TYNDP, because of additionnal need for generation evacuation. Some of the investments are to be commissioned by the mid term and the some by long term.	Support of conventional generation integration in northeastern Germany, maintaining of security of supply and support of market development.	
under construction	mid term	Progresses as planned.	Commercially sensitive information about this new wind farm connection cannot be displayed in the TYNDP report.	Integration of the offshore wind parks and the onshore grid reinforcements in the northern DE.
under construction	mid term	The commission date of this wind farms connection should be in 2012. Energy transportation is however already enable.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
design & permitting	mid term	Progresses depend on development of the offshore wind farm.		
design & permitting	mid term	Progresses depend on development of the offshore wind farm.		
under construction	mid term	Progresses with delay.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
under construction	mid term	New investment in TYNDP, for connection of new offshore wind farms.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
design & permitting	mid term	New investment in TYNDP, for connection of new offshore wind farms.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	42.A84	Cluster BorWin3	Dörpen / West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 180 km. Line capacity: 900 MW	>8,000 MW									
	42.A85	Cluster HelWin2	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 145 km. Line capacity: 690 MW										
	42.A86	Cluster BorWin4 (DE)	Emden / Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 185 km. Line capacity: 900 MW										
	42.A87	Cluster SylWin2 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 210 km. Line capacity: 800 MW										
	42.211	further connections of more offshore wind farms (DE)		Further connections in the clusters BorWin, DolWin, SylWin and HelWin.										
43	43.A81	Osterath (DE)	Philippsburg (DE)	New HVDC lines from Osterath to Philippsburg to integrate new wind generation especially from North / Baltic Sea towards Central-South Germany for consumption and storage.	10,000 MW			Bavaria and Baden-Württemberg area						
	43.A152	Emden (DE)	Osterath (DE)	New HVDC lines from Endem to Osterath to integrate new wind generation especially from north / Baltic Sea towards Central Germany for consumption and storage.										
	43.A153	Wehrendorf (DE)	Urberach (DE)	New lines in HVDC technology from the region of Lower Saxony to North Baden-Württemberg to integrate new wind generation especially from North Sea towards Central-South Europe for consumption and storage. The investment is part of the transmission corridor Cloppenburg – North Baden-Württemberg.										
	43.A154	Cloppenburg (DE)	Westerkappeln (DE)	New 400 kV double circuit OHL Cloppenburg – Westerkappel (75 km). The investment is part of the transmission corridor Cloppenburg – North Baden-Württemberg.										
	43.A88	Brunsbüttel (DE), Wilster (DE), Kaltenkirchen (DE)	Großgartach (DE), Goldshöfe (DE), Grafenrheinfeld (DE)	New DC lines to integrate new wind generation from northern Germany towards southern Germany and southern Europe for consumption and storage.										
	43.A75	Lauchstadt (DE)	Meitingen (DE)	New DC lines to integrate new wind generation from Baltic Sea towards Central / Ssouth Europe for consumption and storage.										
	43.A89	Area of northern Lower Saxony (DE)		New lines for integration of on- and offshore wind generation incl. 380 kV lines Halbemond – Emden, Emden – Conneforde and Conneforde – Cloppenburg. Total length: 160 km										
	43.A90	Area of Schleswig-Holstein (DE)		About 300 km new 380 kV lines and around 24 new transformers for integration of onshore wind in Schleswig-Holstein, incl. lines – Brunsbüttel – Barlt – Heide – Husum – Niebüll – border of Denmark, – Audorf – Kiel – Göhl – Siems – Lübeck – Kaltenkirchen and – Kaltenkirchen – Itzehoe – Brunsbüttel.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	mid term	New investment in TYNDP for connection of new offshore wind farms.		Integration of the offshore wind parks and the onshore grid reinforcements in the northern DE.
under construction	mid term	New investment in TYNDP for connection of new offshore wind farms.	Due to nondisclosure aggreements it is not possible to give further information about this wind farm connection in TYNDP	
under consideration	long term	New investment in TYNDP for connection of new offshore wind farms.		
under consideration	long term	New investment in TYNDP for connection of new offshore wind farms.		
under consideration	long term	Progresses depend on development of the offshore wind farm.		
under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		Combined DC and AC new infrastructure to accommodate the new RES generation, the associated flows from north to south and also to secure the security of supply in South Germany.
under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		
under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		
under consideration	long term	New investment in TYNDP due to increase of RES and changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		
under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.	New Investment due to increase of RES and changes in conventionel power plants in Germany and increase transits.	
under consideration	long term	New investment in TYNDP due to new wind generation projects.		
under consideration	long term	New investment in TYNDP due to new wind generation projects.	The German West-coast line (Brunsbuettel – Niebuel) is planned to be connected to the Danish grid in the 400 kV substation Endrup. The distance from the German/Danish border is approx. 80 km. Bilateral technical/economical investigations are ongoing. Reinforcements in the Danish 400 kV grid are foreseen in order to facilitate the increased power exchange capacity on the Danish-German border	

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
44	44.147	Dollern (DE)	Hamburg / Nord (DE)	New 400 kV double circuit OHL Dollern – Hamburg / Nord including one new 400/230 kV transformer in substation Hamburg / Nord and new 400 kV switchgear Kummerfeld. Length: 43 km	5,000 MW			Bavaria and Baden-Württemberg area						
	44.148	Audorf (DE)	Hamburg / Nord (DE)	New 400 kV double circuit OHL Audorf – Hamburg / Nord including two new 400/230 kV transformers in substation Audorf. Length: 65 km										
	44.151	Wehrendorf (DE)	Ganderkesee (DE)	New line (length: approx. 95 km), extension of existing and erection of substations, erection of 380/110 kV transformers.										
	44.156	Niederrhein (DE)	Dörpen / West (DE)	New 400 kV double circuit OHL Dörpen – Niederrhein including extension of existing substations. Length: 167 km										
	44.157	Wahle (DE)	Mecklar (DE)	New 400 kV double circuit OHL Wahle – Mecklar including two new substations. Length: 210 km										
	44.90.170	Großgartach (DE)	Hüffenhardt (DE)	New 380 kV OHL. Length: 23 km Included with the project: – 1 new 380 kV substation – 2 transformers										
	44.171	Hüffenhardt (DE)	Neurott (DE)	Upgrade of the line from 220 kV to 380 kV. Length: 11 km Included with the project: 1 new 380 kV substation.										
	44.90.172	Mühlhausen (DE)	Großgartach (DE)	Upgrading line from 220 kV to 380 kV. Length: 45 km										
	44.90.173	Hoheneck (DE)	Endersbach (DE)	Upgrading line from 220 kV to 380 kV. Length: 20 km										
	44.174	Bruchsal Kändelweg (DE)	Ubstadt (DE)	A new 380 kV OHL. Length: 6 km										
	44.90.176	Daxlanden (DE)	Eichstetten (DE)	Upgrade of transmission capacity of existing 380 kV line. Length: 120 km										
	44.178	Baden-Württemberg, Süden & Nordosten (DE)"		Installation of 2 × 250 MVAr 380 kV capacitance banks.										
	44.179	Rommerskirchen (DE)	Weißenthurm (DE)	New line, extension of existing and erection of substations, erection of 380/110 kV transformers. Total line length: 100 km.										
	44.181	Dauersberg (DE)	Limburg (DE)	New 380 kV double circuit OHL, extension of existing of substations. Total line length: 20 km										
	44.182	Kriftel (DE)	Obererlenbach (DE)	New 400 kV double circuit OHL Kriftel – Obererlebenbach in existing OHL corridor. Length: 11 km										
	44.A80	Area of West Germany (DE)		Installation of several 300 MVAr 380 kV capacitance banks, extension of existing substations.										
	44.183	Wehrendorf (DE)		Installation of 300 MVAr 380 kV capacitance banks, extension of existing substations.										
	44.184	Bürstadt (DE)		Installation of 2 × 300 MVAr 380 kV capacitance banks, extension of existing substations.										
	44.185	area of Muensterland and Westfalia (DE)		New lines and installation of additional circuits, extension of existing and erection of several 380/110 kV substations. Total length: approx. 110 km										
	44.186	Gütersloh (DE)	Bechterdissen (DE)	New lines and installation of additional circuits, extension of existing and erection of 380/110 kV substation. Total line length: 27 km										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	mid term	Delays due to authorization process.		This project helps accommodating the increasing flows, coming mainly form RES, from northwestern Germany to southwestern Germany and Switzerland.
design & permitting	mid term	This investment was scheduled for 2015. Presently it is foreseen a delay of around 1 year due to permitting process.		
design & permitting	mid term	Delays due to authorization process.		
design & permitting	mid term	Delays due to authorization process.		
design & permitting	mid term	Delays due to authorization process.		
under construction	2012	Progresses as planned		
planned	2020	Progresses as planned		
design & permitting	2014	Progresses as planned.	This investment contributes to both project 90 and 44.	
design & permitting	2014	Progresses as planned.	This investment contributes to both project 90 and 44.	
design & permitting	2014	Postponed from one year due to permitting procedures.		
under consideration	2020	Progresses as planned.	This investment contributes to both project 90 and 44.	
under construction	2014	One more bank in addition. Two have already been installed. Projects realized earlier because the need for reactive power compensation became urgent.		
under construction, design & permitting	mid term	Some parts are commissioned but the main elements of the investment are still in design and permitting due to delays in permitting process.		
under construction, design & permitting	mid term	Some parts are commissioned but the main elements of the investment are still in design and permitting due to delays in permitting process.		
planned	mid term	Some parts are commissioned but the main elements of the investment are still in design and permitting due to delays in permitting process.		
under consideration	long term	New investment in TYNDP, because of additional needs for RES integration (combined with SoS).		
design & permitting	mid term	Delays due to authorization process.		
design & permitting	mid term	Delays due to authorization process.		
design & permitting	long term	Delays due to authorization process.		
under construction	mid term	Delays due to authorization process.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs
	44.187	area of West-Rhineland (DE)		New lines and installation of additional circuits, extension of existing and erection of several 380/110 kV substations.	5,000 MW			Bavaria and Baden-Württemberg area						
	44.188	Kruckel (DE)	Dauersberg (DE)	New lines, extension of existing and erection of several 380/110 kV substations. Total line length: 130 km										
	44.A78	Pkt. Metternich (DE)	Niederstedem (DE)	Construction of new 380 kV double circuit OHLs, decommissioning of existing old 220 kV double circuit OHLs, extension of existing and erection of several 380/110 kV substations. Length: 108 km										
	44.A77	area of South Wuerttemberg (DE)		Construction of new 380 kV double circuit OHLs, decommissioning of existing double circuit OHLs, extension of existing 380 kV-substations. Length: approx. 60 km										
	44.190	Saar-Pfalz-Region (DE)		New lines, extension of existing and erection of several 380/110 kV substations. Upgrade of an existing line from 220 to 380 kV										
	44.A155	Conneforde (DE)	Unterweser (DE)	Upgrade of 230 kV circuit Unterweser – Conneforde to 400 kV. Line length: 32 km										
	44.A156	Dollern (DE)	Elsfleht / West (DE)	New 400 kV line in existing OHL corridor Dollern – Elsfleht / West. Length: 100 km										
	44.A157	Dollern (DE)	Landesbergen (DE)	New 400 kV line in existing OHL corridor Dollern – Sottrum – Wechold – Landesbergen (130 km).										
	44.A158	Hamm / Uentrop (DE)	Kruckel (DE)	Extension of existing line to a 400 kV single circuit OHL Hamm / Uentrop – Kruckel. Length: 60 km										
	44.A159	Pkt. Blatzheim (DE)	Oberzier (DE)	New 400 kV double circuit OHL Pkt. Blatzheim – Oberzier including extension of existing substations. Length: 16 km										
	44.A160	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 400 kV double circuit OHL Urberach – Pfungstadt – Weinheim – Daxlanden including extension of existing substations. Length: 219 km										
	44.A161	Bürstadt (DE)	Daxlanden (DE)	New line and extension of existing line to 400 kV double circuit OHL Bürstadt – Lambshein – Daxlanden including extension of existing substations. Length: 134 km										
	44.A162	Großgartach (DE)	Endersbach (DE)	Extension of existing 400 kV line Großgartach – Endersbach. Lenght: 32 km										
	44.175	Birkenfeld (DE)	Ötisheim (DE)	A new 380 kV OHL. Length: 11 km										
	44.189	Niederrhein (DE)	Utfort (DE)	New 380 kV double circuit OHL Niederrhein – Utfort (24 km).										
45	45.90.177				5,000 MW			Bavaria and Baden-Württemberg area						
	45.191	Neuenhagen (DE)	Vierraden (DE)	Project of new 380 kV double circuit OHL Neuenhagen – Vierraden – Bertikow with 125 km length as prerequisite for the planned upgrading of the existing 220 kV double circuit interconnection Krajnik (PL) – Vierraden (DE / 50Hertz Transmission).										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2013	Progresses as planned.		This project helps accommodating the increasing flows, coming mainly form RES, from northwestern Germany to southwestern Germany and Switzerland.
planned	long term	Progresses as planned.		
planned	long term	New investment in TYNDP.	RES integration / Market integration especially east-west-direction.	
planned	long term	New investment in TYNDP.	RES integration combined with pump storage in the alp region (market) / increasing of the NTC DE – CH / AT.	
planned	long term	Delays due to authorization process.	Security of Supply (Neub. Frltg Fraulaut – Saarwellingen) combined with RES integration.	
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
planned	2020	New investment in TYNDP.		
under consideration	long term	New investment in TYNDP.		
			The investment contributes both to project 45 and project 90. For the technical description see project 90.	This project helps accommodating the increasing flows coming mainly form RES in NE DE to South DE and to the Alps.
design & permitting	2013 / 2015	Project in permitting phase, strong local resistance.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	45.193	Halle / Saale (DE)	Schweinfurt (DE)	New 380 kV double circuit OHL between the substations Vieselbach – Altenfeld – Redwitz with 215 km length combined with upgrade between Redwitz and Grafenrheinfeld (see project 153). The Section Lauchstedt – Vieselbach has already been commissioned. Support of RES integration in Germany, annual redispatching cost reduction, maintaining of security of supply and support of the market development. The line crosses the former border between East and West Germany and is right downstream in the main load flow direction. The project will help to avoid loop flows through neighboring grids.	5,000 MW			Bavaria and Baden-Württemberg area						
	45.197	Neuenhagen (DE)	Wustermark (DE)	Construction of new 380 kV double circuit OHL between the substations Wustermark – Neuenhagen with 75 km length. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.										
	45.199	Western Pomerania (DE)	Uckermark North (DE)	Construction of new 380 kV double circuit OHLs in northeastern part of 50Hertz Transmission control area and decommissioning of existing old 220 kV double circuit OHLs, incl. 380 kV line Bertikow – Pasewalk (30 km). Length: 135 km Support of RES and conventional generation integration in North Germany, maintaining of security of supply and support of market development.										
	45.200	Lubmin (DE)	Erfurt area (DE)	380 kV grid enhancement and structural change area Lubmin / Stralsund and area Magdeburg / Wolmirstedt, incl. 380 kV line Güstrow – Wolmirsted (195 km).										
	45.202	area upper Lausitz (DE)	area Gera(DE)	Upgrading existing double circuit 380 kV OHL Bärwalde – Schmölln in the southeastern part of the control area of 50Hertz Transmission. Length: approx. 50 km Support of RES and conventional generation integration in northeastern Germany, maintaining of security of supply and support of market development.										
	45.204	Calbe (DE)		Construction of new 380 kV double circuit OHL between substation Calbe for double connection / loop into an existing line.										
	45.205	Fördertsedt	area Magdeburg (DE)	Construction of new 380 kV double circuit OHL from the substation Förderstedt with 20 km length for double connection / loop in for Förderstedt. Reinforcement of existing switchgear. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.										
	45.206	area Leipzig(DE)	area Chemnitz (DE)	Construction of new double circuit 380 kV OHL in existing corridor Röhrsdorf – Remptendorf (103 km).										
	45.207	substations in southwestern part of 50Hertz Transmission control area (DE)		Construction of new 380 kV substation in southern Magdeburg area and restructuring of existing 220 kV equipment. Total length: approx. 50 km										
	45.208	lines and substations in southwestern part of 50Hertz Transmission control area (DE)		Construction of new 380 kV double circuit OHL in existing corridor Pulgar – Vieselbach (103 km). Support of RES and conventional generation integration, maintaining of security of supply and support of market development.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	mid term	Project partly completed, strong local public resistance. Delay due to permitting process.		This project helps accommodating the increasing flows coming mainly form RES in NE DE to South DE and to the Alps.
under construction	mid term	Project partly under construction and partly in permitting phase. Expected date of commissioning was adjusted due to long permitting process and strong local public resistance.		
planned	2015	Progresses as planned.		
planned	long term	Progresses as planned.		
design & permitting	2017	Progresses as planned.		
planned	mid term / long term	The evolution of this investment depends on the development of the power plant in the area. The date mentioned in the TYNDP 2010 was a typing mistake.		
planned	2015/2020	Progresses as planned.		
under consideration	2020	Progresses as planned.		
planned	long term	Some of the investments are to be commissioned by the mid term and the some by long term.		
planned	2015/2020	Progresses as planned.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	45.209	substations in 50Hertz Transmission control area (DE)		Extension of existing and erection of new 380 kV substations and several 380/110 kV substations, incl. reactive power compensation devices.	5,000 MW			Bavaria and Baden-Württemberg area						
	45.A163	Wolmirstedt (DE)	Wahle (DE)	New double circuit OHL 380 kV. Line length: 111 km										
	45.A164	Vieselbach (DE)	Mecklar (DE)	New double circuit OHL 400 kV in existing OHL corridor (129 km).										
	45.A165	Mecklar (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400 kV (130 km).										
	45.A166	Altenfeld (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400 kV (130 km).										
	45.A169	Grafenrheinfeld (DE)	Grossgartach (DE)	Additional 380 kV circuit on an existing line. Length: 160 km										
	45.A167	Redwitz (DE)	Schwandorf (DE)	New double circuit OHL 400 kV in existing OHL corridor Redwitz – Mechlenreuth – Etzenricht – Schwandorf (185 km).										
	45.A168	Raitersaich (DE)	Isar (DE)	New 400 kV line in existing OHL corridor Raitersaich – Ludersheim – Sittling – Isar (160 km).										
	45.153	Redwitz (DE)	Grafenrheinfeld (DE)	Upgrade of 230 kV connection Redwitz – Grafenrheinfeld to 400 kV, including new 400 kV switchgear Eltmann. Line length: 97 km										
	45.154	Redwitz (DE)		New 500 MVAr SVC in substation Redwitz.										
	45.155	Raitersaich (DE)		New 500 MVAr SVC in substation Raitersaich.										
	45.47.158													
46	46.194	wind farm cluster Baltic Sea East (DE)	Lüdershagen / Lubmin (DE)"	Offshore wind farm connection project (by AC-cables on transmission voltage level or by clustering with DC connections) has to be constructed and afterwards also to be operated by the TSO (in this project: 50Hertz Transmission) according to German law.	>2,000 MW									
	46.195	wind farm cluster Baltic Sea West (DE)	Bentwisch (DE)	Offshore wind farm connection project (by AC-cables on transmission voltage level or by clustering with DC connections) has to be constructed and afterwards also to be operated by the TSO (in this project: 50Hertz Transmission) according to German law.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	mid term	This investment includes several substations in the 50Hertz Transmission control area. Present status varies form design & permitting, planning to under consideration and the date of commissioning varies from short / mid to long term.		This project helps accommodating the increasing flows coming mainly form RES in NE DE to South DE and to the Alps.
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
design & permitting	mid term	Investment delay due to delay in the implementation or the line Halle – Schweinfurt (investment 45.193).		
planned	mid term	Progresses as planned.		
planned	mid term	Progresses as planned.		
			The investment contributes both to project 45 and project 47. For the technical description see project 47.	
design & permitting	2012-2020	This investment includes several connections of offshore wind farms in the eastern part of the Baltic Sea. The present expected date of commissioning varies from 2012 to 2020.		The integration of offshore wind generation in the Baltic Sea.
design & permitting	2013-2020	This investment includes several connections of offshore wind farms in the western part of the Baltic Sea. The present expected date of commissioning varies from 2013 to 2020.		

		Project identification			Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
47	47.A76	Vöhringen / Leupolz (DE)	Westtirol (AT)	Upgrade of an existing OHL to 380 kV, extension of existing and erection of new 380 kV substations including 380 / 110 kV transformers. Transmissions routs Vöhringen – Westtirol and Pkt. Woringen – Memmingen. Length: 114 km. This project will increase the current power exchange capacity between the DE, AT and CH.	>2,000 MW									
	47.158	Irsching (DE)	Ottenhofen (DE)	Upgrade of 230 kV connection Irsching – Ottenhofen to 400 kV, including new 400 kV switchgear Zolling. Length: 76 km										
	47.212	Isar / Ottenhofen (DE)	St. Peter (AT)	New 400 kV double circuit OHL Isar – St. Peter including new 400 kV switchgears Altheim, Simbach and St. Peter, and one new 400/230 kV transformer in substation Altheim and fourth circuit on line Isar – Ottenhofen. Line length: 90 km										
	47.26.216	St. Peter (AT)	Tauern (AT)	Completion of the 380 kV line St. Peter – Tauern. This contains an upgrade of the existing 380 kV line St. Peter – Salzburg from 220 kV operation to 380 kV operation and the erection of a new internal double circuit 380 kV line connecting the substations Salzburg and Tauern (replacement of existing 220 kV lines on optimized routes). Moreover the erection of the new substations Wagenham and Pongau and the integration of the substations Salzburg and Kaprun is planned. Line length: 130 km										
	47.26.218													
	47.219	Westtirol (AT)	Zell-Ziller (AT)	Upgrade of the existing 220 kV line Westtirol – Zell-Ziller and erection of additional 220/380 kV transformers. Line length: 105 km										
	47.26.220													
	47.221	St. Peter (AT)	Ernsthofen (AT)	Upgrade from 220 kV operation to 380 kV and erection of a 380 kV substation in Ernsthofen and St. Peter.										
48	48.214	Gabcikovo (SK)	Gőnyü area (HU)	New interconnection (new 2 × 400 kV tie-line) between SK and HU starting from Gabčíkovo substation (SK) to the Gőnyü substation on Hungarian side (preliminary decision). Project also includes the erection of new switching station Gabčíkovo next to the existing one.	SK – HU 1,100 MW / HU – SK 400 MW			(North-West Hungary)						
	48.298	Veľký Ďur (SK)	Gabčíkovo (SK)	Erection of new 2 × 400 kV line between two important substations and extension of the substation Veľký Ďur (SK) Line length: 93 km										
	48.A125	Veľký Ďur (SK)	Levice (SK)	The erection of new 1 × 400 kV line between two important Veľký Ďur and Levice substations, including extension of the Veľký Ďur and Levice substation. The driver for this project is expected connection of to new generation units in Veľký Ďur area.										
	48.A126	Rimavská Sobota (SK)	Sajóivánka (HU)	Connection of the two existing substations (R.Sobota (SK) – Sajóivánka (HU)) by the new 2 × 400 kV line (preliminary armed only with one circuit).										
	48.A127	Sajóivánka (HU)	—	Second 400/120 kV transformer and 2 × 70 Mvar shunt reactors in station Sajóivánka.										
	48.A128	Győr (HU)	—	Third 400/120 kV transformer and 70 Mvar shunt reactor in station Győr.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	long term	New investment in TYNDP.		The reinforcement of the interconnection between Austria and Germany. Also the support the interaction between the RES in northern Europe(mainly DE) with the pump storage in the Austrian Alps. The project scheduling is not related only to the network needs, but even to the feasibility and to the authorization process (the possibility to anticipate specific projects could be evaluated in the future considering the three above mentioned elements).
planned	mid term	Progresses as planned.	The investment contributes also to project 45.	
design & permitting	2017	Progresses as planned.		
design & permitting	2017 / 2019	Preparation for the permitting procedure is ongoing. APG is making efforts to set the 380 kV Salzburg-line 2017 into service. Depending on possible delays during the permitting procedure the commissioning is expected between 2017 and 2019	The investment contributes also to project 26.	
partly under construction	2013 – 2020	Project consists of several measures and is on schedule.	The investment contributes both to project 26 and project 47. For technical description please see project 26.	
			The investment contributes both to project 26 and project 47. For technical description please see project 26.	
under construction	2013	The project is on schedule. Permissions are obtained. Commissioning is expected for 2013		
under consideration	2016	The commissioning date has been moved to earlier term due to earlier erection of new 400 kV line Veľký Ďur – Gabčíkovo that help to evacuate power from new NPP.	Negotiations still in progress. This project is closely connected with the project of erection of new line between Rimavska Sobota substation (SK) and Sajoivanka substation (HU) (see below).	This cluster will increase the transfer capacity between Slovak and Hungarian network systems and increase security of supply. The internal interconections in Slovakia are necessary for the same objective. Also this cluster is important for support of North – South flow from RES in North of EU.
planned	2016	The commissioning date has been moved to earlier term due to ensure security of power evacuation from new NPP in Veľký Ďur area.		
under consideration	2018	New investment in TYNDP, which will significantly increase of the security and reliability of the power evacuation from new NPP.		
under consideration	2016	New investment in TYNDP.	Negotiations / bilateral studies in progress. This project is closely connected with the project 2 × 400 kV line Gabčíkovo (SK) – Hungary (see above).	
under consideration	2016	New investment in TYNDP.		
under consideration	2016	New investment in TYNDP.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
49	49.235	Tirana(AL)	Pristina (RS)	New 238 km 400 kV OHL. On 78 km the circuit will be installed on the same towers as the Tirana – Podgorica OHL currently in construction (see project 233), the rest will be built as single circuit line.	600 MW									
	49.236	Leskovac(RS)	Stip (MK)	New 220 km 400 kV single circuit overhead interconnection between Serbia and FYR of Macedonia. A new 400/110 substation will be built in Serbia between connection nodes.										
	49.237	TPP Kosovo (RS)	Skopje (MK)	A new 400 kV OHL relevant to planning investment of 2,000 MW of TPP in the area of Kosovo and Metohija. Line length: 85 km										
	49.252	Melliti (GR)	Kardia (GR)	New 400 kV double circuit OHL. Length: 40 km										
	49.253	Kardia (GR)	Trikala (GR)	New 400 kV double circuit OHL. Length: 80 km										
	49.254	Larissa(GR)	Trikala (GR)	New 400 kV double circuit OHL. Length: 57 km										
50	50.238	Pancevo (RS)	Resita (RO)	New 131 km double circuit 400 kV OHL between existing substations in Romania and Serbia (63 km on Romanian side and 68 km on Serbian side).	1,000 MW			Area Belgrade and south Banat region						
	50.269	Portile de Fier (RO)	Resita (RO)	New 400 kV OHL between existing substation 400 kV Portile de Fier and new 400 kV substation Resita. Line length: 116 km New 400 kV substation Resita, with 400/220 kV and 400/110 kV transformers, as development of the existing 220/110 kV substation.										
	50.A116	Beograd 20 (RS)		New 400/110 kV substation on the Belgrade territory.										
	50.A117	Kraljevo 3 (RS)		Upgrade of the existing 220/110 kV substation Kraljevo 3 by constructing the 400 kV level.										
	50.A118	Kraljevo 3 (RS)	Bajina Basta (RS)	New 140 km double circuit 400 kV OHL between substation Kraljevo 3 and substation Bajina Basta. Kraljevo 3 (400 kV) will be connected to Kragujevac 2 (400 kV) substation, which is connected to Sofia (Bulgaria) through a 400 kV line.										
	50.270	Resita (RO)	Timisoara – Sacalaz – Arad (RO)	Upgrade of an existing 220 kV double circuit line to 400 kV double circuit line and replacement of 220 kV substations Timisoara and Sacalaz with 400 kV substations. Line length: 156 km										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2013	Line in Albania is already constructed. The rest of the lines develops according to the schedule.		It increases significantly the north to south GTC thus accommodating bulk transports to GR, MK and AL.
under construction	Serbian part commissioned, Macedonian part: 2013	Serbian part is completed. Regarding the Macedonian part, the design is finished, the land acquisition is ongoing and the construction tender is in preparation.		
under consideration	2020	Progresses as planned.		
design & permitting	long term	Due to new thermal generation in South Greece the investment is no more needed urgently and postponed to the longer term. (This investment mainly was initially designed to solve voltage problems in South Greece.)		
design & permitting	long term	Progresses as planned.		
under consideration	long term	Progresses as planned.		
design & permitting	2015 (2019?)	Due to financing gap, the commissioning deadline was postponed to 2019. RO intends to apply for funding through the Operational Programme "Increase of Economic Competitiveness" – Priority Axis 4. This would ensure realization of the project and allow for faster finalization (2015 instead of estimated 2019). Constructive characteristics were updated as a result of progress of feasibility and design studies.		This project increases the transfer capability between Serbia, Romania and accommodates new RES generation on the west / east part of Romanian, respectively Serbia. It also increases the transfer capability on the interface between RO + BG / RS + BA + ME.
design & permitting	2016	Constructive characteristics were updated as a result of progress of feasibility and design studies. Commissioning date has been slightly shifted.		
under construction	2012	New investment in TYNDP.	By taking large amount of load from other Belgrade substations, the investment will both – improve the local SoS significantly and – relieve the constraints on the EHV local network and enable greater inter-area transits.	
design & permitting	2015	New investment in TYNDP.		
planned	>2015	New investment in TYNDP.	New axis for transits from east to west, typically from Bulgaria to Bosnia & Herzegovina, Montenegro and further to the west.	
design & permitting	2022	Due to financing gap, the commissioning deadline was postponed to 2022. Constructive characteristics were updated as a result of progress of feasibility and design studies.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
51	51.239	Bitola (MK)	Elbasan (AL)	New 200 km cross-border single circuit 400 kV OHL between existing substations. New 400/110 kV substation in Ohrid area connected in/out to the new 400 kV line Bitola – Elbasan.	BG – AL 1,255 MW / BG – TR >1,000 MW									
	51.244	Filippi (GR)	Lagadas (GR)	New 400 kV substation in Lagadas in Thessaloniki area and connection to the existing substation of Filippi via a new 110 km double circuit 400 kV OHL.										
	51.256	Maritsa East 1 (BG)	N. Santa (GR)	New interconnection line BG – GR by a 130 km single circuit 400 kV OHL.										
	51.257	Maritsa East 1 (BG)	Plovdiv (BG)	New 100 km single circuit 400 kV OHL in parallel to the existing one.										
	51.258	Maritsa East 1 (BG)	Maritsa East 3 (BG)	New 13 km single circuit 400 kV OHL in parallel to the existing one.										
	51.262	Maritsa East 1 (BG)	Burgas (BG)	New 400 kV OHL. Line length: 150 km										
52	52.240	Patras (GR)	400 kV Continental System (GR)	New 400 kV substation in Patras (GIS Technology) and in/out connection to the existing Axeloos – Distomo 400 kV OHL via a new 15 km double circuit line, part of which will consist of subsea cable. The project shall constitute the first 400 kV corridor to Peloponnese.	600 – 700 MW			Peloponnese area						
	52.241	Patras (GR)	Megalopolis (GR)	New 400 kV substation in Megalopolis and connection to Patras 400 kV substation via a 110 km double circuit OHL. 2nd corridor to Peloponnese.										
	52.242	Megalopolis (GR)	Korinthos (GR)	Construction of a new 400 kV substation in Korinthos (GIS Technology) and connection to the Megalopolis substation via a 110 km double circuit 400 kV OHL.										
	52.243	Korinthos (GR)	Koymoyndoyros (GR)	Replacement of the existing 150 kV double circuit line by a 87 km double circuit 400 kV OHL.										
53	53.276	Suceava (RO)	Gadalin (RO)	New 400 kV OHL between existing stations. Line length: 260 km	2,000 – 2,500 MW									
	53.A131	Stejaru (RO)	Gheorghieni (RO)	Reconductoring (with HTLS) of existing simple circuit 220 kV line.										
	53.273	Cernavoda (RO)	Stalpu	New 400 kV double circuit OHL between existing stations. Line length: 145 km										
	53.274	Constanta (RO)	Medgidia (RO)	New 400 kV double circuit (one circuit wired) OHL between existing stations. Line length: 75 km										
	53.275	Smardan (RO)	Gutinas (RO)	New 400 kV double circuit OHL between existing stations. Line length: 140 km										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	2015	Change of date of commissioning due to – resolving the problems in the 110 kV in southwestern Macedonia, – facilitate the market integration and – increased interest of potential investors.	Selection of consultant for preparation of feasibility study.	East-west corridor from Bulgaria to Italy. Investments 257, 258 and 262 can build up an independent sub-project, as they will both – develop altogether, specifically grid transfer capability with Turkey, and – contribute with all other investments clustered in the project to developing GTC east – west from Bulgaria to Bosnia & Herzegovina and Montenegro.
under construction	2013	Initial delays due to authorization process. The project is now under construction.		
design & permitting	long term	After the interconnection with Turkey, the project can be delayed to LT as it is mainly connected to further RES development. The final commissioning date is subject to change depending of the evolution in the area.		
design & permitting	2014	Investments 257, 258 and 262 are postponed because the permitting procedures (environmental requirements) with the land owners induced delays.		
design & permitting	2014			
design & permitting	2014			
design & permitting	2013	The project is likely to be delayed mainly due to the environmental concerns. Strong opposition by the local communities resulted in the delay in permitting procedures and subsequent delay in the expected date of commissioning.		It increases significantly the GTC to / from the peninsula of Peloponnese, thus allowing the accommodation of large amount of RES in the peninsula and also contributes to market integration.
design & permitting	2013			
design & permitting	2014			
design & permitting	2014			
planned	2021	Constructive design characteristics and time schedule were updated as a result of progress of feasibility and design studies.		The project will help evacuate important amount of new generation (wind + nuclear generation) in the eastern part of Romania.
under consideration	2015	New investment in the TYNDP, required to integrate new RES generation and maintain the GTC for the entire project.		
planned	2017	Constructive characteristics were updated as a result of progress of feasibility and design studies.		
planned	2020	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.		
planned	2020	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.		

				Project identification						Project assessment				
Project number	**Investment number**	**Substation 1**	**Substation 2**	**Brief technical description**	**Grid transfer capacity increase**	**Socio-economic welfare**	**RES integration**	**Improved security of supply**	**Losses variation**	**CO_2 mitigation**	**Technical resilience**	**Flexibility**	**Social and environmental impact**	**Project costs**
	53.271	connection in / out in Medgidia (RO) of actual 400 kV OHL Isaccea(RO) – Varna (BG)		The 400 kV Isaccea (RO) – Varna (BG) is passing near 400 kV substation Medgidia S. The line shall be connected in Medgidia S through a double circuit OHL. New wind farms shall be connected to the 400 kV OHL Isaccea – Medgidia S section. Substation Medgidia S, 400 kV, shall be refurbished with GIS technology in order to provide necessary space for new connections.	**2,000 – 2,500 MW**									
	53.A132	Stalpu (RO)	Teleajen (RO) – Brazi (RO)	Upgrade of an existing 220 kV single circuit line to 400 kV. New 400 kV substations: – Stalpu (400/110 kV, 1 × 250 MVA), – Teleajen (400/110 kV, 1 × 400 MVA)										
	53.A133	Fantanele (RO)	Ungheni (RO)	Reconductoring (with HTLS) of existing simple circuit 220 kV line.										
	53.272	connection in / out in Medgidia (RO) of actual 400 kV OHL Isaccea(RO) – Varna (BG)		Connection in / out in Medgidia (RO) of existing 400 kV OHL Isaccea (RO) – Dobrudja (BG), passing nearby. The line shall be connected in Medgidia S through a double circuit OHL. Substation Medgidia S, 400 kV, shall be refurbished with GIS technology in order to provide necessary space for new connections.										
	53.A134	Gheorghieni (RO)	Fantanele (RO)	Reconducting (with HTLS) of existing simple circuit 220 kV line.										
54	54.293	Voľa (SK)	point of splitting (SK)	Splitting of the existing single 400 kV line between Lemešany and Veľké Kapušany substations to connect the new 400 kV substation Voľa with transformation 400/110 kV (replacing existing 220 kV substation). New 400 kV double circuit OHL. Length: 23 km	**500 MW**									
	54.294	Lemešany (SK)	Veľké Kapušany (SK)	Erection of new 400 kV line between Lemešany and Veľké Kapušany substations. The project includes the extension of the substations Lemešany and V.Kapušany. Line length: 100 km (including the loop erected under the investment 54.293)										
	54.A127	Veľké Kapušany (SK)	tbd (HU)	Erection of new 2 × 400 line between SK and Hungary (substation on Hungarian side still to be defined).										
55	55.302	Vyskov (CZ)	Cechy stred (CZ)	New second circuit 400 kV OHL, 1,385 MVA.	**3,000 MW**			**Prague area**						
	55.303	Babylon (CZ)	Bezdecin (CZ)	New second circuit 400 kV OHL, 1,385 MVA.										
	55.304	Babylon (CZ)	Vyskov (CZ)	New second circuit 400 kV OHL, 1,385 MVA.										
	55.A91	Praha Sever (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA.										
	55.310	Vyskov (CZ)	Reporyje (CZ)	New connection between 2 existing substations line single circuit OHL 1,385 MVA.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2015	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.		The project will help evacuate important amount of new generation (wind + nuclear generation) in the eastern part of Romania.
planned	2018	New investment in TYNDP.	This investment was merged with investment 273 in TYNDP 2010. They are now presented as separate investments in TYNDP 2012, according to internal project organization. The network development is still the same.	
under consideration	long term	New investment in the TYNDP, required to accomodate new RES generation not foreseen in the TYNDP 2010, by increasing the GTC for the entire project.		
design & permitting	2015	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.	New wind farms shall be connected to the 400 kV OHL Isaccea – Medgidia S section.	
under consideration	2015	New investment in the TYNDP, required to accomodate new RES generation not foreseen in the TYNDP 2010, by increasing the GTC for the entire project.		
design & permitting	2013	Progresses as planned.		This cluster will increase the transfer capacity between Slovak and Hungarian network systems and increase security of supply. The internal interconnections in Slovakia are necessary for the same objective. Also this cluster is important for support of north-south flow from RES in north of EU.
planned	2018	Progresses as planned.		
under consideration	2021	New investment in TYNDP.		
design & permitting	2015	Progresses as planned.		This project is required both to ease power flows west to east and to enhance security of supply of Prague.
planned	2016	Progresses as planned.		
planned	2018	Progresses as planned.		
planned	long term	New investment in TYNDP.		
under consideration	long term	Schedule harmonization with other priority investments: this investment has been delayed because of priority given to other investments.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
56	56.A92	Chodov (CZ)	Cechy stred (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 35.1 km. Target capacity 2 × 1,385 MVA.	1,000 MW									
	56.A93	Tynec (CZ)	Krasikov (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 103.8 km. Target capacity 2 × 1,385 MVA.										
57	57.320	Dargoleza (PL)	—	A new AC 400/110 kV (450 MVA) substation between existing substations Słupsk and Żarnowiec in northern Poland. New substation Dargoleza is connected by splitting and extending of existing 400 kV line Słupsk – Dargoleza.	3,000 MW									
	57.328	Piła Krzewina (PL)	Bydgoszcz Zachód (PL)	New 84 km 400 kV double circuit 2 × 1,870 MVA OHL interconnection line Piła Krzewina – Bydgoszcz Zachód temporarily on 220 kV.										
	57.329	Żydowo (PL)	Słupsk (PL)	A new AC 400/110 kV substation next to existing 220/110 kV substation in northern Poland with transformation 400/110 kV 450 MVA. New substation Żydowo is connected by new 70 km 400 kV 2 × 1,870 MVA OHL double circuit lines Żydowo – Słupsk and Żydowo – Gdańsk Przyjaźń. Dismantling of existing 220/110 kV transformers + upgrade of substation SŁupsk.										
	57.330	Żydowo (PL)	Gdańsk Przyjaźń (PL)	A new AC substation in Gdańsk Agglomeration Area. New substation Gdańsk Przyjaźń is connected by splitting and extending of one circuit of existing line Żarnowiec – Gdańsk Błonia and new 150 km 400 kV 2 × 1,870 MVA double circuit OHL line Żydowo – Gdańsk Przyjaźń with one circuit from Żydowo to Gdańsk temporarily on 220 kV after dismantling of 220 kV line Żydowo – Gdańsk.										
	57.352	Dunowo (PL)	Plewiska (PL)	Construction of a new double circuit 400 kV OHL Dunowo – Żydowo (2 × 1,870 MVA) partly using existing 220 kV line. Construction of a new 400 kV OHL Plewiska – Piła Krzewina – Żydowo (2x1870 MVA), single circuit temporarily working as a 220 kV. A new AC 400 kV switchgear in existing substation Pila Krzewina. Upgrade of substation Dunowo.										
58	58.353	Krajnik (PL)	Baczyna (PL)	Construction of a new double circuit 400 kV OHL Krajnik – Baczyna (2 × 1,870 MVA, 91 km), single circuit temporarily working at 220 kV on Krajnik – Gorzów part. New substation 400 kV Baczyna will be connected by splitting and extending existing line Krajnik – Plewiska. Upgrading of limitations line Krajnik – Plewiska.	>1,000 MW									
	58.355	Mikułowa (PL)	Świebodzice (PL)	Double circuit line 220 kV Mikułowa – Świebodzice will be upgraded to 400 kV – single circuit temporarily working at 220 kV.										
	58.A67	Gubin (PL)		New 400 kV substation planned near the PL – DE border. The substation will be connected to planned line Eisenhüttenstadt (DE) – Plewiska (PL) creating new lines Eisenhüttenstadt (DE) – Gubin (PL) and Gubin (PL) – Plewiska (PL).										
	58.140	Eisenhüttenstadt (DE)	Plewiska (PL)	New 400 kV double circuit OHL Eisenhüttenstadt (DE) – Plewiska (PL) including the construction of new substation Plewiska Bis (PL).										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	2021	New investment in TYNDP.		This project is required both to ease power flows west to east and for future generation evacuation.
planned	2025	New investment in TYNDP.		
planned	2020	The time horizon for commissioning of this investment has been changed due to change in wind farms connection schedule in the region.	The new substation Dargoleza is required for the connection new wind generation in northern Poland.	Wind The infrastructure in this project assures reliable connection of 3,000 MW of wind generation in northern Poland. It also allows the evacuation of power in the southern direction.
design & permitting	2016	The time schedule of the project was shifted to meet the schedule of the RES (wind) generation connection. This one year delay in the plans appeared after updating of the NDP. The change in the NDP introduced a double circuit.		
planned	2020	The date of commissioning evolved due to regulatory, social and environmental issues. The investment also foresee upgrade works in substation Słupsk.		
planned	2020	The date of commissioning evolved due to regulatory, social and environmental issues.		
design & permitting	2020	Progressed as planned. The investment also foresee upgrade works in substation Dunowo.		
planned	2020	Progresses as planned.		Bridge Third interconnection between Poland and Germany.
planned	2020	Progresses as planned.		
planned	2020	New investment in TYNDP.	This new substation on the third DE – PL connection is necessary for future generation connection while ensuring interconnection capability.	
planned	2020	Progresses as planned.		

		Project identification			Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
59	59.368	Ełk (PL)	PL-LT border (LT)	Construction of a new 400 kV OHL Ełk to PL–LT border. (2 × 1,870 MVA, 108 km).	1,000 MW			South LT and NE/central PL						
	59.369	Siedlce Ujrzanów (PL)	Miłosna (PL)	Construction of a new 400 kV OHL Siedlce Ujrzanów–Miłosna (1,870 MVA, 84 km). A new AC 400 kV switchgear in existing substation Siedlce Ujrzanow with transformation 400/110 kV 400 MVA.										
	59.370	Ełk (PL)	Łomża (PL)	Construction of a new 400 kV double circuit OHL Ełk–Łomża (2 × 1,870 MVA, 95 km). A new AC 400 kV switchgear in existing substation Elk. A new 400 kV AC substation Łomża										
	59.371	Ostrołęka (PL)	Narew (PL)	Construction of a new 400 kV OHL Ostrołęka–Łomża–Narew (1,870 MVA, 120 km). A new AC 400 kV switchgear in existing substation Ostroleka (in two stages) with transformation 400/220 kV 500 MVA and with transformation 400/110 kV 400 MVA. Extension of 400 switchgear in substation Narew.										
	59.372	Oltarzew (PL)		A new AC substation with two transformers 400/220 kV 2 × 500 MVA and one 400/110 kV 330 MVA will be connected by splitting 400 kV line Rogowiec–Miłosna and Miłosna–Płock and 220 kV line Mory–Sochaczew and Mory–Janów.										
	59.373	Ostrołęka (PL)	Stanisławów (PL)	Single circuit line 220 kV Ostrołęka–Miłosna will be partly upgraded to double circuit line 400 kV (2 × 1,870 MVA, 106 km) with development of Ostrołęka 400 kV substation. New substation 400 kV Stanisławów will be connected by splitting and extending existing line Miłosna–Narew and Miłosna–Siedlce.										
	59.374	Kozienice (PL)	Siedlce Ujrzanów (PL)	Existing single circuit line will be upgraded to 400 kV line in the same direction (1,870 MVA, 90 km). Upgrade of Kozienice substation to connect the new line.										
	59.375	Płock (PL)	Olsztyn Mątki (PL)	New single circuit line 400 kV (1,870 MVA, 180 km) with development of Olsztyn Mątki 400 kV substation.										
	59.376	Alytus (LT)	PL-LT border (PL)	Construction of Back-to-Back convertor station near Alytus 330 kV substation. Construction of double circuit 400 kV OHL between Alytus and PL–LT border (2 × 1,870 MVA, 51 km).										
	59.379	Kruonis (LT)	Alytus (LT)	New double circuit 330 kV OHL (2 × 1,870 MVA, 53 km).										
60	60.377	Klaipeda (LT)	Telsiai (LT)	New single circuit 330 kV OHL (943 MVA, 85 km).	700 MW			West LV region						
	60.378	Panevezys (LT)	Musa (LT)	New single circuit 330 kV OHL (1,080 MVA, 80 km).										
	60.383	Klaipeda (LT)	Nybro (SE)	"NordBalt" project: A new 300 kV HVDC VSC partly subsea and partly underground cable between Lithuania and Sweden. Length: 440 km										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2015	Progresses as planned.		"LitPol Link" project. Interconnection of Lithuanian power system with Polish power system via Back to Back station. This project allows integration of Baltics to the internal European power market.
design & permitting	2015	Progresses as planned.		
design & permitting	2015	Łomża has been elected as end substation for the project and the technical description is adapted accordingly. Progresses as planned otherwise.		
design & permitting	2015	Progressed as planned. The investment also foresee extension works in substation Narew.		
under construction	2015	Progresses as planned.		
design & permitting	2020	Progresses as planned.		
design & permitting	2020	Progressed as planned. The investment also foresee extension works in substation Kozienice.		
design & permitting	2020	Progresses as planned.		
design & permitting	2015	Progresses as planned.		
planned	2015	Progresses faster than initially planned to support the LitPol project.		
under construction	2014	Project delayed because of land renting issues.		"NordBalt" project. Planned DC connection between Lithuania and Sweden. The project will connect the Baltic grid to the Nordic and integrate the Baltic countries with the Nordic electricity market, increases security of supply. Possibility to connect offshore wind farms as well.
planned	2018	Project postponed after investment portfolio optimization.		
design & permitting	2015	Progresses as planned.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	60.62.384	RigaCHP1 (LV)	Imanta (LV)	A new 12.5 km AC 330 kV cable will be built from RigaCHP1 substation to Imanta substation. Both substations will be reconstructed, according new line connecting. New cable will be underground and one part will be underwater (under Daugava river). Expected capacity: 880 MW	700 MW			West LV region						
	60.A52	Ekhyddan (SE)	Nybro / Hemsjö (SE)	New single circuit 400 kV OHL.										
	60.62.385	Grobina (LV)	Imanta (LV)	Kurzeme project a Latvian grid reinforcement project with new 330 kV OHL construction and connection to the Riga node. New 330 kV OHL construction mainly instead of the existing 110 kV double circuit line route, 110 kV line will be renovated at the same time and both will be assembled on the same towers. Length: 380 km Capacity: 800 MW										
61	61.380	Visaginas (LT)	Kruonis (LT)	New single circuit 330 kV OHL (1,080 MVA, 200 km).	1,400 MW									
	61.381	Visaginas (LT)	Liksna (LV)	Upgrade single circuit OHL (943 MVA, 50 km).										
	61.382	Vilnius (LT)	Neris (LT)	New single circuit 330 kV OHL (943 MVA, 50 km).										
62	62.60.384				450 – 600 MW			Riga region						
	62.60.385													
	62.386	Kilingi – Nomme(EE)	RigaCHP2 (LV)	Estonia – Latvia third interconnection will consist of 330 kV AC OHL Harku – Lihula – Sindi in Estonian part and OHL between Kilingi – Nõmme substation in Estonia and TEC2 substation in Latvia. The third interconnection allows to increase the NTC between Estonia and Latvia additionally in the range of 450 to 600 MW .										
	62.387	Tartu (EE)	Sindi (EE)	A new 162 km internal connection will be established on existing route resulting in double circuit line with 2 different voltages (330/110 kV).										
	62.388	Harku (EE)	Sindi (EE)	New double circuit OHL with 2 different voltages 330/110 kV and with capacity 1,200/240 MVA and a length of 140 km. Major part of new internal connection will be established on existing right of way on the western part of Estonian mainland.										
63	63.389	Eesti (EE)	Püssi (EE)	Reinforcement of existing 57 km single circuit 330 kV OHL. Expected capacity:1,200 MVA	650 MW			NW Estonia						
	63.390	Balti (EE)	Püssi (EE)	Reconstruction of 68 km single circuit 330 kV OHL.										
	63.391	Püssi (EE)	Anttila (FI)	A new HVDC (450 kV) connection will be built between Estonia and Finland. On the Finnish side, a 14 km DC overhead line will be built to a new substation Anttila where the converter station will be placed. On the Estonian side, a 11 km DC cable line will be built to a existing substation Püssi where the converter station will be placed. Length of marine cable: 140 km Expected capacity: 650 MW										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2012	Progresses as planned.	The investment contributes also to project 62.	"NordBalt" project. Planned DC connection between Lithuania and Sweden. The project will connect the Baltic grid to the Nordic and integrate the Baltic countries with the Nordic electricity market, increases security of supply. Possibility to connect offshore wind farms as well.
under consideration	2019	New investment in TYNDP.		
design & permitting	2018	Investment delays due to authorization process and the extensive works.	The investment contributes also to project 62.	
planned	2020	Progresses as planned.		New NPP project. Grid development for connection of new Lithuanian nuclear power plant planned in Visaginas to the power system. This project allows safe and reliable integration of new NPP to the power system.
under consideration	2020	Progresses as planned.		
planned	2020	Progresses as planned.		
			The investment contributes both to project 62 and project 64. For the technical description see project 60	This project will increase the transfer capability between Estonia and Latvia and will accommodate RES generation in the Baltic Sea. This will be the 3rd corridor between these countries.
			The investment contributes both to project 62 and project 64. For the technical description see project 60	
planned	2020	Progresses as planned.		
under construction	2014	Progresses as planned.		
design & permitting	2018	Progresses as planned.		
commissioned	commissioned	Commissioned.		Estlink2 The main driver for this cluster is integration need of Electricity Market. This project will increase the transfer capability between Estonia and Finland and will accommodate RES generation in the North of Estonia and will increase the security of supply in the Baltics.
commissioned	commissioned	Commissioned.		
under construction	2014	The expected date of commissioning is beginning of 2014, postponed a few months compared to the preliminary estimate end of 2013.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
64	64.392	Yllikkälä (FI)	Huutokoski (FI)	New 155 km single circuit 400 kV OHL and renovation of 400 kV substations in Yllikkälä and Huutokoski. Expected capacity: 1,850 MVA.	700–1,400 MW			West coast Finland						
	64.393	Seinäjoki Ulvila Ventusneva (FI)	Tuovila (FI) Kristinestad (FI) Pyhänselkä (FI)	Four new single circuit 400 kV OHL are part of project in upgrading Ostrobothnian 220 kV system into 400 kV and strengthening the 400 kV grid in northern Finland. Commissioning of first section in year 2011, second in 2014 third in approx. 2018 and fourth approx. 2020. Total length of lines: 520 km Expected capacity: 1,850 MVA										
	64.A62	Pyhänselkä (FI)	Petäjävesi or Vihtavuori (FI)	New single circuit 400 kV OHLs will be built from middle Finland to Oulujoki Area to increase the capacity between North and South Finland.										
65	65.394	Hikiä (FI)	Forssa (FI)	New 80 km single circuit 400 kV OHL and building of 400 kV substation in Forssa.	800 MW			SW Finland						
	65.A63	Forssa (FI)	Lieto (FI)	New 67 km single circuit 400 kV OHL.										
66	66.400	Ekhyddan (SE)	Barkeryd (SE)	New single circuit 400 kV OHL.	1,250 MW									
	66.401	Västervik (SE)	Gotland (SE)	New DC subsea cable interconnection +/- 300 kV (2 × 500 MW).										
67	67.402	Barkeryd (SE) Hallsberg (SE)	Tveiten (NO) Hurva (SE)	"South West link" consisting of three main parts: 1) New 400 kV line between Hallsberg and Barkeryd (SE), lenght 170 km, 2) new double HVDC VSC underground cable and OHL between Barkeryd and Hurva (SE), lenght 250 km, and 3) new double HVDC VSC line between Barkeryd (SE) and Tveiten (NO), lenght 103 km. The project also include new substations and converter stations in the connection points line.	East–West 1,400 MW North–South 1,200 MW									
	67.411	Rød (NO)	Sylling (NO)	Voltage upgrading of existing single circuit 300 kV OHL Rød–Tveiten–Flesaker–Sylling in connection with the new HVDC line to Sweden, the Syd Vest link.										
	67.412	Rød (NO) – Sylling (NO) – Flesaker (NO)	Hasle (NO) Tegneby (NO) Tegneby (NO)	Reinvestment and capacity increase Oslofjord 400 kV subsea cables. Three cables: – Filtvedt–Brenntangen, – Solberg–Brenntangen and – Teigen–Evje.										
68	68.421	Ofoten (NO)	Balsfjord (NO)	New 160 km single circuit 400 kV OHL.	350–1,500 MW			Northern Norway						
	68.422	Balsfjord (NO)	Hammerfest (NO)	New 360 km single circuit 400 kV OHL.										
	68.423	Skaidi (NO)	Varangerbotn (NO)	New 230 km single circuit 400 kV OHL.										
69	69.424j	Bramford (GB)	Twinstead (GB)	New 400 kV double circuit.	2,600 MW									
	69.A39	Sizewell C (GB)	Bramford (GB)	Reconductor Sizewell C–Bramford–Sizewell.	1,800 MW									

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2013	Progresses as planned. Expected date of commission is beginning of 2013.		Several 400 kV AC lines are planned in Finland to be built to increase the north-south transmission capacity thus enabling the integration of new renewable and conventional generation in northern Finland and to compensate the dismantling of the obsolescent existing 220 kV lines. The commissioning of the lines is scheduled to take place in segments both in mid and long term.
under construction	2011 / 2020	Project has progressed as planned. Since TYNDP 2010 Seinäjoki – Tuovila has been constructed and Ulvila – Kristinestad has progressed to design and permitting phase. Keminmaa – Pyhänselkä is now presented as a separate investment item.		
design & permitting	2020	New investment in TYNDP.		
design & permitting	2015	Progresses as planned.		Reinforcements due to changed exchange patterns and reliable grid operation of Southwest Finland.
under consideration	2017	New investment in TYNDP.		
design & permitting	2017	Progresses as planned.		The new subsea connection to the island of Gotland will be two connections with a capacity of 500 MW for each cable.
design & permitting	2017 -2021	The first cable is progressing as planned but the second cable is planned to be in commission after 2017 due to adjustments to RES.	The new subsea connection to the island of Gotland will be two connections with a capacity of 500 MW for each cable. The first cable is planned to be in commission 2017 and the second is planned to be in commission between 2020 and 2021.	
design & permitting	2014-2019	Commissioning date updated after bilateral negotiations between the two countries. Hallsberg – Barkeryd – Hurva expected in 2014, Barkeryd – Tveiten in 2019.		5 investments of HVDC and AC lines in Sweden and Norway as well as between the countries, resulting in increased GTC and market integration.
design & permitting	2018 / 2020	Investment postponed, especially because of long permitting processes.		
design & permitting	2015	Investment delayed, especially because of long permitting processes. One cable is under construction.		
design & permitting	2016	Investment delayed, especially because of long permitting processes.		The main purpose of this project is to secure the northern part of Norway.
design & permitting	2018	Investment delayed, especially because of long permitting processes.		
planned	2022	Investment postponed, especially because of long permitting processes.		
design & permitting	2018 / 2019	Delayed by one year to 2018 / 19 due to an anticipated slower growth in the uptake of wind.		This project supports the evacuation of energy from a new nuclear power plant and from the offshore wind parks of the eastern coast of GB.
planned	2015 / 16	New investment in TYNDP, answering an expected growth in offshore wind and nuclear generation in and around Norfolk and East Anglia, above what was anticipated for the TYNDP 2010.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	69.A40	Norwich Main (GB)	Bramford (GB)	Norfolk Offshore Wind: NORW – BRFO Tee-in to Lowestoft.	1,800 MW									
	69.A41	Walpole (GB)	Bramford (GB)	Reconductoring Norwich Main – Walpole and Bramford – Norwich Main.										
70	70.405	Kristiansand (NO)	Rød (NO)	Voltage upgrading of an existing single circuit 300 kV OHL and a new section of OHL between Rød and Bamle. Total length: 175 km	700 MW									
	70.426	Kristiansand (NO)	Tjele (DK)	Skagerak 4: 4th HVDC connection between southern Norway and western Denmark, built in parallel with the existing 3 HVDC cables, new 700 MW including 230 km 500 kV DC subsea cable.										
71	71.427	Endrup (DK)	Eemshaven (NL)	COBRA: New single circuit HVDC connection between Jutland and the Netherlands via 350 km subsea cable. The DC voltage will be up to 320 kV and the capacity 600 – 700 MW.	700 MW									
72	72.430	Revsing (DK)	Landerupgård (DK)	New 18 km single circuit 400 kV line via cable with capacity of approx. 1,200 MW.	950 MW			DK West and North DE						
	72.435	Endrup (DK)	Revsing(DK)	Upgrade of 50 km double circuit 400 kV OHL to reach a capacity of approx. 2,000 MW.										
	72.436	Idomlund (DK)	Endrup (DK)	New 74 km single circuit 400 kV line via cable with capacity of approx. 1,200 MW.										
73	73.432	Asværket (DK)	Kyndbyværket (DK)	New 60 km single circuit 400 kV line via cable with capacity of approx. 1,200 MW.	>1,000 MW									
	73.433	Glentegård (DK)	Amagerværket & H.C. Ørstedværket (DK)	New 22 km single circuit 400 kV line via cable with capacity of approx. 1,200 MW.										
74	74.443	Richborough (GB)	Zeebrugge (BE)	NEMO project: New DC sea link including 135 km of 250 kV DC subsea cable with 1,000 MW capacity.	>1,000 MW			Thames estuar						
	74.449	Richborough (GB)	Canterbury (GB)	New 400 kV double circuit OHL and new 400 kV substation in Richborough.										
	74.450	Sellindge (GB)	Dungeness (GB)	Reconductor Sellindge – Dungeness.										
75	75.444	Zomergem (BE)	Zeebrugge (BE)	New approx 50 km double circuit 380 kV (3,000 MVA for each circuit) between Zomergem and Zeebrugge to evacuate the locally (offshore) produced power line and allow connection of NEMO project to 380 kV grid.	1,500 MW									
	75.A28	Zeebrugge (BE)	offshore platform (BE)	2 offshore platforms connected to AC grid with underground cables including compensation.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	2015/16	New investment in TYNDP, answering an expected growth in offshore wind and nuclear generation in and around Norfolk and East Anglia, above what was anticipated for the TYNDP 2010.		This project supports the evacuation of energy from a new nuclear power plant and from the offshore wind parks of the eastern coast of GB.
under construction	2015/2016	New investment in TYNDP, answering an expected growth in offshore wind and nuclear generation in and around Norfolk and East Anglia, above what was anticipated for the TYNDP 2010.		
design & permitting	2014	Progresses as planned.		Market integration and RES integration.
under construction	2014	Progresses as planned.		
design & permitting	2016	Progresses as planned.		Cobra
planned	2017	Progresses as planned.		The main purpose of the project is to integrate and transmit large scale wind power in DK West.
design & permitting	2015	Earlier date of commissioning than initially expected caused by reprioritization of project. Also one of the substations has been changed: Endrup was replaced by Tjele.		
under consideration	2018/2020	Envisaged route changed from Idomlund – Tjele to Idomlund – Endrup.		
design & permitting	2014	Progresses as planned.		The project will increase the stability of the DK eastern power system and allow for larger transmission and transit.
planned	2016	Progresses as planned.		
planned	2018	Investment delayed to 2018 due to authorization delays related to needed internal grid reinforcements.	NEMO project	Interconnection between UK and the mainland Europe (BE).
planned	2019/2020	Progresses as planned.	The reinforcements shown here reflect initial options but are subject to consultation and review of other feasible options.	
planned	2014/2015	The reconductoring of the Sellindge to Dungeness circuits (Project 450) remain as originally planned in the TYNDP 2010.		
design & permitting	2014	Progresses as planned.	Stevin project	The project allows the connection of 2.3 GW of offshore wind production. It also allows onshore RES connection. This project enhances security of supply of Belgian coastal area and allows the NEMO connection.
planned	2016	New investment in TYNDP, resulting from recent studies demonstrating such a platform would be optimal for Belgian offshore wind offtake. Planning and implementation of the project depends on the evolution of Belgian legislation.	Belgian offshore platform	

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
76	76.A42	Pelham (GB)	Waltham Cross (GB)	Reconductor Pelham – Rye House – Waltham Cross.	7,600 MW			London area						
	76.A43	Hackney (GB)	Waltham Cross (GB)	Uprate to 400 kV Hackney – Tottenham – Waltham Cross.										
	76.A44	Hackney (GB)	St. John's Wood (GB)	New 400 kV St. John's Wood – Hackney double circuit.										
	76.A45	Tilbury (GB)	Elstree (GB)	Uprate to 400 kV Tilbury – Warley – Elstree.										
	76.A46	St. John's Wood (GB)	Wimbledon (GB)	New 400 kV St. John's Wood – Wimbledon cables.										
	76.A47	West Weybridge (GB)	Beddington (GB)	Uprate to 400 kV West Weybridge – Chessington – Beddington.										
77	77.452	Deeside (GB)	Hunterston (GB)	New 2,000 MW HVDC Link via 360 km 500 kV DC subsea cable on the west coast of the UK and new 400 kV substation in Deeside.	4,000 MW									
	77.453	Peterhead (GB)	Hawthorn Pit (GB)	New 2,000 MW HVDC Link via 365 km 500 kV DC subsea cable on the east coast of the UK and new 400 kV substation in Hawthorn Pit.										
	77.454	Hawthorn Pit (GB)	Norton (GB)	Uprate to 400 kV Hawthorn Pit – Norton.										
	77.456	Harker (GB)	Quernmore (GB)	Reconductor Harker – Hutton – Quernmore.										
	77.449a	Gravir (GB)	Beauly (GB)	Western Isles link. New 450 MW HVDC link, +/- 150 kV. Route length: 156 km (80 km subsea, 76 km onshore underground cable)										
	77.450a	Kergord and Caithness (GB)	Blackhillock (GB)	The Moray Firth HVDC development – Shetland and Caithness links with offshore HVDC hub. Three ended HVDC link, 2 × 600 MW legs and common 1,200 MW leg. Total route length: 395 km										
	77.451a	Dounreay (GB)	Beauly (GB)	String a second 275 kV OHL circuit on existing towers.										
	77.452a	Beauly (GB)	Kintore (GB)	Reconductor existing 275 kV overhead line route.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2015/2016	New investment in TYNDP.	New projects in the London area, not previously reported in the TYNDP 2010. .	All of these investments are required due to a combination of age related asset replacement, increasing power flows and changing customer demand connection requirements. A further driver for all of these projects is that power flows through London increase during interconnector export to mainland Europe (Power flows from the north through London to the interconnectors within the Thames Estuary).
design & permitting	2015/2016	New investment in TYNDP.		
design & permitting	2017/2018	New investment in TYNDP.		
planned	2021/22	New investment in TYNDP.		
design & permitting	2017/2018	New investment in TYNDP.		
planned	2017/2018	New investment in TYNDP.		
design & permitting	2015/2016	Progresses as planned (still targeting the financial year 2015/2016).		This project facilitates the connection of RES and the connection of the remote Scottish Islands.
planned	2018/2019	Progresses as planned (still targeting the financial year 2018/2019).		
planned	2018/2019	Progresses as planned (still targeting the financial year 2018/2019).		
design & permitting	2014/2015	Progresses as planned (still targeting the financial year 2014/2015).		
design & permitting	2015	The 2010 TYNDP showed commissioning scheduled for 2013. However the developers of the large western Isles wind farm projects which drive the need for the link, have experienced commercial delays. Commissioning of the link is therefore now projected for 2015.		
design & permitting	2016	Projected commissioning is now 2016. The 2010 TYNDP showed commissioning scheduled for 2014. At that time the concept was to include an offshore node in a subsea HVDC link that was planned from Shetland to the Scottish mainland. That link was being designed to connect the Viking Energy wind farm project on Shetland. The Shetland link was termed the Base Project and the node was referred to as Incremental Works. The node would receive a connection from Caithness in 2016 for the export of renewables from that region and would also offer the potential for connection of adjacent offshore wind farms. However, the Viking project suffered consenting delays, and so late in 2010 the Caithness to Moray HVDC link was re-designated as the Base Project into which the node would be incorporated. The achievable timetable for the Caithness leg with commissioning in 2016 then became the timetable for the investment.		
under construction	2012	Progresses as planned.		
design & permitting	2014	Progresses as planned (still targeting the financial year 2014/2015).		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	77.453a	Blackhillock (GB)	Kincardine (GB)	Reinsulate existing 275 kV route for 400 kV operation and establish three new 400 kV substations en route.	4,000 MW									
	77.455	Beauly (GB)	Denny (GB)	New double circuit 400 kV OHL (220 km) with new terminal substations and substation extensions en route.										
	77.457	Harker (GB)	Stella West (GB)	New 400 kV series and shunt compensation at a number of locations across the Anglo-Scottish border.										
78	78.458	Hinkley (GB)	Seabank (GB)	New 60 km double circuit 400 kV OHL	3,200 MW									
79	79.A48	Trawsfynydd (GB)	Treudyyn (GB)	Reconductor Trawsfynydd – Treuddyn.	1,700 MW									
	79.459	New Substation (GB)	Legacy – Shrewsbury Tee (GB)	New 400 kV double circuit OHL and new 400 kV substation in Mid-Wales.	880 MW									
	79.459b	Wylfa (GB)	Pembroke (GB)	New HVDC bipolar interconnection with possible offshore connection points at the Irish Sea offshore wind farm.	2,000 MW									
	79.460	Pentir (GB)	Trawsfynydd (GB)	Upgrade Pentir – Trawsfynydd to double circuit.	3,800 MW									
	79.460b	Wylfa (GB)	Pentir (GB)	New 400 kV Wylfa – Pentir double circuit.	3,600 MW									
80	80.461	Woodland (IE)	Deeside (GB)	A new 260 km HVDC (200 kV DC) underground and subsea connection between Ireland and Britain with 500 MW capacity. On the Irish side, a 45 km direct current underground cable will be built to the Woodland substation where the VSC converter station will be placed.	500 MW			Island of Ireland?						
81	81.462	Woodland (IE)	Turleenan (NI)	A new 140 km single circuit 400 kV 1,500 MVA OHL from Turleenan 400/275 kV in Northern Ireland to Woodland 400/220 kV in Ireland. This is a new interconnector project between Ireland and Northern Ireland.	600 MW			NE Ireland						

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2016	Scheduled completion in 2016 is one year later than foreseen in the 2010 TYNDP. The north of Scotland transmission system is significantly depleted by construction outages to accommodate the main Beauly – Denny rebuild by 2014. The system access that is available for this investment (453a) to accommodate a build-up of renewable generation leads to the revised completion date in 2016.		This project facilitates the connection of RES and the connection of the remote Scottish Islands.
under construction	2014	Progresses as planned.		
design & permitting	2014 / 2015	Progresses as planned.		
design & permitting	2019 / 20	Seabank has been delayed by three years due to corresponding delays to the associated new nuclear project.		Project needed for renewables off of the Southwest peninsula, the replanting of Hinkley Point nuclear power station and further CCGT at Seabank.
planned	2017 / 2018	New investment in the TYNDP, as it was mistakenly omitted from the TYNDP 2010 submission. It is necessary due to RES Integration in North Wales.		Reinforcement of the internal grid to integrate the additional flows from the RES generation.
design & permitting	2016 / 2017	Progresses as planned (still targeting the financial year 2016 / 2017).	Investment needed to connect Mid-Wales wind farms	
planned	2020 / 21	Design Change – The design of the HVDC reinforcement circuit from Wylfa has changed from that in the TYNDP 2010 to now terminate at Pembroke instead of Mid-Wales. This has the potential to save some onshore consenting challenges. Additional benefits may be realized by coordinating the development of the offshore transmission assets with that of the onshore system. The location of the Wylfa HVDC termination may yet move offshore to be located closer to the wind turbines. The expected commissioning date has remained at 2020.		
planned	2016 / 2017	Slight delay in expected commissioning date.	Investment needed to accommodate new wind generation off Anglesey and nuclear replanting at Wylfa.	
planned	2017 / 2018	Progresses as planned (still targeting the financial year 2017 / 2018).	Investment needed to connect offshore wind and nuclear.	
under construction	2012	Investment still on schedule for 2012, with less than 1 year delay.		This medium term project will establish 500 MW interconnection capacity between Ireland and GB.
design & permitting	2016	Project delayed due to permitting process in both jurisdictions. The intermediate station Moyhill is deferred pending outcome of future load growth.		This medium term project will increase transfer capacity between Ireland and Northern Ireland to improve security of supply and facilitate Single Market development.

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
82	82.470	Bellacorick (IE)	Cashla or Flagford (IE)	New 130 km single circuit 400 kV OHL from Northwest Mayo to the EHV system.	650 MW									
	82.A37	tbd (NI)	Tunes Wind (NI)	North coast offshore wind farm. Multiple connection options are under consideration.	300 MW									
	82.463	tbd (IE)	tbd (NI)	Strengthening of EHV networks (partial uprate and new) into Donegal and north and west of Northern Ireland and enhanced links between the two countries. Various technologies are being considered.	1,500–2,000 MW									
83	83.467	Moneypoint (IE)	Kilpaddoge (IE)	A new 10 km single circuit 220 kV 500 MVA (underground + subsea) cable constructed across the River Shannon Estuary from Moneypoint in Co. Clare to Tarbert or a new Kilpaddoge station in Co. Kerry. A new 400/220 kV transformer at Moneypoint station is included in this project.	1,500–2,000 MW									
	83.468	Moneypoint (IE)	North Kerry (IE)	A new 27 km single 400 kV circuit, consisting of a submarine cable from Moneypoint across the Shannon Estuary and an overhead line to a new 400 kV station in north Kerry.										
	83.469	Knockraha (IE)	Dunstown (IE)	A new 250 km single circuit 400 kV OHL from Cork to the east, with one intermediary station in the southeast.										
84	84.471	Maynooth (IE)	Woodland (IE)	A new 25 km single circuit 400 kV OHL from Woodland 400 kV station to a new 400 kV station near or at Maynooth 220 kV station. The project may involve upgrading existing 220 kV circuits to 400 kV or utilizing the route.	1,500–2,000 MW			Dublin area						
	84.A31	Finglas / Huntstown (IE)	Woodland (IE)	A new 25 km single circuit 400 kV from Woodland 400 kV station to a new 400 kV station in the vicinity of Huntstown and Finglas 220 kV stations.										
	84.A32	Dunstown (IE)	Maynooth (IE)	A new 40 km single circuit 400 kV OHL circuit from Dunstown 400 kV station to a new 400 kV station in the vicinity of Maynooth 220 kV station.										
	84.A33	Carrickmines (IE)	Dunstown (IE)	A new 45 km single circuit 400 kV OHL from Dunstown 400 kV station to a new 400 kV station in the vicinity of Carrickmines 220 kV station.										
85	85.A3	F. Alentejo – Ourique – Tavira (PT)		New 122 km double circuit 400 + 150 kV OHL F. Alentejo – Ourique – Tavira. The realization of this connection can take advantage of some already existing 150 kV single lines, which can be reconstructed as double circuit line 400 + 150 kV, with needed extension of existing Ourique substation to include 400 kV facilities.	1,390 MW									

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
design & permitting	2019	Investment technical description and commissioning date are now defined, and status changed to "design and permitting".		The infrastructure development is required to facilitate connection of renewables in the north and west of the Island. It will further integrate the Ireland and Northern Ireland transmission systems and provide capacity for substantial demand growth in the area.
under consideration	2020	New investment in TYNDP.		
under consideration	2020	New investment in TYNDP.		
design & permitting	2014	Project delayed by 2 years because awaiting the completion of the Moneypoint 400 kV station redevelopment works to facilitate the new connection, and a delay due to foreshore permitting arising from a change in one of the connection points (from Tarbert to Kilpaddoge).		The infrastructure development is required to facilitate connection of renewables in the south of the Island. The project will also facilitate new interconnection connecting to the grid in the south.
design & permitting	2019	Investment technical description and commissioning date are now defined and status changed to "design and permitting".	Increased capacity between the southwest and the midwest regions.	
design & permitting	2020	Investment technical description and commissioning date are now defined and status changed to "design and permitting".	Increased capacity between Knockraha in the southwest and Dunstown in the mideast regions. The project will also facilitate future interconnection.	
under consideration	>2020	TYNDP 2010 investment 471 now presented in two parts (471 and IE2).		This project will provide a high capacity path around Dublin improving security of supply to the city and operability of the Dublin network.
under consideration	>2020	New investment in TYNDP to avoid overloads in Dublin City network and to ensure supply to north Dublin City load.		
under consideration	>2020	New investment in TYNDP to avoid overloads in Dublin City network, split out from TYNDP 2010 investment 471.		
under consideration	>2020	New investment in TYNDP to avoid overloads in Dublin City network.		
planned	2018/2019	New investment in TYNDP. This project helps integrate new solar and wind power plans in Alentejo and Algarve area.		This project integrates new amounts of solar (and also some wind) generation in the south of Portugal. The existing network of 150 kV is not sufficient to integrate these amounts of power and a new 400 kV axis should be launched in this region, establishing a connection between the two southern interconnections between Portugal and Spain, the Ferreira do Alentejo – Alqueva – Brovales and Tavira – Puebla de Gusman. This axis will also close a ring of 400 kV in the southern part of Portugal that will guarantee the load growth in the region (Algarve is one of the regions that presents the biggest growth rate in Portugal) in a safe, secure and quality way.

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
86	86.A49	Keadby (GB)	Grimsby West (GB)	KEAD – KILL KILL – SHBA KEAD – GRIW circuit uprate.	5,200 MW									
	86.A50	under consideration (GB East Coast)	under consideration (GB East Coast)	Connection of Triton Knoll, Doggerbank & Hornsea GB Wind Farms and all associated works.										
87	87.A53	Forsmark (SE)	Råsten (SE)	New 50 km single circuit 400 kV OHL.	1,215 MW									
	87.A54	Råsten (SE)	Hamra (SE)	New 85 km single circuit 400 kV OHL.										
	87.A55	Forsmark (SE)	Stackbo (SE)	New 70 km single circuit 400 kV OHL.										
	87.A56	Ängsberg (SE)	Horndal (SE)	New 55 km single circuit 400 kV OHL.										
	87.A57	Horndal (SE)	Lindbacka (SE)	New 145 km single circuit 400 kV OHL.										
	87.A58	Hamra (SE)	Västerås (SE)	New 50 km single circuit 400 kV OHL.										
	87.399	Vasteras (SE)	Lindbaka (SE)	Upgrade / replacement of existing single circuit 220 kV lines to 400 kV.										
88	88.A23	offshore wind farms (FR)	several French substations (FR)	Subsea cables and substations works.	3,000 MW (MT) 6,000 MW (LT)									
89	89.A24	Calan (FR)	Plaine-Haute (FR)	New 80 km double circuit 220 kV underground cable with 2 phase shifters and T-connection of an existing HV substation. 1,150 MVARs of capacitors and SVC. New transformer 400/220 kV	500 MW			Brittany area						
90	90.131	Bickigen (CH)		Addition of a second 400/220 kV transformer in an existing substation.	4,000 MW									
	90.132	Mühleberg (CH)		Construction of a new 400/220 kV substation.										
	90.134	Bassecourt (CH)	Romanel (CH)	Construction of different new 400 kV line sections and voltage upgrade of existing 225 kV lines into 400 kV lines. Total length: 140 km										
	90.136	area of Bodensee (DE, AT, CH)		Construction of new lines, extension of existing ones and erection of 400/220/110 kV substation. This project will increase the current power exchange capacity between the DE, AT and CH. The project is expected to increase NTC and improve the security of supply.										
	90.129	Beznau (CH)	Mettlen (CH)	Upgrade of the existing 65 km double circuit 220 kV OHL to 400 kV.										
	90.130	La Punt (CH)	Pradella / Ova Spin (CH)	Installation of the second circuit on existing towers of a double circuit 400 kV OHL (50 km).										
	90.133	Bonaduz (CH)	Mettlen (CH)	Upgrade of the existing 180 km double circuit 220 kV OHL into 400 kV.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under consideration	long term	New investment in TYNDP.	These investments are required due to unprecedented volumes of offshore wind generation connection requests.	This projects helps accommodate new offshore RES generation in the North Sea .
under consideration	long term	This investment groups former 424b, 424c, 424d, 424e, 424f, 424g, 424h and 424i investments of TYNDP 2010. The group of projects on the east coast of Great Britain has been removed as work is in progress to optimize the onshore / offshore coordination and reduce potential consenting issues. Given the potential for more than 20 GW of renewable offshore generation capacity in UK waters on the East Coast it is expected that multiple connection sites will be required together with suitable circuit capacity, both onshore and offshore.		
design & permitting	2019	New investment in TYNDP.		Several 400 kV AC lines and stations due to increase of nuclear power and RES, result in increased GTC.
design & permitting	2019	New investment in TYNDP.		
design & permitting	2018	New investment in TYNDP.		
under consideration	2020	New investment in TYNDP.		
under consideration	2020	New investment in TYNDP.		
planned	2021	New investment in TYNDP.		
under consideration	2021	All investments in project 87 has been prioritized and result in new commissioning dates		
planned	2015 – 2020	New investment in TYNDP, required to connect offshore wind farms as decided by the French government in 2010.	Project development will adapt to the pace of generation installation.	Connection of 6 GW offshore wind farms in 2 phases. First 3 GW phase in progress (tender).
design & permitting	2017	New investment in TYNDP, required to secure Brittany's supply, along with DSM management plan and a new CCGT in Finistère area.		Security of supply of the Brittany.
design & permitting	2012	Progresses as planned.		This project increase the transfer capability between FR, DE, AT towards pump storage in CH.
design & permitting	2015	Delays due to authorization process.		
design & permitting	2015	Delays due to authorization process.		
planned	long term	Progress as planned.		
design & permitting	2015	Progresses as planned.		
planned	2017	Delays due to authorization process.		
under consideration	2020	Progresses as planned.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
	90.44.170				4,000 MW									
	90.44.172													
	90.44.173													
	90.44.176													
	90.45.177	Goldshöfe (DE)	Bünzwangen (DE)	A new 380 kV OHL. Length: 45 km										
91	91.121	Bickigen (CH)	Romanel (CH)	Construction of different new 400 kV OHL sections and voltage upgrade of existing 225 kV lines into 400 kV lines. Total length: 250 km	>4,000 MW									
	91.122	Chippis (CH)	Lavorgo (CH)	Construction of different new 400 kV line sections and voltage upgrade of existing 225 kV lines into 400 kV. Total length: 120 km.										
	91.123	Mettlen (CH)	Ulrichen (CH)	Construction of different new 400 kV line sections and voltage upgrade of existing 225 kV lines into 400 kV lines. Total length: 90 km										
	91.125	Schwanden (CH)	Limmern (CH)	New 400 kV double circuit (OHL and underground cable) between Schwanden and Limmern.										
	91.126	Golbia (CH)	Robbia (CH)	New 2 × 400 kV cable connection between Golbia and the Bernina line double circuit.										
	91.127	Magadino (CH)	Verzasca (CH)	Upgrade of existing 150 kV line into 220 kV line.										
	91.128	Bâtiaz (CH)	Nant de Drance (CH)	New 400 kV double circuit OHL between Bâtiaz and Châtelard. New 2 × 400 kV cable connection between Châtelard and Nant de Drance. Total length: 22 km										
92	92.146	Aachen / Düren region (DE)	Lixhe (BE)	Connection between Germany and Belgium including new 100 km HVDC underground cable and extension of existing 380 kV substations. On Belgian side, new 380 kV circuit between Lixhe and Herderen and second 380 kV OHL in / out from Herderen to Lixhe. In Belgium, addition of 2 transformers 380/150 kV in Lixhe and in Limburg part.	1,000 MW			Northern Belgium						

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
			The investment contributes both to project 44 and project 90. For the technical description see project 44.	This project increase the transfer capability between FR, DE, AT towards pump storage in CH.
			The investment contributes both to project 44 and project 90. For the technical description see project 44.	
			The investment contributes both to project 44 and project 90. For the technical description see project 44.	
			The investment contributes both to project 44 and project 90. For the technical description see project 44.	
under consideration	2020	Progresses as planned.	The investment contributes also to project 45.	
design & permitting	2015	Delays due to authorization process.		The investments help accommodating new pumping storage units which support mainly the increasing RES generation in North Sea area.
design & permitting	2017	Delays due to authorization process.		
planned	2019	Delays due to authorization process.		
design & permitting	2015	Progresses as planned.		
under consideration	2019	Progresses as planned.		
under consideration	2020	Progresses as planned.		
design & permitting	2016	Delays due to authorization process.		
design & permitting	2017	Project entered design and permitting phase in 2011, technical description has been completed and expected date of commissioning is 2017.	Alegro Project	First Belgium – Germany interconnection. This project enhances security of supply of both BE and DE. This HVDC link in an AC grid brings flexibility and bidirectional power control allowing integration of RES in both countries. This project aims to be a demonstration for HVDC link integration in the AC meshed grid.

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
93	93.413	Ørskog (NO)	Fardal (NO)	New 285 km single circuit 400 kV OHL.	2,250 MW			Southwest of Trondheim (county Møre and Romsdal)						
	93.398A	under consideration (SE)		New shunt compensation of OHL.										
	93.403	Scandinavia North (SE)	Scandinavia South (SE)	A joint Stattnett & Svenska Kraftnat study north-south reinforcement (AC or VSC), expected length: 400 – 500 km, under study.										
	93.414	Fardal (NO)	Aurland (NO)	Voltage upgrading of existing single circuit 300 kV OHL Fardal – Aurland Extension of 413 – Ørskog – Fardal.										
	93.417	Aura / Viklandet (NO)	Fåberg (NO)	Voltage upgrading of existing single circuit 300 kV OHL Aura / Viklandet – Fåberg.										
	93.416	Klæbu (NO)	Aura / Viklandet (NO)	Voltage upgrading of existing single circuit 300 kV OHL Klæbu – Aura.										
94	94.139	Vierraden (DE)	Krajnik (PL)	Upgrade of existing 220 kV line Vierraden – Krajnik to double circuit 400 kV OHL.	>1,000 MW									
	94.A68	Krajnik (PL)		Upgrade 400 kV.										
	94.A69	Mikułowa (PL)		Upgrade 400 kV.										
	94.A70	Krajnik (PL)		New PST.										
	94.A71	Mikułowa (PL)		New PST.										
95	95.A119	Dobrudja(BG)	Burgas (BG)	New 140 km single circuit 400 kV OHL in parallel to the existing one.	1,500 MW									
	95.265	Vidno (BG)	Svoboda (BG)	New 400 kV double circuit OHL to accommodate 2,000 MW RES generation in Northeast Bulgaria (Dobruja region). Line length: 2 × 70 km										
	95.263	SS 400/110 kV Svoboda (Krusari)		New 400/110 kV substation to accommodate the expected RES generation(2,000 MW) in Northeast Bulgaria (Dobruja region).										
	95.264	SS 400/110 kV Vidno		New 400/110 kV substation to accommodate the expected RES generation(2,000 MW) in Northeast Bulgaria (Dobruja region).										
	95.266	in / out in Svoboda on actual 400 kV OHL Isaccea (RO) – Varna (BG)		New 400 kV double circuit OHL to accommodate the expected RES generation(2,000 MW) in Northeast Bulgaria (Dobruja region). Line length: 2 × 10 km										
96	96.A64	Keminmaa (FI)	Pyhänselkä (FI)	Integration of new generation + increased transmission capacity demand.	1,000 MW									
97	97.A65	Uusnivala (FI)	Pyhäjoki (FI)	New double circuit 400 kV OHLs.	1,600 MW									

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under construction	2015	Investment delayed due to due to long permitting procedure.	The project is key to improve security of supply in Mid-Norway: Presently, for several N-1 contingencies, load might be disconnected. The project is also the pre-requisite to lift the ban on RES development in the whole area covered by the new line Ørskog – Fardal.	Security of supply for Mid-Norway (Møre and Romsdal mainly) and RES integration in western Norway.
under consideration	2015	New part of investment 398 in TYNDP 2010.	Investment 398 in TYNDP 2010 has been divided into 398A and 398B. 398B is described in project 104.	
under consideration	2025	Postponed after reprioritization of the project portfolio.		
planned	2020	Investment postponed, especially because of long permitting processes.		
under consideration	long term	Investment postponed, especially because of long permitting processes.		
design & permitting	2018 (2016-2020)	Investment postponed, especially because of long permitting processes.		
design & permitting	long term	Expected date of commissioning was adjusted due to long permitting process and strong local public resistance.		PSTs: Control of the transits of power on the polish synchronous profile (increase of import capacity, increase of grid operation safety).
design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
planned	2016	New investment in TYNDP, required to accommodate 2,000 MW RES in Dobrudja region.		It contributes to the accommodation of large amount of RES in Dobrudja region (2,000 MW). It also contributes to north-south transfers and increases the security of supply in Burgas region.
planned	2015	Moved from LT (TYNDP 2010) to MT due to high interest for very fast implementation of about 2,000 MW RES generation in Dobrudja region.		
planned	2015			
planned	2015			
planned	2015			
under consideration	2019	New investment in TYNDP, split out from investment 393, and now been moved as a stand-alone project cluster because of his specific benefits.		Integration of new generation and increased transmission capacity demand.
under consideration	2020	New investment in TYNDP, required to connect Fennovoimas new 1,250 – 1,700 MW nuclear power plant that will be built in Pyhäjoki.		New investment in TYNDP, required to connect Fennovoimas new 1,250 – 1,700 MW nuclear power plant that will be built in Pyhäjoki.

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
98	98.A66	Rauma (FI)	Forssa (FI) Lieto (FI) Ulvila (FI)	New single circuit 400 kV OHLs.	1,600 MW									
99	99.324	Dobrzeń (PL)	Wrocław/Pasikurowice (PL)	New 76 km 400 kV 2 × 1,870 MVA OHL double circuit line from Dobrzeń to splitted Pasikurowice – Wrocław line. Upgrade and extension of 400 kV switchgear in substation Dobrzeń.	1,800 MW			Warsaw and lower Silesia area						
100	100.335	Ostrołęka (PL)	Olsztyn Mątki (PL)	New 138 km 400 kV 2 × 1,870 MVA double circuit OHL line Ostrołęka – Olsztyn Mątki after dismantling of 220 kV line Ostrołęka – Olsztyn with one circuit from Ostrołęka to Olsztyn temporarily on 220 kV.	1,000 MW									
101	101.327	Kozienice (PL)	Ołtarzew (PL)	New 130 km 400 kV 2 × 1,870 MVA OHL double circuit line Kozienice – Ołtarzew. Upgrade and extension of 400 kV switchgear in substation Kozienice for the connevtion of new line.	1,000 MW			Warsaw area						
	101.338	Kozienice (PL)	Mory/Piaseczno (PL)	Replacement of conductors (high temperature conductors).										
102	102.A72	Gdańsk Błonia (PL)		Extension and upgrade of an existing 400/110 kV substation Gdańsk Błonia for connection of planned 900 MW power plant.	2,900 MW									
	102.334	Pątnów (PL)	Grudziądz (PL)	New 174 km 400 kV 2 × 1,870 MVA double circuit OHL line Pątnów – Grudziądz after dismantling of 220 kV line Pątnów – Jasiniec (two parallel lines) and Jasiniec – Grudziądz. One circuit from Pątnów to Grudziądz via Jasiniec temporarily on 220 kV.										
	102.326	Grudziądz (PL)	Gdańsk Przyjaźń (PL)	A new AC 400/110 kV substation between existing substation Grudziądz and planned substation Gdańsk Przyjaźń. New substation Pelplin is connected by new 110 km 400 kV 2 × 1,870 MVA OHL double circuit lines Grudziądz – Pelplin and Pelplin – Gdańsk Przyjaźń after dismantling of 220 kV line Jasiniec – Gdańsk.										
103	103.145	Niederrhein (DE)	Doetinchem (NL)	New 400 kV line double circuit DE-NL interconnection line. Length: 60 km	13,900 MW			NW part of Netherlands						
	103.438	Eemshaven (NL)	Diemen (NL)	New 175 – 200 km AC overhead line with capacity of 2 × 2,650 MVA of 380 kV.										
	103.439	Borssele (NL)	Geertruidenberg (NL)	New 100 – 130 km double circuit 380 kV OHL with 2 × 2,650 MVA capacity.										
	103.440	Maasvlakte (NL)	Beverwijk (NL)	New 380 kV double circuit mixed project (OHL + underground cable) including approximately 20 km of underground cable for 2,650 MVA. The cable sections are a pilot project. The total length of cable at 380 kV is frozen until more experience is gained.										
	103.441	Zwolle (NL)	Hengelo (NL)	Upgrade of the capacity of the existing 60 km double circuit 380 kV OHL to reach a capacity of 2 × 2,650 MVA.										
	103.442	Krimpen aan de Ijssel (NL)	Maasbracht (NL)	Upgrade of the capacity of the existing 150 km double circuit 380 kV OHL to reach a capacity of 2 × 2,650 MVA.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under consideration	2020	New investment in TYNDP, required to connect TVO's new 1,000 – 1,800 MW nuclear power plant that will be built in Olkiluoto.		New investment in TYNDP, required to connect TVO's new 1,000 – 1,800 MW nuclear power plant that will be built in Olkiluoto.
design & permitting	2017	Progresses globally as planned. Technical description and commissioning date have been updated so as to deliver full benefit as from 2017.		Dobrzeń: The project introduces new infrastructure (2 × 400 kV line) to allow power evacuation from two (2 × 9,000 MW) conventional units to be installed in existing power plant Opole. The new line provides power supply for agglomeration Wroclaw, it increases the security of supply for this area.
design & permitting	2017	The time schedule of the project was shifted to meet the schedule of the generation connection.		Ostrołęka: The new 400 kV line allows power evacuation from new 1,000 MW conventional unit to be installed in existing power plant Ostroleka.
design & permitting	2017	The time schedule of the project was shifted to meet the schedule of the generation connection.		Kozienice: The new 2 × 400 kV line allows power evacuation from new 1,000 MW conventional unit to be installed in existing power plant Kozienice. The new unit is foreseen to supply Warsaw agglomeration area. The project also allows to close the 400 kV ring around Warsaw agglomeration are increasing the security of supply significantly.
under construction	2014	Progresses as planned, with commissioning now expected in 2014.		
planned	2020	New investment in TYNDP.	Power Evacuation North. The upgraded substation will connect a planned 900 MW CCPP.	North: The north-south corridor provides necessary capacity to evacuate the power from new 2,900 MW of conventional generation planned to be installed in northern Poland.
design & permitting	2020	The time schedule of the project was shifted to meet the schedule of the generation connection.	Power Evacuation North.	
planned	2020	The time schedule of the project was shifted to meet the schedule of the generation connection.	Power Evacuation North.	
design & permitting	>2013	Delays due to authorization process.		The project reinforces the Dutch grid to accommodate new conventional and renewable generation, to handle new flow patterns and to increase the interconnection capacity between DE and NL.
design & permitting	2018	Delays due to authorization process.		
design & permitting	2016	Delays due to authorization process.		
under construction	2016	Delays due to authorization process.		
under consideration	long term	Progresses as planned.		
under consideration	long term	Progresses as planned.		

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
104	104.398B	under consideration (SE)		New series compensation of OHL.	1,200 MW									
	104.415	Namsos (NO)	Klæbu and Storeheia (NO)	New line and voltage upgrade of 286 km single circuit 400 kV OHL										
	104.418	Nedre Røssåga (NO)	Namsos (NO)	Upgrade of 70 km single circuit 400 kV OHL.										
	104.420	Storheia (NO)	Orkdal / Trollheim (NO)	New 130 km single circuit 400 kV OHL.										
	104.A59	Råbäcken (SE)	Letsi – Betåsen (SE)	New 55 km single circuit 400 kV OHL.										
	104.A51	Svartisen (NO)	Nedre Røssåga (NO)	New 116 km 400 kV OHL.										
105	105.A60	Skogssäter (SE)	Stenungsund / Stenkullen (SE)	New 80 km single circuit 400 kV OHL.	600 MW									
106	106.A34	tbd (IE)	tbd (GB)	A new HVDC subsea connection between Ireland and Great Britain.	700 – 1,000 MW									
107	107.A25	tbd (IE)	tbd (FR)	A new HVDC subsea connection between Ireland and France.	700 – 1,000 MW									
108	108.A134	Tarnita (RO)	Mintia (RO)	New 145 km double circuit 400 kV OHL.	1,000 MW									
	108.A135	Tarnita (RO)	Cluj E – Gadalin (RO)	New 40 km double circuit 400 kV OHL.										
	108.A136	Tarnita (RO)		New 400 kV substation.										
109	109.A35	Oriel (IE)	Oriel wind farm (IE)	Oriel offshore wind farm connecting to a new Oriel 220 kV station located on the Louth – Woodland 220 kV circuit.	330 MW									
	109.A36	Carrickmines (IE)	Kish Bank wind farm (IE)	Kish Bank offshore wind farm connecting to the existing Carrickmines 220 kV station.	364 MW									
	109.A38	Northern Ireland (NI)	East Coast Offshore (IE)	"East Coast Offshore" wind farm connecting to a 275 kV station to be determined. Multiple connection options are under consideration.	300 – 600 MW									
110	110.424	Kvilldal (NO)	tbd (GB)	A new 1,000 MW HVDC bipolar installation connecting western Norway and Great Britain via 800 km subsea cable. DC voltage is to be determined.	1,000 – 1,400 MW									
111	111.396	Finland North (FI)	Sweden North (SE)	Third single circuit 400 kV AC OHL between Sweden and Finland. Expected capacity: 1,850 MVA	700 MW									

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
under consideration	2015	Reprioritization of projects.	Investment 398 in TYNDP 2010 have been divided into 398A and 398B. 398A is described in project 93.	RES integration in Mid-Norway (Trøndelag and Nordland) and reinforcement of Swedish internal interconnections in order to facilitate wind power integration in northern Sweden.
design & permitting	2015	Delays due to authorization process.	New line and voltage upgrade to facilitate new wind power generation.	
design & permitting	2019	Investment postponed, especially because of long permitting processes.	Increased capacity between North and Mid-Norway. Facilitates RES integration.	
design & permitting	2017–2020	Investment postponed due to long permitting procedure.	New line to facilitate wind power generation.	
under consideration	2017	New investment in TYNDP. Will probably be postponed after 2020 due to later development of wind power in the area.		
planned	2020	New investment in TYNDP.	New line to facilitate wind power generation.	
under consideration	2019	New investment in TYNDP.		This project facilitates the connection of wind power along the Swedish west coast.
under consideration	long term	New investment in TYNDP, conceptual, cost benefit analysis to be confirmed.		This project will increase interconnection capacity between Ireland and Great Britain.
under consideration	long term	New investment in TYNDP, conceptual, cost benefit analysis to be confirmed.		This project will establish interconnection capacity between Ireland and France.
planned	2018	New investment in TYNDP.	Connection of pumped storage hydro plant Tarnita Lapustesti to the grid. The plant has an installed capacity of 1,000 MW and will support system balancing, especially in order to face the intermittent RES output.	The project will connect to the grid 1,000 MW hydro pump storage.
planned	2018	New investment in TYNDP.		
planned	2018	New investment in TYNDP.		
under consideration	2016	New investment in TYNDP, required to connect offshore wind.		This project will facilitate the connection of offshore wind.
under consideration	2015	New investment in TYNDP, required to connect offshore wind.		
under consideration	2018	New investment in TYNDP, required to connect offshore wind.		
design & permitting	2018/2021	Capacity revised. Investment postponed, especially because of long permitting processes.		Market integration. Facilitate RES integration in southern and western Norway and improve security of supply.
under consideration	2021	The projects reinforcing the north-south transmission in the Scandinavia have been prioritized ahead of this project. Based on common estimation project can be delayed to 2021. SvK will evaluate the project and the timetable in ongoing studies		Third AC 400 kV cross border line between North-Sweden and North-Finland is under consideration. Strengthening the AC connection between Finland and Sweden is necessary due to new wind power generation, larger conventional units and decommissioning of the existing 220 kV interconnector.

Project identification					Project assessment									
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs
112	112.98	Pordenone (IT)		Voltage upgrade of the existing Pordenone 220 kV substation up to 400 kV. The substation will be connected in and out to the existing Udine O. – Cordignano 400 kV line.	2,150 MW			Triveneto area						
	112.105	Treviso (IT)		New 380/132 kV substation in Treviso area, connected in and out to the existing 380 kV line Sandrigo – Cordignano.										
	112.106	Schio (IT)		New 220/132 kV substation in Schio area, providing the connection in and out to the existing 220 kV line Ala – Vicenza Monte Viale.										
	112.107	Vicenza Industrial (IT)		New 380/132 kV substation in the industrial area of Vicenza, connected in and out to the existing Sandrigo – Dugale 400 kV line.										
	112.108	Northwest Padova (IT)		New 220/132 kV substation in Northwest Padova area, complying with 400 kV standards, providing the connection in and out to the existing Dugale – Marghera Substation1 220 kV line.										

Table 12.1: Projects of pan-European significance

Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
planned	long term	Progresses as planned.		This projects helps to increase the security of supply in the northeastern part of Italy.
design & permitting	mid term	Project delayed by 2 years due to longer than expected permitting procedure.		
planned	mid term	Project delayed by 2 years due to longer than expected permitting procedure.		
planned	long term	Progresses as planned.		
planned	long term	Progresses as planned.		

12.2 Appendix 2: Key Concepts and Definitions

12.2.1 ENTSO-E

The European Network of Transmission System Operators for Electricity (ENTSO-E) was established on a voluntary basis on 19 December 2008 and became fully operational on 1 July 2009, in anticipation of the entry in to force of the 3rd Package on 3 March 2011.

Today, 41 TSOs from 34 European countries are members of ENTSO-E. The working structure of the association consists of Working and Regional Groups, coordinated by three Committees (System Development, System Operations and Markets), supervised by a management Board and the Assembly of ENTSO-E, and supported by the Secretariat, the Legal and Regulatory Group, and Expert Groups.

The main purposes of ENTSO-E are
- to pursue the co-operation of the European TSOs both on the pan-European and regional level and
- to have an active and important role in the European rule setting process in compliance with EU legislation.

For more information, please refer to **www.entsoe.eu**

Country	Company	Regional groups					
		NS	BS	CCE	CSE	CCS	CSW
Austria	APG-Austrian Power Grid AG			X		X	
	Vorarlberger Energienetze GmbH			X		X	
Belgium	Elia System Operator SA	X					
Bosnia & Herzegovina	Nezavisni operator sustava u Bosni i Hercegovini				X		
Bulgaria	Electroenergien Sistemen Operator EAD				X		
Croatia	HEP-Operator prijenosnog sustava d.o.o.			X	X		
Cyprus	Cyprus Transmission System Operator						
Czech Republic	CEPS a.s.			X			
Denmark	Energinet.dk	X	X				
Estonia	Elering		X				
Finland	Fingrid OyJ		X				
France	Réseau de Transport d'Electricité	X				X	X
FYROM	Macedonian Transmission System Operator AD				X		
Germany	50Hertz Transmission GmbH		X	X			
	Amprion GmbH	X				X	
	TransnetBW GmbH	X				X	
	TenneT TSO GmbH	X		X		X	
Greece	Hellenic Transmission System Operator S.A.				X		
Hungary	MAVIR			X	X		
Iceland	Landsnet hf						
Ireland	EirGrid plc	X					
Italy	Terna – Rete Elettrica Nazionale SpA				X	X	
Latvia	AS Augstsprieguma tĭkls		X				
Lithuania	LITGRID AB		X				
Luxembourg	Creos Luxembourg S.A.	X					
Montenegro	Crnogorski elektroprenosni sistem AD				X		
Netherlands	TenneT TSO B.V.	X					
Norway	Statnett SF	X	X				
Poland	PSE Operator S.A.		X	X			
Portugal	Rede Eléctrica Nacional, S.A.						X
Romania	C.N. Transelectrica S.A.			X	X		
Serbia	JP Elektromreža Srbije				X		
Slovak Republic	Slovenska elektrizacna prenosova sustava, a.s.			X			
Slovenia	Elektro Slovenija d.o.o.			X	X	X	
Spain	Red Eléctrica de España: S.A.						X
Sweden	Affärsverket Svenska Kraftnät		X				
Switzerland	swissgrid ag					X	
United Kingdom	National Grid Electricity Transmission plc	X					
	Scottish and Southern Energy plc	X					
	Scottish Power Transmission plc	X					
	System Operation Northern Ireland Ltd	X					

Table 12.2:
ENTSO-E countries and member TSOs

12.2.2 Legal Requirements for TYNDP (EC 714/2009)

The key requirements of the 3rd Package, especially Regulation EC 714/2009, that forms the legislative driver for the "2012 Ten-Year Network Development Plan" suite of documents (the "TYNDP 2012 package") are under:

Art 8.3 (b) of Regulation

ENTSO-E shall adopt a non-binding Community-wide 10 year network development plan, including a European generation adequacy outlook, every two years.

Art 8.4

The European generation adequacy outlook shall cover the overall adequacy of the electricity system to supply current and projected demands for electricity for the next five-year period as well as for the period between five and 15 years from the date of the outlook. The European generation adequacy outlook shall build on national generation adequacy outlooks prepared by each individual transmission operator.

Art 8.10

ENTSO-E shall adopt and publish a network development plan every two years.

The network development plan shall include the modelling of the integrated network, scenario development, a European generation adequacy outlook and an assessment of the resilience of the system.

The network development plan shall:

- build on national investment plans, taking into account regional plans, and if appropriate Community aspects of network planning, including the guidelines for trans-European energy networks.
- build on the reasonable needs of different system users and integrate long-term commitments from investors referred to in Article 8 (tendering procedures), article 13 (ISO) and article 22 (network development) of the Directive.
- identify investment gaps, notably with respect to cross-border capacities. A review of barriers to the increase of cross-border capacities arising from different approval procedures or practices may be annexed to the network development plan.

12.2.3 Scenarios and Cases

As introduced in TYNDP 2010, § 4.1.2, network planning makes use of two different levels of details to describe the hypotheses, both of which are often referred to as "scenarios" (and thus become sources of confusion):

- A **scenario**:
  - General economic conditions (economic growth, prices of primary fuels and CO_2),
  - General level of load (with underlying uses of electricity, resulting for example in typical shape of load curve and sensitivity to temperature)
  - Generation fleet (number of units of every type, and respective size, network consistency)
- A **case**: i.e. a particular situation that may occur within the framework of a scenario, featuring
  - one specific point-in-time (e.g. winter / summer, peak hours / low load conditions),
  - a particular realization of random phenomena, generally linked to climatic conditions (such as wind conditions, hydro inflows, temperature, etc.) or availability of plants (forced and planned) and
  - the corresponding merit-order dispatch of all generating units resulting from all above assumptions.

A scenario can thus be described quite synthetically, and debated. Cases correspond however to the relevant situations that network planers study to assess likely investments needs and the efficiency of any measure to solve them.

12.2.4 Investment Needs Typology

As introduced in TYNDP 2010, § 5, **Investment needs** are every concern ahead on the regional grid and of European significance, and which are likely to trigger extra-high voltage grid investment in order to restore the grid ability to fulfil the duties and services expected from this infrastructure.

The investment needs are sorted in the following categories:

- **Demand growth**
  Large cities or regions, where the security of supply can be at risk despite a sufficient generation capacity overall, i.e.: at risk specifically because of lacking transmission means.

- **Future generation evacuation**
  Places where new generation facilities asked (or are likely to ask) for connection, be they large power plants and/or distributed generation, RES or not, and the existing network does not assure an adequate evacuation and integration into the system. In the present TYNDP 2012 package, RES and conventional generation have been distinguished to provide a clearer picture.

- **Existing generation evacuation**
  Places where existing generation cannot be evacuated reliably in all situations because of a change in surrounding power flow patterns.

- **Generation decommissioning**
  Places where large power plants are decommissioned, modifying the surrounding power flow patterns, or causing local voltage level concerns.

- **Insufficient cross-border capacity**
  i.e. structural market congestion between price zones 29.
  Two subset of structural congestion are specifically identified:
  - **Change in exchange patterns**
    Grid section, the transfer capability of which may appear no more appropriate to accommodate power exchanges, that is new (or recent) congestion.
  - **Isolated systems to be connected**
    Typically islands to be connected to the mainland.

- **Reliable grid operation**
  Substations, where risks of current and voltage limits violation require upgrade of HV equipment to withstand now likely high short circuit currents, to manage reactive power issues, transient stability issues etc. in steady state and fault situations.

- **Ageing/obsolescence of existing network equipment**
  Asset requiring replacement or heavy refurbishment in order to maintain the grid transfer capability at its present standards, but possibly address new environmental concerns (e.g. higher standards against climatic conditions).

Isolation of systems, demand growth, commissioning and decommissioning of generation, ageing/obsolescence of existing network equipment are **primary drivers**, i.e. exogenous causes for grid development. Other needs (change in exchange patterns, existing generation evacuation, insufficient cross-border capacity, reliable grid operation) are assessed only once the primary drivers are set.

12.2.5 Investment Items, Projects, Projects of pan-European Significance

A **Project** in the TYNDP package 2012 can cluster several **Investment items**. Every row of the table in appendix 1 to the TYNDP or Regional Investment Plan report corresponds to one investment item. The basic rule for the clustering is that **an investment item belongs to a project if this item is required to develop the grid transfer capability increase associated to the project**.

A project can be limited to one investment item only.

An investment item can contribute to two projects. In this case it is depicted only once, in one of the projects, and only referred to in the other project (no technical description, status, etc. are repeated).

A **Project of Pan-European Significance** is a set of Extra High Voltage assets, matching the following criteria:

- The main equipment is at least 220 kV if it is an overhead line AC or at least 150 kV otherwise and is, at least partially, located in one of the 32 countries represented in TYNDP.
- Altogether, these assets contribute to a grid transfer capability increase across a network boundary within the ENTSO-E interconnected network (e.g. additional NTC between two market areas) or at its borders (i.e. increasing the import and/or export capability of ENTSO-E countries vis-à-vis others).
- An estimate of the above-mentioned grid transfer capability increase is explicitly provided in MW in the application.
- The grid transfer capability increase meets least one of the following minimums:
  - At least 500 MW of additional NTC or
  - connecting or securing output of at least 1 GW/1,000 km^2 of generation or
  - securing load growth for at least 10 years for an area representing consumption greater than 3 TWh/yr.

NB:

- Regional Investment Plans and National Development Plans can complement the development perspective with respect to other projects than Projects of Pan-European Significance.
- Projects of pan-European significance are candidate projects for the Project of Common Interest foreseen by the future EIP.

12.2.6 Boundaries, Bulk Power Flows, Grid Transfer Capability

According to the "Guideline for the assessment of impacts of projects" (see Appendix 3) a **Boundary** is one section of the grid between one area and another (price zone, area within a country or a TSO), or several sections of the grid sharing the same concern, across which it appears relevant for TSOs to assess grid transfer capability values (in order to auction capacity, to advertise the possibility of new generation connection upstream, or to communicate on securing load growth for several years downstream). A boundary, across which a grid transfer capability assessed, is hence oriented, i.e. relates to a specific direction of power flows (for an international border A – B, one boundary A > B and another boundary B > A can be defined. The PL > DE + CZ + SK is a boundary, CZ > PL is another).

A boundary may remain stable (border between states or price zones), or vary from one horizon or scenario to another. It may be internal to a country or a price zone.

A **Bulk Power Flow** is the typical power flow triggering grid development across a boundary.

The **Grid Transfer Capability (GTC)** is the ability of the grid to transport electricity across a boundary, i.e. from one area (price zone, area within a country or a TSO) to another. It depends on the considered state of consumption, generation and exchange, as well as the topology and availability of the grid, and account for safety rules (such as the N-1 rule). It is expressed in MW, and represents maximum transfer capabilities between two areas calculated under certain conditions.

The Grid Transfer Capability is oriented, which means that across a boundary, there may be two different values.

The Grid Transfer Capability compares rather directly with the NTC when the boundary separates prices zones if the transmission reliability margin is neglected or, roughly again, with the amount of generation or load that can be accommodated.

12.3 Appendix 3: Guidelines for Grid Development

NB: the Guidelines for Grid Development are general guidelines that apply in particular but not only for TYNDP underlying studies. It is published by ENTSO-E and as independent document. It is recalled here in appendix to the TYNDP 2012.

12.3.1 Introduction and Scope

Transmission system planning

The move to a more diverse power generation portfolio due to the rapid development of renewable energy sources and the liberalization of the European market have resulted in more and more interdependent power flows across Europe, with large and correlated variations. Therefore, transmission systems need to be designed looking beyond the traditional TSO boundaries, towards regional and European solutions. Thus, close co-operation of member companies responsible for the future development of the European transmission system is required to achieve a coherent and coordinated planning

The main objective of transmission system planning is to ensure, with respect to mid- and long-term horizons, the development of an adequate transmission system which

- ensures safe system operation,
- provides a high level of security of supply,
- contributes to a sustainable development,
- facilitates grid access to all market participants,
- contributes to internal market integration, facilitates competition and harmonization and
- contributes to efficiency of the system.

In this process certain key rules have to be kept in mind, in particular:

- Requirements and general regulations of the literalized European power and electricity market set by relevant EU legislation,
- EU policies and targets,
- national legislation and regulatory framework,
- security of people and infrastructure,
- environmental policies and constraints,
- transparency in procedures applied and
- economic efficiency.

The planning criteria to which transmission systems are designed are generally specified in transmission planning documents. Such criteria have been developed for application by individual TSOs taking into account the above factors and specific conditions to the network to which they relate. The planning standards inherited from individual TSOs are technically very similar, but clarity and common assessment criteria for reinforcements at a pan-european level are required. In order to optimize the efforts of each TSO involved and comply with a coherent pan-european Ten-Year Network Development Plan, suitable methodologies have been adopted on future development projects, and common investment assessments have been developed. This document gives an overview of the common methodologies adopted by ENTSO-E.

Scope of the document

This document describes the common principles and procedures to be used by TSOs within ENTSO-E when elaborating Regional Investment Plans and the Community-wide Ten-Year Network Development Plan (TYNDP), as ratified by EC Regulation 714/2009 of the 3rd Legislative Package.

Typically, development transmission projects fall into three categories as follows:

1. Those that only affect transfer capabilities between individual TSOs. These projects will be developed according to the criteria in this document.
2. Those that influence both transfer capabilities between TSOs and the internal capability of a TSO's network. These projects will meet the criteria of this document and of the affected TSO's internal standard.
3. Those that impact only on an internal national network and neither influence interconnection capability or are of European interest. These are not in the scope of this code, and are developed according to the TSO's internal standard.

Content of the document

Transmission system development focuses on the long-term preparation and scheduling of reinforcements and extensions to the existing transmission grid. This document describes each phase of the development planning process and the planning criteria adopted by ENTSO-E.

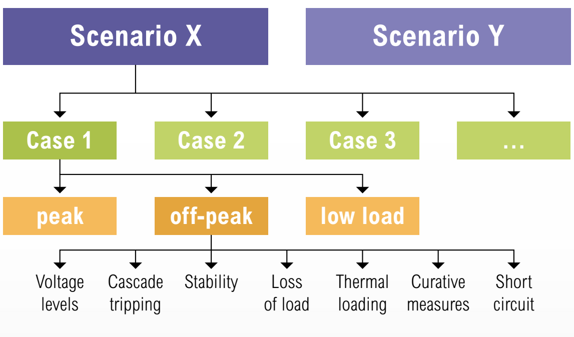


Figure 12.2:
Planning process

The first phase of the planning process consists of the definition of scenarios, which represent a coherent, comprehensive and internally consistent description of a plausible future. The aim of scenario analysis is to depict uncertainties on future system developments on both the production and demand sides. In order to incorporate these uncertainties in the planning process, a number of planning cases are built, taking into account forecasted future demand level and location, dispatch and location of generating units, power exchange patterns, as well as planned transmission assets. This phase is detailed in Chapter 2.

The analyses and "network stress tests" performed on each planning case in order to identify reinforcement needs follow specific technical planning criteria developed by ENTSO-E on the basis of long-term engineering practice. The criteria cover both the kind of contingencies[1)] chosen as "proxies" for hundreds of other events that could happen to the grid, and the adequacy criteria relevant for assessing overall behavior of the transmission system. The behavior of the grid when simulating the contingencies indicates the "health" and robustness of the system. A power system that fails one of these tests is considered "unhealthy" and steps must be taken so that the system will respond successfully under the tested conditions. Several planning cases are thus assessed in order to identify how robust reinforcement is. This process is developed in Chapter 3.

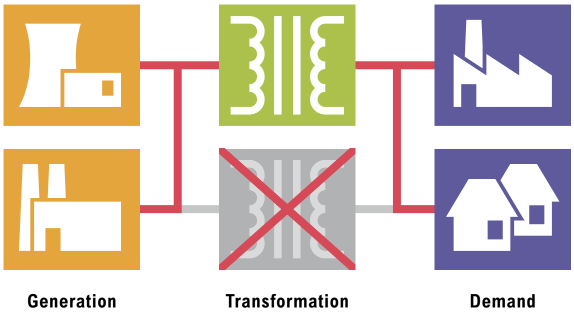


Figure 12.3:
Contingency analysis

Finally, the last step of planning process is the identification of projects necessary to restore the "health" of the system and their assessment. Chapter 4 thus describes the procedure and multi-criteria framework adopted for project assessment.

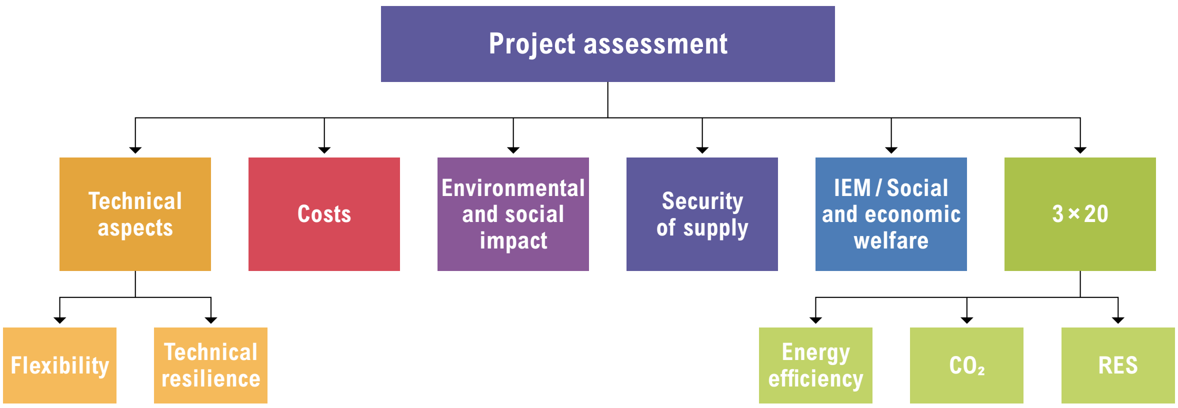


Figure 12.4:
Main categories of the project assessment

1) A contingency is the loss of one or several elements of the power transmission system.

The impact assessment criteria adopted in this document reflect each transmission project's added value for society, in terms of increased capacity for trading of energy and balancing services between price zones, RES integration and security of supply. The indicators also reflect the effects of the project in terms of costs and environmental impact.

The whole process is continuingly evolving, and it is the intention that this document will be reviewed periodically in line with prudent planning practice and further editions of the TYNDP.

12.3.2 Planning Scenarios

Planning scenarios are defined to represent future environments. The essence of scenario analysis is to come up with plausible pictures of the future. Scenarios are means to approach the uncertainties and the interaction between these uncertainties.

Planning studies require a set of assumptions as inputs. In order to provide planning studies with the required data, scenarios are defined to represent technical and economic conditions by considering a demand forecast, a generation mix and a set of exchange patterns with systems outside the studied region.

The following are the more important issues that have to be taken into account when building detailed cases for planning studies:

- Demand, generation and power exchange forecasts in different time horizons, and specific sets of network facilities are to be considered.
- Demand and generation fluctuates through a day and through the year.
- Weather is a factor that not only influences demand and, increasingly, generation but also the technical capabilities of the transmission network.

Definitions

D.1 Planning scenario

It is a coherent, comprehensive and internally consistent description of a plausible future (in general composed of several time horizons) built on the imagined interaction of economic key parameters (including economic growth, fuel prices, CO_2 prices etc.). A planning scenario is characterized by a generation portfolio (power installation forecast, type of generation etc.), a demand forecast (impact of efficiency measures, rate of growth, shape of demand curve etc.), and exchange patterns with the systems outside the studied region. A scenario may be based on trends (bottom-up scenarios) or energy policy targets (top-down scenarios). A scenario is represented by several cases.

D.2 Planning case

A planning case represents a particular situation that may occur within the framework of a planning scenario, featuring

- one specific point-in-time (e.g. winter/summer, peak hours/ low demand conditions, year), with its corresponding demand and environmental conditions,
- a particular realization of random phenomena, generally linked to climatic conditions (such as wind conditions, hydro inflows, temperature etc.) or availability of plants (forced and planned),
- the corresponding dispatch (coming from a market simulator or a merit order) of all generating units (and international flows),
- detailed location of generation and demand,
- power exchange forecasts with regions neighbor to the studied region and
- assumption on grid development.

D.3 Representative planning scenarios

Scenarios defined from EU objectives and/or from trends by ENTSO-E and TSOs, taking into account regional and national particularities.

D.4 Representative planning case

Representative planning cases are those that are considered relevant to represent a planning scenario in order to assess the need of grid reinforcement and/or grid optimization. They are defined based on criticality and/or frequency of occurrence.

D.5 Merit order

In cases where multiple generation sources are available, generating facilities and individual generating units within those facilities are ranked according to their availability and their variable cost of generation (supposing a perfect market). This ranking is referred to as merit order rank. Non dispatchable units (such as wind and PV), then generation facilities with the lowest prices, are used first to balance the demand.

Common criteria

C.1 Representative planning scenarios are to be used

C.2 Each scenario is assessed through its representative planning cases

Each selected scenario is assessed by analyzing the cases that represent it. These cases are defined (considering the issues mentioned in C.4) by the TSOs involved in each study, taking into account regional and national particularities.

C.3 Time horizons

At least two time horizons, with a 5 years span, will be considered when building representative cases:

- Mid-term horizon (typically 5 years)
- Long-term horizon (typically 10 years)

C.4 When building representative planning cases the following issues should be considered:

- Estimated main power exchanges with external systems
- Seasonal variation (e.g. winter/summer)
- Demand variation (e.g. peak/valley)
- Weather variation (e.g. wind, temperature, precipitations, sun, tides …)

C.5 Planned transmission system

All the transmission assets that are included in existing plans will be dealt with in the corresponding case taking into account the forecasted commissioning and decommission dates (other cases may be used, see chapter 12.3.2: "Best practice", R.2).

Best practice

R.1 Representative cases may be established using results of market studies.

R.2 Other cases different from representative cases can be investigated if needed.

These other cases might be defined in a multi-case or probabilistic analysis. This approach aims to assess risks of grid operation throughout the year or several years and to determine the uncertainties that characterise it. The objective is to cover many transmission system states in order to

- detect "critical system states" that are not detected by other means and
- estimate the probability of occurrence of each case assessed, facilitating the priority evaluation of the needed new assets.

For more information about multi-case analysis, see chapter 12.3.3: "Best practice", R.8.

R.3 Planned transmission system expansion projects.
The uncertainty in the commissioning date of some future assets could require a conservative approach when building the cases, taking into account

- state of permitting procedure (permits already obtained and permits that are pending),
- existence of local objection to the construction of the infrastructure and
- manufacturing and constructing deadlines.

A case without one or some reinforcements foreseen, as well as cases including less conservative approaches, could be analyzed.

R.4 Obsolete or old assets.
To check the actual role of a grid element, and thus compare different strategies (e.g. refurbishment of the asset vs. dismantling and building a new asset), it may be considered as absent in the planning case.

12.3.3 Technical Criteria for Planning

Technical methods and criteria are defined to be used when assessing the planning scenarios, in order to identify future problems and determine the required development of the transmission grid.

The general methodology implies:

- Grid analysis
  - Investigation of base case topology (all network elements available).
  - Different type of events (failures of network elements, loss of generation …) are considered depending on their probability of occurrence.

- Evaluation of results
  - Evaluation of consequences by checking the main technical indicators:
    - Cascade tripping,
    - thermal limits,
    - voltages,
    - loss of demand,
    - loss of generation,
    - short circuit levels,
    - stability conditions and
    - angular difference.
  - Acceptable consequences can depend on the probability of occurrence of the event.

Currently deterministic criteria are used in the planning of the grid.

Definitions

D.6 Base Case for network analysis

Data used for analysis are mainly determined by the planning cases. For any relevant point in time, the expected state of the whole system, "with all network equipment available", forms the basis for the analysis ("Base case analysis").

D.7 Contingencies

A contingency is the loss of one or several elements of the power transmission system. A differentiation is made between normal, rare and out-of-range contingencies. The wide range of climatic conditions and the size and strength of different networks within ENTSO-E mean that the frequency and consequences of contingencies vary among TSOs. As a result, the definitions of normal and rare contingencies can differ between TSOs. The standard allows for some variation in the categorization of contingencies, based on their likelihood and impact within a specific TSO network.

- A normal contingency is the (not unusual) loss of one of the following elements:
  - Generator,
  - transmission circuit (overhead, underground or mixed),
  - a single transmission transformer or two transformers connected to the same bay,
  - shunt device (i.e. capacitors, reactors …),
  - single DC circuit,
  - network equipment for load flow control (phase shifter, FACTS …) or
  - a line with two or more circuits on the same towers if a TSO considers this appropriate and includes this contingency in its normal system planning

- A rare contingency is the (unusual) loss of one of the following elements:
  - A line with two or more circuits on the same towers if a TSO considers this appropriate and does not include this contingency in its normal system planning,
  - a single busbar,
  - a common mode failure with the loss of more than one generating unit or plant or
  - a common mode failure with the loss of more than one DC link.

- An out-of-range contingency includes the (very unusual) loss of one of the following:
  - Two lines independently and simultaneously,
  - a total substation with more than one busbar or
  - loss of more than one generation unit independently.

D.8 N-1 criterion for grid planning

The N-1 security criterion is satisfied if the network is within acceptable limits for expected transmission and supply situations as defined by the planning cases, following a temporary (or permanent) outage of one of the elements of the normal contingency list (see chapter 12.3.3: D.7 and "Common criteria / Criteria for assessing consequences").

Common criteria

Studies to be performed:

C.6 Load flow analysis

- **Examination of normal contingencies**
  N-1 criterion is systematically assessed taking into account each single normal contingency of one of the elements mentioned above.
- **Examination of rare contingencies**
  Rare contingencies are assessed in order to prevent serious interruption of supply within a wide-spread area. This kind of assessment is done for specific cases based on the probability of occurrence and/or based on the severity of the consequences.
- **Examination of out-of-range contingencies**
  Out-of-range contingencies are very rarely assessed. Their consequences are minimized through Defence Plans.

C.7 Short circuit analysis

Maximum and minimum symmetrical and single-phase short-circuit currents are evaluated according to the IEC 60 909, in every bus of the transmission network

C.8 Voltage collapse

Analysis of cases with a further demand increase by a certain percentage above the peak demand value is undertaken. The resulting voltage profile, reactive power reserves, and transformer tap positions are calculated.

C.9 Stability analysis

Transient simulations and other detailed analysis oriented to identifying possible instability shall be performed only in cases where problems with stability can be expected, based on TSO knowledge.

Criteria for assessing consequences

C.10 Steady state criteria

- **Cascade tripping**
  A single contingency must not result in any cascade tripping that may lead to a serious interruption of supply within a wide-spread area (e.g. further tripping due to system protection schemes after the tripping of the primarily failed element).
- **Maximum permissible thermal load**
  The base case and the case of failure must not result in an excess of the permitted rating of the network equipment. Taking into account duration, short-term overload capability can be considered, but only assuming that the overloads can be eliminated by operational countermeasures within the defined time interval, and do not cause a threat to safe operation.
- **Maximum and minimum voltage levels**
  The base case and the case of failure shall not result in a voltage collapse, nor in a permanent shortfall of the minimum voltage level of the transmission grid, which are needed to ensure acceptable voltage levels in the sub-transmission grid.
  The base case and the case of failure shall not result in an excess of the maximum admissible voltage level of the transmission grids defined by equipment ratings and national regulation, taking into account duration.

C.11 Maximum loss of load or generation
should not exceed the power available in primary regulation reserve for each synchronous region.

C.12 Short circuit criteria
The rating of equipment shall not be exceeded to be able to withstand both the initial symmetrical and single-phase short-circuit current (e.g. the make rating) when energizing on to a fault and the short circuit current at the point of arc extinction (e.g. the break rating). Minimum short-circuit currents must be assessed in particular in busbars where a HVDC installation is connected in order to check that it works properly.

C.13 Voltage collapse criteria
The reactive power output of generators and compensation equipment in the area should not exceed their continuous rating, taking into account transformer tap ranges …

C.14 Stability criteria
Taking into account the definitions and classifications of stability phenomena[1)], the objective of stability analysis is the rotor angle stability, frequency stability and voltage stability in case of normal contingencies (see section 3.1), i.e. incidents which are specifically

1) Definition and Classification of Power System Stability, IEEE/CIGRE Joint Task Force, June 2003

foreseen in the planning and operation of the system. For the assessment of normal contingencies a successful fault clearing by the primary protection system is implied.

- **Transient stability**
  Any 3-phase short circuits successfully cleared by the primary protection system in service (or forecasted) shall not result in the loss of the rotor angle and the disconnection of the generation unit (unless the protection scheme requires the disconnection of a generation unit from the grid).
- **Small Disturbance Angle Stability**
  Possible phase swinging and power oscillations (e.g. triggered by switching operation) in the transmission grid shall not result in poorly damped or even undamped power oscillations.
- **Voltage security**
  Normal contingencies (including loss of reactive power infeed) must not lead to violation of the admissible voltage range that is specified by the respective TSO (generally 0.95 p.u. – 1.05 p.u.)

Solution proposal

C.15 If the standards described previously are not met, then reinforcement of the grid is planned. These measures can include but are not limited to the following:

- Reinforcement of overhead circuits to increase their capacity (e.g. increased distance to ground, replacing of circuits),
- duplication of cables to increase rating.
- replacing of network equipment or reinforcement of substations (e.g. based on short-circuit rating).
- extension of substations and construction of new ones.
- installation of reactive-power compensation equipment (e.g. capacitor banks).
- addition of network equipment to control the active power flow (e.g. phase shifter, series compensation devices).
- additional transformer capacities or
- construction of new circuits (overhead and cable).

Best practice

R.5 Load flow analysis
Failures combined with maintenance
Certain combinations of possible failures and non-availabilitiy of transmission elements may be considered in some occasions. Maintenance related non-availability of one element combined with a failure of another one may be assessed. Such investigations are done by the TSO based on the probability of occurrence and/or based on the severity of the consequences, and are of particular relevance for network equipment that may be unavailable for a considerable period of time due to a failure, maintenance, overhaul (for instance cables or transformers) or during major constructions.

R.6 Steady state analysis
Acceptable consequences depend on the type of event that is assessed. In the case of rare contingencies, acceptable consequences can be defined regarding the scale of the incident, and include loss of demand. Angular differences should be assessed to ensure that circuit breakers can re-close without imposing unacceptable step changes on local generators.

R.7 Voltage Collapse analysis
The aim of voltage collapse analysis is to give some confidence that there is sufficient margin to the point of system collapse in the analyzed case to allow for some uncertainty in future levels of demand and generation.

R.8 Multi-case analysis
The decisions in ENTSO-E system planning studies are generally based on deterministic analysis, in which several representative planning cases are taken into account. Additionally, studies based on a probabilistic approach may be carried out. This approach aims to assess the likelihood of risks of grid operation throughout the year, and to determine the uncertainties that characterise it. The objective is to cover many transmission system states across the entire year taking into account many cases. Thus it is possible to:
- detect "critical system states" that are not detected by other means and
- estimate the probability of occurrence of each case assessed, facilitating the priority evaluation of the needed new assets.

The basic idea of probabilistic methods is based on creating multiple cases depending on the variation of certain variables (that are uncertain). Many uncertainties can lead to building multiple cases: demand, generation availability, renewable production, exchange patterns, network components availability etc. The general method consists of the following steps:
- Definition of variables to be considered (for example: demand).
- Definition of values to be considered for each of the variables and estimation of the probability of occurrence.

In the case where a variable with many possible values is considered (for example: network unavailability), the amount of different possible combinations could recommend the use of a random approach method.

- Building of all the planning cases needed.
  The amount of cases will depend on the amount of variables and the amount of different values of each of them.
- Each case is analyzed separately.
- Assessment of the results.
  Depending on the amount of cases, a probabilistic approach could be needed to assess the results. A priority list of actions could result from this assessment.

If the variables used to build multiple cases are estimated in a pure probabilistic way a statistical tool is needed for the assessment. In this case, besides helping to make a priority list of the actions needed in a development plan and identifying critical cases not known to be critical in advance, the probabilistic approach allows forecasting the Energy Not Supplied (ENS) and Loss of Load Expectation (LOLE) and congestion costs. The probabilistic assessment of other variables, like short-circuit current, could also be very useful for planning decisions.

12.3.4 Project assessment

The goal of project assessment is to characterise the impact of transmission projects, both in terms of added value for society (increase of capacity for trading of energy and balancing services between price zones, RES integration, increased security of supply …) as well as in terms of costs.

The present chapter establishes harmonised guidelines to characterise the impact of individual investments or "projects" (clusters of candidate investments).[1)]

It is important to note that ranking of projects is out of the scope of this document.

1) A project is a cluster of investment(s) that have to be realized in total to achieve a desired effect. An interconnection project may therefore be composed by the cross-border line, as well as internal reinforcements necessary to achieve the desired capability.

Assessment framework

The assessment framework is a multi-criteria one. The criteria set out in this document have been selected on the following basis:

- They will enable an appreciation of project benefits in terms of EU network objectives, to
  - ensure the development of a single European grid to permit the European 20-20-20 objectives,
  - guarantee security of supply,
  - complete the internal energy market, especially through a contribution to increased social welfare and
  - ensure technical resilience of the system,

  as expressed in the Green paper on infrastructure networks[1)], the European Regulation 2009-714, the European Infrastructure Package[2)] and further detailed during the consultation on the TYNDP 2010[3)] and the Stakeholder Workshop on the assessment of projects of European interest.

- They will give a measure of project costs and feasibility (especially environmental and social impact).

- The indicators used will be as simple and robust as possible. This will lead to simplified methodologies for some indicators.

Figure 12.5 shows the main categories that group the indicators used to assess the impact of projects.

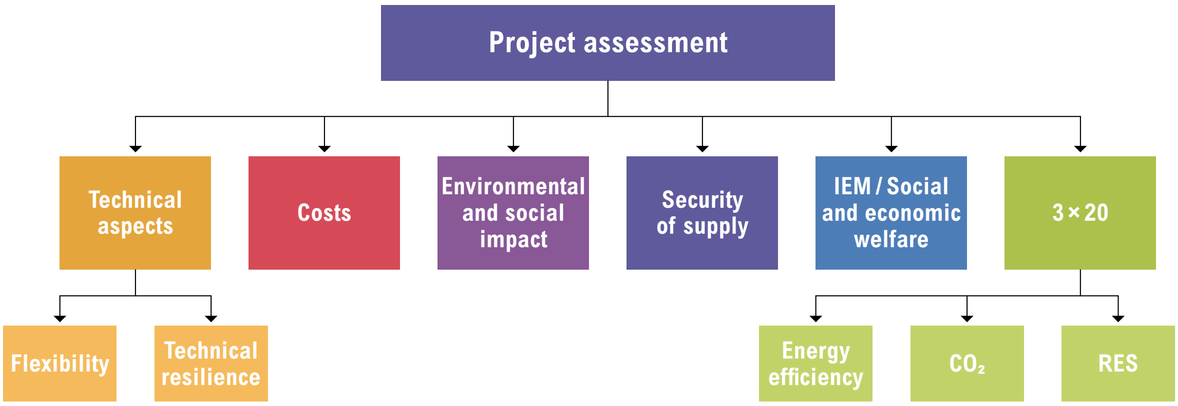


Figure 12.5:
Main categories of the project assessment

1) Green Paper on Infrastructure Networks, November 2008

2) Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on guidelines for trans-European energy infrastructure, * COM/2011/0658, October 2011

3) Ten-Year Network Development Plan 2010

Some investments or projects will provide all the benefit categories, whereas other projects will only contribute significantly to one or two of them.

Other impacts, such as benefits for competition, more flexible operation etc. also exist. These are more difficult to model, and will not be explicitly taken into account at this stage.

This assessment has to be done independently for each evaluated scenario.

The **Benefit Categories**[1)] are defined as follows:

B.1 Improved security of supply (SoS)[2)]
is the ability of a power system to provide an adequate and secure supply of electricity in normal conditions.

B.2 Social and economic welfare
on electricity markets is characterized by the ability of a power system to reduce congestions and thus providing an adequate grid transfer capability.[3)]

B.3 RES integration
Support to RES integration is defined as the ability of the system to allow the connection of new RES plants and unlock existing "green" generation, while minimizing curtailments.

B.4 Variation in losses
in the transmission grid is the characterisation of the evolution of thermal losses in the power system. It is an indicator of energy efficiency.

B.5 Variation in CO_2 emissions
is the characterisation of the evolution of CO_2 emissions in the power system. It is a result of B.2 (unlock of generation with lower carbon content) and B.4 (variations in losses).

B.6 Technical resilience/system safety
is the ability of the system to withstand increasingly extreme system conditions (rare contingencies).

---

1) Some definitions of a market benefit include an aspect of facilitating competition in the generation of electricity. These Guidelines are unable to well-define any metric solely relating to facilitation of competition. If transmission reinforcement has minimized congestion, that has facilitated competition in generation to the greatest extent possible.

2) Adequacy measures the ability of a power system to supply demand in full, at the current state of network availability – the power system can be said to be in an N-0 state. Security measures the ability of a power system to meet demand in full, and to continue to do so under all credible contingencies of single transmission faults – such a system is said to be N-1 secure.

3) The reduction of congestions is an indicator of social and economic welfare assuming equitable distribution of benefits under the goal of the European Union to develop an integrated market (perfect market assumption).

B.7 Flexibility
is the ability of the proposed reinforcement to be adequate in different possible future development paths or scenarios, including trading of balancing services.

The **Project costs** are defined as follows:

C.1 Total project expenditures
are based on prices used within each TSO and rough estimates on project consistency (e.g. km of lines). Land costs, costs of obtaining permissions, damages also vary between TSOs. The project cost should consider life cycle costs.

The **Project impact on society** is defined as follows:

S.1 Social and Environmental impact
characterizes the project impact as perceived by the local population, and as such, gives a measure of probability that the project will be built at the planned commissioning date.

Assessment Summary Table

The collated assessments findings are shown diagrammatically in the form of an assessment table. This table displays the assessment results mainly in terms of a simple color code for each of the benefits, as well as costs and social and environmental impact. The calculated increase of Grid Transfer Capability (GTC) is also provided.

Grid transfer capacity increase:	**+ … MW**
Socio-economic welfare:	
RES integration:	
Improved security of supply:	
Losses variation:	
CO_2 emissions mitigation:	
Technical resilience:	
Flexibility:	
Social and environmental impact:	
Project costs:	

Table 12.3:
Example of assessment summary table

Cost and environmental liability assessment

C.1 Total project expenditure

For each project costs have to be estimated. Within ENTSO-E, project expenditures are strongly dependent on local conditions and therefore differing. Consequently, project costs may be calculated by using local standard-cost.

Indicative colors are assigned as follows:
- Light green: Higher than 1,000 M€
- Green: Between 300 M€ and 1,000 M€
- Dark green: Lower than 300 M€

S.1 Social and environmental impact

Social and Environmental impact characterizes the project impact as perceived by the local population, and as such, gives a measure of probability that the project will be built at the planned commissioning date. Impact on nature (biodiversity …), on human activity and social compatibility (visual impact …) are analyzed in order to identify the impact on the planned commissioning date. Early assessment of social and environmental impact will help increasing social compatibility and successful licensing. The indication is found through an expert assessment, if possible supported by preliminary environmental studies.

Indicative colors are assigned as follows:
- Light green:
  The probability of carrying out a project at the planned commissioning date is considered as high (no protected or dense urban area is affected, there are no known former infrastructure conflicts in the area, the visual impact is perceived as low).
- Yellow:
  The probability of carrying out a project at the planned commissioning date is considered as realistic but exposed to uncertainty (protected or urban area may be affected in a limited way, visual impact is perceived as moderate).
- Red:
  The probability of carrying out a project at the planned commissioning date is considered as low (visual impact is perceived as high, protected or urban area may be affected, there have been former conflicts in the area).

Benefit assessment

Geographical scope of the analysis

The geographical scope of the analysis is an ENTSO-E Region as a minimum. If necessary, it can be extended to surrounding countries.

Benefit analysis

- The evaluation of the effects may be performed using both market studies and network analysis, including expert assessment.
- Market based assessment gives a detailed assessment of generation and consumption profile, using a simplified representation of the grid. Market studies performing hourly analysis throughout the year have the advantage of clearly highlighting the structural rather than incidental bottlenecks.
- Network assessment is carried out on a sample of planning cases, selected on the basis of information (system dispatch, frequency or gravity of constraints) given by the market study.[1] It has a simplified representation of generation and demand profiles, and a detailed representation of the grid. Network studies have the advantage of taking into account internal congestions on the network (including loop flows). An iteration of both methods is recommended.

Grid Transfer Capability

D.9 Grid Transfer Capability (GTC)
The GTC reflects the ability of the grid to transport electricity across a boundary, i.e. from one area (price zone, area within a country or a TSO) to another. It depends on the considered state of consumption, generation and exchange, as well as the topology and availability of the grid. The Grid Transfer Capability is oriented, which means that across a boundary, there may be two different values. It's measured in MW.

D.10 Boundary
A boundary may be fixed (border between states or price zones), or vary from one horizon or scenario to another.

D.11 Cross-boundary impact
A project with a grid transfer capability increase by at least 500 MW compared to the situation without commissioning of the project is deemed to have a significant cross-border impact.

---

1) See Chapter 2

Methodology for each benefit indicator

B.1 Security of supply

Security of supply is the ability of a power system to provide an adequate and secure supply of electricity in normal conditions, in a specific area. The improvement of security of supply is assessed under contingencies defined in Chapter 3. The assessment shall be focused on a delimited geographical area. The boundary of the area may consist of the nodes of a quasi-radial sub-system or semi-isolated area (e.g. with a single 400 kV injection). The system is at risk if the given contingency criteria are not fulfilled during 10 years following its commissioning.

As an example, a simple indicator is shown in Figure 12.6.

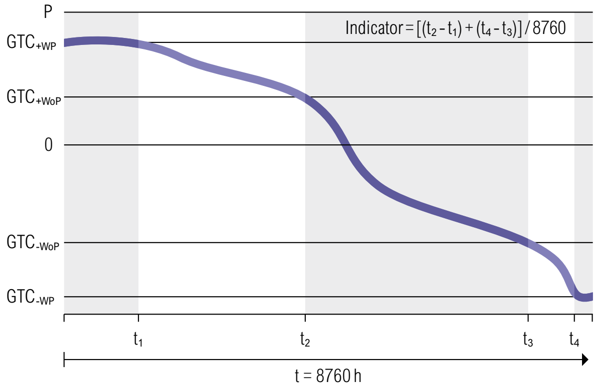


Figure 12.6:
Methodology to compute indicators
Deriving an estimation of security of supply improvement from the market based simulation results (a duration curve of power flow in a cross-section under study) when a project is implemented.
Grid transfer capabilities with (GTC + WP, GTC - WP) and without (GTC + WoP, GTC - WoP) the project have to be known.

Indicative colors are assigned as follows:

- Light green:
  The project will not improve security of supply, i.e. for supplying electricity for normal contingencies, during the ten years following its commissioning.
- Green:
  The project improves the security of supply under normal contingencies as defined in chapter 2 during the ten years following its commissioning.
- Dark green:
  The project additionally improves the security of supply under rare contingencies as defined in Chapter 2 during the ten years following its commissioning.

B.2 Social and economic welfare

The social and economic welfare benefit is calculated from the reduction in total generation costs[1)] associated with the GTC variation that the project allows. By removing network bottlenecks that restrict the access of generation to the full European market, a project can facilitate increased competition between generators, reducing the cost of electricity to end consumers. Similarly, a project can contribute to reduced costs by providing a direct system connection to new, relatively low cost, generation.

1) Since electricity demand is considered inelastic, net decrease in generation costs is a relevant measure for social benefit. Only variable costs are taken into account (no investment costs or subsidies are considered).

This cost reduction is calculated from an economic assessment to determine the optimum cost of total generation dispatch, with and without the project. The benefit for each case is calculated from: Benefit (for each hour) = Generation dispatch costs without the project – Generation dispatch costs with the project. The "social and economic welfare" is expressed by the socio-economic benefit. This benefit is measured in €.

The total benefit for the horizon is calculated by summing the benefit for all the hours of the year.

Indicative colors are assigned as follows[1]:

- Light Green:
  The project has an annual benefit < € 30 million.
- Stripped light green:
  The project has an annual benefit < € 30 million and, additionally, includes direct connection of new generation.
- Green:
  The project has an annual benefit between € 30 and € 100 million.
- Stripped green:
  The project has an annual benefit between € 30 and € 100 million and, additionally, includes direct connection of new generation.
- Dark green:
  The project has an annual benefit ≥ € 100 million.

B.3 RES integration[2]

RES integration is facilitated by

1. connection to the main system and
2. increasing the GTC between an area with excess of RES generation to share this with other areas in order to facilitate higher level of RES penetration.

For point 1, RES integration is measured by amount of MW connected in a given area. For point 2, the border for calculating the GTC is to be placed in a way that divides an area with an excess of RES from an area where that RES generation can be consumed. The RES integration benefit is then calculated in MW through the calculation of the increase in GTC provided by a project.

---

1) Stripes indicate that the project is triggered by direct connection of generation.

2) Calculating impact of RES in absolute numbers (MW) facilitates the comparison of projects all over Europe when looking at the sole aspect of RES integration.
Relative numbers (i.e. the contribution of a project compared to the objectives of the NREA) can easily be calculated ex post for analysis at a national level.

The analysis process consists of taking two cases, one with and one without the project, and for each case increasing the renewable production in the excess generation area until the criteria of chapter 2 is not fulfilled. The RES benefit is calculated by the difference between the values of GTC obtained for both cases.

Market studies may also be used to calculate RES energy that is integrated in the model in the area with excess of RES, taking into account RES production time profiles.

Indicative colors are assigned as follows[1]:

- White:
  The project has a neutral effect on the capability of integrating RES.
- Stripped light green:
  The project allows direct connection of less than 500 MW RES production.
- Stripped dark green:
  The project allows direct connection of more than 500 MW RES production.
- Dark green:
  This project allows an increase of capacity between an area with excess of RES generation to share this with other areas[2] (in order to facilitate at least 500 MW of RES penetration).

B.4 Variation in losses (Energy efficiency)

The energy efficiency benefit of a project is measured through the reduction of thermal losses (MW) in the system.[3] The losses in the system are quantified for each case, with and without the project. The total benefit is then calculated as the difference between both values.

Indicative colors are assigned as follows:

- Red:
  The project contributes to increase the volume of losses on the grid.
- White:
  The project may help decreasing losses in some situations and increasing them in others.
- Green:
  The project contributes to decrease the volume of losses on the grid

1) Stripes indicate that the project is triggered by direct connection of generation.

2) Direct access can be also achieved incidentally.

3) It should be noted that an increase in losses means a higher utilisation of the grid, e.g. due to additional cross border exchanges or RES infeed.

B.5 Variation in CO_2 emissions

By relieving congestion, reinforcements may enable low-carbon power plants to generate more electricity than without the reinforcement, replacing conventional plants with higher carbon content.

Furthermore, reinforcements may reduce losses in the grid, and thus reduce the amount of generation needed to cover demand. Calculation of CO_2 variations is therefore a two-step approach, taking into account both the substitution effect and the effect on losses.

Indicative colors are assigned as follows:

- White: The project has no positive effect on CO_2 emissions.
- Green: The total of projects reduces CO_2 emissions by < 500 kt/year.
- Dark green: The total of projects reduces CO_2 emissions by > 500 kt/year.

B.6 Technical resilience/system safety margin

A quantitative summation of the technical resilience and system safety margin of a project is performed by scoring a number of key performance indicators (KPI) and aggregating these to provide the total impact of the project.

Note:
Some of the KPIs given below may be used as part of the assessment criteria to determine the acceptability of a project as a viable solution to the network needs. In this case they will not be applicable for inclusion under B6.

KPI	Score (either ++/+/0)
Able to meet the recommendation R.5 (failures combined with maintenance) set out in chapter 3 (as applicable).	
Able to meet the recommendation R.6 (steady state criteria) set out in chapter 3 (as applicable).	
Able to meet the recommendation R.7 (voltage collapse criteria) set out in chapter 3 (as applicable).	

Indicative colors are assigned as follows:

- White: the score of KPIs is 0
- Green: the score of KPIs is ≤ 3+
- Dark green: the score of KPIs is > 3+

B.7 Robustness/flexibility

A quantitative summation of the flexibility and robustness of a project is performed by scoring a number of key performance indicators and aggregating these to provide a total impact of the project.

Indicative colors are assigned as follows:

- White: the score of KPIs is 0
- Green: the score of KPIs is ≤ 5+
- Dark green: the score of KPIs is > 5+

KPI	Score (either ++/+/0)
Able to comply with all planning scenarios recommendation R.1 (investigation of cases using results of market studies) set out in chapter 2 (as applicable).	
Able to comply with all planning scenarios recommendation R.2 (investigation of cases using a probabilistic or multi-case approach) set out in chapter 2 (as applicable).	
Able to comply with all planning scenarios recommendations R.3 (investigation of cases taking out some of the foreseen reinforcements) set out in chapter 2 (as applicable).	
Ability to modify the project.	
Ability to facilitate sharing of balancing services on wider geographical areas, including between synchronous areas.	

End note

System development tools are continuingly evolving, and it is the intention that this document will be reviewed periodically in line with prudent planning practice and further editions of the TYNDP.

12.4 Appendix 4: Social Acceptance of Projects

Better streamlined authorization processes for power lines would secure EU energy policy goals

Effective electricity infrastructure is fundamental for guaranteeing EU security of energy supply. Ensuring the development of the grid is necessary to permit the achievement of the EU's renewable energy and climate change objectives and for completing the internal energy market. These are challenges for the governments of all member states. As detailed in the TYNDP 2010 report, the development of electricity infrastructure is thus of crucial national and European importance to make Europe meet these challenges.

Yet, many electricity infrastructure projects face long and complex procedures in the authorization phase, across the different European countries. For the most part, these concerns arise irrespective of whether the developments are domestic or cross-border lines. The procedures for Extra High Voltage assets prove often longer and more complex than for any other infrastructure (roads, railways, gas-pipes).

Authorization processes for power lines must be streamlined so as to ensure both fulfilment of legal obligations as for other infrastructure and industrial facilities, and the timely commissioning of the transmissions assets which would help the EU meet their energy policy goals.

The TYNDP 2010 summed up the key concerns regarding social acceptance of transmission projects

The TYNDP 2010 report explains all concerns with respect to long and complex, possibly redundant, and long authorization procedures for power lines, summed up hereafter:

- Unharmonized legislation between countries and even between regions within the same country.
- Lack of reasonable and concrete time limits for issuing the approvals.
- High number of approval agencies that share different interests.
- Balance between the necessity for grid development and environmental interests.
- Different permitting procedures for different technologies (e.g. line/ substations, OHL/Cable) esp. with respect to EIA.
- Lack of stakeholder (including political) support for projects.

- Lack of social acceptance of projects:
  - Lack of public understanding with respect to the requirement for the project – consideration proposals are mere transit/commercial lines without public benefit.
  - Doubts about the project necessity, environmental impact, EMF, property devaluation.
  - Existence of alternative solutions even if are more expensive and technical complicated.

The draft Energy Infrastructure Package sets promising leads for improving social acceptance of transmission projects

ENTSO-E released the TYNDP 2010 early 2010 so as to raise concerns about the urgency to solve structural problems with respect to power grid development. In late 2010, the EC launched the drafting of new legislation to foster the development of key energy network assets. The so-called Energy Infrastructure Package, proposes in particular a whole range of measures to improve social acceptance of projects:

- Priority status for permit granting Projects of Common Interest at national level
- One competent national authority taking the final decision.
- Clear time limits for decisions by competent authority:
  - Pre application (max 2 years)
  - Statutory granting procedure (max 1 year)
- In the case of Substantive delays – a European Coordinator to be appointed
- Increase of transparency, efficiency and reduction of complexity.
- Member States within 9 months after decision to take measures to streamline decision-making process. Appointment CA within 6 months.
- Member States to provide joint procedures with respect to the environmental assessment.

ENTSO-E welcomes these proposals, as there are many positive elements in the permitting section which will facilitate the fast tracking of transmission infrastructure projects including the proposal on one stop shop and defined time lines.

More thorough analyses are however required so as to ensure the measure can be successfully implemented, in particular in relation to whether the timelines proposed are achievable particularly in the context of the public participation process and the potential for legal delays.

One must also notice that the supporting schemes are limited to the so-called Project of Common Interest (PCIs) whereas there are many significant national transmission projects which are crucial to the achievement of Europe's targets for climate change, renewable and market integration.

12.5 Appendix 5: Technologies – Outlook, Perspectives

12.5.1 Introduction

As we can observe changes in electricity markets requirements, power demand shape, power sources distribution or other external constraints, Transmission System Operators need to anticipate their future needs and participate in an active way in the research and development of new technologies. For the same reasons, TSOs consider permanently the panel of available technologies and strive to make the best use of them, including technologies considered as unconventional rather than new, for their little use does not offer the very large experience shared on conventional technologies.

The technologies employed to date in the transmission grids are efficient, reliable, well-engineered and are widely available techniques for transferring energy in high-voltage grids.

The evolution of technologies depends on several factors. As a matter of fact, documents such as the European "Smart Grids Vision" formulate a demand pull on technology, which is fully experienced by TSOs through their deep involvement in R&D projects. Liberalization of the European electricity market, massive integration of renewable generation in the system, as well as environmental, social and economic constraints, constitute the major drivers of this demand pull.

On the other hand, power industry offers a variety of new, emerging technologies for the evolution of power systems, as observed in many available studies and recently compiled by the "Realisegrid" European co-funded project.

Of course, the present appendix is not bound to give a comprehensive description of all the research done about grid operation and development. Moreover, as some projects are considered as demonstration projects rather than network development projects, they do not appear at the TYNDP level.

Therefore, the reader is invited to refer to the ENTSO-E R&D Plan, which describes a plan of around € 790 million over ten years.

Research fields, which are included in the R&D plan and subsequently in R&D projects managed by ENTSO-E members – and therefore monitored by ENTSO-E – include the following:

- Architecture and planning tools for the pan-European network,
- tools to prove the efficiency of technology aimed at increasing both the flexibility and the security of the operation of transmission systems and
- new tools based on simulation techniques that will give rise to new market design options.

In this respect, this appendix only presents a brief illustration of the researched fields, to illustrate how transmission projects presented in Chapter "Foreseen Investments on the European Grid" indeed take advantage of the best available technologies to meet present and future grid development challenges.

In the present selection of innovative and unconventional technologies, each technology has its own advantages and drawbacks, which have to be considered and assessed in the context of a given project. As ENTSO-E considers it very difficult and delicate to assess a technology in a global way and apart from given local needs and constraints, the current document does not provide any quantitative assessment or any comparison between examined technologies.

Indeed, each project is different and therefore inherits different levels of benefits from new technologies. Although some new technologies have been granted a lot of publicity, there is no universal solution for transmission networks so far.

Each project has to be studied with its own characteristics and assessment of the best fitted technologies.

12.5.2 Overview of Available or Promising Technologies Today

This section deals with novel techniques as well as with unconventional techniques, i.e. known technologies that have not been widely used for various reasons. Basically technologies can be sorted into four categories depending on their maturity:

1. Some are mature, even though they might not be largely implemented, i.e. they have already proved their general applicability, have been fully developed, tested, their operation within the existing meshed grid proved reliable and introducing new items is not a technological challenge. DC connections between synchronous and asynchronous areas, Phase Shifting Transformers (PSTs) are examples of such mature technologies.

2. Some are in large scale testing phase, i.e. they have been fully developed (laboratory devices work) but their insertion into the existing meshed grid is still being, or to be, tested, in order to check they can be reliably operated along with other equipment in all likely situations. For instance Real Time Thermal Rating (RTTR), low sag conductors reached this level of maturity.

3. Some are in development phase, i.e. no feasibility questions remain, but some resources are needed to engineer some still missing brick (e.g. some operating IT, some kind of Flexible AC Transmission System – FACTS).

4. Some are in research phase, i.e. some key-issue is not yet solved and hence feasibility is not demonstrated. Typically, distributed storage solutions are today no alternative solution to transmission grid development as their capability, regarding power as energy issues, is about 100 or 1,000 times too small compared to transmission grid requirements. Implementation of superconductors and nanotechnologies is also still researched with no practical application yet.

This section presents an overview of selected new transmission technologies that have the potential for large scale integration in the transmission grid in Europe in the future.

Transmission lines (overhead lines and cables)

High Temperature Conductors (HTCs) are able to withstand higher operating temperatures, thus carrying higher amount of power compared to conventional conductors. However, as the losses depend on the square of transmitted current, operating at higher rates generates significantly more losses.

HTCs can enhance transmission capacity without impacting the negotiated right-of-way, ideally without modifications of transmission towers, but this is not always the case. Although existing lines are used, in some countries such projects have to go through the impact assessment procedure again, especially when expected currents are higher due to the increase of magnetic field level.

HTCs encompass a broad family of very different technologies in terms of potential for transmission capacity and investment costs level. This explains the diverging viewpoints observed between equipment manufacturers and TSOs: the appropriate selection of a conductor will follow an in-depth analysis of the power system including operational and climatic conditions, fatigue and safety issues as well as the overall investment costs. Gains in capacity can reach 30 % for the most used HT Conductors, while transfer capacity could be more than doubled with some technical solutions such as composite type conductors.

HTC costs are generally higher (in some cases much higher) than conventional ACSR (Aluminium Conductor, Steel Reinforced) conductors. Investment cost figures need to be tuned by considering electrical losses, potential structure reinforcement, installation and maintenance costs. The assessment of performances over the whole life-time through a better understanding of reconductored lines (models, endurance testing and level of electrical losses) is essential to further extend HTC uses.

Among the studied technologies, High Temperature Superconducting (HTS) cables are the ones which are the farthest away from commercial applications. Some optimistic experts consider first applications of HTS by 2020 thanks to a second generation of materials (Yttrium Barium Copper Oxide, YBCO) and advanced deposition techniques, starting at distribution system level. However, the majority of manufacturers are much more prudent with regards to their use in transmission systems and do not consider any significant application at least before 2030. Costs and size of the cryogenic refrigeration units will remain a major obstacle. Field tests experimentations within very specific situations (short distance, dense urban area, DC applications) will contribute to the further development of the HTS technology blocks.

Illustration:
Illustrating the above-mentioned difficulties, the choice of HTC has been made for only two projects of the TYNDP: the 260 km long 400 kV overhead line between France and Italy, and the ongoing upgrade of a 220 kV line in Poland.

The **High Voltage Direct Current (HVDC)** technology has proven its reliability and attractiveness for long distance power transmission, long submarine cable links and interconnection of asynchronous systems. Converters to convert current from AC to DC and DC to AC are critical.

The most recent technology, self-commutated Voltage Source Converter (VSC), is more flexible than the more conventional line-commutated Current Source Converter (CSC) since it allows controlling active and reactive power independently.

HVDC key benefits are in terms of increased transmission capacity compared to conventional HVAC for the same asset size, and power flow controllability, which in turn can enhance the stability of the link and of its surrounding environment.

Although the investment costs of a VSC-HVDC converter station are higher than those of an AC substation, the overall investment costs of a DC transmission link can be lower than those ones of a corresponding AC interconnection if a certain transmission distance is reached (i.e. "break-even" distance). This break-even distance strongly depends on the specific project parameters: it is typically between 80 and 120 km for offshore submarine cable connections; while for onshore applications, the break-even distance between an AC and DC OHL is usually in the order of 700 km. Nevertheless, other constraints have then to be taken into account.

Typical applications of VSC-HVDC include the active control of flows, interconnection of offshore wind farms, black start functionalities and multi-terminal DC applications. This technology is a key component of future European grid architectures, as we already can observe in the TYNDP.

Meshed DC systems could appear with the advent of commercial DC breakers.

Illustration:
Around 45 HVDC projects representing some 10,000 km of lines (up to 800 km for the UK – NO interconnector), mostly undersea and located in North, West, Central and South Europe, are described in the TYNDP 2012. Nevertheless, some cables are to be installed onshore, e.g. in France between Haute Normandie and the south of Paris.

Real-Time Thermal Rating (RTTR) – monitored cables/overhead lines, or **Dynamic Line Rating** –, are on their way to become a mature technology based on the real time control of thermal rating of an overhead line or a cable. It aims at maximizing the capability of a transmission line/cable while respecting design margins, thus reducing potential congestion problems. Its further development will be facilitated by solving some practical integration challenges: integration with other tools, interoperability with protection equipment settings, coordination of RTTR monitored links, communication with SCADA and use of RTTR output values at a dispatch level.

Combined uses of RTTR measurements with weather forecast might significantly increase the value of RTTR for network operations: it could become an interesting option for TSOs to achieve higher transmission capacity ratings safely and reliably for existing systems, at relatively low investment costs (when compared to the investment needed for new transmission links). The challenge here consists in developing more reliable and precise wind forecasts.

Illustration:
Real-Time Thermal Rating Projects do not explicitly appear as such in the TYNDP list, for they are not considered by TSOs as necessarily directly related to the development of the European transmission grid.

Underground and submarine XLPE (Cross-Linked Poly-Ethene) cables present a good potential for transmission. Such cables for HVDC applications are more and more used. For HVAC XLPE cables, however, notwithstanding the recent technological progress, the further deployment and consequent cost reduction, the cost barrier (when compared to conventional solutions) is still high and expected to remain so due to the intrinsic higher complexity and installation constraints of this technology.

Yet, the cost barrier might be reduced when all types of benefits stemming from this technology are considered, such as the consideration of losses during the whole life-time, authorization procedures duration in some countries, visual impacts, etc.

Nevertheless, these underground assets represent a specific risk for operation that has to be carefully analyzed: on the one hand this technology is less exposed to external events, but on the other hand causes long outages when damaged.

Illustration:
Some above-mentioned HVDC projects consider the use or will use XLPE cables.

Gas Insulated Line (GIL) is a proven, yet not widespread, technology mostly used in short length installations (exploiting tunnels, bridges, or other existing infrastructures). It allows carrying a much higher amount of power through a single line than conventional solutions and XLPE cables. Yet, it faces strong environmental concerns in terms of SF_6 emissions, which are more than 20,000 times more harmful than CO_2 emissions, with a cost ratio over conventional solutions that remains high. GIL deployment is likely to continue within niche applications valorizing existing nonelectrical infrastructures: much will also depend on the successful implementation of GILs in planned projects at European level (like it is discussed for the Brenner tunnel).

Illustration:
Pilot project in the Brenner Tunnel between Italy and Austria being currently under consideration, constituted of a 65 km long double circuit 400 kV Gas Insulated Line.

Substations

Phase Shifting Transformers (PSTs) are a mature technology, implemented by TSOs in Europe to control active power through preventive or curative strategies. PSTs do not increase the capacity of the line themselves; but in case some lines are overloaded while capacity is still available on others parallel to them, then optimizing the transits with PSTs can increase the overall grid capacity. In the future, the focus will be on enabling issues: the development of shared PST models by TSOs and standards should facilitate PST integration in transmission systems. In parallel, the development of cross-border power trade and the integration of renewable generation will increase the need for such a technology, possibly operated by power electronics and enhanced by coordinated control protocols implemented within inter-TSO coordination centers.

Illustration:
A dozen of Phase Shifting Transformers are to be installed in Europe in the coming ten years, like in Zandvliet (4th PST on the Belgian north border).

Fault Current Limiters (FCLs) comprise technologies with different degrees of maturity. When addressing novel concepts (High Temperature Superconducting FCL, solid-state FCL, hybrid FCL), technology challenges still remain to be faced before a commercial exploitation (especially for High Temperature Superconducting FCL). The implementation of joint testing facilities by TSOs at EU level would help converging on design types and materials, cost reduction and standards and might speed-up the technology take-up in some niche applications in Europe.

Illustration:
Such a technology is considered as a possible help in operations, but does not appear as full part of the TYNDP list of investments.

Flexible Alternating Current Transmission System (FACTS) equipment is a family of power electronics-based devices able to enhance AC system controllability and stability and to increase power transfer capability. FACTS are naturally compared by TSOs with mechanical driven equipment providing controllability features, such as Phase Shifting Transformers (a simpler, more robust, reliable and generally less costly solution, but with limited dynamic capabilities).

FACTS devices can be classified according to their shunt, series or combined types of connection. Shunt type devices present relevant features for reactive power compensation and voltage control, while series devices offer key advantages for active power flow control and transient stability enhancement.

Costs, complexity and reliability issues represent nowadays the main barriers to the integration of these promising technologies from the TSOs' perspective. Up to present, shunt devices (like the SVC, Static VAR Compensator) have been the most widespread and mature FACTS technologies. Further FACTS penetration will depend on the technology providers' ability to overcome these barriers, thanks to more standardization, interoperability and economies of scale.

Key technology challenges are in terms of power electronic topologies and exploration of new types of semiconductors replacing silicon. More user-friendly interfaces and proof of performance through field testing will contribute to improve TSOs' confidence in these new technologies. Like other active equipment (HVDC (VSC) and PST), FACTS will be crucial for the future integration of RES into the European system, while delivering full benefits when subject to a coordinated control, in combination with Wide Area Measurement Systems (WAMS).

Illustration:
Such a technology is considered as a possible help in operations, but does not appear specifically under this name in the TYNDP list of investments. Nevertheless, some TYNDP projects involving banks of capacitors include SVC.

Operating strategies

Wide Area Monitoring System (WAMS) is an information platform with monitoring purposes. Based on Phasor Measurements Units (PMUs), WAMS allow monitoring transmission system conditions over large areas in view of detecting and further counteracting grid instabilities. This early warning system contributes to increase system reliability by avoiding the spreading of large area disturbances, and optimizing the use of assets. Yet, some critical R&D challenges lie in signal accuracy and reliability, communication architectures and data processing.

Standards for data processing, large scale demonstrations, possibly in combination with other active equipment, will be needed to estimate benefits brought by WAMS.

Illustration:
Such a technology is considered as a possible help in operations, but does not appear as full part of the TYNDP list of investments.

Electric Storage
Although not generally operated by TSOs, electricity storage solutions could have a significant impact on transmission planning and operations. Storage solutions (centralized ones like hydro pumping e.g. or decentralized ones like batteries in cars, if and when electric cars will be deployed massively) can provide TSOs with new options to cope with variable power flows.

Storage could help maximizing electricity system stability in case of any sudden drop/surge due to the variability of most RES generation plants. It could also support CO_2 emissions abatement targets either during off-peak periods, by avoiding electricity spillage, or during peak periods in the case of a generation mix that is highly fossil fuel dependent.

Historically, storage is related to technologies like Pumped Hydro and Compressed Air Energy Storage, whereas other storage technologies are not clearly addressing large scale system issues. Yet, there are still technical and mostly regulatory issues to be faced. In terms of regulatory issues, open questions are related to which players (private market operators contributing to system optimization or regulated operators) shall own and manage storage facilities. Implementing large scale demonstrations of storage solutions at European level appears to be a necessary step to validate both storage benefits based on full scale studies and the potential asset ownership options for storage regulations.

Illustration:
As for now, there are around 15 projects among Europe, which are limited to the connection of hydro pump power plants, mainly in Switzerland, Austria, Romania, Spain and Portugal. As for storage demonstration projects, the TWENTIES project involving several ENTSO-E members, responding to the ENERGY 2009.7.1.1 call (optimization of the electricity grid with large-scale renewables and storage) can be quoted, as well as the Almacena project in Spain.

12.5.3 Conclusion

As already mentioned, European TSO's are supporting the development of the above-mentioned new technologies by testing new products supplied by manufacturers, testing new technologies, influencing thus the improvement of the most relevant technologies. In fact TSOs are frontrunners in all these advances in new technologies, while carefully choosing the most promising ones.

Some of the technologies are still in a premature state and a large scale integration of these technologies in the transmission grid is not possible due to reliability constraints. As the TSO's have the responsibility for the whole electrical system in their control zone, precaution is needed with respect to the introduction of new technologies.

As a matter of fact, none of the examined technology is a universal solution. Each project has to be considered in a dedicated study assessing the best fitting technologies.

For that reason, some technologies play a real role in the European TSOs' transmission projects in the next ten years, and some other technologies do not appear yet, for their level of maturity and reliability are not satisfying yet within this timeframe.

Moreover, as some projects are considered as demonstrations rather than network development projects, they do not appear at the TYNDP level. The ENTSO-E R&D Plan is providing a larger and exhaustive approach of projects involving new technologies, and for that reason, the reader is invited to refer to this document in order to get more detailed information regarding new technologies.

12.6 Appendix 6: Import Capacity Compared to Net Generating Capacity

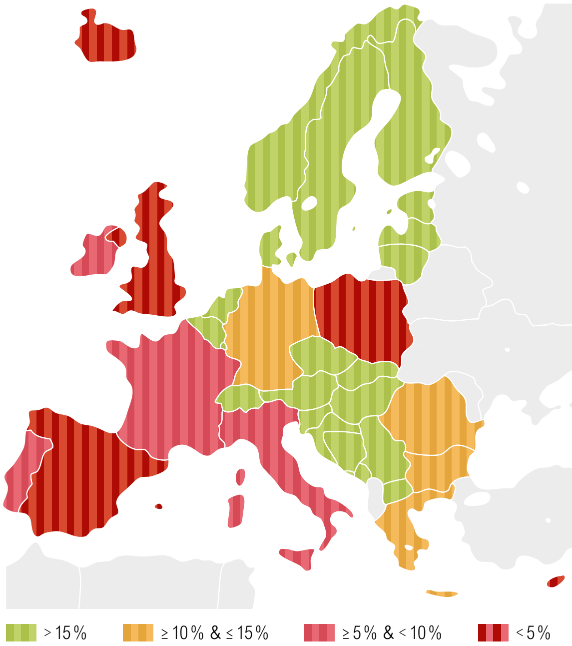


Figure 12.7:
Import capacity/net generation capacity in 2011

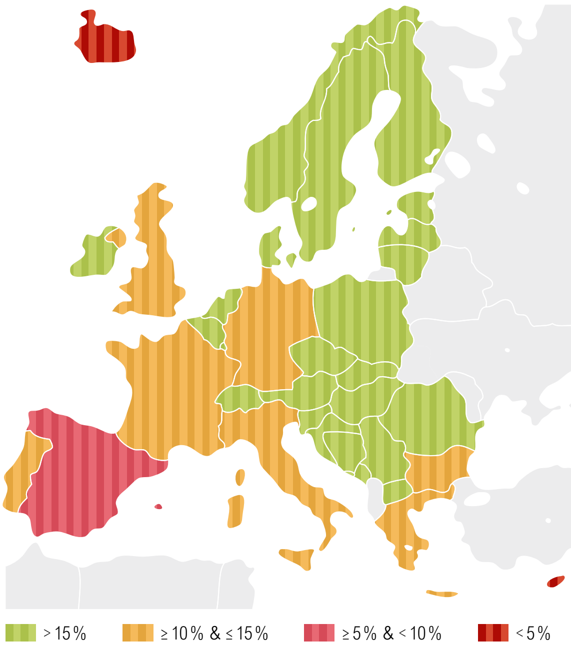


Figure 12.8:
Import capacity/net generation capacity in 2020

The European Council[1] has proposed a very simple criterion for interconnection development, asking from every Member States a minimum import capacity level equivalent to 10 % of its installed production. The result is depicted in Figure 12.7.

The map shows that Island systems or electricity quasi-Island systems (Ireland and UK, Iberian peninsula) but also Poland show the lowest import – generation ratios. France and Italy are slightly under the 10 % threshold and Germany, Romania, Bulgaria and Greece slightly above. All other countries display index levels greater than 15 %. This shows both the power and the limits of the indicator: every Baltic state for instance display a high index level. As they are mutually interconnected, assessing the indicator for all three of them, and towards EU countries, would lead to a mere 4 %.

[1] Presidency Conclusions, Barcelona European Council, 15 and 16 March 2002.

The criterion computed for the present situation can be reassessed after a projection in 2020, assuming all projects of pan-European significance implemented. The result is depicted in Figure 12.8.

Poland, Great-Britain, Italy, Portugal and France reach the 10 % target threshold by 2020 once projects of pan-European significance are implemented. Despite its interconnection capacity is multiplied by about 4, Spain still show a 4 %,below the target threshold.

Abbreviations

AC	Alternating Current
ACER	Agency for the Cooperation of Energy Regulators
CCS	Carbon Capture and Storage
CHP	Combined Heat and Power Generation
DC	Direct Current
EIP	Energy Infrastructure Package
ELF	Extremely Low Frequency
EMF	Electromagnetic Field
ETS	Emission Trading System
ENTSO-E	European Network of Transmission System Operators for Electricity (see § A2.1)
FACTS	Flexible AC Transmission System
FLM	Flexible Line Management
GTC	Grid Transfer Capability (see § A2.6)
HTLS	High Temperature Low Sag Conductors
HV	High Voltage
HVAC	High Voltage AC
HVDC	High Voltage DC
KPI	Key Performance Indicator
IEM	Internal Energy Market
LCC	Line Commutated Converter
LOLE	Loss of Load Expectation
NGC	Net Generation Capacity
NRA	National Regulatory Authority
NREAP	National Renewable Energy Action Plan
NTC	Net Transfer Capacity
OHL	Overhead Line
PEMD	Pan European Market Database
PCI	Project of Common Interest (see EIP)
PST	Phase Shifting Transformer
RAC	Reliable Available Capacity
RC	Remaining Capacity
RES	Renewable Energy Sources
RG BS	Regional Group Baltic Sea
RG CCE	Regional Group Continental Central East
RG CCS	Regional Group Continental Central South
RG CSE	Regional Group Continental South East
RG CSW	Regional Group Continental South West
RG NS	Regional Group North Sea
SEW	Social and Economic Welfare
SO&AF	Scenario Outlook & Adequacy Forecast
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
VSC	Voltage Source Converter

Imprint

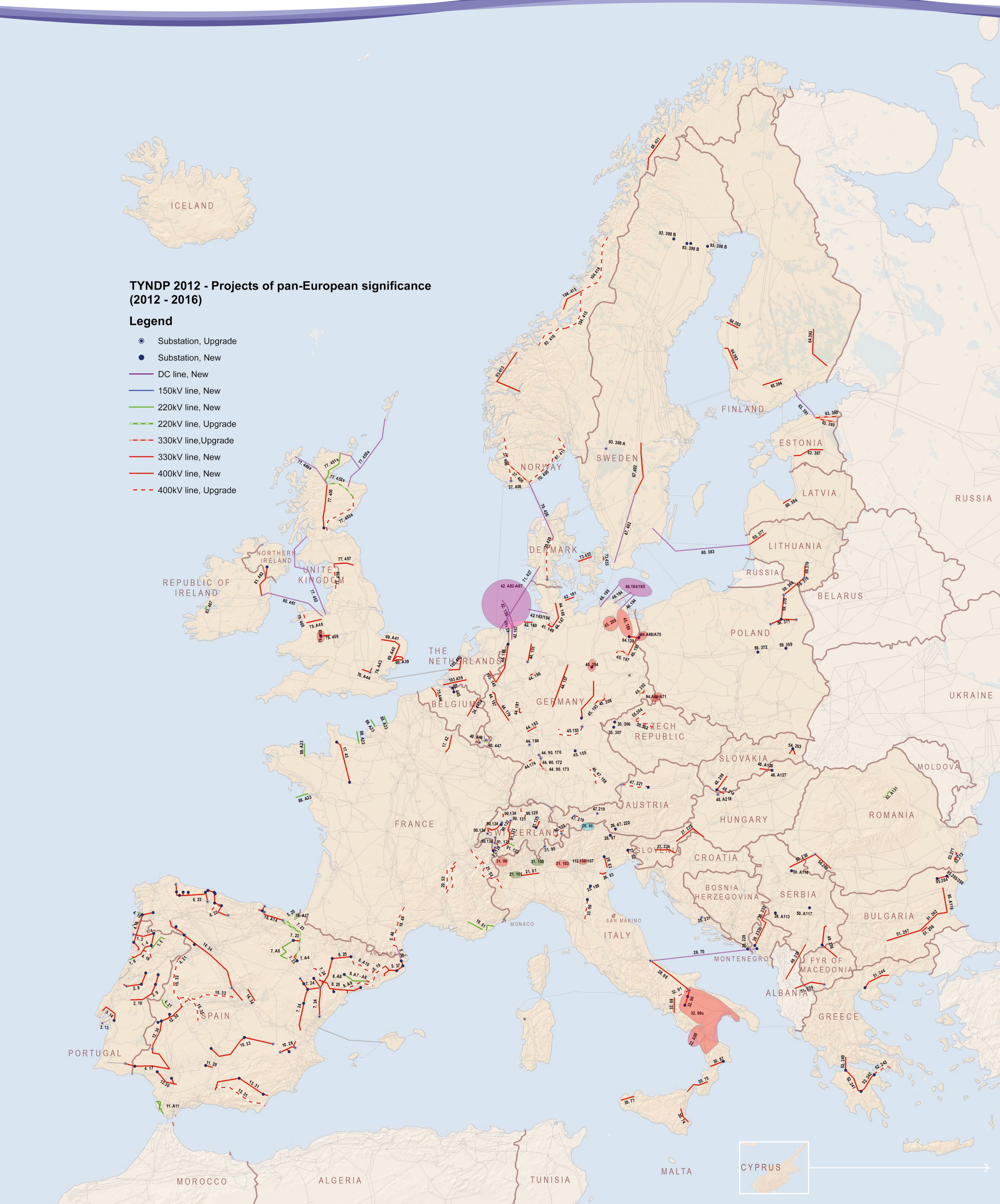
Publisher: ENTSO-E AISBL
Avenue de Cortenbergh 100
1000 Brussels – Belgium

Design & Layout: Oswald und Martin Werbeagentur, Berlin

Photos: 50Hertz Transmission (p. 93),
Elia (p. 32)
Energinet.dk (p. 71)
ENTSO-E (p. 22)
Fingrid (p. 7, 75)
iStock (p. 38, 89),
Réseau de Transport d'électricité (p. 43, 78)
TenneT TSO BV (p. 58)
Terna – Rete Elettrica Nazionale SpA (title, p. 29)

10-Year Network Development Plan 2012 –
Projects of pan-European significance mid-term

entsoe



10-Year Network Development Plan 2012 – Projects of pan-European significance long-term

entsoe