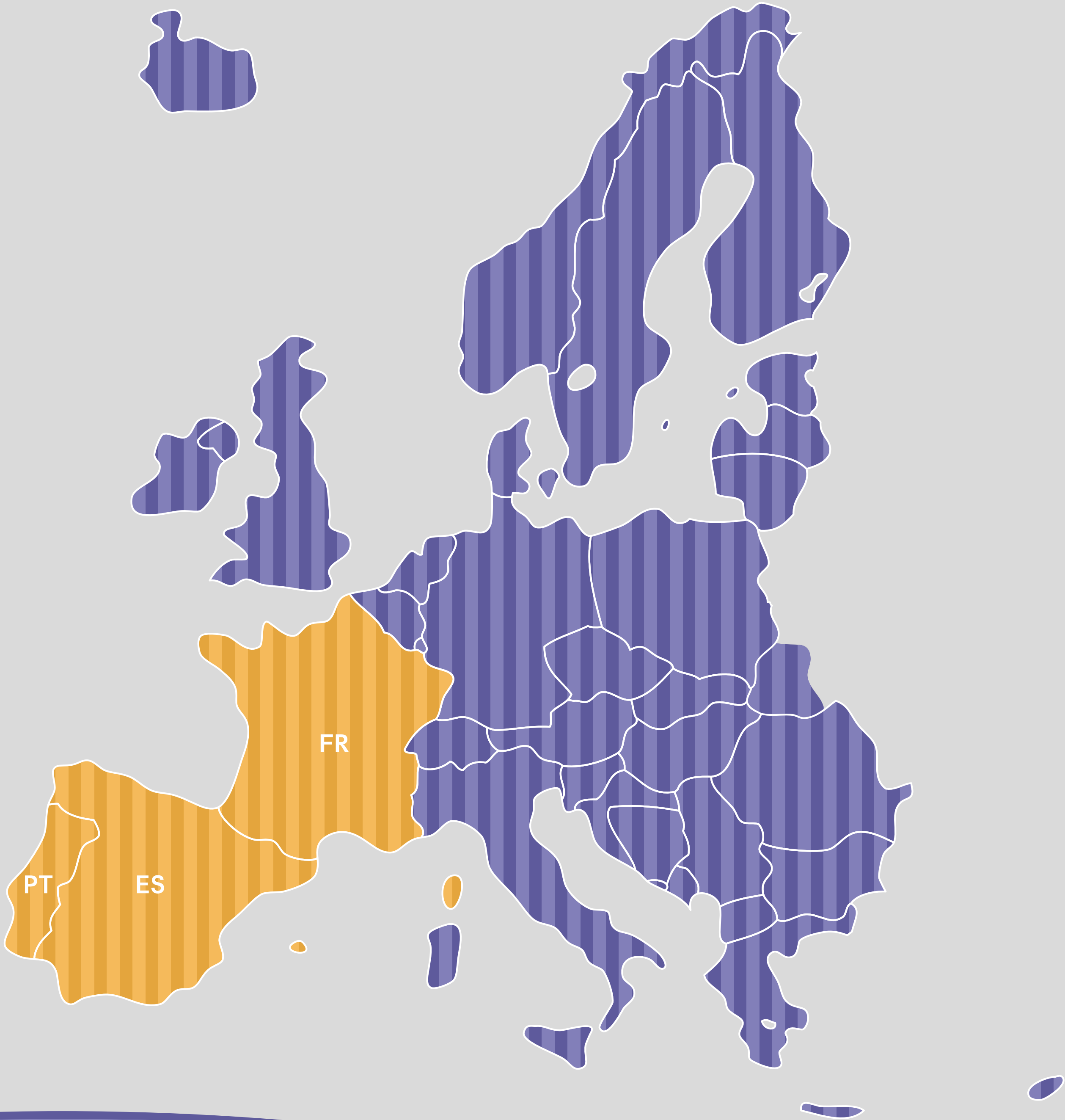
Regional Investment Plan Continental South West

Final



European Network of
Transmission System Operators
for Electricity

entsoe

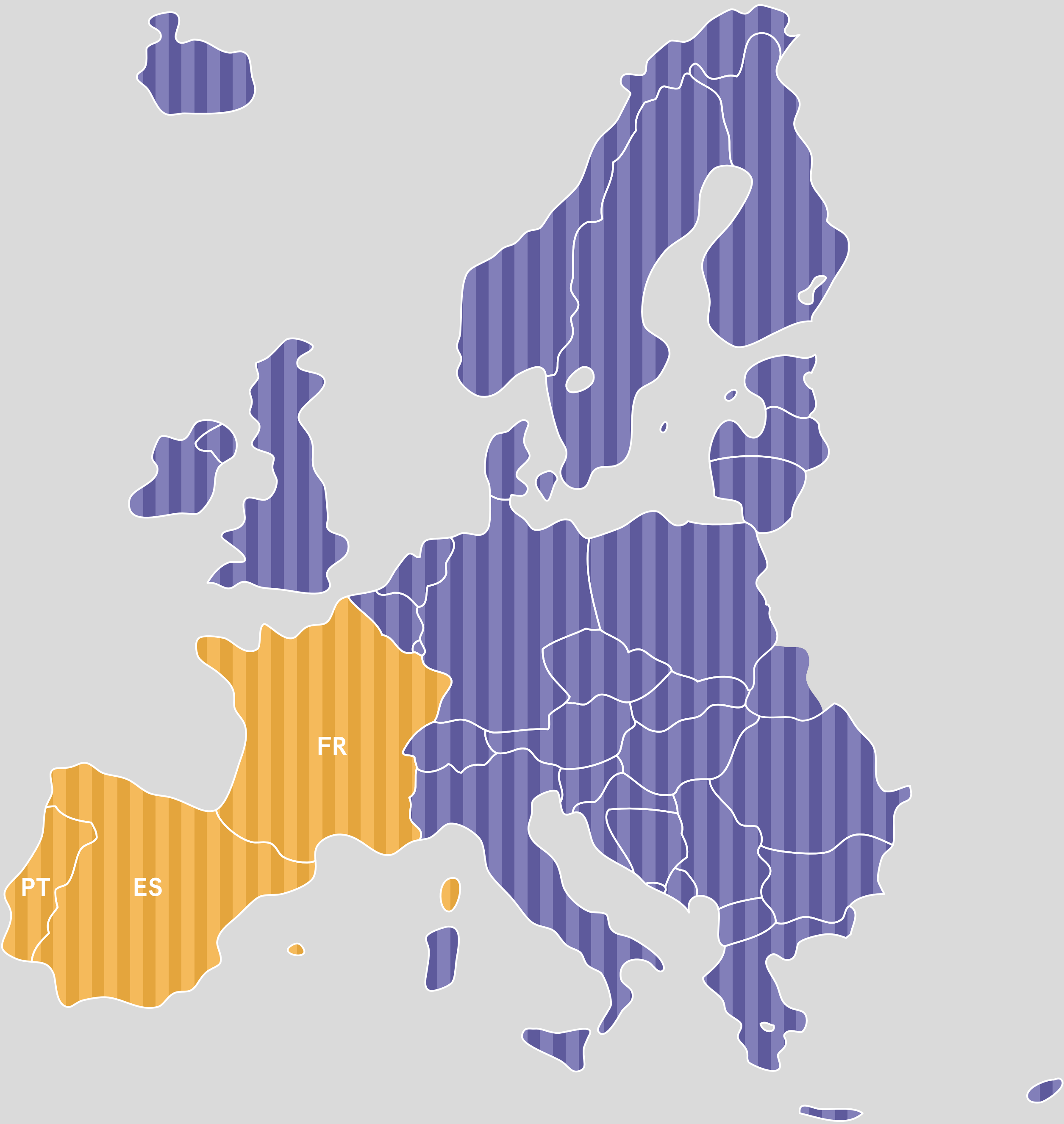
Regional Investment Plan Continental South West

Final

5 July 2012

Content

1 Executive Summary



The 3rd European Energy Package requires European Transmission System Operators (TSOs) to cooperate with promoting the development of the Electricity Infrastructures, both within and between Member States, which help with satisfying European needs. In this regard, the TSOs of ENTSO-E are required to prepare development plans at national, regional and pan-European levels.

The present report is part of an 8-document suite comprising a Scenario Outlook and Adequacy Forecast (SOAF), a Ten-Year Network Development Plan (TYNDP), and 6 Regional Investment Plans (RgIPs). In June 2010, ENTSO-E published a pilot TYNDP in anticipation of the entry into force of the 3rd Package in March 2011, which included projects based largely on existing studies carried out by TSOs, individually or bilaterally. The TYNDP 2012 and the six Regional Investment Plans associated are supported by regional and pan-European analyses, and take into account the feedback received from stakeholders in several consultation processes during 2011.

This Regional Investment Plan aims to describe the investment needs and associated planned projects for the next 10 years in the Continental South West (CSW) region, which covers Portugal, Spain and France. It assesses cross-border and internal projects of regional and/or European significance, which allow reaching the European targets, with particular regard to the Security of Supply (SoS), the development of the Internal Electricity Market (IEM) and the integration of Renewable Energy Sources (RES). Moreover, the RgIP provides information for monitoring the progress of TYNDP 2010 projects.

Two common scenarios have been built at the European level and are the base of the 2012 edition of the TYNDP and the Regional Investment Plans. Both are based on the SOAF 2011. A first scenario with a top-down approach is called the **"EU 2020"**, and represents a context in which the European 20-20-20 objectives are met (20% RES share in gross energy consumption, 20% reduction of GHG, and 20% increase in energy efficiency). A second scenario with a bottom-up approach is called the **"Best Estimate Scenario"**, or **"Scenario B"**, and represents the best estimation of the TSOs, according to their expertise and the information provided by stakeholders (no matter whether European objectives are globally met or not). In the CSW region, Scenario EU2020 considers a load lower by 7% than Scenario B, due to energy efficiency measures. RES plans are similar in the Iberian Peninsula in both scenarios, but not in France where they are significantly lower in Scenario B. During the study, and following Fukushima's events, Germany decided to change its nuclear policy and to shut down approximately 20 GW of nuclear generation by 2020, compared to 2010. A sensitivity analysis taking into account this decision has also been performed.

A set of studies has been performed for the mentioned scenarios:

- Market studies focused mainly on RES integration, generation mix and economic efficiency (in terms of variable generation costs) at a European level;

– Generation adequacy studies assessed potential energy not supplied;

– Network studies detected congestions, proposed and confirmed projects and assessed transmission adequacy.

Different tools have been used for each type of study. Cross-analyses showed that results were quite similar, and thus confirmed the robustness of the main conclusions.

One of the main interests of the Market studies in the CSW region is to assess the impact of the new interconnection projects in the system, which are Northern and Southern interconnections between Spain and Portugal, and Eastern and Western interconnections between France and Spain. Market studies have showed that France will still be a big exporter and that Spain and Portugal will experience higher exchange volumes, both in import and export, but which will result in being globally rather balanced.

These higher exchanges of energy in both directions will provide an important social economic welfare to the system. Therefore, all planned interconnections could be profitable for the system in less than 10 years, and for Eastern Reinforcement ES-FR in even less than 5 years. In addition, proposed interconnections will reduce around 2.3 Mtons CO_2/y for the whole EU in Scenario EU2020, the savings being almost neutral in Scenario B. Scenario EU2020 is marked by higher spillages, higher congestions and higher exchanges between countries than Scenario B, and so cross-border reinforcements are more economically profitable in Scenario EU2020. It shows the big impact of CO_2 cost in the energy system. The Nuclear phase out implies higher imports of Germany, which are smoothly dispatched between many countries. This has a low impact in the CSW region, slightly affecting congestion and energy flows, and slightly reducing the benefits of interconnection projects in the region. The generation adequacy indicators in the CSW region are generally low or very low in all scenarios, and fulfill the different national criteria.

The regional analysis shows that there are significant transmission needs arising between now and 2022. These needs are driven by a number of different factors. One main driver of transmission network development is the connection and evacuation of new generation (both renewable and conventional energy). The CSW region expects a deep penetration of RES in 2020. Nowadays, there are around 41 GW of RES installed in the region, and by 2020 around 45 – 57 GW of new RES will be installed. The ambitious renewable plans in Spain and Portugal imply an important investment in transmission infrastructure. The reason is that these new Renewable Energy Sources (mainly wind, hydro – with and without pumping station – , and solar) are usually located in remote areas, without an existent connection or with a poor connection to the transmission network. In addition, the evacuation of new generation will require more flexible conventional generation and transmission grid, and will create bulk power flows that can cause congestion in the existing network and require additional grid capacity.

Another main driver in the region is an insufficient cross-border capacity that causes structural market congestion between price zones, especially between Spain and France. The interconnection ratio for Spain is today around 4%, far away from the objective set by the Barcelona EU Council in 2002. In fact, the exchange capacity is so low compared to the size of the Iberian system that it is usually considered as an electric island. Therefore, full integration within the Iberian Electricity Market (MIBEL) and Integration of MIBEL with continental Europe is one of the main key issues for the region. The forecasted demand growth, while modest, gives rise to security of supply issues in certain areas or big cities that will require transmission investment.

Apart from integrating new generation, mainly intermittent renewable energy, thus assuring the security of supply and supporting the completion of the European Internal Market, there are some other challenges that the whole of Europe as well as this region face. Future contexts will represent an increasing complexity of grid operation. The large number of decentralized RES requires monitoring and control capabilities (such as the Renewable Control Centre in the Spanish TSO, the CECRE), and new equipment capable of active power flow control, like the planned HVDC, FACTS, and PSTs. Uncertainties regarding decommissioning and materialization of agent portfolios (volume, type and location) is also a challenge for grid development. All these situations require more complex studies and more coordination at every level, between Transmission System Operators but also with Distribution System Operators and every stakeholder.

Another important challenge is the permitting procedures and the social acceptance. The required grid may not be in time if there are important delays in permitting procedures, like today, which can lead to not being able to integrate the installed RES. If energy and climate objectives are to be achieved, a smooth authorization process is necessary. Therefore, TSOs support the Energy Infrastructure Package proposals, such as establishing a one-stop shop, or setting a deadline of 3 years for authorization.

In response to the regional needs, the Continental Southwest Region has identified 29 projects of Regional and European relevance. Around 78 % of the individual investments in these projects were included in the TYNDP in 2010; 33 % are progressing as planned, although some of them have some reshuffling; 28 % will be commissioned by the end of 2012 (13 % already commissioned), and around 3 % are ahead of the former schedule. However, 34 % of the planned projects in TYNDP 2010 have experienced delays mainly related to the permitting process, generally due to consultation results or environmental issues, which sometimes force reviewing and redefining the project, in order to introduce some changes in its definition, or even, in some extreme cases, to look for an alternative solution (new project). New projects are mainly caused by long-term needs.

The investment plan proposed sums up 14000 km, 84 % of them being overhead lines in AC. It includes 4 new cross-border lines within the region, 5 interconnection projects with the rest of Europe, and 20 internal projects. The plan shows a big effort to make the best of existing assets in order to minimize grid extension and avoid creating new routes, as 25% of the AC projects are upgrades, uprates or a change of conductor, including High Temperature conductors. Moreover, FACTS and Phase Shifter Transformers are considered to control active power flows in some parts of the network. In addition, new but efficient technologies are considered in the project definition, such as the VSC technology for the HVDC projects.

The midterm horizon assumes 57 % of the total km, and includes many investments in the Iberian Peninsula, while the long-term horizon considers projects mainly in France. The reason is that the high development of RES is one of the main drivers for 400 kV reinforcements in the Iberian Peninsula and as RES facilities, and their required infrastructures, have been planned already several years ago, they are progressing and will be mainly commissioned in the midterm; some of them have even been already commissioned. On the other hand, France develops long-term cross-border projects or studies with every neighboring country. In addition, French internal projects are mainly located in the long term, triggered by the development of generation (mostly RES but also conventional) as well as the increase of cross-border flows.

The projects have been assessed with a multi-criteria assessment that evaluates their contribution to the social economic welfare, RES integration, Security of Supply, variation of losses, CO_2 emissions, compliance with network codes, resilience, flexibility, costs, and social and environmental impacts.

The planned projects are a direct support to the EU energy policies. More than 70 % of the projects contribute to integrating RES directly or indirectly. Projects of EU significance integrate around 30 GW of new RES in the region. It is worth mentioning that not all the National Master Plans are included in this RgIP, and therefore not all Renewable National plans are attached to projects of EU significance. Some projects of EU significance also improve the Security of Supply. However, local investment of national relevance is generally required in addition to the projects included in this plan in order to secure supply of local load. On the other hand, 83 % of the projects of EU significance contribute importantly to increase the social economic welfare, as they allow the production with more sustainable and cheaper power plants, which means variable generation cost savings; therefore, they contribute to the Internal Electricity Market. They also contribute to significantly mitigating CO_2 emissions in Europe.

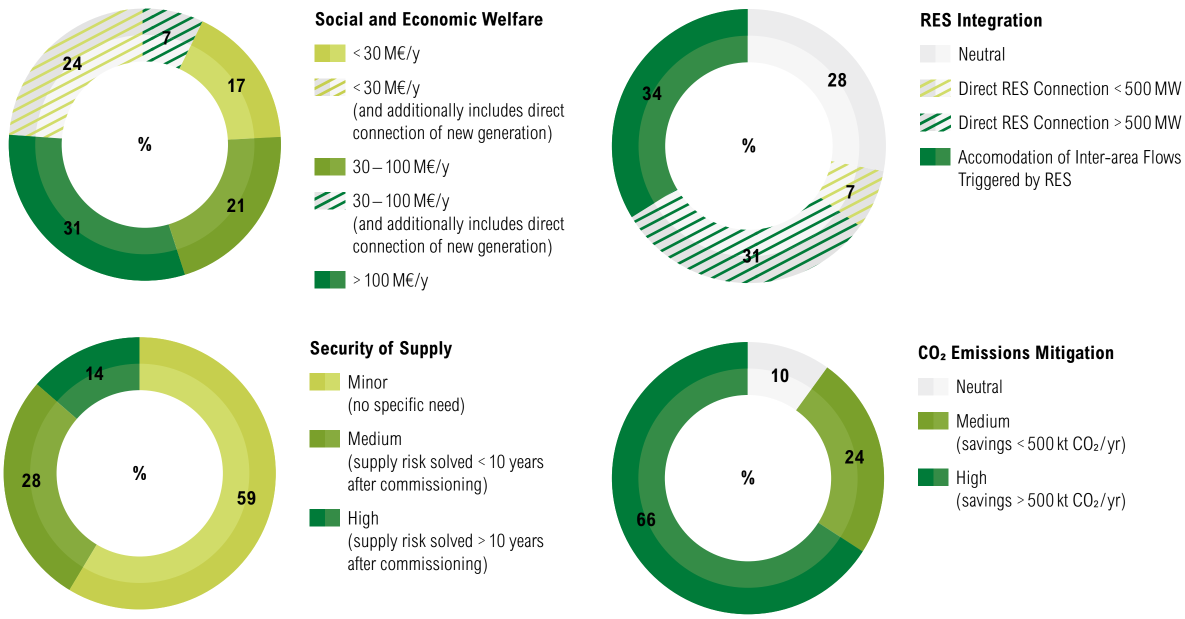


Figure 1:
CSW projects of regional and pan-European significance – contribution to EU energy policies

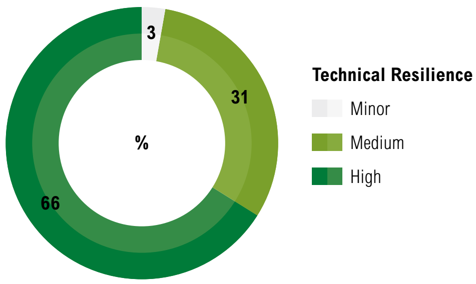
Projects' technical resilience and flexibility are at the hand of the TSOs and hence all the projects display high technical performances. On the other hand, losses, for instance, depend on exogenous factors, and projects in this respect are diverse: positive for those merely improving the grid meshing, negative when connection of new remote generation is at stake, and undetermined when the appraisal is more complex.

Total investment costs in the region amount to € 14.7 billion, of which 42% is in the midterm. As said before, National Development Plans of the three countries include much more infrastructure (on top of the projects included in this RgIP) and thus present higher investment costs.

52% of the proposed projects have a high probability of being commissioned at a planned date; 48% are realistic but have some uncertainty. There are no projects considered to heavily affect the environment.

The analysis carried out to support this plan shows that the planned projects will cover almost all the needs arising within the period of this plan if they are commissioned on time. Furthermore, they are compatible with longer-run challenges, although new investments could be required (with changes in the needs). The only need for additional investment, on top of those presented in the plan, may be on the French-Spanish border, which shows a significant level of residual congestion (around 50%) even with all the projects that are planned so far. Additional studies, assessing costs and benefits, are needed to confirm this need and to define a potential solution.

Proposed projects in this RgIP, as projects of pan-European significance, intend to be an input for the list of Projects of Common Interest to be performed in the North-South West Initiative of the recent EC Energy Infrastructure Package (EIP). For TSOs, the main priority in the region is the interconnection development, and especially the reinforcement of the France-Spain border, which is the main bottleneck in both scenarios. The valuation of projects and the integrated realization of both the pan-European and regional report are also intended to efficiently support the selection of Projects of Common Interest in 2012.



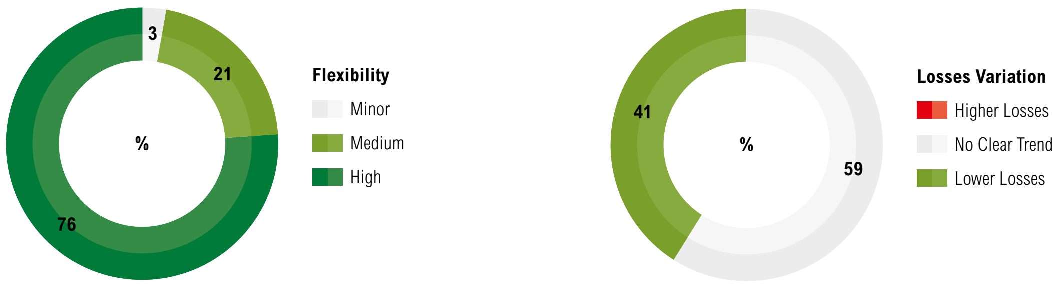


Figure 2:
CSW Projects of regional and pan-European significance –Technical assessment

It is worthy to mention that transmission planning is a living process, and that an updated RgIP will be published every two years. Scenarios in the SOAF are released every year to accommodate every required update. ENTSO-E now expects stakeholders' feedback to further develop the methodologies to deliver future TYNDP. The preparation of the TYNDP 2014 and RgIP 2014 has already started!

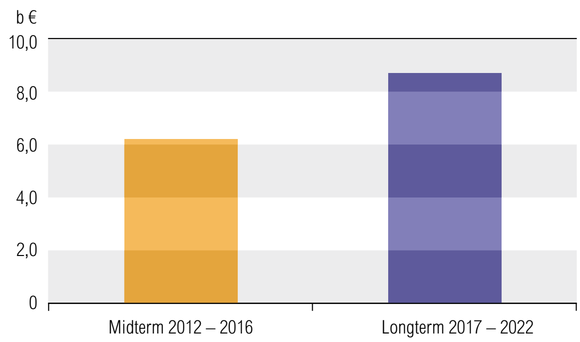
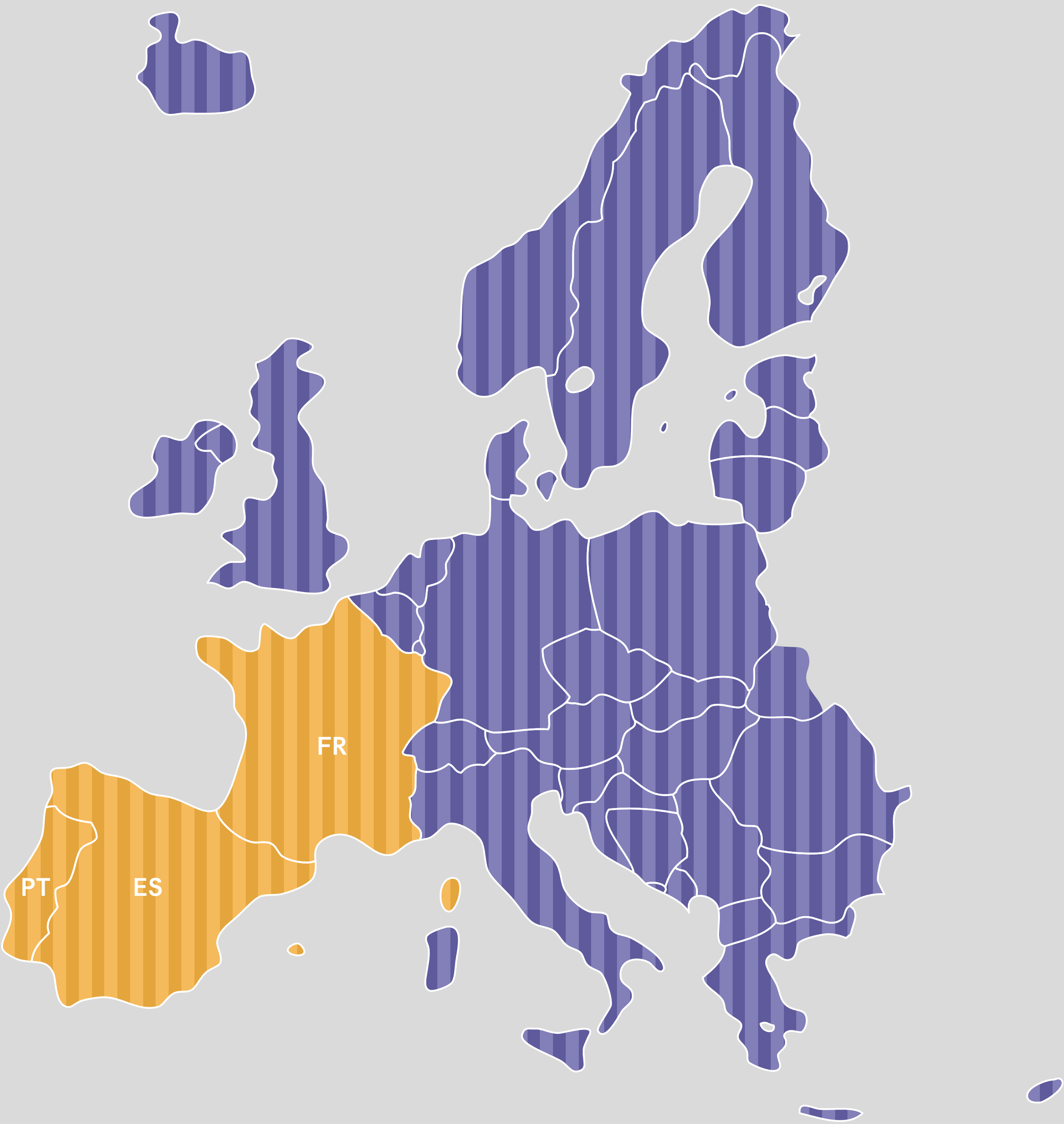


Figure 3:
CSW Projects of regional and pan-European significance – Costs

2 Introduction



2.1 Expectations of the 3rd Legislative Package

The 3rd Legislative Package for the Internal Electricity Market[1] (hereinafter the 3rd Package), which entered into force 3 March 2011, delivered a number of requirements upon the European Electricity Industry in terms of regional cooperation to promote the development of the Electricity Infrastructure, both within and between Member States, and looking at Cross-border Exchanges of Electricity between the Member States.

The key requirement of the 3rd Package that forms the legislative driver for the "2012 Ten-Year Network Development Plan" suite of documents is Article 8.3(b) of The Regulation, whereby "The ENTSO for Electricity shall adopt: (b) a non-binding Community-wide network development plan… including a European generation adequacy outlook, every two years".

The specific requirements are elaborated upon under Articles 8.4, 8.10 and 12.1 of The Regulation, covering the scope and content required in the publication. This includes: time frames for assessing overall generation adequacy, the relationship between National Development Plans and the Community-wide Network Development Plans, identification of investment needs, and the requirement to publish Regional Investment Plans every two years.

An explanation of how the Ten-Year Network Development Plan (TYNDP) package meets these requirements is contained in section 2.3.

2.2 ENTSO-E

ENTSO-E[2] was established on a voluntary basis on the 19th of December 2008 and became fully operational on the 1st of July 2009, in anticipation of the entry into force of the 3rd Package on the 3rd of 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

---

1) The 3rd Legislative Package for the Internal Market in Electricity refers to Directive 2009/72/EC, Regulation (EC) 713/2009 and Regulation (EC) 714/2009

2) ENTSO-E = European Network of Transmission System Operators for Electricity

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. A list of countries and TSO members can be found at the end of this document.

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.

2.3 Documents in the TYNDP Package

The objectives of the TYNDP package are to ensure transparency, regarding the electricity transmission network, and to support decision-making processes at regional and European levels. The report is the most comprehensive and up-to-date European-wide reference for the transmission network. It points to significant investments in the European power grid in order to help achieve European energy policy goals.

The Ten-Year Network Development Plan 2012, the Regional Investment Plans 2012 and the Scenario Outlook and Adequacy Forecast 2012 combine together to meet the above aims and to fulfill the requirements of Articles 8.3(b), 8.4, 8.10 and 12.1 of The Regulation, as detailed in section 2.1.

The focus of each document in the package is outlined below:

1. **Ten-Year Network Development Plan 2012:** The TYNDP focuses specifically on the projects of pan-European significance detailed within each Regional Investment Plan, covering those with significant contributions to enabling Renewable Energy Supply connections, facilitating cross-border flows and meeting security of supply in large areas of demand. Further information on the content, methodology and selection criteria can be found in the TYNDP document itself.
2. **Regional Investment Plans 2012:** [Comprising 6 individual, regional documents] The Regional Investment Plans overlap between the National Development Plans that TSOs are bound to publish to their regulatory authority (under Article 22 of Directive 2009/72/EC) and the TYNDP document outlined above. Each Regional Investment Plan provides a regional approach to the specific drivers for grid development and the planned projects to face these European and regional needs.

3. **Scenario Outlook and Adequacy Forecast 2012:** The Scenario Outlook & Adequacy Forecast (SO&AF) assesses the future system adequacy at a mid to long-term time horizon. It provides an overview of generation adequacy analyses for all of ENTSO-E, its regions as well as for individual countries, including an assessment of the role of the transmission capacities and security of supply on a regional basis.

More information about the history and evolution of the Ten-Year Network Development Plan can be found in the TYNDP document.

2.4 Regional Groups

As described in section 2.2, co-operation of the European TSOs, both on the pan-European and regional levels, in order to undertake effective planning is the main requirement of the 3rd package, and is therefore one of ENTSO-E's key purposes. To achieve this, ENTSO-E is split into 6 regional groups for grid planning and system development tasks. The Member States belonging to each group are shown in Figure 4.

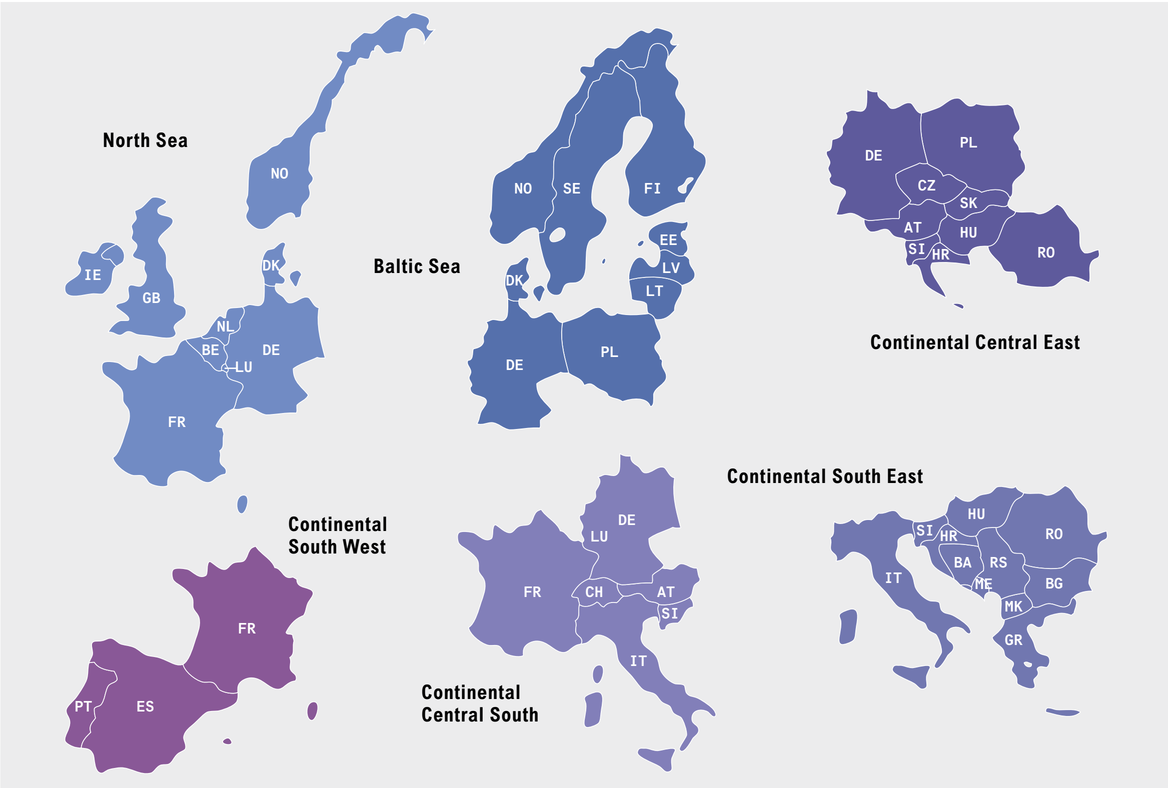


Figure 4:
ENTSO-E Regions (System Development Committee)

ENTSO-E considers the regional approach to be the most appropriate framework for grid development in Europe, and contains numerous instances of overlapping to ensure overall consistency of the **Regional Investment Plans.**

2.5 How to Read the Document

The present document is focused on the Continental South West (CSW) Region, which embraces France, Spain and Portugal.

Chapter 3 identifies and explains the main changes that have occurred in the investments, including the TYNDP 2010 submission.

Chapter 4 describes the specific methods and tools used in the regional market and network studies.

Chapter 5 describes the scenarios considered while developing the **Regional Investment Plan,** looking at the common scenarios at the ENTSO-E level, contributing to the **TYNDP 2012-2022,** but also highlighting any specific regional scenario.

Chapter 6 presents the forecast evolution of power flows and transmission capacity across the region for the ten-year period of this plan, looking at the main drivers for system evolution and the consequences these will have.

Chapter 7 focuses on the Projects of European significance and projects of regional interest identified to meet the investment needs presented in Chapter 6, split up in to medium-term (2012 to 2016 inclusive) and long-term (2017 to 2022) projects.

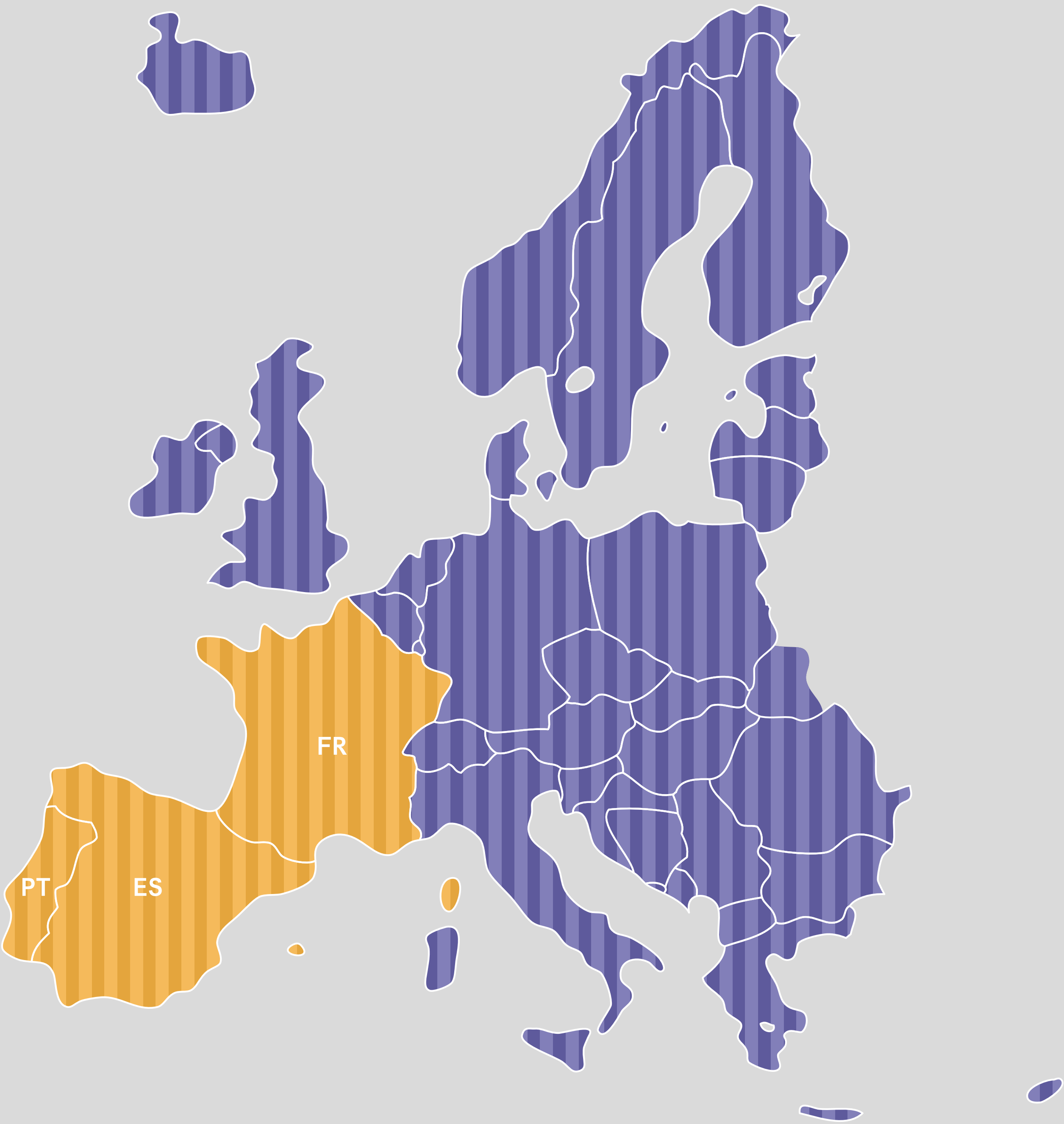
Chapter 8 then looks at the overall adequacy of the transmission network after the proposed investments in the proposed scenarios, and identifies any remaining challenges.

Chapter 9 underlines the process of environmental assessment considered in the course of constructing the **Regional Investment Plan** and presents key statistics.

Chapter 10 revisits the resilience principles highlighted in the **TYNDP 2012-2022** and justifies the planned investments. It also highlights and describes the adverse scenarios that may occur in the region that require special attention and possible future investment.

Finally, the summary & conclusions present aggregated figures and statistics for the whole Regional Investment Plan.

3 Assessment of the TYNDP 2010



This chapter presents an overview of the changes to those investments that were in the TYNDP 2010, compared to the current RgIP 2012. Detailed information is presented in Appendix 1.

From the pilot TYNDP published on June 2010 to the present TYNDP 2012, some changes have been introduced to the list of regional projects, taking into consideration the meantime developments, either on project implementation or on network needs.

Next figures summarize the current project status on the CSW region and ENTSO-E in terms of TYNDP 2012 compared to the TYNDP 2010:

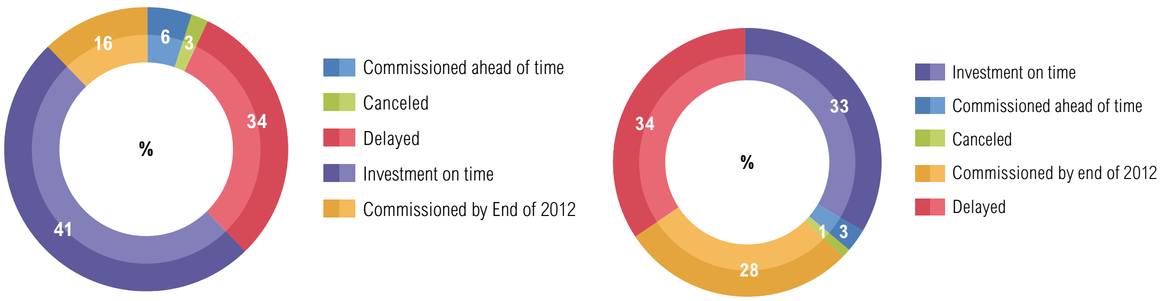


Figure 5:
Monitoring TYNDP2010 in CSW Region (right) and ENTSO-E (left)

Concerning TYNDP 2012 projects on the CSW region, on a total number of around 113 investments, most of them – 78 % – were contained in previous TYNDP 2010, and are hence confirmed, although some of them have some reshuffling. The scope of some of the investments has been updated, introducing changes due to results of relevant studies; for instance, deeper feasibility studies cause changes of routes, location of substations or connections to existing networks, or changes resulting from accommodating additional investment need.

For instance, in Spain no new projects have been included, but a better analysis and definition of some of the projects includes some new investments in existing projects, such as the FACTS elements in Tudela-Magallón 220 kV and Torres del Segre-Mequinenza 220 kV, the 400 kV double circuit Olmedilla-Valdemingomez, etc.

About 33 % of those investments already included in TYNDP 2010 maintain the expected commissioning date, although some of them have some reshuffling; 28 % will be commissioned by the end of 2012, 34 % have some delay and around 3 % are ahead of the former schedule.

From the set of TYNDP 2010 projects, in the CSW region around 13 % have been already commissioned. Among these, the following ones are highlighted:

- In the northeast zone of Portugal, the new 400 kV OHL Lagoaça-Armamar has been commissioned, as well as the new 400 kV interconnection Lagoaça (PT) - Aldeadavila (SP), between Portugal and Spain. Within this project, the 400 kV link Armamar-Recarei is not yet concluded.
- In the middle north, the new 400/220 kV substation of Armamar was commissioned and the existing substation of Bodiosa was upgraded from 220/60 kV to 400/60 kV, together with the upgrading from 220 kV to 400 kV of one circuit of the double-circuit OHL Armamar-Bodiosa-Paraimo, which was constructed according to the 400 kV standards but which started operating at 220 kV.
- Still in Portugal, near the littoral, the new 400 kV OHL Batalha-Lavos and Paraimo-Lavos have also been commissioned.
- In the Setúbal Peninsula, the 400 kV OHL Palmela-Fernão Ferro-Ribatejo was commissioned, although it is foreseen that the expansion of the Fernão Ferro substation to include the 400 kV will be concluded only in 2012.
- In the south, the new 400/150 kV Tavira substation, along with the 400 kV OHL Portimão-Tavira have been commissioned. In what concerns the new 400 kV interconnection Tavira (PT) - Puebla de Guzman (SP), the Portuguese section between Tavira and the border is already concluded, while the Spanish section is under permitting.
- In the planned North Axis in Spain, the sections of Pesoz-Salas 400 kV, Soto-Penagos 400 kV, Aguayo/Penagos-Udalla 400 kV and Abanto-Zierbena 400 kV have been already commissioned. On the other hand, in the planned Cantabric-Mediterranean Axis, the section Castejón-Muruarte 400 kV has been commissioned too. Some other sections are required to be built in order to have fully operational the connection between Galicia and the Basque Country, and between the Basque Country and Levante.
- The HVDC project Morvedre - Santa Ponsa, which connects Mallorca in the Balearic Islands to the Spanish mainland, was commissioned at the end of 2011.
- In the south of Spain, the section Arcos-Cabra-Guadame 400 kV of the Cartuja project, which represents a new connection from the coast of Cadiz toward Madrid and the center of the country, has been commissioned. Within this project, the long-term security of supply of the Cordoba region and the possible connection of certain offshore wind power energy is still in progress.
- In France, the conductors of the Tavel-Tamareau 400 kV OHL were replaced by high temperature ones in 2011.

– Only one project has been cancelled from the TYNDP 2010. After the suspension in Portugal of the High Speed Train project by the Portuguese Government, the previous TYNDP 2010 project related with the electrical feed of the High Speed Train (Falagueira-Estremoz – Divor – Pegões) was also suspended until new decisions are taken. Several projects in TYNDP 2010 are now considered as projects of regional interest as they do not fulfill the criteria to be projects of Pan-European significance.

Delays on investments are caused, on the one hand, by an overoptimistic date in TYNDP 2010, as it had to be coherent with former official National Development Plans, and, on the other hand, by difficulties in the authorization and permitting processes, generally due to consultation results or environmental issues, which sometimes forces a project revision in order to introduce some changes to its definition, or even, in more extreme cases, to look for an alternative solution (new project/investment). Additionally, a few delays are caused by postponing the investment for a certain period as a consequence of a relaxation of the need that triggers it. This is the case with the Romica-Manzanares 400 kV section in the Trasmanchega project in Spain.

There are also some investments whose date had to be put ahead of schedule, as a result of either an earlier date of the needs to which they are linked (e.g. the new 400 kV Frades B substation and the two 400 OHL links Frades B - Pedralva 1/2 in Portugal, and some uprates in Spain) or as a result of more detailed feasibility studies leading to optimized operating modes (e.g. reconductoring of the OHL Baixas-Gaudière in France).

New investments included in TYNDP 2012 represent something like 22 % of the total number of investements. From the set of these new, the following ones can be mentioned:

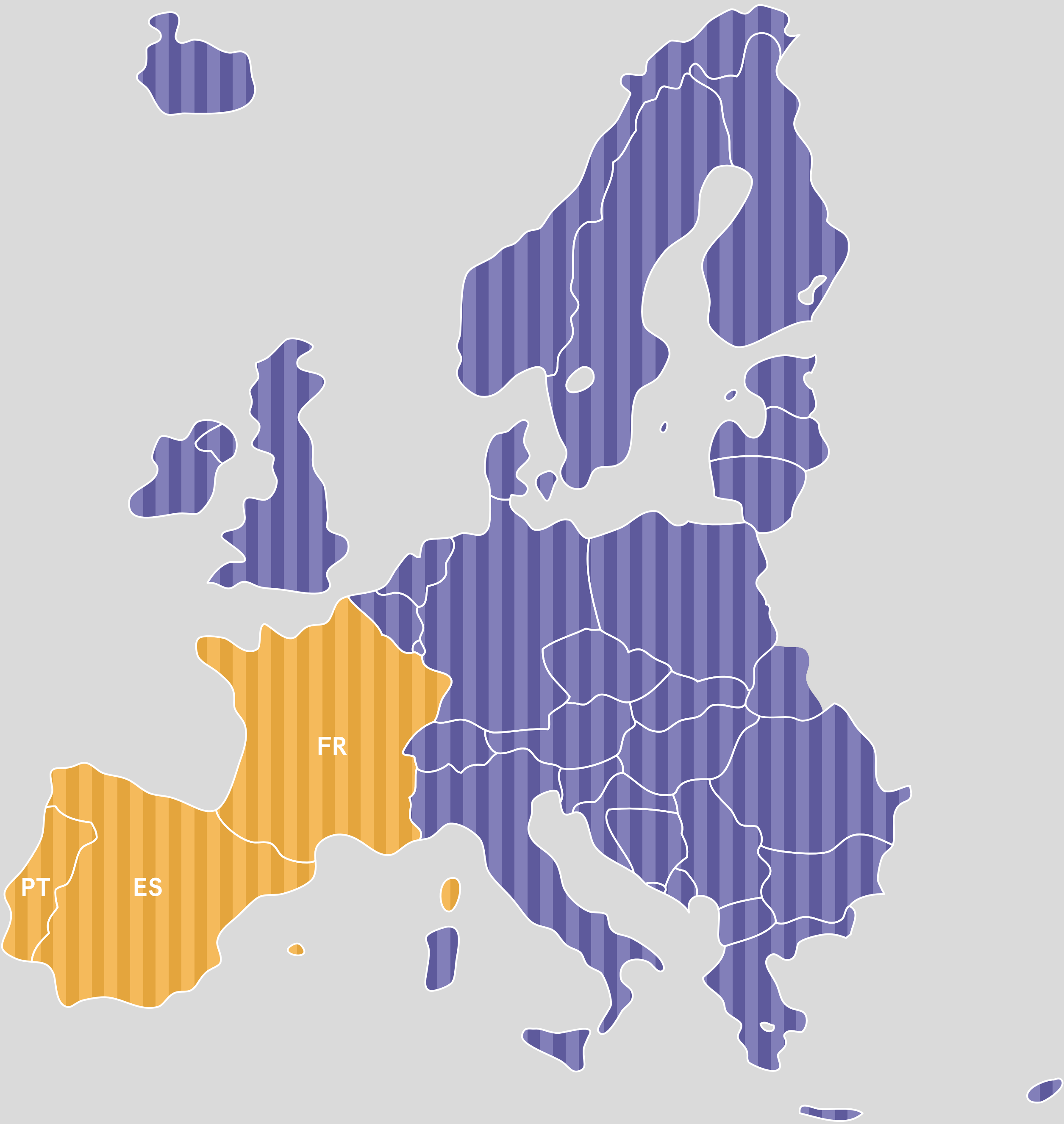
– In Portugal, in the north, the 400 kV OHL lines of Ribeira de Pena - Guarda and Guarda - Vila Chã B are both to integrate new renewable energy, mainly hydro with pumping and wind.

– In the south, the 400 kV OHL lines of Ferreira do Alentejo – Ourique and Ourique - Tavira and the extension of the Ourique substation are to integrate new renewable energy, mainly solar.

– In France, a new HVDC subsea cable “Midi-Provence” will help mutual support of southwestern and southeastern France, together with new generation integration in the Fos area and the Rhône valley as well as increased ability to cope with increased exchanges with the Iberian Peninsula.

– The grid of the Massif Central, which comprises some of the oldest EHV lines of the French grid, will need some restructuration and additional investment in order to cope with additional RES generation as well as increased exchanges with the Iberian Peninsula.

4 Specific RG Methodology and Assumptions



4.1 TYNDP 2012 Methodology

Common main scenarios build the base of the analysis for the TYNDP and the RgIP. These scenarios are described in chapter 5. Also, during the process of preparing the TYNDP and the Regional plans, a Pan European Market Database (PEMD) has been developed containing scenario supply and demand data and other common data, such as interconnection exchange capacities. In addition, fuel prices based on the World Energy Outlook 2010 published by the IEA have been used (New Policies Scenario, year 2020).

These common data are the basis for the Regional analysis, for both market analysis and network analysis.

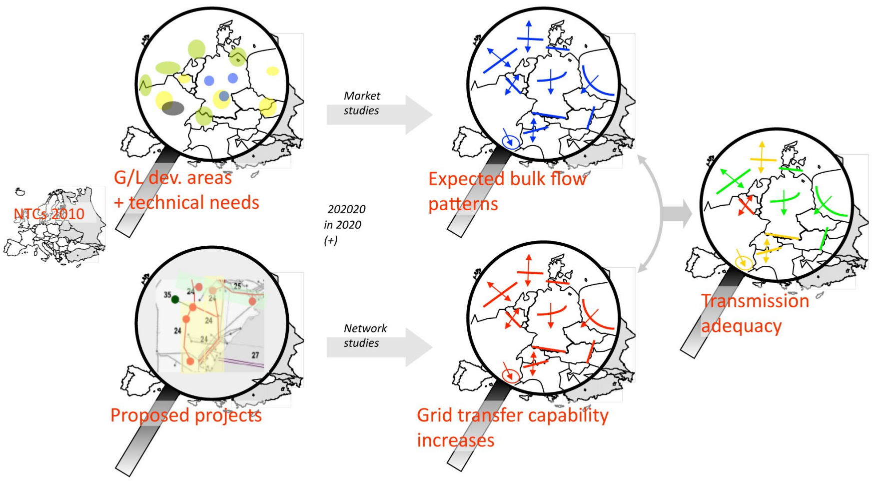


Figure 6:
Overview of the General Methodology

Market study results have been used in defining the benefits of the planned investments. Common guidelines have been defined for project assessments.

Market studies have been performed at the regional level, taking advantage of the existing competence and tools.

A common grid model is used in checking the future grid transfer capability with the planned investments and the resilience in stressed grid situations.

Additionally, the methodology in the Continental South West region consists of firstly carrying out market analysis to determine the range of generation and flow patterns across the region. The information derived from the results of the market analysis, together with TSO expertise, is then brought into network studies that assess the grid power flows that would result in 2020 and check performance of already planned projects and future new projects that would solve remaining bottlenecks. A more detailed description of the common method can be found in the TYNDP 2012.

4.2 Market Studies Methodology

The CSW region has already some experience with market studies, as it was stated in TYNDP 2010 (Appendix 14.2), where a summarized methodology and results were provided.

4.2.1 Purpose of Market and Adequacy Studies

The purpose of the **market studies** is to forecast the future behavior of the system in agreed general scenarios, and to investigate the impact of the new interconnection projects, by comparing two different grid situations in terms of **economic efficiency:** the ability of the system to schedule plants according to their intrinsic merit-order[1)], the overall resulting variable generation costs[2)] as well as the overall amount of CO_2 emissions, and volumes of spilled energy (curtailment). The tools used in the RG perform an economic optimization for the entire year, taking into account several constraints, such as flexibility and availability of thermal units, wind and solar profiles, load profile and sensitivity to temperatures, transmission capacity between countries, etc.

The assumption is that of a **"perfect market"**, which implies mainly that the market reaches a perfect least-cost generation schedule at a regional level, with no modeling of subsidies, capacity payment, stakeholders' behavior… Therefore, the presented savings cannot be directly interpreted as a reduction of market prices. Adequate market rules should allow that most savings in generation costs should be passed to the consumers, by an equivalent reduction in prices.

The purpose of the generation **adequacy studies** is to assess the **security of supply** of an interconnected system. Shortfall in any country may result

---

1) The variable generation costs of a given unit, and consequently the merit-order, being a consequence of mainly fuel cost and CO2 cost

2) No variable cost is assigned to RES

from the conjunction of demand higher than average (caused by low temperatures for instance), low availability of thermal units (due to planned or unplanned outages), and low levels of hydro-reservoirs in addition to low levels of wind and solar power (because of unfavorable meteorological conditions).

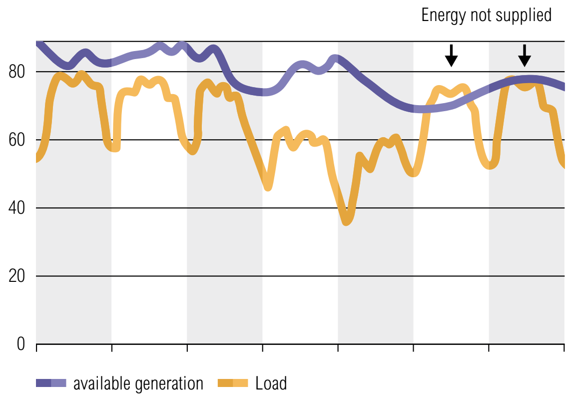


Figure 7:
Principle of Generation and Load adequacy studies

4.2.2 System Modeling

Each country is modeled as one single node, with all generation and load data being aggregated to this single node. It is considered that there is no internal constraint within the country, but limited network transmission capacity (NTC[1]) between countries. If these capacities limit market opportunities, this results in a suboptimal dispatch and different prices for the region.

The rationale behind system modeling is to use very detailed information within the CSW region, and decreasing levels of details when getting far from the studied area. With all the information provided, the electrical behavior of the whole interconnected system is simulated for the 8760 hours of the horizon year, and results are available from the hourly to the annual step. The detailed modeling of the system is presented in Appendix 3.

[1] The Net Transfer Capacity (NTC) is the maximum exchange program between two areas, compatible with security standards applicable in both areas and taking into account the technical uncertainties on future network conditions

4.2.3 Indicators Provided by Market and Adequacy Studies

The main usefulness of the market studies in the CSW region is to obtain the impact of the new interconnection projects in the system. The benefits assessed in the **market studies** process are those provided by successive cross-border reinforcements, which increase the capacity either between France and Spain or between Spain and Portugal. The comparison of two situations (simulations with or without the studied reinforcement) allows measuring the benefits of the planned successive cross-border reinforcements, mainly in terms of generation dispatch, economic efficiency (variation of the variable generation costs), CO_2 emissions, RES integration (how much RES energy spillage is avoided), energy exchanged on the interconnections and % of congestion.

Besides, additional specific analysis of the hourly behavior (peak or off-peak) and seasonal behavior (summer or winter) of the cross-border exchanges has also been performed, in order to improve hypotheses used in the framework of network studies and to help assess the bulk power flows indicators.

Adequacy studies, which are focused on security of supply, provide the benefits in terms of Security of Supply (SoS) associated with the new cross-border reinforcements. Main indicators obtained in the **adequacy studies** are:

– EENS, Expected Energy Not Supplied (GWh / year);

– LOLP, Loss of Load Probability (% / year): how often ENS occurs;

– LOLE, Loss of Load Expectation (hours / year): how long ENS occurs.

4.2.4 Market and Adequacy Studies Tools Used

Three simulation programs have been used in the CSW region for the market and adequacy analysis: ANTARES, MAREA and RESERVAS.

– MAREA was developed by REE, and its role within this study is to address the **Economic** analysis.

– The RESERVAS model, developed jointly by REN and REE, is assigned to the **Adequacy** analysis.

– ANTARES was developed by RTE, and addresses both **Economic** and **Adequacy** analysis.

Cross analysis showed that results were quite similar and thus confirmed the robustness of the main conclusions; results provided in this report are the average of Marea and Antares (market studies tool) or the average of Reservas and Antares (adequacy studies). The detailed descriptions of tools are in Appendix 4.

4.3 Network Studies Methodology

Network studies answer the question "will the forecasted dispatch of generation and load result in power flows that endanger the safe operation of the system (accounting especially for the well-known N-1 rule)"? If yes, then new network reinforcements (investment projects) are designed, tested and evaluated for all relevant cases.

4.3.1 Market Studies as an Input to the Network Studies

As market studies provide a big amount of cases (8760 for one year) and because only a small number of cases could be considered for network studies, a selection had to be done to find out those points in time that should be assessed for further detail. Planning cases chosen to perform network studies aim for situations with stressful conditions (even if they have a low probability of occurrence) as well as less severe but more probable situations.

Based on market studies results and on the CSW region particularities (e.g. the amount of renewable generation - High RES or Low RES scenarios – and of power exchanges among the involved countries), TSOs have defined six representative planning cases for network studies, which were:

Situation	Season	Demand	RES Iberia	PT-SP exchange	SP-FR exchange
probable	**Winter**	**Peak**	**High**	**1600 PT>SP**	**4000 SP>FR**
extreme	Winter	Peak	High	3000 PT>SP	4000 SP>FR
extreme	Winter	Peak	Low	2800 SP>PT	4000 FR>SP
probable	**Summer**	**Peak**	**Low**	**2600 SP>PT**	**4000 FR>SP**
extreme	Summer	Peak	High	2200 PT>SP	4000 SP>FR
extreme	Summer	Valley	High	1400 PT>SP	4000 SP>FR

Table 1:
Representative planning cases for network studies in CSWRG

From market studies, the amount of production by country and technology is obtained, but in the network model, the location of new power plants has to be assigned based on the TSO expertise and production based on the merit order, as given by the market model.

Two of these six cases were selected to perform a more detailed network analysis: the Winter Peak with High RES in the Iberian Peninsula, and the Summer Peak with Low RES in the Iberian Peninsula. For instance, Figure 8 shows this winter peak model in an aggregated way. The map in the left shows the demand profile, the map in the center shows the generation profile and the map in the right shows generation minus demand in the region, so that main flows in this situation can be detected.

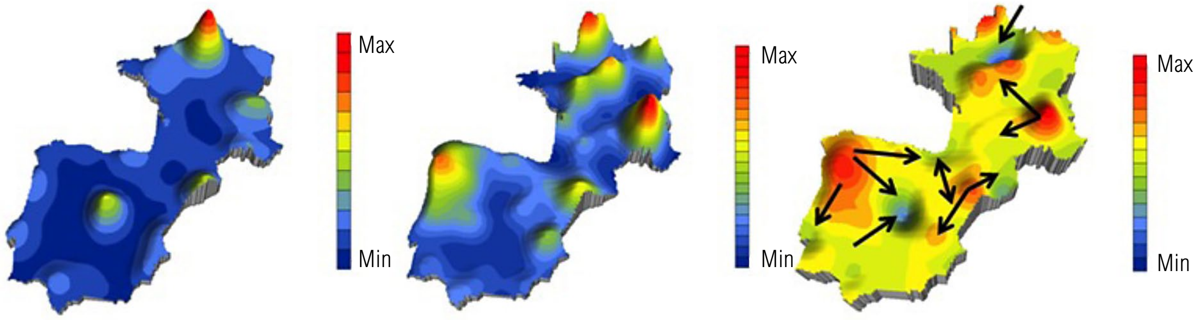


Figure 8:
Power Flow Mountains in the region, for demand, generation and generation minus demand

Methodology for network studies is depicted in the TYNDP report (Appendix 3).

4.3.2 Network Studies Tools Used

Three different software tools that were in the basis for the performed simulations carry on along with network studies:

- **CONVERGENCE model,** developed by RTE, used for load flow (AC) analysis;
- **PSSE model,** commercial model used by REN and REE, used for load flow (AC) analysis;
- **UPLAN model,** commercial model used by REE, used for a joint market and load flow (AC/DC) analysis for internal network.

4.3.3 An Explicit and Practical Valuation of the Projects

Selected projects of European and regional interest are presented in Appendix 1, displaying both a synthetic technical description of every project item as well as the added value of every project, through the following multi-criteria assessment scale developed by ENTSO-E (see TYNDP report for definitions).

Grid transfer capability provided by every project is depicted. The social and economic welfare, RES integration and improved Security of Supply indicators value the benefits of the projects in the three 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 202020 policy. The technical resilience and flexibility indicators refer to the technical performance of the assets in the grid. Finally, the social & environmental impact completes the date of commissioning and the status of the project as well as shows risks attached to the project completion.

The assessment of the benefits compares the situation with and without the projects, ceteris paribus, and it can be compared to the cost of the project in order to check economic performance.

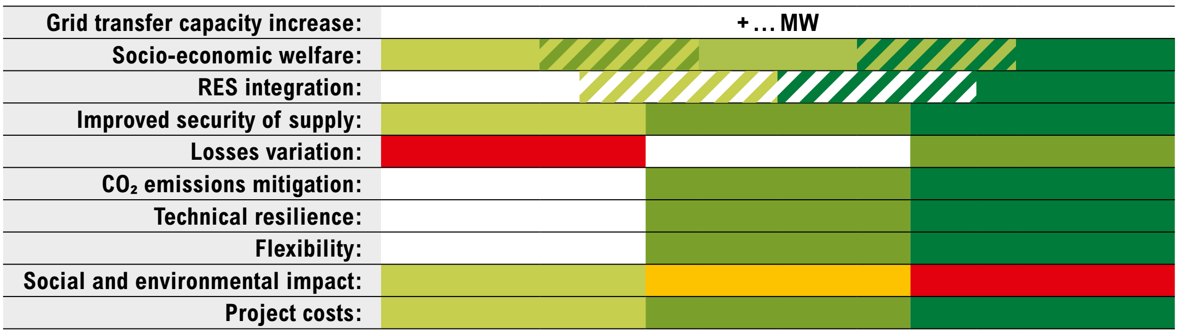
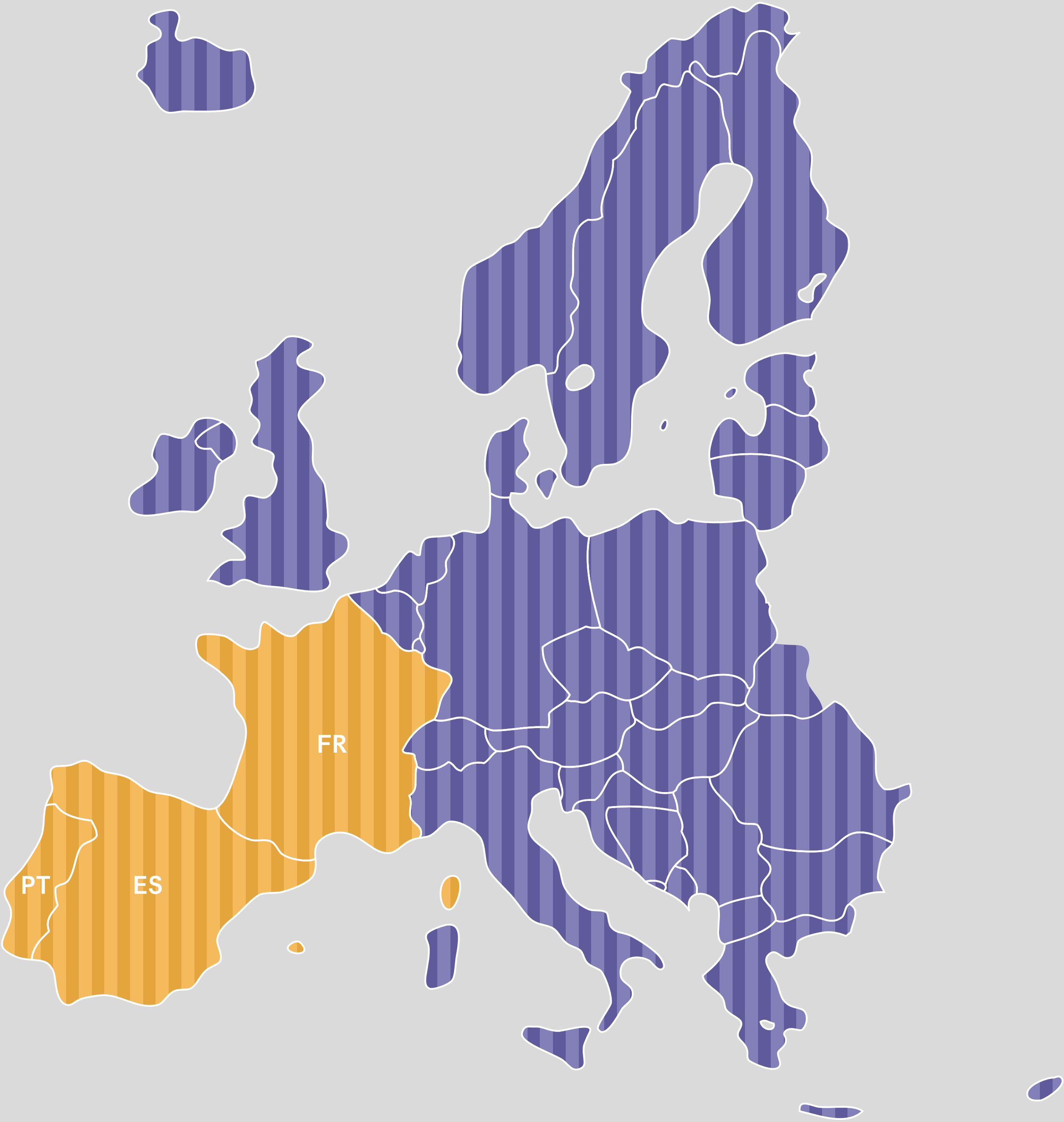


Figure 9:
Principles of multi-criteria assessment of projects of pan-European significance

5 Scenarios and Market Results



This chapter describes the scenarios that were used in the RgIP and the market simulation results. It starts with a description of the two scenarios that are used within all ENTSO-E Regional Groups. Next, the scenarios specific to the Regional Group are addressed. Finally, the market simulation results and conclusions are presented.

5.1 Description of Scenarios

Two different base scenarios for the 2020 horizon have been considered in TYNDP 2012 at the ENTSO-E level. They are based on the SOAF 2011 and represent different possibilities of the main variables involved in the behavior of the electric system and thus, in the market.

A first scenario has a top-down approach; it is called the **"EU 2020"**, and represents a context in which the European 20-20-20 objectives are met (20% of Renewable Energy Sources in the final energy, 20% reduction of Green House Gases –GHG-, and a 20% increase in energy efficiency).

Adopted efficiency measures result in low annual demands in every country.

The prices of the main fuels, gas and coal, are taken from the reference scenario of the International Energy Agency (IEA) in its World Energy Outlook 2009. The CO_2 price is higher, and CCGT units are generally cheaper than coal plants, except for the coal with "must-run" conditions, which is not price driven.

The installation of RES power is coherent with the National Renewable Energies Action Plans sent to the European Commission in June 2010.

A second scenario has a bottom-up approach. It is called "Scenario Best Estimate", or **"Scenario B"**, similar to ENTSO-E SOAF documents, and represents the best estimate forecasts of the TSOs, no matter whether European objectives are globally met or not.

Higher demand growth rates result in significantly higher demands all over the simulated region, compared to Scenario EU2020.

The price of CO_2 emissions used is the central forecast of the IEA, and is cheaper than in "EU2020". That results in lower variable generation costs for most coal plants in Europe.

The installation of RES power is the central forecast of the TSOs, and it is generally (but not always) lower than the national targets.

Additionally, a sensitivity analysis has been performed: "Nuclear Phase Out" (NPO), in which part of the nuclear units in Germany will be shut down (the total phase out is expected for 2022). The need for this additional scenario arose from the wish to analyze the impact of the German decision regarding their nuclear phase out (after the Fukushima accident), which was taken during the course of these ENTSO-E market studies. Scenario B is the base scenario for this variant, in order to analyze potential difficulties in the more conservative conditions (higher demand and lower RES).

For both scenarios and the NPO sensitivity analysis, similar data of all countries on generation and demand has been compiled through the pan-European Market Database (PEMD) with a common standard format, in order to allow a pan-European simplified modeling.

5.2 RG Specificities

The main differences in the CSW region between the analyzed scenarios are a lower demand in Scenario EU2020 (68 TWh) compared to Scenario B, which reflects the impact of efficiency measures, and a higher installed capacity, mainly of wind power (11 GW). The NPO sensitivity analysis includes 10.7 GW less nuclear power in Germany, and higher imports of Germany from the non-simulated region, according to pan European ENTSO-E simulations.

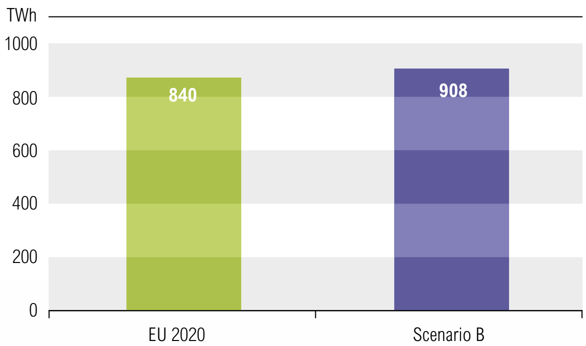


Figure 10:
CSW annual electricity consumption in 2020

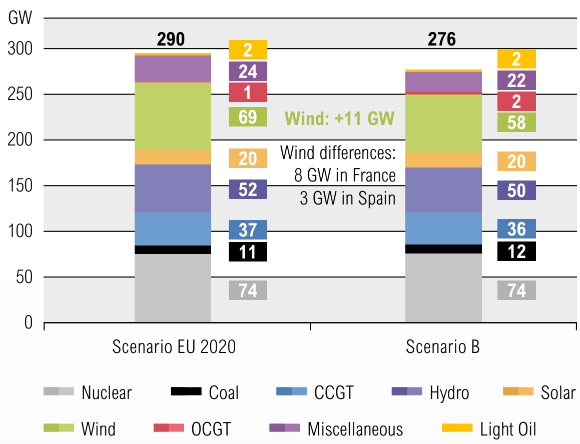


Figure 11:
CSW installed generation capacity in 2020

5.3 RG Specific Scenarios

5.3.1 Analyzed Grid Configurations

For each of the scenarios considered for the 2020 horizon, "EU2020", "B", and "NPO", different grid configurations have been tested, taking into account successive reinforcement projects that allow increasing the exchange capacity in the two borders within the region, Portugal-Spain and France-Spain.

For the base Scenarios "EU2020" and "B", up to 5 yearly simulations have been performed. They involve different NTC (Net Transfer Capacities) between countries, associated with specific projects. They have been named as follows:

– **Simulation 1:** Base case, with the NTCs as of 2010.

– **Simulation 2:** Portugal-Spain new interconnections (Northern and Southern reinforcements expected to be commissioned in 2013 and 2014) increase the Portuguese-Spanish NTC up to 3200 MW in both directions. French-Spanish NTC is maintained, as in Simulation 1.

– **Simulation 3:** The French-Spanish Eastern HVDC project, which is expected to be commissioned in 2014, increases the NTC up to 1700-2800 MW. Portuguese-Spanish NTC is maintained, as in Simulation 2.

– **Simulation 4:** The French-Spanish Western HVDC project, expected to be commissioned around 2020, increases the NTC up to 4000 MW in both directions. Portuguese-Spanish NTC is maintained, as in Simulation 2. This simulation represents the planned 2020 horizon.

– **Simulation 5:** Copper plate in the CSW region, with unlimited NTC in both borders, in order to quantify the maximum economic savings potential.

For the "NPO", Simulation 3 and Simulation 4 have been performed in order to assess the impact on the CSW region as well as the impact on the benefits of long-term projects.

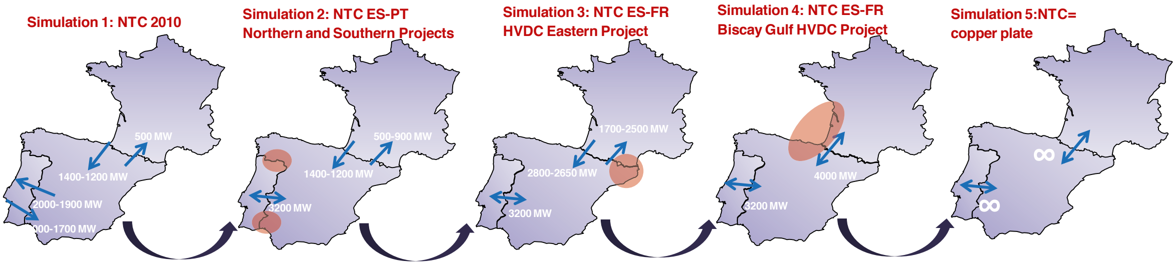


Figure 12:
Analyzed grid configurations

5.4 Market Results and Conclusions

5.4.1 Economic Results

For each scenario of the 2020 horizon, the different simulations corresponding to the different grid configurations have provided numerous hourly and yearly results. The main differences of the economic results and energy flows between simulations, representing the benefits of the corresponding projects, are depicted in this section.

Savings, referred always to the whole of Europe, are much higher in Scenario EU2020 than in Scenario B, because of higher variable generation costs due to a higher CO_2 price, and higher RES surpluses in the Iberian Peninsula that can replace thermal power plants. The NPO variant has little impact on the CSW region.

In a 2020 horizon, the highest savings are provided by the France-Spain HVDC Eastern and Western projects. They provide alone 390 M€/y and 240 M€/y respectively in EU2020, and 217 M€/y and 141 M€/y respectively in Scenario B (130 M€/y with the Nuclear Phase Out). The projects in the Spanish-Portuguese border increasing the exchange capacity up to 3,2 GW provide savings of 34 M€/y in EU2020 or 11 M€/y in Scenario B.

Interconnection projects in the region planned to be commissioned in the next decade provide a social economic welfare for the European system in the range of 369-664 M€/y in 2020, considering savings in variable generation cost. With an approximate yearly regional electricity demand of 840-908 TWh/y, this overall cost saving implies a reduction of variable electricity production cost by 0.4 to 0.8 €/MWh.

The copperplate in the CSW region provides savings of 554 M€/y in EU2020, and 311 M€/y in Scenario B, over the NTCs 2020 (Simulation 4), which indicates that higher exchange capacities could provide additional savings.

However, the cost-effective exchange capacities that would lead to higher savings than investment costs for the region have not been analyzed in detail, as it depends on the progress of already planned interconnections.

Generation Costs Savings [M€/y]	SP-PT N&S projects	FR-SP East HVDC	FR-SP West HVDC	Copper-plate in CSW – NTC 2020	All interconnections 2012–2020
EU 2020	-34	-390	-240	-554	-664
Scenario B	-11	-217	-141	-311	-369

Table 2:
Annual variable generation costs savings in CSW Region in 2020 horizon

Considering the costs of these projects, and the social economic welfare as the variable generation costs savings of these projects, all planned interconnections could be profitable for the system in less than 10 years, and the Eastern Reinforcement Spain-France in even less than 5 years.

5.4.2 Production and Energy Flows

The CSW region is in every situation an exporting region to the rest of Europe (very rare hourly exceptions). French exports to the rest of Europe (excluding those within the CSW region) are over 100 TWh in Scenario EU2020, and over 80 TWh in Scenario B. Interconnections within the region allow higher exchanges of energy in both directions. Their main impacts are a reduction of exports to the rest of the simulated region beyond CSW and consequently a reduction of CO2 emissions in CSW, a replacement of more expensive thermal units by cheaper thermal units of other countries in the region, and a significant increase of RES integration.

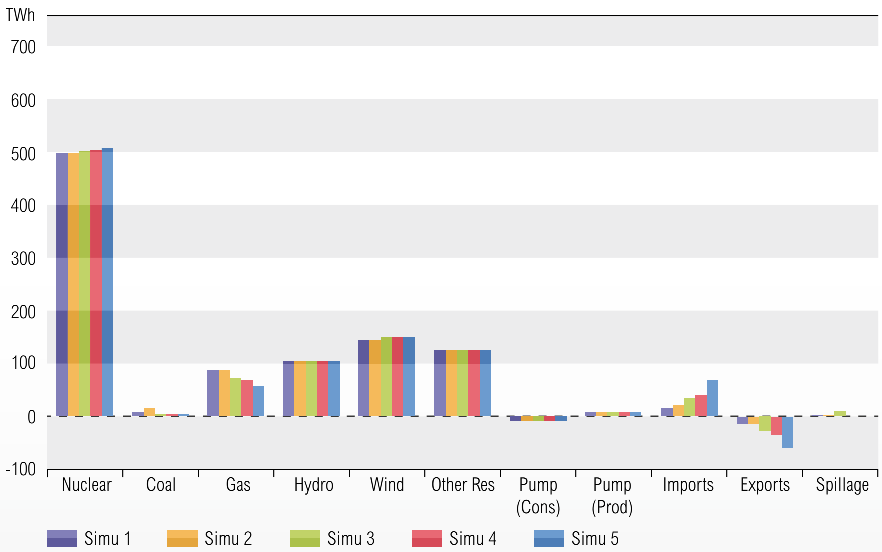


Figure 13a:
Production in the CSW region in scenario EU 2020

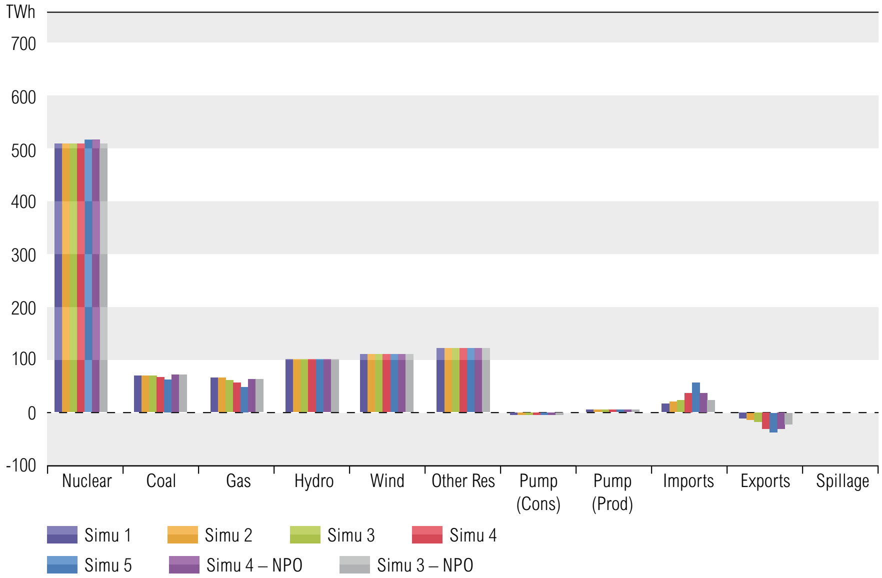


Figure 13b:
Production in the CSW region in scenario B

Spain and Portugal are expected to be in 2020 net importing systems (small imports in relative terms), as well as slightly increase their net imports as the NTCs are increased from NTC 2010 to NTC 2020. They both reach near 4 TWh of net imports in EU2020 and near 5 TWh of net imports in Scenario B[1]. Transits are in the range of +10/-5 TWh for the Portugal→Spain border, and -20/+8 TWh for the Spain→France border. France increases its exports to the Iberian Peninsula, mainly as a consequence of higher nuclear production, and net exports to Spain reach 10 to 14 TWh with NTC 2020 in both main scenarios. Some new gas units (cheaper) of other European countries also replace old gas units in CSW, and the total production and exports of the CSW region slightly decrease.

Increasing the NTC between Spain and Portugal avoids around 80 GWh and 60 GWh of spillage of RES in Scenario EU2020 and Scenario B, respectively. The two HVDC projects between Spain and France avoid around 1500 GWh and 900 GWh renewable spillage, in Scenario EU2020 and Scenario B, respectively; additionally, they decrease the thermal production of the region, with a reduction of CCGTs production and an increase of nuclear energy in France.

There is a low impact on coal, both in EU2020 and Scenario B: in EU2020, the demand is lower and more expensive coal is not used, except for the part which has a "must-run" condition, or is very cheap lignite or coal with Carbon Capture and Storage (CCS); in Scenario B, more coal is used in all cases, but the marginal technology is more often gas, which is more expensive than coal, and therefore combined cycle plants are more affected than coal.

[1] In 2010 France obtained a balance of 28.6 TWh (net exporting country), Spain 8 TWh (net exporting country) and Portugal 2.6 TWh (net importing country).

Because some coal is also sometimes marginal, some gas is replaced by cheaper European coal outside the CSW region. There is a significant reduction on the spillage of RES, which goes down to 0 in the copperplate, but remains slightly above 1 TWh in EU2020 or slightly below in Scenario B.

The Nuclear Phase Out implies that Germany increases its imports by 40 TWh, but the impact in the CSW region is low, with a total increase of the CSW production and exports by 5 TWh. This low generation variation is produced half by French nuclear energy, and half by coal and gas in all three countries of the CSW region.

5.4.3 Congestion in the Interconnections

The new interconnection projects between France and Spain, and between Portugal and Spain, have a significant impact on the annual congestions of the borders in the Continental South West region.

Regarding Spain-Portugal, the new Northern and Southern interconnections, which are planned to be commissioned by 2014 and 2013 respectively, reduce in 2020 the congestion of the border compared to the NTC 2010, from medium-low values (36 – 40%) to low values (10 – 15%). Portugal-Spain projects do not affect the French-Spanish border, but Spain-France projects slightly increase the Portuguese-Spanish congestion as they allow slightly higher transits.

In regards to the France-Spain border, the congestions are high in every simulation, and the decreases gained by the successive reinforcements are significant. In 2020, with NTC 2010, congestion would be in the range of 85 – 90%. Eastern reinforcement allows reducing it by a range of 15 – 21% and Western reinforcement allows reducing the congestion by a range of 10 – 13%, depending on the scenario. After implementation of French-Spanish reinforcement up to a 4 GW exchange capacity objective, congestion is still expected for around 50 – 60% of the hours of the year.

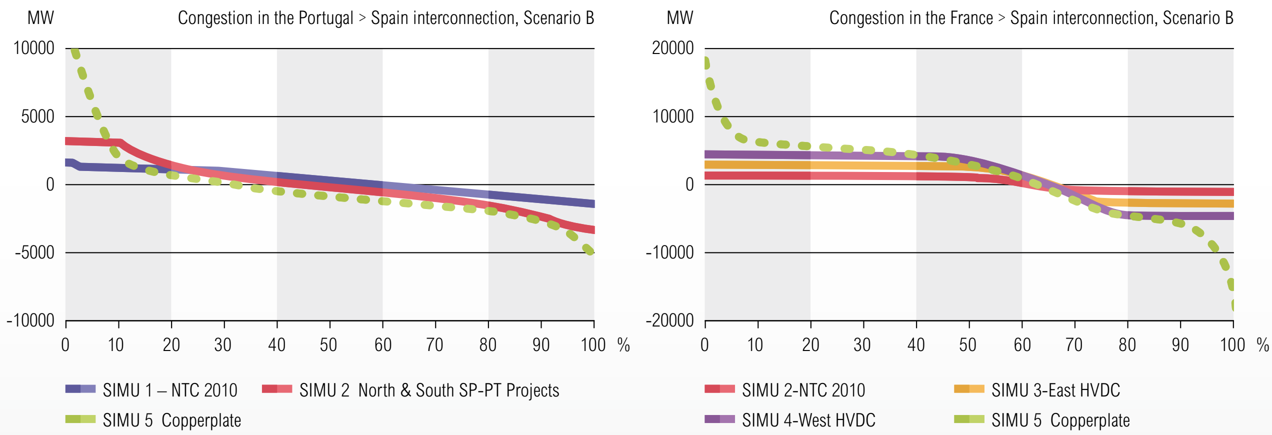


Figure 14:
Congestion time in the Portugal-Spain (left) and the France-Spain (right) interconnections. Scenario B

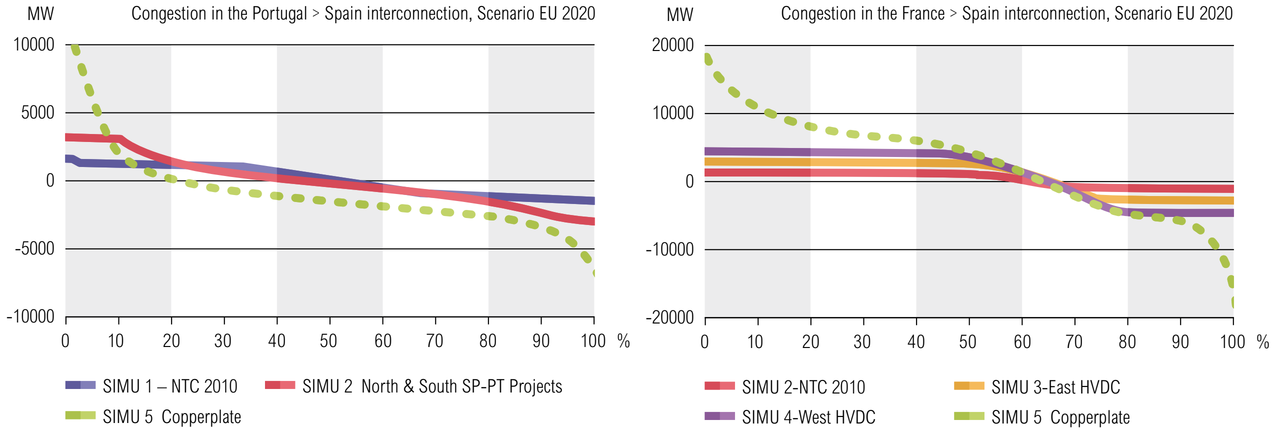


Figure 15:
Congestion time in the Portugal-Spain (left) and the France-Spain (right) interconnections. Scenario EU2020

Reaching 0% congestion would not be cost effective, as the high transmission costs would not compensate the decreasing generation savings (maximum exchanges in the copperplate are near 30000 MW for France-Spain and 13000 MW for Spain-Portugal). France-Spain NTC that would imply an acceptable congestion of 10% on either direction amounts to 11000 MW in EU2020, and to 8000 – 10000 MW in Scenario B. The cost-effective interest in neither of these NTCs has been validated by cost-benefit analysis, and also depends on the progress of already planned projects.

5.4.4 Typical Hourly Exchanges

The expected hourly flows in 2020 in the Spain-Portugal and Spain-France borders are very volatile, depending on the random production of RES in the Iberian Peninsula. For both borders, flows in both directions occur during every month and at all periods of the day. Nevertheless, the most frequent situations can be extracted.

In regards to the France-Spain interconnection, the typical flow is from France to Spain, in summer and winter, both in Scenarios EU2020 and B. During winter peak hours, however, French exports to Spain are reduced to low values or even reversed, as a consequence of the high demands in France (especially during cold situations). Flows from Spain to France are more likely to occur in winter peaks of Scenario B and sunny hours in Spring due to the low demands combined with the high availability or RES (both wind and solar) in Spain and Portugal. During the summer, the hourly flows from France to Spain are reduced around noon, following the solar production profile in the Iberian Peninsula, and sporadically reversed.

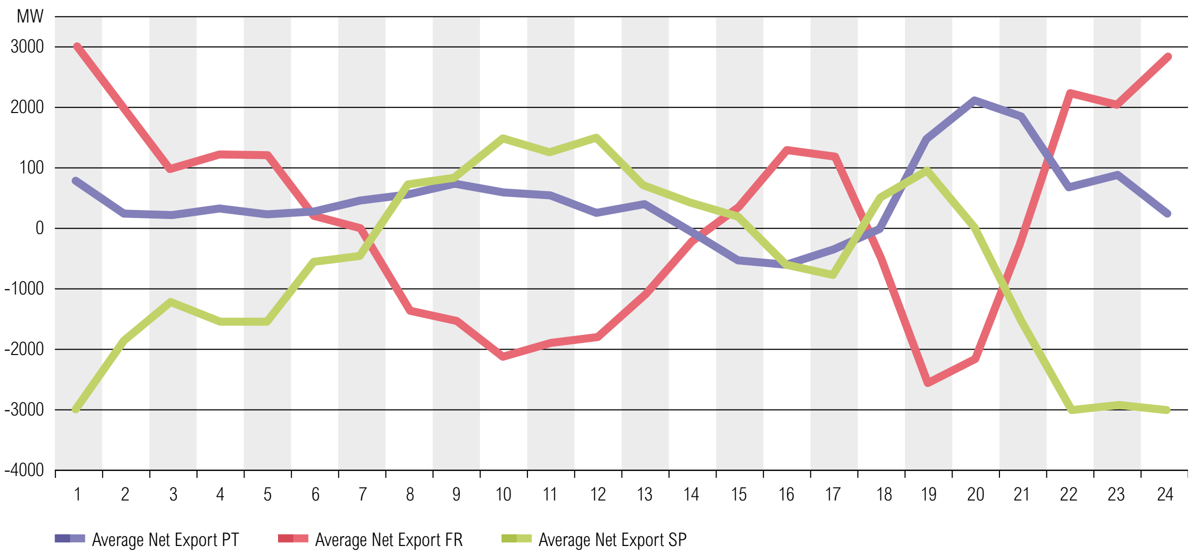


Figure 16:
Average hourly exchanges in the Portugal-Spain and France-Spain borders. Workdays in Jan-Feb-Dec. Scenario B. Simu 4

In regard to the Portugal-Spain border, the expected flows are especially volatile and affected by the fact that the marginal generation technologies are quite similar in both countries. They roughly follow the same direction as the Spain-France flows, with exports from Portugal to Spain during winter peak hours. In the remaining periods, typical flows are low exports from Spain to Portugal, except in very windy nights when the flows are reversed.

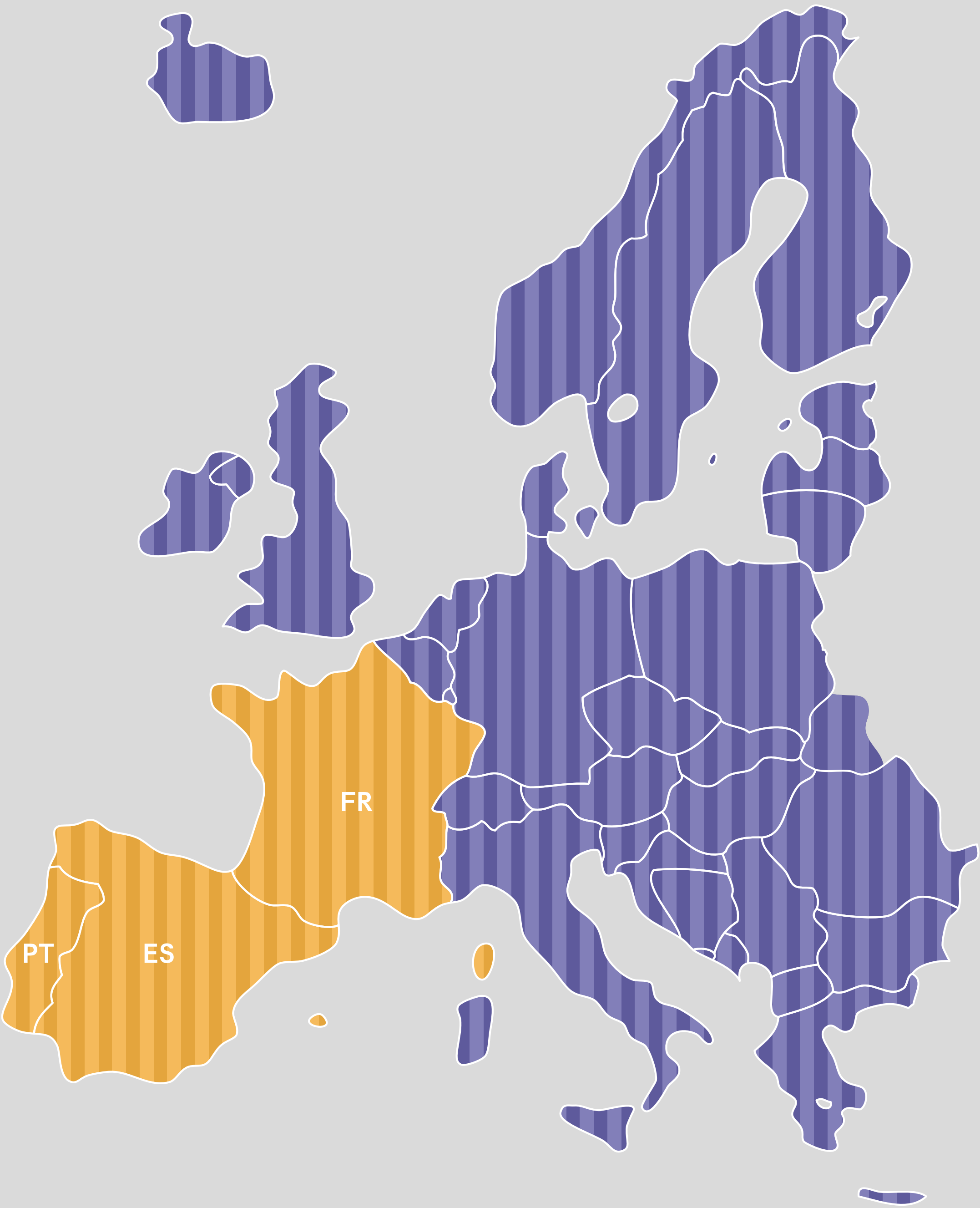
5.4.5 Adequacy Indicators

The generation adequacy indicators in the CSW region are generally low or very low in every simulation, even with low interconnection capacities as of 2010. The results presented are calculated considering the probabilistic support of the neighboring systems.

In Scenario EU2020, LOLE (in hours/year) is almost zero in Spain and Portugal (and zero in France) with NTC 2010. Thanks to the cross-border reinforcements, it is reduced to zero in all three systems.

In Scenario B, reinforcements reduce the LOLE from low values (always below the international reference of 3 hours/year) to very low values in the three countries. The Nuclear Phase Out has an insignificant effect on the French adequacy indicators, and no effect in the Iberian Peninsula.

6 Investment Needs



The present chapter gives an overview of all the expected investment needs on the power grid in the Continental South West region for the coming ten years. This information is presented graphically on maps.

6.1 Present Situation

The Iberian Peninsula (Portugal and Spain) is almost an electric island with only four tie-lines (2 of 220 kV and 2 of 400 kV) between France and Spain, the last one having been built in 1982, and facing constant congestions. Between France and Spain, 2010 NTC values are 1200 – 1400 MW from France to Spain and 500 MW from Spain to France (by the end of 2011, values from Spain to France have increased up to 700 – 1000 MW).

On the other hand, although 2010/2011 NTC values between Portugal and Spain (1500 – 1600 MW from Portugal to Spain and 1800 – 1900 MW from Spain to Portugal) are higher than those between France and Spain, some constraints still occur.

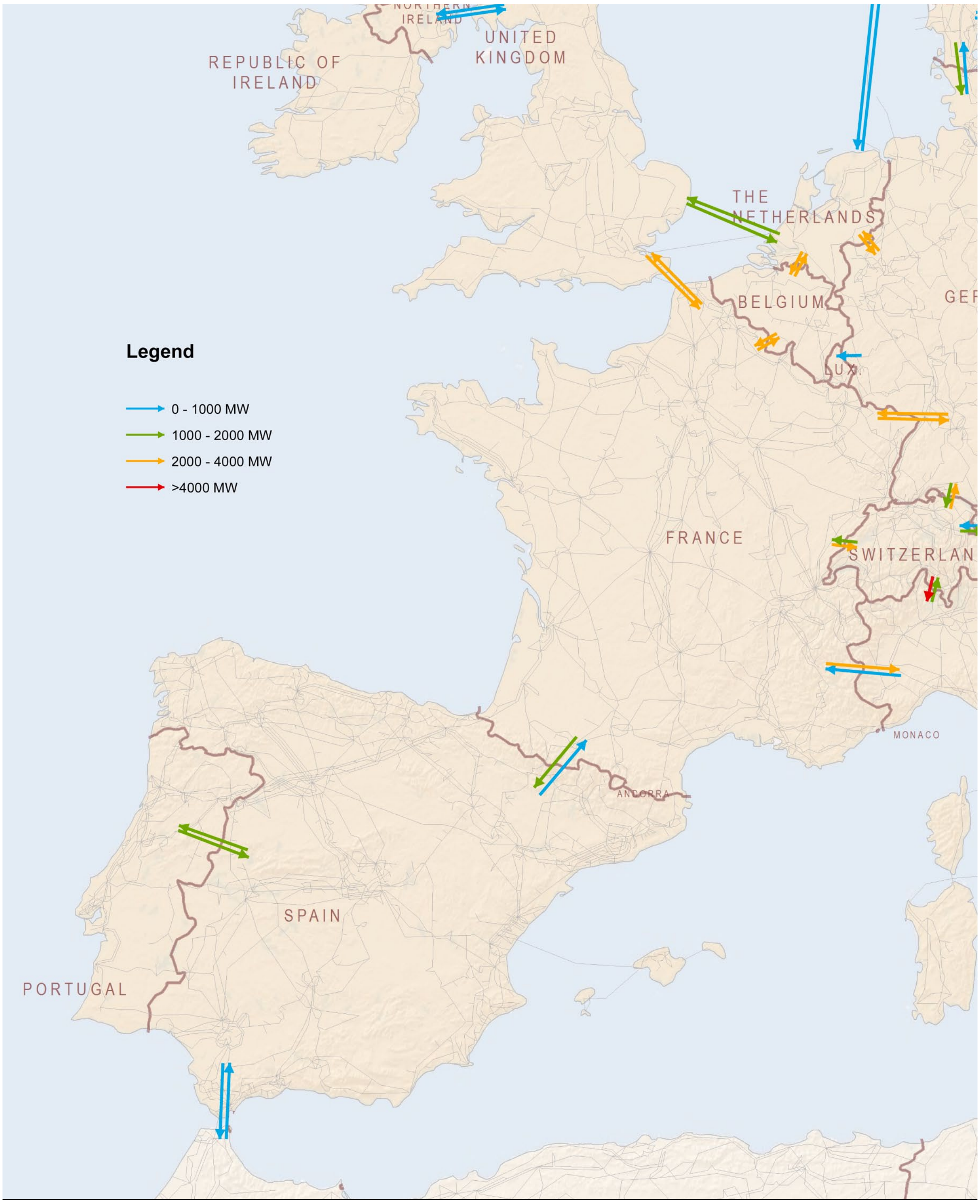


Figure 17:
NTC map – winter 2010/2011

6.2 Drivers of Grid Development

Over the plan period, the main drivers for system evolution within the CSW region could be sorted into four categories, as follows:

– **Insufficient cross-border capacity**: i.e. structural market congestion between price zones;

– **Existing generation evacuation:** areas where existing generation cannot be evacuated reliably in all situations as a result of a change in surrounding power flow patterns;

– **Future generation evacuation:** areas where new generation facilities have been asked (or are likely to be asked) for connection, as it may be the case of large power plants and/or distributed generation, RES or not, as the existing network does not assure conditions for an adequate evacuation;

– **Demand growth:** large areas of demand, where security of supply can be at risk.

The following map (Figure 18) shows these investment drivers on the CSW region, with each driver being highlighted with a specific color:

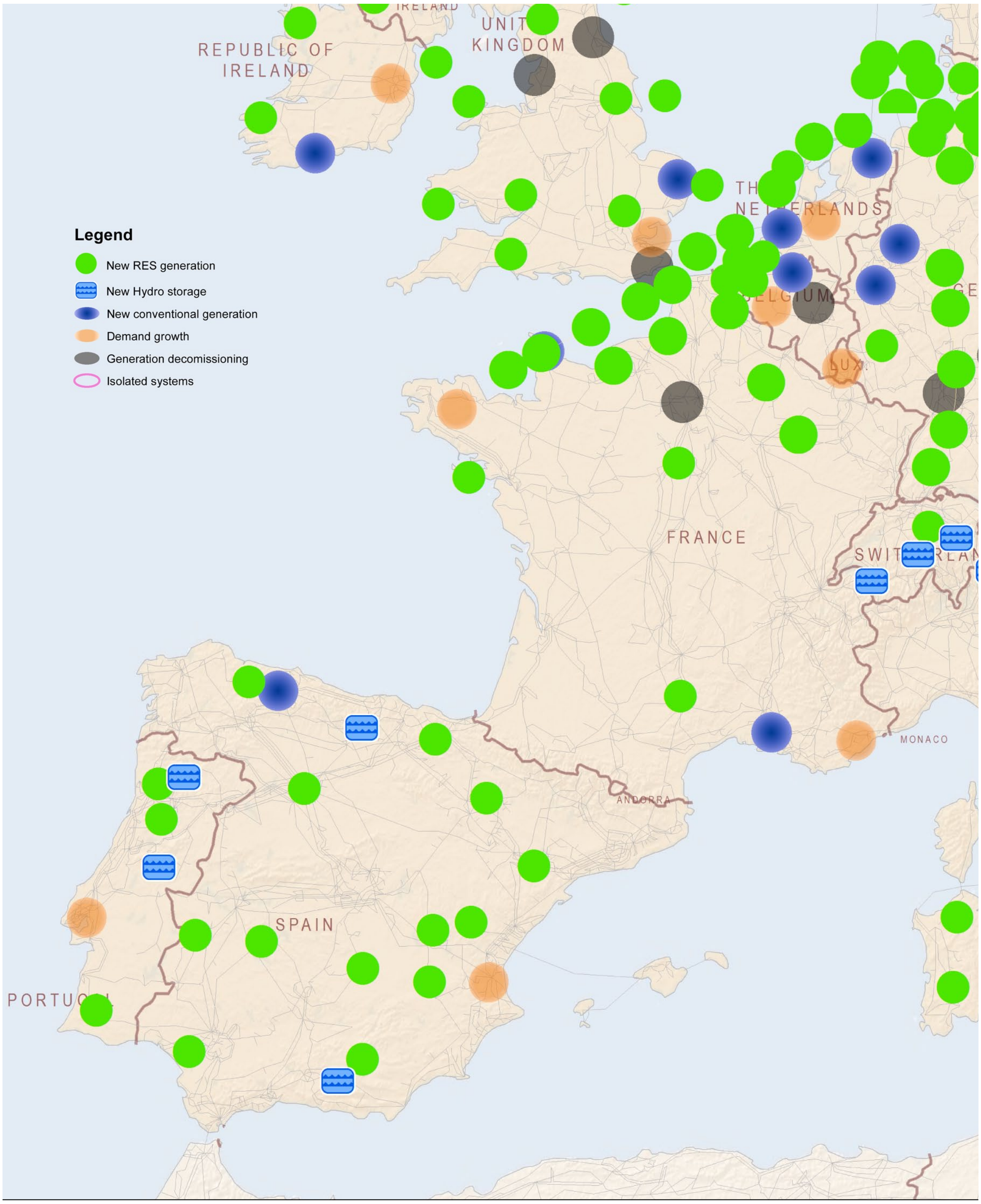


Figure 18:
Drivers of system evolution – medium and long term – map

6.3 Main Concerns in the Region

In order to identify the main constraints on the network, each regional group has defined boundaries that represent the bottlenecks, which could be due to an increase of capacity exchanges, market integration, generation integration or security of supply issues. In Figure 19, there is a representation of the boundary locations in the CSW region, related to their main concern (sometimes not the only one) and the main flows expected in 2020. When the boundary is closed, it represents a zone where the congestions are principally due to consumption or generation evacuation located in that area.

The main flows expected in 2020 in Spain are toward Madrid, mainly from the South and the Northwest (this last also toward the East and South), and North-South flows in the Mediterranean coast. In Portugal, the main flows will go from north and interior areas to Lisbon and also flows coming from Spain are expected in the North, while in the South, Portugal will export to Spain. In France, North to South flows (from the Massif Central) and East to West (from the Rhone Valley) are expected in the mid-term toward the Eastern Pyrenees and the Iberian Peninsula; however, in the long term, both directions through the Pyrenees border are expected.

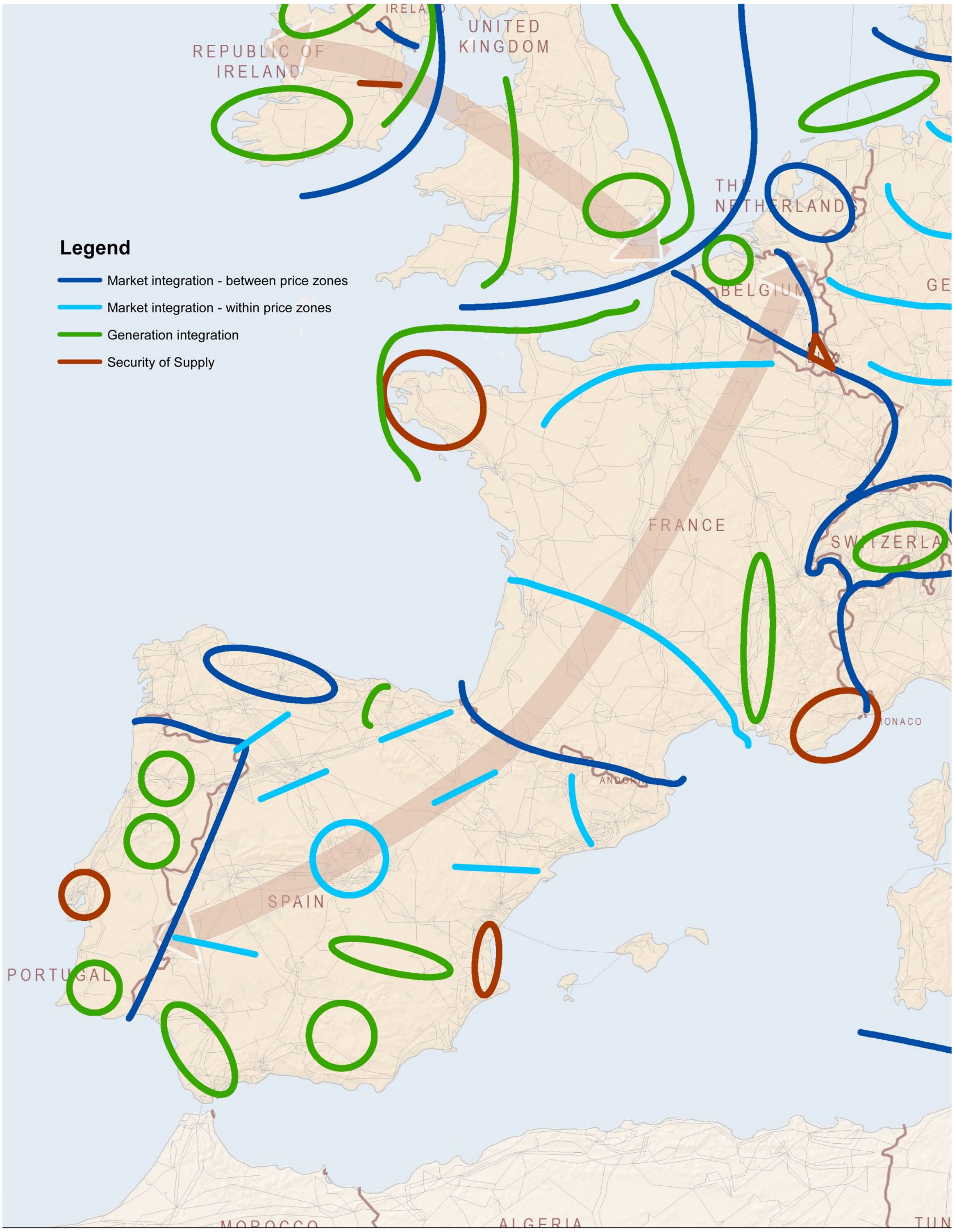


Figure 19:
Main concern in the CSW region

6.3.1 Market Integration Concerns

The following map displays market integration concerns, both in the border between countries and in the internal boundaries that connect generation areas with demand centers.

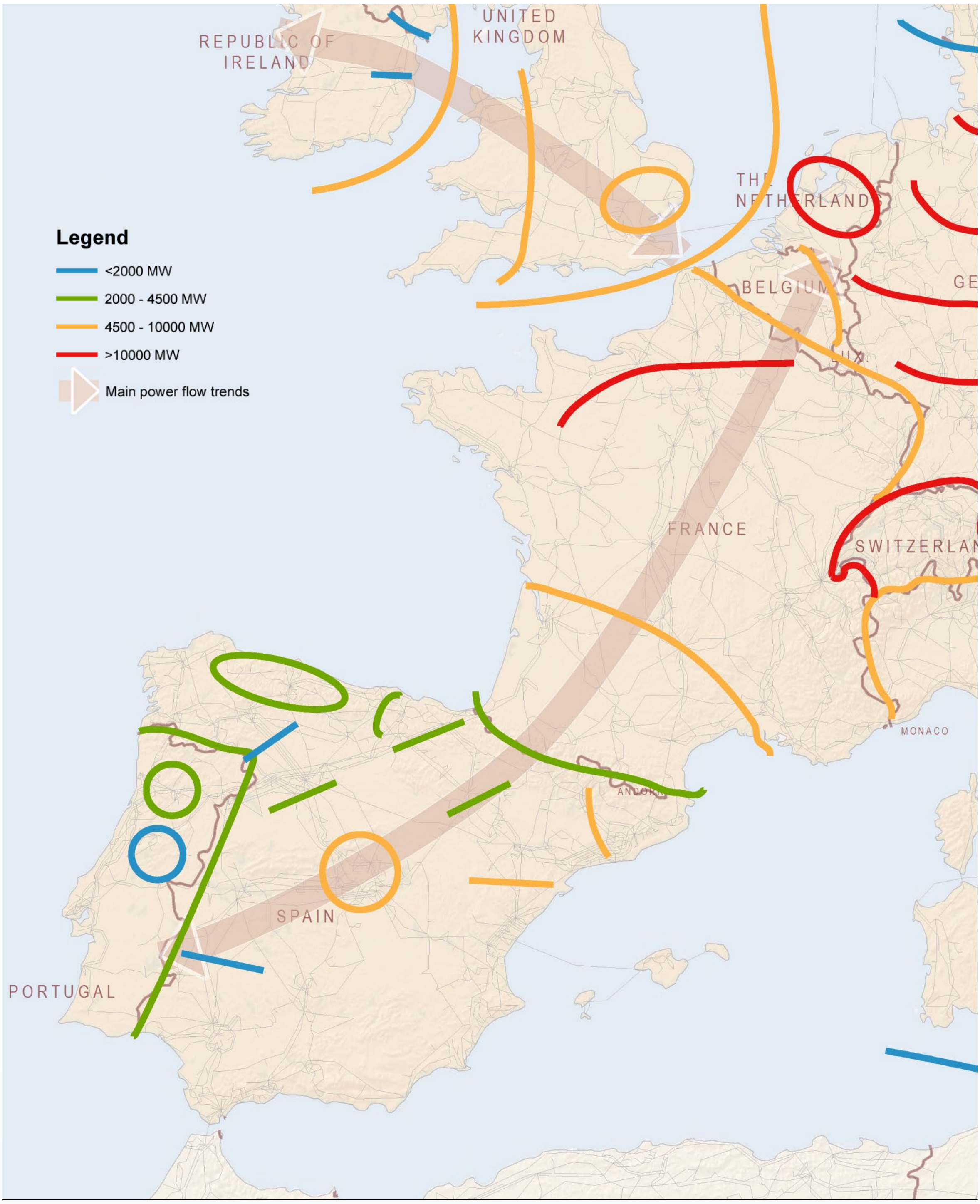


Figure 20:
Bulk Power Flows related to market integration

6.3.1.1 Insufficient cross-border capacity

Considering 2010 NTC values between France and Spain as well as the fact that this border faces continuous congestions, France and Spain have the shared goal of increasing their common transfer capacity. The objective, set in 2001, is to reach an exchange capacity of 2800 MW in the short term and 4000 MW in the long term. The short-term objective will be fulfilled in 2014 with the new Eastern reinforcement, and the long-term objective, by 2020, with the new planned Western reinforcement. This cross-border transfer capacity increase between France-Spain will induce an increase of the North to South and South to North flows in France. Indeed, the energy coming from/to Spain crosses the Southwestern part of France to reach the locations of consumption or generation, which can be in France but also in the rest of Europe. This induces an increase of congestions principally in the Massif Central zone.

On the other hand, Portugal and Spain also have the objective of increasing their NTC from the current values up to 3000 MW in both directions, in order to avoid current and future congestions and thus allowing a full operation of the Iberian Electricity Market (MIBEL). The new Southern and Northern interconnections, whose expected commissioning dates are 2013 and 2014, respectively, will allow reaching this objective. Also it is expected that in 2020 the NTC will reach 3200 MW in both directions.

Considering the interconnection ratio indicator (sum of import capacities with all the neighbors divided by the total installed generation capacity), which the EC Council defined in Barcelona in 2002 whereby setting the reference value in 10%, it could be said that Spain is far away from the reference value of 10%, even taking into account the new interconnection projects with Portugal and France.

Portugal	Spain	France	Objective
9%	4%	9%	10%

Table 3:
2011 Interconnection ratio

6.3.2 Existing and Future Generation Evacuation

For the midterm in the CSW Region, other main investment need is the connection and evacuation of new generation (both renewable and conventional energy).

The connection and evacuation of renewable energy sources, mainly wind, hydro (with and without pumping) and solar, are one of the most important investment needs in the Southwestern region of Europe. The CSW region expects a deep penetration of RES in 2020. Nowadays, there are around 41 GW of RES installed in the region, and by 2020 around 45-57 GW of new RES will be installed.

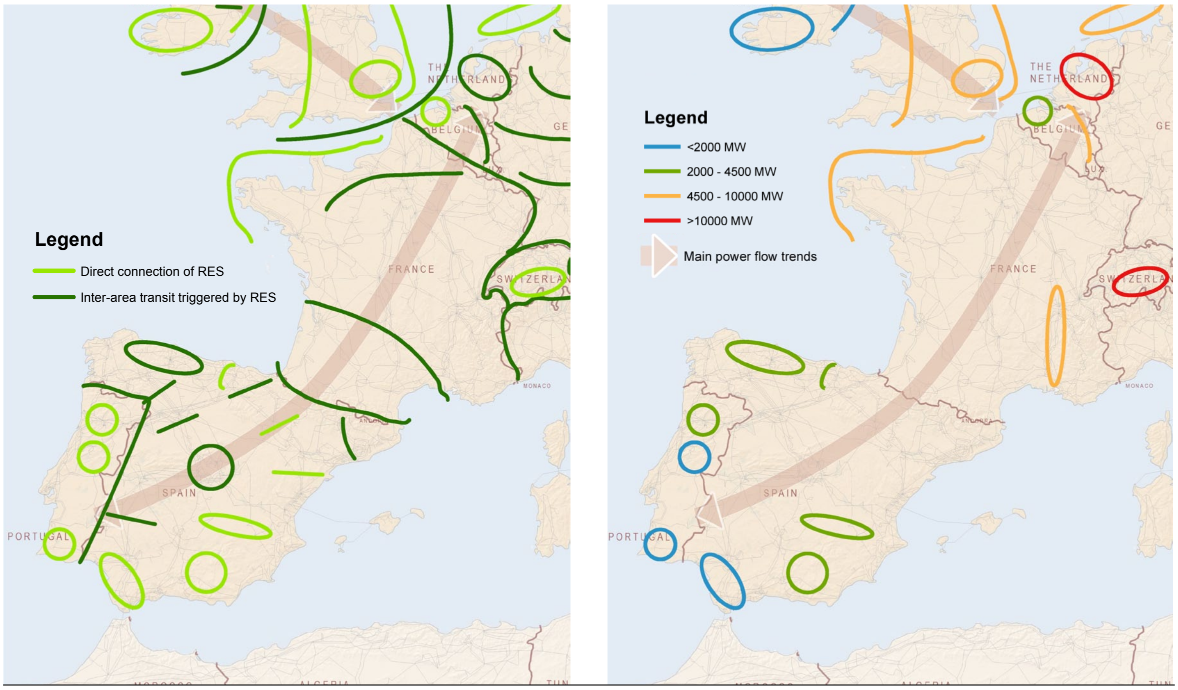


Figure 21:
RES concerns in CSW region (left) and Bulk Power Flows related to generation connection (right)

The ambitious renewable plans in Spain and Portugal, already set several years ago, imply important investments on transmission infrastructures, some of them already commissioned or under construction. One reason for that is that new wind farms are mostly located in remote areas, where connections to main transmission networks are weak or don't even exist, as is the case with the South of Aragón, the area of Baza in Andalucia and the North-western of Spain in Galicia and Asturias. The same happens on the North of Portugal in Trás-os-Montes and in the interior of Portugal in Beira Alta and Beira Baixa. Also in France, on top of solar and onshore wind, 3 GW of offshore wind is expected in the Atlantic Ocean and English Channel (call for tenders currently on-going), and 3 additional GW are foreseen in the French NREAP by 2020.

These new power plants induce new network flows that need to be accommodated in the electric system, which was designed for different patterns of flows (for instance, the congestions in the axis between the Cantabric and the Mediterranean Sea).

Nevertheless, conventional generation evacuation is also another driver, mainly in areas with a big attraction as a production site. Lavos and Sines in Portugal, the area of Fos, in France, the North-western part of the Peninsula, or Sagunto, in Spain, are examples of potentially congested areas due to conventional generation if no new reinforcements are implemented (some of those areas are already experiencing congestions).

6.3.3 Demand Growth

The need of guaranteeing the demand supply and enhancing its quality is also an important investment need in Lisbon/Setúbal in Portugal and Levante in Spain. Nevertheless, local investments of national relevance are required in order to secure supply of local load, which are better than projects of European relevance.

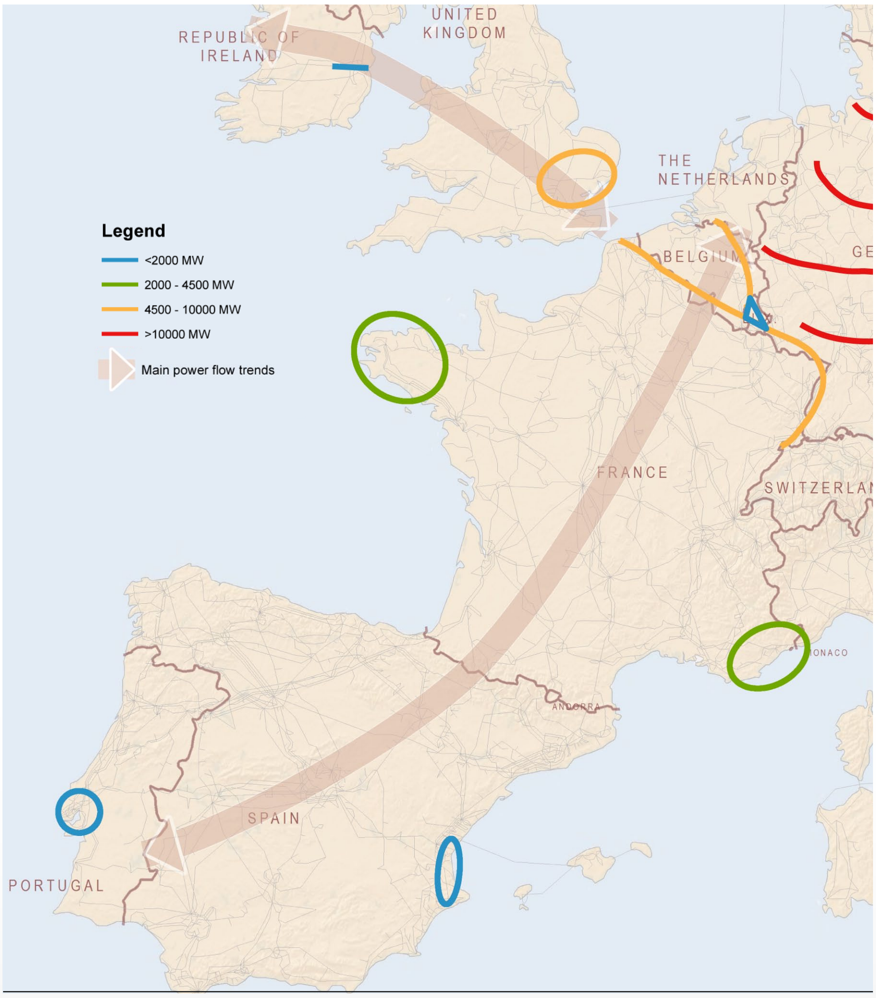
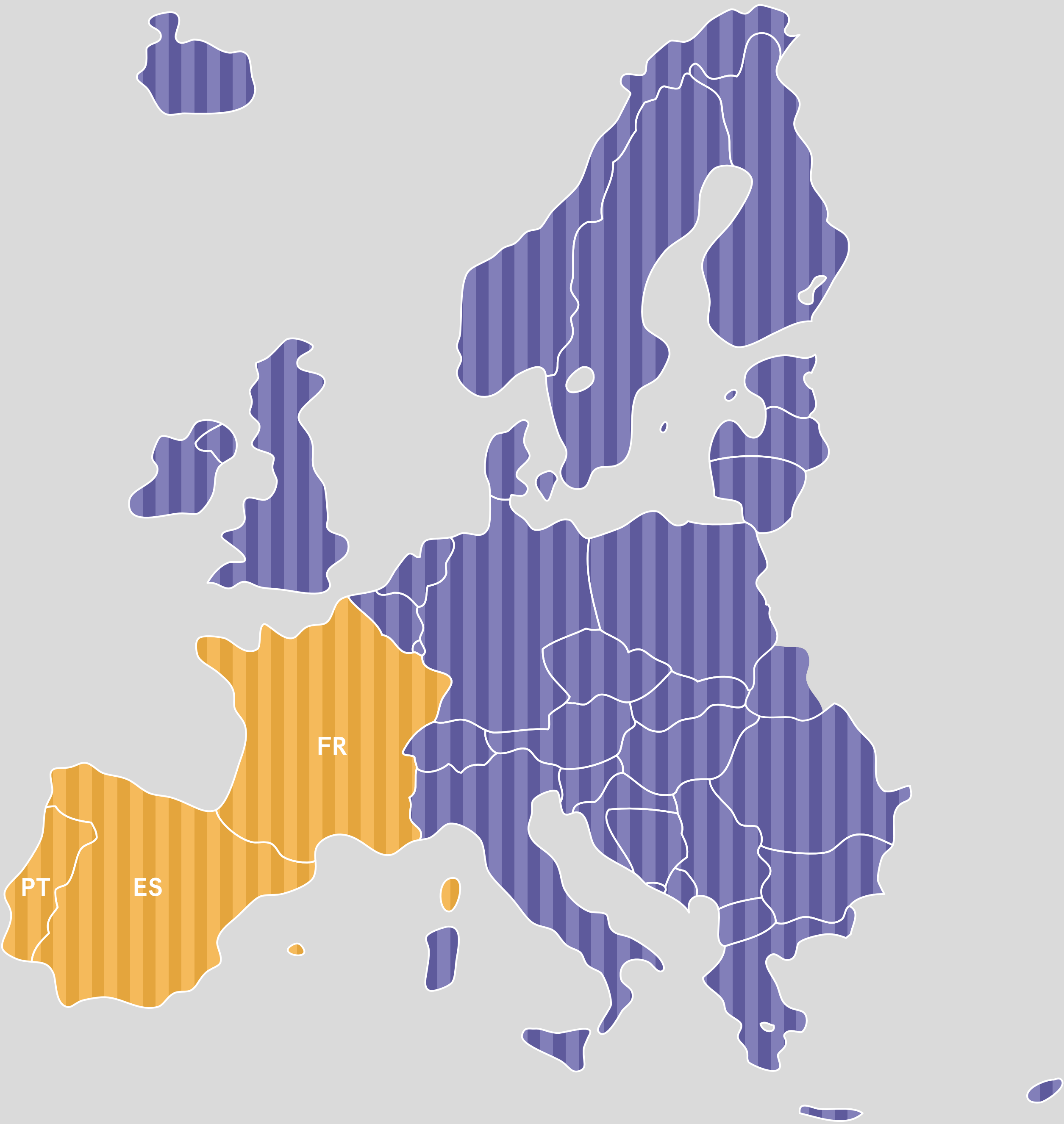


Figure 22:
Bulk Power Flows related to security of supply

7 Investments



7.1 Projects of pan-European Significance in CSW Region

To achieve the challenges of the future needs in the European transmission grid, the European TSOs evaluated in close cooperation numerous grid reinforcements. The RgIP focuses mainly on projects of European significance in the CSW region (see definition in TYNDP 2012 report). These projects are on an Extra-High-Voltage-Level with an increasing impact on grid transfer capability on network boundaries between market areas or borders within the ENTSO-E interconnected network. Projects with more national impact are evaluated and published in the National Grid Developments Plans. However, most of these projects are in close relationship within the projects of pan-European significance.

Every project of pan-European relevance is listed, described and valuated in Appendix 1.

The present chapter provides an overall view about the projects. The next two maps will display geographically all projects proposed in the region, divided into two 5-year periods (2012 – 2016 and 2017 – 2022). The maps show basic information regarding locations, routes and technology. When the precise location of an investment is not yet clear, a bubble then shows where the investment is likely to occur. The labels ease the correspondence with the table in Appendix 1.

Note: some projects are quite mature, and already under construction; others are only under study. No filter with respect to maturity has been applied so as to deliver the most transparent and comprehensive information to the reader.

7.1.1 Midterm (2012 – 2016)

The following map illustrates the projects of European relevance proposed for the period 2012 – 2016 in the Continental South West Regional Group. All these projects, selected in order to address the needs identified in chapter 6, have been classified in cross-border projects and internal projects, which are related to security of supply and to generation integration, mainly RES.

7.1.1.1 Cross-border projects

7.1.1.1.1 France-Spain Eastern Interconnection

In order to fulfill the governmental 2800 MW objective of exchange capacity between France-Spain, a new interconnection of France-Spain is planned in the midterm. After being classified as a Priority Project by the European Commission, and after the involvement of Mario Monti as European Coordinator, it was stated that the unique feasible alternative for the development of the Spanish-French interconnection by the Eastern Pyrenees was a solution in DC totally buried for the cross-border section of the interconnection, with a terrestrial drawing up, as well as using, as far as possible, existing infrastructure corridors within a certain area.

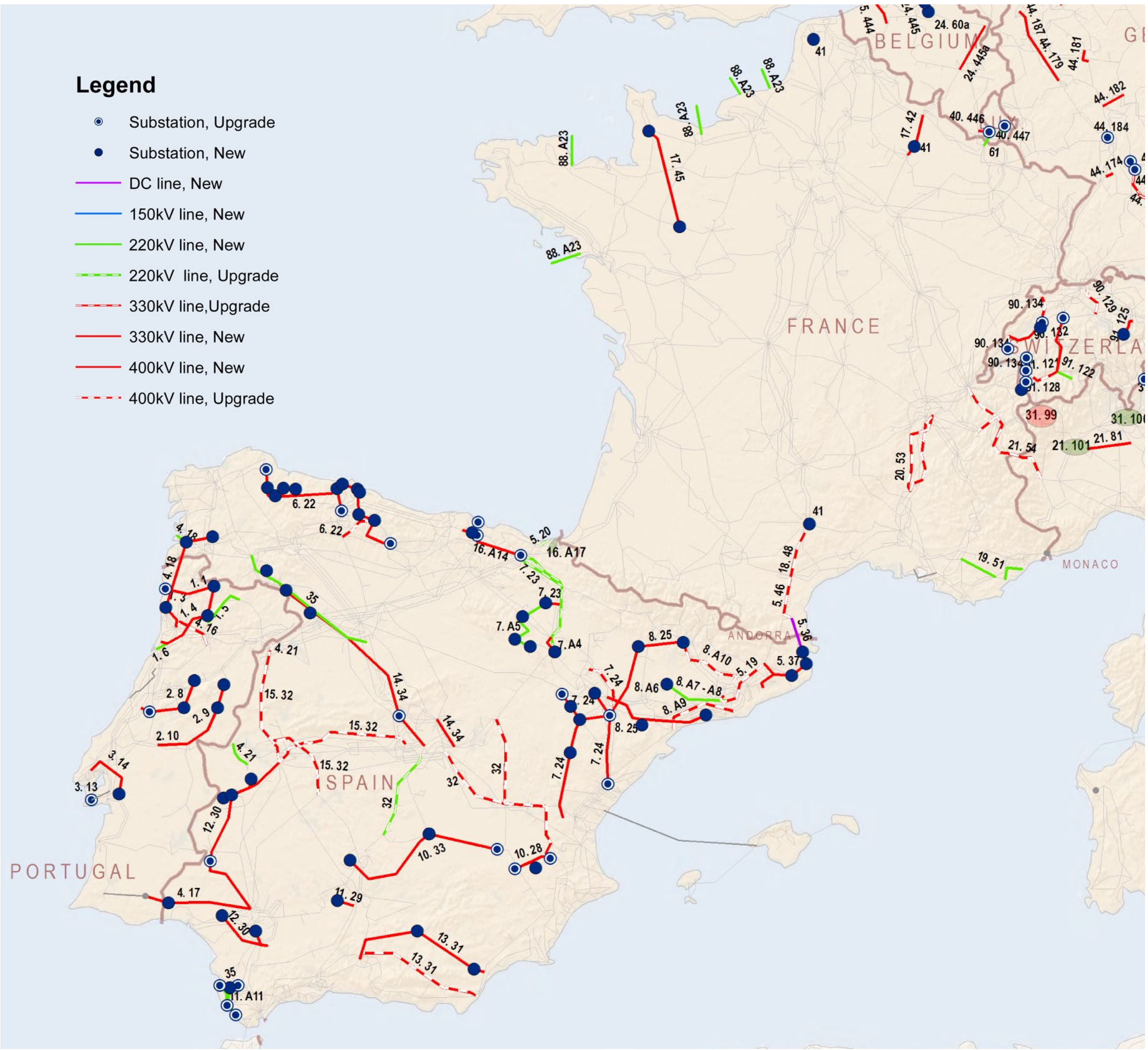


Figure 23:
Projects of pan-European and regional relevance in CSW region (2012 – 2016)

The interconnection link based on the new VSC technology will connect Baixas (France) to Santa-Llogaia (Spain), via a 65-km long HVDC +/- 320 kV underground cable system, with 2*1000 MW rated power and AC/DC converters at both ends. Authorizations are in progress on both sides of the border and the installation is expected to be commissioned in 2014. This project is carried out by INELFE, a REE-RTE joint venture, created for this purpose.

The provided NTC increase is 1200-1400 MW in both directions. However, some internal reinforcements, both in Spain and France, are required: some uprating of existing lines, and also in Spain a new 400 kV line between Sta Llogaia and Bescanó in order to accommodate the new flows and to connect the existing network to the new HVDC. The project allows important Social Economic Welfare, as it allows the use of more efficient and cheaper technologies, and avoids spillage of some wind energy, especially in the Iberian Peninsula.

7.1.1.1.2 Spain-Portugal Interconnection

Between Portugal and Spain, two new cross-border interconnection lines are planned to fulfill the 3000 MW governmental objective of exchange capacity in both directions:

- A new Southern interconnection by 2013: 400 kV Puebla de Guzman (ES) – Tavira (PT) – Portimão (PT).
- A new Northern interconnection by 2014: 400 kV Bóboras (ES) – O Covelo (ES) – Vila Fria (PT) – Vila do Conde (PT) – Recarei (PT).

The accommodation of the new and higher flows in the internal networks is also required with some uprates and new lines in the internal network, such as, for example, the uprate of the 400 kV line of Aldeadavila-Villarino in the Duero region to avoid important restrictions of NTC from Portugal to Spain in case of high production in the north of Portugal.

This project allows an increase of NTC between the two countries of 1700 MW in the direction of Portugal to Spain and 1400 MW for Spain to Portugal. With all these reinforcements, the reduction of losses on the grids and the reduction of CO_2 (due to better use of RES in both countries) are high.

7.1.1.2 Internal reinforcements

7.1.1.2.1 North axis

The North Axis Project between Galicia and the Basque Country has been set a long time ago in the national Master Plan in order to evacuate the generation of the North Western part of the country and to feed the high industrial and demanding regions of the north of Spain. Some sections, such as the 400 kV Soto-Penagos, have been commissioned in 2011. The project allows connecting and integrating future generation (both at transmission and distribution level), especially wind power energy, but also a new hydro-pumping plant in Cantabria. Part of the project is considered as the Asturias Ring.

7.1.1.2.2 Cantabric-Mediterranean axis

A new Cantabric-Mediterranean project is needed to accommodate geographical unbalances between production (in Northern Spain) and consumption (Mediterranean area), which otherwise would produce congestion in the 400 kV corridors of Valladolid/Palencia-Madrid and Aragón/Cataluña-Levante. The project will also allow integrating an important contingent of renewable energy, sometimes avoiding congestion in existing networks, such as Pamplona or La Rioja, and sometimes in areas without transmission networks, such as in Teruel. The section of Castejón – Muruarte 400 kV has already been commissioned.

7.1.1.2.3 Aragon-Cataluña axis

Reinforcement between Aragón and Cataluña is required to solve the congestion on the existing grid, due to unbalanced production and consumption between Aragón and Cataluña, mainly between Teruel and Tarragona. Reinforcement of the connection between Teruel and Tarragona is planned with a new 400 kV line of Escatrón-La Secuita, new 220kV axis Mangraners-Begues and two associated uprates. In addition, a new route is planned between Aragón and Lérida with a 400 kV double circuit line of Aragón-S.Pallars, complemented with some uprate toward Barcelona. New wind power energy will be connected and integrated in this project.

7.1.1.2.4 Transmanchega project

A connection between Valencia, Albacete and Ciudad Real is planned. It involves the new double circuit 400 kV OHL line Romica-Manzanares (original Transmanchega line), a 400 kV Manzanares-Brazatortas, a new single circuit Cofrentes-Ayora-Campanario-Pinilla 400 kV OHL, and required new substations. Wind power energy development in this area is very important and this project will accommodate it in the system, taking advantage also of the existing pumping in Cofrentes.

7.1.1.2.5 Cadiz-Cordoba axis

The 400 kV double circuit Cartuja-Arcos de la Frontera-La Roda-Cabra-Cordoba-Guadame 400 kV OHL has been commissioned time ago to send the surplus of energy in the Cadiz area to high demand areas in the center of Spain. The section Arcos-Guadame is already commissioned. The remaining section is the connection to Arenal that will assure the demand in Cordoba and the development of a Cartuja-Arcos 400 kV line, and the 220 kV lines Puerto Sta Maria-Pto.Real-Parralejo-Facinas, both attached to existing and future wind power energy. The Cartuja 400 kV substation will be the connection of an important potential of offshore wind power energy in this area.

7.1.1.2.6 South-North axis in Southwestern Spain

A new route is required to avoid congestions in the southwestern part of Spain, mainly due to flows. A new double circuit 400 kV OHL Guillena-Brovales-Arroyo S.Servan-Carmonita- Almaraz is considered, which integrates new generation, both conventional and renewable, with an important potential of solar energy, and accommodates the expected high flows in this area. This new generation is consumed in different areas, such as in Sevilla with the new double circuit 400 kV OHL: Aznalcollar-Guadaira-Don Rodrigo that also helps with the integration of new solar energy, and of course Madrid.

7.1.1.2.7 Baza project

A new double circuit Caparacena-Baza-La Ribina 400 kV OHL, with two new 400 kV substations in Baza and La Ribina, will allow integrating an important contingent of wind and solar generation, both at transmission and distribution level in the northeastern part of Andalucia that does not have a transmission network. On the other hand, a new pumping hydropower plant is expected in this area. In addition, the existing single circuit Litoral-Tabernas-Hueneja-Caparacena 400 kV line will be uprated in order to increase its capacity to avoid existing congestions.

7.1.1.2.8 North Suma project

A new axis between the North Western and the central area of the country was required in order to avoid congestions caused by the flows from the north, which is a typical production area (both conventional and renewable, and both existing and new) toward the demand in Madrid. The project includes a new line 220 kV/400 kV between Trives and Tordesillas and a new double circuit 400 kV line between Tordesillas and Madrid (Galapagar/La Cereal). In Madrid, these new flows require some investments to be accommodated, such as some uprates and upgrades and a new input/output of Moraleja in Segovia-Galapagar 400 kV OHL, together with a new PST in the 400 kV line Galapagar-Moraleja. Wind power energy is also collected in the middle substations in the axis, and supply to demand is also supplied in the middle of the axis with the new Tordesillas-Mudarra 400 kV line.

7.1.1.2.9 South Suma project

The demand of Madrid is also supplied from the south and new investments are required to avoid congestions in the existing network. This project consists in the midterm of uprates of several 400 kV and 220 kV lines between Madrid and Castilla La Mancha- Extremadura.

7.1.1.2.10 West-Littoral axis

The new 400 kV axis between the west side of Serra da Estrela and the littoral will accommodate the new hydro (with pumping) and wind generation that will be put in operation in the inland middle region of Portugal. This project includes the new 400 kV double OHL Paraimo/Batalha-Penela and a 400 kV single OHL Penela-Arganil/Gois-Vila Chã B, and a 400 kV double OHL Guarda-Covilhã-Falagueira-Pego.

7.1.1.2.11 Minho-Trás-Os-Montes axis

These reinforcements are necessary to evacuate the significant amounts of generation coming from the new hydro production of the Portuguese National Plan for Hydro Power Plants and also from power reinforcements on already existent plants (the total new power is 3210 MW with 2700 MW of pumping). This project also improves the security of supply on the Trás-os-Montes region where, at this moment, there are three substations fed in each case by a single long line.

7.1.1.2.12 Reinforcements on the 400 KV Network near Lisbon

The reinforcements on the 400 kV network planned near the Lisbon area will increase the security of supply on the region of Lisbon and the Setúbal Peninsula. These reinforcements include the new 400 kV double OHL Pegões-Fanhões and the extension of the 400 kV voltage level to the Fernão Ferro substation. The new 400 kV OHL Pegões-Fanhões will also contribute to avoiding possible congestions caused by south to north flows in dry conditions.

7.1.1.2.13 Change of conductors on French 400 KV lines

In the midterm, reconductoring is required on some French 400 kV lines between the Pyrenées Orientales and the main grid of Southern Massif Central in order to cope with the North to South and East to West flows due to upstream generation evacuation and supply of local load, while accommodating increased power flows to the Iberian Peninsula.

7.1.2 Long Term (2017-2022)

Figure 24 shows the projects of European relevance proposed for the period 2017-2022 in the Continental South West Regional Group.

7.1.2.1 Cross-border projects

7.1.2.1.1 France-Spain Western Interconnection

In order to reach the 4000 MW long-term objective of exchange capacity, French and Spanish TSOs have analyzed several alternatives across the border between both countries. In preliminary studies, the preferential strategy, both from a technical feasibility and environmental point of view, is a new HVDC submarine interconnection through the Biscay/Gascogne Bay from the Basque Country in Spain to the Aquitaine area in France. As the project is still in a very first stage, more detailed analyses are required to confirm technical feasibility of the subsea route, and connection to the existing network. This new interconnection is proposed with a similar model to the midterm Eastern interconnection, which is two identical but independent voltage source converter (VSC) links with a nominal active power of 1,000 MW each and a rated DC voltage of ±320 kV (positive - negative pole), and assuming a maximal loss of 1,000 MW (one link).

A new Phase Shifter Transformer in the cross-border line Arkale-Argia 220 kV is also considered in this project. It will be located in the Arkale substation and will not only help to increase exchange capacity but will also secure the local load on both sides of the border, especially in France. This phase shifter will be commissioned before the submarine connection.

In addition, some internal reinforcements in Spain are required to reach the expected NTC. The French project in Massif Central, amongst other benefits, could permit reaching a higher NTC.

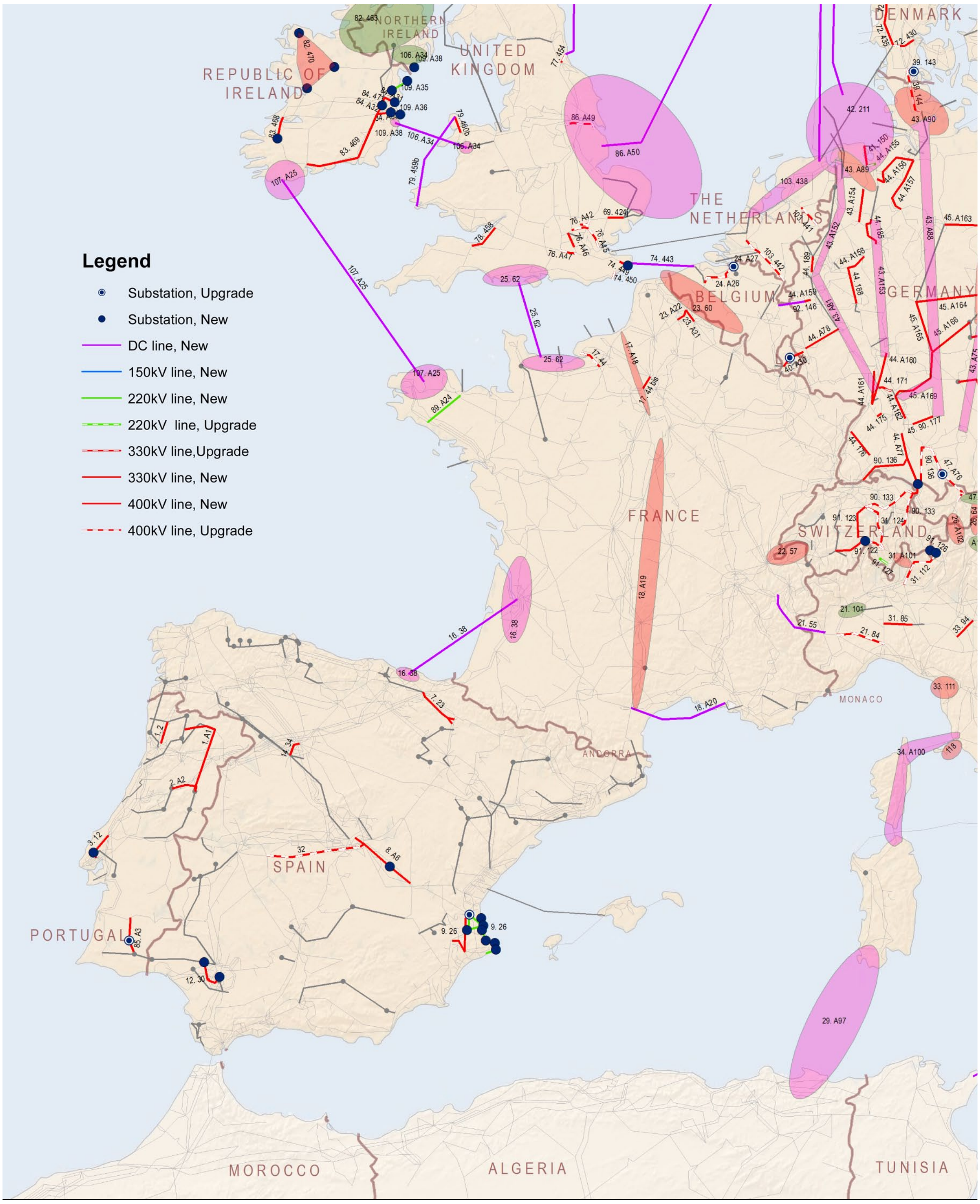


Figure 24:
Projects of pan-European and regional relevance in CSW Region (2017–2022)

7.1.2.2 North Africa – Spain

Today, two submarine AC lines allow a commercial exchange capacity of 900 MW from Spain to Morocco and 600-700 MW from Morocco to Spain.

There are plans that pretend installing thousands of renewable MWs in the Maghreb countries that could supply the increasing demand in these countries, whereas the surplus could be exported to Europe. In the long term, this situation can affect the power flow patterns in the Morocco-Spain existing interconnection, and also the internal networks, necessitating new investments. However, it is expected that the increase of installed renewable generation in North Africa achieved by 2022 would in a first step supply the high increasing demand in Maghreb countries and would reduce prices substituting thermal production. It could be possible that the NTC used today at maximum with flows from Spain to Morocco changes the direction in certain situations if energy in North Africa is cheaper than in Spain/ Europe, but no congestions are expected in the interconnection by the horizon of this report.

Therefore, no new reinforcement is considered by the 2022 horizon in the border between Spain and North Africa. However, further studies have to be performed in order to detect when potential constraints will occur in the existing interconnection so that the reinforcement of the interconnection will be profitable.

7.1.2.3 Internal grid reinforcement

7.1.2.3.1 Levante

New double-circuit Catadau-Jijona-Benejama 400 kV is required to accommodate high flows between Valencia and Alicante, caused by the high demand in the Mediterranean coast. A new 400 kV substation will be installed at Jijona and transformers will be installed in Jijona and Catadau. In addition, an upgrade of existing 132 kV lines to 220 kV from Catadau to Jijona through the coast, as well as some new lines and substations, are crucial for a proper quality and security of supply in Costa Blanca.

7.1.2.3.2 South Suma Project

The demand of Madrid is also supplied from the south and new investments are required to avoid congestions in the existing network. This project consists in the long term of an uprate of a 400 kV line and a new double circuit Olmedilla-Villares-Morata-Valdemingomez 400 kV OHL, which collect the new wind power generation in the area of Cuenca and Albacete.

7.1.2.3.3 Massif Central in France

In this area in France, which is linked to European flows crossing France between Spain and the North and East of France, several long-term projects have been defined more or less precisely. One of the projects is a 1000 MW HVDC link with underground and subsea sections, which will be the first HVDC internal link in France. The objective of this investment is to participate in the integration of generation from southeastern France, to increase the security of supply of local consumption, and also to participate in European exchanges (North-to-South flows).

Investment FR2, still under investigation, is necessary in order to evacuate generation in the Massif Central area, and particularly renewable generation (wind and hydro), but also to cope with the evolution of the capacity exchanges with Spain associated with the growth of consumption in southwestern France. Some restructuration of the EHV grid, together with additional investment, is expected. The detailed scope of the reinforcements will depend on the evolution of the hypothesis on the target for RES and on the generation location for several important sites.

7.1.2.4 New 400 KV Line Ferreira Do Alentejo-Ourique-Tavira

To integrate new renewable generation on the south, mainly solar and wind, a new 400 kV OHL Ferreira do Alentejo-Ourique-Tavira will be constructed. The realization of this connection can take advantage of some already existing 150 kV single lines, which can be reconstructed as double circuit lines 400+150 kV. This new reinforcement will also improve the security of supply to the Algarve region, which is the Portuguese region that has presented the highest growth rates in the last years, also providing robustness to the new Portugal-Spain South interconnection.

7.1.2.5 Lisbon 400 KV North Ring

The continuous growth of consumption in the Lisbon/Peninsula of Setúbal region area has to be accompanied by additional reinforcements in this area. To ensure safe supply for the region, a new 400 kV OHL Rio Maior-Almargem do Bispo-Fanhões is planned. This new connection will allow the future establishment of a 400 kV ring in the north of Lisbon.

3rd Parties Promoted Projects

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 2010 TYDNP, elaborated and made available in February 2011 a set of guidelines for the inclusion of the third party projects in the 2012 release of the TYNDP.[1)]

Country A	Country B	Technology	Technical description	Regulatory and legal criteria fulfillment	Brief benefits for the project
GB	ES	HVDC	Yes	No	"The project is market driven. The project will facilitate the development of renewables in Spain and GB and will contribute to security of supply in these member states by providing a source of back-up power. It will also be an economic source of balancing power and should enable the most efficient sharing of energy resources amongst the two member states."

Table 4:
3rd party projects with affection to CSW region

As a result, ENTSO-E received five submissions, although only one affects this region, as depicted in Table 4.

This project failed to demonstrate evidence of a transmission license or an exemption for such a license granted by the relevant national regulatory authorities and EC, as required by the ENTSO-E guidelines. The non-discrimination principle (especially with regard to similar projects that may not have applied for inclusion for this reason) makes it inappropriate for this project to be incorporated in the table of projects of the TYNDP 2012 package.

1) https://www.ENTSOE.eu/system-development/tyndp/tyndp-2012/

7.2 Projects of National Relevance

7.2.1 Spain

Complete information about transmission projects of national interest is available in the official Master Plan "Planificación de los Sectores de Electricidad y Gas 2008-2016: Desarrollo de las redes de transporte“ approved in May 2008 and published on the website of the Spanish Ministry of Industry[1] A new plan for 2012-2020 is in progress, but it has not been published yet. Therefore, the content in the TYNDP 2012 is consistent with the draft Spanish Master Plan published by the Ministry of Industry for public consultation in December 2010.

7.2.2 Portugal

Complete information about transmission projects of national interest is available in the official Master Plan “Plano de Desenvolvimento e Investimento da Rede de Transporte de Electricidade 2012-2017 (2022)”[2], published in July 2011 and approved by the government in December 2011.

7.2.3 France

For further information about the projects of national interest in France, the French TSO (RTE) has published on his website[3] the draft of the National Development Plan.

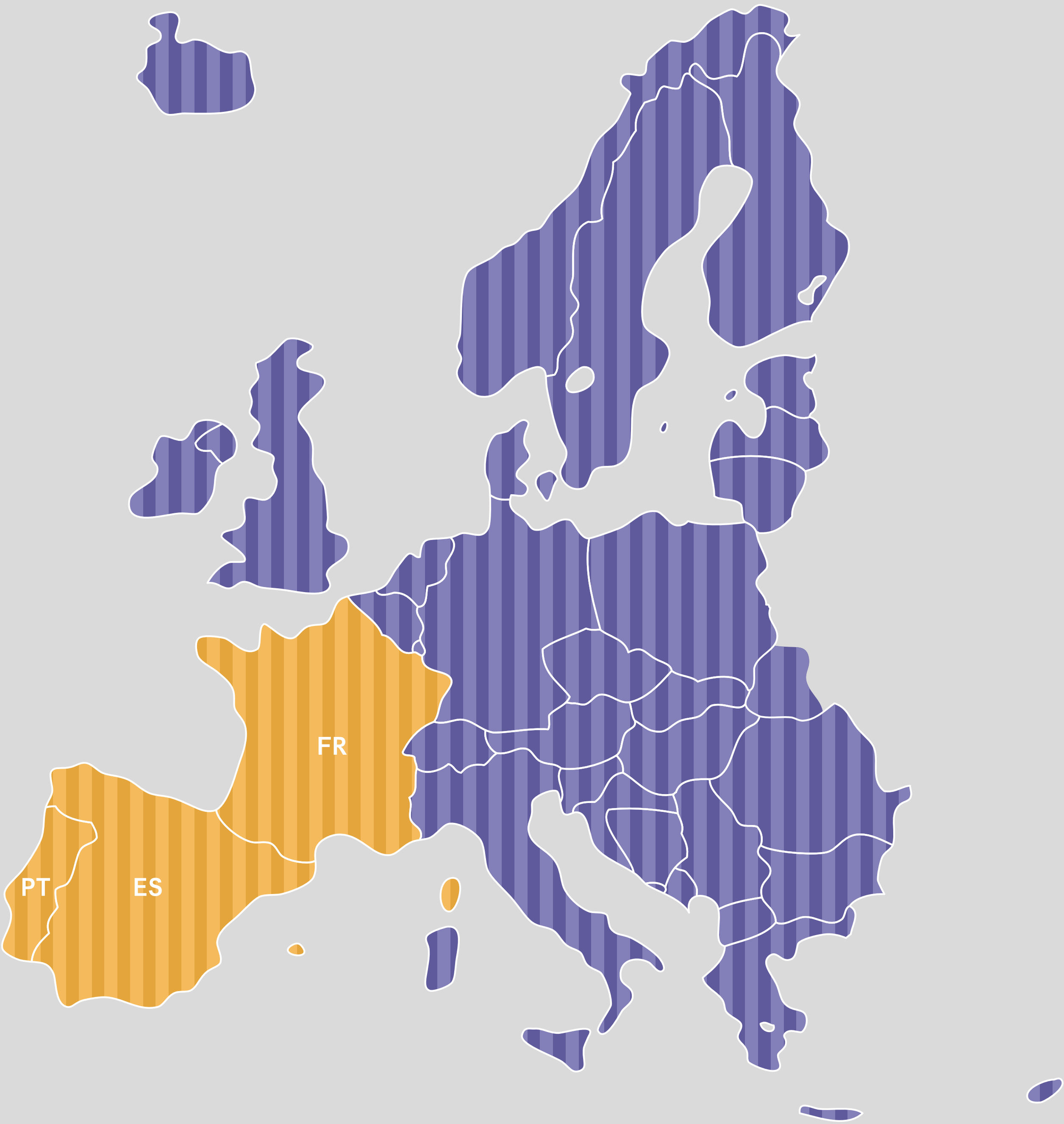
---

1) http://www.mityc.es/energia/planificacion/Planificacionelectricidadygas/Desarrollo2008/Paginas/Desarrollo2008.aspx

2) http://www.centrodeinformacao.ren.pt/PT/publicacoes/Paginas/PlanoInvestimentoRNT.aspx?RootFolder=%2fPT%2fpublicacoes%2fPlanoInvestimentoRNT%2fPDIRT%202012%2d2017%20%282022%29&FolderCTID=&View=%7b2B35D46D%2d4B75%2d46D3%2d908F%2d9737E7A0118C%7d

3) http://www.rte-france.com/uploads/Mediatheque_docs/vie_systeme/annuelles/Schema_developpement/Projet_Schema_decennal_20111231.pdf

8 Transmission Adequacy



8.1 Transmission adequacy is ensured in the considered scenarios

Transmission Adequacy shows how adequate the transmission system is in the future in the analyzed scenarios, considering that the presented projects are already 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:

1. **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;

2. **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 ;

3. **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.

The France-Spain interconnection stands out. With all projects included in this Plan, it is still expected that this interconnection will continue to have congestions more than 50 % of the time. However, from the TSO's point of view, projects have to be implemented step by step, and they are complex enough not to be able to commission more than one project in a timeframe of 6 years.

The boundaries marked as "likely" have the following main reasons:

- Feeding large areas of demand, like Lisbon/Setúbal and Madrid. The projects are directly associated with the growth of the consumption, and although problems are not expected if consumption increase is higher than expected there, additional reinforcements will be needed.

- Areas with high potential of RES. In the analyzed scenarios, no major congestions are expected, but if an acceleration of the implementation of RES in those areas occurs, it could require additional investment in some extreme RES development conditions.

- Interconnection Portugal-Spain. A large amount of hydro (mostly with pumping) and wind are expected to be connected in the North of Portugal. Beyond those, there are also more requests for new hydro power plants with pumping in the North. Assuming that all these new power plants get a license for a grid connection, this could have a significant and negative impact on the NTC values between Portugal and Spain.

– Depending on the amount and location of new future generation (RES and conventional), and on the level of the exchanges with foreign countries that will occur in the future, congestion in the south of France due to high south-north/north-south flows could happen in some extreme conditions and could require further investigation.

The following map (see Figure 25) displays the overall picture for the Continental South West region:

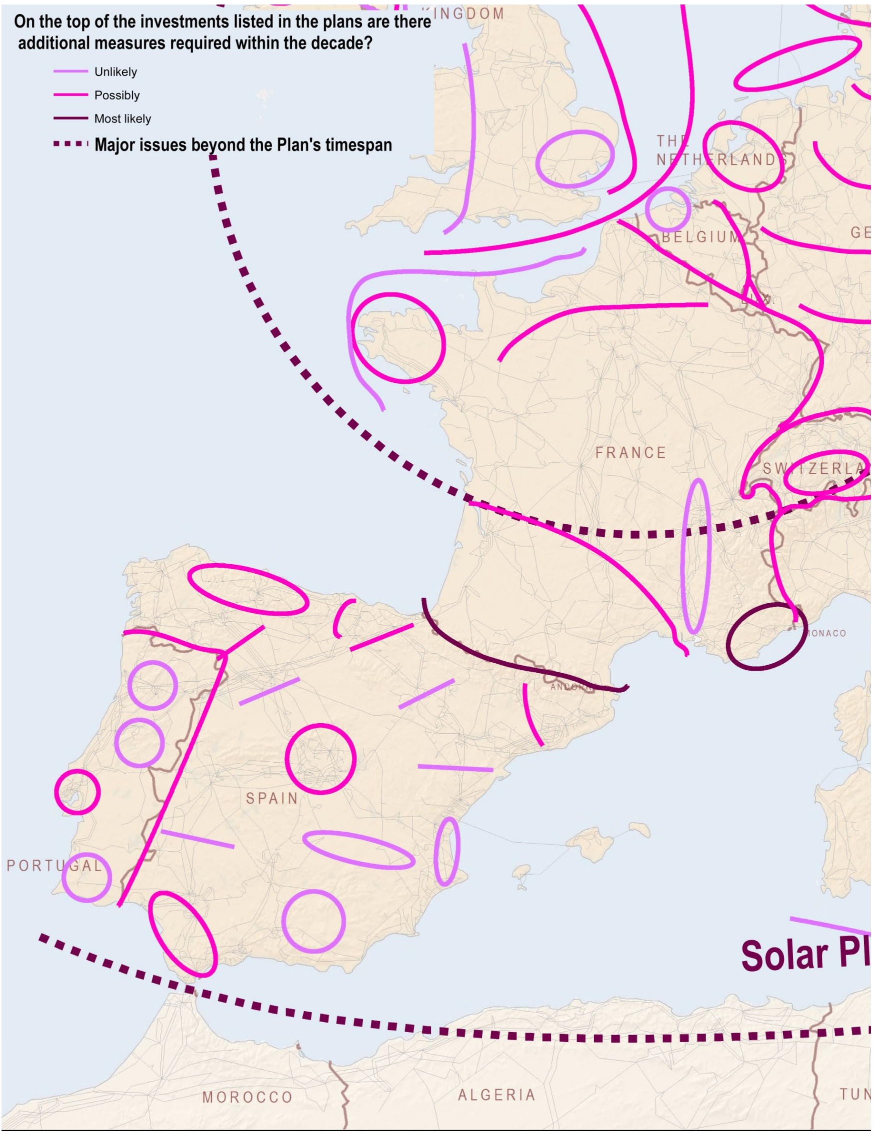


Figure 25:
Transmission adequacy in CSW region by 2020

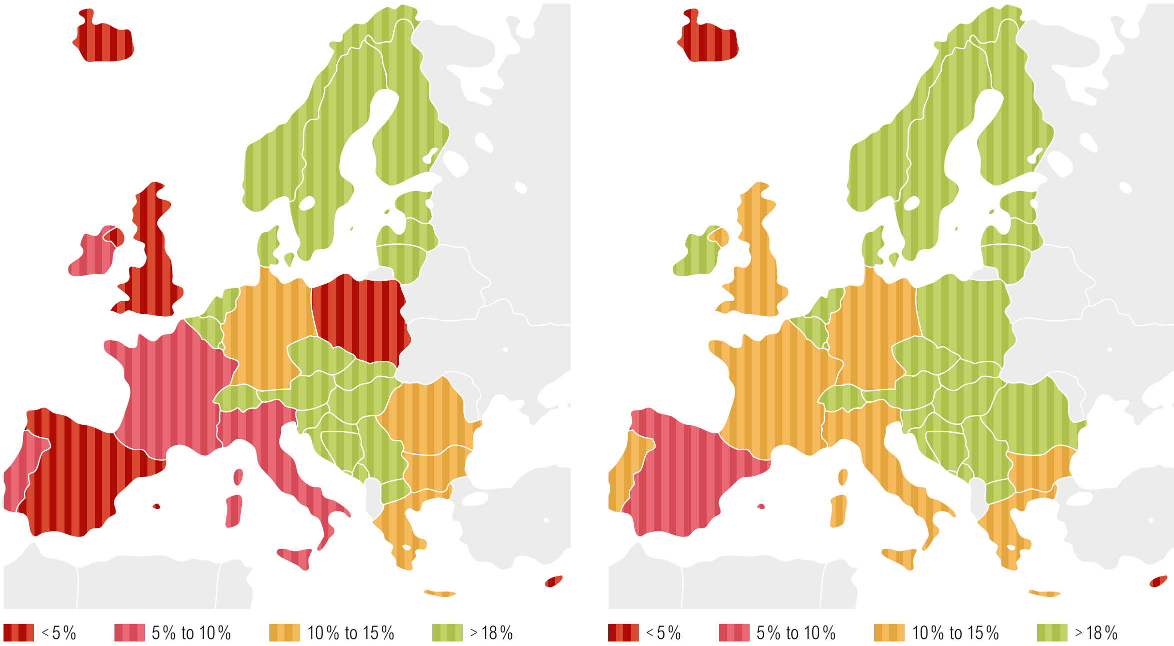
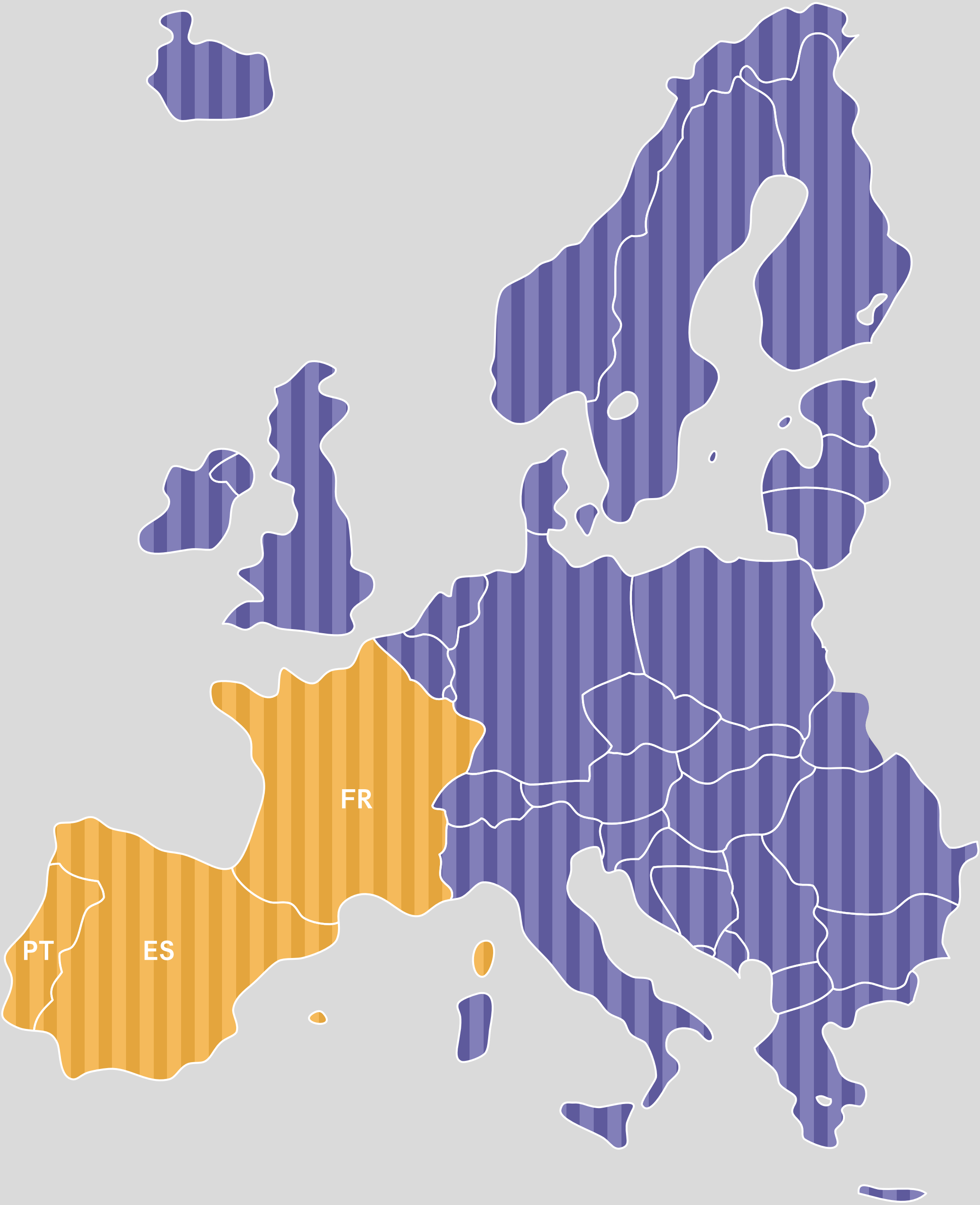


Figure 26:
Interconnection ratio (import capacity / net generation capacity) in 2011 (left) and 2020 (right)

The interconnection ratio computed for the present situation in chapter 6 can be reassessed in 2020, assuming all projects of pan-European significance are implemented. The assessment depicted in Figure 26 shows improvements of the interconnection ratio all around Europe and shows that in spite of that increase also in Spain up to a value around 6%, it will be the only continental country in 2020 below the 10% objective.

9 Environmental Assessment



9.1 Overview

From the European point of view, the environmental protection requirements are taken into account under directive 2001/42/EC on the assessment of the effects of certain plans and programs on the environment.

In Spain and Portugal, the directive 2001/42/EC has been incorporated into the national laws with the approval of the law 9/2006 and the Decree-Law 232/2007, respectively. In both cases, the environmental assessment is carried out as an integrated procedure, along with the national network planning process, and using the Strategic Environmental Assessment (SEA) approach. The key goals of the SEA are to identify, describe and assess the relevant environmental and sustainability issues necessary to guide the technical strategic options that support the decision on the solutions for network evolution in the National Development Plans. The SEA, as required by law, is submitted to a public consultation.

In France, there is not an SEA associated with a National Development Plan. However, an environmental impact assessment at project level (new lines, substations…) has been a common practice in the French case for many years. This process gives evidence of the environmental concerns, such as protected areas, flora, fauna, etc., when planning new projects.

9.2 Environmental Indicators

In the following paragraphs, main environmental indicators are shown:

9.2.1 Impact of the Regional Investment Plan in Terms of KM of New Line

In order to minimize the impact of the new investments required from the environmental point of view, in the proposal of the projects in this plan a big effort has been made to use existing infrastructures; 25 % of the total km of all AC projects are uprated lines (referred either to a voltage level increase or to a capacity increase by retightening, elevation or a change of conductor). The detail in km of new as well as uprated lines in the CSW region is shown in the following figures:

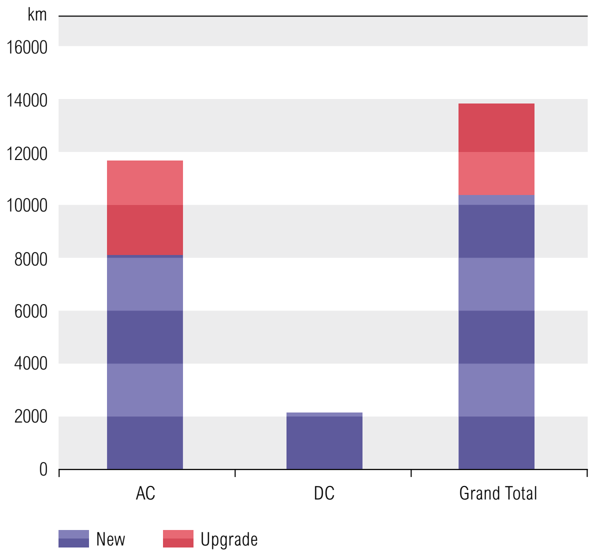
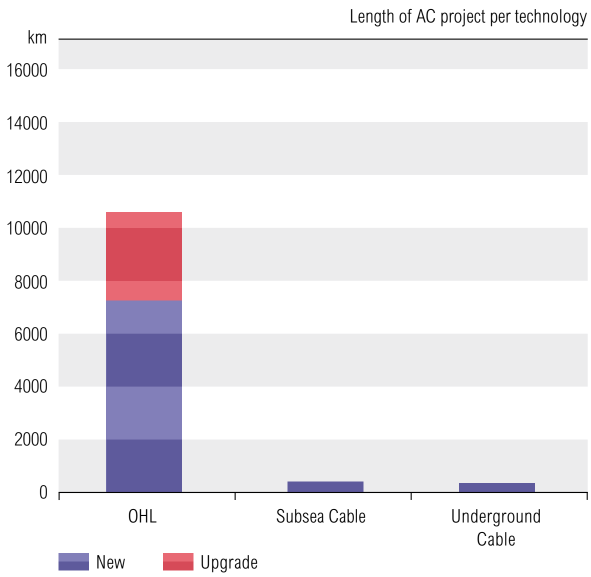


Figure 27:
Statistics of new projects in the perimeter of RG Continental South West [km]



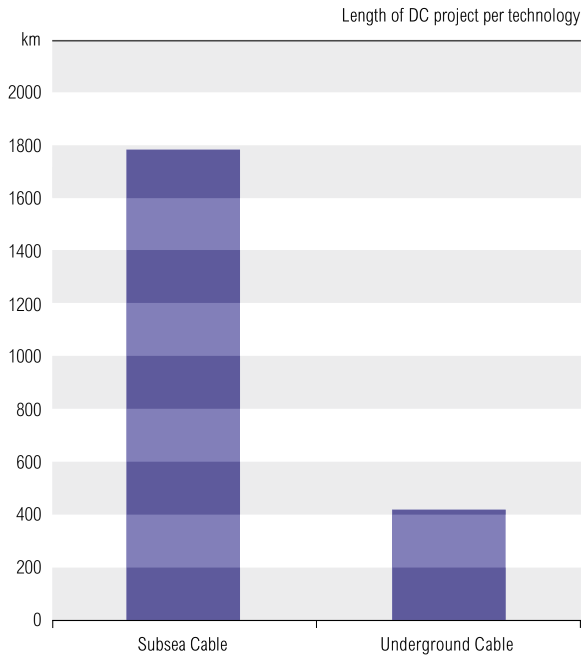


Figure 28:
Technology of new projects in the perimeter of RG Continental South West [km]

9.2.2 CO_2 Emission Savings

As all the investments included in the RgIP mean a better utilization of generation units with the integration of a major quantity of RES, a reduction in CO_2 emissions is expected thanks to the projects of European significance. The reduction has been quantified for all the projects of the CSW region (without considering those associated with French interconnections with the rest of Europe) in 30 Mton/y of CO_2. In terms of energy, this value is equivalent (according to the International Energy Agency document "CO_2 emissions from fuel combustion highlights 2011") to 84000 GWh with an average generation mix.

With more detail, CO_2 emission savings for the mid-term as well as long-term interconnection projects for Scenario EU2020 as well as Scenario B are shown in the following figure.

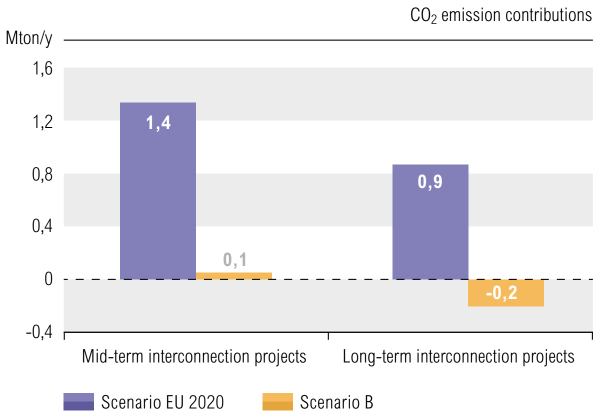


Figure 29:
CO_2 emission savings in Europe caused by interconnection projects in the region [Mton/y]

Interconnection projects in Scenario EU2020 decrease the CO_2 emissions from the whole European point of view; nevertheless, this reduction in CO_2 emissions is much lower, and even for the long-term interconnection projects it means an increase, in case of Scenario B, as in this scenario, cheaper coal generation has replaced gas generation in the whole of Europe, mainly in Central Europe.

9.2.3 Increasing Midterm and Long-Term Scenarios: Load and RES Growth versus new KM of Lines

In the next figure, a comparison between the load growth, the RES increase (reference document is SOAF 2011 for both), and the grid expansion in terms of length of new lines is shown. According to this figure, the main driver for pan-European projects is RES integration.

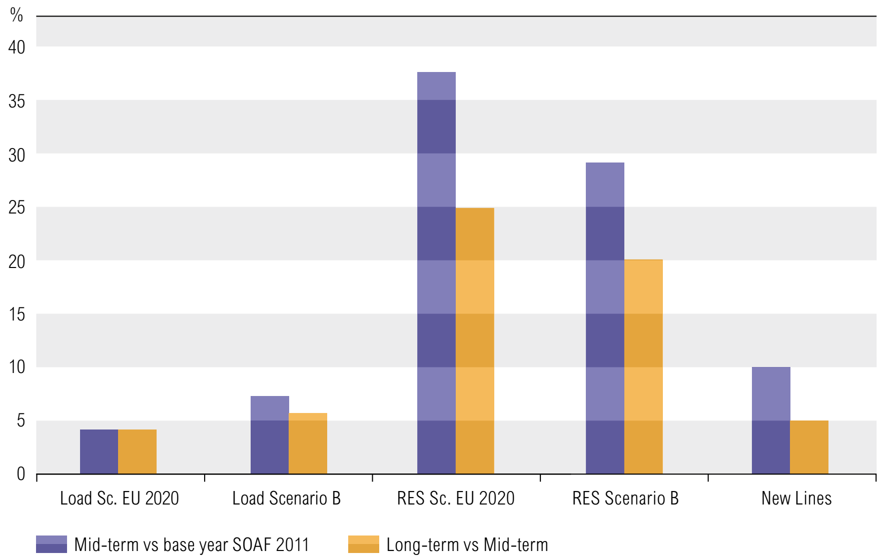
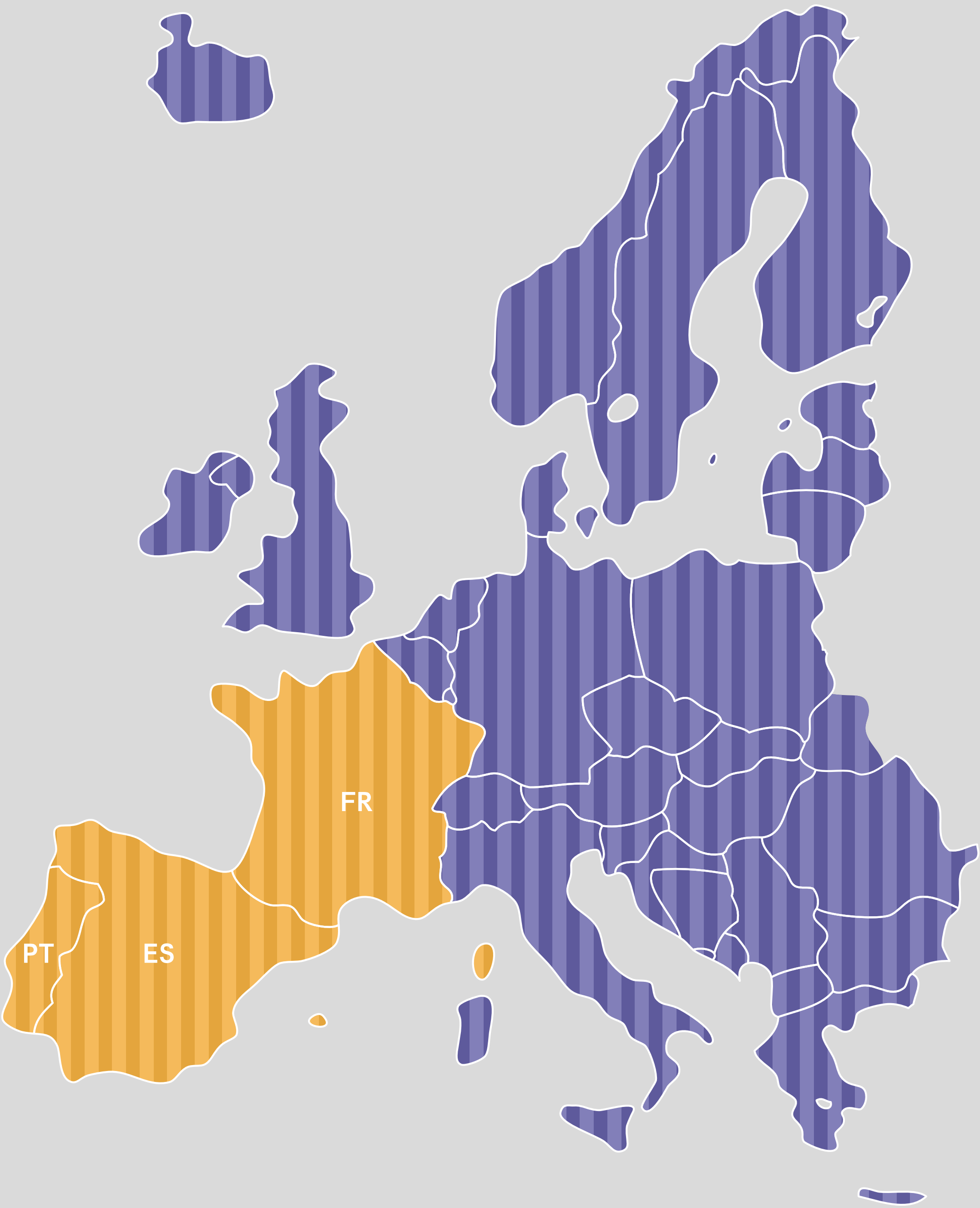


Figure 30:
Increasing in Load, RES and New Lines in the perimeter of CSW region (%)

10 Assessment of Resilience



High voltage grid investments are expensive infrastructure projects, with a long lifetime (more than 40 years), setting precedence for coming projects and requiring years to be carried out. Both in order to avoid stranded costs and to meet grid users' expectations on time with appropriate solutions, TSOs assess the resilience of their investment projects. This assessment is performed in seven major directions:

- Ability of the system to face uncertain future conditions and deliver the expected quality: this is why TSOs use scenarios;
- Ability of the system to cope with severe, adverse conditions (climatic conditions as well as severe contingencies);
- Ability of the system to face very different configurations: even in a given scenario, generation and demand patterns as well as cross-border flows vary according to seasonal or daily profiles, but also to random phenomena;
- Economic viability: investments should prove useful and profitable in as many scenarios as possible, bringing more benefits to the European population than they cost;
- Flexibility and smart grids: most advantage should be taken of the existing grid, using traditional and unconventional control systems to adapt the grid and minimize the new routes;
- Ability to integrate new technologies: as long-lasting expensive infrastructure components, investments should take advantage of technological evolution so as to optimize their performance and ensure they do not become obsolete in the course of their expected lifetime;
- Compatibility with longer-run challenges looking ahead until 2050: present projects must be appropriate steps to meet future challenges and fit into wider and longer-term perspectives.

Methodologies and criteria developed by TSOs focus on risk assessment and mitigation. They assess the resilience of the system for whatever situation it may realistically have to face: high/low demand growth, different generation dispatch and exchange patterns, adverse climatic conditions, severe contingencies, etc.

Ability of the system to face uncertain future conditions

The planning process begins with the definition of scenarios, depicting uncertainties on future development on both the generation and demand sides, as well as a number of alternative grid operational conditions and development states that have to be considered to ensure the secure and efficient operation of the transmission grid in the future. In the present document, Scenario B and Scenario EU2020 have been considered. In addition, these scenarios are regularly updated in the course of the planning process and adapted in case of sudden change (e.g. nuclear phase out).

Ability of the system to face very different configurations

In order to check the behavior of the planned grid against a large number of possible conditions, a number of cases are built taking into account forecasted future demand, a mix of generating units and cross-border power exchange patterns. As already presented in 4.3, six representative planning cases based on market studies results have been provided to TSOs in order for them to conduct the relevant network studies. Not only the most frequent, but also extreme cases, as shown in Figure 31 below, are investigated.

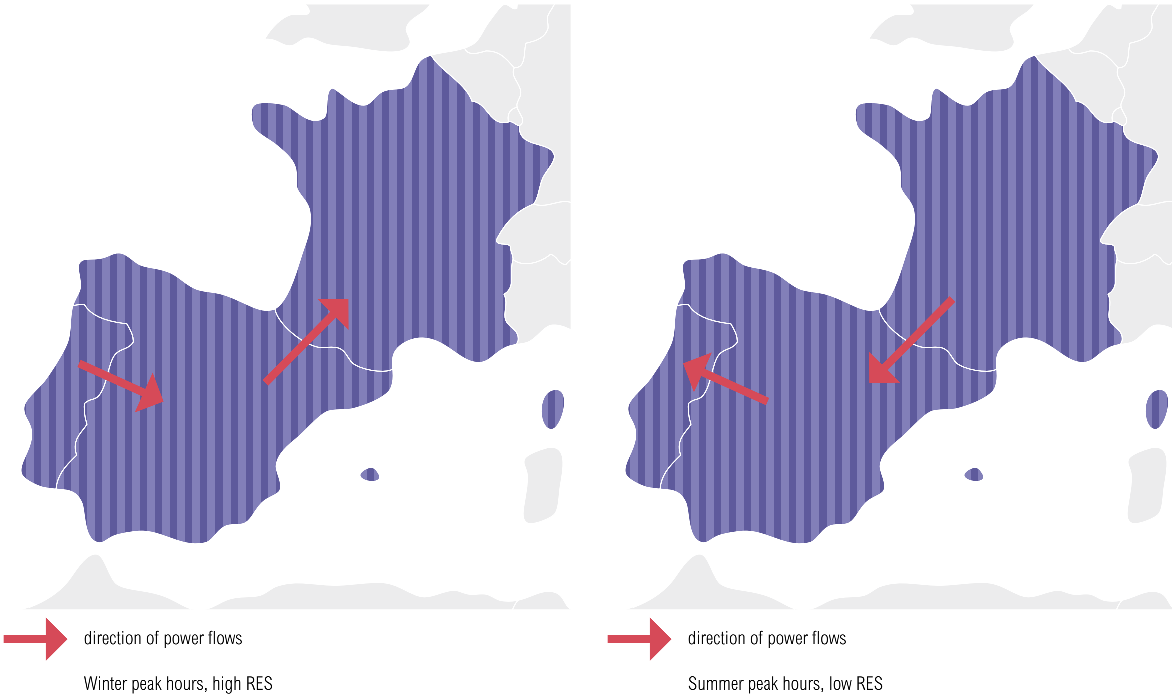


Figure 31:
Extreme cases to be considered for resilience assessment

Ability of the system to cope with severe, adverse conditions

In addition, extreme conditions (e.g. ice, storms) are considered when designing the assets (towers, substations) and also when deciding the structure of the transmission grid (e.g. in France, in case of storms, at least one infeed must remain available to each EHV transmission substation and in case of loss of load, the supply should be restored within a given time).

Economic viability

Benefit analyses are regularly updated against different scenarios all along the planning phase in order to assess the economic soundness of the planned grid investment. Thus, the risk of stranded cost should be minimized.

Flexibility and smart grids

Transmission grids are equipped with an SPS (Special Protection Scheme) that allows ensuring the safe operation of the grid in adverse conditions. In addition, control systems that allow changing the network topology and transmitting signals to grid users (generators, consumers) are available, making congestion management possible in stressed situations. An example is the Spanish Renewable Control Centre (CECRE) handled by the Spanish TSO. In addition, TSOs make higher use of systems for monitoring the temperature on the lines, allowing better use of the existing assets by having a more accurate assessment of grid thermal capacities, and also fault location systems in cables, etc. All these issues require an investment in IT systems, which will allow the transmission network to be smarter than today.

Phase Shifter Transformers (PST) have been used for many years in order to control the power flows and to manage congestion. Such devices already exist in RG CSW, for example, in Pragnères, at the France-Spain border, in order to limit the flow on a 220-kV line in case of contingency; therefore, the line can be operated closed, which contributes to cross-border flows. Others examples of PST use are in Portugal at Pedralva and Falagueira substations, to control distribution of flows between the 400 and 150 kV, and another in the 220 kV Arkale substation, near the French-Spanish border (this will secure the local load on both sides of the border, and will increase exchange capacity). Another PST project in the area of Madrid is also considered.

In addition, HVDC systems become more frequent, not only for subsea links or connections of offshore generation or non-synchronous systems, but are also inserted within the synchronous AC grid. Flows on these facilities are fully controllable and the margins left by the market could be used in operation for congestion mitigation.

Two cross-border HVDC projects are foreseen at the French-Spanish border; in addition, an HVDC subsea cable is planned between the French Provence and the Languedoc region in order to cope with flows either East-to-West (from the generating areas of the Rhône Valley and Fos area toward South-Western France and the Iberian peninsula) or West-to-East from the Iberian peninsula to the PACA region.

Lastly, grid development strategies are developed in a modular scheme (step by step implementation), which gives opportunities for adapting or even cancelling the projects according to external conditions or economic framework evolution.

Ability to integrate new technologies

The ongoing technology progression has led to new techniques that may have the potential to be employed in the future transmission grid. However, none of these new techniques are a universal solution. Each project has to be considered in a dedicated study assessing the best fitting technologies, cost effective and without disturbance to the reliability of the system.

TSOs use new technologies where appropriate, for instance, Voltage Source Converter technology for some HVDC projects (France-Spain interconnections, and internal projects, like "Midi-Provence" already mentioned); although it is not as spread as classic Line Commutated Converter technology, it gives higher performance and possibilities.

In order to test R&D products and to develop some feedback before developing the industrial use, TSOs also develop demonstrators, such as the FACTS planned in Spain: CRSS (Combination of Reactors Switch by Steps) in the Tudela-Magallon 220 kV line, and the SSSC (Static Synchronous Series Compensator) in Torres del Segre – Mequinenza 220 kV, resulting from the TWENTIES European project and other R&D projects.

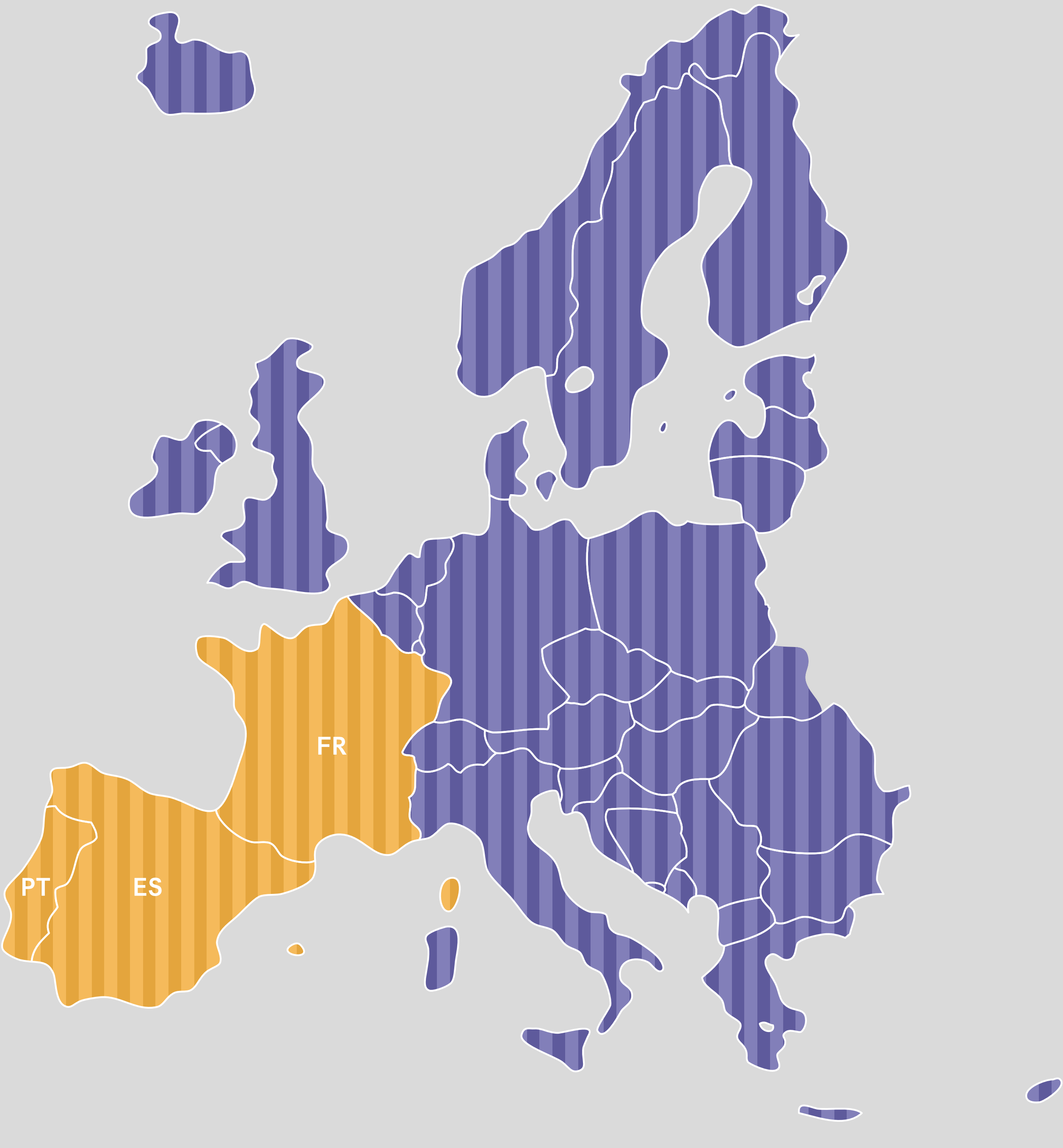
High Temperature conductors, despite being quite common in France, are a new technology in the Iberian Peninsula networks that are starting to be considered.

Compatibility with longer-run challenges

As the lifetime of grid assets is around 40 years or more, TSOs develop long-term visions and plan grid development as the first steps toward a long-term future. Projects that are launched now should not jeopardize the expected grid development in the longer run. An example of such a long-term issue is the increasing flows to and from northern Africa.

Reciprocally, long-term grid development is considered on top of existing and planned assets. Overall consistency with long-term issues will be checked in the ongoing Electricity Highways study for the 2050 time horizon.

11 Summary and Conclusions



This Regional Investment Plan aims to describe the investment needs and associated planned projects for the next 10 years in the Continental South West (CSW) region, which covers Portugal, Spain and France, located in a peripheral area or in Europe. It assesses cross-border and internal projects, of regional and/or European significance, which allow reaching the European targets, with particular regard to the Security of Supply (SoS), the development of the Internal Electricity Market (IEM) and the integration of Renewable Energy Sources (RES). Moreover, the RgIP provides information for monitoring the progress of TYNDP 2010 projects.

This Regional Investment Plan has been founded on the most complete regionwide market and grid analysis ever coordinated at the ENTSO-E level. A pilot market study in this region was presented in TYNDP 2010 as a best practice exercise, although it was not based on a European database, procedures or methodologies, as in TYNDP 2012. On the other hand, bilateral analyses on interconnection development and NTC assessment have been performed for years, although without a real European approach as this time.

Two main scenarios were developed for assessment in the analysis. Scenario EU2020 represents the countries' NREAP targets (topdown scenario), while Scenario B represents the best estimation of TSOs, according to their expertise and the information provided by stakeholders. In the CSW region, Scenario EU2020 considers a load lower by 7% than Scenario B, due to energy efficiency measures. RES plans are similar in the Iberian Peninsula in both scenarios, but not in France where they are significantly lower in Scenario B. Both scenarios envisage predominance of nuclear and renewable generation in the region's generation portfolio in 2020, complemented by gas-fired plants in Scenario EU2020 and by coal plants in Scenario B. The analysis also took account of the nuclear phase out strategy in Germany, which emerged during the course of the studies, by consideration of sensitivity on Scenario B.

Market Studies performed showed that the CSW region would always be an exporting region to the rest of Europe (with very rare hourly exceptions importing), with around 80 to 110 TWh per annum. Within CSW, France will be a big exporter today, and Spain and Portugal will experience higher exchange volumes both in import and export, but which will result globally rather balanced.

One of the main objectives of the market studies in the CSW region was to assess the impact of the new planned interconnection projects in the system (Northern and Southern interconnections between Spain and Portugal, and Eastern and Western interconnections between France and Spain). Interconnections within the region allow higher and more volatile exchanges of energy in both directions, and provide an important social economic welfare to the system that compensates enough of their costs, especially French-Spanish reinforcements. In addition, proposed interconnections reduce around 2.3 Mtons CO_2/y in the whole of Europe in Scenario EU2020, while the effect is almost neutral in Scenario B. Scenario EU2020 is marked by higher spillages, higher congestions and higher exchanges between countries than Scenario B, and so cross-border reinforcements are more economically profitable in Scenario EU2020. That shows the big impact of CO_2 cost in the energy system.

The Nuclear phase out implies higher imports of Germany (40 TWh), which are smoothly dispatched between many countries. This has a low impact in the CSW region, with a total increase of the CSW production and exports by 5 TWh, slightly affecting congestion and energy flows, and slightly reducing the benefits of interconnection projects in the region.

The generation adequacy indicators, which inform about the risk of security of supply due to insufficient available generation, are generally low or very low in all scenarios, and fulfill the different national criteria.

The regional analysis shows that there are significant transmission needs arising between 2012 and 2022. These needs are driven by a number of different factors. One main driver of transmission network development is the connection and evacuation of new generation, mainly intermittent energy sources. The CSW region expects a deep penetration of RES in 2020. Nowadays, there is around 41 GW of RES installed in the region, and by 2020 around 86-100 GW of new RES will be installed. The ambitious renewable plans in Spain and Portugal imply an important investment in transmission infrastructure. The reason is that these new Renewable Energy Sources (mainly wind, hydro -with and without a pumping station-, and solar) are usually located in remote areas, without existent connection, or with a poor connection, to the transmission network. In addition, the evacuation of new generation will require more flexible conventional generation and transmission grids, and will create bulk power flows that can cause congestion in the existing network and require additional grid capacity. Renewable plans in the Iberian Peninsula that started to be set several years ago take advantage of the huge potential of wind and solar energy. Offshore is not yet an important issue, because there is enough potential onshore, and the continental platform is sloping, which does not favor offshore installation. However, some areas in the English Channel and the Atlantic Ocean near the French coast already consider in the long term significant quantities of offshore wind.

Another main driver in the region is an insufficient cross-border capacity that causes structural market congestion between price zones, especially between Spain and France. Interconnection ratio for Spain is today around 4%, far away from the objective set by the Barcelona EU Council in 2002. In fact, exchange capacity is so low compared to the size of the Iberian system that it is usually considered as an electric island. Therefore, full integration within the Iberian Electricity Market (MIBEL) and Integration of MIBEL with continental Europe is one of the main key issues for the region. The forecasted demand growth, while modest, gives rise to security of supply issues in certain areas or big cities that will require transmission investment.

This regional investment plan presents 29 projects necessary to meet the medium- and long-term needs of the region presented above and that fulfill the criteria of projects of European significance. However, national development plans include much more projects of local importance. About 78% of the investment items were already present in the TYNDP 2010 and are hence confirmed, while 22% are new in this plan due to better definition of the projects or new long-term needs. These figures show both the robustness of TYNDP 2010, and that the TYNDP is a living process.

About 33 % of those investments already included in TYNDP 2010 maintain the expected commissioning date, although some of them have some reshuffling; 28 % will be commissioned by the end of 2012, 34 % have some delay and around 3% are ahead of the former schedule.

The total cost of this Regional Investment Plan in the CSW region is estimated at € 14.7 billion. This expenditure splits rather equally between the two 5-year subperiods, the investment being a bit higher in the long term. Midterm includes a lot of projects in the Iberian Peninsula that are planned mainly to integrate and evacuate the RES plans set already several years ago, and long term includes less but more expensive, especially in France, as many of them projects include HVDC technology.

The investment plan proposed sums up 14000 km, with 84% of them overhead lines in AC. It includes 4 new cross-border lines within the region, 5 interconnection projects with the rest of Europe, and 20 internal projects. The plan shows a big effort to make the best of existing assets in order to minimize grid extension and avoid creating new routes, as 25% of the AC projects are upgrades, uprates or change of conductor, including High Temperature conductors. Moreover, FACTS and Phase Shifter Transformers are considered to control active power flows in some parts of the network. In addition, new and efficient but usually expensive technologies are considered in certain project definitions, such as VSC in HVDC.

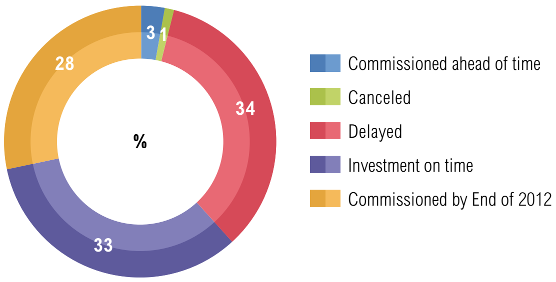


Figure 32:
TYNDP 2010 monitoring – Regional Group Continental South West

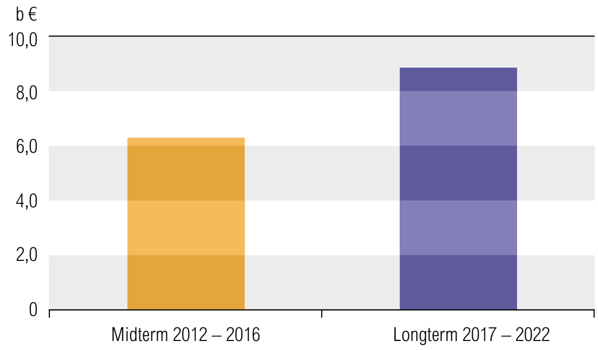


Figure 33:
Costs of CSWRG Projects

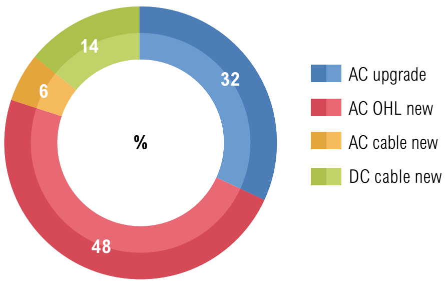


Figure 34:
Summary of projects by technology AC or DC and use of existing lines

Most of the new DC projects are subsea cables, while the rest are underground cables. Regarding AC, 93% of the investment items are overhead lines, while 3% are subsea AC lines and only 3% are AC underground cables at a medium voltage level.

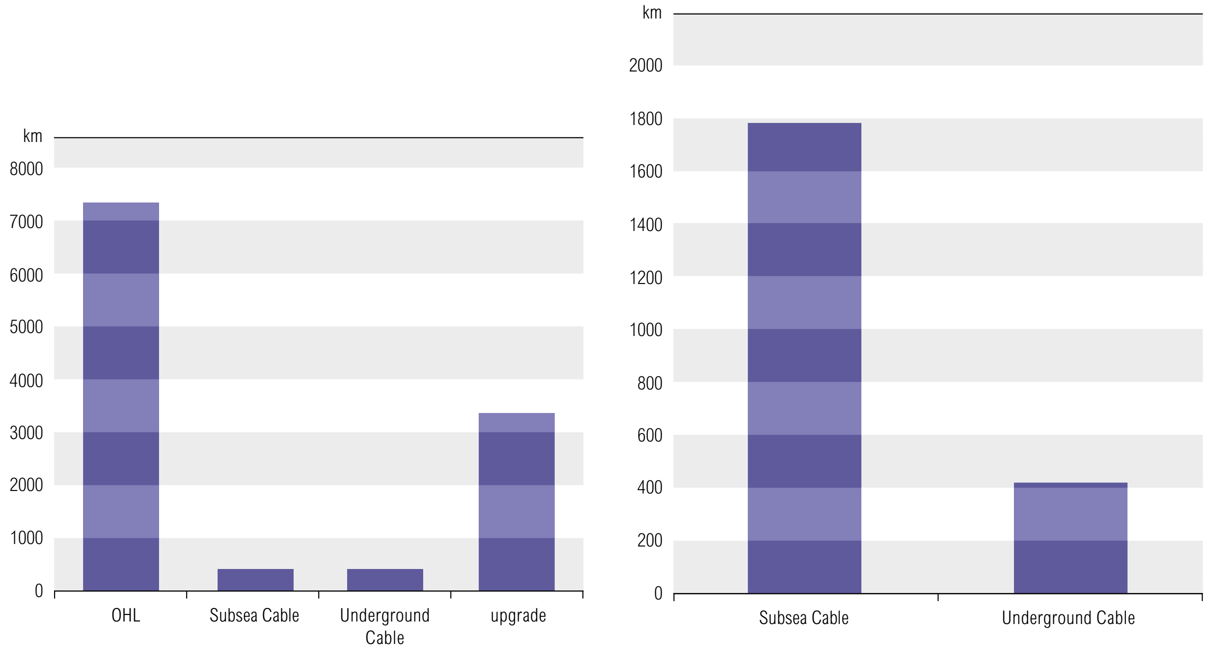


Figure 35:
Length of AC (left) and DC (right) projects by type

The projects have been assessed with a set of indicators that evaluate their contribution to the social economic welfare, renewable integration, security of supply, variation of losses, CO_2 emissions, compliance with network codes, resilience and flexibility. The indicators have generally three stages according to a high benefit, medium or low/no benefit and are generally represented with a dark, medium and light green/white, respectively.

The planned projects contribute highly to the European policy and the 3x20 objectives. About 72% of the projects contribute to integrating RES, either because direct connection of RES is at stake, or because the network section or corridor is a keyhole between RES and load areas. Projects of EU significance integrate about 30 GW of new RES in the region, which is more than half of the expected RES development in the region (45-57 GW). It is worth mentioning that not all the National Master Plans are included in RgIP, and therefore not all Renewable National Plans are attached to projects of EU significance, but many projects of national relevance are essential for national RES objectives. Security of Supply is enhanced with projects of EU significance. However, local investments of national relevance are generally required, in addition to the projects included in this plan, in order to secure supply.

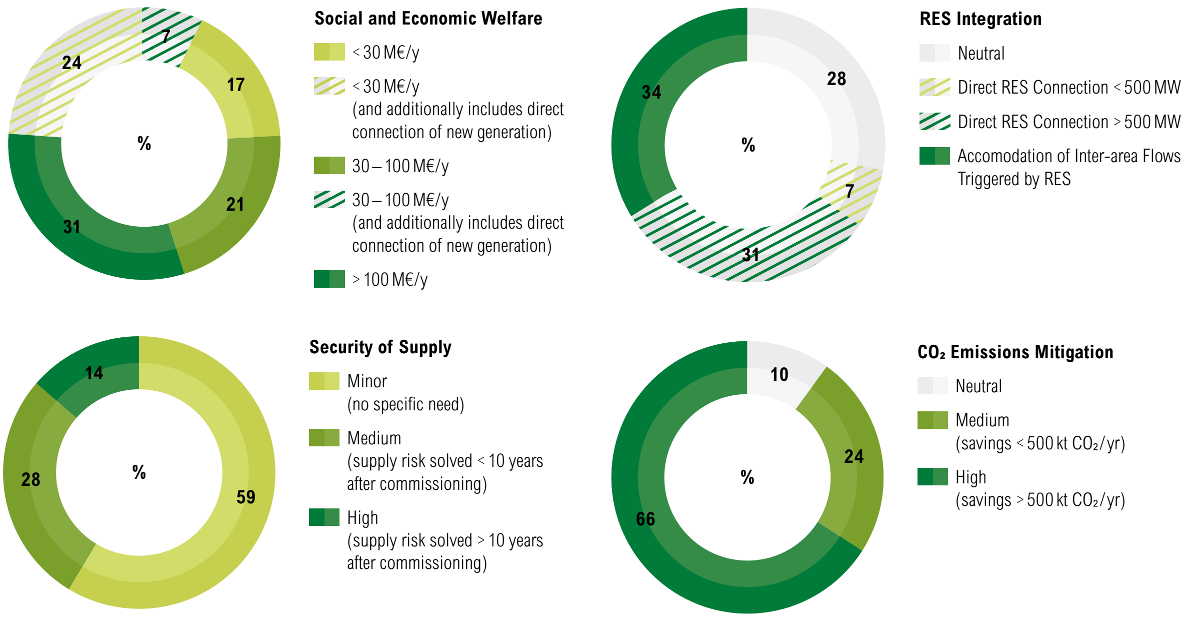


Figure 36:
Contribution to EU energy policy of CSW projects

On the other hand, more than 83% of the projects contribute importantly to increasing the social economic welfare, as they allow the production with more sustainable and cheaper power plants, which means variable generation cost savings (and CO_2 savings) and therefore, they contribute to the Internal Electricity Market.

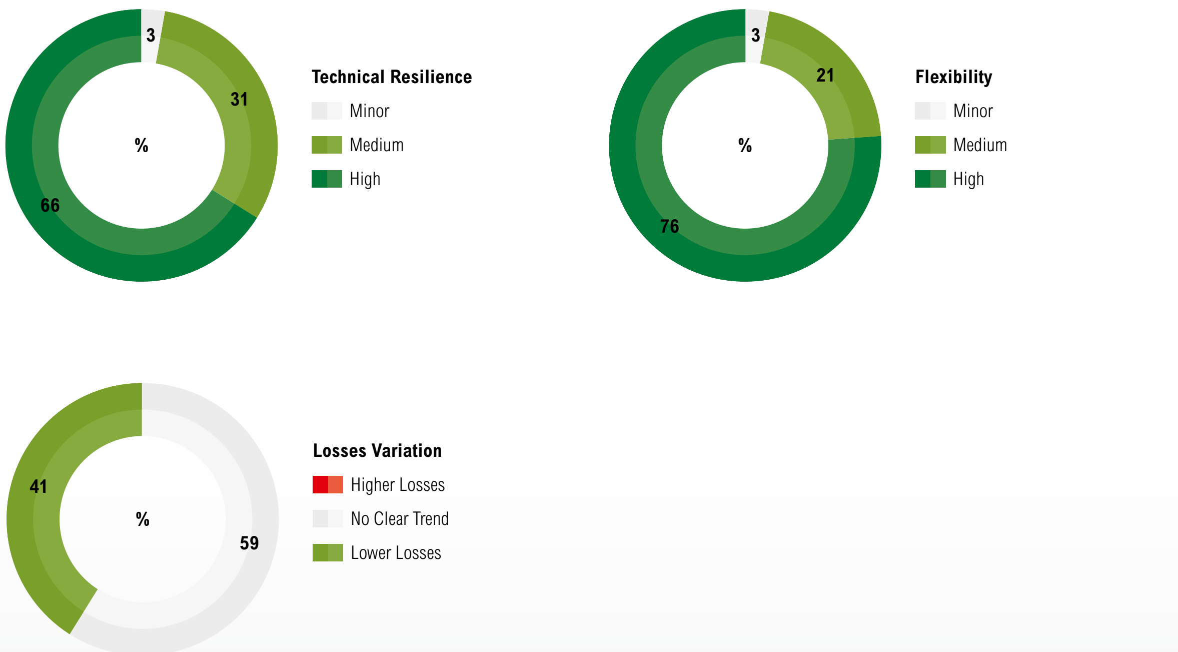


Figure 37:
Technical assessment of CSW projects

Projects' technical resilience and flexibility are at the hand of the TSOs and hence all the projects display high technical performances. On the other hand, losses, for instance, depend on exogenous factors, and projects in this respect are diverse: 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.

52% of the proposed projects have a high probability of being commissioned at the planned date, 48% are realistic but have some uncertainty. None of the projects are considered to affect heavily to the environment or to social opposition. Prefeasibility analysis has been performed in the National Development Plans framework.

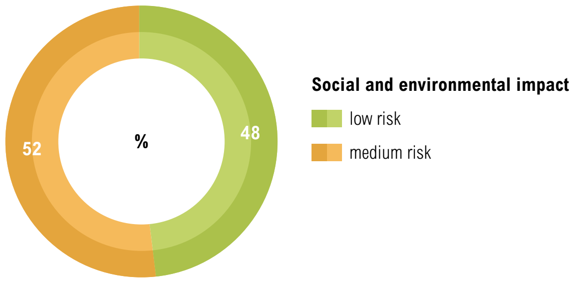


Figure 38:
Social and environmental impact of CSW projects

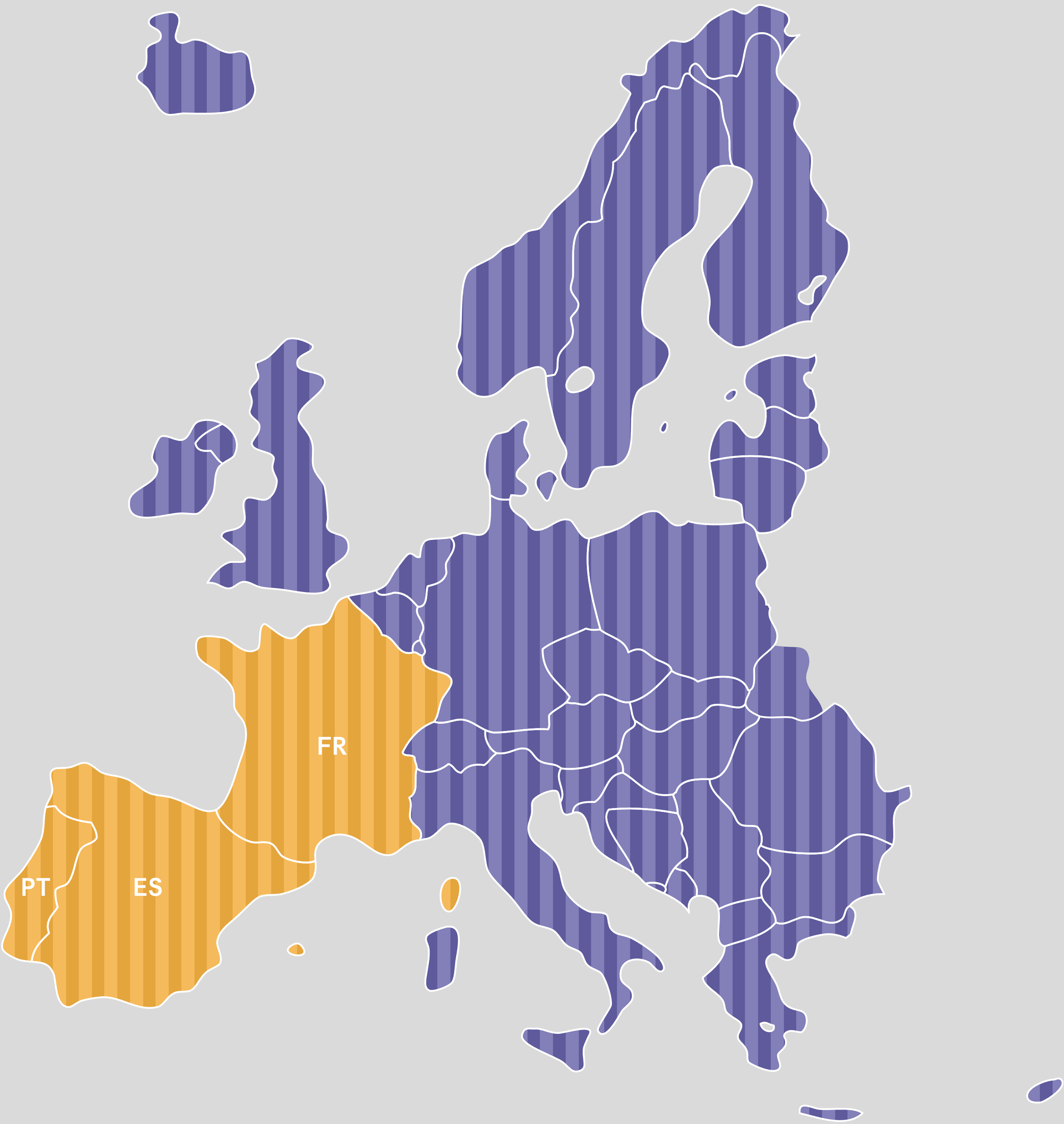
The analysis undertaken shows that completion of the identified projects will provide sufficient transmission adequacy to meet the needs presented by the 2020 scenarios, except for the French-Spanish border, which is expected to face congestions of around 50% in 2020, even with the Eastern and Western planned reinforcements. In addition, Spain will have in 2020 an interconnection ratio of 6%, still far away from the objective of 10% set in the Barcelona EC Council. Additional capacity between France and Spain would allow increasing this interconnection ratio, and to set away the "electric island" consideration of the Iberian Peninsula. Additional studies, assessing costs and benefits, are needed to confirm this need and to define a potential feasible and profitable solution.

It should be noted however that those long-term scenarios are likely to change over the course of the coming years and, in some cases, further investments will be required. Updates to future situations can be considered in future plans and TYNDP is updated every 2 years.

Proposed projects in this RgIP, as projects of pan-European significance, intend to be an input for the list of Projects of Common Interest to be performed in the North-South West Initiative of the recent EC Energy Infrastructure Package (EIP). For TSOs, the main priority in the region is the interconnection development, and especially the reinforcement of the France-Spain border, which is the main bottleneck in both scenarios. The valuation of projects and the integrated realization of both the pan-European and regional report are also intended to efficiently support the selection of Projects of Common Interest in 2012.

It is worthy to mention that transmission planning is a living process, and that an updated RgIP will be published every two years. Scenarios in the SOAF are released every year to accommodate every required update. ENTSO-E now expects stakeholders' feedback to further develop the methodologies to deliver future TYNDP. The preparation of the TYNDP 2014 and RgIP 2014 has already started!

12 Appendices



12.1 Appendix 1: Table of Projects

The following table shows some synthetic information about the projects mentioned in the main body of the document. It gives a synthetic description of each project with some factual information as well as the expected project impacts and commissioning information.

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 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 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 table of projects below.

Investment items, which were present in the TYNDP 2010, have the same index in the TYNDP 2012 package. Indices of investment 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.

Projects develop grid transfer capability across the boundaries, as displayed on the following map (see Figure 39). The numbers attached to every boundary on the following map correspond to the projects' indices, relieving the constraints across that boundary:

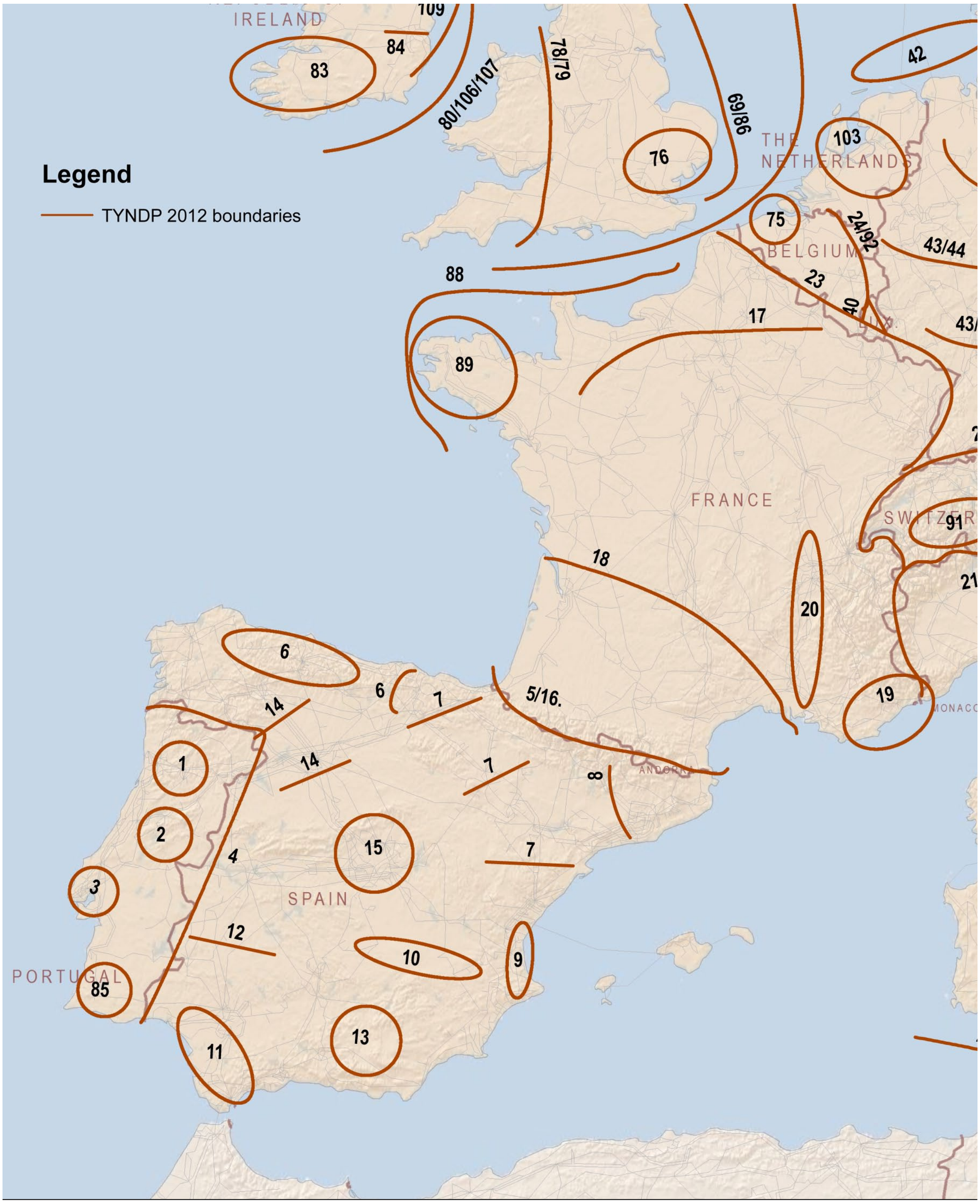


Figure 39:
Projects-boundaries correspondence

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

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.[1)]
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.

More information on the methodology on how to calculate the indicators corresponding to the columns 6 – 15 can be found in appendix 3 of the TYNDP report.

[1)] This date highly depends of the duration of the permitting process, which TSOs do not master. The date given here is the most likely one, according to present status and to TSO's experience in conducting projects. The date proposed for reinforcements at a very early stage, the consistency of which is still uncertain, is likely to be further refined by the next 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 environ-mental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
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							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 authoriza-tion for connection.
	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.											planned	2017	Adjustment resulting from the new date of the hydro power plant.		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.
	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.											design & permitting	2014 / 2015	Delays due to authorization process.		
	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.											design & permitting	2015 / 2016	Progresses as planned.		
	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.											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.	
	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.											design & permitting	2013	Delays due to authorization process.	This investment allows the connection of the RES (mainly wind) and new load in the area.	
	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 con-structed (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										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).
	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											design & permitting	2015 / 2016	Adjustment resulting from the new date of the renewables project.		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 interconnection with Spain (Falagueira – Cedillo).
	2.10	Falagueira (PT)	Pego (PT)	New 40 km double circuit 400 + 150 kV OHL substituting for an existing 150 kV line.											design & permitting	2014	Progresses as planned.		
	2.A2	V. Chã B – Guarda (PT)		New double circuit 400 kV OHL Vila Chã B-Guarda (55 km)											planned	2020	New investment in TYNDP. This investment supports the integration of new hydro and wind power plant in northern Portugal.		

Table of projects – Regional Group Continental South West

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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
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							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.
	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.											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.		
	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.											under construction	2012	Progresses as planned.		
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										partly completed, 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".
	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)											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.		
	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)											design & permitting	2014	Progresses as planned. Changes in route and connecting point in Spain due to environmental constraints.		
	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											under construction	2013	Progress as planned, although there are difficulties to find a suitable period for a planned outage to carry on the project.		
	4.21	JM Oriol (ES)	Arenales – Caceres (ES)	New 220 kV JM Oriol – Arenales, and new Arenales substation.											design & permitting	2014	Delays due to authorization process.		

Table of projects – Regional Group Continental South West

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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
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							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.
	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.											design & permitting	2014	Delays due to authorization process.		
	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.											partly under construction, design & permitting	2014	Progresses as planned.		
	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.											under construction	2011 – 2013	Bescano-Vic / Senmenat 400 kV commissioned. Difficulties in the authorization process of the section Bescano – Sta Llogaia 400 kV		
	5.46	Baixas (FR)	Gaudière (FR)	Reconductoring of existing 70 km double circuit 400 kV OHL to increase its capacity.											design & permitting	end 2013	Progresses as planned.		
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.	2,000 – 4,200 MW										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.
	6.22	Soto – Grado – Gozon-Reboria (ES)	Costaverde – Sama (ES)	– 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.											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.		
	6.22	Soto (ES)	Penagos (ES)	– New double circuit Gueñes – Ichaso OHL.											commissioned	commissioned	commissioned		
	6.22	Sama (ES)	Velilla (ES)	– New double circuit Gozón – Reboria – Sama – Lada 400 kV OHL.											design & permitting	2015	Delays due to authorization process.		
	6.22	Lada (ES)	Robla (ES												commissioned	commissioned	commissioned		
	6.22	Penagos / Aguayo (ES)	Abanto (ES)	– 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.											partly commissioned, design & permitting	2012	From Penagos / Aguayo to Udalla commissioned. The connection from Udalla to Abanto has delays in authorisation process.		
	6.22	Zierbena (ES)	Abanto (ES)	– 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.											commissioned	commissioned	commissioned		
	6.22	Abanto / Gueñes (ES)	Ichaso (ES)												design & permitting	2016	Delays due to authorization process.		
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										partly completed, 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 sub-stitutes 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.
	7.23	La Serna (ES)	Magallón (ES)	New double circuit La Serna – Magallón 400 kV OHL.											design & permitting	2014	Delays due to authorization process.		
	7.A4	Tudela (ES)	Magallón (ES)	New CCRS (Combination of Reactors step by step) in Magalló 220 kV.											design & permitting	2013	New investment in the TYNDP, as it is required to ensure the GTC increase for the entire project.		
	7.A5	Dicastillo (ES)	Moncayo (ES)	New double circuit Dicastillo – El Sequero – Santa Engracia – Magaña – Moncayo 220 kV OHL.											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.		
	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.											design & permitting	2013 – 2014	New investment in the TYNDP. Difficulties in the authorization process.		

Table of projects – Regional Group Continental South West

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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	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										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.
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										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.
	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.											design & permitting	2015	Delays due to authorization process.		
	8.A6	Torres del Segre (ES)	Mequinenza (ES)	New SSSC (Static Synchronous Series Compensator) in Torres del Segre / Mequinenza 220 kV.											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.		
	8.A7	Mangraners (ES)	Begues (ES)	New Double circuit Mangraners – Espluga – Begues and Mangraners – Juneda – Secuita – Perafort – Begues 220 kV.											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.		
	8.A8	Espluga (ES)	Penedes (ES)	Uprate 116 km single circuit 220 kV OHL.											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.		
	8.A9	Garraf (ES)	Vandellos (ES)	Uprate 108 km single circuit 400 kV OHL.											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.		
	8.A10	Isona (ES)	Calders (ES)	Uprate 79 km single circuit 400 kV OHL.											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.		
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							design & permitting	2017	Delays due to authorization process.		Security of supply of the Costablanca area in Levante Mediterranean coast.
	9.26	Catadau (ES)	Jijona (ES)	220 kV lines from Catadau to Jijona in the coast of Costablanca using partially the 132 kV lines											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.		
10	10.28	Cofrentes (ES)	Ayora (ES)	New single circuit Cofrentes – Ayora 400 kV OHL.	3,380 – 4,270 MW										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.
	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.											design & permitting	2012 – 2013	Progresses globally as planned.		
	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.											design & permitting	2016	Postponed in new National Master Plan as need is not imminent.		
	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.											design & permitting	2013	Progresses as planned.		

Table of projects – Regional Group Continental South West

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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
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										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.
	11.A11	Cartuja – Pto. Sta Maria (ES)	Facinas (ES)	New 52 km single circuit 220 kV OHL Puerto Sta Maria – Pto. Real – Parralejo – Facinas.											design & permitting	2012 / 2013	New investment in the TYNDP, contributing also to evacuate the generation in the coast of Cadiz.		
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										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.
	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.											design & permitting	2012	Alcuescar substation substited by Carmonita. Progresses as planned otherwise.		
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										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.
	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.											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.		
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										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.
	14.34	Tordesillas (ES)	La Cereal / Moraleja (ES)	New double circuit Tordesillas – Segovia – Galapagar 400 kV OHL.											under construction	2012 – 2013	Partly commissioned. Progresses as planned.		
	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.											design & permitting	2013 – 2015	Delays due to authorization process.		
	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.											design & permitting	2015	Delays due to authorization process.		
	14.34	Fuencarral (ES)	Galapagar (ES)	Uprate Galapagar – Fuencarral 400 kV.											design & permitting	2014	New investment in TYNDP.		
	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.											partly under construction, design & permitting	2018	Uprate fostered because of necessity. New line postponed in new Master Plan.		

Table of projects – Regional Group Continental South West

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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
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										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.
	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 Aldeadavi-la – Hinojosa – Almaraz 400 kV, – Picon – Aceca – Los Pradillos-Torrejon de Velasco and – Añover – Torrejón de Velasco – Pinto Ayuden – El Hornillo – Villaverde 220 kV											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.		
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							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.
	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.											under consideration	2016	New investment in TYNDP meant to solve congestion in this area.		
	16.A17	Arkale (ES)		New PST on Arkale – Argia 220 kV interconnection line.											design & permitting	2016	New investment enabling to take full advantage of the transfer capacity.		
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							design & permitting	2016	Progresses as planned.		Project needed to cope with larger and more vol-atile 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.
	17.44	Havre (FR)	Rougemontier (FR)	Reconductoring of existing 54 km double circuit 400 kV OHL to increase its capacity.											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	
	17.A18	tbd (FR)	tbd (FR)	New network reinforcement between Haute Normandie and the south of Paris area. Length about 160 km.											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.	
	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.											under construction	2013	Delays due to authorization process.		
	17.A144	Cergy (FR)	Terrier (FR)	MORP project: New single circuit 400 kV line between existing 400 kV substations.											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.		
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							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.
	18.A19	tbd (FR)	tbd (FR)	Rectructuration of whole EHV grid in Massif Central area.											under consideration	long term	New investment in TYNDP, defined since last release, triggered by larger and more volatile power flows in Southwest France.		
	18.20.A20	(Provence) (FR)	(Midi) (FR)	New subsea HVDC link between Marseille area and Langue-doc.											design & permitting	2018	New investment in TYNDP, defined since last release, triggered by larger and more volatile power flows in Southwest France.		

Table of projects – Regional Group Continental South West

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**	**Present status**	**Expected date of commissioning**	**Evolution compared to the TYNDP 2010 situation**	**Investment comment**	**Project comment**
19	19.51	Boutre (FR)	La Bocca (FR)	PACA "Filet de sécurité" project: 3 new AC 220 kV underground cables – Boutre – Trans (65 km), – Biançon – Fréjus (26 km) and – Biançon – La Bocca (17 km). Installation of reactive power compensation devices in 220 kV Boutre and Trans substations.	500 MW			French riviera							design & permitting	2015	Progresses as planned.		Security of supply of the 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							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.
	20. 18, A20																	The investment contributes both to project 18 and project 20. For the technical description see project 18.	
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 600 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)										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
	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.											design & permitting	2017 – 2018	Progresses as planned.		
	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.											under construction	2013	Authorization process ended, construction phase on going.		
	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.											design & permitting	long term	Delays due to authorization process.		
	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											design & permitting	long term	Progresses as planned.		
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										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.
23	23.60	under consideration (FR)	under consideration (BE)	To be determined.	1,800 – 3,000 MW			Lille, Ruien area							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.
	23.A21	Avelin (FR)	Mastaing (FR)	Operation at 400 kV of existing line currently operated at 220 kV.											design & permitting	2017	New investment in the TYNDP.	Upgrade of all grid assets in northern France at the same standard	
	23.A22	Avelin (FR)	Gavrelle (FR)	Substitution of a new double circuit 400 kV OHL to an existing 400 kV single circuit OHL											design & permitting	2017	New investment in the TYNDP.		
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										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.

Table of projects – Regional Group Continental South West

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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
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							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.
	40.A29	Bascharage (LU)	tbd (BE, DE and/or FR)	New interconnection with neighbor(s) either 220 kV or 400 kV											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.	
	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.											design & permitting	2012/2017	Progresses as planned.		
	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.											under consideration	2020	New investment in TYNDP.		
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										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	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
88	88.A23	offshore wind farms (FR)	several French substations (FR)	Subsea cables and substations works.	3,000 MW (MT) 6,000 MW (LT)										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).
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							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.		The project is needed to secure Brittany's supply.
107	107.A25	tbd (IE)	tbd (FR)	A new HVDC subsea connection between Ireland and France.	700 – 1,000 MW										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.
	15	Falagueira – Estremoz – Divor – Pegões (PT)		New 400/60 kV substations in Pegoes and Divor connected by a new 116 km Pegoes (PT) – Divor (PT) – Estremoz (PT) single circuit 400 kV OHL. In addition, the operating voltage of the existing Estermoz substations and the 93 km single circuit Falagueira (PT) – Estremoz (PT) 150 kV OHL will be changed to 400 kV (where prepared for that).											cancelled	cancelled	The construction of the project is linked with the construction of the High Speed Train infra-structure which has been suspended. Therefore the project was also suspended.		
	27	Morvedre (ES)	Santa Ponsa (ES)	Connection of Balearic Islands to Mainland. New bipolar 2 × 200 MW HVDC (LCC) 250 km connection between Morvedre (mainland) and Santa Ponsa (Mallorca) via 250 kV subsea cable. In addition, Mallorca will be connected to Menorca with a new HVDC 120 km link between Santa Ponsa (Mallorca) and Torrente (Menorca). A second connection between Mallorca and Ibiza (60 km) will also be constructed.											design & permitting	2013 – 2018	The cable Morvedre – Sta Ponsa was commis-sioned according to the plan. The remaining investments are in delay due to authorisation process.		
	35	tbd (ES)	tbd (ES)	Reinforcements in the 220 kV network overall the country, in addition to upgrading of 300 km of 220 kV network, due to wind power evacuation.											design & permitting	2011 – 2018	Progress as planned.		
	40	Avelin (FR) Mastaing (FR)		Installation of a 3rd busbar in Avelin (existing 400 kV substation) andreplacement of components to increase the ability to withstand short-circuit power. Connection of Mastaing (existing 400 kV substation) to existing 400 kV circuit between Avelin (FR) and Lonny (FR).											commissioned	commissioned	Commissioned.		
	41	Fruges, Sud-Aveyron, Marne-Sud, Somme (FR)	0	New 400 kV substations connected to existing 400 kV network and equipped with transformers to 220 kV or high voltage networks.											design & permitting	mid term	Project progress according to the plan.		
	52	Feuillane (FR)	Realtor (FR)	Operation at 400 kV of existing 63 km double circuit OHL previously operated at 220 kV, creation of a new 400 kV substation and restructuring of the existing 220 kV local network.											under construction	2012	To be commissioned by end of 2012. Delays due to longer than expected authorization process.		
	61	Moulaine (FR)	Belval (LU)	Connection of SOTEL (industrial grid in LU) to RTE network by mixed (underground cable & OHL) single circuit 220 kV line. Parts of the new line use existing ones.											under construction	short term	Commissioned in 2010 for the FR part, the LU part is still pending.		
	11	Batalha – Lavos – Paraimo (PT)		Two new 400 kV lines Batalha – Lavos and Lavos – Paraimo, needed to accommodate two new combined cycle power plants (4 × 435 MW) on Littoral Central Region. Total length: 115 km											commissioned	commissioned	Line Batalha – Lavos completed. Line Lavos – Paraimo was commissioned at the end of 2011.		

Table of projects – Regional Group Continental South West

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**	**Present status**	**Expected date of commissioning**	**Evolution compared to the TYNDP 2010 situation**	**Investment comment**	**Project comment**
	39	Avelin (FR)	Warande (FR)	Reconductoring (with ACSS) of both circuits of existing 400 kV OHL between Avelin, Weppes and Warande. Total length: 85 km											commissioned	commissioned	Commissioned in 2010.		
	43	Mandarins (FR)		Replacement of thyristors in the AC/DC substation (IFA 2000 interconnector, DC voltage 270 kV).											commissioned	commissioned	Currently under final tests; will be commissioned in Summer 2012.		
	47	Tamareau (FR)	Tavel (FR)	Reconductoring with ACCS of both circuits of existing 92 km double circuit 400 kV OHL to increase its capacity.											commissioned	commissioned	Commissioned in 2011.		
	49	Cantegrit (FR)	Mouguerre (FR)	Reconductoring (with ACSS) of existing 83 km single circuit 220 kV OHL to increase its capacity.											commissioned	commissioned	Commissioned in 2011.		
	50	Néoules (FR)	Broc-Carros (FR)	The second circuit (formerly operated at 220 kV) of a 197 km double circuit 400 kV OHL will be operated at 400 kV and 400/225 autotransformers installed in relevant substations.											commissioned	commissioned	Commissioned in 2010.		
	56	Camporosso (IT)		New 450 MVA PST in Camporosso (IT) 220 kV substation on Camporosso (IT) – Menton (FR) – Trinité-Victor (FR) OHL.											under construction	2012	Will be commissioned in 2012.		
	59	Moulaine (FR)	Aubange (BE)	Installation of a second circuit on the existing 220 kV cross-border OHL											commissioned	commissioned	Commissioned in 2010.		
	7	Armamar – Bodiosa – Paraimo (PT)		This 120 km double circuit OHL has been constructed according to 400 kV standards but is currently operated at 220 kV as Valdigem (PT) – Bodiosa (PT) – Paraimo (PT). The project consists of operating one circuit at 400 kV while creating a new 400/220 kV substation in Armamar and upgrading the existing Bodiosa substation from 220/60 kV to 400/60 kV. Total length of line: 120 km											commissioned	commissioned	Commissioned.		
	A15	Torernte (Ibiza / ES)	Formentera (ES)	New double circuit Ibiza – Formentera 132 kV.											design & permitting	2013 / 2017	New project.		

12.2 Appendix 2: List of ENTSO-E Countries and TSOs

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

United Kingdom	National Grid Electricity Transmission plc						
	Scottish and Southern Energy plc						
	Scottish Power Transmission plc						
	System Operation Northern Ireland Ltd						

Table 5:
ENTSO-E members and regional group membership

12.3 Appendix 3: System Modeling

Modeling of the European system is done fundamentally in 3 steps:

1. Modeling of CSW countries

The CSW region is modeled with detailed system data exchanged in the framework of the Regional Group. These data refer mainly to:

- Load (hourly profile, sensitivity to temperature…)
- Generation:
  - Thermal units, with their characteristics: installed capacity, efficiency, flexibility…
  - Hydraulic system: run-of-river, storage, pumping capacity...
  - Other renewable generation (wind, solar…)
  - Other generation (CHP, waste…)
- Transmission capacities between countries (NTC)
- Exchanges with non-ENTSO-E countries (profile of Spain ←→ Morocco exchanges)

Besides, a time-correlated wind profile provided by EWIS[1)] (an hourly load factor based on the historical data of the year 2006) has been used in order to have a consistent behavior of the wind generation within so many countries.

Regarding the hydraulic system of the Iberian Peninsula, which has a very specific behavior with very high differences between different years, historical data (from year 1991 to year 2005) has been used. In general, the other more simple hydro systems use monthly average values and standard deviations.

2. Modeling of neighboring countries

CSW being part of the whole ENTSO-E interconnected system and having interaction with the rest of Europe, the 1st neighbors of CSW (Great Britain, Belgium, Germany, Switzerland, Italy), plus the Netherlands, which is assumed to have influence too in the system, are modeled (except for Luxembourg, which is assumed to have little impact on the regional system). Description of those countries is based on the pan-European Market Database, which contains the same kind of data than the ones exchanged for CSW countries (load, generation, exchanges with non-ENTSO-E countries, etc.…) but with less detailed information.

---

1) EWIS: European Wind Integration Study ; http://www.wind-integration.eu/

3. Modeling of exchanges with the rest of ENTSO-E

Finally, in order to take into account the interaction of the whole modeled system (9 countries) with the rest of ENTSO-E, limit exchanges conditions have been fixed with an hourly step, based on a pan-European simulation performed at the ENTSO-E level for each scenario.

The map below synthesizes how countries and exchanges are modeled:

Additionally, must-run obligations are applied to some thermal units (coal, lignite, gas) in order to consider technical constraints (voltage control, min-

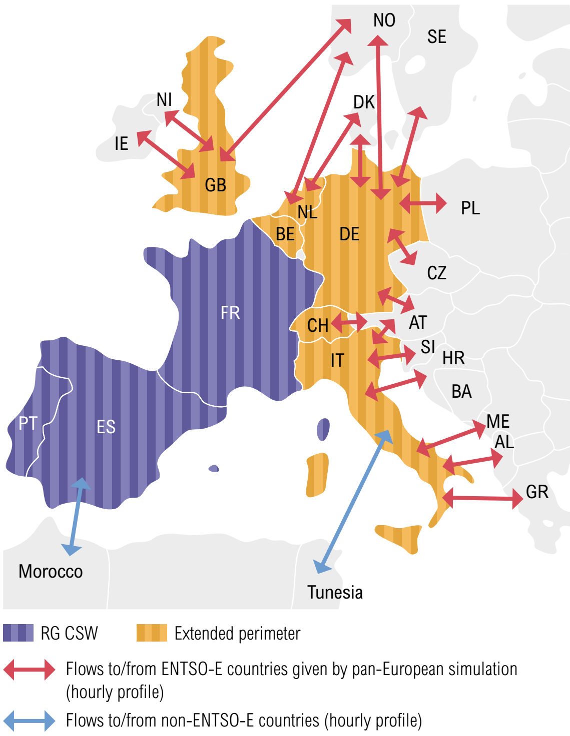


Figure 40:
Modeling of the European system in market studies

imum primary or secondary power reserves…) expected to occur no matter the fuel prices or specific policies (externalities, use of lignite mines…). These units are imposed (i.e. not price-driven) during the entire year, or at a specific moment.

The NTC or commercial exchange capacity represents the maximum exchange capacity admissible by both countries. NTC are defined with an hourly profile depending on the seasons and hours of the day (peak, off-peak, average situations…), resulting in this region from bilateral studies.

12.4 Appendix 4: Market Studies and Adequacy Models

ANTARES & RESERVAS

The two simulators belong to the class of Sequential Monte-Carlo Simulators (SMCS). The rationale behind adequacy or market analysis with a Monte-Carlo sequential simulator is the following: situations are the outcome of random events whose possible combinations form a set of scenarios so large that their comprehensive examination is out of the question. For any of the 8760 hours of a year, shortfall in any country may result from the conjunction of a demand higher than average (because of low outdoor temperatures, for instance), abnormally low availability of thermal units (possibly due to both planned and unplanned outages), low levels of hydro-reservoirs and low levels of wind-power (as a result of unfavorable meteorological conditions).

RESERVAS development is focused on generation adequacy results through a single-node approach (i.e. standalone system simulations of interconnected systems), where possible imports are modeled through available capacity from neighbor systems. Besides conventional (static) probabilistic indicators, this model is able to assess if the available operating reserve in each hour is sufficient to compensate the load forecasting error, the intermittent power forecasting (e.g. wind) and the forced outages (within that hour).

ANTARES – A New Tool for generation Adequacy Reporting of Electric Systems – is a sequential Monte-Carlo multi-area adequacy and market simulator, which provides system operators with a tool specifically designed to carry out some of the joint analysis work implicitly requested by the European Directives. The market simulator (resolution of linear and quadratic problems) makes use of Economic Efficiency parameters (generation costs) that do not appear in the generation adequacy problem but are necessary for the determination of any kind of Economic Efficiency equilibrium. The specific equilibrium determined, hour by hour, is that of a perfectly competitive market (which implies, among other assumptions, that information is not only complete but also perfect).

MAREA

MAREA is Unit Commitment software, traditionally used to calculate a short-term generation schedule. It calculates the least-cost hourly generation schedule of all power plants in a system, in order to satisfy the demand while respecting all operational constraints of the generation system (reserve requirements, minimum times up/down of thermal units, ramp-up rates, power limitations, energy limitations etc.). It allows modeling thermal generation, hydro generation and non-manageable generation, as well as Independent Power Producers or exchange contracts. For the present study, some simplifications have been made on the models of the generators (generally one modeled equivalent generator for all the units of one same technology) of each node. One node per country has been modeled, with a limited exchange capacity between each node.

12.5 Appendix 5: Market Studies Results

This appendix includes additional details on the hypothesis and the results of the Market Studies presented in Chapter 5 of the Regional Investment Plan for the Continental South West region.

12.5.1 Hypothesis

12.5.1.1 Load assumptions

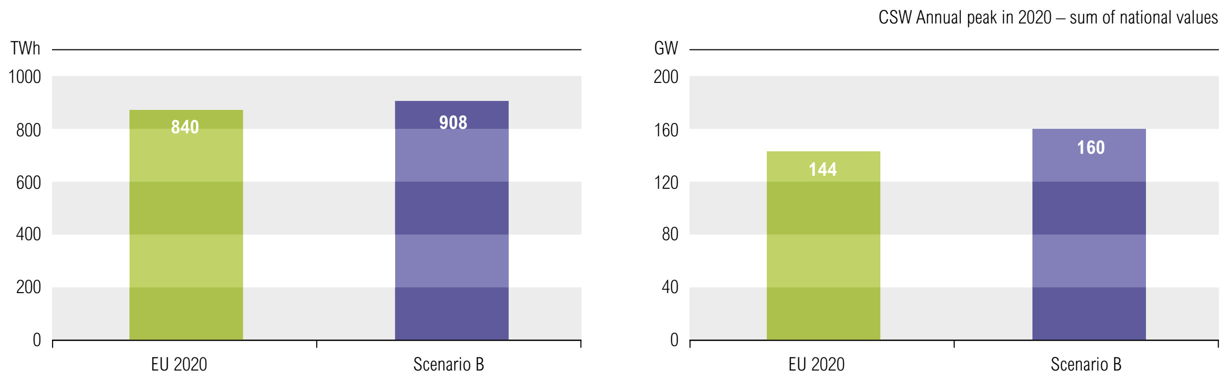


Figure 41:
Annual load and peak demand in 2020 in the CSW region

12.5.1.2 Installed capacity

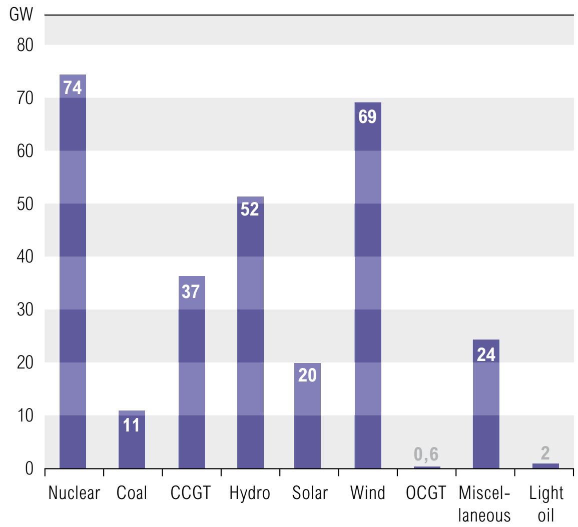


Figure 42:
Installed power in the CSW region, Scenario EU 2020

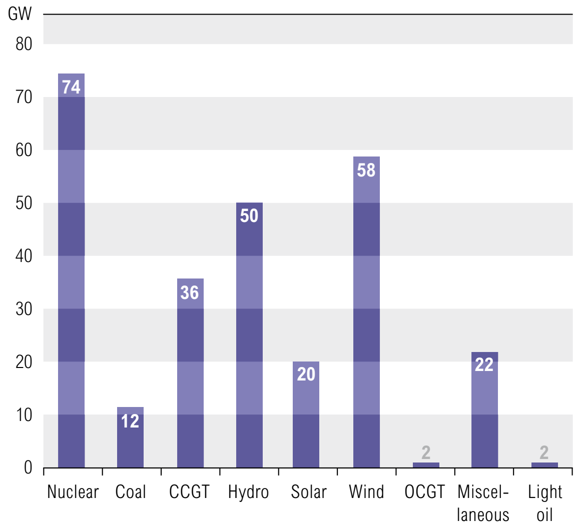


Figure 43:
Installed power in the CSW region, Scenario B

12.5.1.3 Grid configurations

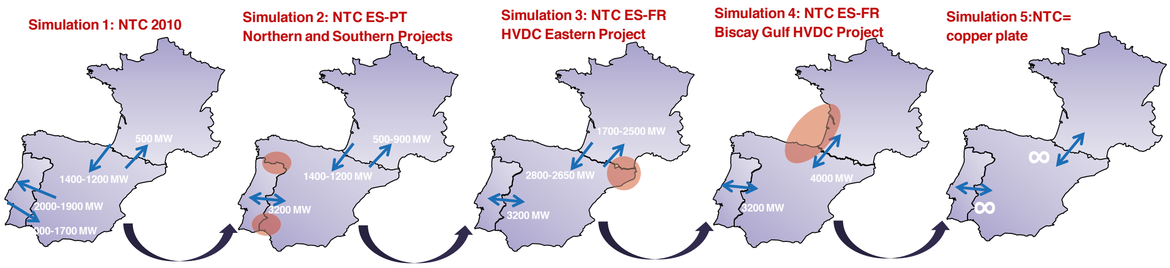
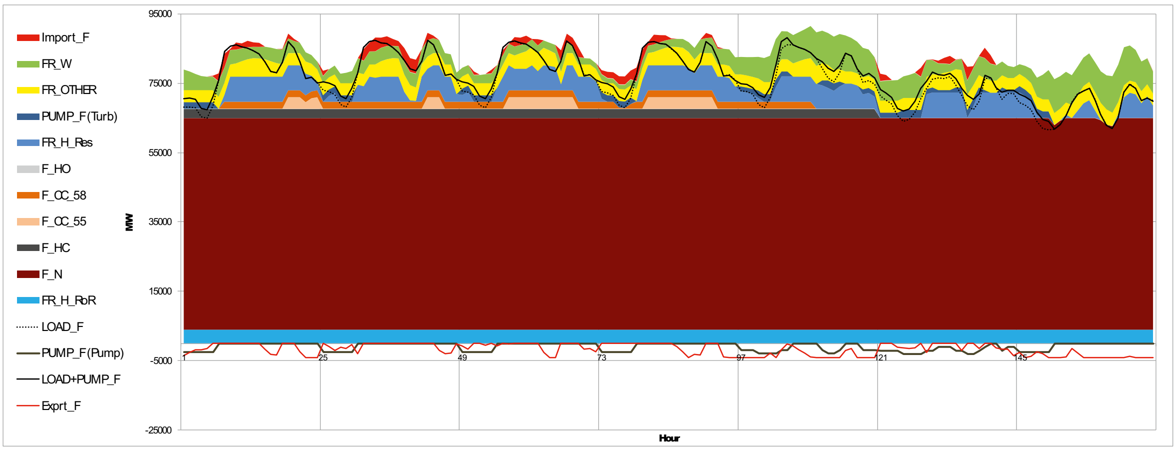
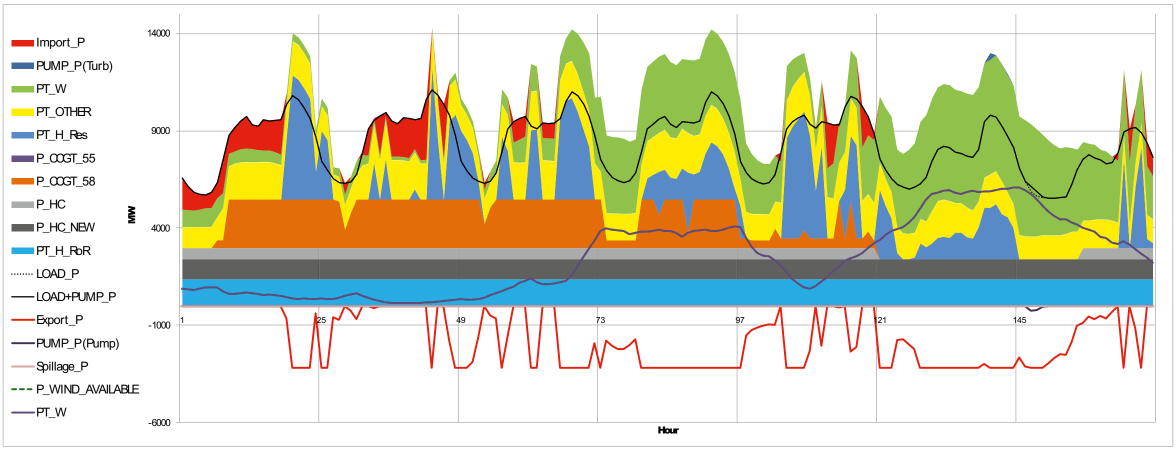


Figure 44:
Grid configurations considered in the market studies

12.5.2 Market Results and Conclusions

12.5.2.1 Example hourly results in 2020





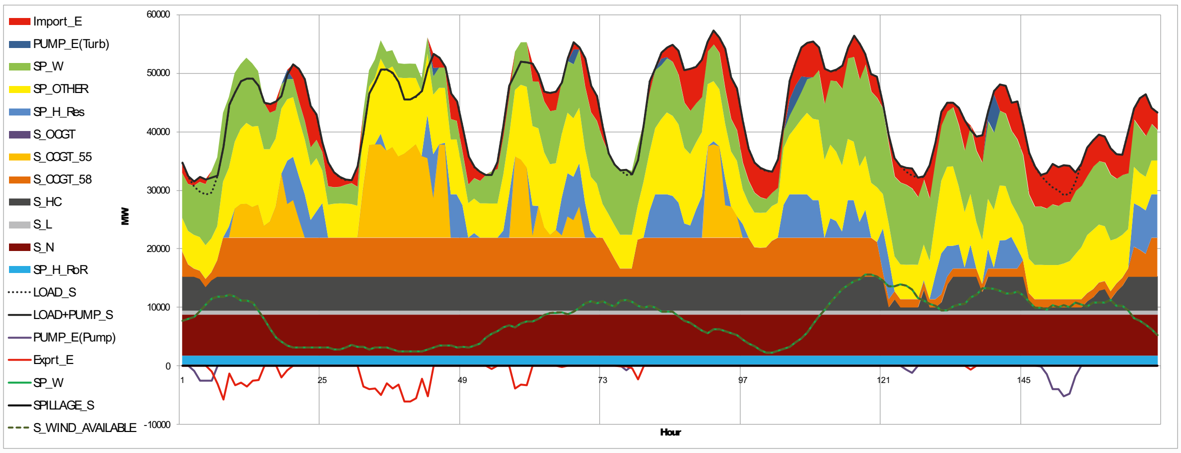
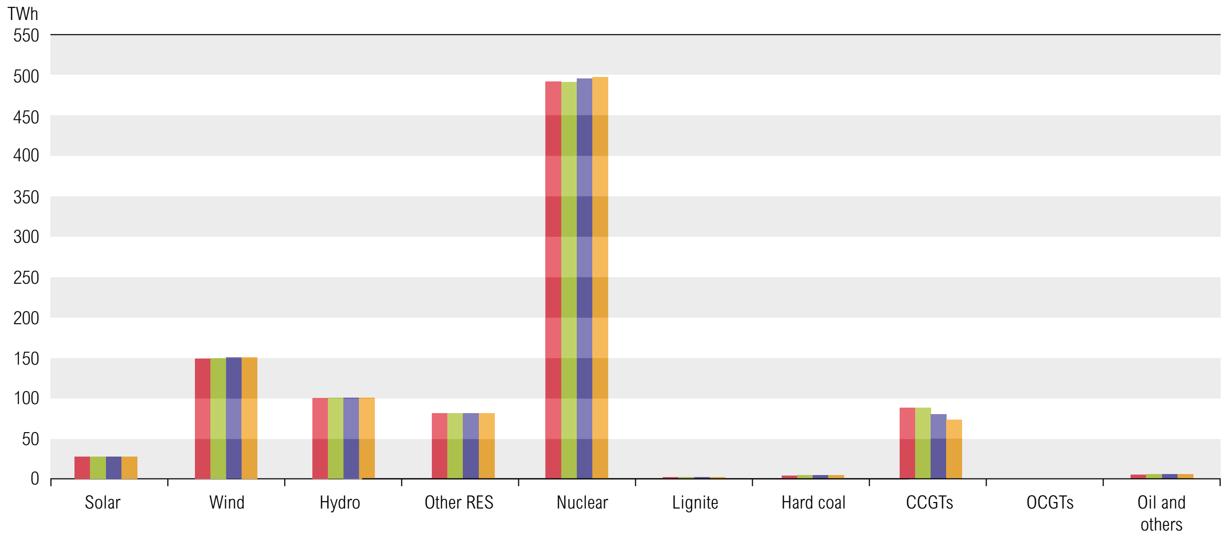


Figure 45:

Hourly results of simulation models. France, Portugal and Spain. 1st week of January, Scenario B.

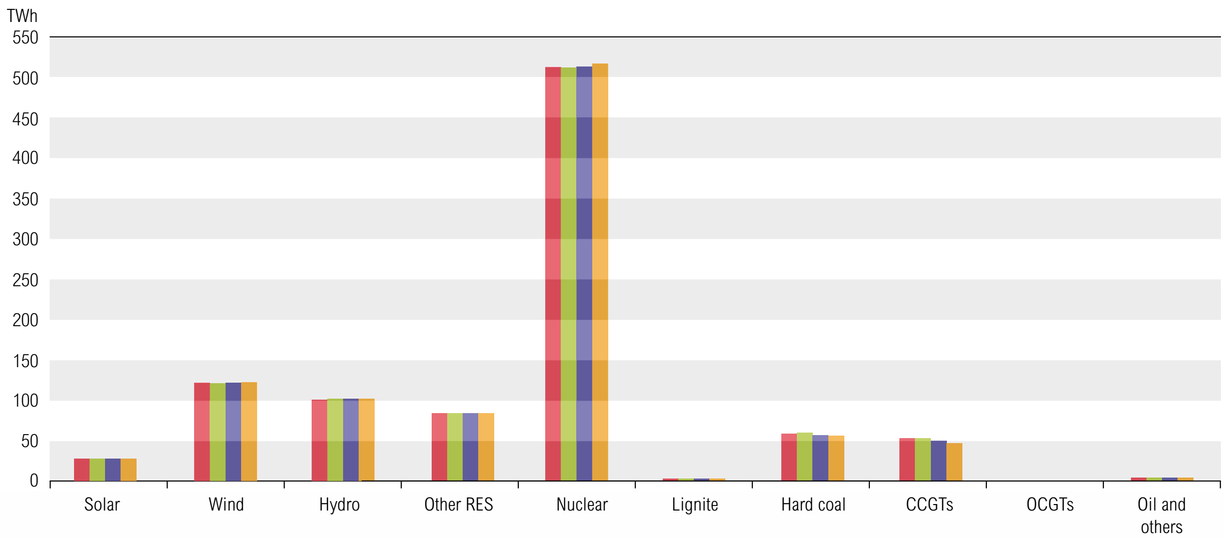
12.5.2.2 Production and energy flows



	Solar	Wind	Hydro	Other RES	Nuclear	Lignite	Hard coal	CCGTs	OCGTs	Oil and others
SIMU 1	35,9875	149,495	100,268	85,6315	494,174	1,8315	5,8185	81,1235	0	8,63
SIMU 2	35,9875	149,995	100,445	85,6075	493,655	0,97	6,73	81,315	0	8,63
SIMU 3	35,9875	150,499	100,771	85,651	497,139	1,8	5,4295	73,6475	0	8,63
SIMU 4	35,9875	150,8535	100,9485	85,651	499,116	1,744	5,4155	70,707	0	8,63

SIMU 1 SIMU 2 SIMU 3 SIMU 4

Figure 46:
Energy production in the CSW region in 2020. Scenario EU 2020



	Solar	Wind	Hydro	Other RES	Nuclear	Lignite	Hard coal	CCGTs	OCGTs	Oil and others
SIMU 1	35,735	124,655	102,225	88,21	513,315	5,16	62,995	55,015	0	8,1
SIMU 2	35,735	124,855	103,2665	88,21	513,121	5,18	63,378	55,2485	0	8,1
SIMU 3	35,735	125,055	103,4595	88,2065	514,975	5,115	62,687	50,355	0	8,1035
SIMU 4	35,741	125,255	103,605	88,242	516,12	5,055	62,09	47,395	0	8,107

SIMU 1 SIMU 2 SIMU 3 SIMU 4

Figure 47:
Energy production in the CSW region in 2020. Scenario B

12.5.2.3 Congestion in the interconnections

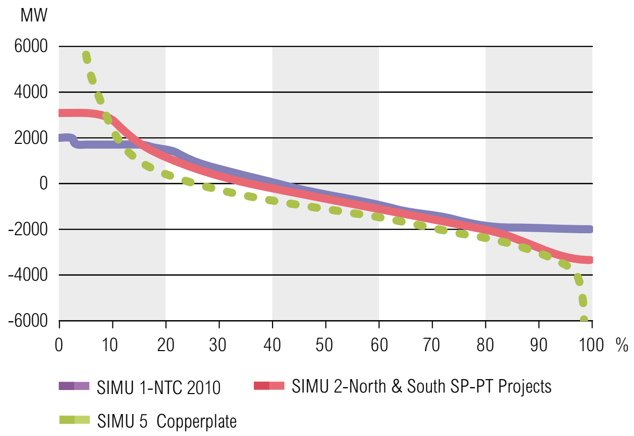


Figure 48:

Congestion time in 2020 in the Portugal-Spain interconnection. Scenario EU 2020

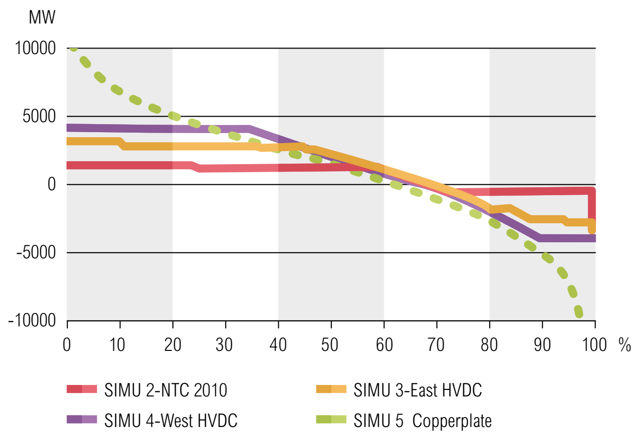
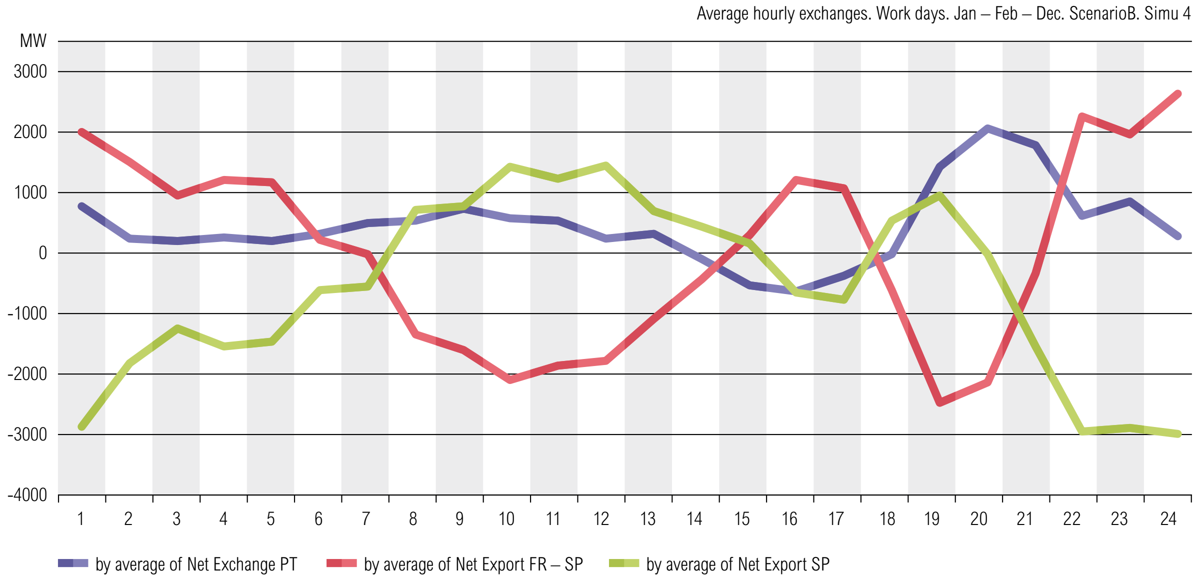
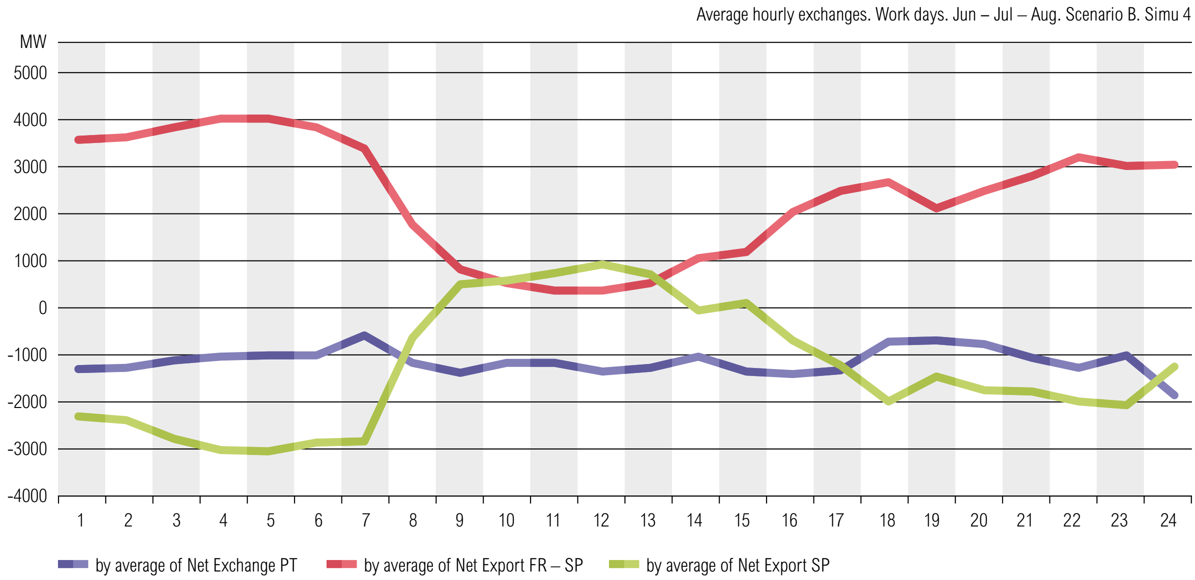


Figure 49:

Congestion time in 2020 in the France-Spain interconnection. Scenario B

12.5.2.4 Typical hourly exchanges





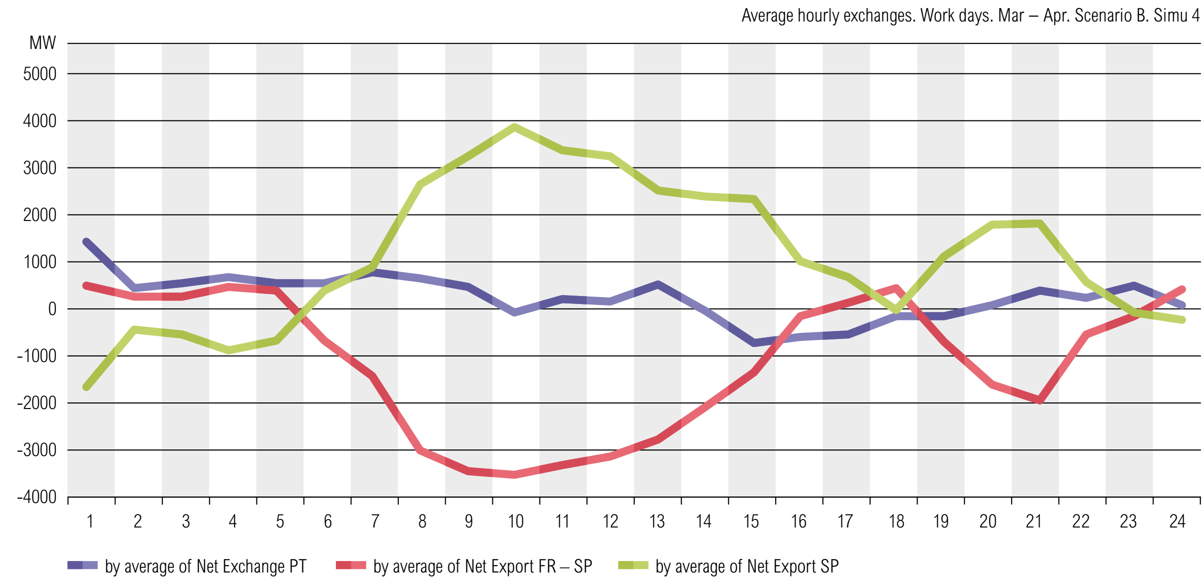


Figure 50:
Hourly exchanges in the Portugal-Spain and France-Spain borders in 2020

12.5.2.5 Adequacy indicators

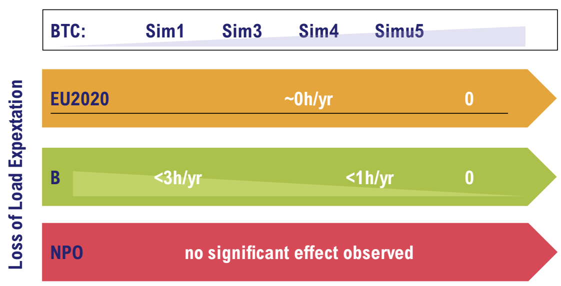


Figure 51:
LOLE indicators in the CSW region

12.6 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

12.7 Imprint

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

Design & Layout: Oswald und Martin Werbeagentur, Berlin

Contact

ENTSO-E AISBL

Avenue de Cortenbergh 100
1000 Brussels – Belgium

Tel +32 2 741 09 50
Fax +32 2 741 09 51

info@entsoe.eu
www.entsoe.eu

European Network of
Transmission System Operators
for Electricity