Regional Investment Plan Continental South West region

- Draft for consultation

24 June 2015

Contents

1 EXECUTIVE SUMMARY

1.1 Regional Investment Plans as foundation for the TYNDP 2016

The TYNDP for Electricity is the most comprehensive and up-to-date planning reference for the pan-European transmission electricity network. It presents and assesses all relevant pan-European projects at a specific time horizon as defined by a set of scenarios. The TYNDP is a biennial report published every even year by ENTSO-E and acts as an essential basis to derive the next Projects of Common Interest (PCI) list, in line with the Regulation (EU) No. 347/2013 ("the Energy Infrastructure Regulation").

ENTSO-E is structured into six regional groups for grid planning and other system development tasks. The countries belonging to each regional group are shown in Figure 1-1.

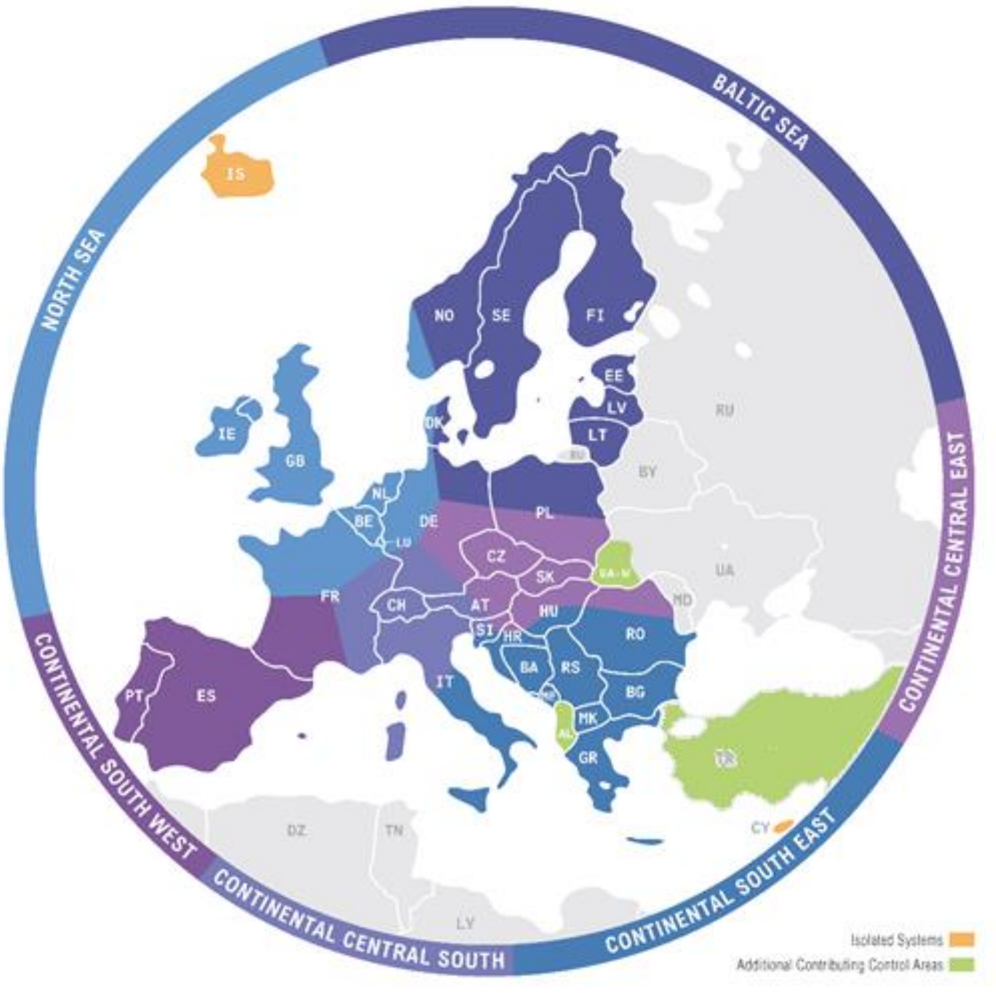

Figure 1-1 ENTSO-E System Development Regions

The TYNDP 2016 and the six Regional Investment Plans associated are supported by regional and pan-European analyses and take into account feedback received from institutions and stakeholder associations. The work of TYNDP 2016 has been split in two key phases:

- The first phase (summer 2014 to summer 2015) is devoted to common planning studies and results in the six Regional Investment Plans and the identification of a list of TYNDP2016 project candidates. During this phase also a set of TYNDP scenarios are developed.
- The second phase (summer 2015 to end 2016) will be dedicated to coordinated project assessments using the Cost Benefit Analysis Methodology (CBA) and based on common 2020/2030 scenarios. The results will be published in the TYNDP2016 report.

The common planning studies as basis of the Regional Investment Plans report are built on past TYNDP, on recent national plans, and follow a consolidated European network planning approach. It is worth noting that this is an intense and continuous work, where during the finalization of one TYNDP, the development of the next is already being initiated.

These common planning studies aim to identify the grid bottlenecks and potential investment solutions of pan-European significance for a 2030 time-horizon, in a robust, unified and consistent manner based on best available joint TSO expertise. Specifically, this report identifies cross-border and internal projects of regional and/or European significance, which allow the main European energy targets to be met with particular regard to the strengthening of the Internal Energy Market (IEM), the integration of Renewable Energy Sources (RES) and addressing security of supply (SoS) issues.

Proposed cross-border interconnections will also build on the reasonable needs of different system users, integrate long-term commitments from investors, and identify investment gaps.

The European Council has recently (October 2014 and March 2015) sent a strong signal that grid infrastructure development is an essential component of Europe’s Energy Union goals, by confirming the need of an interconnection ratio of at least 10% of the installed generation capacity in every Member State by 2020. In addition, the Council also endorsed the objective of reaching a 15% level by 2030 "while taking into account the costs aspects and the potential of commercial exchanges", aiming at strengthening security of supply and facilitating cross-border trade and mandated the EC to report on their implementation. According to the Council, this is one of the pre-requisites to accomplish an effective internal market for electricity.

This panorama is one of the challenges for ENTSOE in order to establish the most efficient and collaborative way to reach all defined targets of a working Internal Energy Market and a sustainable and secure electricity system for all European consumers.

1.2 Key messages of the region

1.2.1 Main drivers for grid development in CSW area

The Continental South West Region within ENTSO-E embraces France, Spain and Portugal. This RgIP2015 for CSW Region builds upon the key findings of the studies conducted for the 2030 time horizon in the framework of the TYNDP2014 and RgIP2014 and the 2015 Common Planning Studies.

The main drivers for grid development in the region are insufficient cross-border capacity between the Iberian Peninsula and mainland Europe and the integration of existing and future generation, mainly from Renewable Energy Sources (RES). For instance in TYNDP2014 Vision 4, the RES generation in the region represented approximately 57% of total generation production, equalling around 70% of total installed capacity. This RES generation came mainly from wind, solar and hydro within the whole CSW region. The decrease in nuclear generation in France and central Europe as result of political decisions and some pump

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storage potentials in the Iberian Peninsula are also some of the outstanding characteristics that will challenge the whole future electricity system in the region, especially transmission.

Whereas there were some areas requiring investments for ensuring Security of Supply (SoS), in 2030 SoS generally remains an issue of national importance.

1.2.2 Interconnection ratio and transmission adequacy as from TYNDP2014

The European Council established on 15 and 16 March 2002[1] the objective to reach a minimum interconnection ratio of at least 10% of the installed generation in every Member State.

TYNDP 2014 included the following projects with cross-border impact:

- In the Spanish-Portuguese border, the northern interconnection between Galicia in Spain and Minho in Portugal (project 4);
- In the Spanish-French border:
    - the Eastern Interconnection between Santa Llogaia in Spain and Baixas in France (project 5) and the 400kV network in Spain to connect this eastern interconnection to the existing network (project 213) (both projects are already built);
    - a Phase-shifter transformer in Arkale substation in Spain (project 184); and
    - the Western Interconnection-HVDC Biscay Gulf project (project 16).
- The BRITIB project, a multiterminal HVDC link between Great Britain, France and Spain promoted by a non-ENTSOE member (project 182).

In 2030, despite all the projects considered in TYNDP2014, the interconnection ratio for Spain varied from 4,2% to 6,8% depending on the scenarios (those with high amount of RES corresponding to the lowest ratio due to higher installed generation capacity), and there was still a significant level of congestion between Iberian Peninsula and the rest of Europe (40%-60%) with significant price difference. Therefore, TYNDP and CSW RgIP 2014 releases already pointed out a clear need for additional projects on the Spanish northern border in all visions and also mentioned some additional investigations should be conducted on the Portugal-Spain border that showed a congestion rate of 23% in Vision 4.

Recently, the European Council in October 2014 recommended Member States and EC a speedy implementation of all the measures to meet the target of achieving by 2020 an interconnection level of at least 10 % of their installed electricity production capacity for all Member States[1]. The Energy Union package of 25 February 2015 responds to this call by presenting a strategy to ensure the full integration of the internal electricity market through adequate levels of interconnection.

In line with this, the French, Spanish and Portuguese TSOs together with the EC signed on January 2015 an agreement on a common strategy for defining new electricity interconnection options for the integration of the Iberian Peninsula in the Internal Electricity Market, beyond the Biscay Gulf project. In addition, in March 2015 the Declaration of Madrid of the Energy Interconnection Links Summit among the Governments of Spain, France, and Portugal, the EC and the EIB gave support to ongoing regulations and TSOs studies.

[1] COM (2001)775 final

1.2.3 Shaping additional cross-border projects

In preparation of the TYNDP2016, in order to ensure that project portfolio is sufficient to accommodate any of the TYNDP visions for 2030, ENTSOE conducted a pan-European iterative market study consisting in increasing step by step the capacity of every border of the region and comparing the socio-economic welfare (SEW) from this increase to the investment cost of a potential standard project that would provide it. The more reinforcements are added on a given border, the lower is the SEW from additional increases and generally the more expensive additional projects are; thus the optimal value is obtained when the expected additional SEW does no more balance the needed investment cost.

It must be noted that this approach includes some simplification. The most important one is that for benefits it only considers SEW, whereas other benefits should be also taken into account in a CBA. The reason, is that the latter are possibly more difficult to monetize than the variable generation costs. Another simplification is the fact that the candidate projects are not yet defined by the time they are simulated. Therefore the expected GTC increase is a standard value (e.g. 1 GW) and the costs of the projects are assessed by expert view, taking into account, as far as possible, the specificity of the area (e.g. presence of mountain or sea) and internal grid considerations.

As the new scenarios of TYNDP2016 were not available, TYNDP2014 scenarios were used, focussing on Vision 4 (High RES scenario) that would demand most grid development. The process was coordinated among the six ENTSOE RGs, in order to get a consistent approach.

For CSW region new cross border increases on top of the TYNDP 2014 projects were tested for the borders Spain-France, Spain-Portugal, Spain-Great Britain and Spain-Italy. The outcome of the analysis was:

- Profitability of increasing by 3GW the ES-FR profile (from 5 GW to 8 GW, in addition to the non-ENTSO-E multi-terminal ES-FR-GB 1 GW project as included in the TYNDP 2014).
- Profitability of increasing the ES-PT profile by 1 GW (from 3.2 GW to 4.2 GW).
- Non profitability of increasing ES-GB or ES-IT.

The relevance of increasing these borders in the long term was confirmed by the results of the eH2050 project that showed in all five scenarios simulated for 2050 time horizon a clear interest in increasing the capacity of the northern border of Spain in order to reach 12 - 24 GW. A certain increase with respect to current value was also considered for the ES-PT border.

It is worth mentioning that a quick assessment of the SEW from these increases under the assumptions of the draft TYNDP2016 Vision3, i.e. lower RES with bottom-up approach and lower demand, showed lower benefit that in the top-down high RES scenario. These results also imply higher efficiency of a European common approach for optimizing the location of RES versus national and independent approaches of RES policies.

After defining those market-based target capacities, in preparation of TYNDP2016, grid studies were conducted in order to shape potential candidate projects to provide them.

France-Spain:
Seven alternatives were derived from the three proposals suggested in the January 2015 TSOs common strategy document to address the 3-GW capacity increase (from 5 to 8 GW). Studies showed that two cross-border investments with 1,5 - 2 GW capacity each are needed. In order to optimize the use of existing grid, one of them would be in the western part and the other in the central-western part of the border. More precisely:

- Western axis between Landes and Navarra:

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    - HVDC between Cantegrit (FR) and Dicastillo (ES),
    - Upgrading both existing 400-kV Cantegrit (FR) – Saucats (FR) lines,
    - Upgrading the existing Cantegrit (FR) – Marsillon (FR) double circuit 225-kV line to 400 kV single circuit line,
    - Connection of the new Dicastillo substation to existing grid in Spain.
- Western-Central axis between Pyrénées Atlantiques and Aragon :
    - New interconnection line between Marsillon (FR) and Sabiñanigo (ES),
    - New 400-kV line between Sabiñanigo and Cinco Villas

Total investment cost has been estimated around 2 bn€, including internal reinforcements. According to the urgency stated by the Madrid Declaration, preliminary technical and environmental studies are currently in progress to further define the route and scope of the proposed cross-border projects.

Moreover, it is worth mentioning that these investigations take into account in the reference case, additional internal projects that would be also needed for other reasons and have their own drivers, especially:

- In France,
    - Upgrading the Massif Central grid in the north to south direction, from Marmagne to La Gaudière (already included in TYNDP2014)
    - Upgrading the existing 400 kV axis between northern Aquitaine and southern Paris area (needed to integrate RES and accommodate consequently the larger and more volatile power flows),
- In Spain,
    - New double circuit Ichaso-Castejón/Muruarte 400 kV
    - New double circuit Ichaso-Abanto/Gueñes-Ichaso 400 kV
    - Uprate of the trans-Pyrenees axis T-Escalona- Escalona-T.Foradada-La Pobla 220 kV
    - New double circuit Vic-Vandellos/ Pierola 400 kV

Should this grid development not be realized, the 8 GW capacity could not be obtained.

Last, in the high RES scenario, even with all the above-mentioned grid development, significant additional congestion is observed in contingency situations on other internal axes between South-Western France and respectively Pays de Loire and Rhône Valley. Also in Spain additional congestion can occur in the path between Levante and the north (Catalonia and Aragón), and between the centre and the Basque Country. Nevertheless, this congestion may not be confirmed for new TYNDP2016 scenarios and updated list of projects including projects presented by non-ENTSO-E members. Therefore specific additional projects were not developed at this stage.

Spain-Portugal

The results of the Common Planning Studies which considers the most up-to-date information of future generation and demand, as well as their location, showed that the planned new northern interconnection between Galicia in Spain and Minho in Portugal could make possible exchange capacities higher than the values obtained in previous analysis, especially in the direction from Spain to Portugal where it can reach the 4.2 GW value.

In the opposite direction, from Portugal to Spain, the studies performed with the above new northern interconnection between Spain and Portugal showed an increment up to 3.5 GW, limited by bottlenecks in the Douro region, highly affected by the hydro and wind production in the north area . Therefore, a new conceptual project consisting of new reinforcements in the Douro region has been proposed for a CBA assessment in the ENTSO-E TYNDP2016 framework. Additional studies will be needed regarding to this project, including the clearly identification of the potential investments associated.

As a general remark in the region, it should be noted that the investigations conducted mainly referred to steady state analyses. The dynamic system behaviour under severe contingencies (and especially the frequency stability) must be subject to complementary studies, since larger and more volatile transit flows over longer distances trigger new technical challenges regarding system operation (frequency control, reserve management, voltage control, etc). Especially the connection of the Iberian Peninsula to continental mainland via DC and AC technology with only limited contribution of AC is an unusual situation that deserves specific studies.

In order to be closer to the 10% interconnection ratio, also an additional conceptual project has been proposed in the French-Spanish border for a CBA assessment in the ENTSO-E framework. No non-ENTSOE member project fulfilled the legal criteria of the draft EC Guidelines to be included in the plan.

With all proposed projects, the interconnection ratios of Portugal and France are higher than 10% in 2020 and 15% in 2030 for all draft TYNDP2016 scenarios.

On the other hand, the situation for Spain is pretty much improved from current values, and from the situation presented in the TYNDP 2014, however there is still a gap to fulfil the objectives. The interconnection ratio for Spain is around 8% in 2020, after commissioning of Biscay Gulf and the northern interconnection with Portugal. In 2030, the interconnection ratio with planned projects is in the range of 7-9%. With all projects in the plan, the ratio is higher than 10% (although not reaching the 15%) in Visions 1 and 2, but still lower in Visions 3 and 4. Also it is worth mentioning that complementary ratios can be computed in order to give a more wide perspective of the interconnection situation per country (e.g.: dividing import capacity by peak load or dividing export by generation capacity).

Last, 2 storage projects (pumping hydro) have been accepted and will be assessed in the TYNDP216:

- 3300 MW in Mequinenza (Aragón)
- 574 MW in Montearenas (León)

1.2.4 Energy transition requires grid, and the grid requires everyone's support

A major challenge is that the grid development may not be completed in time whereas RES targets are met as planned by 2030 or to fulfil the political objectives. At present many stakeholders support grid development to facilitate the changes in the energy system; at the same time, other stakeholders that are directly affected by new lines or new power plants show only a low level of acceptance for the new infrastructures. This low social acceptance plus the lengthy permit granting procedures often causes commissioning delays.

In this respect, PCI labelling is expected to smooth the permitting process and facilitate the fast tracking of transmission infrastructure projects, including the proposal of one stop shop and defined timelines. In addition, the Madrid Declaration of the Energy Interconnection Links Summit on 4 March 2015 appealed to strong involvement of all, including EC, Member States and all relevant parties in each country in order to meet the ambitious deadline of achieving the interconnection objective by 2020. It also established a High Level Group in order to coordinate and monitor interconnection projects.

A stable regulatory framework, ensuring the investment costs will be included in the tariffs is also essential to ensure grid development can be completed in time, and this is the task for the Regulators. Although grid projects provide a net reduction of the power generation costs, they represent large investments and financing them still remains an issue for TSOs in times of limited public finances, and therefore securing the perspectives of investors is key for success. In this respect, the Madrid Declaration welcomed all support available at European level, including the Connecting Europe Facility, the Structural Funds and the European Fund for Strategic Investment.

2 INTRODUCTION

2.1 General and legal requirements

The TYNDP 2016 package, developed over the course of two years, will be composed of the following documents:

- The **TYNDP report** provides a helicopter view on the grid development in Europe, it shows where progress is made and where support is still needed, and it provides a standardized assessment of all projects of pan-European significance.
- The **six Regional Investment Plans** analyse the power system development from a regional perspective, based on common guidelines, and identify investment needs linked with a set of proposed projects.
- The **Scenario Development Report** sketches a set of possible futures, each with their own particular challenges, which the proposed TYNDP projects must address. All TYNDP projects are assessed in perspective of these scenarios.
- The **Scenario Outlook & Adequacy Forecast (SO&AF)** is delivered every year and assesses the adequacy of generation and demand in the ENTSO-E interconnected power system on mid- and long-term time horizons.
- The **Cost Benefit Analysis Methodology (CBA)** as developed by ENTSO-E and adopted by the EC, allows the assessment of infrastructure projects in an objective, transparent and economically sound manner against a series of indicators which range from market integration, security of supply, integration of renewable energy sources (RES-E) to environmental impact.

The Regional Investment Plans are published in summer 2015 and focus on regional planning studies and the identification of the pan-European project candidates. It provides key information to understand the need for new projects, which are listed and published for public consultation until mid-September.

The Regional Investment Plans are complemented by a monitoring update of the TYNDP 2014 investments, providing insight in the changed status of these items and possible reasons.

The TYNDP report will be delivered by end of 2016 and will concentrate on individual project assessments based on common scenarios, data and CBA methodology.

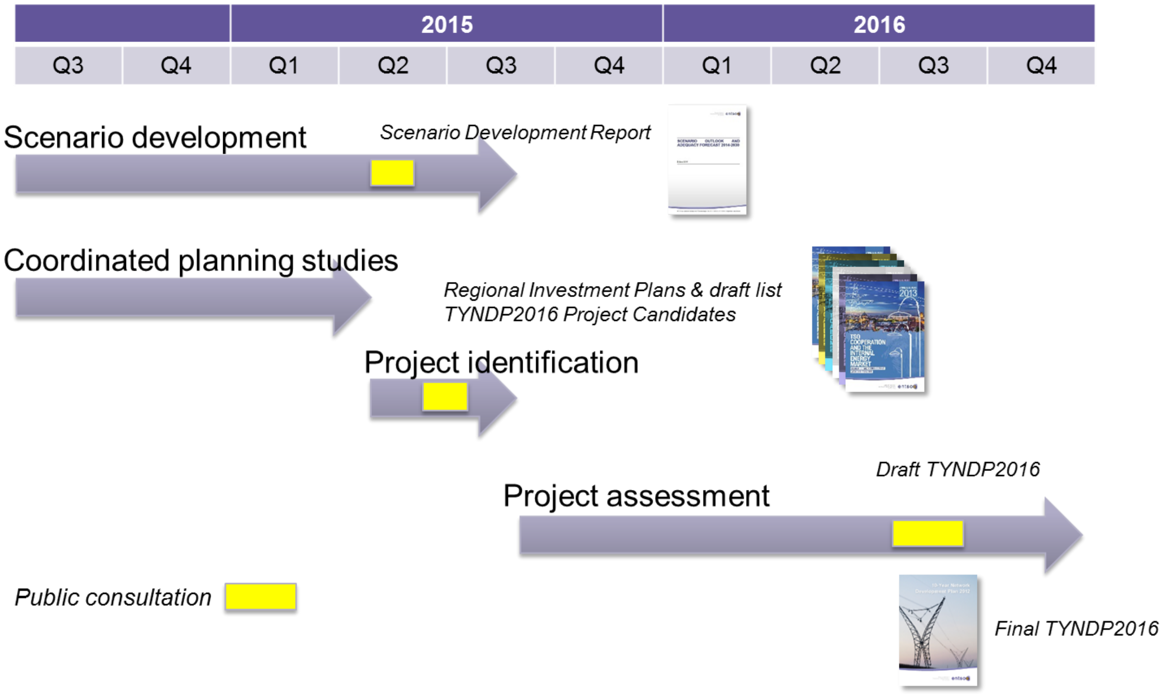

Figure 2-1 Overview of a two-year TYNDP process

The present publication complies with Regulation (EC) 714/2009 Article 12, where it is requested that TSOs shall establish regional cooperations within ENTSO-E and shall publish a regional investment plan every two years. TSOs may take investment decisions based on that regional investment plan. ENTSO-E shall provide a Community-wide ten-year network development plan which is built on national plans and reasonable needs of all system users, and identifies investment gaps.

As of 2016, the TYNDP package must also comply with Regulation (EU) 347/2013. This regulation sets a new European governance to foster transmission grid development". It establishes Projects of Common Interest (PCIs), foresees various tools (financial, permitting) to support the realisation of these PCIs, and makes the TYNDP the sole basis for identifying and assessing the PCIs according to a Cost-Benefit-Analysis (CBA) methodology. The ENTSO-E CBA methodology has been developed since 2012, based on stakeholder consultation, and the opinions of ACER, Member States and EC; it has been adopted by the EC in February 2015. Work continues to further improve the methodology

This Regional Investment Plan as such is to provide information on future European transmission needs and projects to a wide range of audiences:

- Agency for the Cooperation of Energy Regulators (ACER) who has a crucial role in coordinating regulatory views on national plans, providing an opinion on the TYNDP itself and its coherence with national plans, and giving an opinion on the EC’s draft list of PCI projects;
- European institutions (EC, Parliament, Council) who have acknowledged infrastructure targets as a crucial part of pan-European energy goals, to give insight in how various targets influence and complement each other;
- Energy industry, covering network asset owners (within ENTSO-E perimeter and the periphery) and system users (generators, demand facilities, and energy service companies);

- National regulatory authorities and ministries, to place national energy matters in an overall European common context;
- Organizations having a key function to disseminate energy related information (sector organizations, NGOs, press) for who this plan serves as a "communication tool-kit";
- The general public, to understand what drives infrastructure investments in the context of new energy goals (RES, market integration).

2.2 The scope of the report

The scope and focus of the present Regional Investment Plans has evolved as compared to the past editions of 2014. This Regional Investment Plan focuses on a set of common planning studies performed across ENTSO-E's regions with particular attention for the context of each individual region.

The Regional Investment Plan presents the methodologies used for these studies, relevant results and assumptions, and the resulting list of the project candidates as nominated by project promoters.

At present no detailed CBA analysis is provided in the Regional Investment Plan. This will be a key element of further studies leading to the final TYNDP2016 report to be released next year. This regional report takes the opportunity also to inform readers on regional context, studies and projects.

These studies re-confirm the main findings past TYNDP studies as well as others in terms of main corridors, general scenarios, and the key conclusion that an energy shift requires targeted future-proof infrastructure.

2.3 General methodology

This Regional Investment Plan 2015 builds on the conclusions of a Common Planning Study carried out jointly across the six regions of ENTSO-E's System Development Committee. The aim of this joint study is to identify investment needs triggered by market integration, security of supply, RES integration and interconnection targets, in a coordinated pan-European manner building on the expertise of all TSOs. These investment needs are translated to new project candidates where possible, and give in most cases a re-confirmation of past TYNDP2014 projects. This chapter explains the overall planning process of how project candidates have been identified by market studies, network studies and regional knowledge. More details about this process as well as regional intermediate steps can be found in Appendix 7.1 and 7.2.

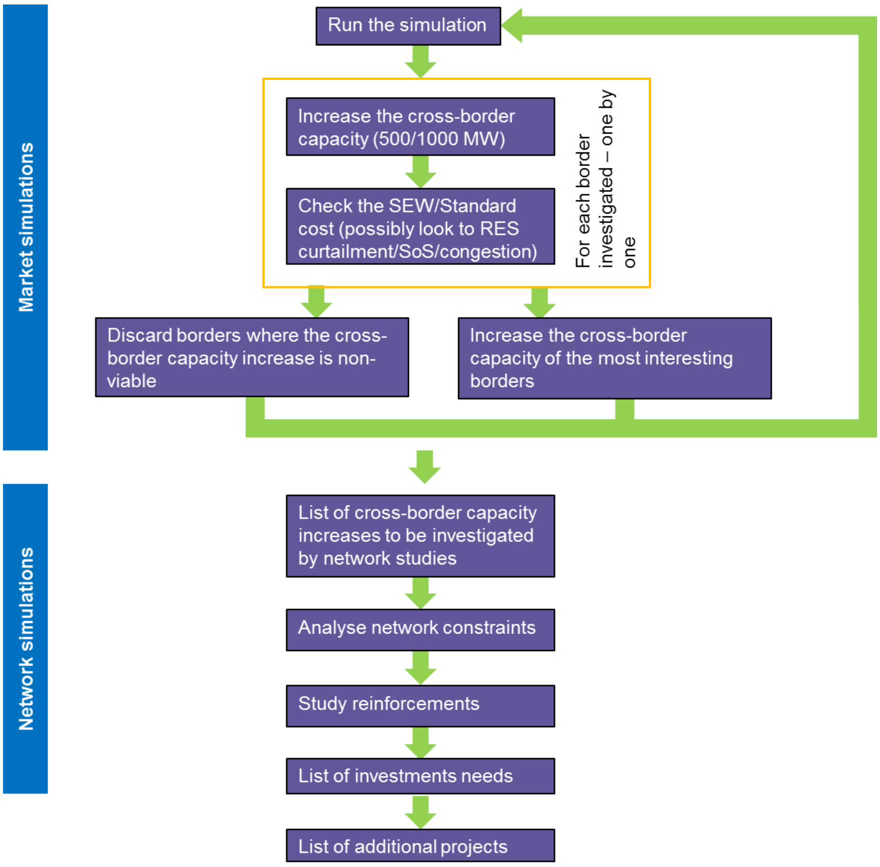

Figure 2-2 Common Planning Study workflow

Market Studies

All regions have jointly investigated all borders in order to identify the most beneficial ones based on a criteria of SEW/cost-ratio. The SEW indicator represents the socioeconomic welfare of a full-year market simulation. The cost indicator is an estimation of the capex of a potential cross-border capacity increase, including necessary internal reinforcements. Note that both indicators for a given capacity do not represent the same level of detail as the cost and SEW indicator retrieved in a CBA assessment for a specific project.

The analysis is carried out across the ENTSO-E perimeter in several iterations, each time increasing border capacities identified as being most valuable for the European system.

It is worth pointing out that this approach includes some simplifications. The most important one is that it simplifies the benefits just as SEW, without taking into account additional benefits, which are possibly more difficult to monetize than the savings in variable generation cost. Another one is the fact that the candidate projects are not yet defined by the time they are simulated. Therefore the expected GTC increase is a standard value (e.g. 1 GW) and the costs of the projects are assessed by expert view, taking into account the specificity of the area (e.g. mountain, sea). Cost of internal grid reinforcements considered as needed to get the expected GTC increase is also included in the cost of the candidate projects.

As a reference scenario the TYNDP2014 Vision 4 is taken, which represents the most challenging scenario coming from the present day situation and the most useful to identify new investment needs. Even if this scenario does not become reality by 2030, it can for the purpose of this planning study still be seen as a step between 2030 and 2050. In addition to the pan-European study iterations, regions repeated the exercise or performed a sensitivity analysis on the outcome to gain additional insight in relevant investment needs that trigger project candidates or evaluate other regional aspects, for instance Security of Supply.

Network Studies

Following these market simulations, network studies on detailed grid models show possible bottlenecks that would not allow the result from the market studies come true. This allows to explore reinforcements, to design suitable project candidates and update market-based target capacities resulting from the initial market study iterations. Depending on the models and tools used in a region, the translation from market to network studies can be done in two ways:

1. Select and study an adequate number of representative Points In Time (PiTs), based on the flow duration curves for the each studied border. Complemented this with a second analysis of the regional grid by means of a Power Transfer Distribution Factor (PTDF) matrix which gives approximate flows.
2. Compute all 8760 hours in a year with demand and generation dispatch profiles obtained from market studies in full DC load flow calculations.

These network analyses allow to test **project candidates**, as suitable grid reinforcements to eliminate bottlenecks.

Regional knowledge

Market studies focus primarily on SEW/cost-ratios. Network studies identify additional (internal) capacity needs. Sensitivity studies of market simulations (e.g. an extreme condition) and in particular network studies allow to capture additional views and model interpretations based on regional experts, and in many cases complementing the findings of national development plans and/or past studies.

2.4 Report overview

This chapter describes how the report is built up and the content of the different chapters.

Chapter 1 – Executive Summary

In this section the key take-aways of the region are presented and it is explained how the development of the report fits into the TYNDP2016 process.

Chapter 2 - Introduction

This chapter sets out in detail the general and legal basis of the TYNDP work, the overall scope of the report and its evolutions compared to the previous regional and TYNDP plans. The reader is presented with a short summary of the planning methodology used by all ENTSO-E regions.

Chapter 3 – Regional Context

This chapter describes the general characteristics of the region, in the as-is situation and in anticipated evolutions up to 2030 and beyond. It gives a general overview of TSO collaboration efforts in regional planning based on pan-European methodologies and coordination.

Chapter 4 – Regional results

It gives a synthetic overview of the basic scenarios and assumptions used in common planning and the overall results. The results are also placed in perspective of further ahead challenges and roadmaps leading up to 2050.

Chapter 5 – Project candidates

This chapter gives an overview of all projects proposed by promoters in the region, labelled as either TYNDP projects or projects of regional relevance. It links these projects to investment needs identified in ENTSOE joint TSO studies, clarifies possible barriers to address these system needs, and gives the baseline for future project CBA assessments (e.g. by means of boundary reference capacities).

Chapter 6 – Next steps

This chapter presents a look forward on how the TYNDP work will continue in the next year, leading to a full TYDNP2016 report.

Chapter 7 – Appendices

This chapter gives more insight in the used methodologies, as well conducted market and network studies.

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3 REGIONAL CONTEXT

The Continental South West Regional Group (CSW RG) under the scope of the ENTSO-E System Development Committee is among the 6 regional groups for grid planning and system development tasks. The countries belonging to each group are shown in the Figure below. CSW RG comprises three countries, France, Portugal and Spain; with the involvement of 3 companies / TSOs : RTE, REN and REE. The list of ENTSO-E countries and TSOs in the CSW RG outlined here is presented in Table 3-1 below:

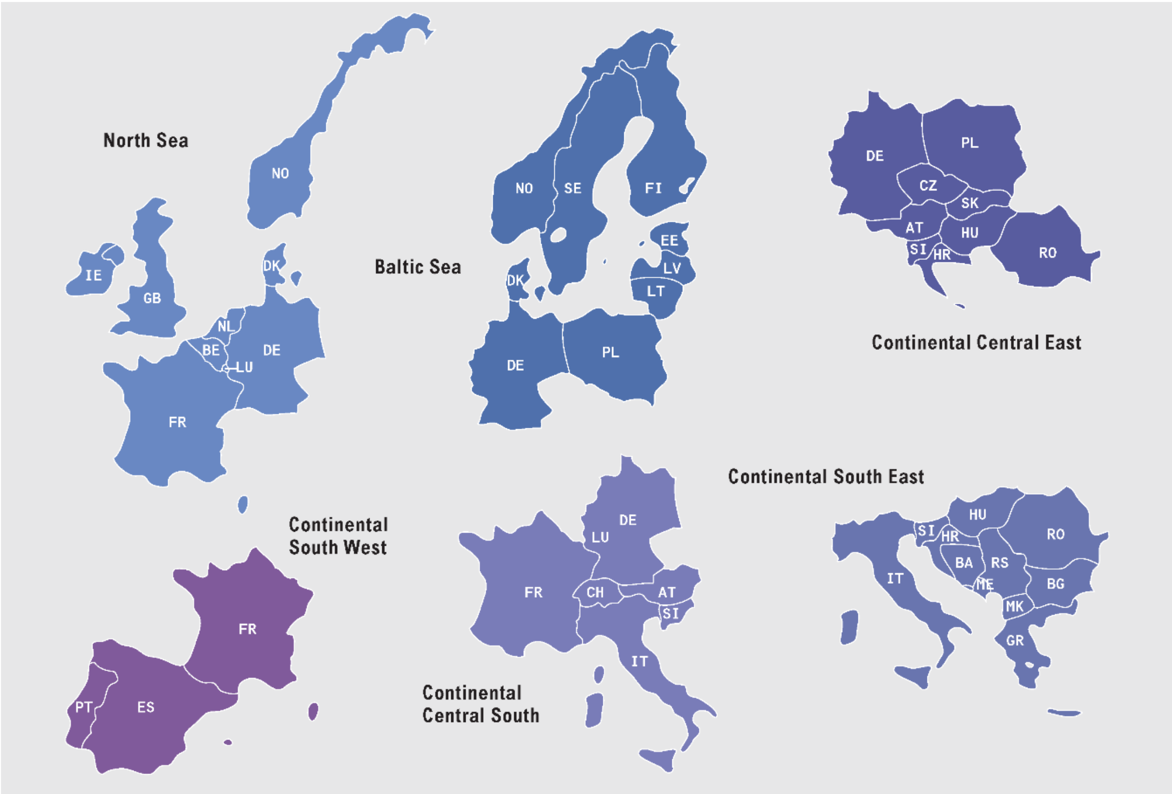


Figure 3-1 ENTSO-E regions (System Development Committee)

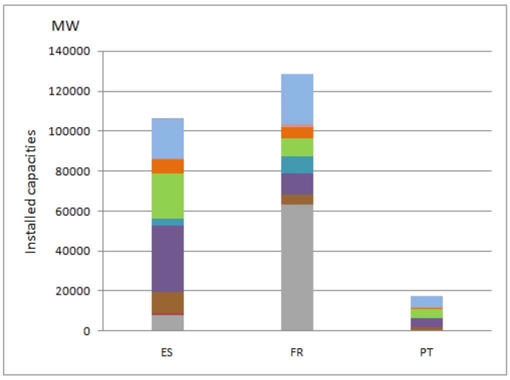
Country	Company/TSO
France	RTE – Réseau de Transport d'Electricité
Portugal	REN – Rede Eléctrica Nacional, S.A.
Spain	REE – Red Eléctrica de España, S.A.U.

Table 3-1 ENTSO-E Regional Group CSW membership

3.1 Present situation

The low interconnection between the Iberian Peninsula and the rest of Europe, the wind and solar production, the hydro generation and the impact of the temperature in the consumption are the main features for the CSW region.

The following figures report the details of the generation mix, in terms of installed capacity, annual generation and balances in 2014:



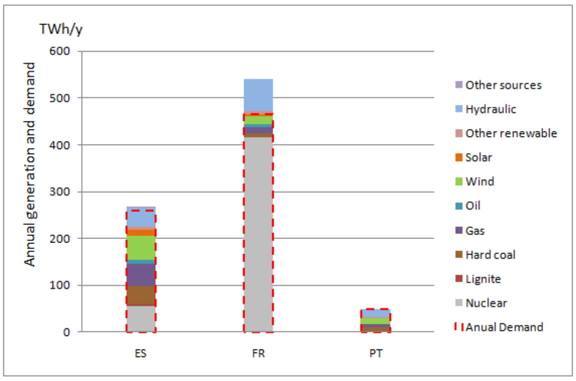


Figure 3.11 Installed capacities and annual generation and demand in RG CSW (2014)

As it can be seen from the figures in the CSW region the main contribution to cover demand comes from nuclear energy which represents 61% of the total demand of the region and 28% in terms of installed capacity. Wind energy together with solar energy provide 13% of the demand and represent 19% of the total installed capacity.

In 2014, Portugal resulted to be a net importing country (0.9 TWh), and France and Spain net exporting countries (65.1 TWh and 3.4 TWh respectively).

The following figure contains a map with diverse level of Net Transfer Capacities (NTC) in the CSW region. The NTC is the maximum exchange program between two adjacent control areas that is compatible with security standards and applicable in all control areas of the synchronous area, whilst taking into account the technical uncertainties on future network conditions. The values represent the maximum capacity available. In operation those values can vary by one hour to the other based on the availability of grid elements, changes in generation portfolio and new expected flows previously unplanned.

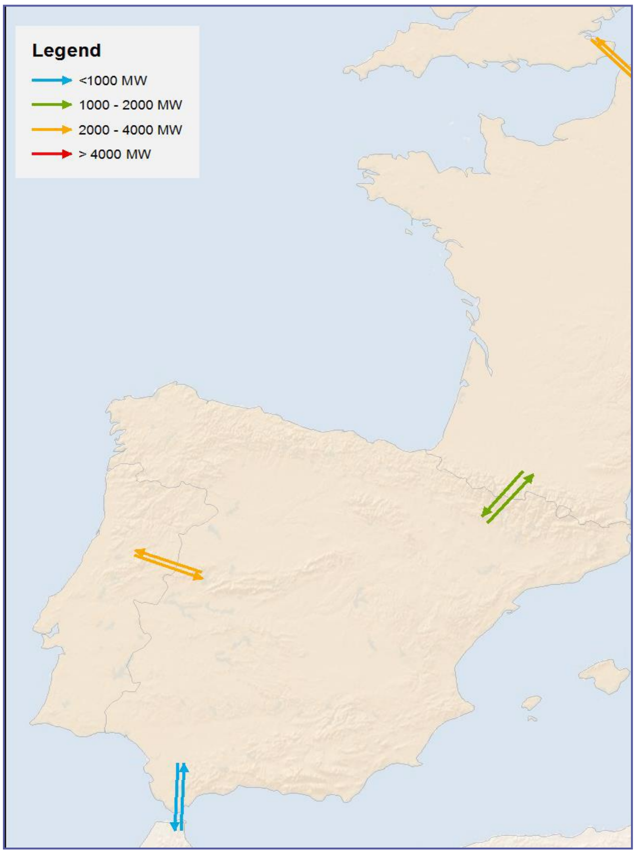


Figure 3.1-2 Illustration of Net Transfer Capacities in the CSW region (2014)

Currently, by mid 2015, the NTC values between France and Spain are in the range of 1200-1400 MW from France to Spain, and 900-1100 MW from Spain to France. However, these values are considerably lower than the requirements of the market, as can be seen by the 71% rate of congestion on this border in 2014. It should be noted that the Iberian Peninsula (Portugal and Spain) is almost an electrical island, with four interconnectors between France and Spain in AC. In summer 2015 the new HVDC Eastern Interconnection between Sta.Llogaia and Baixas is commissioned. This former TYNDP project will be the first new cross-border project between France and Spain in the last 30 years, will allow doubling the exchange capacity and will help reducing the congestion and isolation of the Iberian Peninsula.

Although the 2015 NTC values between Portugal and Spain (1700-2300 MW from Portugal to Spain and 1800-2300 MW from Spain to Portugal) are higher than those between France and Spain, some constraints still occur (in 2014 the congestion rate was 4%) and additional investments are needed (the new Northern Interconnection between Galicia (ES) and Minho (PT) and some reinforcements near Sevilla (ES) to achieve the main political goals of 3000 MW NTC, established for reaching a complete operational Iberian Electricity Market (MIBEL). In 2014 the new Southern interconnection Puebla de Guzman (ES) – Tavira (PT) has entered into operation, reinforcing the capacity, mainly on the direction Portugal to Spain, and reducing the congestion in around 6%.

The Continental South West region is also interconnected with Morocco, which is a non-ENTSO-E country. Current NTC values with Morocco have not changed since the commissioning of the second cable in 2006. These NTC values are 600 MW from Morocco to Spain and 900 MW from Spain to Morocco. Additionally, this border experiences high flows from Spain to Morocco for almost all the hours of the year. This situation is expected to remain similar in the following decade.

3.2 Main drivers

Developments in the electricity sector such as the implementation of market mechanisms and integration of renewable generation on a large scale have a significant impact on the system operation conditions in Europe and on the CSW Region as well. This poses significant challenges to peripheral areas in Europe, particularly for those that are not sufficiently interconnected with Central Europe as is the case with the Iberian Peninsula.
In the CSW region, the main drivers for system evolution can be briefly summarised as follows:

- **Insufficient cross-border capacity**: i.e. structural market congestion between price zones, namely between the Iberian Peninsula and the rest of the Europe.
- **Existing generation integration**: areas where existing generation cannot be transmitted reliably in all situations as a result of a change in surrounding power flow patterns; in fact, in some particular operation conditions there is RES spillage in the Iberian Peninsula due to internal constraints or to the insufficient cross-border capacity between this region and the rest of the Europe.
- **Future generation integration**: areas where new generation facilities have asked (or are likely to ask) for connections, as may be the case of large power plants and/or distributed generation, whether RES or not, and the existing network does not assure conditions for adequate integration (e.g, hydro generation with and without pumping in north of Portugal and solar energy in all three countries).
- **Security of Supply in certain specific areas**: the goal of assuring appropriate power supply conditions on some cities and local bottlenecks has created the need for several regional investments. Nevertheless, in 2030 SoS will be generally an issue of national importance rather than European significance.

Based on the drivers listed above, several transmission expansion projects of pan-European and of Regional significance were already planned within the CSW Region in the past TYNDPs.

The identification of further cross border network development need triggered by bulk power flows, especially under high RES conditions - as it is in the scope of this document - cannot leave behind and in fact should start from the analysis of the *target capacities* and consequently of the transmission *adequacy needs* reported in the last TYNDP 2014.
For every cross-border boundary, the market based target capacity corresponds in essence to the transmission capacity above which additional development would not be profitable in terms of SEW, i.e. the economic value for the system derived from any additional capacity quantum cannot outweigh the corresponding costs. However, it must also be considered if the criterion on minimum value of interconnection ratio set by the European Council as a prerequisite for an efficient market functioning are met (see section 5.5 below). Then, comparing the target capacity and the project portfolio for every cross-border boundary, a transmission adequacy index can be supplied.

The transmission adequacy prospect in the CSW region is depicted in the following figure, showing that for the regional boundaries, the TYNDP 2014 still gave room for potential development needs to be investigated in the framework of TYNDP 2016 common planning activities.

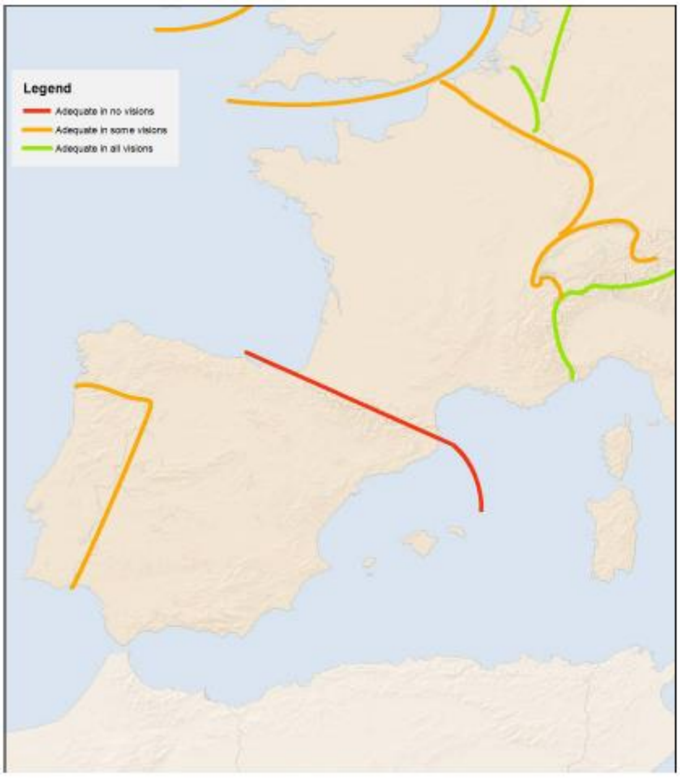


Figure 3.2-1 Transmission adequacy by 2030 in TYNDP 2014

3.3 Interconnection ratio - Madrid declaration 4th March 2015

The current interconnection capacity between Iberia and mainland Europe is too low to enable the Iberian Peninsula to fully participate in the internal electricity market.

The European Council established on 15 and 16 March 2002 the objective of reaching a minimum interconnection ratio of at least 10% of the installed generation capacity in every Member State[2]. In the European Commission's view, the EU energy policy goals and the 2020 and 2030 energy and climate targets will not be achievable without a fully interconnected European electricity grid with more cross-border interconnections, storage potential and smart grids to manage demand and ensure a secure energy supply in a system with higher shares of variable renewable energy. In this respect the gradual construction of the pan-European electricity highways will also be crucial. The Commission announced in January 2014 its intention to monitor the level of interconnections between Member States, with particular urgency between those that are furthest away from meeting the agreed objective of 10% of their installed production capacity.

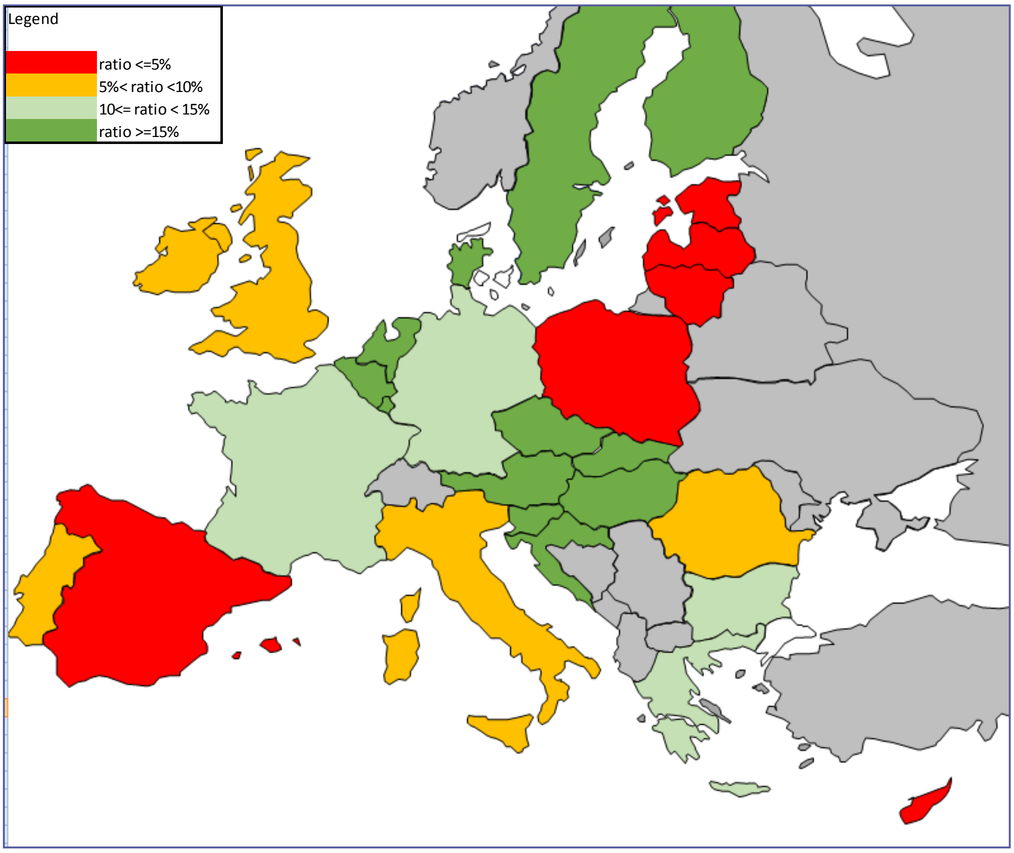
More recently the European Council in October 2014 called for speedy implementation of all the measures to meet the target of achieving by 2020 an interconnection level of at least 10 % of their installed electricity production capacity for all Member States. The Energy Union package of 25 February 2015 responds to

[2] The COM (2001) 775 establishes that "all Member States should achieve a level of electricity interconnection equivalent to at least 10% of their installed generation capacity". This goal was confirmed at the European Council of March 2002 in Barcelona and chosen as an indicator the EU Regulation 347/2013 (annex IV 2.a) The interconnection ratio is obtained as the sum of importing GTCs/total installed generation capacity

this call by presenting a strategy to ensure the full integration of the internal electricity market through adequate levels of interconnection.
In October 2014 the European Council added also an indicative objective for 2030, to enhance this threshold to 15% while taking into account the cost aspects and the potential of commercial exchanges in the relevant regions.
"The completion of the internal electricity market, notably ending the isolation of electricity islands, secure energy supplies for all consumers and a greater share of electricity generation based on variable renewable energy sources require more than 10 % interconnection capacity, and efforts by the EU and Member States must be guided by the need for all Member States to reach at least 15 % by 2030. At the same time, differences between Member States in terms of geographic location and structure of energy mix and supply mean that a case-by-case approach based on a thorough assessment of the bottlenecks, taking into account the costs, is needed".

Both targets are aimed to be achieved mainly through the implementation of the projects of common interest (PCIs).

At present, based on European Commission Communication on 25 February 2015[3], twelve Member States, mainly in the periphery of the EU, remain below the 10% electricity interconnection target and are thus isolated from the internal electricity market:



[3] Energy Union Package. Communication from the Commission to the European Parliament and the Council. Achieving the 10% electricity interconnection target. Making Europe's electricity grid fit for 2020.

Member States below 10% interconnection	
IE	9%
IT	7%
RO	7%
PT	7%
EE	4%
LT	4%
LV	4%
UK	6%
ES	3%
PL	2%
CY	0%
MT	0%

Figura 3.3-1 Interconnection levels for electricity in 2014: Source, EC communication 25/02/2015

The TYNDP 2014 included for the CSW region the following projects with cross-border impact:

- In the Spanish-Portuguese border, the northern interconnection between Galicia in Spain and Minho in Portugal (project 4).
- In the Spanish-French border, the eastern interconnection between Santa Llogaia in Spain and Baixas in France (project 5), the 400kV network in Spain to connect the eastern interconnection to the existing network (project 213), a Phase-shifter transformer in Arkale substation in Spain (project 184), and the Western Interconnection-HVDC Biscay Gulf project (project 16).
- The BRITIB project, a multiterminal HVDC link between Great Britain, France and Spain promoted by a non-ENTSO-E promoter (project 182).

From these, the northern PT-ES interconnection, the PST in Arkale, the Biscay Gulf project and the 400kV network in Spain to connect the eastern interconnection to the existing network were included as Projects of Common Interest in the 2013 list.

In 2030, despite all the projects considered in TYNDP2014 the interconnection ratio for Spain varies from 4,2% in Vision 4 to 6,8% in Vision 1, and there is still a significant level of congestion between Iberian Peninsula and the rest of Europe (40%-60%) together with significant price differences. Therefore, the Regional Investment Plan CSW 2014 release already pointed out a clear need for additional projects on the Spanish northern border in all visions to reach the objective of 10% interconnection ratio; and it also mentioned that some additional investigations should be conducted on the Portugal-Spain border that showed a congestion rate of 23% in Vision 4.

In line with this, the French, Spanish and Portuguese TSOs together with the EC signed an agreement on January 2015 on a common strategy for the development of new electricity interconnection options beyond the Biscay Gulf project for the integration of the Iberian Peninsula in the Internal Electricity Market.

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In addition, in March 2015 the Declaration of Madrid of the Energy Interconnection Links Summit among the Governments of Spain, France, and Portugal, the EC and the EIB gives support to ongoing regulations and TSOs studies.

The rationale behind this Declaration is the need to develop the Iberian integration in the internal electricity market, also taking into consideration the importance of the existing projects for interconnection between Portugal and Spain, to enable:

- The Iberian Peninsula to fully benefit from the advantages of the internal electricity market.
- The central European market connected through some countries with the Iberian Peninsula to benefit from some of the comparative advantages present in the Spanish and Portuguese markets, such as the availability of cleaner electricity at competitive prices (e.g. wet winters).
- To increase security of supply through the internal electricity market, taking advantage of the existing generation capacity already installed in the Iberian Peninsula, largely based on RES and also on low carbon technologies (CCGT), these last ones well supported by the presence of half of the LNG facilities available in Europe.

The Declaration of Madrid highlights the urgency of conducting further investigations aiming at developing and following-up on the TYNDP2014 electrical interconnection projects in order to reach 8 GW capacity for the France-Spain border. The present document displays the most up-to-date information on this topic.

4 REGIONAL RESULTS

4.1 Scenarios and study results

4.1.1 Choice of the scenarios

In order to identify a wider spectrum of further potential needs, it is particularly relevant to refer to the most "network demanding" conditions. In this respect, the TYNDP 2014 Vision 4 scenario under highest RES development conditions has been chosen as starting reference, leading to intensified interactions between market areas, and higher usage of the transmission capacity.

Starting from this *basic scenario (TYNDP2014 Vision 4)*, Common Planning Studies have been performed within the CSW region in order to:

- identify in a complete, consistent and transparent manner further transmission development needs (especially from a market perspective)
- assess the robustness of the additional needs by means of market and network studies including regional sensitivities, to properly set future target capacities. In this sense the draft TYNDP2016 Vision 3scenario has been used for that purpose
- define conceptual development projects to achieve target capacities (both market-based and political objectives)
- provide information on gaps or additional investigations that are necessary in case it would not be possible to propose any even conceptual project to meet the target.

According to the general methodology described in chapter 2.3 network studies were also conducted for TYNDP2014 Vision 1 and Vision 3 in order to shape additional candidate projects and needed development/upgrade of internal grids. Some TSOs also conducted some investigations with draft TYNDP2016 Vision 3[4].

The results of the Common Planning Studies, reported in detail in the present chapter, confirmed the preliminary findings of the TYNDP 2014 and especially the opportunity to consider - further to the projects already planned in the TYNDP 2014 - additional transmission capacity increases on the borders in the region.

Nevertheless, the results for the basic scenario (TYNDP 2014 Vision 4) for Common Planning Studies present some difference regarding the ones obtained in the RgIP 2014 due to the starting overall hypothesis accepted in the process in order to get consistency in the results from all RGs: European dataset and RES profile from the climate data base were considered and other simplifications in contrast to some regional characteristics and other issues analyzed in the RgIP 2014.

4.1.2 Description of the scenarios

The following figures show basic assumptions of TYNDP 2014 Vision 4 scenario before the starting of the Common Planning Studies, namely the installed capacities and the annual generation and demand per country in the Continental South West Region.

[4] Scenario provisionally released in April 2015 for internal ENTSO-E use, and submitted to public consultation. Afterwards the final one will be included in the final release of TYNDP 2016 Scenario Development Report, made publicly available in the ENTSO-E website.

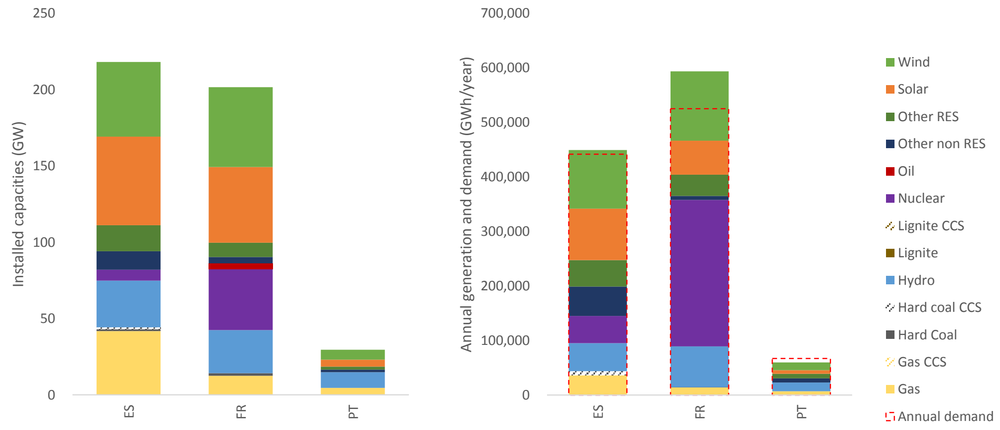

Figure 4.1.2-1 Installed capacities (GW) and annual demand and generation (GWh/year) in Vision 4 TYNDP 2014 in the Common Planing Studies in the RG CSW

On Figure 4.1.2-1 it can be seen that the level of wind and solar power is very high in the RG CSW (as in all RGs). On the other hand the importance of nuclear energy is still high but lower than in other TYNDP 2014 Visions , not only because of the increase of renewable energy, but also because this Vision considers a decrease of the share of nuclear generation to 50% of the energy mix in France, in line with the objective of the French energy policy. Actually, this Vision considers only 40 GW installed nuclear capacity in France (instead of 63 GW today).
For the initial situation for the Common Planning Studies, the participation of each generation type in the CSW region with respect to the total generation is 46%, 35%, 13% and 6% for renewable, thermal, hydro and others non renewable, respectively. High CO2 price results in having gas before coal in the merit order. Basic assumptions in fuel type and CO2 prices for TYNDP2014 Vision 4, and draft TYNDP 2016 Vision 3 are included in chapter 7.2.

4.1.3 Market studies results

Market-based target capacities

In the preparation of the TYNDP 2016, in order to ensure that the regional project portfolio is sufficient to accommodate any of the TYNDP visions for 2030, ENTSOE conducted a pan-European iterative market study consisting in increasing step by step the interconnection capacity of every border of the region and comparing the Socio-Economic Welfare (SEW) from this increase to the investment cost of a potential standard project that would provide it. The more reinforcements (higher capacity) are added on a given border, the lower is the SEW given by the last additional increases and generally the more expensive additional projects are; thus the optimal value for a border is obtained when the expected additional SEW of a new increase in that border does not cover the needed investment cost that would be necessary to obtain this increase.

The following figure shows the standard costs and the SEW after the first iteration of the Common Planning Studies :

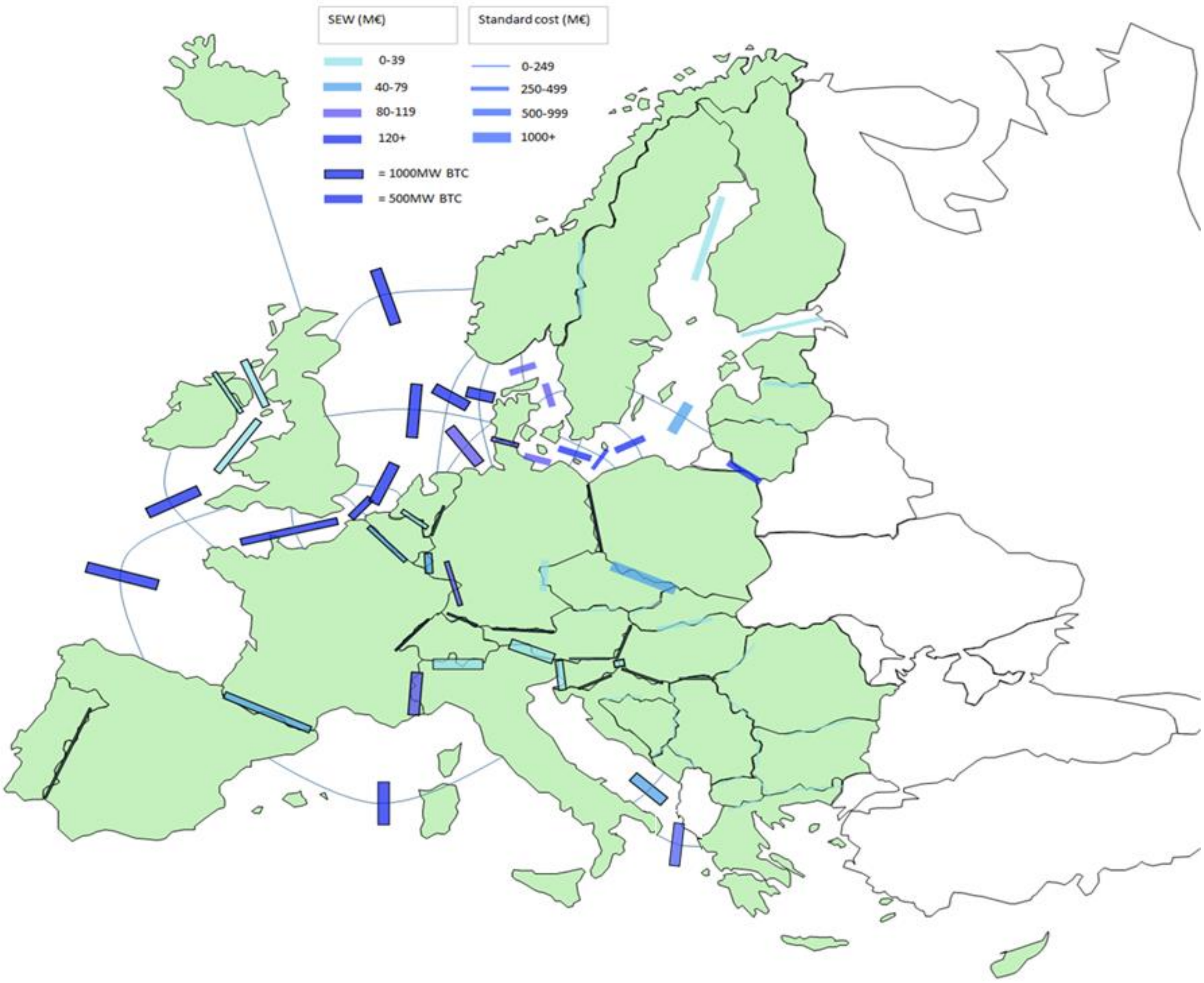

Figure 4.1.3-1 Borders with SEW and standard costs range in the 1st iteration of the screening process

For CSW region, the borders tested in the analysis were Spain-France, Spain-Portugal, Spain – Great Britain and Spain-Italy. After three iterations, the pan-European study enabled the selection or rejection of potential interconnector project candidates. In the Continental South West (CSW) region, the outcome of the analysis was:

- Increase of 3GW on the ES-FR border (from 5 GW to 8 GW of NTC, in addition to considering a multiterminal ES-FR-GB with 1 GW from a non-ENTSO-E project promoter as included in the TYNDP 2014)
- Increase of 1GW on the ES-PT border (from 3.2 GW to 4.2 GW of NTC)
- No increase of ES-GB nor ES-IT

The possibilities connecting Spain to Great Britain or Italy were taken into account as possibilities to directly connect the Iberian Peninsula to these countries without stopping in France. However they did not show enough profitability. They have a high cost due to the high length of the links (900-1200 km) that have to be adapted to particularities of the seabed regarding depths, slopes, canyons, etc…while also considering socio-environmental constraints like protected areas, commercial ports and leisure marinas. Apart from the cost, there are also additional considerations that could impact the feasibility of such connections, especially the connection to Italy.

Connections between Great Britain and continental Europe showed in general high profitability in the Common Planning Studies due to the high levels of renewable generation in Great Britain considered in the TYNDP 2014 Vision 4. However, the cost of projects was cheaper for connections to the nearest countries such as France, Belgium, and the Netherlands. Taken this into account, the Common Planning Studies concluded the profitability of several GW of new projects between Great Britain and these countries, while potential connections to Spain resulted non profitable. North Sea Regional Group proposes for TYNDP2016 assessment 3 GW of new projects on top of TYNDP2014 projects.

The market based target capacities, resulting of the market Common Planning Study, are represented on the Figure below. The results shown have been obtained after five iterations starting from the base case (initial situation) for TYNDP2014 Vision 4. Notice that all TYNDP2014 projects in the region were considered in the base case, including a 1GW multi-terminal ES-FR-GB link promoted by a non-ENTSO-E project promoter.

Figure4.1. 3-2: Common planning studies (TYNDP2014 Vision 4) Market-based Target Capacities

The following Figure shows the annual generation and demand per country in the Continental South West Region after finalizing the market Common Planning Studies (final situation), that is with 8GW between France and Spain, 4.2 GW between Portugal and Spain and with the 1 GW multiterminal ES-FR-GB.

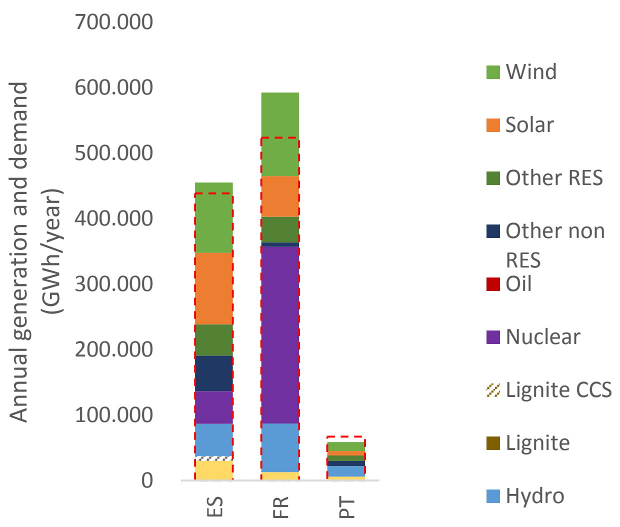

Figure 4.1.3-3 Annual demand and generation for final situation of Common Planning Studies Vision 4 TYNDP2014

For the final situation for the Vision 4 in the Common Planning Studies, the participation of each generation type in the Continental South West region with respect to the total generation is 47%, 34%, 13% and 6% for renewable, thermal, hydro and others non-renewable, respectively. In comparison to the initial case, the renewable generation increases and the thermal generation decreases.

The Figure 4.1.3-4 shows the country balances in the RG CSW in the starting and final situation of the market Common Planning Studies.

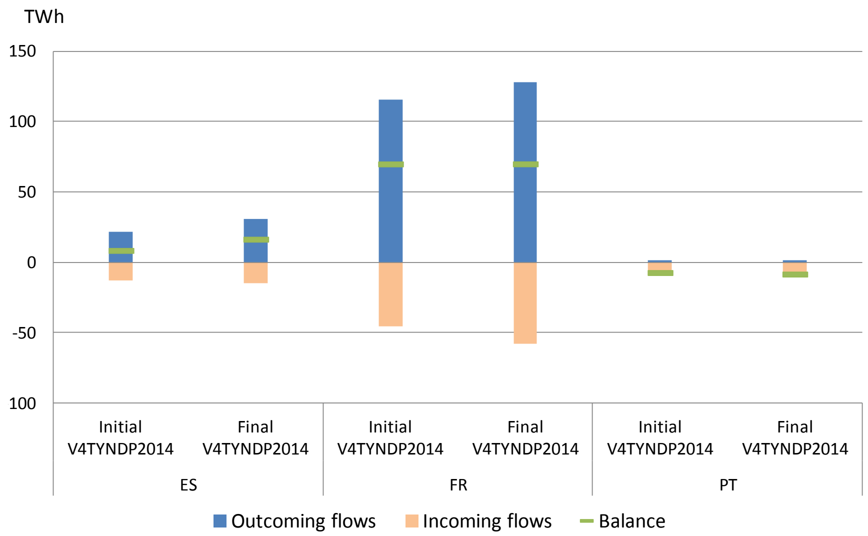

Figure 4.1.3-4 Gross cross-border import and export volumes in RG CSW for TYNDP2014 Vision 4 in Common Planning Studies

As cross-border capacity increases by 3GW (from 5 GW to 8 GW) between Spain and France, exchanges increase in both directions although the annual net balance is quite the same. However, in the table 4.1.3-1 we can see that the congestion rate drops significantly in the direction from France to Spain.

	ES ->FR	FR -> ES	ES -> PT	PT -> ES
Initial V4TYNDP2014	21%	19%	14%	2%
Final V4TYNDP2014	19%	10%	7%	1%

Table 4.1.3-1 Level of congestion in RG CSW (% yearly hours of congestions) in the market Common Planning Studies

Regarding the border Spain-Portugal, the capacity increase of 1GW (from 3.2 GW to 4.2 GW) provides a small increases in the export from Portugal to Spain but increases more the exports from Spain to Portugal. We can also see that the congestion rate decreases in both directions presenting higher values in Spain-Portugal direction.

The Figure 4.1.3-5 shows the yearly average marginal cost difference in TYNDP2014 Vision 4 scenario countries in the starting and final situation of the market Common Planning Studies.

The average marginal costs differ among the countries due to a different generation mix and limited capacity that do not allow having yet a single electricity market. These results correspond to a yearly average for the hourly absolute price difference. Nevertheless, the hourly results show that in 2030 with the planned interconnections in the region both the Spanish-Portuguese and the Spanish-French border will experience higher energy exchange volumes, with price differences sometimes higher than 20€/MWh.

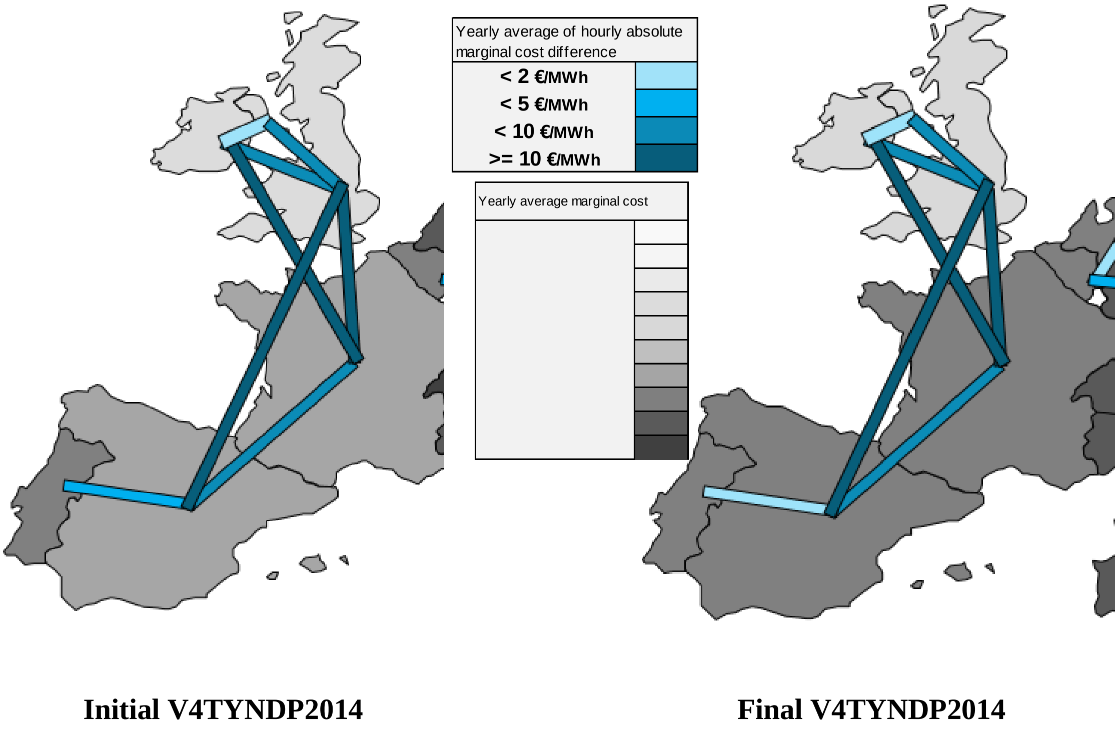

Figure 4.1.3-5 Yearly average marginal cost (grey scale) and average hourly absolute values of price difference (blue scale) in Vision 4 TYNDP 2014 scenario in the market Common Planning Studies

Regarding marginal cost results, increasing cross-border capacities does not involve a significant rise of the yearly average marginal cost in Spain and France and no changes for Portugal. Thus the gap in marginal costs between Spain and Portugal decreases. The gap in marginal prices between France and Spain is reduced from around 8 €/MWh to around 6 €/MWh.

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Additional analysis to check the robustness of the Common Planning Studies results has been made. For RG CSW this sensitivity analysis compare previous TYNDP 2014 Vision 4 and draft TYNDP2016 Vision 3 market results. The benefit from the above mentioned increases is significantly lower in this new scenario; detailed results are shown in chapter 7.2.

4.1.4 Network studies results

Reference grid

After obtaining market-based target capacities, the Common Planning Studies were focused on grid studies in order to shape potential candidate projects to provide the mentioned capacities increases.

- 8000 MW on the border Spain – France (+3000 MW compared to the cross border capacity in TYNDP 2014)
- 4200 MW on the border Spain – Portugal (+1000 MW compared to the cross border capacity in TYNDP 2014)

As previously said, the Common Planning studies were conducted with the scenario of TYNDP2014 Vision 4. This scenario is characterized by a high level of renewable energy sources. Based on the detailed results of market studies with the new exchange capacities on the borders, some points in time (PiT) were chosen on a regional basis. For these points in time, the generation mix per type and the consumption along with their location were simulated using the power-flow simulation tools (Convergence for RTE, and PSSE for REE and REN). After having exchanged the national models and merged those models to have a regional model, an AC load flow has been performed to assess bottlenecks. A complementary study has been done with a DC approximation in order to assess flows on a yearly basis on the complete grid.

The flows in N-situation (without contingency) for case 1 (Point in Time of 4th December at 11:00) are shown in the following figure. The same data for cases 2 (Point in Time of 13th April at 22:00) and 3 (Point in Time of 18th August at 10:00) can be found in chapter 7.2. As can be seen in the figure in winter average load situation with flows from France to Spain would have high flows in the east part of the Spain-France border to support the high load in Catalonia, while setting all the HVDC projects at maximum there is a reverse flows in the AC lines in the Basque Country to support the French area near the border. In the Portuguese-Spanish border, with flows from Spain to Portugal, the interconnection lines in the north assume higher flows than the southern ones.

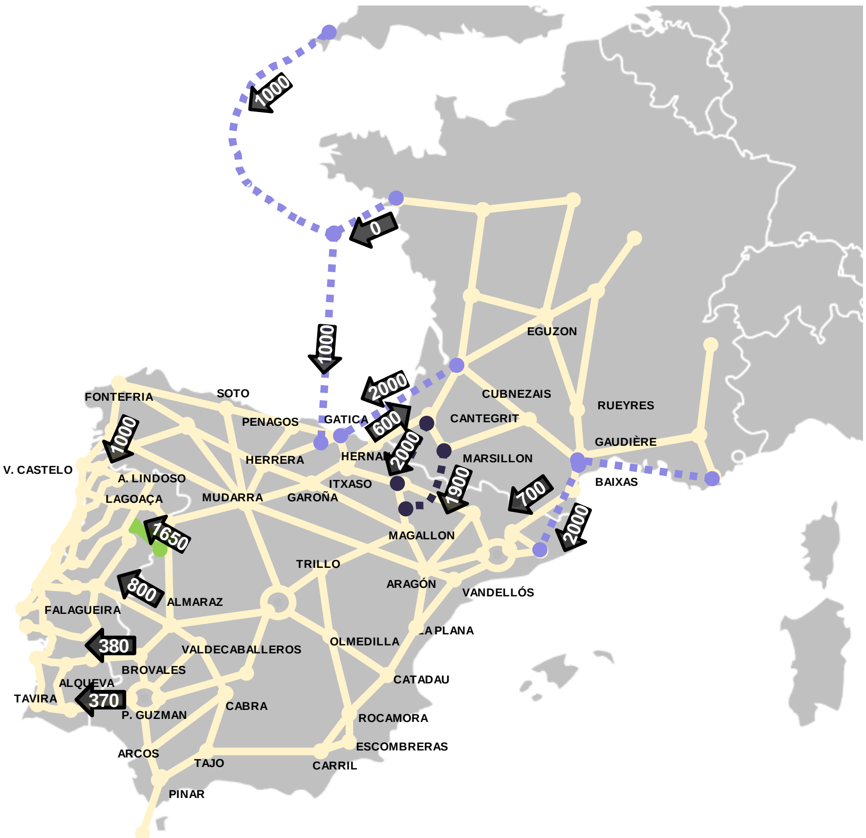

Figure 4.1.4-1 Map of active power (MW) for Case 1: Point in Time 04 December 11 :00

New projects proposed for TYNDP2016

Interconnection Spain-France

In order to address the 3GW capacity increase obtained in the market-based target capacities, seven alternatives were considered as presented in the next Figure. These alternatives are the evolution of the three proposals suggested in the TSO agreement on the 5th of January 2015 introduced in chapter 3.3, giving special attention to the environmental conditions of the Pyrenees on both sides of the border. This analysis results in some projects considering underground solutions in long sections, and therefore with HVDC technology.

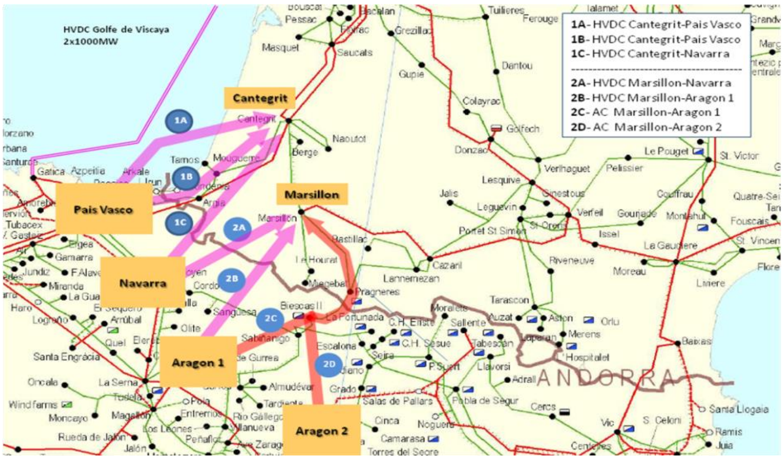

Figure 4.1.4-2 Alternatives for additional cross border projects between France and Spain

Studies showed that two new cross-border investments are needed for achieving this 3 GW increase. In order to optimize the use of existing grid, one of them would be in the western part of the border (with the highest amount of flows in a high renewable scenario), connected to the French substation of Cantegrit and to País Vasco or Navarra in Spain. This connection allows using the corridor along the French coast to Bordeaux, which load is alleviated with the Biscay Gulf. The other should be in the Central-Western part of the border, connected to the French substation of Marsillon and to Navarra or Aragón in Spain.

A preliminary environmental study has been performed in order to estimate the possible routes for every alternative, and the most up-to-date conclusion is that the most efficient solution is a combination of two separate interconnection projects: one between Navarra (Spain) and Landes (France) and one between Aragon (Spain) and Pyrénées Atlantiques (France). To analyse the internal needs in France and Spain, the projects were defined as:

- HVDC 2*1000 MW technology VSC = Cantegrit (France) – Dicastillo (Spain), and connection of the new Dicastillo substation to existing grid in Spain.
- HVDC 2*1000 MW or Double circuit AC 2*1800 MVA = Marsillón (France) – Sabiñánigo (Spain), which requires in Spain a new 400 kV axis between the Cinco Villas area and Sabiñánigo, to connect the new interconnection to a strong point of the existing network.

With these new interconnectors, the grid as planned in the TYNDP 2014 (pan-European projects) is not adequate to sustain the targeted level of market exchange capacity. The main bottlenecks identified are described in the following table and figure 4.1.4-3:

Area	Severity	Origin
South West of France	Bottleneck in N and N-1	Transmit the energy coming from or to the HVDC at Cantegrit
North of Aquitaine (France) up to Paris	Bottleneck in N	Flows from Spain to French north-eastern border, including evacuation of future generation in the South West of France and demand in Paris
Axis West – East in the South of France	Bottleneck in N-1	Transmission of RES generation in case of high level of solar in South Western France plus high import from Spain
Connection Navarra-Basque Country	Bottleneck in N and N-1	Transmit the energy coming from or to the HVDC at Dicastillo or area of Pamplona. Solve east-west constraints due to RES
400kV east-west axis in Basque Country	Bottleneck in N-1	Manage the power flows to/from France (HVDC Biscay Gulf, AC lines in Basque Country and HVDC in Navarra); and between the north Axis and the Levante region
Transpyrenees axis	Bottleneck in N-1	Transmission of hydro in the Pyrenees combined with a high exchange Spain-France
Catalonia	Bottleneck in N-2	Overloads in 220kV in Catalonia which becomes a transfer path to France from Spain, especially in peak situations

In order to alleviate these bottlenecks the following investments should be added to the Western axis between Landes and Navarra:

- Upgrading both existing 400 kV Cantegrit (FR) – Saucats (FR) lines,
- Upgrading the existing Cantegrit (FR) – Marsillon (FR) double circuit 225 kV line to 400 kV single circuit line,

Moreover, it is worth mentioning that these investigations take into account additional projects in the reference case in France and Spain, that would be needed in order to integrate high amounts of RES generation included in the scenario and to accommodate the consequently larger and more volatile power flows,

- In France, upgrading the existing 400 kV axis between northern Aquitaine and southern Paris area (needed to integrate RES and accommodate consequently the larger and more volatile power flows),
- In Spain,
  - New double circuit Ichaso-Castejón/Muruarte 400 kV, already planned in the NDP
  - New double circuit Ichaso-Abanto/Gueñes-Ichaso 400kV, already planned in the NDP
  - Uprate of the trans-Pyrenees axis T-Escalona- Escalona-T.Foradada-La Pobla 220 kV, partially planned in the NDP
  - New double circuit Vic-Vandellos/ Pierola 400 kV

Should this grid development not be realized, the 8 GW capacity could not be obtained.

Projects are already proposed at national level in Spain to solve the congestion but they were not included in the TYNDP 2014 as they did not fulfil the eligibility criteria. Now, with higher exchange with France these constraints become more critical. However, they still are projects of which main drivers are independent from the interconnection and that will be built independently from the progress of cross-border projects (so it was decided not to cluster these projects with the new interconnections) but they do not fulfil the criteria to be independent TYNDP projects. Therefore, they will be considered as regional with special influence on the interconnection.

Last, even with all the above-mentioned grid development, significant additional congestion is observed in contingency situations on other internal axes, like i/ the 400-kV line between south-western France and the Rhône Valley in case of high power flows from Spain to Italy, Switzerland and Germany; and ii/ the 400 kV line connecting northern Aquitaine to Pays de Loire region (see figure 4.1.4-3 below). Also in Spain additional congestion can occur in the path between Levante and the north (Catalonia and Aragon) and between the centre and the Basque Country. As the level of congestion on these axis highly depends on the amount of RES generation in Spain and France but also in the British Isles, Germany and Italy, the location of nuclear units shutdown and on potential non-ENTSO-E members projects considered in the base case, specific projects were not developed at this stage to mitigate residual congestion on these axes.

Interconnection Spain- Portugal

In order to assess how to reach the 4.2 GW obtained in the market studies, detailed network studies were performed for the 2020 and 2030 horizons. The results of the Common Planning Studies which considers the most up-to-date information of future generation and demand, as well as its location showed that with the new northern interconnection the exchange capacities could reach higher values than the ones obtained in previous analysis, especially in the direction from Spain to Portugal where now it can reach the 4.2 GW value.

In the opposite direction, from Portugal to Spain where the exchange capacity value can reach 3.5 GW after the new northern interconnection and the reinforcement of Sevilla ring, the Common Planning Studies showed that the weakest area was the Douro region. With high level of renewable energy - Vision 4 of TYNDP 2014 – high values of RES generation (wind and hydro) with significant exports from Portugal to Spain showed bottlenecks in the 400 kV interconnection line Lagoaça (PT) - Aldeadavila (ES) and in the 400 kV Spanish axis between Aldeadavila – Villarino - Tordesillas considering N-1 and N-2 contingencies. In addition, in dry conditions with high exports from Spain to Portugal some congestions was identified in the 220 kV Portuguese axis between Lagoaça and Porto region, also considering N-1 contingencies.

The main bottlenecks identified are described in the following table and figure 4.1.4-3:

Area	Severity	Origin
Douro region cross border axis	Bottleneck in N-1 and N-2	high RES (wind and hydro) conditions with significant exports from Portugal to Spain
Axis Lagoaça- Porto	Bottleneck in N-1	Dry conditions with high exports from Spain to Portugal
Cedillo-Falagueira axis	Bottleneck in N-1	High export from Spain to Portugal

Therefore, a new conceptual project considering new reinforcements in the Douro region (axis Armamar – Pocinho – Lagoaça in Portugal and Aldeadavilla – Villarino in Spain) has been proposed for a CBA assessment in the ENTSO-E framework. Additional studies will be needed to confirm this project and to identify more deeply the investments needed. These investments can be just the uprate and/or reconductoring and/or upgrading of existing lines or even the construction of new lines. Special attention is needed to the cross-border zone that is considered a protected area (Natura 2000 Network).

Regional Bottlenecks and additional studies

The following Figure summarizes the bottlenecks in the region without and with the reinforcements proposed. As these congestion situations are highly dependent on the amount and location of RES generation and the location of nuclear units shutdown and on potential projects from non-ENTSO-E members considered in the base case, specific projects were not developed at this stage to mitigate these residual congestions.

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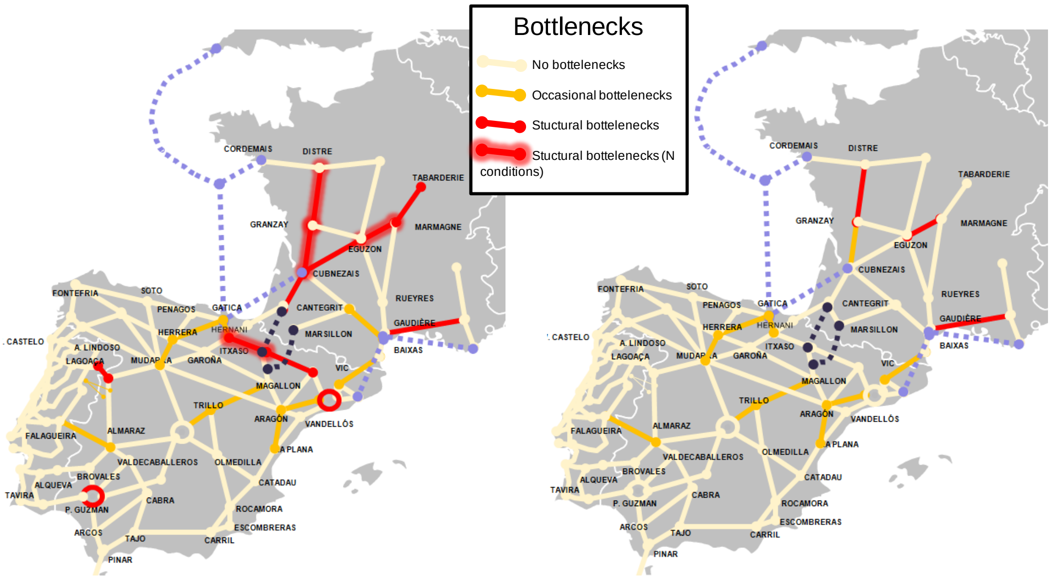

*Figure 4.1.4-3 Bottlenecks in Vision 4 TYNDP 2014 wit*th 8GW in FR-ES and 4.2 GW in ES-PT and new crossborder projects in ES-FR border (left), bottlenecks with the new reinforcement in ES-PT border and internal reinforcements proposed (right).

A sensitivity analysis was performed considering to the assumptions of the draft Vision 3 from TYNDP 2016. With a scenario with less renewables energy, the proposed internal reinforcements are sufficient to solve most of situations that were still identified considering the proposed projects (interconnections and internal reinforcements, see Appendix 7.2).

It must be noted that the investigations performed during the Common Planning Studies phase only referred to steady state studies (load-flow analysis). With higher cross-border flows on 400 kV lines and few thermal units running, some static or dynamic voltage constraint may occur. Complementary studies are needed to estimate the volume, the characteristics and the location of the MVAr investments, and ensure the dynamics of the scenario. Also the dynamic behaviour of the system under more severe contingencies (and especially the frequency stability) should be studied in complementary studies, since larger and more volatile transit flows over longer distances trigger new technical challenges regarding system operation (frequency control, reserve management, voltage control, etc. Especially the connection of the Iberian Peninsula to continental mainland mainly via DC technology with significant AC support is a specific situation that would deserve dedicated studies. In addition, the maximum angle deviation that can occur between two border busbars after the trip of a line connecting those two busbars, which may difficult the reconnection of the line, has not yet been analysed.

4.1.5 Progress of Cross Border reinforcements considered in TYNDP 2014

Interconnection Spain-France

The Eastern Interconnection between Santa Llogaia in Spain and Baixas in France (TYNDP2014 project 5), and the connection in Gerona to the Spanish network (project 213) have achieved the construction in December 2014, and commercial operation is planned for summer 2015 after a test period. This new interconnection will double the exchange capacity France-Spain reaching 2.800 MW. The full capacity transfer from Spain to France requires the commissioning of the phase shifter transformer in Arkale (project 184) scheduled for 2017.

Since 2009 the Spanish and French TSOs are working on an additional new cross border project. The studies performed show that for a efficient transmission of energy between France and Spain once the HVDC Baixas-Santa Llogaia will be in operation in the East, a new link in the West is the best way to balance the East-West energy flows and, therefore, to grant a better increase of the exchange capacity in both directions. Having analysed different alternatives across the Pyrenees and the sea taking into account all the political and technical restrictions, the investment optimisation shows that the link that has to be regarded as the most efficient, and so as first priority, is the “Gulf of Biscay” project, saving expensive reinforcements in the internal transmission grids. The feasibility studies are ongoing by RTE and REE in order to allow the initiation of the administrative processing for permit granting as soon as possible in 2016.

Interconnection Spain- Portugal

As previously said, a new Portugal-Spain Interconnection is planned between the regions of Minho in Portugal and Galicia in Spain (TYNDP 2014 Project 4). This project was conceived to achieve the main political goals (agreed in 2006 in Badajoz Summit between the Spanish and Portuguese governments) established for reaching a complete operational Iberian Electricity Market (MIBEL), i.e. a minimum commercial exchange capacity of 3 GW.

Given the difficulties of political and social nature for this new interconnection in the cross-border area (public local opposition regarding the establishment of the line), that is causing delays in the project, REN had to take the decision to withdraw the Portuguese section of this interconnection (between Ponte de Lima and the border) from the Environmental Impact Assessment (EIA) process that was in progress, in order to maintain the schedule of other Portuguese investments that were included in the same EIA process, as they are essential for the network integration of the new hydro power plants of Salamonde II and Venda Nova III. The separation of the permitting procedure was considered as the best approach to ensure the commissioning date of the network reinforcements that are needed to integrate the new hydro power plants.

Studies and EIA process for the interconnection line have been restarted by REN, in particular to evaluate alternative solutions in the border area. However this situation implies a delay of the previous expected commissioning date, now to 2018.

4.2 E-Highway2050 scenarios perspective

The e-Highway2050 project is supported by the EU Seventh Framework Programme and aims at developing a methodology to support the planning of the Pan-European Transmission Network. The study project started in September 2012 and will end in December 2015.
The main goal is to develop a top-down methodology for the expansion of the pan-European electricity grid from 2020 to 2050, with a view to meeting the EU energy policy objectives. Concretely, the methodology will ensure that future EU grids can host large quantities of electricity from renewable energy sources and transport it over long distances as well as foster market integration.
The e-Highway2050 project is based on five future power system scenarios (Example, see figure below), which are extreme but realistic for a 2050 perspective. The corridors identified provide a modular development plan for a possible long-term architecture. The five scenarios span uncertainties (technical, economics, political, social...) as well as different future choices (RES incentives, energy market integration, regulations, industry standards...).

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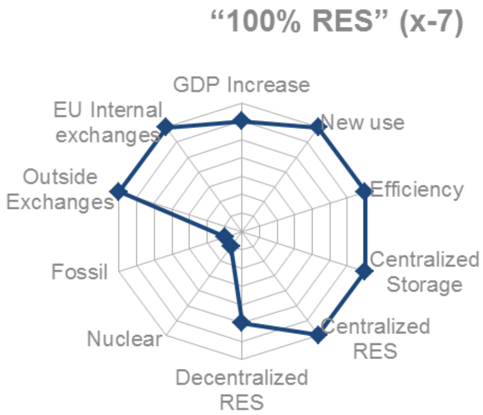


Figure 4-5 - Example of scenario characteristics

The methodology used in the e-Highway project, though different from the TYNDP planning, is still based on market and network studies. To focus on 2050 pan-European adequacy and efficiencies, it is based on stochastic analysis of unsupplied energy, energy spillage and thermal generation re-dispatching. The network model used is much simplified, based on a limited number of clusters all interconnected by equivalent impedance links (see figure below).

Figure 4-6 - Reduced European grid

A comparison between 2030 and 2050 scenarios is subjective and in essence a fast evolving energy domain can always move from one 2030 Vision to any 2050 scenario. Therefore the four TYNDP Visions all show rather different ways to move forward to the 2050 goals. Regardless of the scenario perspective taken, it is important to see the TYNDP2016 projects as no-regret options across the common corridors identified in the e-Highway project, meaning that TYNDP2016 projects are the first steps to be considered by 2030 in order to match with 2050 very long term perspectives.

The regional results in this report provide further insight on this.

In the following figure, the draft results concerning additional reinforcements throughout the five EH2050 visions are displayed (colour codes represent the number of appearances in the different scenarios). It is possible to see that national borders are first object for reinforcements, but huge needs to transport RES from pan-European periphery to central Europe are envisaged as well.

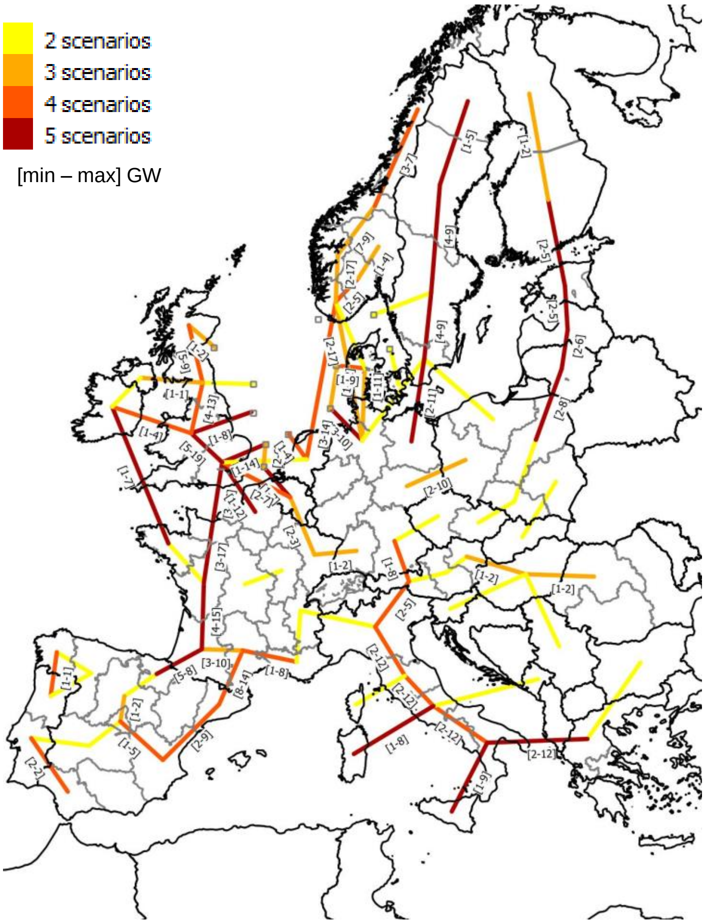


Figure 4.2-3 EH2050 common reinforcements (number of appearances in the different scenarios)

In general the reinforcements yielded by e-Highway project (to be implemented from 2030 till 2050) are to be considered on top of the TYNDP2014 projects (to be implemented from now till 2050).
In all scenarios, e-Highway results show a need for a strong North-to-South interconnection in Western Europe, from the British Isles to European mainland, especially France and beyond to the Iberian peninsula. Main drivers are the installation of wind in the northern part of Europe (especially GB and Ireland) and the very high load growth and installation of RES in the Iberian Peninsula, combined in some scenarios to large scale development of solar energy in North Africa. Need for additional interconnection between Spain and Portugal also appears in all scenarios, but with limited capacity. The additional interconnections between Spain and France and France and Great Britain presented in this report as well as the internal project "Façade Atlantique" in France and the additional interconnection between Spain and Portugal are a first step towards this long term perspective. Beyond those projects, according to E-highways results, it will be necessary to further develop the grid in the North-South direction in Western Europe between the British Isles, France and the Iberian Peninsula, following the pace the main drivers will happen.

5 PROJECT CANDIDATES

5.1 Introduction

This chapter lists all TYNDP project candidates which after finalization of the list will be assessed by ENTSO-E as part of the TYNDP2016 process. In addition, projects that have impact on the region but are not of pan-European significance are also presented in this chapter; these are not part of the TYNDP list and will not be further assessed in the final TYNDP report.

A project is defined as the smallest set of assets that effectively add capacity to the transmission infrastructure that can be used to transmit electric power, such as a transformer + overhead line + transformer. In situations where multiple projects depend on each other to perform a single function (i.e. a single project cannot perform its function without a certain other project) they can be clustered in order to be assessed as a group providing that they achieve a common measurable goal.

TYNDP2016 projects as well as regional projects are based on earlier TYNDP2014 projects, result from recent common planning studies, and/or are driven by political targets.

TYNDP project candidates in this list are structured by

- **Boundary** – which can be a specific border, a combination of borders, or an internal boundary;
- **Maturity** – based on commissioning date and national approval projects are grouped as
    - Mid-term projects: Project to be commissioned by 2022 will be assessed by TOOT method against the expected 2020 network if is acknowledged in the latest national plans or is having intergovernmental agreement;
    - Long-term projects: Project to be commissioned by 2030 will be assessed by TOOT method against the expected 2030 network and PINT method against the expected 2020 network if the project is acknowledged in the latest national plans or is having intergovernmental agreement;
    - Future project candidates: All other projects which do not fall under the previous categories will be assessed with PINT method against the expected 2030 network.

The following map shows all cross-border projects to be analyzed during TYNDP2016. The projects are categorised by the following colour code:

- **Dark blue** – new TYNDP project candidates (among which the ones identified during the Common Planning Studies)
- **Light blue** – re-confirmed TYNDP2014 projects
- **Grey** – Regional projects (if specified)

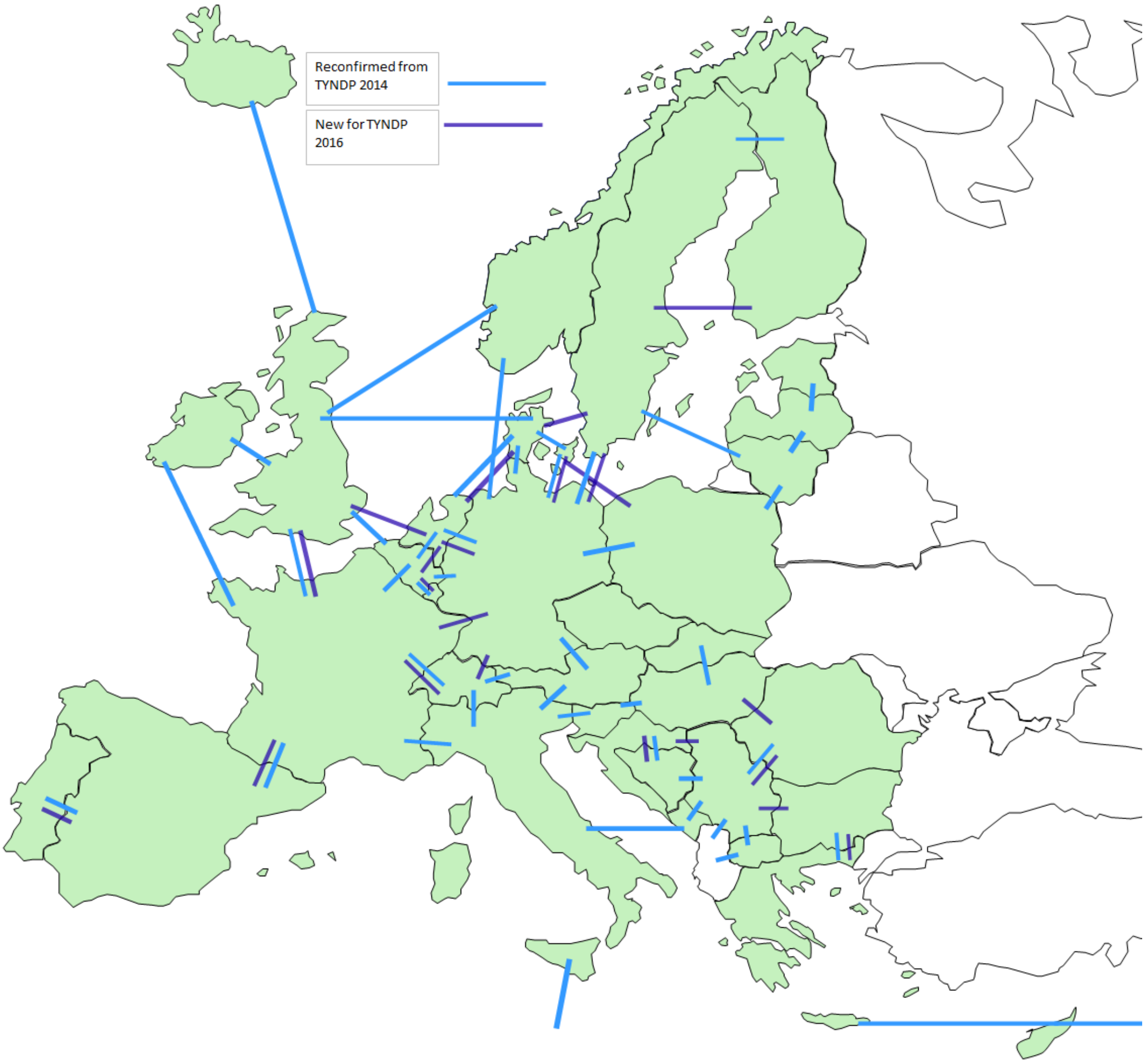


Figure 5-1 Borders with reconfirmed or new projects

5.2 List of TYNDP2016 project candidates

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
East-West	**Aragón-Catalonia south**	This project is a reinforcement between Aragón and Cataluña required to solve the congestion on the existing grid, due to unbalanced production and consumption between Aragón and Cataluña, mainly between Teruel and Tarragona. The project consists of a new 400 kV double circuit OHL line between Escatrón and La Secuita (Spain), and includes new substations in Els Aubals (with direct connection of wind power) and in La Secuita (400/220 kV).	Direction A: 0-30 - Direction B: 0-500	157	market and RES integration, constraints solution	2027	Future Project	REE
inside-outside	**RES in north of Portugal**	This project integrates new amounts of Hydro Power Plants in the Northern region of Portugal and creates better conditions to evacuate Wind Power already existent and new with authorization for connection (with the reinforcement of the local 220kV network). These new amounts of power will increase the flows in the region, and it is expected that the flows could reach 3800 MW, which must be evacuated to the littoral strip and south Portugal through three new 400kV 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 400kV Alto Lindoso-Riba de Ave-Recarei and Lagoaça-Aldeadávila axis, which induces additional needs for reinforcement of this axis in a coordinated way.	Direction A: 3700-5100 - Direction B: 0-0	1		2022	Mid-term Project	REN

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
inside-outside	**Baza project**	A new double circuit Caparacena-Baza-La Ribina 400 kV OHL, in Spain with two new 400 kV substations in Baza and La Ribina. This project will allow integrating an important contingent of wind and solar generation, both at transmission and distribution level in an area of Jaen where the transmission network is very weak. Moreover, a new pumping hydropower plant with pumping storage is expected in this area. On the other hand, the project will help reducing congestion in the existing single circuit Litoral- Tabernas-Hueneja-Caparacena 400 kV, between Almeria and Granada	Direction A: 550-770 - Direction B: 3280-3630	13	RES integration and constraints solution	2025	Future Project	REE
inside-outside	**Integration of RES in Alentejo**	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 doAlentejo-Alqueva-Brovales andTavira-Puebla deGusman. 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.	Direction A: 1400 - Direction B: 0	85		2025	Long-term Project	REN

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Internal boundary in France North-South	**Massif Central North**	The project is a new 400 kV line in an existing corridor. The precise description of the project needs additional studies.	Direction A: 3300 - Direction B: 3800	216	The main driver of the project is the integration of future hydro generation and specially new pump storage. The project is also needed to accomodate some scenarios with high RES and nuclear shutdown.	2030	Long-term Project	RTE
Internal boundary in France North-South	**Massif Central South**	The project will develop in the north-to-south direction in the south of the Massif Central area (France), between Rueyres and La Gaudière. It will mainly consists in a new double-circuit 400-kV overhead line substituting to the existing 400-kV single circuit line.	Direction A: 3300 - Direction B: 3800	158	The main driver for the project is the integration of existing and new wind & hydro generation in the Massif Central (France) including possible pump storage.	2025	Long-term Project	RTE
Internal boundary in south-western France	**Façade Atlantique**	Investments in France. Upgrade of the North-South 400 kV corridor between Aquitaine (Cubnezais) and Vallée de la Loire (Tabarderie). Exact scope of the project will be defined in the follow up of the studies.	3000	Market integration, RES connection. The projects allows to evacuate to the North of France additional generation located in the South West of France, specially Solar and wind. It is needed for high exchange between France and Spain.	Common Planning studies. Internal studies performed by RTE.	2030	Future Project	RTE
Internal boundary in Spain (generation)	**Spanish Pumping**	Potential necessary transmission development for the connection of potential 3rd party storage projects (mainly pumping storage) in the TYNDP	3000	storage connection and evacuation	none	2020	Future Project	REE

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Internal boundary in Spain Navarra-Basque Country or ES-FR	**Connection Navarra-Basque Country**	New OHL 400kV double circuit Ichaso-Castejón/Muruarte 400kV	1500-2000	Essential project to connect futureFR-ES Navarra-Atlantic Pyrenees, but independently to this, it is required for internal needs such as solve existing congestions between Navarra and Basque Country and RES integration in the area	National Development Plan and Common Planning Studies	2020	Mid-term Project	REE
North-South	**Godelleta-Morella/La Plana**	This projects consist of a new OHL 400 kV AC axis Godelleta-Morella/La Plana (Spain) and represents the reinforcement of the Mediterranean axis needed to accommodate geographical unbalances between North and South, especially between Castellón and Valencia, which besides are influenced by the exchanges with France. Congestions are expected due to important south-north flows caused by renewable energy sources (onshore wind but mainly solar), which result in dumped energy without the project.	Direction A: 670-850 - Direction B: 1400-1500	193	market and RES integration. Constraints solution	2023	Future Project	REE

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
outside-inside	**Asturian Ring**	This project consist of closing the 400kV Asturias Ring in the northern part of Spain, and comprises a new 400 kV OHL line between Gozón and Sama, with two new 400kV substations in Reboria and Costa Verde (Spain) , which main purpose is support the distribution network. Therefore, this project is required to ensure the security of supply in the area of Asturias in a future with very low thermal generation in the region.	Direction A: 400-500 - Direction B: 700-700	151	Security of supply	2026	Future Project	REE

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Portugal - Spain	**Interconnection Portugal-Spain**	A new OHL 400kV interconnection betweenFontefría (Spain) and Ponte de Lima (Portugal). Internal reinforcements complement the cross border section, such as the axis in Spain betweenFontefría andBeariz and in Portugal between Ponte de Lima (previouslyViana do Castelo), Vila Nova deFamalicão (previously Vila doConde) and Vermoim/Recarei. This project was included in the 2013 PCI list (PCI 2.17).	ES->PT 1900 MW and PT->ES 1000 MW	4	This project will allow to increase the interconnection capacity between Portugal and Spain up to governmental agreements. 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 a new 400kV interconnection route in the North (Fontefría-Ponte de Lima), besides the 400kV internal reinforcements required, due to the important loop flows between the two countries. This project will also have a benefit in reducing the spilled energy in the Iberian Peninsula.	2018	Mid-term Project	REE;REN
South-North	**Cartuja**	The 400 kV double circuit Cartuja-Arcos de la Frontera and the Cartuja 400 kV substation intend to be the connection point of an important amount of wind power energy in the coastal area of Cadiz, mainly offshore but also onshore. In case of low wind production, the project will be useful as an additional injection for secure the load in the area of Cadiz.	Direction A: 425-600 - Direction B: 1560-2700	194	RES integration, and SoS	2029	Future Project	REE

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Spain - France	**Biscay Gulf**	The project is a subsea HVDC link (2000 MW) between Gatica (Basque Counrty, ES) and Cubnezais (Aquitaine, FR), that came up as the preferential strategy after deep technical and environmental prefeasibility studies accross the whole French-Spanish border.	Direction A: 2600 - Direction B: 2200	16	The project is necessary to achieve the political will to increase the connection of the Iberian Penisula to the European market. Its location allows to balance the flows on the Western and Eastern axes of the border, optimising the use of existing grid and avoiding any internal reinforcement. TYNDP2014 studies showed it would bring significant Socio-economic welfare by allowing the use of cheaper and more efficient technologies and avoiding RES spillage, especially in the Iberian Peninsula.	2022	Mid-term Project	REE;RTE

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Spain - France	**PST Arkale**	This project is a new PST (phase shifting transformer) in the Spanish substation Arkale 220 kV with affection to the Arkale-Argia cross border line between France and Spain. This device is required to increase the France-Spain exchange capacity, especially from Spain to France, and not only is able to have an independent good impact in the exchange capacity without taking into account the Eastern and Western interconnections, but also helps making the most of these projects. In addition, as this project avoids the tripping of the Arkale-Argia tie line in case of contingencies, it helps improving the Security of supply in the French Basque country. This project have been included in the 2013 PCI list	Es->FR: 500MW - FR->ES: 100MW	184	market integration, increase of crossborder capacity ES-FR	2017	Mid-term Project	REE
Spain - France	**Additional project France - Spain**	Additional projects for the 10% ratio in case of. The projects have to take into account all the 3rd Party projects.	1500	Market integration	TYNDP 2016	2030	Future Project	RTE;REE
Spain - France	**FR-ES project -Navarra-Landes**	A new interconnection between France and Spain in the Western part of the Pyrenees between Dicastillo (Spain) and Cantegrit (France). The project is considered as a HVDC project of 2x1000 MW. Internal reinforcements complement the cross border section, such as the upgrade of the connections of Cantegrit with Saucats and Marsillón, and the connection of the new Dicastillo substation.	1500-2000	Market Integration. Increase capacity in the French-Spanish border. Increase of the Interconnection ratio for Spain and the Iberian Peninsula as political guidelines.	Common Planning Studies, eHighway2050	2023	Long-term Project	REE;RTE

Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Spain - France	**FR-ES project -Aragón-Atlantic Pyrenees**	A new interconnection between France and Spain in the Central part of the Pyrenees between Sabiñánigo (Spain) and Marsillón (France). Internal reinforcements complement the cross border section, such as a new 400 kV line between Sabiñánigo and Cinco Villas, including both substations.	1500-2000	Market Integration. Increase capacity in the French-Spanish border. Increase of the Interconnection ratio for Spain and the Iberian Peninsula as political guidelines.	Common Planning Studies, EHighway2050	2023	Long-term Project	REE;RTE
Spain - Portugal	**Uprate the western 220kV Sevilla Ring**	Uprate the 220 kV lines D.Rodrigo-Aljarafe and Aljarafe-Santiponce to increase their capacity	500 PT-->ES	Market integration in the Spanish-Portuguese border. Some congestions in the transmission network of Sevilla decrease in certain demand/generation situations the cross border exchange capacity in order to maintain the security of the network and fulfill the network codes.	TSO and bilateral planning Studies in the short term.	2019	Mid-term Project	REE
Spain - Portugal	**Douro Spanish-Portuguese reinforcement**	Reinforcement of the Douro cross border region pending for complementary studies for a better definition of the investments. Draft proposal is the reinforcement of the axis Armamar (PT) - Pocinho (PT) - Lagoaça (PT) - Aldeadávila (ES) - Villarino (ES)	PT->ES 700MW; ES->PT 300MW	Market Integration in the Spanish-Portuguese border, by eliminating cross border congestions in a high RES future scenario	TYNDP 2016Common Planning Studies	2030	Future Project	REE;REN

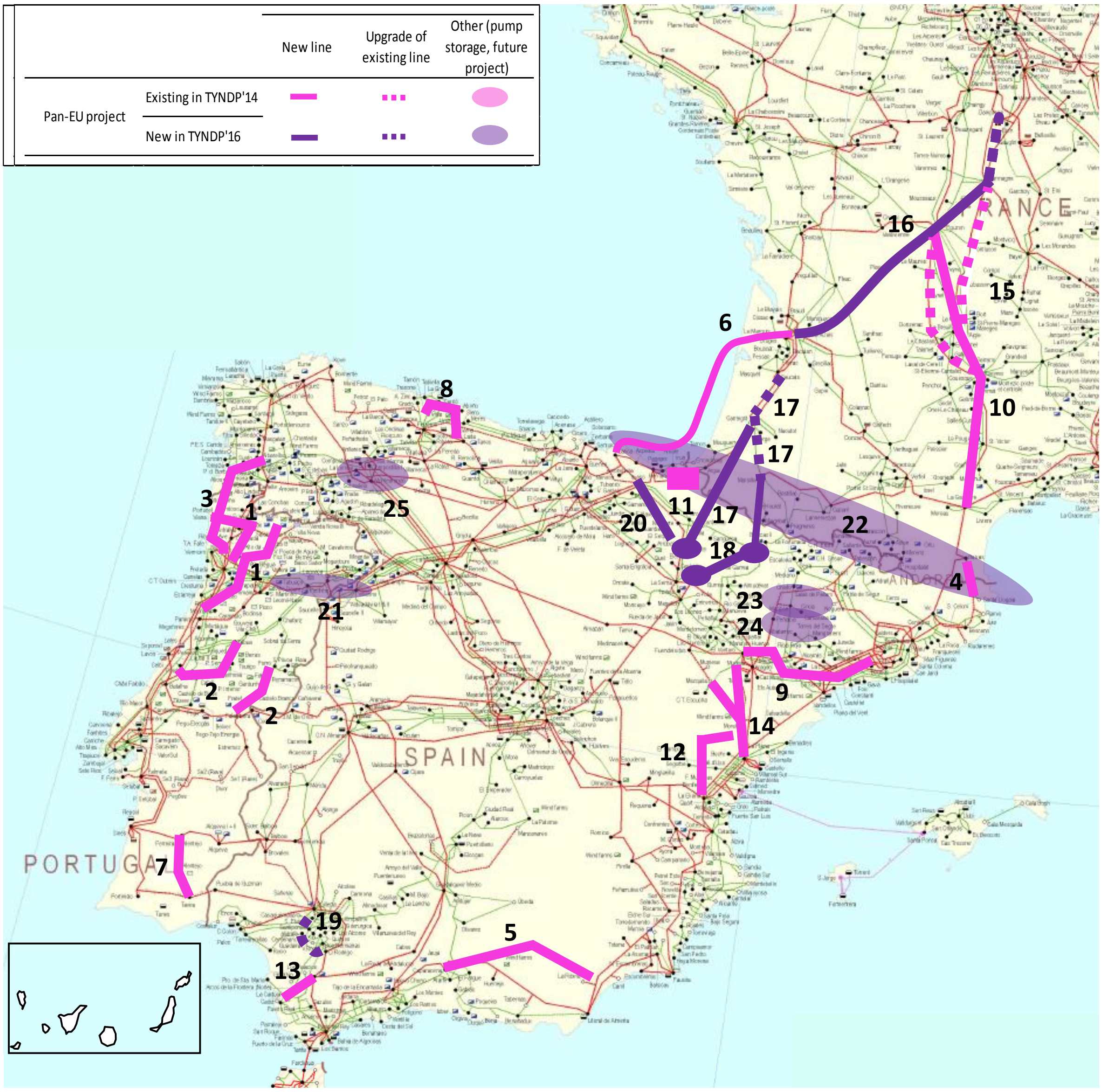
Boundary	Project name	Description	Provisional GTC [MW]	TYNDP2014 reference (if applicable) or motivation for new project candidates	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
upstream-downstream	**RES in center of Portugal**	This project integrates new hydro power plants (some of them with pumping) and evacuates the existent and new wind generation in the inner central region of Portugal (the wind target in this region overcomes surmounts of more than 2000 MW). The existing network of 220 kV and 150kV is no more adequate to integrate these new amounts of power, and a new 400kV 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).	Direction A: 1200-1600 - Direction B: 0-0	2		2020	Mid-term Project	REN
West-East	**Aragón-Castellón**	This project represents the reinforcement of the Cantabric-Mediterranean axis needed to accommodate geographical unbalances between Northern Spain and the Mediterranean area, which otherwise would produce congestions in the 400 kV corridors. Therefore, this project is required to solve constraints in the existing and future network, caused by existing and new RES and because of flows in both directions between Aragón and Castellón, and affected by high exchanges with France. The project consists of two 400kV axis Mudejar-Morella and Mezquita-Morella that converge in an axis Morella-La Plana. The project also includes a new 400kV substation Mudejar with connection to the axis Aragón-Teruel (Spain).	Direction A: 100-900 - Direction B: 1900-2600	203	market and RES integration. Constraints solution	2016	Mid-term Project	REE

In addition, the following storage projects have been promoted as TYNDP2016 project candidate

Name of the project	Country	Type of storage	Maximum active power [MW]	Total storage capacity [GWh][5]	Expected commissioning date
Reversible pumped-storage hydro-electric exploitation "MONT-NEGRE" power 3300 MW Zaragoza, Spain	Spain	Pure pumping	3300	7511,0	2020
Purifying -Pumped Hydroelectric Energy Storage (P-PHES Navaleo)	Spain	Pure pumping plant	541	3,5	2018

[5] defined as total energy delivered to the grid when reservoir is totally emptied, starting at reservoir full condition

In the following figure the pan-European projects of the CSW region are shown with more detail:



Id on the map	Name of the Project	Project ID in TYNDP2014
1	RES in north of Portugal	1
2	RES in center of Portugal	2
3	Interconnection Portugal-Spain	4
4	Eastern interconnection ES-FR (commissioned in 2015)	5
5	Baza Project	13
6	Biscay Gulf	16
7	Integration of RES in Alentejo	85
8	Asturian Ring	151
9	Aragón-Catalonia south	157
10	Massif Central South	158
11	PST Arkale	184

Id on the map	Name of the Project	Project ID in TYNDP2014
12	Godelleta-Morella/La Plana	193
13	Cartuja	194
14	Aragón-Castellón	203
15	Massif Central North	216
16	Façade Atlantique	New in TYNDP2016
17	FR-ES project -Navarra-Landes	New in TYNDP2016
18	FR-ES project –Aragón - Pyrénées Atlantiques	New in TYNDP2016
19	Uprate the western 220kV Sevilla Ring	New in TYNDP2016
20	Connection Navarra-Basque Country	New in TYNDP2016
21	Douro Spanish-Portuguese reinforcement	New in TYNDP2016
22	Additional FR-ES project	New in TYNDP2016
23	Spanish Pumping transmission project	New in TYNDP2016
24	Mont-Negre pump storage	New in TYNDP2016
25	Navaleo pump storage	New in TYNDP2016

Figure 5.2-1 Map of Pan-European projects in the CSW region

5.3 List of projects of regional significance

Some regional projects are considered in the Continental South West region. Although these projects do not fulfil the criteria to be considered pan-European ones, they are of importance regarding their influence in the region from SoS, RES integration and/or market integration point of view.

In Spain there are some projects that are considered important for the new interconnection development but which have their own drivers, so they cannot be clustered with the interconnection as they will be built independently. This is the situation for the Navarra-Basque Country axis (Ichaso-Castejón/Muruarte 400kV), the TransPyrenean axis and the Ichaso-Abanto/Gueñes-Ichaso 400kV).

Another group of projects considered as regional projects because of their influence in market integration and reduction of generation costs are connections between the Iberian Peninsula and other external Spanish regions such as Ceuta and Mallorca, and the connection among Balearic Islands. These projects also contribute importantly to the security of supply of these areas.

A last group of projects also reported are the interconnection among Canary Islands and projects for RES integration and market integration. Although they do not have influence on the continental transmission system, the production of RES in the islands also contributes to the European objectives.

In Portugal there are several investment needs considered as of regional importance. They were identified in the planning exercises carried out under the TYNDP scope and they are mainly related with connection of RES generation. These investments (400 kV axis Fundão-Guarda-Seia and Ribeira de Pena-Guarda) were included in the set of projects of Pan European significance proposed in TYNDP 2012, although with the new rules of clustering projects for TYNDP 2014 (Investment items may be clustered as long as their respective commissioning dates do not exceed a difference of five years) they had to be removed from the initial clusters and were included as investments of regional importance.

These regional investment projects are important to provide the adequate conditions for the evacuation of those foreseen amounts of new power generation and to reach the TYNDP goals, namely concerning RES.

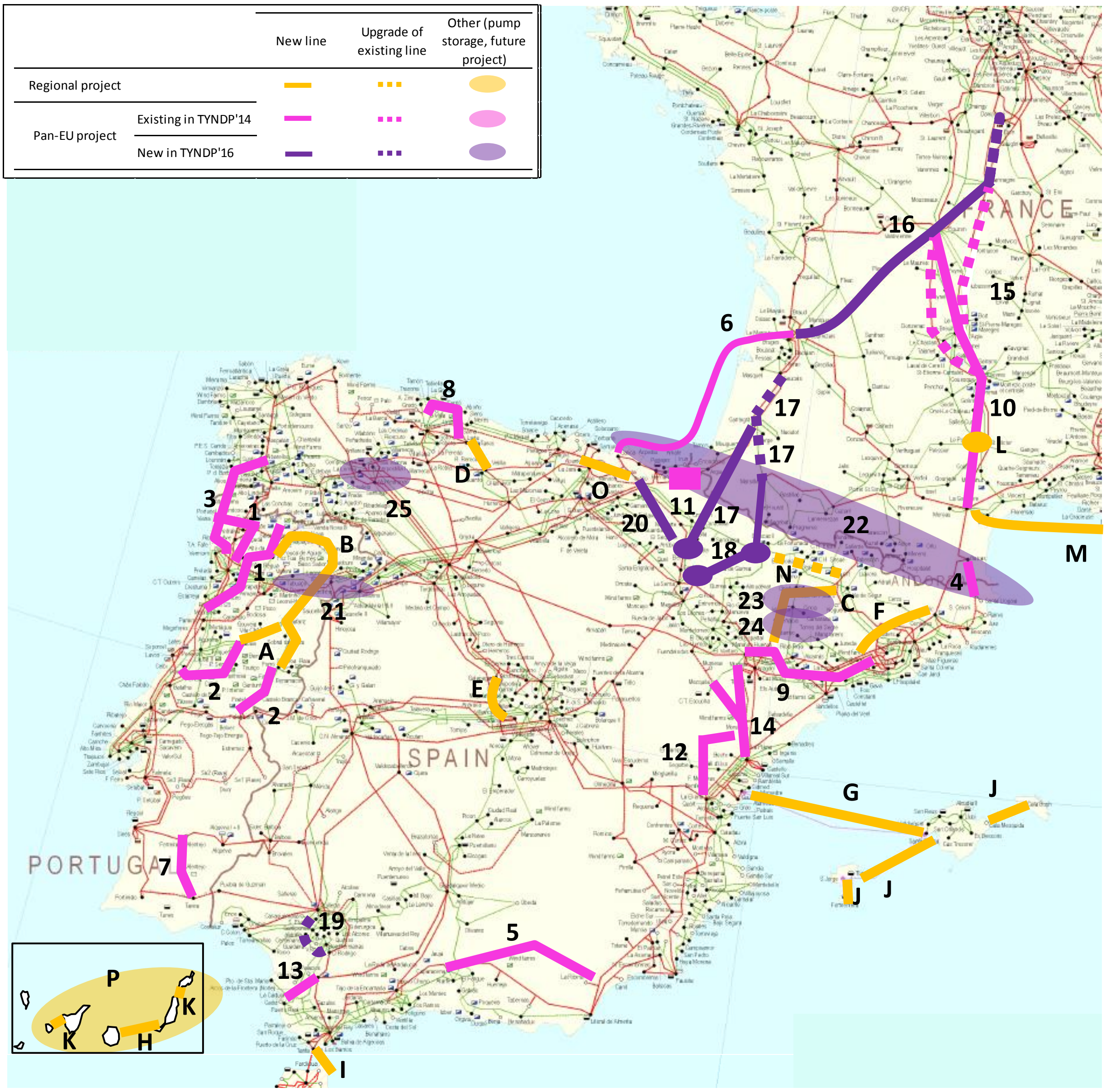
In France, the projects that are important for the region – on top of the pan-European ones – are i/ the creation of Sud Aveyron, a new 400kV substation in South Massif Central area connected to existing grid and needed to accommodate new wind generation and ii/ Midi-Provence, a new HVDC subsea connection needed to increase transmission capacity and mutual support between south-eastern and south-western France.

In the following table and figure **regional projects** of the CSW region are described:

Project name	Description	Main driver	General comments on the project	In RgIP 2014	Expected commissioning date	Monitoring Commissioning date in RgIP2014	Evolution since RgIP2014. Short explanation
Peñalba-Arnero-Isona	400kV axis Aragón/Peñalba-Isona and new subestation Arnero	RES, evacuation of generation, interconnector between internal zones	Arnero substation is linked to the development of pumping generation in the aresa (>3000 MW)	Yes (project 156)	>2020	2029	Commissioning date of the project is in line with previous estimations
Sama-Velilla	Internal 400kV line, >100km long	RES, SoS	Main driver varies depending on the situation of the flows	Yes (investment 512)	>2020	2026	Commissioning date of the project is in line with previous estimations
Madrid ring	Moraleja - Segovia/Galapagar 400kV line	SoS	Closure of the 400kV ring of Madrid	Yes, partially (project 160)	>2020	2030	Commissioning date of the project is in line with previous estimations
Ichaso project	Internal 400kV lines of Ichaso-Castejon/Muruarte and Ichaso-Abanto/Gueñes	Market integration	Meshing of the grid and route to evacuate HVDC interconnectors in Ichaso. Analysed in NDP: TNE-2, TN7	Yes, partially (project 7)	2020	2020	Commissioning date of the project is in line with previous estimations
Catalonia Ring	New OHL 400 kV double circuit Vic-Vandellos/Pierola	Market Integration	Solve internal congestions that can affect the French-Spanish cross border capacity in certain demand/generation situations, especially if the flows are increased with new projects.	No	>2020		
Uprate of the TransPirenean axis	Uprate the OHL 220 kV axis Sabiñanigo-T- Escalona-Escalona-T-Foradada-La Pobla	Market integration	Project required for internal needs (evacuation of generation in the Pyrennees, mainly hydro) but the internal needs become more critical with the new Frech-Spanish interconnections project.	No	2017		
Mallorca 2nd DC link	Subsea DC 2x500MW link from Valencia to Mallorca	Market integration, interconnection	Strengthening of the integration of Balearic Islands into the mainland electricity system	No	>2020		
Gran Canaria DC link	Subsea DC 2x100MW link from Gran Canaria to Fuerteventura-Lanzarote	Market integration, interconnection	The integration of electrical subsystems contributes greatly to system stability. Analysed in NDP: TIC-12	No	>2020		
Ceuta link	Subsea DC 132kV link from Pto de la Cruz to Ceuta	Market integration, interconnection	The isolated Spanish electrical system of Ceuta to be integrated into the mainland electricity system	No	2020		
Balearic links	Subsea AC 132kV internal links among the islands	Interconnection, SoS, market integration	Formentera - Ibiza (new double circuit in 2016-2019, 2x53MW), Ibiza - Mallorca (3rd circuit in 2020, 118MW) and Mallorca - Menorca (2nd circuit in 2016, 118MW)	No	2016-2020		

Project name	Description	Main driver	General comments on the project	In RgIP 2014	Expected commissioning date	Monitoring Commissioning date in RgIP2014	Evolution since RgIP2014. Short explanation
Canary links	Subsea AC links among Canary Islands	Interconnection, SoS, market integration	Fuerteventura - Lanzarote 120MW132kV link and La Gomera - Tenerife 2x50MW 66kV link	No	2019-2020		
RES integration in the Canary Islands	Transmission network reinforcements (66kV, 132kV and 220kV)	RES	This set of network reinforcements will allow to duplicate the % of RES/demand in the Canary Islands and hence contribute to european RES objectives	No	2017-2019		
Sud-Aveyron	New 400/225 kV substation connected to existing grid in south Massif Central area	RES	This substation is needed to integrate new RES generation in the area, mainly wind.	Yes	2018	2018	
Midi-Provence	New 210-km HVDC subsea link between Fos area and Languedoc	Market integration, SoS, generation integration	This HVDC link will increase transmission capacity between south-eastern and south-western France, allowing for mutual support and taking benefit of complementarity of generation mixes	Yes	2020	2020	
Seia-Guarda-Fundão	New 400 kV axis Seia-Guarda-Fundão	RES	This project is necessary to provide security N-1 to *Project 2 – RES in center of Portugal*. This investment also creates conditions for the connection of new amounts of RES as in the region the estimated wind potential overcomes more than 2000 MW	Yes (project 156)	2023-2025	2021-2025	Investments Rescheduled and/or on time
Riberia de Pena-Guarda	New 400 kV link between Ribeira de Pena and Guarda	RES	Ribeira de Pena – Guarda link will create capacity for the integration of new amounts of RES generation, mainly wind, in Trás-os-Montes northern area of Portugal. At same time it increases security to *Project 1 – RES in north of Portugal*. Project 1 integrates significant new amounts of generation coming from new hydro production of the Portuguese National Plan for Hydro Power Plants and also from power reinforcements on some already existent plants (the total new power is 3210 MW including 2700 MW of pumping).	Yes (project 156)	2025	2025	

Table 5.2-1 Regional projects in the CSW region



Id on the map	Name of the Regional Project	Project ID in TYNDP2014
A	Seia-Guarda-Fundão	128
B	Ribeira de Pena-Guarda	128
C	Peñalba-Arnero-Isona	156
D	Sama-Velilla	Inv. 512
E	Madrid ring	160
F	Catalonia Ring	New in TYNDP2016
G	Mallorca 2nd DC link	New in TYNDP2016
H	Gran Canaria DC link	New in TYNDP2016
I	Ceuta link	New in TYNDP2016
J	Balearic links	New in TYNDP2016
K	Canary links	New in TYNDP2016
L	Sud-Aveyron	823

Id on the map	Name of the Regional Project	Project ID in TYNDP2014
M	Midi-Provence	598
N	Uprate of the TransPirenean axis	New in TYNDP2016
O	Ichaso project	7
P	RES integration in the Canary Islands	New in TYNDP2016

Figure 5.2-1 Map of regional projects in the CSW region

5.4 Reference capacities

Reference capacities should not be confused with market based target capacities under a high RES scenario. These capacities were a result of the Common Planning Studies of TYNDP2014 vision 4 and they were one basis for promoted TYNDP2016 project candidates.
The aim of the reference capacities however, is to give a common ground for comparison and assessing benefits of the different projects. Reference capacities are formed by taking into account today's capacities and the capacity increases on the borders by taking into account mid- and long-term projects as described in chapter 5.1. Projects will be assessed based on either TOOT- or PINT-methodology and a detailed description of how this will be done with respect to the reference capacities, will be provided in the TYNDP-report.

	Reference Capacities Reference Capacities (including present situation, Mid-term and Long-Term project but not including future projects) (MW)	
Border	2020 Expected Progress	2030 Visions
ES-FR	5000	8000
ES-FR-GB	0	0
ES-PT	4200	4200
FR-ES	5000	8000
GB-FR-ES	0	0
PT-ES	3500	3500

Table 5.4-1 Reference cross-border capacities for the Assessment phase, 2020 and 2030

5.5 Interconnection ratios

The following figures show the interconnection ratios based on the draft TYDNP2016 scenarios for 2020 (Expected Progress) and 2030 (four Visions)[6].

The objective set by the European Council is to reach 10% for all Member States in 2020 and to aim at 15% for 2030 "while taking into account the costs aspects and the potential of commercial exchanges".

6 https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP%202016/150521_TYNDP2016_Scenario_Development_Report_for_consultationv2.pdf

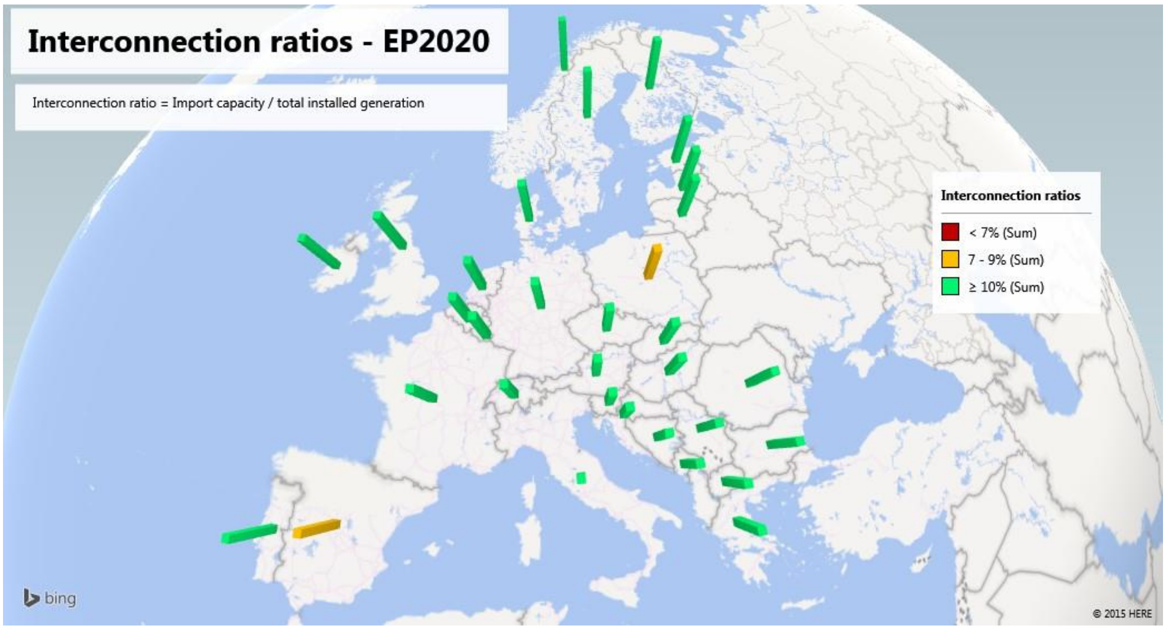


Figure 5.5-1 EP2020 Interconnection ratio

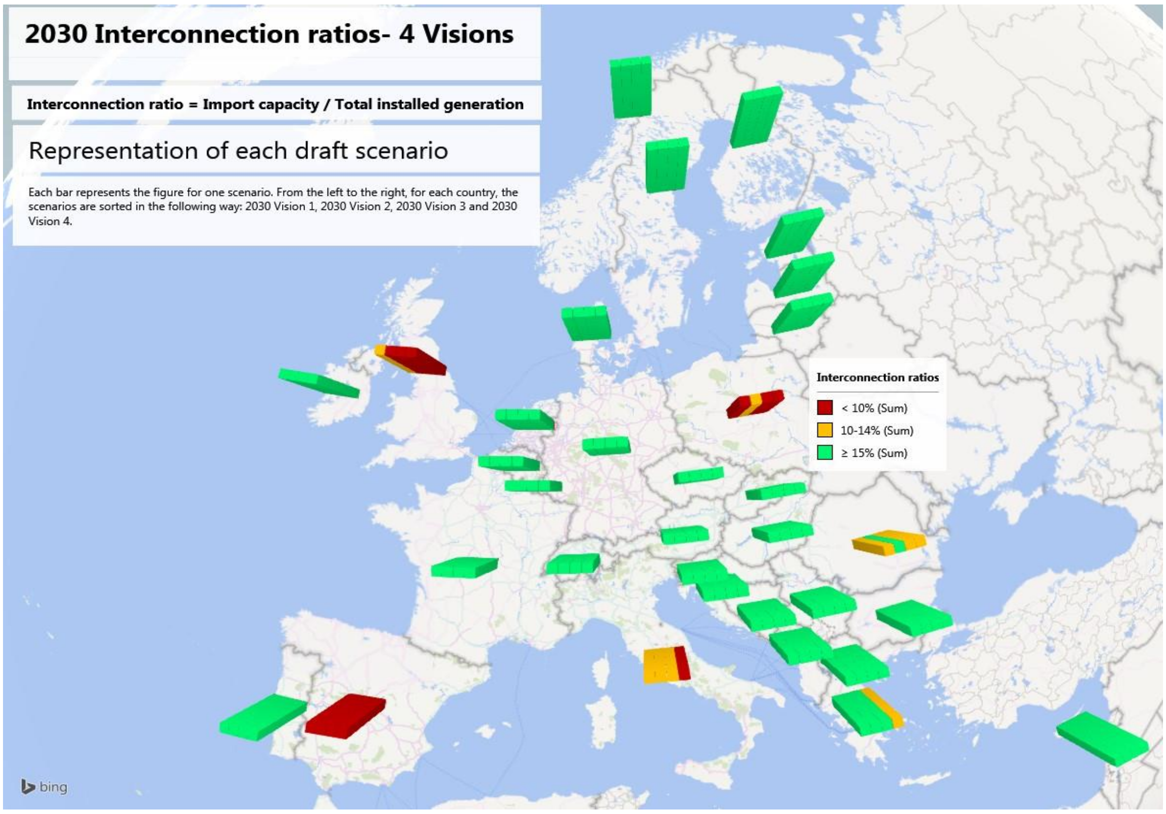


Figure 5.5-2 Interconnection ratio – 2030 Visions - import capacity divided by net generating capacity

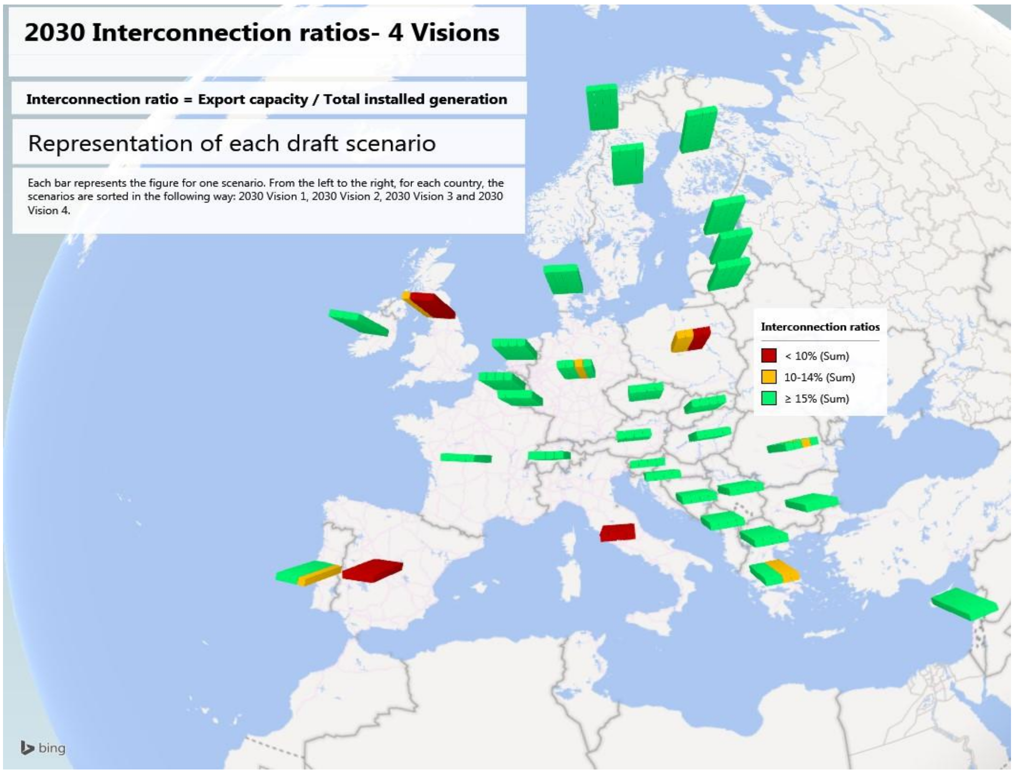


Figure 5.5-3 Interconnection ratio – 2030 Visions - export interconnection capacity divided by total installed generation

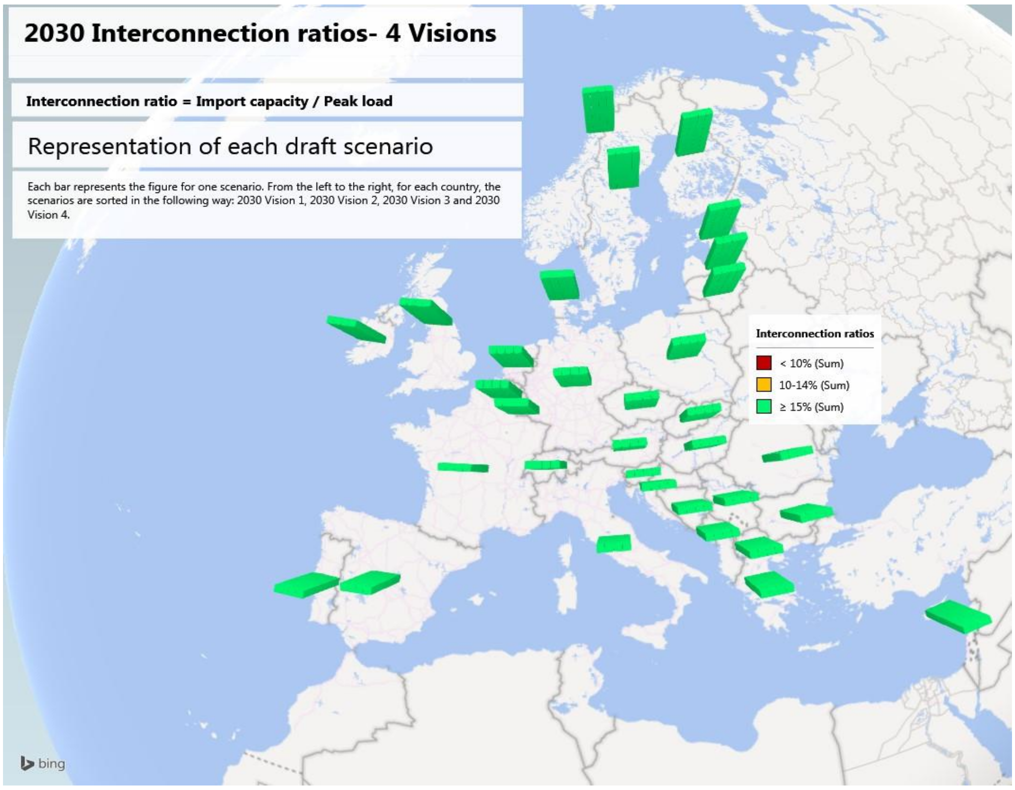


Figure 5.5-4 Interconnection ratio – 2030 Visions - import interconnection capacity divided by peak load

Three maps are presented for the 2030 interconnection ratios. These represent three different ways of defining the interconnection ratio for each country: the combined import capacity of its cross border interconnections divided by its total installed generation; the combined export capacity of its cross border connections divided by its total installed generation, and its import capacity divided by its peak load. The import and export capacities include planned mid and long term projects, but do not include future projects (those that would be commissioned beyond 2030).

Only one map is presented for the 2020 situation: this is as there is one accepted definition of interconnection ratio for the 2020 goal of 10% interconnection. This is import capacity divided by total installed generation.

French and Portuguese interconnection ratio are higher than 10% in 2020 and 15% in 2030 for all scenarios. The situation for Spain is pretty much improved from current values, and from the situation presented in the TYNDP 2014, however there is still a gap to fulfill the objectives.

For 2020 time horizon, taking into account the planned projects and considering the sum of import capacities divided by the total generation capacity, the interconnection ratio for Spain is around 8% excluding Morocco[7] and 8.5% including Morocco, after commissioning of Biscay Gulf and the planned northern interconnection with Portugal.

In 2030, the interconnection ratio with planned projects is in the range of 7-9% for Spain, depending on the scenario (the visions with high RES having higher installed capacities and therefore showing lower ratios). With all projects in the plan, the ratio is higher than 10% in Visions 1 and 2 (although not reaching the 15%), but still lower in Visions 3 and 4.

The other two additional complementary ratios have been included in order to give a wider perspective of the interconnection situation per country: one ratio dividing the sum of import capacity by the peak load and another one dividing the sum of export capacity by the generation capacity.

The first alternative (Figure 5.5 3) could reflect the possibility for a country to place its generation in neighboring countries. This approach gives similar values than the approach with import capacities except for Portugal that would not reach 15% in Vision 4. However with all the projects in the plan Portugal would reach the 15%.

The second alternative (Figure 5.5 4) could reflect the support that the neighboring countries can provide to the national Security of Supply. It should be analyzed together with the system adequacy computations provided in the ENTSOE System Adequacy Forecast report. This approach results in every country in Europe fulfilling a 15% ratio.

5.6 Long term perspective and remaining challenges

It should be reminded that TYNDP204 Vision 4 is far beyond what the TSO scenarios usually have considered up to now and will require important investments of national, regional and pan-European relevance on the network. Some of them (especially national investments) are not defined yet, as the location of the new generation is highly uncertain and has a high impact. Therefore, further analysis will be needed on this scenario if Europe commits to a sustainable energy policy. Additionally to the network studies already performed, for which it will be needed to have clear the flexibility potential of both demand (Demand Side Response) and generation, further stability analyses should also be performed in order to evaluate the network behavior with a scenario with such high amount of renewable energy sources.

[7] Regulation is not clear about non European countries. However, as this European objective is based on the principle of solidarity between Members States, Morocco should not be considered

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However, at least interconnection proposals have been improved in this plan versus previous TYNDP 2014. By 2030 the Iberian Peninsula will be provided with an electrical transmission system which not only promotes and allows a high penetration of RES generation, but also has gradually created the physical conditions to implement a real Iberian Electricity Market. On the other hand, the situation of Iberian Peninsula with respect to the rest of Europe, that is still today considered an electrical island, will be pretty much improved, allowing reducing the future congestion Spain-France and improving the 10% interconnection ratio especially for Spain. Nevertheless, reaching of the 10% and 15% interconnection ratios will need to be monitored in the forthcoming releases of the Plan in order to ensure appropriate fulfillment and regularly updates on cost and benefits.

Another possible challenge for future editions is the situation with the North African countries. The European perspective today for 2030 does not forecast changes from the existing situation with high imports in the Spain-Morocco interconnection, and the plans from the beginning of this decade with high RES in North Africa to export to Europe did not get so far their initial impulse due to high uncertainty on this generation installation. Nevertheless, it requires monitoring in the forthcoming editions.

However, to get the commissioning of the projects listed in this Regional Investment Plan on time several barriers need to be removed, especially in the cross border projects, with a strong contribution and guidance from the European Commission, such as:

- permitting procedures in order to clarify/harmonise projects approval decisions in the countries involved, since the lack of harmonisation increases social acceptance difficulties and costs of development;

- regulatory issues related with interconnection projects cost acceptance by the different energy regulators involved allowing a fair approach for investment recovery in the different national energy systems;

- the recognition of the setting of PCI priorities for the acceptance of these projects and the perspective of public financial support, if needed, taking into account the costs and benefits;

A major challenge is that the grid development may not be completed in time whereas RES targets are met as planned by 2030. At present many stakeholders support grid development to facilitate the changes in the energy system; at the same time, other stakeholders that are directly affected by new lines or new plants show only a low level of acceptance for the new infrastructure. This social acceptance plus the lengthy permit granting procedures often causes commissioning delays.

If energy and climate objectives have to be achieved, it is therefore of utmost importance to smooth the authorisation processes and to gain political support at every level. In this respect, ENTSO-E welcomes Regulation EU No 347/2013 as there are many positive elements in the PCI labelling and the new permitting process which will facilitate the fast tracking of transmission infrastructure projects, including the proposal on one stop shop and defined timelines. In France, the consultation dialogue process has been streamlined in order to allow achieving the 3.5-year target for permitting process. Spain and Portugal have already a procedure for PCIs with a maximum permitting timeframe of 3.5 years. Nevertheless, some regional and national projects of importance follow go on with regular procedures. On the other hand, the experience of a Joint Venture (INELFE) for the eastern French-Spanish cross-border project is a good practice to maintain, and specially regarding permitting ensures a coordinated process.

More thorough analyses are however required so as to ensure the measures can be successfully implemented, in particular in relation to whether the timelines proposed are achievable, particularly in the context of the public participation process and the potential for legal delays.
Especially the Madrid Declaration of the Energy Interconnection Links Summit on 4th March 2015 appealed to strong involvement of all, including EC, Member States and all relevant parties in each country

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in order to meet the ambitious deadline of attaining the interconnection objective by 2020. In addition, the EC has set up a High Level Group on the Interconnectivity of the Iberian Peninsula in order to coordinate and monitor the process for the French-Spanish border. ENTSO-E welcomes these actions that give to transmission infrastructure the importance that it deserves.

Concerning the financeability of projects, and especially for cross-border projects and projects with especial characteristics regarding technology and costs, a stable regulatory framework, ensuring that the investment costs will be included in the tariffs is also essential to ensure grid reinforcement can be completed in time, and this is the task for the Regulators. Although grid projects prove beneficial for the European community as a whole, with a net reduction of the power supply costs, they represent large investments and financing them still remains an issue for TSOs in times of limited public finances, and therefore securing the perspectives of investors is key for success. In this respect, from the generic point of view. ENTSOE has concrete proposals in the “towards a future –looking regulation”paper[8]. On the other hand, for the French-Spanish interconnection, the Madrid Declaration welcomed all support available at European level, including the Connecting Europe Facility, the Structural Funds and the European Fund for Strategic Investment.

In summary, energy transition to get European goals requires exceptional projects as described in this Regional Investment Plan, and these will not become true if exceptional support is not there.

[8] https://www.entsoe.eu/publications/position-papers/position-papers-archive/Pages/Position%20Papers/Fostering-Electricity-Transmission-Investments-to-Achieve-Europe%C2%B4s-Energy-Goals-towards-a-Future-Looking-Regulation.aspx

6 NEXT STEPS

6.1 A two-year cycle & CBA evolvement

Assessment methodology

The present version of the Cost Benefit Analysis (CBA) methodology, developed by ENTSO-E in close collaboration with stakeholders and ACER, was officially approved by EC in February 2015. The TYNDP2016 assessments of projects will be carried out based on this CBA methodology version as required by Regulation (EU) 347/2013. The previous TYNDP2014 was already to a large extent based on a nearly final CBA methodology, and the lessons learned in this process will contribute to the TYDNP2016 process. The CBA methodology provides for a multi-criteria assessment of all TYNDP projects across a wide range of indicators as presented in the figure below.

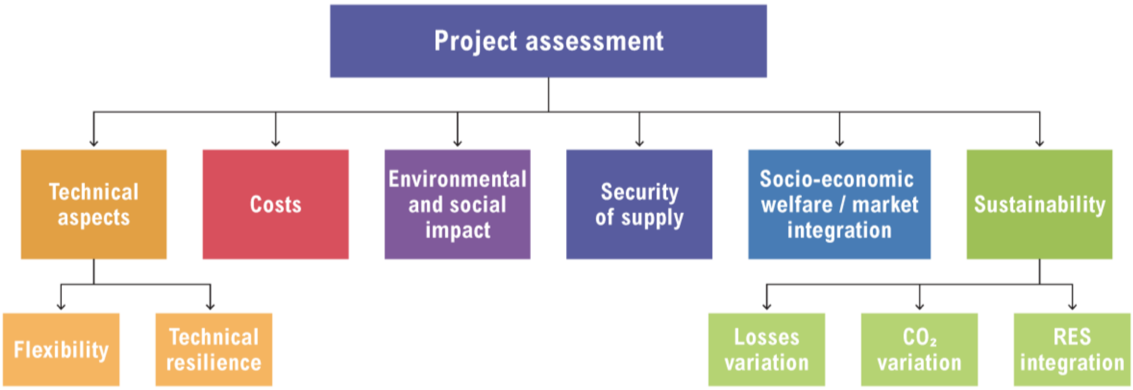


Figure 6-1 CBA Indicators

Even as an approved CBA methodology is ready for use in TYNDP2016, work is continuing to further improve the methodology for future TYNDPs. Several elements which are already being explored further is how storage, Security of Supply and Ancillary Services can be addressed in a transparent, objective, and European consistent manner.

In the final TYNDP2016 report, the reader can expect to see an assessment sheet for each individual TYNDP project in the following format:

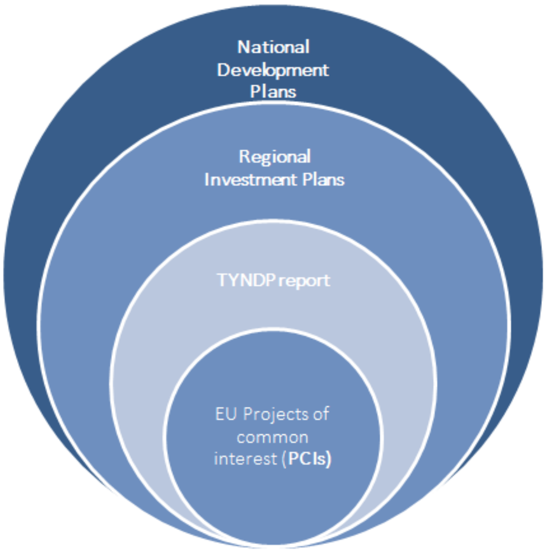
	CBA results non specific scenario		CBA results for each scenario							CBA results non specific scenario				
	GTC increase - direction 1 [MW]	GTC increase - direction 2 [MW]	TYNDP scenarios	Contribution to Intercon-nection rate [%]	B1 - SoS [MWh/y]	B2 - SEW [M€/y]	B3 - RES integration [MWh/y or MW/y]	B4 - Losses [MWh]	B5 - CO2 Emiss [kT/y]	B6 – Technical Resilience	B7 – Flexibility	S1 - protected areas [km]	S2 - urban areas [km]	C1 - Estimated cost [M€]
Assessment results CLUSTER														

Scenarios

While this set of Regional Investment Plans is being published in summer 2015, ENTSO-E recently concluded a public consultation on a proposed Scenario Development Report in May-June 2015[9]. This report proposes a set of possible futures, describing storylines, methodologies, assumptions, and resulting load/generation mixes. One best estimate scenario for 2020 and four possible contrasting visions for 2030 have been proposed. These provide the mid- and long-term horizons as referred to in the CBA methodology against which all TYNDP2016 projects will be assessed.

Other infrastructure plans

It is worth highlighting how the TYNDP and the Regional Investment Plans are related to national plans and EU support measures.



- National Development Plans: provided by TSOs at specific time intervals and based on (national) scenarios which not always one-to-one relate to those of the Community-wide TYNDP. These are developed according to Article 22 of Directive 2009/72/EC.

- Regional Investment Plans: developed by TSOs in ENTSO-E's cooperation structure, following Article 12 of Regulation (EC) 714/2009.

- Community-wide Ten Year Network Development Plan: a key ENTSO-E deliverable as mandated by Regulation (EC) 714/2009. It inter alia needs to build on national investment plans, taking into account regional investment plans and, if appropriate, Community aspects of network planning.

- Projects of Common Interest: Procedure set forth in Regulation (EU) 347/2013, aiming to stimulate particular infrastructure projects with direct funding, financial leverage and/or permitting streamlining. PCIs are adopted by the EC in every year in between two TYNDP publication years. To be eligible for PCI labelling, inclusion in the last available TYNDP is an explicit condition.

[9] https://www.entsoe.eu/news-events/announcements/announcements-archive/Pages/News/TYNDP-2016--ENTSO-E-calls-for-views-on-the-scenarios-report.aspx

7 APPENDICIES

7.1 Detailed description of the methodology used

In chapter 2.3 General methodology, the overall process overview was described, for the readers for faster orientation and better understanding of the whole Common Planning Studies process. This chapter will describe both market and network methodologies used in more details, also with practical examples given. The Common Planning Studies are an important part of the TYNDP2016 process. They were carried out jointly and coordinated by all regional groups of ENTSO-E for the TYNDP2014 Vision 4 model. Beside this, regional groups could carry out additional regional scenarios and sensitivities, to analyze specific impacts, issues or particularities of the regions, which they wanted to be shown in this report.

Market modelling description of the approach

The aim of the Common Planning Studies was to identify beneficial borders that will be increased in 500 or 1000 MW steps. Preliminary to the market studies members of the regional network-groups provided a list of costs for each possible increase and border. These costs included necessary internal reinforcements to make the additional cross-border capacity possible.

It was not necessary to specify costs for borders where new projects are not feasible. However – a good reason for why an increase of the cross-border capacity at this border is not feasible had be provided and agreed with the regional groups involved.

The following approach has been used.

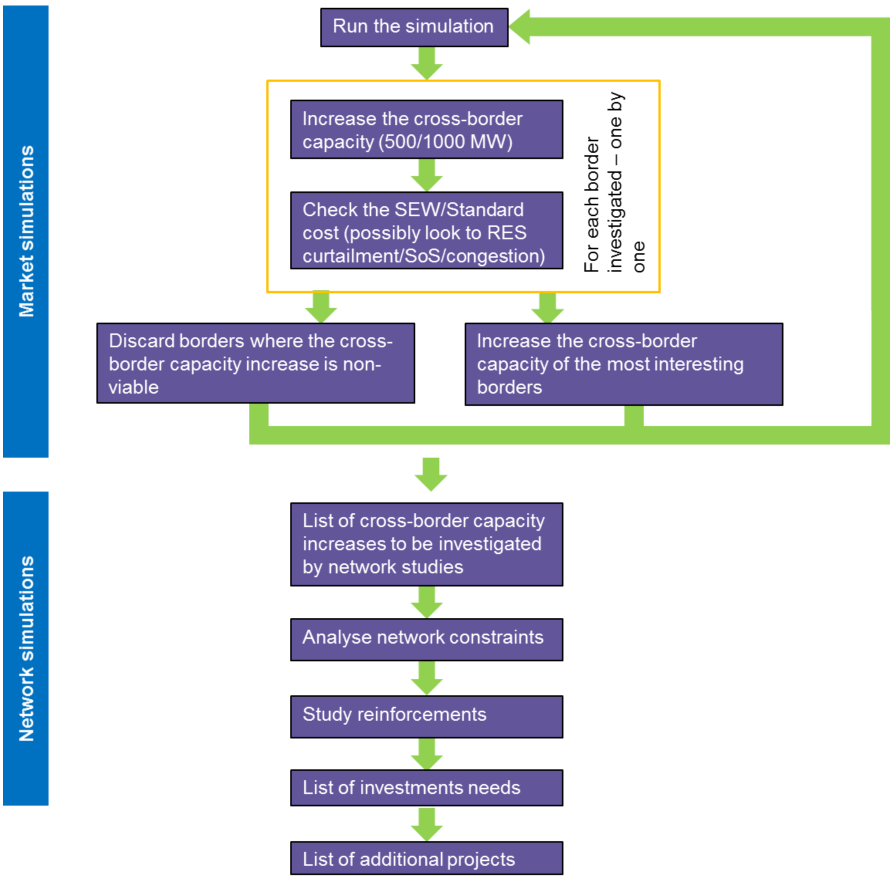


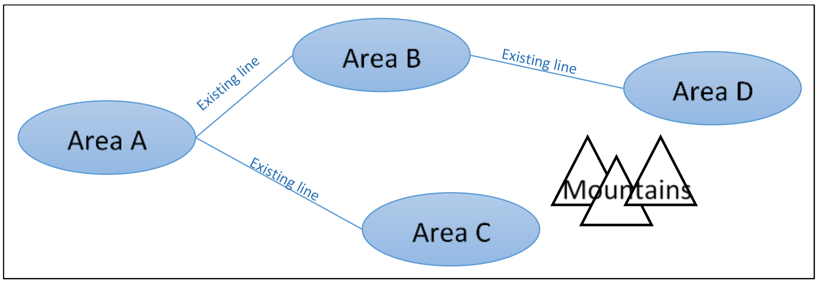
Figure 7-1 Overall overview of the Common Planning Studies process

1. The market simulation were run for the base case which was defined:
   - on the base of data used TYNDP2014 V4 2030 Regional assessment (high RES conditions),
   - on the base of an alignment performed by Project Group Market Modelling (PG MM) members respect the installed generation capacity and the generation profile (provided by PECD – Pan European Climate Database) for photovoltaics and wind,
   - on the base of an update of the reference capacities (in order to guarantee consistency with the TYNDP 2014 projects list).

   Additional details were permitted in the Regional area.
2. One market simulation was run for each border with an increased capacity of 500 or 1000 MW.
3. The socioeconomic welfare of all increases were calculated (by subtracting the SEW from the base case simulation of step 1 from each simulation of step 2)
4. The increase(s), which gave the highest SEW/cost ratio in the region ("the most interesting borders"), were put into the (new) base case
5. Some borders shown results that make further simulations and checks of these borders unnecessary. These borders could be removed from the list and were not analyzed any more in this process. However, it was needed to be careful which borders might be removed. A bottleneck can indeed move from one border to another when the border capacity is increased. It was important not to remove borders from the list too early.
6. Then the loop started again with the updated base case. Unless no more beneficial increases could be identified, process went back to step 2[10].
7. After every beneficial increases on all borders of the region were identified, the market groups could present a list of borders, which capacity should be increased and the amount of these increases (the same border can be chosen in more than one loop, increasing the capacity by 500MW each time).
8. Regional network subgroups investigated the new "target capacities" and converted these into possible project candidates.

Practical example

Purpose of this practical example is to visualize the above mentioned market modelling approach and process. This example assumes four market areas A, B, C and D. Areas A-B, A-C and B-D are already connected. Due to geographical constraints it is not possible to connect area C and D. To connect area A with area D is not possible either because of too large distances.



[10] New base case do not need to be re-calculated. This simulation has just been done!

The network group has specified the following list of costs for increasing cross border capacity (only as example):

Border	+500 MW (first increase of 500 MW)	+1000 MW (second increase of 500 MW)	+1500 MW (third increase of 500 MW)
A-B	100 M€	110 M€	100 M€
A-C	100 M€	120 M€	100 M€
B-C	70 M€	140 M€	200 M€
B-D	300 M€	300 M€	500 M€

1. The picture above shows the base case.
2. The market simulation is run for the base case.
3. Market simulations for all feasible borders (A<->B, A<->C, B<->C and B<->D) are run
4. Socioeconomic welfare are calculated for all border increases
5. Project B-C has for instance a SEW of 20 M€, giving a SEW/cost ratio of 2/7 which is the highest value of the four projects. Project B-C is put into the base case.
6. Project B-D has for instance only a SEW of 5M€ and with a cost of 300 M€ this gives a ratio of 1/60. This border is considered not necessary to be investigated further.
7. In this stage the market groups run again market simulations for all remaining feasible borders (A<->B, A<->C and B<->C) – by continuing the loop with step 4.

Network modelling description of the approach
This chapter describes the primary network studies performed by the regional groups during the Common Planning Studies for TYNDP2016. The aim was to simulate the impact of the increased border capacities, as simulated in the market simulations of the Common Planning Studies, on the European grid and detect the corresponding new concerns for grid development ("investment needs"). The outcome of this study was a map of internal bottlenecks in each country and a list of additional network reinforcement investments, with a brief technical description and the associated transfer capacity contribution (order of magnitude).

In the framework of the Common Planning Studies, the scope of Network Studies was to analyse, according to the market studies11 findings, the most promising borders in terms of transfer capacity increase and identify the candidate projects which would achieve such potential transfer capacity increases in a feasible and cost efficient manner.

The work of the network studies during this phase is described below:

- The Common Planning Network Studies were based on market outputs results in each Region (8760 hours simulations).
- Duration curves were displayed directly using market study results. For example, by sorting out the hours according to exchange between 2 countries or Wind in North Sea and PV in Southern Europe. These curves were used as one of the indicators for selection of points in time.
- RG Network Studies selected a number of representative snap-shots so called points in time (PiT) within the market study outputs and PTDF (Power Transfer Distribution Factor) Matrix. For instance wind production, high market exchanges on long distances, low load, high load etc. The selection of PiT was a regional specific process, according to the regional most important parameters.
- Based on PTDF Matrix, the market data of each hour were transposed into the simplified grid represented by the PTDF Matrix. Then a PTDF flows were calculated for each of the 8736 hours and on each synchronous borders. Each synchronous are was represented through grid parameter duration curves showing loading of profiles. As mentioned above these PTDF flows were used to define detail points in time calculated by full AC load flow calculation to obtain particular line loadings together with voltage profile.
- The results of calculation were displayed on a regional map (based on a Pan European common tool), allowing possible further reinforcement identification. This map of was based on a visualisation of the combined frequency and severity of line loading (e.g. overloads).
- Project candidates with its investment items were identified based on the described process above without any preference whether internal or cross-border project.
- Expected grid transfer capacity per project candidate was appointed proceeding to load flows on already selected PiT. At this stage no detail calculation according to CBA were performed yet (carried out in assessment phase from mid 2015).

[11] The input reference capacities data of Market Studies are aligned to Vision4 TYNDP14 and projects assessed in the TYNDP14, including several updates

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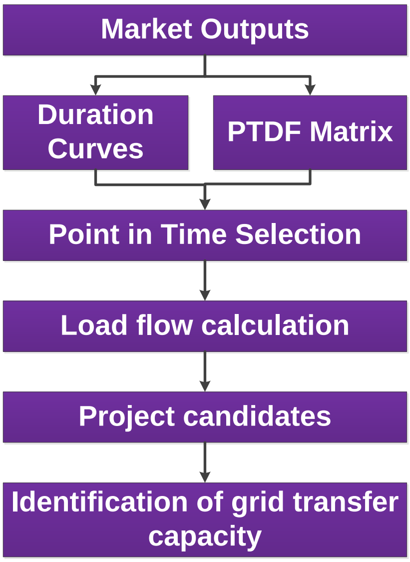


Figure 7-2 workflow of the Network Studies during Common Planning Studies

Network modelling

Network analyses were performed under the following framework:

- Network datasets used to perform network simulations: the starting point for each region was the 2030 Vision4 regional grid data set developed in TYNDP 2014 covering entire continental synchronous area.
- Models were updated according to the new projects listed in TYNDP 2014 and if relevant by other cross-border or national investment items.

At the end of the Common Planning Studies, the network models will be updated accordingly.

Inputs from market results

The following detailed Market outputs from final market simulation run were required to create points in time (per country and per hour):

- Thermal generation per fuel type and efficiency
- Renewable generation sources (wind, solar, …)
- Hydro generation (pumping, turbine)
- Dump energy per country
- Demand
- Energy not supplied
- Balances
- Market exchanges on the border of the modelled perimeter (mostly HVDC connection to Northern countries or UK)

Load flow simulations

First of all, the main critical activities of the network simulation were an AC convergence after a PiT is implemented under the condition of scenario assumptions.

Bottleneck identification

In order to evaluate the importance of bottleneck, following "FS²" criteria can be used, where:

- F: frequency of occurrence (% of the year);
- S: severity (% of overload)

Example of calculation of FS^2 in N conditions for a line (based on 5 PiT, with winter and summer limits):

PiT (N condition)	Weight (%)	F	P (MW)	Limit (MW) N condition	Overload (%)	S
WINTER 1	0,10	10	750	1000	-	0
WINTER 2	0,40	40	1100	1000	0,10	10
SUMMER 1	0,30	30	850	800	0,06	6
SUMMER 2	0,15	15	550	800	-	0
SUMMER 3	0,05	5	900	800	0,13	13
	FS^2	5 925				

Figure 7-3 Workflow of the Network Studies during Common Planning Studies

The reinforcement projects:

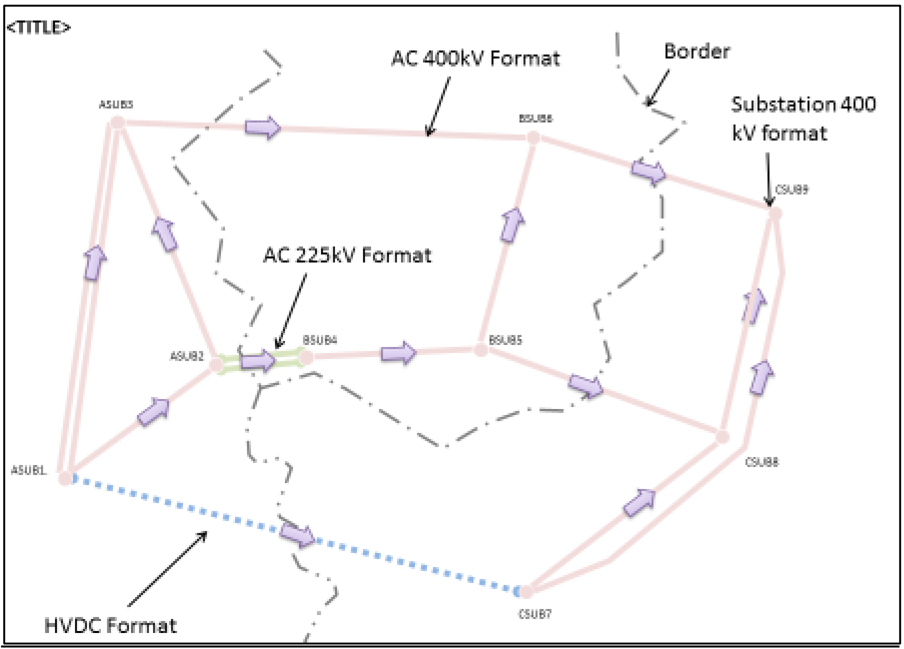
- were selected considering the severity and frequency of the bottlenecks
- considered first the border concerned by market increased target capacities

Map representation

Maps to illustrate physical flows:

Following types of map can were used:

- bulk power flow maps (e.g. percentile 95% or 80% and 5% or 20% of the cross-border yearly distribution from PTDF flows)
- map of link loadings using AC load flow calculation



Maps to illustrate bottlenecks:

- Map illustrating bottlenecks in N and N-1 condition, using a qualitative approach with colors, based on the results of the FS² criteria:
  - Color green = no bottleneck
  - Color yellow = occasional bottleneck in N-1
  - Color red = structural bottleneck in N-1
  - Color highlighted red = bottleneck in N

7.2 Detailed regional walkthrough of process

7.2.1 Market Studies

This chapter will provide the detailed walkthrough on how the Common Planning Studies was conducted in the market modelling group of the RG CSW. The software used for tor the market simulation in the RG CSW was ANTARES. Based on the already described “General methodology” the Common Planning Studies was conducted as followed.

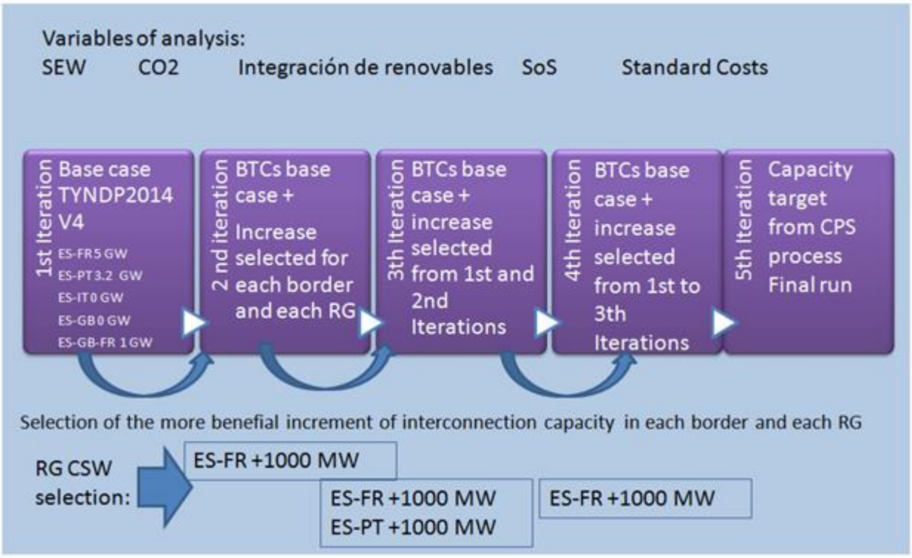


Figure 7.2-1 Common Planning Studies process and capacity increase in each iteration for RG CSW

In the first iteration of the Common Planning Studies, in order to check the coherency and consistency of the process, only one beneficial in all border was consider, and the border ES-FR was selected and increased by 1000 MW. In the second iteration the borders ES-FR and ES-PT were selected as the most beneficial. In the following iterations only the ES-FR border was selected. Then as the results of the iterations process ES-GB and ES-IT were discarded.

The last iteration included all increased capacities in all RGs.

As results the following target capacities for RG CSW has been considered:

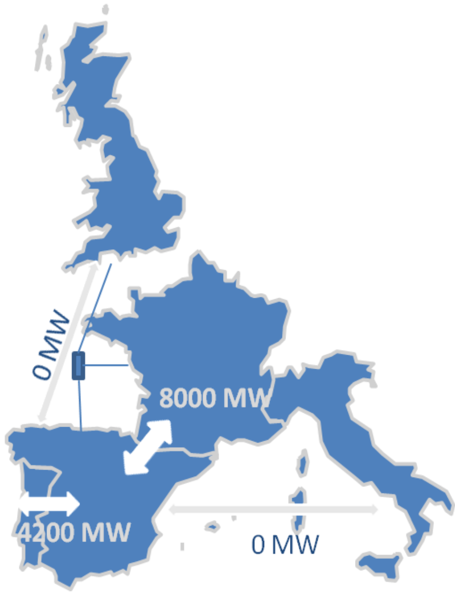


Figure 7.2-2 RG CSW Market based target capacity from Common Planning Studies process

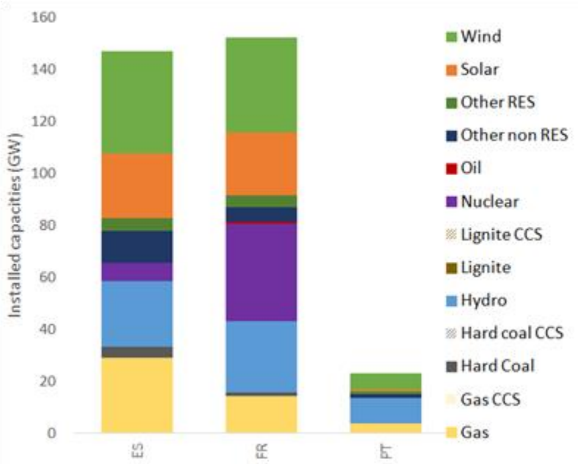
The market results for the Common Planning Studies vision have been detailed in chapter 4.

To analyze the robustness of the Common Planning Studies results, a comparison to preliminary PEMs for draft TYNDP2016 Vision 3 has been made.

The main hypothesis for the draft TYNDP2016 Vision 3 compared to TYNDP2014 Vision 4 in RG CSW perimeter are:

- The demand for draft TYNDP 2016 Vision 3 is 901 TWh against 997 TWh for Vision 4 TYNDP2014
- Less renewable installed capacity than Vision 4 TYNDP2014 (mainly solar and wind power, -55% and -24%, respectively).
- Less thermal installed capacity than in Vision 4 TYNDP2014 (-14%), mainly OCGT power, -57%, (French nuclear capacity is lower than in Vision 4)

The following Figure shows the hypothesis for installed capacity and for fuel prices and the annual generation for the coverage of the demand as results for the market studies.



MW

	Draft TYNDP2016 V3			TYNDP2014 V4		
	ES	FR	PT	ES	FR	PT
Gas	29100	14051	3717	41770	12480	4605
Gas CCS	0	0	0	0	0	0
Hard Coal	4160	1740	0	1420	1740	0
Hard coal CCS	0	0	0	1068	0	0
Hydro	25050	27200	9717,3	30655	28200	10280
Lignite	0	0	0	0	0	0
Lignite CCS	0	0	0	0	0	0
Nuclear	7120	37646	0	7070	40000	0
Oil	0	819	0	0	3750	0
Other non RES	12210	5400	1560	12210	4200	1740
Other RES	5100	4800	850	17000	9300	1950
Solar	25000	24100	910	58000	49600	4550
Wind	39300	36600	6400	49000	52400	6400
Total general	147040	152356	23154,3	218193	201670	29525

Figure 7.2-3 Installed capacities in Draft TYNDP2016 V3 in RG CSW and its comparison to TYNDP2014 V4

		Vision 4 2030 (TYNDP 2014)	Draft V3 2030 (TYNDP 2016)
Fuel prices (€/Net GJ)	Nuclear	0,377	0,46
	Lignite	0.44	1,1
	Hard coal	2,21	2,8
	Gas	7,91	7,23
	Biofuel	same price as primary fuel type	
	Light oil	16.73	13,26
	Heavy oil	9.88	9,88
	Oil shale	2.3	2,3

	Vision 4 2030 (TYNDP 2014)	Draft V3 2030 (TYNDP 2016)
CO_2 prices (€/ton)	93	71

Table 7.2-1 Basic assumptions in fuel and CO_2 prices for TYNDP2014 Vision 4 and Draft TYNDP2016 Vision 3

The main differences between both scenarios regarding installed capacity and annual demand are reflected in the yearly generation balance results. The share of renewable and thermal generation in the total generation for Draft TYNDP2016 Vision 3 is lower than TYNDP2014 Vision 4. Regarding the dump energy in the RG CSW for Draft Vision 3, the value is zero. This figure contrasts with the TYNDP2014 Vision 4 dump energy value where the spillage for Spain is about 1600 TWh and for France is about 400 TWh (for Portugal this value is zero).

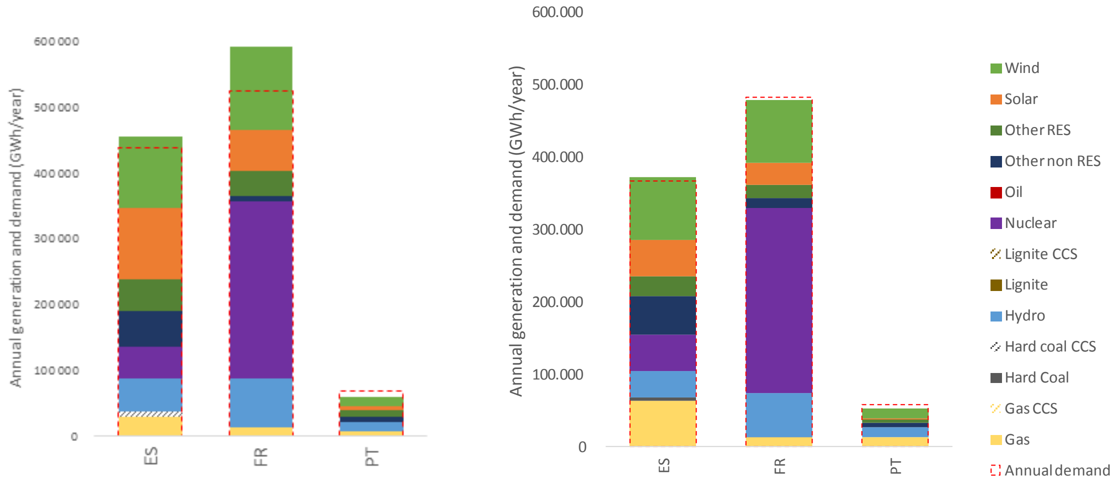


Figure 7.2-4 Annual Generation and Demand for final situation of Common Planning Studies Vision 4 TYNDP2014 (left) and Draft Vision 3 TYNDP2016 (right)

The following graph shows the yearly average of hourly marginal cost differences in draft TYNDP2014 Vision 3. In comparison to TYNDP2014 Vision 4, the yearly average marginal cost difference between Spain - France and Spain - Great Britain are lower, meanwhile the price difference between Spain – Portugal is similar. It can justify the annual net balance exchange between these borders shown in the Figure 7.2-6.

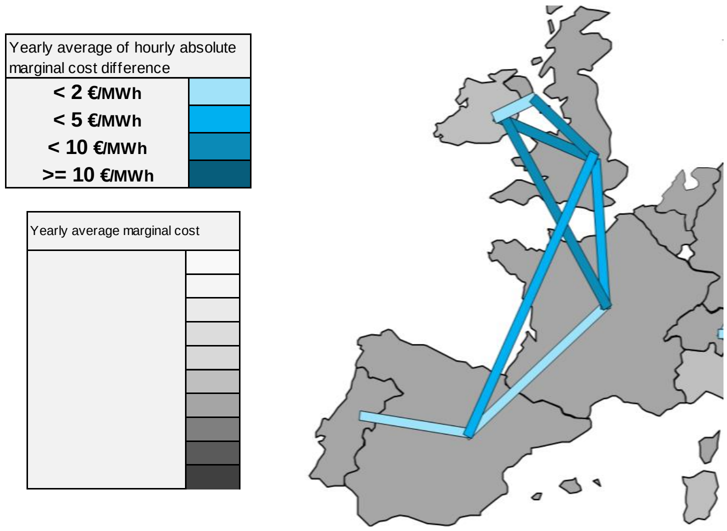


Figure 7.2-5 Yearly average marginal cost difference in Draft TYNDP2016 V3

The interconnection capacities are the same in both cases (draft TYNDP2016 Vision 3 and final case Vision 4 TYNDP2014): 8 GW for ES-FR and 4.2 GW for ES-PT. However situations, especially country balances,

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are very different. Nevertheless, total cross border flows (outcoming plus incoming flows) are higher in the draft Vision 3.

When the balance was positive for Spain and France in the final case Vision 4 TYNDP 2014, it becomes a zero balance in Spain and a negative one in France for draft Vision 3 TYNDP2016. However, the opposite occurs in Portugal: from a slightly negative balance in Vision 4 TYNDP 2014, we obtain a slightly positive one in Draft Vision 3 TYNDP 2016.

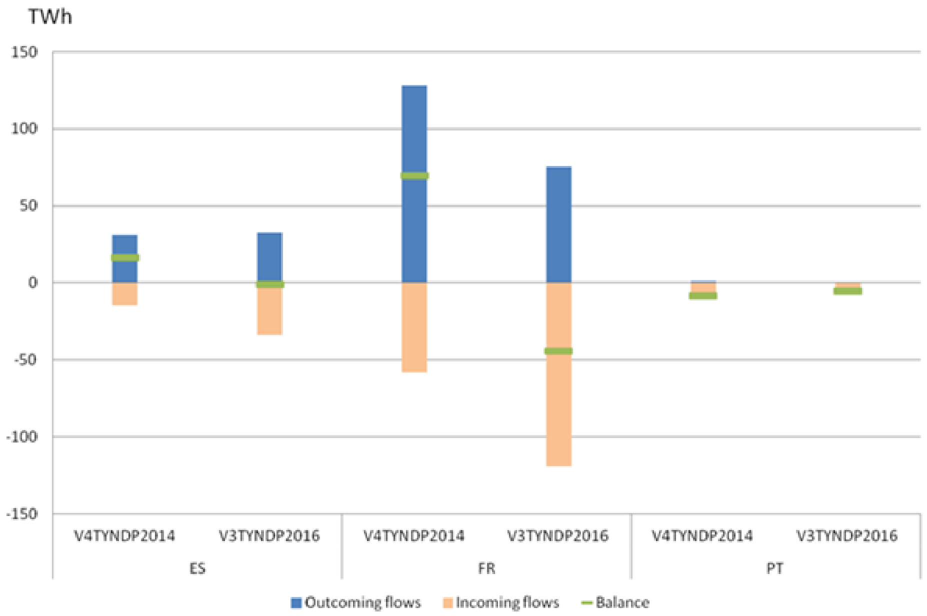

Figure 7.2-6 Gross cross-border import and export volumes in RG CSW for Draft TYNDP2016 V3 and TYNDP2014 V4

The previous Figure shows an important difference regarding net exchange balance for France. France becomes net importer in Draft TYNDP2016 V3. This behaviour did not appear in any of the TYNDP 2014 visions. One reason is obviously the different assumptions for RG CSW and another reason is the wind installed capacity in Great Britain and the decrease of load in Germany (two major neighbours of France) as results from their national energy policy to fulfil the European target, as reflected in Draft TYNDP2016 V3. These countries have a big penetration of RES generation, which makes that France imports this cheaper generation and reduces its exports (mainly nuclear generation). As a result of this, the CSW region becomes in draft V3 a net importer.

As it is shown in the table below, the level of congestion rate is less important in draft Vision 3 TYNDP2016 than in Vision 4 TYNDP2014 with the same cross border capacities.

	ES ->FR	FR -> ES	ES -> PT	PT -> ES
Final V4TYNDP2014	19%	10%	7%	1%
Draft V3TYNDP2016	9%	13%	1%	0%

Table 7.2-2 Level of congestion in RG CSW (% hours of congestions) for Draft TYNDP2016 V3 and TYNDP2014 V4

Finally, it is worth mentioning that another sensitivity study was conducted, taking into account a new Spanish PV profile for the draft TYNDP2016 Vision 3, considering an improved feedback from historical data. It had no impact on the results for this vision but it has not been checked for other visions. It can be expected that the new profile affects the results of visions with a high penetration of RES.

7.2.2 Network Studies

After defining market-based target capacities, the Common Planning Studies were focused on grid studies in order to detect potential investment need on top of the TYNDP2014 project list and shape potential candidate projects to provide the capacities increases resulting from the market studies.

- +3000 MW on the border Spain – France (compared to the cross border capacity in TYNDP 2014)), leading to 8000 MW in total (the multi-terminal link ES-FR-GB not included);
- +1000 MW on the border Spain – Portugal (compared to the cross border capacity in TYNDP 2014), leading to 4200 MW in total.

Methodology and Models

The network models used in the Common Planning Studies were the same used in the assessment phase for Vision 4 TYNDP 2014, only fine-tuned with the latest information on new solar generation location in France (the overall generation mix remaining exactly the same), and the grid in terms of updating those projects from TYNDP 2014 that were cancelled. They include detailed modelling of the transmission system with all busses, lines and transformers, and of generation and demand. In terms of complexity, the regional model includes more than 4500 nodes, 3900 loads, 5000 power plants, 6000 branches, 1400 transformers and 380 switched shunts.

Several different but complementary methodologies were used in the CSW region: firstly, an AC load flow analysis considering the selection and study of a limited number of Points In Time (PiTs), based on the flow duration curves for the each studied border and the generation mix in each country, both provided by market studies.
In addition, a Power Transfer Distribution Factor (PTDF) matrix approach based on DC load flow calculations was tested by RTE on the French grid. This approach gives approximate flows for the 8760 hours in a year with demand and generation dispatch profiles obtained directly from one point in time from market studies. Also REE performed an annual computation with the UPLAN model merging market and network studies (DC load flow computations) to test the Spanish grid.

Points-in-Time approach:
A limited number of representative snap shots within the market study outputs were selected for performing detailed network studies. Starting from the duration curve of the power flow exchange between countries the chosen of PiTs where mainly focused in the first and last part of the curve where the exchanges are higher and the weakness of the network can arise easily.

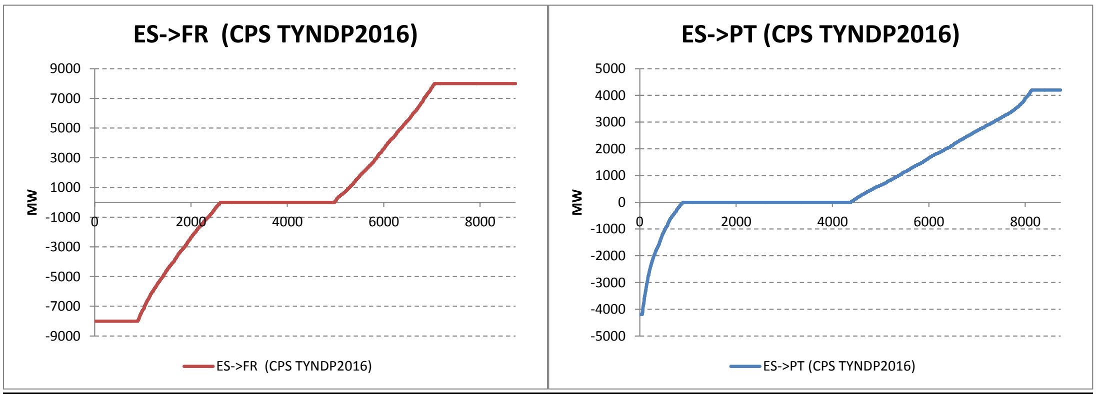

Figure 7.2-7. Duration curves for ES-FR and ES-PT borders resulting from the market studies

On the base of the detailed results of market study with new capacity on the borders, three points in time were chosen on a regional basis:

Case 1	4 December 11:00	– ES->PT 4200 MW – ES<-FR 8000 MW
Case 2	13 April 22:00	– ES<-PT 4200 MW – ES->FR 8000 MW
Case 3	18 August 10:00	– ES<-PT 2000 MW – ES->FR 8000 MW

Table 7.2-1 List of Points in Time studied in RG CSW with detailed Network studies

Below it is presented the generation mix for each case:

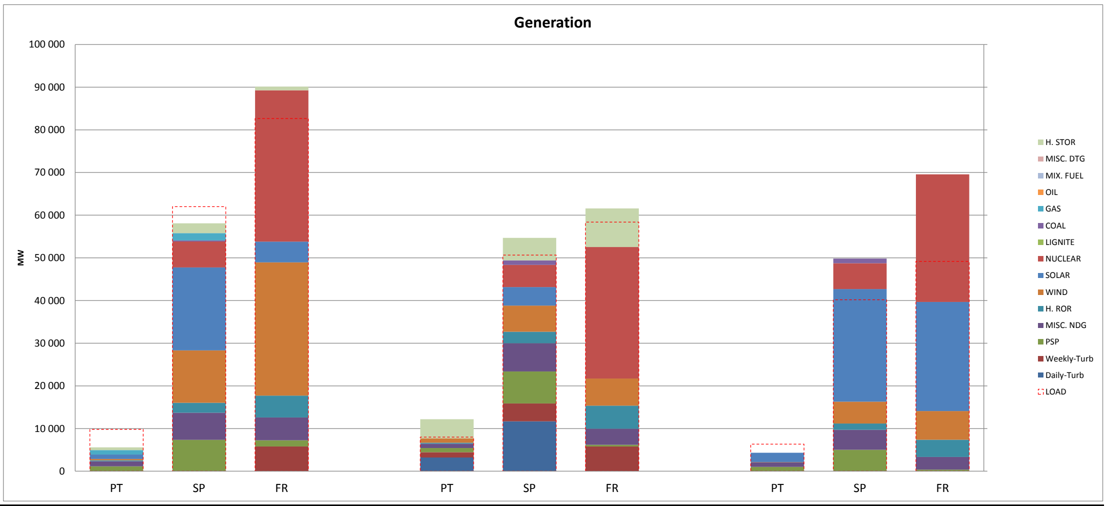

Figure 7.2-8 Generation mix in the selected PiTs

For these PiT, the generation mix per type and consumption were located in the tools (Convergence for RTE and PSSE for REE and REN). After exchanging and merging the cases, a load flow on AC has been used to determine the bulk power flows and identify the bottlenecks.

PTDF approach:

In order to complete the study done in the Regional Group, the French Transmission Operator RTE used the ptdf methodology. The objective was to convert detailed market study results to hourly flows on the grid. With the approximation of Direct Current load flow, the principle is to calculate with the current tool (Convergence for RTE) the influence of each parameter of the market study on each line. Using a regional network model file as a starting point, hourly flows in MW for each lines of the model were calculated. This method has been used in order to have a probabilistic approach based on the market results for the common planning studies. This approach has been used with the same data used to determine the common Points in Time used for the load flow analysis. This methodology has the advantage to calculate the flows in normal and contingency situations for a complete year, giving information on the frequency of constraint and severity. However, the disadvantage is that it does not consider any information on voltage and reactive power, and that issues such as the number of variables considered or the consideration of N-2 contingencies are simplified. This method is in a testing phase in the region and could be improved for the next TYNDP process. RTE's results for the particular points in time chosen in the region have been extracted of the complete results in order to be included in the region results for the grid studies.

Bulk power flows

The next figure shows the bulk power flows for the chosen cases 2 and 3:

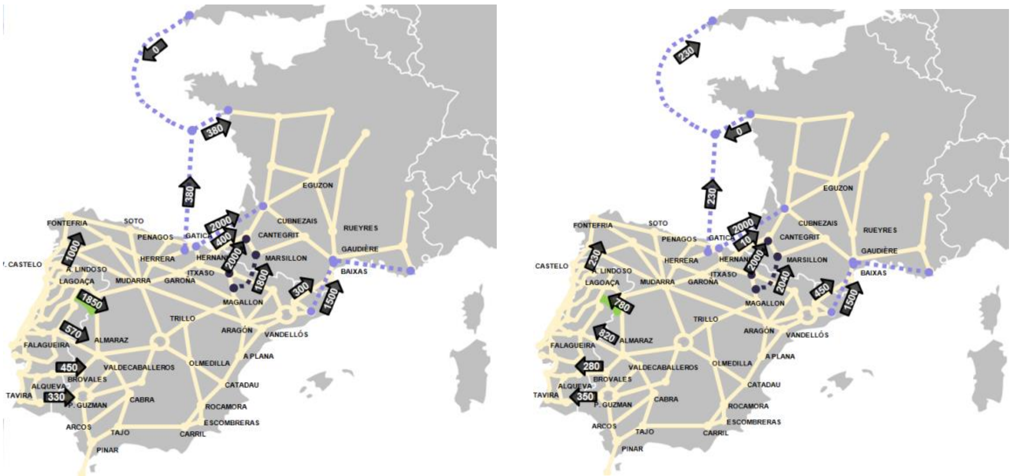

Figure 7.2-9. Bulk power flows in case 2 (left) and in case 3 (right)

Bottlenecks and investment needs identification

The basic computation is a steady-state load flow, i.e. simulating the power flows on every grid element resulting from a specific generation dispatch. Voltage at every node and currents in every branch must remain within secured ranges. The check is performed with all grid elements available, and then considering the outage of every grid element and power unit (N-1 criterion), and thus for every point in time, and possibly considering several options for grid topology and testing remedial measures.

In the French-Spanish border it was clear that the 3GW increase was not possible to be achieved without new crossborder projects on top of the ones considered in the TYNDP 2014. Therefore 2 new projects were considered according to the explanations in chapter 4. The landing points of the interconnectors proposed are the ones that combine result more preferable from a pre-feasibility study from the socio and environmental point of view, together with causing the lowest internal impact in terms of bottlenecks, in order to reduce the total investment cost of the projects. Changing the interconnectors landing point from its proposed locations would have impact on the bottlenecks identification.

The results have been analyzed both in frequency and severity of overloads. The combination of these analyses is presented in the following Table. It should be noted that the Spanish and Portuguese system are planned for N-1 and N-2 conditions. Therefore more potential reinforcement or some conditions to the project definition could be required to cater those eventualities. In the common planning studies, the increase of the exchange between France and Spain up to 8000 MW and between Portugal and Spain up to 4200 MW has been simulated with the hypothesis of the Vision 4 from TYNDP 2014. This scenario is characterised by a very high level of renewables (wind and solar).

With these new interconnectors, the grid as planned in the TYNDP 2014 (pan-European projects) is not adequate to sustain the targeted level of market exchange capacity. The main bottlenecks identified are described in the following table:

Area	Severity	Origin
South West of France	Bottleneck in N and N-1	Transmit the energy coming from or to the HVDC at Cantegrit
North of Aquitaine (France) up to Paris	Bottleneck in N	Flows from Spain to French north-eastern border, including evacuation of future generation in the South West of France and demand in Paris
Axis West – East in the South of France	Bottleneck in N-1	Transmission of RES generation in case of high level of solar in South Western France plus high import from Spain
Connection Navarra-Basque Country	Bottleneck in N and N-1	Transmit the energy coming from or to the HVDC at Dicastillo or area of Pamplona. Solve east-west constraints due to RES
400kV east-west axis in Basque Country	Bottleneck in N-1	Manage the power flows to/from France (HVDC Biscay Gulf, AC lines in Basque Country and HVDC in Navarra); and between the north Axis and the Levante region
Transpyrenees axis	Bottleneck in N-1	Transmission of hydro in the Pyrenees combined with a high exchange Spain-France
Catalonia	Bottleneck in N-2	Overloads in 220kV in Catalonia which becomes a transfer path to France from Spain, especially in peak situations
Douro region cross border axis	Bottleneck in N-1 and N-2	high RES (wind and hydro) conditions with significant exports from Portugal to Spain
Axis Lagoaça- Porto	Bottleneck in N-1	Dry conditions with high exports from Spain to Portugal
Cedillo-Falagueira axis	Bottleneck in N-1	High export from Spain to Portugal

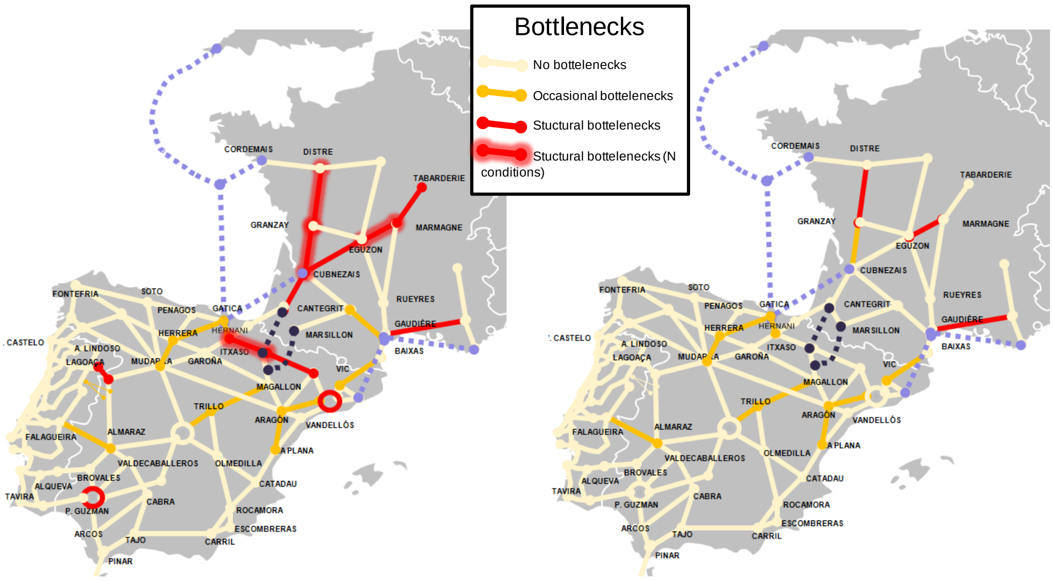

*Figure 7.2-10 Bottlenecks in Vision 4 TYNDP 2014 wit*th 8GW in FR-ES and 4.2 GW in ES-PT and new crossborder projects in ES-FR border (left), bottlenecks with the new reeinforcement in ES-PT border and internal reinforcements proposed (right).

In the grid studies results, for France even after adding internal reinforcements, as described in chapter 4, some residual constraints are still present with high solar and importation from Spain.

In order to analyse the needs to increase the capacity of the French grid to support such flows RTE has conducted a sensitivity study with the draft Vision 3 of TYNDP 2016. It has been computed that the proposed internal reinforcements in France are sufficient with the new scenario. As the need was not confirmed in the new scenario, no precise additional projects were proposed to solve the residual congestions in Vision 4 TYNDP 2014 with 8 GW of exchanges.

Due to high level of active power on several 400 kV lines in the region, some static or dynamical voltage constraints could appear. With few thermal generation connected, the reactive power coming seems to be not sufficient. Complementary studies are needed to estimate the volume, the characteristics and the location of the MVAr investments, and ensure the dynamics of the scenario. In addition, it should be noted that the investigations conducted mainly referred to steady state analyses. The dynamic system behaviour under severe contingencies (and especially the frequency stability) must be subject to complementary studies, once larger and more volatile over longer distances transit flows trigger new technical challenges regarding system operation (frequency control, reserve management, voltage control, etc.).

7.3 Guidelines for Project Promoters

In line with Regulation (EU) 347/2013, the EC provides a set of guidelines[12] for ENTSO-E to apply when handling all applications by project promoters for TYNDP inclusion. These guidelines ensure the same procedure, timeline and qualification criteria are used for all project promoters, and enshrine the rights and responsibilities of promoters, ACER, EC and ENTSO-E. It addresses Promoters of transmission infrastructure projects within a regulated environment, Promoters of transmission infrastructure projects within a non-regulated environment (i.e. exempted in accordance with Article 17 of Regulation (EC) No

12 https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP%202016/20150217_Guidelines_Update_ENER_TC_24.02.2015_1st%20draft.pdf

714/2009, referred to as "merchant lines"), and Promoters of storage projects. All who aspire inclusion of their project in the PCI list in year X, need to be included in the latest available TYNDP of year X-1.
Based on the EC's draft guidelines, and building on the experience of past TYNDPs, all promoters of electricity transmission and storage projects were invited by ENTSO-E to submit between 1 April and 30 April 2015 their application for inclusion in the Ten-Year Network Development Plan 2016.
During May 2015 ENTSO-E reviewed the data submitted in order to verify its completeness and compliance with the guidelines. Throughout May any promoter had the opportunity to complete or update its project details, and ENTSO-E was in regular contact with all promoters to ensure a smooth process. All promoters were invited to provide information via a dedicated Sharepoint platform. Ultimately it is the applicant's responsibility to ensure the application was completed by end of May.
This procedure allowed ENTSO-E to compile a list of TYNDP project candidates which completes the picture of planning studies, regional context and investment needs sketched in the Regional Investment Plans[13]. This timely compilation of a list of TYNDP projects allows ENTSO-E to have a baseline reference architecture for CBA assessments starting in summer 2015. Any late request for TYNDP inclusion can be handled evidently in future TYNDP editions. Any request for significant change to TYNDP projects during the 2016 process will be assessed in line with ENTSO-E's governance rules, with oversight from EC and ACER, and taking on board the role of ENTSO-E's neutral Network Development Stakeholder Group.
The main drivers in this approach is to keep transparency over the development and updates of the TYNDP project list, and ensure clarity over the CBA assessment 'ingredients' (methodology, list of projects, scenarios, data).

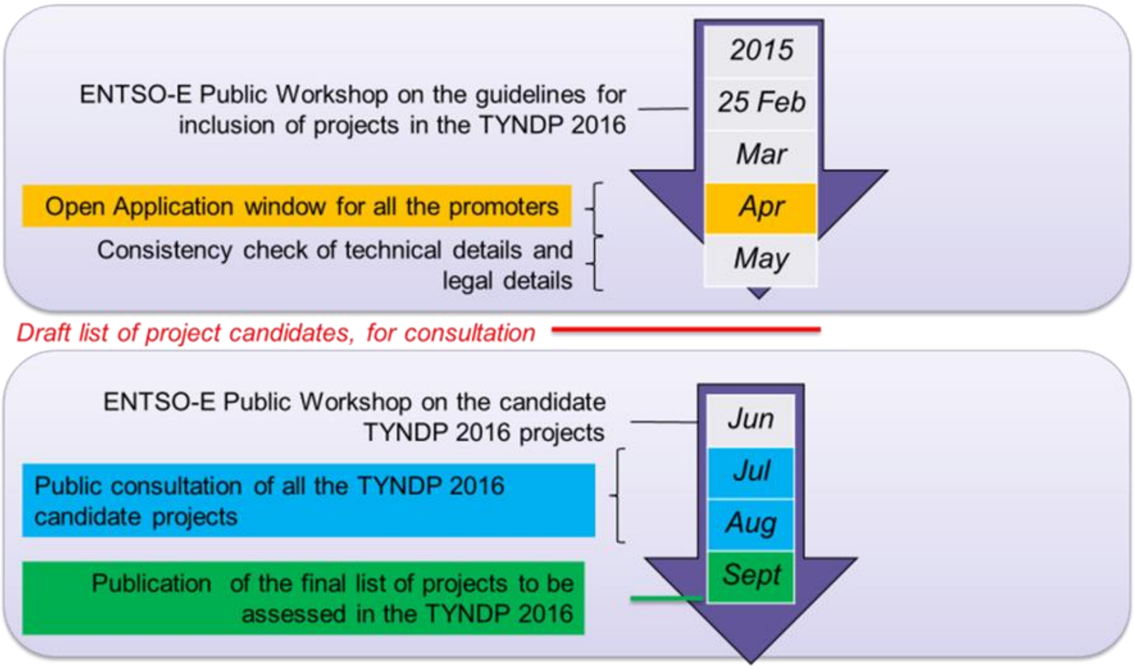

Figure 7-4 Workplan for project promotors

7.4 Abbreviations

The following list shows abbreviations used in the Regional Investment Plans 2015.

- AC Alternating Current

13 https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP%202016/150331_TYNDP_2016_FAQs_application_for_projects.pdf

- ACER Agency for the Cooperation of Energy Regulators
- CCS Carbon Capture and Storage
- CBA Cost-Benefit-Analysis
- CHP Combined Heat and Power Generation
- DC Direct Current
- EH2050 e-Highway2050
- EIP Energy Infrastructure Package
- ENTSO-E European Network of Transmission System Operators for Electricity
- ENTSOG European Network of Transmission System Operators for Gas
- EU European Union
- GTC Grid Transfer Capability
- HV High Voltage
- HVAC High Voltage AC
- HVDC High Voltage DC
- IEA International Energy Agency
- KPI Key Performance Indicator
- IEM Internal Energy Market
- LCC Line Commutated Converter
- LOLE Loss of Load Expectation
- MS Member State
- MWh Megawatt hour
- NGC Net Generation Capacity
- NRA National Regulatory Authority
- NREAP National Renewable Energy Action Plan
- NTC Net Transfer Capacity
- OHL Overhead Line
- PCI Projects of Common Interest
- PINT Put IN one at the Time
- PST Phase Shifting Transformer
- RegIP Regional investment plan
- RES Renewable Energy Sources
- RG BS Regional Group Baltic Sea
- RG CCE Regional Group Continental Central East
- RG CCS Regional Group Continental Central South

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- RG CSE Regional Group Continental South East
- RG CSW Regional Group Continental South West
- RG NS Regional Group North Sea
- SEW Socio-Economic Welfare
- SOAF Scenario Outlook & Adequacy Forecast
- SoS Security of Supply
- TEN-E Trans-European Energy Networks
- TOOT Take Out One at the Time
- TSO Transmission System Operator
- TWh Terawatt hour
- TYNDP Ten-Year Network Development Plan
- VOLL Value of Lost Load
- VSC Voltage Source Converter

7.5 Terminology

The following list describes a number of terms used in this Regional Investment Plan.

Congestion revenue/ congestion rent – The revenue derived by interconnector owners from sale of the interconnector capacity through auctions. In general, the value of the congestion rent is equal to the price differential between the two connected markets, multiplied by the capacity of the interconnector.

Congestion - means a situation in which an interconnection linking national transmission networks cannot accommodate all physical flows resulting from international trade requested by market participants, because of a lack of capacity of the interconnectors and/or the national transmission systems concerned.]

Cost-Benefit-Analysis (CBA) – Analysis carried out to define to what extent a project is worthwhile from a social perspective.

Corridors – The CBA clustering rules proved however challenging for complex grid reinforcement strategies: the largest investment needs may require some 30 investments items, scheduled over more than five years but addressing the same concern. In this case, for the sake of transparency, they are formally presented in a series – a corridor – of smaller projects, each matching the clustering rules.

Cluster – several investment items, matching the CBA clustering rules. Essentially, a project clusters all investment items that have to be realised in total to achieve a desired effect.

Grid transfer capacity (GTC) – represents the aggregated capacity of the physical infrastructure connecting nodes in reality; it is not only set by the transmission capacities of cross-border lines but also by the ratings of so-called “critical” domestic components. The GTC value is thus generally not equal to the sum of the capacities of the physical lines that are represented by this branch; it is represented by a typical value across the year.

Investment – individual equipment or facility, such as a transmission line, a cable or a substation.

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Net Transfer Capacity (NTC) – the maximum total exchange program between two adjacent control areas compatible with security standards applicable in all control areas of the synchronous area, and taking into account the technical uncertainties on future network conditions.

N-1 Criterion – The rule according to which elements remaining in operation within TSO's Responsibility Area after a Contingency from the Contingency List must be capable of accommodating the new operational situation without violating Operational Security Limits.

Project – either a single investment or a set of investments, clustered together to form a project, in order to achieve a common goal.

Project candidate– investment(s) considered for inclusion in the TYNDP.

Project of Common Interest – A project which meets the general and at least one of the specific criteria defined in Art. 4 of the TEN-E Regulation and which has been granted the label of PCI Project according to the provisions of the TEN-E Regulation.

Put IN one at the Time (PINT) – methodology, that considers each new network investment/project (line, substation, PST or other transmission network device) on the given network structure one-by-one and evaluates the load flows over the lines with and without the examined network reinforcement.

Reference network – the existing network plus all mature TYNDP developments, allowing the application of the TOOT approach.

Reference capacity – cross-border capacity of the reference grid, used for applying the TOOT/PINT methodology in the assessment according to the CBA.

Scenario – A set of assumptions for modelling purposes related to a specific future situation in which certain conditions regarding gas demand and gas supply, gas infrastructures, fuel prices and global context occur.

Transmission capacity (also called Total Transfer Capacity) – the maximum transmission of active power in accordance with the system security criteria which is permitted in transmission cross-sections between the subsystems/areas or individual installations.

Take Out One at the Time (TOOT) – methodology, that consists of excluding investment items (line, substation, PST or other transmission network device) or complete projects from the forecasted network structure on a one-by-one basis and to evaluate the load flows over the lines with and without the examined network reinforcement.

Ten-Year Network Development Plan – The Union-wide report carried out by ENTSO-E every other year as (TYNDP) part of its regulatory obligation as defined under Article 8 para 10 of Regulation (EC) 714 / 2009

Total transfer capacity (TTC) – See Transmission capacity above.

Vision – plausible future states selected as wide-ranging possible alternatives.