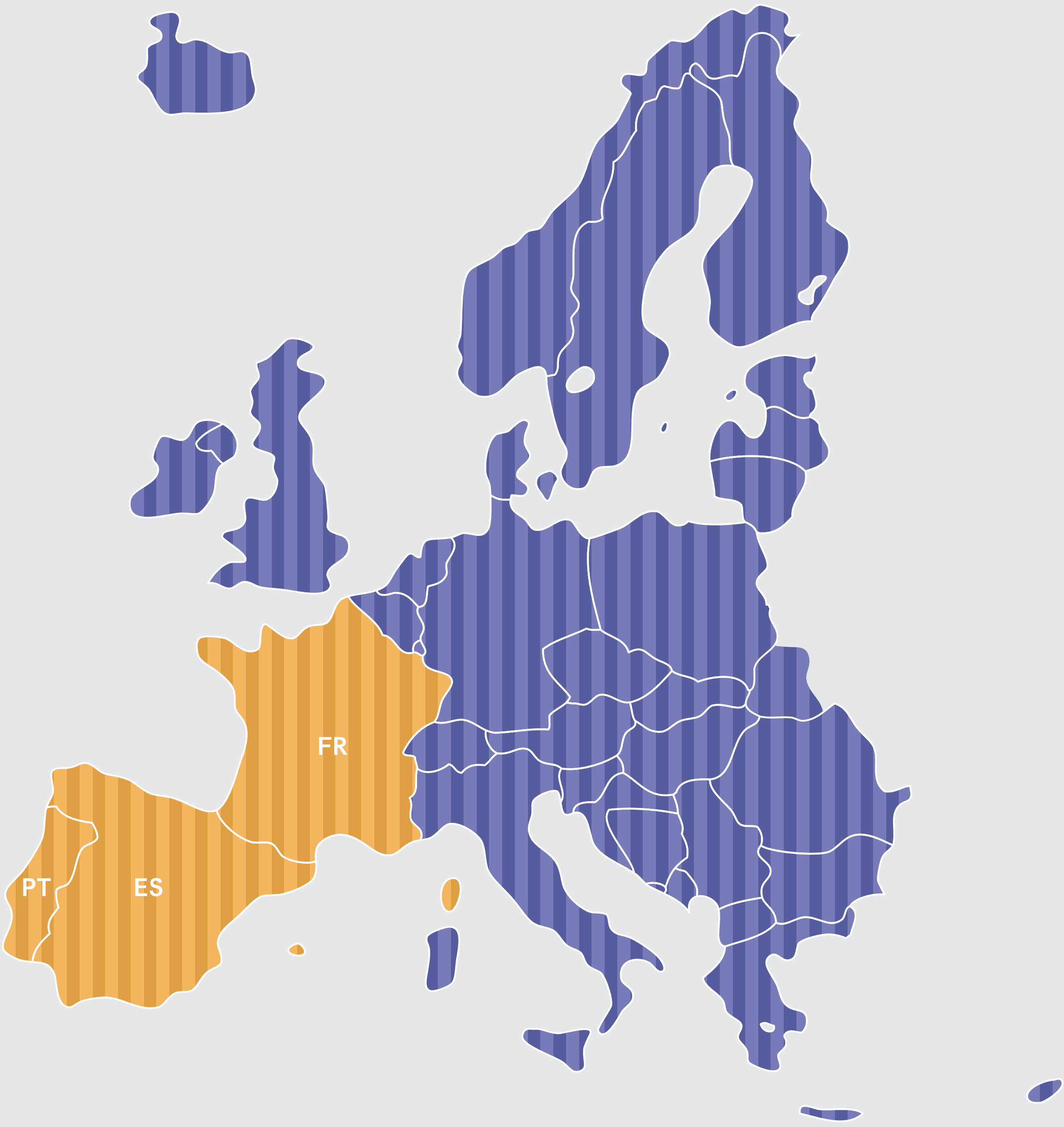
REGIONAL INVESTMENT PLAN 2014
CONTINENTAL SOUTH WEST Final



European Network of
Transmission System Operators
for Electricity

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<u>Disclaimer:</u> ENTSO-E has published this Regional Investment plan end of 2014 before the release by ACER of its opinion on the draft TYNDP 2014 package. In order to take into account the upcoming ACER opinion to be available in the coming weeks, changes at the margin may be implemented in this report.

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0 Executive summary

0.1 RG CSW delivers the RgIP 2014 as part of the ENTSO-E TYNDP 2014 Package

The Continental South West Regional Group (RG CSW) under the scope of the European Network of Transmission System Operators for Electricity (ENTSO-E) provides herewith the 2014 release of the Continental South West Regional Investment Plan (hereinafter "CSW RgIP 2014"), as one of the documents of the community-wide Ten-Year Network Development Plan (TYNDP) 2014 Package. The CSW RgIP 2014 is the proposed plan covering the period from now until 2030 and supersedes the CSW RgIP 2012.

This present publication complies with the requirements of Regulation (EC) No 714/2009, in force since March 2011, whereby "ENTSO-E shall adopt a non-binding Community-wide 10 year network development plan, including an European generation adequacy outlook, every two years". The TYNDP 2014 is released as a package including this CSW RgIP 2014, the five other Regional Investment plans and the Scenario Outlook and Adequacy Forecast (SOAF).

The formal role of the TYNDP in the European system development was further strengthened via the Energy Infrastructure package, in force since April 2013, where TYNDP has been stated as the sole basis for the selection of the Projects of Common Interest.

The CSW RgIP and the TYNDP 2014 at large is a result of a tight and active two year period, during which extensive improvements were made to the scenario development, stakeholder involvement and also the cost and benefit assessment methodology.

The development of the transmission infrastructure is crucial for reaching European targets, with particular regard to the development of the European internal energy market (IEM), integration of renewable energy sources (RES) and the security of supply (SoS). It is the statutory requirement of the TYNDP 2014 and the RgIP 2014 as part of the TYNDP 2014 to focus on all relevant aspects of the development of the transmission infrastructure. This constrains the European Energy targets and the system operation responsibility of the TSOs.

In addition, action by the European Commission to boost the necessary investment is urgently needed. More efforts are necessary in order to modernise and expand Europe's energy infrastructure and to interconnect electricity networks across borders in order to meet these objectives.

With each release of the TYNDP, the issues and goals are widened and deepened and there is growing interest from stakeholders towards the TYNDP plan. ENTSO-E will further develop the process and content of the TYNDP with the collaboration of the stakeholders.

In this context, the TSOs of the RG CSW within the ENTSO-E present this Regional Investment Plan for 2030. The CSW region within ENTSO-E embraces France, Portugal and Spain.

0.2 Stakeholders actively contributed to the TYNDP 2014 package

ENTSO-E and its Regional Groups welcome and encourage stakeholder involvement in the TYNDP 2014 process. During the two-year period ENTSO-E both provided information and asked for input from stakeholders during several phases of the process via 15 open workshops, both European and regional, six public web-consultations or requests for contributions and bilateral meetings. Additionally, a dedicated Long-Term Network Development Stakeholders Group was created, gathering European organisations to provide views on long-term grid development related issues. The scenarios and the Cost Benefit Analysis (CBA) methodology reflect the extremely valuable inputs received in this framework.

In addition to their contribution to the CBA methodology and scenario building for which their participation was organised at the ENTSO-E level, stakeholders also participated in the 25 March regional Workshop (held in Lisbon), which was dedicated to presentation and discussion of the CSW project assessment results.

0.3 How the TYNDP 2014 package was achieved and the improvements that have been made since 2012

The TYNDP 2014 Package is a continuously improving process which started with the first TYNDP in June 2010 ahead of the entry into force of Regulation (EC) No 714/2009. Since the TYNDP 2012, several improvements have been carried out in scenario development, stakeholder involvement and cost and benefit assessment. The main new features in the TYNDP 2014 are:

- The exploration of a longer run horizon, namely 2030, beyond the ten-year horizon, using four contrasted "Visions", encompassing the futures that stakeholders required ENTSO-E to consider.
- New clustering rules to define projects of pan-European significance, focusing on a few core investment items (other regionally significant supporting investments are presented in the Regional Investment Plans).
- A numerical quantification of every project benefit assessment according to the consulted CBA methodology, with refined definitions for the security of supply, RES integration, socioeconomic welfare, technical resilience, robustness/flexibility, and social and environmental indicators.
- A synthetic appraisal of the interconnection target capacities in the different scenarios.
- Easier and more frequent opportunities for stakeholders to take part, especially for transmission or storage project promoters that are not members of ENTSO-E.

For the TYNDP 2014 Package implementation, ENTSO-E and the RGs, including the RG CSW, also improved their study tools and processes compared to TYNDP 2012, speeding up and strengthening data collection, model calibration, consistency checks and the merging of pan-European and regional results. In fact, the quality of the integrated market and network modelling relies on knowledge of all the specific features of every local power system in Europe, a detailed grid description, and the resulting ability to master and cut aptly through numerous parameters with high uncertainty.

Thus, for the CSW region 27 grid investment projects have been investigated, analysed and assessed in a limited timeframe of two years, including a project promoted by a third party from a non-ENTSO-E member. All in all, this RgIP presents a more holistic view of grid development, combining power transmission issues with environmental and resilience concerns.

0.4 The TYNDP 2014 package explores a large span of possible futures by 2030

The TYNDP 2014 Package analyses are based on an expansive exploration of the 2030 horizon. The year 2030 is used as a bridge between the European energy targets for 2020 and 2050. This choice has been made based on stakeholder feedback, preferring a large scope of contrasting longer-run credible scenarios instead of a more limited number and an intermediate horizon of 2020.

The basis for the TYNDP 2014 analysis is four different Visions for 2030. The Visions are less forecasts of the future than a selection of possible extremes of the future so that the pathway realised in the future falls with a high level of certainty in the range described by the Visions. The span of these four Visions is large and meets the various expectations of the stakeholders. They differ mainly with respect to:

- The trajectory toward the Energy roadmap 2050: Visions 3 and 4 maintain a regular pace from now until 2050, whereas Visions 1 and 2 assume a slower start with an acceleration after 2030. Fuel and CO_2 prices favour coal (resp. gas) in Visions 1 and 2 (resp. Visions 3 and 4).

- The consistency of the generation mix development strategy: Visions 1 and 3 have a bottom-up design based upon each country's energy policy but still have a harmonised approach across Europe; Visions 2 and 4 assume a top-down and consistent pan-European approach.

At a regional level, these four Visions were also considered to perform the regional market and network analyses in order to incorporate the main assumptions of the pan-European studies. Nevertheless, at a regional level, it is necessary to consider the specificities of each region and country. For the CSW region, the wind and solar profiles, the hydro generation and the impact of the temperature in the consumption were defined with more detail in order to incorporate regional specificities in the studies.

Figure 0-1 Total Installed capacity in the CSW region for the four Visions analyzed

Figure 0-2 Expected generation mix in the CSW region for the four Visions analyzed

The main differences among the four Visions are described above for all of Europe and, for the CSW region, the Visions describe a large difference between Vision 1 - "Slow Progress" and Vision 4 - "Green Revolution". For Vision 1, the nuclear generation has the main role in the generation mix (almost 50% of the total generation), representing 22% of total installed capacity. For Vision 4, the RES generation represents approximately 57% of total generation production, equalling around 70% of total installed capacity. This RES generation comes mainly from wind and solar within the whole CSW region and also from hydro in Portugal and Spain. In Visions 3 and 4 there is also a significant reduction of nuclear installed capacity in France.

0.5 The RgIP CSW 2014 confirms and enriches the key findings of RgIP 2012

0.5.1 Main Drivers of Grid Development in the CSW region

As stated above, 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, five main needs drivers for system evolution can be briefly summarised:

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- **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 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.

0.5.2 Key Findings in the CSW region

The regional analysis shows that there are important transmission needs arising from now until 2030. These needs are driven by two main factors. The first main driver is the connection and evacuation of new generation (mainly renewable). Concerning RES, there is currently about 90 GW of installed capacity in the region, and by 2030 this figure will be in the range 150 – 320 GW (including new hydro) depending on the Vision considered. The ambitious renewable targets assumed in this plan (prepared in close cooperation with the stakeholders), namely for Vision 4, represent a major shift in the generation mix within the CSW region and imply important investments in transmission infrastructure. The main reason is that these new RES power plants, mainly wind, hydro (with and without pumping) and solar, are mostly located in remote areas far away from major consumption centres, where the transmission network is usually weak or does not exist at all.

However, this high RES penetration sets additional challenges for the system as a whole, with respect to its dynamic behaviour (how can frequency be maintained if the system inertia is dramatically reduced? What voltage supporting equipment would be needed and where and when power plants closer to load centres and traditionally contributing to voltage control are massively shut-down? How will long distance bulk power flows be managed on AC grids? How will actually interact with the other HVDC equipment installations working in parallel actually interact with each other? How will embedded generation on distribution system behave? Etc.). Therefore, although the CSW region already has good experience and good results integrating RES into the system, further studies are needed in subsequent TYNDP releases in order to ensure the security and stability of the overall future European electrical system. The support from stakeholders in this task is of vital importance (to provide realistic forecasts, data and models). With more precise inputs in this respect, additional investment needs may be identified and a more comprehensive picture of the grid infrastructure required by 2030 in this context will be supplied in the next release of the TYNDP.

The other main driver in the CSW region is the insufficient cross-border capacity between the Iberian Peninsula (in particular Spain) and the rest of the European Continent. In this RgIP the concretisation of three new interconnections between the Iberian Peninsula and the rest of Europe is already taken into account, which will allow the interconnection capacity across this boundary to be increased from 1 GW today to 6 GW in 2030. Nevertheless, the studies still show a high congestion level (40-60%) for all Visions. In order to reduce the congestions level and to fulfil the EC objective for the minimum interconnection ratio (10%), there is the need for a further increase in this interconnection capacity to values in the range of 7-10 GW in Visions 1 and 2, and greater than 10 GW in Visions 3 and 4.

Security of supply is also a focus of the regional studies. Nevertheless, as the construction of the scenarios for the four Visions assumes that the generation is sufficient to balance the load, it is not expected that projects of pan-European significance contribute to enhanced security of supply as a primary driver. So security of supply issues are analysed in this RgIP at a more regional level, while National Development Plans will address local issues.

Regional Market Studies have also shown that the CSW is a net exporter region, supported by the nuclear generation in France for the more conservative Visions (e.g. Visions 1 and 2) and by the RES generation, mainly in the Iberian Peninsula, for the green Visions (Visions 3 and 4). Focusing on the countries net balances, it is expected that Portugal continues to be a net importer, France a net exporter and Spain a net importer for Visions 1 and 2 and a net exporter for Visions 3 and 4. These differences in net balances and the increase and variability of exchanges, namely in Spain, leads to markedly different power flow profiles in the region, which creates several challenges for the transmission system in the CSW region.

All the interconnection projects included in the CSW RgIP show important benefits for the European system: increasing Social Economic Welfare, helping RESs integration, reducing CO_2 emissions (more pronounced in Visions 3 and 4) and reducing the isolation of the Iberian Peninsula. The projects between the Iberian Peninsula and the rest of Europe have also an important impact on flows and generation outside the CSW region.

Considering the regional needs described above, the CSW Region has identified 27 projects of European relevance. The investment plan proposed sums up 14000Km (71% of them on overhead AC lines). It includes 3 cross-border lines within the region (1 on the PT-ES border and 2 on the ES-FR border), 11 interconnection projects between the region and the rest of Europe (10 of them are interconnections between France and the rest of the Europe which are being assessed in other ENTSO-E regional groups), and 13 internal projects.

The plan shows a big effort to make the best of existing assets in order to minimize grid extension and avoid creating new routes, as 27% of the AC projects are upgrades, uprates or change of conductor, including the use of High Temperature conductors. Moreover, FACTS and Phase Shifter Transformers are considered, to control active power flows in some parts of the network. In addition, new and efficient but usually expensive technologies are considered in certain project definition, such as VSC in HVDC.

The investment cost in the CSW region is around €13.4 billion, of which around 35% refers to interconnections in the region, 40% to interconnections of the region (France) with the rest of Europe, and 25% to internal projects. This expenditure splits rather equally between the first 5 year (2014-2018) and the following 12 year (2019-2030) sub-periods, the investment being a bit higher in the long term. Long term includes some more expensive projects, especially regarding interconnections, as some of them are submarine and include HVDC technology.

Around 80% of the individual investments in these projects were already included in the TYNDP 2012; 47% are progressing as planned, although some of them have undergone some rearranging, and 24% will be commissioned by the end of 2014. However, 32% of the planned projects in the TYNDP 2012 have experienced delays; these are mainly related to the permitting process, generally due to consultation results or environmental issues, which sometimes force reviews and redefinitions of the project in order to introduce some changes in its definition, or even, in some extreme cases, to look for an alternative solution (new project). The non-approval of the Spanish National Development Plan is also a justification for this situation.

0.5.3 The Resilience of the portfolio creates a large choice of options to fulfil the European energy policy goals

Thousands of market situations considering a large set of hazards that may affect the power system have been simulated and processed for this RgIP CSW 2014. Frequent situations or rare ones resulting in particularly extreme flow patterns have then been identified for further analysis in order to test the grid's ability to withstand them and define, if necessary, the required measures. Typical such situations are peak loads in winter or summer with extreme but likely low or high wind/solar generation. Lower load conditions with high RES generation have also been considered.

Such thorough investigations were performed for all four contrasting Visions by 2030. Thus, TSOs can ensure the proposed investments are adapted and robust. The already proposed grid investments from TYNDP 2012 remain valid; the only exceptions involve projects that were in a very early phase in 2012 which have since proved technically unfeasible and were substituted by other projects. The proposed projects cover most of the described investment needs. Conversely, some additional reinforcements are still to be designed to cover investment needs specific to the most ambitious scenarios of RES development by 2030.

The set of projects of pan-European significance is still to be completed in order to meet the energy revolution proposed in Vision 4. With its validation first in October 2013, Vision 4 could only be used to assess the portfolio of already identified projects. Investment needs investigation in this Vision requires additional input and feedback from stakeholders (more precise location of generation especially) so that a more comprehensive picture of the grid infrastructure can be supplied. Such interaction and continuous adaptation is normal, considering uncertainties regarding the realisation of the challenging transformation of the generation mix or the interconnection of Europe with Africa.

It should be noted that the present project assessment mainly refers 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).The following map summarises the situation in this respect: the boundaries where the project portfolio is sufficient to cover the target capacity on the interconnections in all Visions in 2030 are green; where boundaries are orange or red, the Plan may need to be completed.

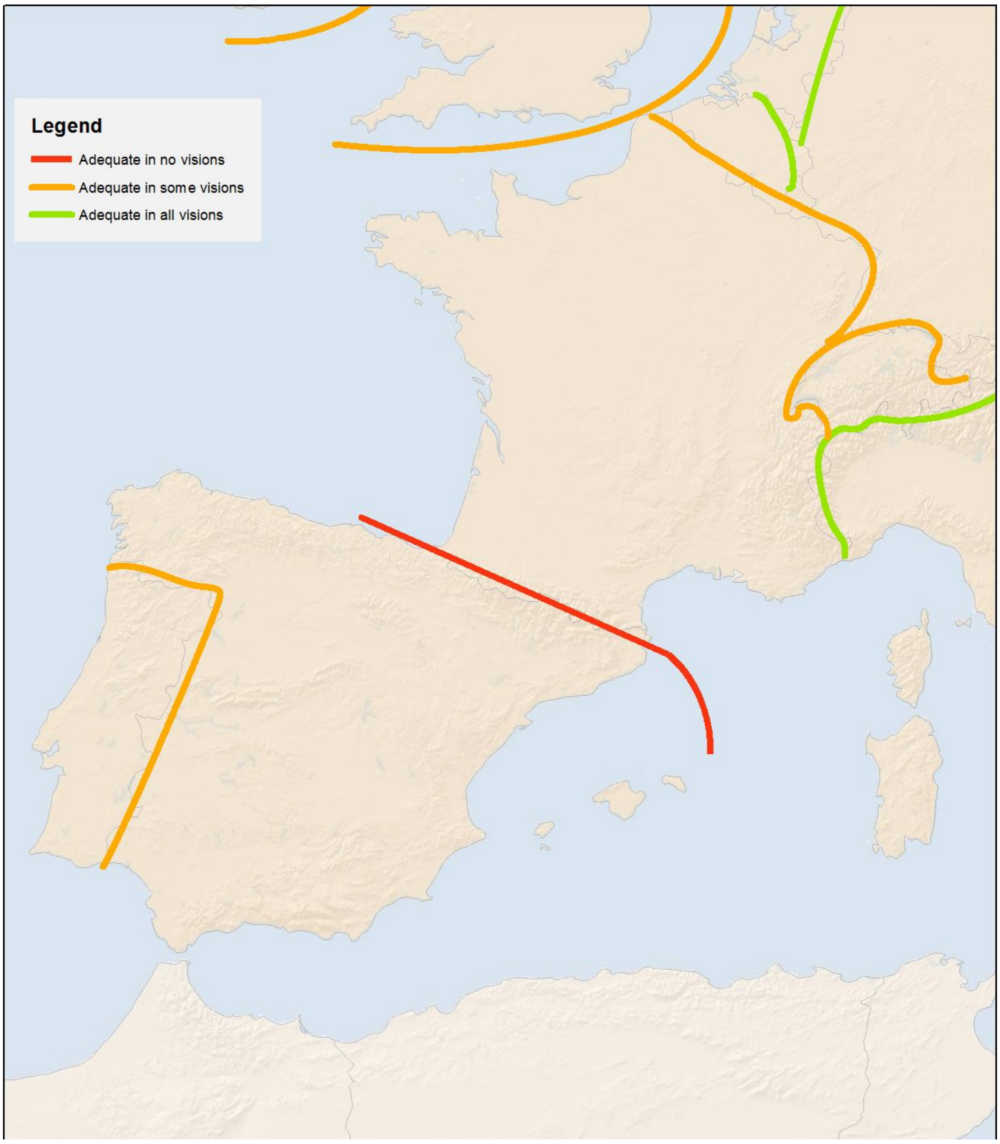

Figure 0-3 Transmission adequacy by 2030 in CSW region

As can be seen, in the CSW region the interconnection between the Iberian Peninsula and the rest of the Europe is not adequate for 2030 even with the project portfolio included in this RgIP. So in order to reach the EC objectives new projects will be needed. Further studies are then needed in the RG CSW. However, the currently planned projects are quite complex, from a technical point of view, and according to the experience they should be implemented step by step, so in spite of the necessity it will be a challenge to implement additional capacities by 2030. Planning studies on this should continue in the framework of the RG CSW.

0.5.4 Energy transition requires the 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. 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. As a result, most of the projects shown in the TYNDP 2014 Package that have already entered in the permitting process experience delays.

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If energy and climate objectives have to be achieved, it is of utmost importance to smooth the authorisation processes and to gain political support on all levels. In this respect, ENTSO-E welcomes Regulation EU No 347/2013 as there are many positive elements in the new permitting process which will facilitate the fast tracking of transmission infrastructure projects, including the proposal on one stop shop and defined timelines.

More thorough analyses are however required so as to ensure the measure can be successfully implemented, in particular in relation to whether the timelines proposed are achievable, particularly in the context of the public participation process and the potential for legal delays. One must also note that the supporting schemes are limited to the Projects of Common Interest, whereas there are many significant national transmission projects that are crucial to the achievement of Europe's targets for climate change, renewables and market integration.

A stable regulatory framework is also essential to ensure grid reinforcement can be completed in time. 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.

Finally, it is worth mentioning that transmission planning is a continuous living process and that an updated RgIP will be published every two years. Accordingly, the scenarios assessed in this plan are updated every two years taking into consideration the stakeholder community to make the optimisation of the strategy for the evolution of the electrical transmission system in the region possible. In fact, the preparation of the TYNDP 2016 package has already started.

1 Introduction

1.1 ENTSO-E compiles a Vision for grid development: the TYNDP package 2014

The European Network of Transmission System Operators for Electricity (ENTSO-E) provides herewith the 2014 release of the Community-wide Ten-Year Network Development Plan (TYNDP). The objectives of the TYNDP package are to ensure transparency regarding the electricity transmission network and to support decision making processes at the regional and European level. The pan-European report and the appended Regional Investment Plans (RgIPs) are the most comprehensive and up-to-date European-wide references for the transmission network. They point to significant investments in the European power grid in order to help achieve European energy policy goals.

Since the 2012 release, ENTSO-E has supplied a TYNDP "package", a group of documents consisting of the following:

- the present Community-wide TYNDP report 2014;
- the six Regional Investment Plans 2014; and
- the Scenario Outlook and Adequacy Forecast (SOAF) 2014.

Collectively, these documents present information of European and regional importance. They complement each other, with only limited repetition of information between documents when necessary to make each of them sufficiently self-supported. Scenarios are comprehensively depicted in the SOAF, investments needs and projects of European importance are comprehensively depicted in the Regional Investment Plans, whilst the Community-wide TYNDP reports purely synthetic information regarding concerns and projects of pan-European significance. ENTSO-E hopes to meet the various expectations of their stakeholders, leading to grid development and detailed perspectives at the same time.

ENTSO-E cannot be held liable for any inaccurate or incomplete information received from third parties or for any resulting misled assessment results based on such information. The TYNDP 2014 package was consulted during summer 2014 in order to be finalised in December 2014.

This report (Continental South West Regional Investment Plan – RgIP CSW) is one of the six Regional Investment plans (RgIP) and complements the TYNDP 2014 by focusing on the transmission needs of Portugal, Spain and France.

1.2 Regulation EU No 347/2013 sets a new role for the TYNDP package

The present publication complies with the requirements of Regulation EC No 714/2009 (the Regulation), in force since March 2011, whereby "ENTSO-E shall adopt a non-binding Community-wide Ten-Year Network Development Plan, including a European generation adequacy outlook, every two years".

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

The present TYNDP package also anticipates the implementation of Regulation EU No 347/2013 (the Energy Infrastructure Regulation), in force since June 2013 and normally applying to the TYNDP 2016. This regulation organises a new framework to foster transmission grid development in Europe. Regulation EU No 347/2013 defines the status of Projects of Common Interest (PCIs), foresees various supporting tools to support the realisation of PCIs, and makes the TYNDP the sole basis for identifying and assessing the PCIs according to a standard Cost Benefit Analysis (CBA) methodology.

The TYNDP package is therefore not only a framework for planning the European grid, supplying a long-term Vision. It also now serves the assessment of every PCI candidate, whatever their commissioning time. The preparation of the TYNDP package will be even more demanding since the two roles complement each other more than they match and therefore additional resources are required.

1.3 A top-down, open and constantly improving process

The first Ten-Year Network Development Plan was published by ENTSO-E on a voluntary basis in spring 2010, in anticipation of Directive 72/2009 and Regulation 714/2009. The 2012 release was built on this experience and the feedback received from stakeholders, proposing the first sketch of a systematic CBA. For the 2014 release, ENTSO-E launched a large project founded on three main pillars: the inputs and expectations from stakeholders; the anticipation of the Energy Infrastructure Regulation and the expertise of the TSOs, Members of ENTSO-E.

In the last two years, ENTSO-E has organised discussion and information exchanges with stakeholders at four levels to ensure as much transparency as possible, at four levels:

- Public workshops and consultations[1]: non-specific conferences and events, which ENTSO-E has been invited to, in total 15 dedicated workshops in Brussels or regional and six consultations paved the way for the construction of the scenarios (the so-called "Visions"), the preparation of the CBA methodology and the production of the first results and project assessments. The last consultation on scenarios was concluded in October 2013.
- A "Long-Term Network Development Stakeholders Group[2]" gathering 15 members designed to debate and finalise the methodology (scenarios, CBA) improvements, regarding the TYNDP package itself or grid development more generally. The group contributed in particular to refining the social and environmental indicators of the CBA and rethinking the basis for more transparent scenario development.
- A non-discriminatory framework enabling non-ENTSO-E Members to submit transmission and storage project candidates for assessment. Two submission windows were opened officially in February and in September 2013.
- Dedicated bilateral meetings, especially with DG Energy, ACER and market players also contributed to concerns being shared, more and more harmonised methodologies being jointly developed and agreements on the expected outcomes of the process being reached.

[1] https://www.entsoe.eu/major-projects/ten-year-network-development-plan/tyndp-2014/stakeholder-interaction/
[2] https://www.entsoe.eu/major-projects/ten-year-network-development-plan/tyndp-2014/long-term-network-development-stakeholder-group/

The preparation of the TYNDP 2014 package was a big challenge as ENTSO-E decided to anticipate the implementation of the Energy Infrastructure Regulation and to support DG Energy in starting its implementation:

- ENTSO-E started drafting and consulting the CBA methodology in 2012 and has tested it over the whole TYNDP 2014 portfolio, even before the validation of the CBA methodology in September 2014. The CBA is implemented in the TYNDP 2014 package for four 2030 Visions. This choice has been made based on stakeholder feedback, preferring a large scope of contrasting scenarios instead of a more limited number and an intermediate horizon of 2020.
- ENTSOE invited non-ENTSO-E Members to submit transmission and storage project candidates for assessment, with the latest submission window in September 2013. Two third party projects were received with affection to the CSW region, although only one fulfilled the criteria established in the ENTSO-E Procedure for the inclusion of third party projects.
- ENTSO-E included an assessment of storage projects in the TYNDP 2014 package in addition to transmission projects. Nevertheless, although several hydro power plants with pumping are expected in the region, **no storage projects from third parties were submitted for inclusion in the TYNDP 2014 in the CSW region,** and therefore no project assessment for storage is presented in this report.

In a volatile environment, the TYNDP and its methodology are bound to evolve. ENTSO-E targets a regular delivery every two years of an enhanced product, introducing methodology improvements to ensure timely and consistent results, achieving efficiency rather than aiming at perfection. The following chart sums up the TYNDP evolution since 2010:

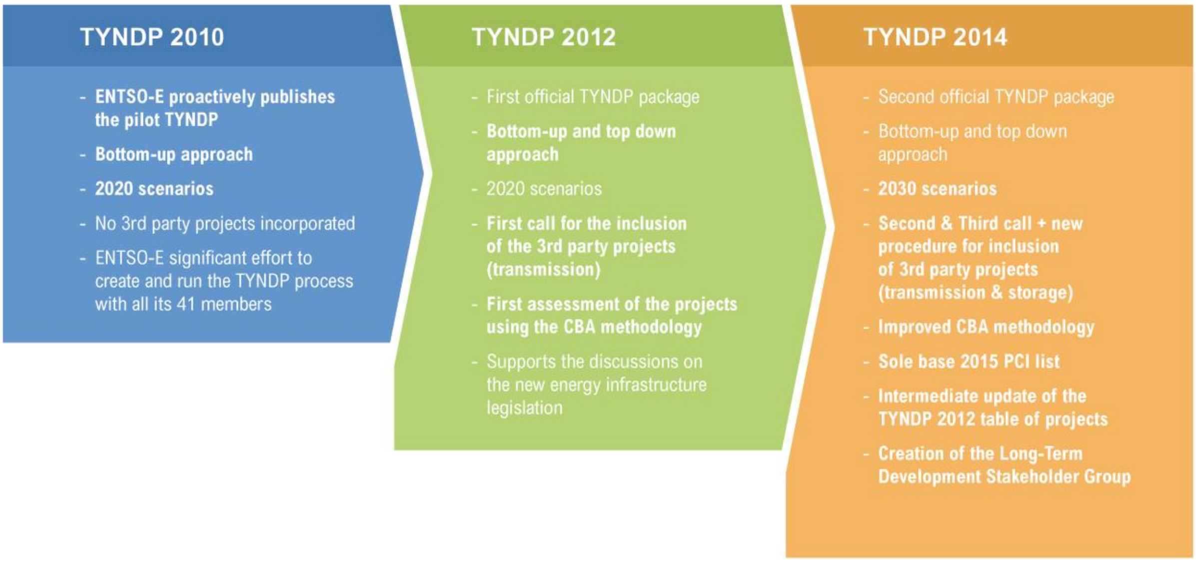

Figure 1-2 Overview of the TYNDP development over the versions

1.4 Regional Investment Plan for the Continental South West part of the TYNDP Package

As mentioned before, the present report is part of an eight-document suite comprising a Scenario Outlook and Adequacy Forecast (SOAF), a Ten-Year Network Development Plan (TYNDP), and six Regional Investment Plans (RgIPs). The TYNDP 2014 and the six Regional Investment Plans associated are supported by regional and pan-European analyses and take into account feedback received from stakeholders during the public consultation of the TYNDP 2012, mainly related to scenario building and CBA methodology applications and improvements.

ENTSO-E is divided into six regional groups for grid planning and system development tasks. The Member States belonging to each regional group are shown in Figure 1-3. The Continental South West (CSW) Regional Group embraces Portugal, Spain and France.

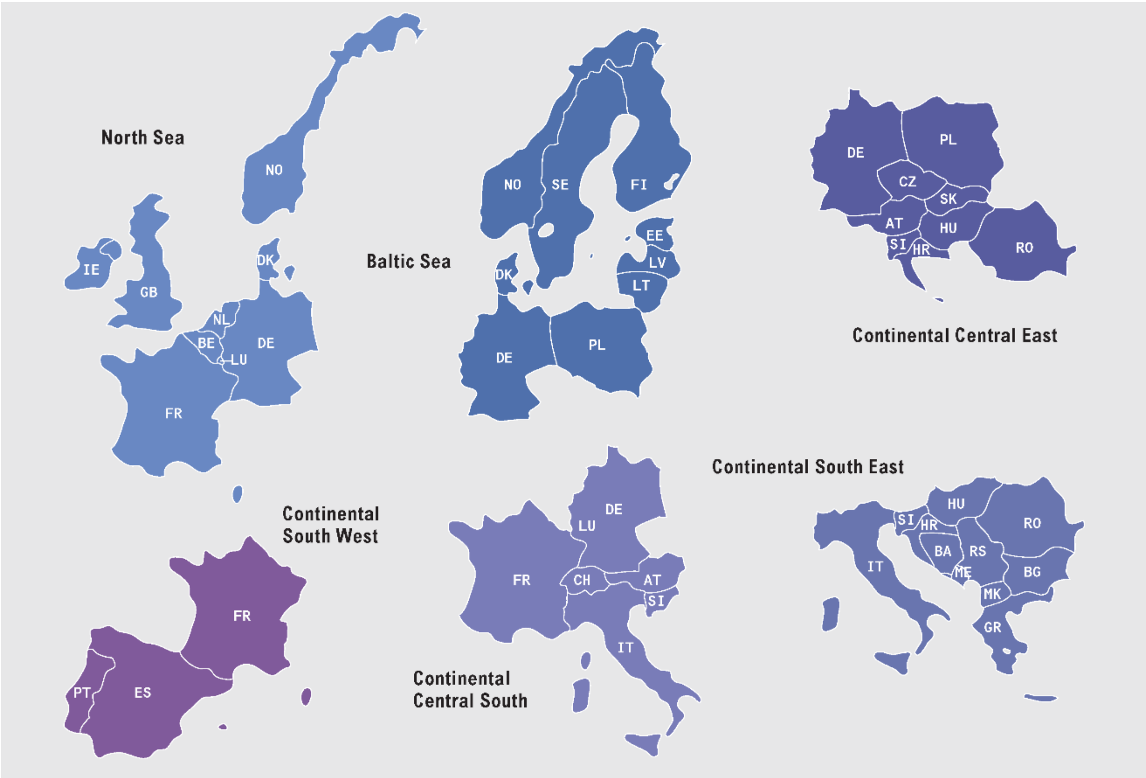

Figure 1-3 ENTSO-E Regions (System Development Committee)

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

This RgIP aims to describe the investment needs and assess the associated planned projects for 2030 (the time horizon agreed with stakeholders that allows long-term investments in the region to be anticipated) in the Continental South West (CSW) region, which covers Portugal, Spain and France. It assesses cross-border and internal projects of regional and/or European significance, which allow the main European targets to be met with particular regard to the development of the Internal Electricity Market (IEM) and the integration of Renewable Energy Sources (RES). It also addresses some security of supply (SoS) issues at a more local level. Moreover, the CSW RgIP provides information for monitoring of the progress of TYNDP 2012 projects.

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2 Methodology and Assumptions

2.1 General overview of the TYNDP 2014 process

ENTSO-E has taken into account stakeholder feedback from the previous TYNDP releases and developed an enhanced methodology for TYNDP 2014. The process was developed with input from all of the regional groups and working groups involved in the TYNDP, whilst also ensuring equal treatment for TSO projects and third party projects.

This chapter outlines the TYNDP macro-process, including methodological improvements developed for the 2014 edition of the TYNDP. The improvements are deemed necessary in order to ensure compliance with the implementation of the Energy Infrastructure Package (Regulation (EU) No 347/2013), which was enacted in 2013 and formalised the role of the TYNDP in the Project of Common Interest selection process.

Figure 2-1 provides an overview of the TYNDP 2014 process, in which, the stars represent stakeholder workshops held during this two-year process.

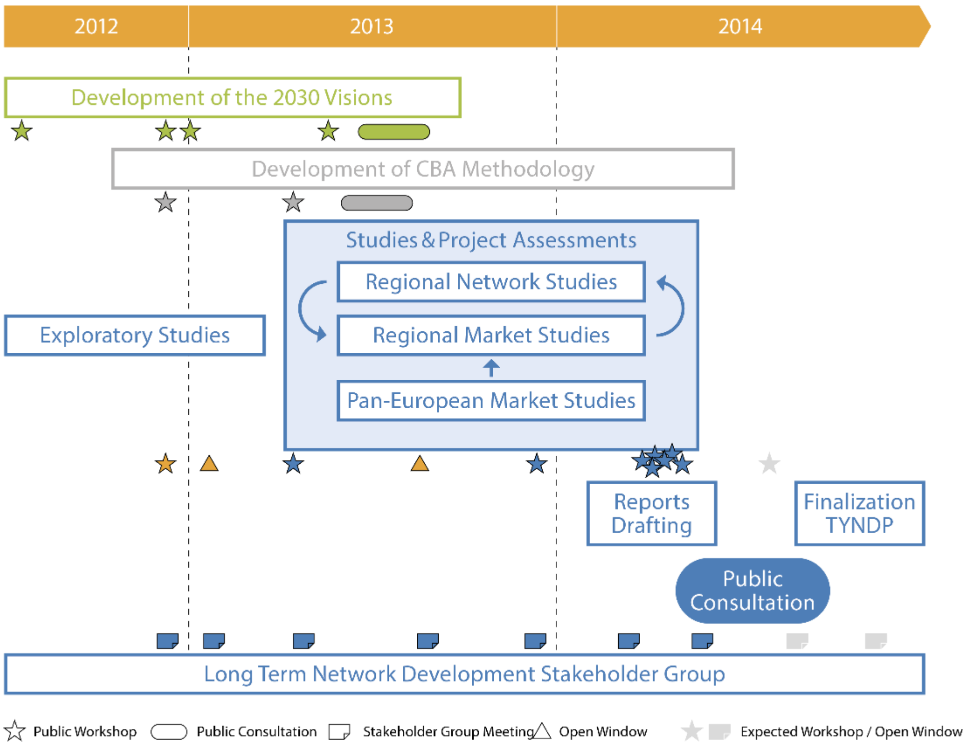

Figure 2-1 Overview of the TYNDP 2014 process

2.1.1 Scenarios to encompass all possible futures

The TYNDP 2014 analysis is based on an extensive exploration of the 2030 horizon. The year 2030 is used as a bridge between the European energy targets for 2020 and 2050. This choice has been made based on stakeholder feedback, preferring a large scope of contrasted longer-run scenarios instead of a more limited number and an intermediate horizon of 2020.

The 2014 version of the TYNDP covers four scenarios, known as the 2030 Visions. The 2030 Visions were developed by ENTSO-E in collaboration with stakeholders through the Long-Term Network Development Stakeholder Group, multiple workshops and public consultations.

The Visions are contrasted in order to cover every possible development foreseen by stakeholders. The Visions are less forecasts of the future than selected possible extremes of the future so that the pathway realised in the future falls with a high level of certainty in the range described by the Visions. The span of the four Visions is large and meets the various expectations of stakeholders. They differ mainly with respect to:

- The trajectory toward the Energy roadmap 2050: Visions 3 and 4 maintain a regular pace from now until 2050, whereas Visions 1 and 2 assume a slower start before an acceleration after 2030. Fuel and CO_2 prices are in favour of coal in Visions 1 and 2 while gas is favoured in Visions 3 and 4.
- The consistency of the generation mix development strategy: Visions 1 and 3 build from the bottom-up for each country's energy policy with common guidelines; Visions 2 and 4 assume a top-down approach, with a more harmonised European integration.

The 2030 Visions are further developed in the SOAF report and in chapter 3 of the present report.

2.1.2 A joint exploration of the future

Compared to the TYNDP 2012, the TYNDP 2014 is built to cover a longer-term horizon which 41 TSOs in the framework of the six Regional Groups have jointly explored both during the exploratory studies and during the assessment phase.

The objectives of the exploratory studies are to establish the main flow patterns and indicate the subsequent investment needs. When applicable, the exploratory phase resulted in the proposal of new projects, with further justification based the CBA assessment in the TYNDP 2014 package for CBA assessment.

With the validation of Vision 4 in October 2013, further investigation may be necessary to devise appropriate reinforcement solutions to the investment needs identified in the studies. More information on the investment needs can be found in Chapter 4.

2.1.3 A complex process articulating several studies in a two-year timeframe

The articulation of the studies performed within the framework of TYNDP 2014 to assess projects is described in Figure 2-2 and in the following section.

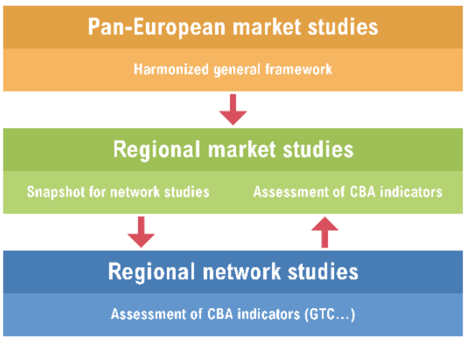

Figure 2-2 An iterative process towards the preparation of TYNDP 2014

Pan-European market studies have been introduced in the TYNDP 2014 process to improve both the scenario building and the assessment of projects. These studies, performed jointly by a group of TSOs experts from all regional groups, are set-up to both:

- define parameters and datasets necessary to perform the market simulation based on the four 2030 Visions developed.

- provide the boundary conditions for the regional market studies necessary to ensure a consistent and harmonised framework for the regional assessment of the projects with the CBA methodology.

More details on the modelling and the tools used can be found in sections 2.3 and 2.4 of this report.

Building on the common framework set by the pan-European market studies, every Regional Group undertook more detailed **regional market and network studies** in order to explore every Vision and perform the CBA assessment of the TYNDP 2014 projects:

- Regional market studies deliver bulk power flows and pinpoint which specific cases need to be further studied via network studies; they also deliver the economic part of the CBA assessment.
- Regional network studies analyse exactly how the grid handles the various cases of generation dispatch identified during the previous step and deliver the technical part of the CBA assessment.

Further details on the methodology of the regional studies can be found in chapters 2.3 and 2.4.

2.1.4 A TYNDP 2014 built with active involvement from stakeholders

As mentioned in the introduction chapter of the report, ENTSO-E has improved the process of the TYNDP in order to include, in every phase, interactions with stakeholders. These are key in the process because of the TYNDP's increased relevance in the European energy industry and the need to enhance common understanding about the transmission infrastructure in Europe. ENTSO-E organised six public web-consultations and requests for input as well as 17 open workshops at the regional and European levels or bilateral meetings:

Table 2-1 Example of stakeholder involvement

Phase of the process	Interactions
Scenario building	4 workshops including requests for inputs + 1 two-month public consultation
Definition of the improved 3rd party procedure	1 workshop
Development of the CBA methodology	2 workshops and 2 two-month public consultation
Call for 3rd party projects	1 workshop and 2 calls during the process (last one in September-October 2013)
Assessment of projects	1 pan-European workshop + 7 Regional workshops
Final consultation	1 two-month public consultation + 1 workshop

ENTSO-E has also launched a **Long-Term Network Development Stakeholders Group** (LTND SG), gathering European organisations and incorporating the major stakeholders of ENTSO-E. As views on the TYNDP, the broader challenges facing the power system and the best methods of addressing those challenges differ across countries and regions, the target is to create an open and transparent environment in which all involved parties can discuss and debate.

A particularly concrete outcome of this cooperation is a specific appraisal of the benefits of the projects with respect to potential spillage from RES generation and the replacement of the former social and environmental indicators by two more specific indicators with respect to the crossing of urbanised areas and protected areas.

The LTND SG also organised a task force to provide recommendations on the involvement of stakeholders in the scenario building for future releases of the TYNDP..

2.2 Implementation of Cost Benefit Analysis (CBA)

The prospect of climate change combined with other factors, such as the phase-out of power plants due to age or environmental issues, has led to a major shift in the generation mix meaning that the energy sector in Europe is undergoing major changes. All these evolutions trigger grid development and the growing investment needs are currently reflected both in European TSOs' investment plans and in the ENTSO-E TYNDP.

In this uncertain environment and with huge needs for transmission investment, several options for grid development have arisen. Cost Benefit Analysis, combined with multi-criteria assessment is essential to identify transmission projects that significantly contribute to European energy policies and that are robust enough to provide value for society in a large range of possible future energy projections, while at the same time being efficient in order to minimise costs for consumers. The results of project assessment can also highlight projects which have a particular relevance in terms of achieving core European energy policy targets, such as RES integration or completing the Internal Electricity Market.

Figure 2-3 Scope of the cost benefit analysis (source: THINK project[3])

ENTSO-E developed the Cost Benefits Methodology

ENTSO-E developed a multi-criteria assessment methodology in 2011. The methodology was applied for the TYNDP 2012 and is detailed in Appendix 3 of the TYNDP. The CBA methodology has been developed by ENTSO-E as an update of this methodology, in compliance with Regulation (EU) 347/2013. It takes into account the comments received by ENTSO-E during public consultation and includes the outcome of an extensive consultation process through bilateral meetings with stakeholder organisations, continuous interactions with a Long-Term Network Development Stakeholder Group, the report on target CBA methodology prepared by the THINK consortium, several public workshops and direct interactions with ACER, the European Commission and Member States.

The CBA methodology takes into account the comments received by ENTSO-E during the public consultation of the "Guideline for Cost Benefit Analysis of Grid Development Projects – Update 12 June 2013". This consultation was organised between 03 July and 15 September 2013 in an open and transparent manner, in compliance with Article 11 of Regulation (EU) 347/2013.

More information can be found in the following chapter on the CBA and its implementation in the TYNDP 2014.

[3] http://www.eui.eu/Projects/THINK/Home.aspx

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2.2.1 Scope of Cost Benefit Analysis

Regulation (EU) No 347/2013, in force since June 2013, aims to ensure strategic energy networks[4] by 2020. To this end, the Regulation proposes a regime of "common interest" for trans-European transmission grid projects contributing to implementing these priority projects (Projects of Common Interest; PCIs), and entrusts ENTSO-E with the responsibility of establishing a cost benefit methodology[5] with the following goals:

- System wide cost benefit analysis, allowing a homogenous assessment of all TYNDP projects;
- Assessment of candidate Projects of Common Interest.

The system wide Cost Benefit Analysis methodology is an update of ENTSO-E's Guidelines for Grid Development intended to allow an evaluation of all TYNDP projects in a homogenous way. Based on the requirements defined in the Reg. (EU) No 347/2013[6], ENTSO-E has defined a robust and consistent CBA methodology to apply to future TYNDP project assessments. This CBA methodology has been adopted by each ENTSO-E Regional Group, which have responsibility for pan-European development project assessments.

The CBA describes the common principles and procedures, including network and market modelling methodologies, to be used when identifying transmission projects and for measuring each of the cost and benefit indicators in a multi-criteria analysis in view of elaborating Regional Investment Plans and the Community-wide TYNDP. In order to ensure a full assessment of all transmission benefits, some of the indicators are monetised (inner ring of Figure 2-3), while others are measured through physical units such as tons or kWh (outer ring of Figure 2-3).

This set of common indicators forms a complete and solid basis both for project evaluation within the TYNDP and for the PCI selection process. With a multi-criteria approach, the projects can be ranked by the Member States in the groups foreseen by Regulation (EU) No 347/2013. Art 4.2.4 states: « each Group shall determine its assessment method on the basis of the aggregated contribution to the criteria […] this assessment shall lead to a ranking of projects for internal use of the Group. Neither the regional list nor the Union list shall contain any ranking, nor shall the ranking be used for any subsequent purpose ».

The CBA assesses both electricity transmission and storage projects.

2.2.2 A multi-criteria assessment

The cost benefit analysis framework is a multi-criteria assessment, complying with Article 11 and Annexes IV and V of Regulation (EU) No 347/2013.

The criteria set out in this document have been selected on the following basis:

- To enable an appreciation of project benefits in terms of EU network objectives:
    - To ensure the development of a single European grid to permit the EU climate policy and sustainability objectives (RES, energy efficiency, CO_2).
    - To guarantee security of supply.
    - To complete the internal energy market, especially through a contribution to increased socio-economic welfare.
    - To ensure the technical resilience of the system.

[4] Recital 20, Regulation (EU) 347/2013 : http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:115:0039:0075:EN:PDF
[5] Article 11, Regulation (EU) 347/2013
[6] Reg. (EU) 347/2013, Annexes IV and V

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- To provide a measurement of project costs and feasibility (especially environmental and social viability).

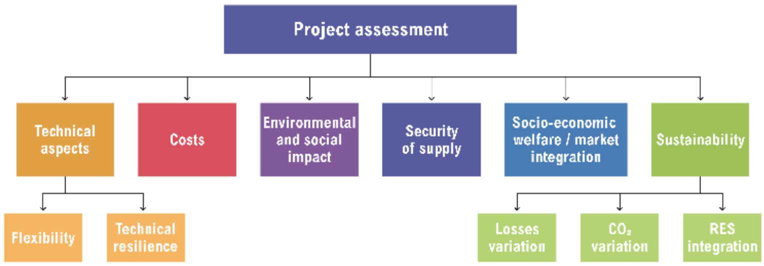

Figure 2-4 Main categories of the project assessment methodology

The indicators used are as simple and robust as possible. This leads to simplified methodologies for some indicators. Some projects will provide all the benefit categories, whereas other projects will only contribute significantly to one or two of them. Other benefits also exist such as the benefit of competition; these are more difficult to model and will not be explicitly taken into account.

The different criteria are explained below, grouped by Benefits, Cost, impact on society and Grid Transfer Capability.

The **Benefit Categories** are defined as follows:

B1. Improved security of supply[7] (SoS) is the ability of a power system to provide an adequate and secure supply of electricity under ordinary conditions[8].

B2. Socio-economic welfare (SEW)[9] or market integration is characterised by the ability of a power system to reduce congestion and thus provide an adequate GTC so that electricity markets can trade power in an economically efficient manner[10].

B3. RES integration: Support for RES integration is defined as the ability of the system to allow the connection of new RES plants and unlock existing and future "green" generation, while also minimising curtailments[11].

B4. Variation in losses in the transmission grid is the characterisation of the evolution of thermal losses in the power system. It is an indicator of energy efficiency[12] and is correlated with SEW.

[7] Adequacy measures the ability of a power system to supply demand in full, at the current state of network availability; the power system can be said to be in an N-0 state. Security measures the ability of a power system to meet demand in full and to continue to do so under all credible contingencies of single transmission faults; such a system is said to be N-1 secure.
[8] This category covers criteria 2b of Annex IV of the EU Regulation 347/2013, namely "secure system operation and interoperability".
[9] The reduction of congestions is an indicator of social and economic welfare assuming equitable distribution of benefits under the goal of the European Union to develop an integrated market (perfect market assumption).
[10] This category contributes to the criteria 'market integration" set out in Article 4, 2a and to criteria 6b of Annex V, namely "evolution of future generation costs".
[11] This category corresponds to criterion 2a of Article 4, namely "sustainability", and covers criteria 2b of Annex IV.
[12] This category contributes to criterion 6b of Annex V, namely "transmission losses over the technical lifecycle of the project".

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B5. Variation in CO_2 emissions is the characterisation of the evolution of CO_2 emissions in the power system. It is a consequence of B3 (unlock of generation with lower carbon content)[13].

B6. Technical resilience/system safety is the ability of the system to withstand increasingly extreme system conditions (exceptional contingencies)[14].

B7. Flexibility is the ability of the proposed reinforcement to be adequate in different possible future development paths or scenarios, including trade of balancing services[15].

The **project costs**[16] are defined as follows:

C1. Total project expenditures are based on prices used within each TSO and rough estimates of project consistency (e.g. km of lines).

The project impact on the society is defined as follows:

S.1. Protected areas characterises the project impact as assessed through preliminary studies, and aims to provide a measure of the environmental sensitivity associated with the project.

S.2. Urbanised areas characterises the project impact on the (local) population that is affected by the project as assessed through preliminary studies, aiming to give a measure of the social sensitivity associated with the project.

These two indicators refer to the remaining impacts after potential mitigation measures defined when the project definition becomes more precise.

The Grid Transfer Capability (GTC) is defined as follows:

The GTC reflects the ability of the grid to transport electricity across a boundary, i.e. from one bidding area (an area within a country or a TSO) to another or within a country, increasing security of supply or generation accommodation capacity.

The GTC is expressed in MW. It depends on the considered state of consumption, generation and exchange, as well as the topology and availability of the grid, and accounts for the safety rules described in the ENTSO-E CBA Methodology document. The Grid Transfer Capability is oriented, which means that there may be two different values across a boundary. A boundary may be fixed (e.g. a border between states or bidding areas), or vary from one horizon or scenario to another.

2.2.3 Implementation of CBA in the TYNDP 2014

The CBA methodology shall be validated by ACER in September 2014. ENTSO-E has used the TYNDP 2014 as an opportunity to conduct a real-life test of the methodology in order to be able to tune it if necessary. The implementation of the CBA in this trial phase hence focuses on checking the feasibility of its implementation while also answering actual stakeholder concerns.

Every single indicator has been computed for a large selection of project cases. In this respect, the RES – avoided RES spillage – indicator (resp. the SoS – loss of load expectation – indicator) must be completed in order to get the full picture of the benefits of projects with respect to RES integration or security of supply;

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[13] This category contributes to the criterion « sustainability » set out in Article 4, 2b and to criteria 6b of Annex V, namely " greenhouse gas emissions"".
[14] This category contributes to the criterion "interoperability and secure system operation" set out in Article 4, 2b and to criteria 2d of Annex IV, as well as to criteria 6b of Annex V, namely "system resilience" (EU Regulation 347/2013).
[15] This category contributes to the criterion "interoperability and secure system operation" set out in Article 4, 2b , and to criteria 2d of Annex IV, as well as to criteria 6e of Annex V, namely "operational flexibility" (idem note 26).
[16] Project costs, as with all other monetised values, are pre-tax.

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projects of pan-European significance may incidentally also be key for indirectly enabling RES connection in an area, although no spillage is entailed resp. to solve local SoS issues. However, the pan-European modelling implied by the CBA is too broad to capture these effects and underestimates the benefits. This is commented in the projects assessments sheets, whenever appropriate.

Projects assessments against four contrasted Visions enable the applicability of the methodology to be tested in markedly different scenarios. The practical implementation shows the importance of finalising the planning phase before running every project assessment.

Performing more than 100 project assessments against four Visions is sufficient to compare the relative values of all projects for all criteria measured, mitigating the need for analysing an intermediate horizon.

The CBA clustering rules have been fully implemented, although they proved challenging for complex grid reinforcement strategies. Essentially, a project clusters all investment items that have to be realised in total to achieve a desired effect. Therefore, a project consists of one or a set of various strictly related investments. The CBA rules state:

- Investment items may be clustered as long as their respective commissioning dates do not exceed a difference of five years;
- Each of them contributes to significantly developing the grid transfer capability along a given boundary, i.e. it supports the main investment item in the project by bringing at least 20% of the grid transfer capability developed by the latter.

The largest investment needs (e.g. offshore wind power to load centres in Germany, the Balkan corridor, etc.) 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 of smaller projects, each matching the clustering rules, with related assessments; however, an introductory section explains the overall consistency of the bigger picture and how each project contributes to it.

2.3 Market study methodology

2.3.1 Purpose of Market Studies

The purpose of the market studies is first to understand and define the system behaviour in terms of country balances, exchange in the borders, production per type of technology, etc. and then investigate the impact of the new interconnection projects by comparing two different grid situations in terms of economic efficiency. Market Studies also aim identifying the ability of the system to schedule plants accordingly to their intrinsic merit-order, to get the generation costs, the overall amount of CO_2 emissions, and volumes of spilled energy. In a market simulation an economic optimisation is conducted for every hour of the year taking into account several constraints; such as flexibility and availability of thermal units, wind and solar profiles, load profile and uncertainties, and transmission capacity between countries.

2.3.2 Modelling

ENTSO-E's pan European Market Database provides a market model of the whole Europe which ensures consistency across all regional groups of ENTSO-E. The CBA assessment of TYNDP projects is then performed using regional market and network studies, and comparing situations with and without the project.

There were two tools used in CSW for the market studies: ANTARES (RTE) and UPLAN (REE). A more detailed description of the tools can be found in 3.3.3. In the TYNDP 2012 adequacy was also analysed. However in this TYNDP package, no regional adequacy analysis has been performed, as it was concluded that there was no need for adequacy studies because scenarios for 2030 have been built in order to be compliant with adequacy criteria.

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Each country was modelled as one single node for the generation and load data. It was assumed that there were no internal constraints within the country, but only with limited Net Transfer Capacity (NTC) between countries. If these capacities limit market opportunities, the result is a suboptimal dispatch and different prices for the region. Simulations are done for 52 weeks (364 days) of the year by Antares the 8760 hours (365 days) of the year by UPLAN. Results are available from the hourly to the annual step.

The CSW region was modelled using very detailed information. Some input data, such as wind profiles and maintenance periods, have been adapted according to the regional specificities.

The size of the modelled perimeter varied depending on which tool was used and the progress of the studies which allowed improving the modelling. ANTARES modelled all countries within the ENTSO-E area for every Vision, while UPLAN only modelled all the ENTSO-E area for Vision 3. However, the first simulations performed (Vision 1, 2 and 4) with UPLAN included only the countries within the CSW region perimeter, plus the first neighbouring countries of France, Poland and Czech Republic; because of their influence on the flows in the CSW region. All other non-modelled countries by UPLAN were implemented as exchange profiles taken from the pan-European simulations (see Figure 2-5).

In the Figure below there are presented the three kinds of areas considered in CSW simulation, namely:

- Regional areas (blue), modelled as detailed as possible.
- Perimeter areas (light violet), modelled following ENTSO-E's PEMMDBs.
- Non-modelled areas (white), implemented as pre-defined flows taken from pan-European simulations (PEMS) and used in regional simulations.

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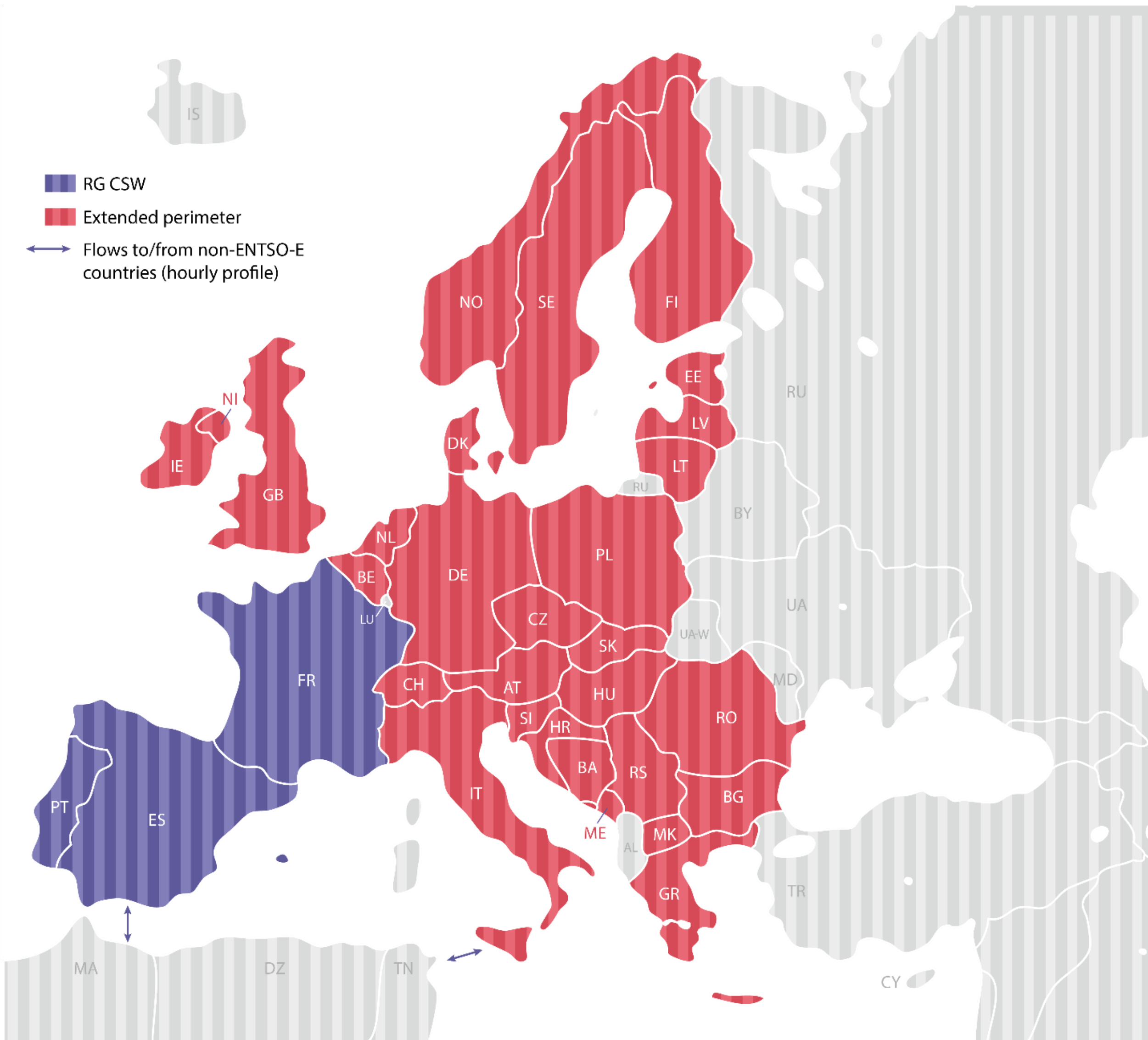

Figure 2-5 Modelled perimeter

It is important to remark that UPLAN is a deterministic tool and ANTARES is a probabilistic tool. Nevertheless, cross analysis checks showed that results were quite similar and thus confirmed the robustness of the main conclusions.

2.3.3 Tools Used for Market Studies

As it was said, two simulation programs have been used in the CSW region for the market studies, ANTARES and UPLAN:

- UPLAN is a commercial SCUC (Security Constrained Unit Commitment) software used to calculate a long-term generation schedule. UPLAN has been developed by LCG Consulting during the last three decades focused on the USA utilities. It has been updated recently, specifically the hydro modelling has been adapted to the European TSOs needs on the ENTSO-E studies. It calculates the minimum-cost hourly generation schedule of all power plants in a system on a chronological simulation, in order to satisfy the demand while respecting all operational constraints of an interconnected system.

- It allows modelling thermal generation, hydro generation, energy storages and non-manageable generation simulated as a profile input. In addition, it allows modelling the internal network of a country detailing all branches and transformers at different voltage levels. The approach of the model allows to run a DC load flow with a list of specified hourly contingencies and assures a yearly output fulfilling all the network restrictions imposed under normal conditions and contingency situations (N, N-1 and N-X). Therefore, UPLAN's holistic approach ensures that a complete, optimal, least-cost solution is provided without compromise or relying on heuristics.
- The main market results of the model are the generation mix for each country (including RES), the variable generation costs for the system, the CO_2 emissions and the use of interconnection capacities. Regarding the network utility, the tool reports the congested internal lines and tie-lines and the event that produces that congestion.

Limits of the modelling:

- The underlying assumption hour by hour, is that of a perfectly competitive market (which implies, among other assumptions, that information is not only complete but also perfect).
- DC load flow instead of a complete AC load flow.

Moreover, UPLAN contains a number of features and modules within the software suite for performing specific tasks such as the optimized Maintenance Scheduler; the PowerStack for distributed processing; the Volatility Model for introducing stochastic variables; the Application Programming Interface for automating tasks; and PSS/E import and export to integrate UPLAN with other engineering models. These features require to be further analysed to optimize the results and could be able to be incorporated in the next TYNDP issue.

- ANTARES (A New Tool for generation Adequacy Reporting of Electric Systems) is a sequential Monte-Carlo multi-area adequacy and market simulator. The rationale behind adequacy or market analysis with a Monte-Carlo sequential simulator is the following: situations are the outcome of random events whose possible combinations form a set of scenarios so large that their comprehensive examination is very complex. The basis of the model is an optimizer connected in output of random simulators.
- Each country is represented by one node and cross-border exchanges in both directions are limited by the corresponding transfer capacity between the countries.
- Random simulators provide Monte-Carlo years, each of them being described by 8760 hourly climatic conditions (temperature, wind, solar, hydro); planned /unplanned outages of units are also represented. For each of the Monte-Carlo year, the optimiser provides a unit commitment that minimises the variable generation cost for the whole system, taking into account the dynamic constraints of the units. Hydro generation can be optimized within each week while respecting the weekly energy.
- The results of the model are the use of the generation mix in each country (including RES), the variable generation costs for the system, the CO_2 emissions and the use of interconnection capacities.

Limits of the modelling:

- The underlying assumption hour by hour, is that of a perfectly competitive market (which implies, among other assumptions, that information is not only complete but also perfect).
- Each country is represented by one node, therefore internal congestion is ignored.
- Physical flows are not represented.

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2.4 Network Studies Methodology

2.4.1 Purpose of the network Studies

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

2.4.2 Market Studies as an Input to the Network Studies

Market studies analyses the electrical system, namely the fit between generation mix and demand, taking into consideration the cross-border capacities between countries, for all the 8760 hours of one year. The main objective of network studies is to identify possible constraints on the network and check grid codes fulfilment, based on the results given by the market studies (mix of generation and consumption).

In addition to its main goal, network studies also help assessing some technical CBA indicators, as the grid transfer capability, and its increase enabled by the new transmission projects. This output of the network studies can be retrofitted in market studies to assess the improvement brought by the enhanced grid to the market. Market studies (assessment of all hours with simplified grid description) and network studies (extensive grid description for one particular case) are thus duals. They are wisely articulated in a two-step, iterative process in order to ensure consistency and efficiency (every concern being properly addressed with the appropriate modelling) and to avoid too complex all-in-one blackbox models either too complex to run or lacking detailed enough modelling of some aspects.

As with most of the network tools available, it is not possible to simulate the 8760 network cases derived from market studies, only a small number of cases were considered for the common network studies. Once the market studies results are available, the selection of the planning cases for the network studies considers not only stressful conditions, but also likely situations in order to ensure the representativeness of the analysis.

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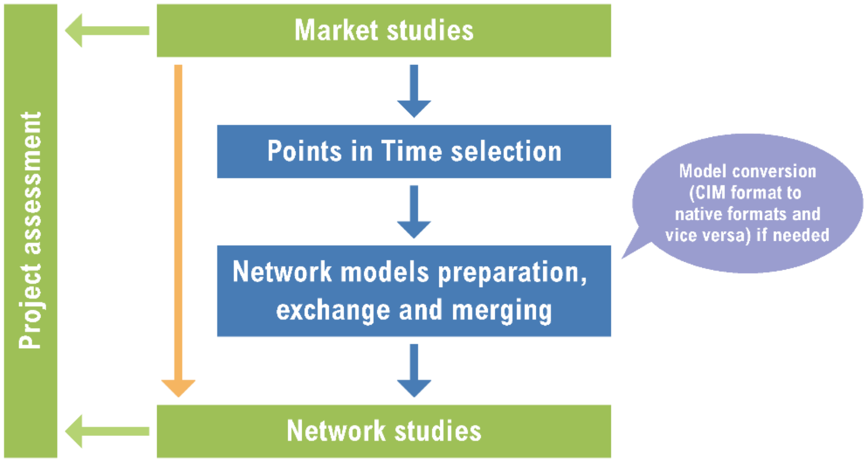

Figure 2-6 Assessment process of the projects in a nutshell, describing two possible ways how to get from the market studies to network studies (depicted in orange and violet)

From market studies, the load, the amount of production per country and technology and the power exchanges in the borders can be obtained for each point in time, but in the network model, the location of the installed capacity, generation type of the power plants and the load distribution has to be assigned based on the TSO expertise and the information received from the stakeholders. The generation production is based on the merit order, according to the market model point in time.

The network cases selection in the CSW region depends basically on the variables presented in table below. TSO expertise supported by the market study results allow to the RG select the several points in time analysed for the four Visions presented in this report. Usually they represent the different schemes of RES generation, consumption patterns and level of cross border exchanges.

Table 2-2 Typical points in time for grid studies

Level of RES generation		Electrical consumption		Cross-order exchanges	
High	Low	Peak	Off-Peak	High	Low

The selection and identification of the points in time is done by the use of different approaches. Rather high load and RES generation situations are selected commonly within the subgroup. For the selection of representative points in time a statistical selection process was used based on relevant criteria for the regional group.

2.4.3 Network modelling and network studies

Network studies enable to assess in detail the behaviour of the transmission grid under different assumptions (among others effect of the growing installed capacities of RES, of peak of demand, of the weather conditions, etc) that is not able to be captured by the market studies.

Network models used in regional network studies include detailed modelling of the transmission system with all busses, lines and transformers, and of the generation and demand. In terms of complexity, a regional model includes more than 4500 nodes, 3900 loads, 5000 power plants, 6000 branches, 1400 transformers and 380 switched shunts.

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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 chapter "network study results (Chapter 3.3)", some examples of these points in time are presented for the four scenarios under analysis in this framework. By this way, it is possible to illustrate how different could be the load flow patterns in the CSW region.

2.4.4 Network Studies Tools

Three different software tools are used to perform the simulations to carry the network studies:

- CONVERGENCE model, developed by RTE, used for load flow (AC) analysis;
- PSSE model, commercial model used by REN and REE, used for load flow (AC) analysis;
- UPLAN model, commercial model used by REE, which integrates market and load flow (DC) simulations for internal network, including detailed model of the three countries in the region.

3 Scenarios and study results

3.1 Description of the scenarios

This section describes qualitatively the scenario approach used for the preparation of the TYNDP 2014 package. Quantitative description of the scenarios is provided in the Scenario Outlook and Adequacy Forecast 2014-2030.

The year 2030 is used as a bridge between the European energy targets for 2020 and 2050.The aim of the “2030 Visions Approach” used for the TYNDP 2014 scenarios should be that the pathway realised in the future falls with a high level of certainty in the range described by the Visions that have been formulated taking into account the results of an extensive consultation with several workshops and a formal consultation during summer 2013

The Visions are not forecasts and there is no probability attached to them. In addition, these Visions are not optimized scenarios in terms of where the new generation would be most economically viable, then national inputs and namely TSO expertise must be considered. These Visions have either no adequacy analysis associated with them as they are built so that adequacy is ensured, and are based on previous ENTSO-E and regional market studies, public economic analyses, existing European documents and inputs from stakeholders in public consultations.

This is a markedly different concept from that taken for the Scenarios until 2020 used in the TYNDP 2012, which aim to estimate the evolution of parameters under different assumptions, while the 2030 Visions aim to estimate the extreme values, between which the evolution of parameters is foreseen to occur.

The TYNDP 2014 package, and therefore the CSW region, uses 4 scenarios to depict the future and to assess the project portfolio with the Cost Benefit Analysis methodology:

- Two bottom-up (Vision 1 and 3): result from the input received from the TSOs based on common European guidelines.
- Two top down (Vision 2 and 4): are developed centralized at the European level. These Visions are based on data provided by the TSOs for the bottom-up Visions which is further improved in order to reflect the assumptions[17] established in the methodology which in turn was established based on the inputs received from stakeholders.

Figures 3-1 and 3-2 give an overview of the political and economic frameworks considered in the four Visions and the considerations in generation and load. Differences in the high-level assumptions of the Visions are manifested among others in quite different amount of RES, fuel and CO_2 prices sets, in Visions 3 and 4, compared to Visions 1 and 2, resulting in a reversed merit order of gas and coal units and different RES share.

[17] For a further insight on the assumptions please see the presentations from the 3rd 2030 Visions workshop

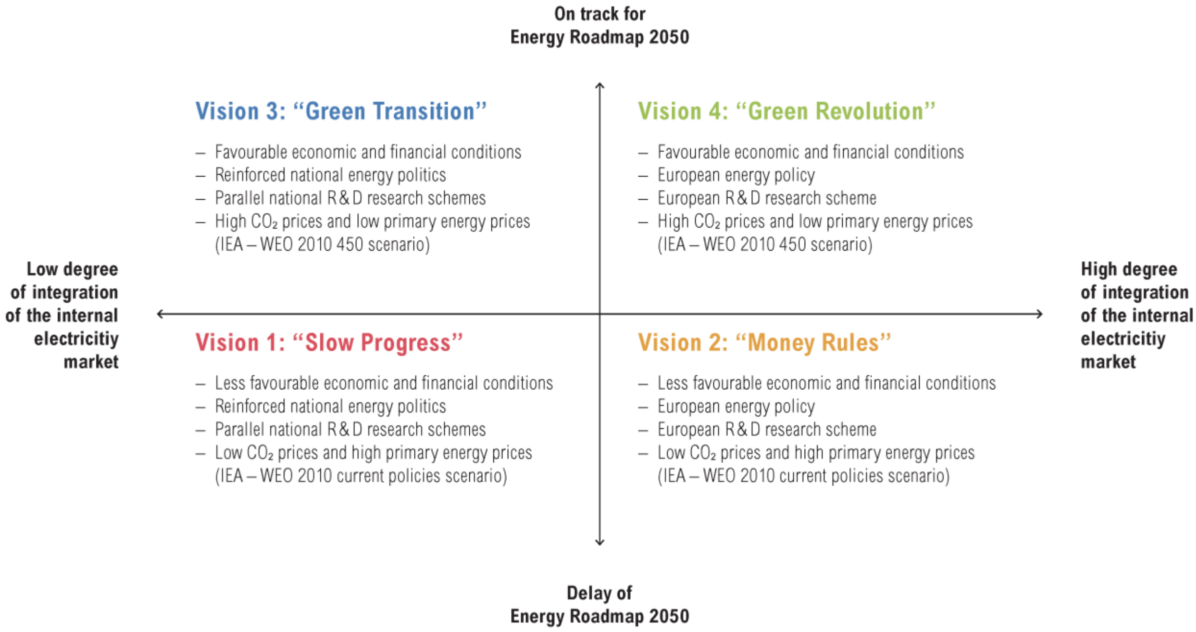

Figure 3-1 Overview of the political and economic frameworks of the four Visions

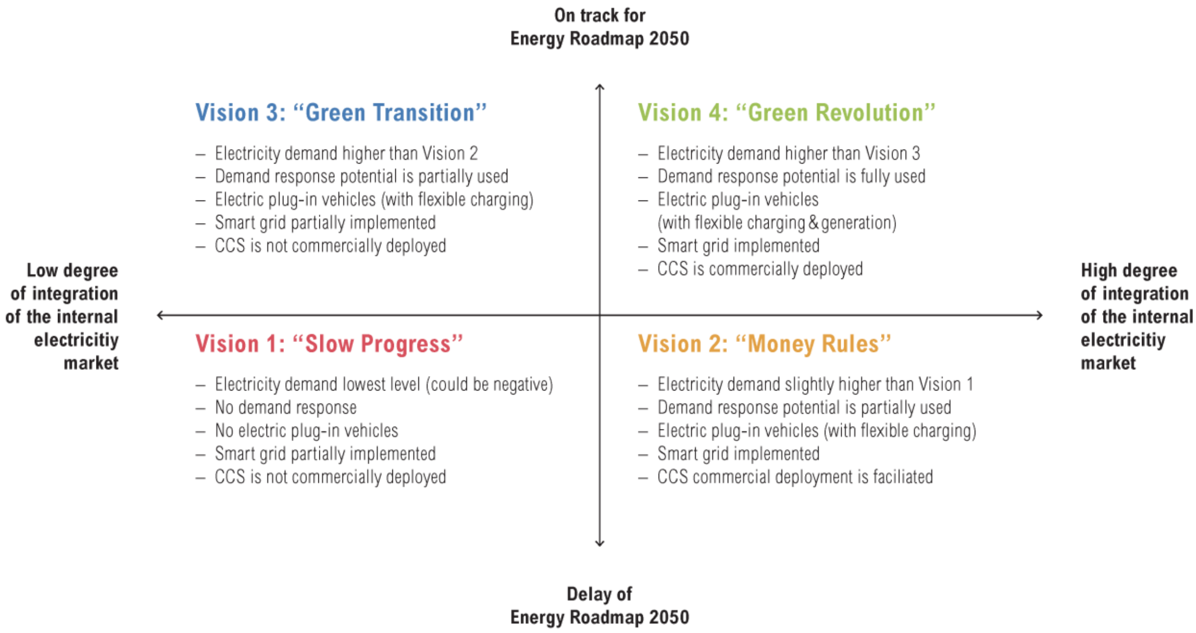

Figure 3-2 Overview of the generation and load frameworks of the four Visions

3.2 Market study results of different Visions

3.2.1 Market Study Results - Vision 1

As introduced before, the Pan-European projects included in the RG CSW have been evaluated in four different frameworks. The first of these is the “Slow progress” scenario (following Vision 1). It reflects a slow progress in energy system development with less favourable economic and financial conditions. Vision 1 is also the Vision with the lowest increase of green generation. The level of demand grows with a slow annual rate, reaching the 850 TWh in the CSW region in 2030. The Figures 3-3 and 3-4 report the details of the generation mix, in terms of installed capacity and annual generation production which come from the regional market studies.

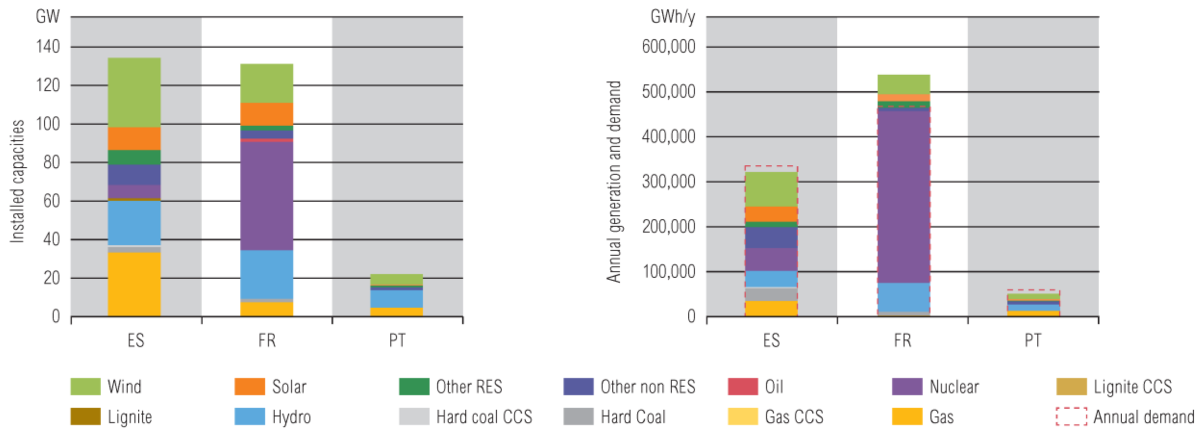

Figure 3-3 Installed capacity in Vision 1 in RG CSW (GW)

Figure 3-4 Annual generation and demand in Vision 1 in RG CSW (GWh/year)

For Vision 1, despite some reduction in installed capacity in France, nuclear energy still remains an important source of energy in the region (22% in terms of installed capacity). Renewable energy sources represent and provide around 50% of the total installed capacity. In fact, the amount of installed capacity of wind and solar power is actually close to the values for 2020 in the bottom-up Scenario B of TYNDP 2012, which means a low development from now to 2030.

Figure 3-4 represents the annual generation and demand (red dotted line) for the RG CSW countries. These values are the results of the regional market studies performed for the whole Europe considering the input data for the CSW region. Although more than 50% of the installed capacity comes from renewable sources, only 36% of the electricity production in the region is ”green”, while at ENTSO-E level it is 41%. Almost half of the generation in the region comes from nuclear units. In addition, the analysis performed shows that Spain and Portugal result in slightly net importing countries while France is a net exporting country18.

[18] *In 2013 France obtained a balance of 47.2 TWh (net exporting country), Spain 6.7 TWh (net exporting country) and Portugal 2.8 TWh (net importing country).*

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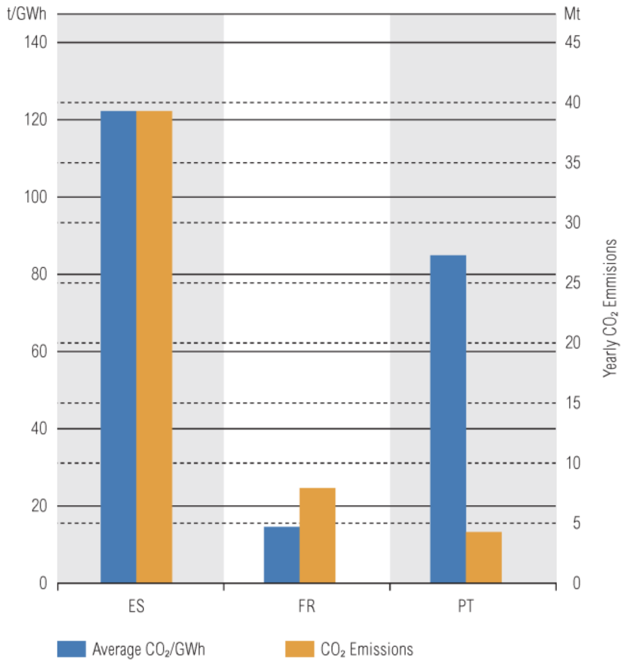

Figure 3-5 CO_2 emissions in Vision 1 in RG CSW (Mtons/year) and carbon intensity (Tons/GWh)

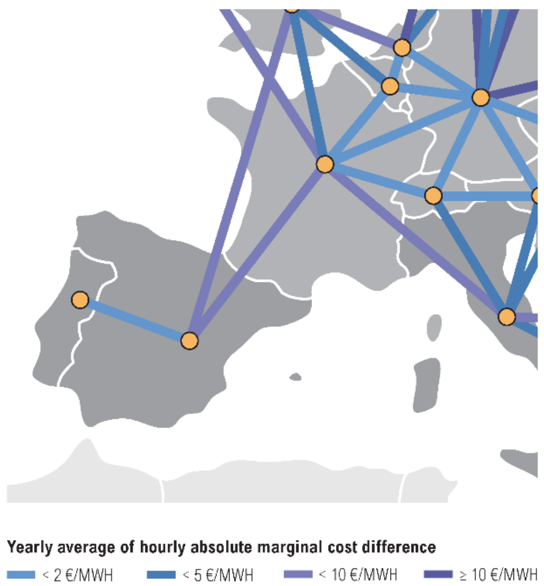

Figure 3-6 Yearly average marginal cost difference in Vision 1 in RG CSW.

Figure 3-5 depicts the CO_2 emissions in Vision 1, both in terms of yearly CO_2 emissions per country (MTons/y) and in terms of CO_2 intensity of electricity generation (Tons/GWh). Compared to the level of 1990, in Vision 1, the emissions are reduced by 83% in the CSW region.

The different values of emissions each year depend on the size of the country and the generation of the country, while the values of carbon intensity are only dependent on the generation mix production. Therefore, in Vision 1 Spanish and Portuguese values of CO_2 intensity of electricity generation are higher than French values due to a higher weight of fossil fuels and also due to the fact that coal generation has competitive advantage compared with CCGT power plants. The average marginal costs (Figure 3-6) differ among the countries due to a different generation mix and limited capacity that don't allow having yet a single electricity market. However at least only the average marginal cost is not a sufficient indicator for necessary grid extensions, as the benefits of grid extension also depends on the hourly prices spread.

It must be highlighted that these results correspond to a yearly average both for the balance and the price difference. In fact, the hourly results show that in 2030 with the interconnections planned in the region both, the Spanish-Portuguese and the Spanish-French borders, will experience high energy exchange volumes, both in import and export directions, but which will result in being annually rather balanced, as a result of complementary generation mixes. On the other hand, the price differences include hours with price convergence, which correspond to thermal marginal units, and hours with price differences higher than 30€/MWh. For example, it occurs when the marginal costs are lower in the Iberian Peninsula than in France due to high RES penetration, than in France, especially with low temperature. .

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3.2.2 Market Study Results – Vision 2

For Vision 2 the results of the regional market studies are presented in next figures for the CSW countries. Figure 3-7 and Figure 3-8 report the details of the generation mix, in terms of installed capacity and annual generation production.

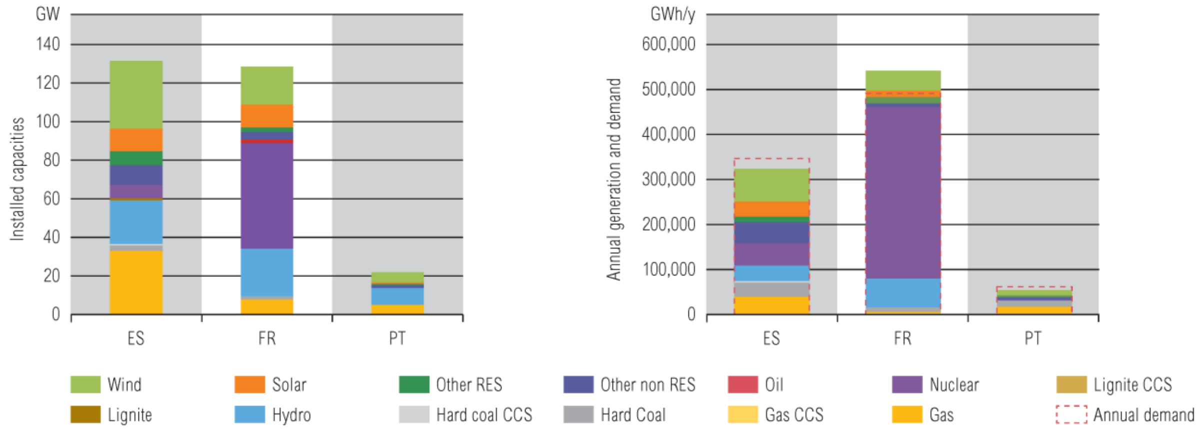

Figure 3-7 Installed capacity in Vision 2 in RG CSW (GW)

Figure 3-8 Annual generation and demand in Vision 2 in RG CSW (GWh/year)

In fact, the installed capacity in the three countries of the CSW region is very similar to Vision1 with only a slight decrease on the gas installed capacity. The main difference comparing to this Vision is some increase of the demand in the CSW region, namely 5% for France, 3% for Spain and 2 % for Portugal.

As a consequence, and regarding energy flows, less energy is exported from Spain to Portugal, and interchanges in the opposite direction (Portugal to Spain) are slightly increased. Also the flows from Spain to France are reduced. In terms of annual generation, it is noted some increase of CCGT generation in Spain and Portugal with respect to Vision 1. This also implies that the average hourly prices for Spain and Portugal are higher than in Vision 1.

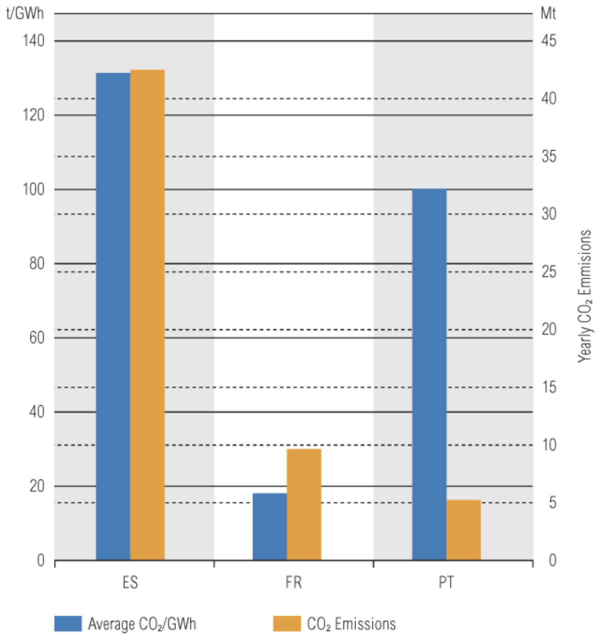

Figure 3-9 CO_2 emissions in Vision 2 in RG CSW (Mtons/year) and carbon intensity (Tons/GWh)

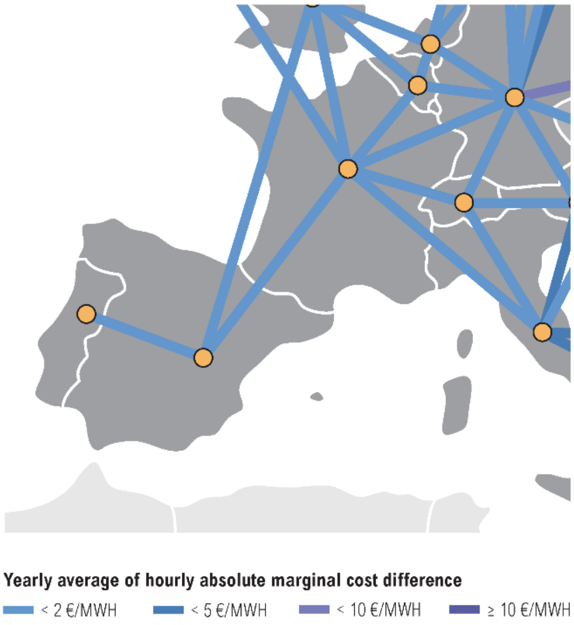

Figure 3-10 Yearly average marginal cost difference in Vision 2 in RG CSW.

Because of the higher CCGT generation that occurs in the Iberian Peninsula, the CO_2 emissions are slightly higher than those in Vision 1.

Regarding the average marginal costs difference among the three countries, apart from the comments considered in Vision 1, it is possible to conclude that with the available cross-border capacity it is not possible to have a single electricity market

3.2.3 Market Study Results – Vision 3

The results of the regional market studies for Vision 3 ("Green Transition") are presented in the next figures for the CSW countries. Figure 3-11 and Figure 3-12 report the details of the generation mix, in terms of installed capacity and annual generation production.

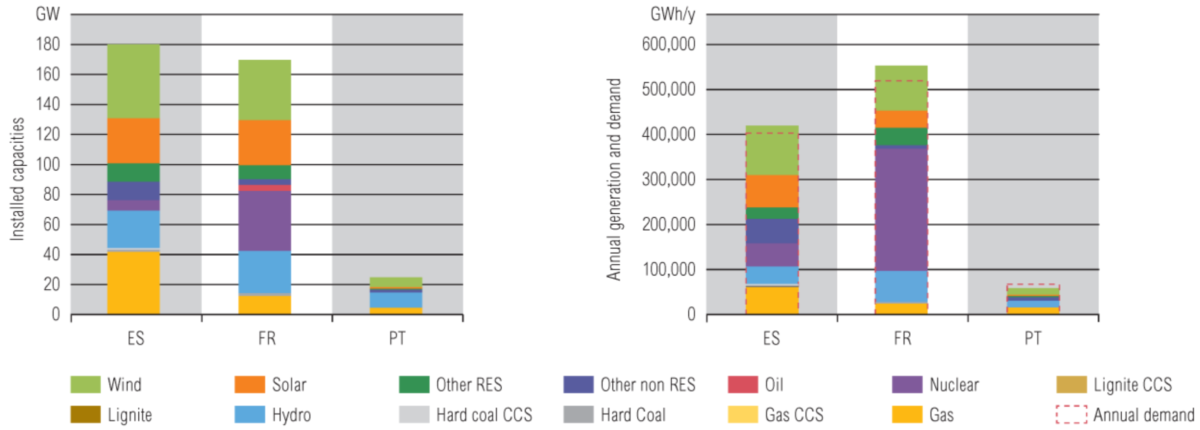

Figure 3-11 Installed capacity in Vision 3 in RG CSW (GW)

Figure 3-12 Annual generation and demand in Vision 3 in RG CSW (GWh/year)

This Vision, behind the increase of RES installed capacity in the region (represents around 65%[19] of total installed capacity), it also takes into account the objective of the energy transition in France to reduce the share of nuclear energy in the generation mix. This leads to a strong reduction of the nuclear installed capacity in France (Figure 3-11), resulting in a global decrease of nuclear installed capacity in the region (almost 25%) compared to Visions 1 and 2. Also compared with Vision 1 and 2, Vision 3 assumes a more favourable economic framework and a higher pace of RES penetration. The result is an increase of the demand in the region by around 13% (compared to Vision 1) and an increase of RES generation up to 65% of the total installed capacity in the region.

Regarding the generation mix (Figure 3-12), RES represents around 50% of the total CSW generation and nuclear generation share in the energy mix of the region decreases from almost 50% of total generation in Vision 1 to around 32% of total generation in Vision 3. Finally, the regional market results show that Portugal remains a net importer country while France and Spain are net exporting countries.

Another important output from market studies for Vision 3 is that, even taking into account the planned interconnections, there is some dumped energy in the region. The dumped energy in the region reaches about 1.2 TWh and occurs mainly in Spain.

[19] 61% without considering Pure pumped-storage plants

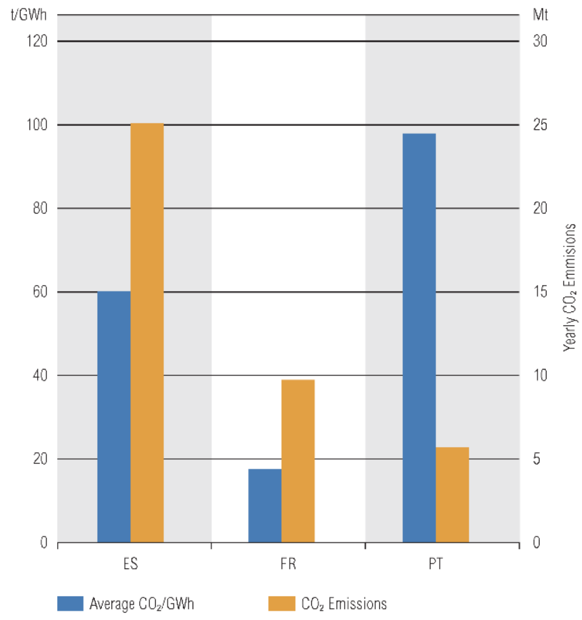

Figure 3-13 CO_2 emissions in Vision 3 in RG CSW (Mtons/year) and carbon intensity (Tons/GWh)

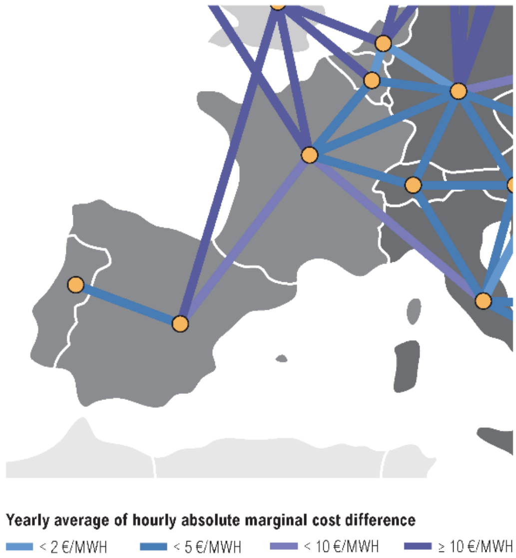

Figure 3-14 Yearly average marginal cost difference in Vision 3 in RG CSW

The Figure 3-13 depicts the CO_2 emissions in Vision 3 both in terms of yearly CO_2 emissions per country (MTons/y) and in terms of CO_2 intensity of electricity generation (Tons/GWh). Compared to the level of 1990, the emissions are reduced by 87% in the CSW region. All the values are considerably lower when compared with Vision 1, with reductions of around 15-20% for yearly CO_2 emissions on the overall region and reaching the 35% for Spain. Also the CO_2 intensity of electricity generation is reduced. This is due to the increase of RES generation and also to the merit order that gives priority in the merit order to CCGT over coal units with higher CO_2 emission rate.

Regarding the average marginal costs difference among the three countries (Figure 3-14), apart from the comments already considered in Vision 1, once more it is possible to conclude that with the available cross-border capacity it is not possible to have a single electricity market.

3.2.4 Market Study Results - Vision 4

Figure 3-15 and Figure 3-16 report the details of the generation mix per country for Vision 4 ('Green Revolution') in the CSW region per country, in terms of installed capacity and annual generation production (also demand on the red dotted line).

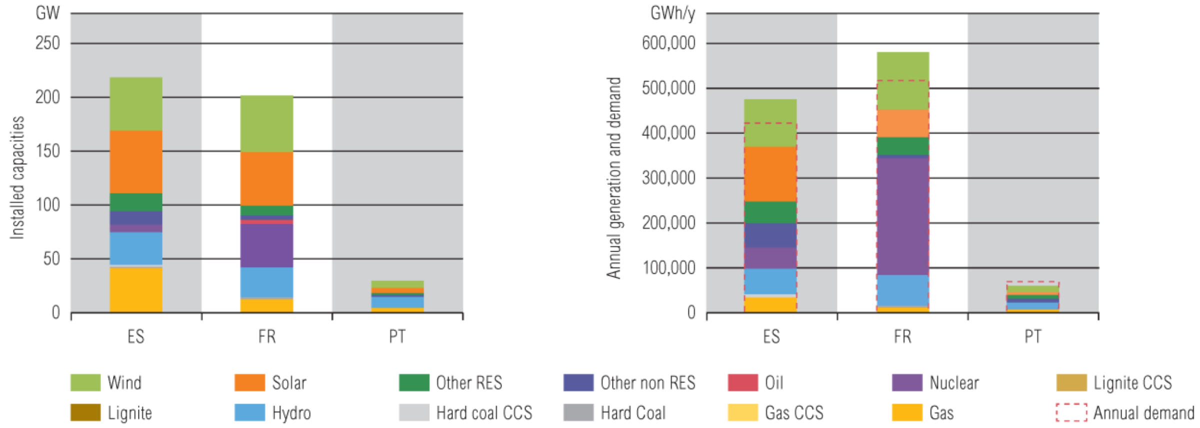

Figure 3-15 Installed capacity in Vision 4 in RG CSW (GW)

Figure 3-16 Annual generation and demand in Vision 4 in RG CSW (GWh/year)

On Figure 3-15 it can be seen that the level of wind and solar power is very high in all the RG countries compared to Vision 1 (RES represents around 70%[20] of the total installed capacity). On the other hand the importance of nuclear energy is reduced in this Vision, not only because of the increase of renewable energy, but also because this Vision considers a nuclear reduction of the share in the French generation, in line with the objective of the French energy policy. Actually, this Vision considers an installed nuclear capacity in France of only 40 GW[21].

Values of Figure 3-16 are the results of regional market studies for the whole Europe considering for the region the input data in Figure 3-15. Although more than 70%[22] of the installed capacity comes from renewable sources, in the region, only 57% of the electricity production is "green", while at ENTSOE level it is 60%. The contribution from nuclear in the region is reduced and represents approximately 30%. Results show that Portugal remains a net importer country while France and Spain are net exporting countries. From Figure 3-16 we can also conclude that, in this Vision, it is expected the highest demand for the CSW region, mainly due to the increase of usage of the electricity (e.g. Electrical Vehicle) which overcomes the gains obtained with the development of energy efficiency measures.

Another important output from market studies for Vision 4 is that the dumped energy increases when compared with the other Visions and reaches 7 TWh/year for the CSW region. The dumped energy in the region occurs mainly in Spain.

[20] 66% without considering Pure pumped-storage plants
[21] 2013 value is 63 GW
[22] 66% without considering Pure pumped-storage plants

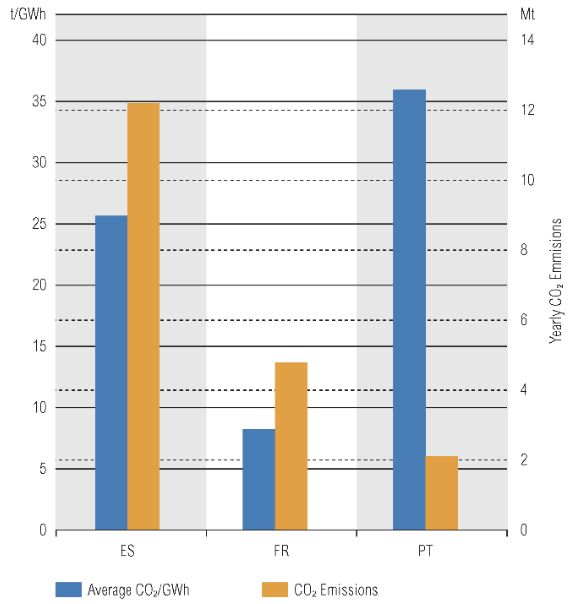

Figure 3-17 CO_2 emissions in Vision 4 in RG CSW (Mtons/year) and carbon intensity (Tons/GWh)

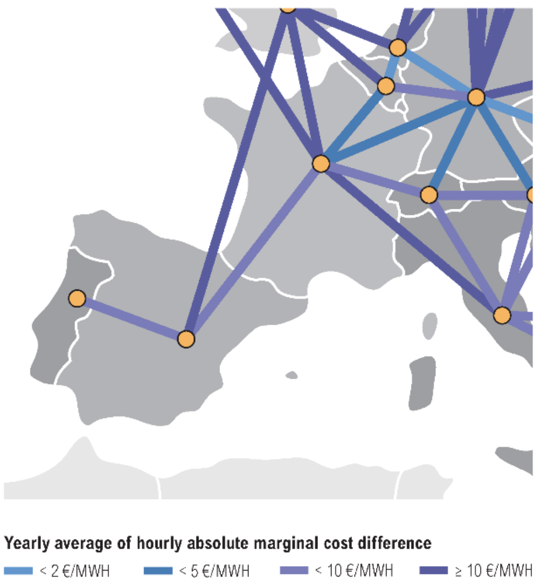

Figure 3-18 Yearly average marginal cost difference in Vision 4 in RG CSW

The Figure 3-17 depicts the CO_2 emissions in Vision 4 both in terms of yearly CO_2 emissions per country (MTons/y) and in terms of CO_2 intensity of electricity generation (Tons/GWh). Compared to the level of 1990, the emissions are reduced by 93% in the CSW region. All the values are considerably lower when compared with Vision 1, with reductions of 50% for yearly CO_2 emissions for Portugal and France and higher for Spain, and even higher for the CO_2 intensity of electricity generation. These results confirm that the investment in RES generation allows to reduce significantly the CO_2 emissions and to align the performance of the electrical system with the European political goals for energy established for 2030.

As stated before, the average marginal costs (Figure 3-18) differ among the countries due to a different generation mix and a limited capacity that don't allow having yet a single electricity market.

These results correspond to a yearly average both for the balance and the price difference. Nevertheless, similarly to the other Visions, but even with higher stress, 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 higher than 20€/MWh.

3.3 Network Studies Results

The main objectives of network studies is to identify possible constrains on the network, based on the results given by the market studies (mix of generation and consumption) and compute the following CBA indicators (technical indicators which come up from network studies): grid transfer capacity, losses, resilience and robustness/flexibility.

Each analysed vision has its own characteristics and assumptions. Based on those assumptions the results from network studies can identify different constraints and load flow patterns for all the visions.

In next sub-chapters there are presented some illustrations of the common network studies obtained by the RG CSW for all visions. Visions 1 and 4 are the extreme ones assessed under the TYNDP 2014 umbrella.

3.3.1 Vision 1 Results

Vision 1 - "Slow Progress" - is mainly characterized by:

In terms of demand, there are no major breakthroughs in energy efficiency developments and in the usage of electricity for transportation. As a consequence, electricity demand is expected to grow at a slower rate than in other visions.

In terms of generation, due to a lack of financial resources and construction delays due to permitting issues, the generation mix in 2030 fails to be on track for the realization of the Energy Roadmap 2050. The carbon pricing remains at such a level that base load electricity production based on hard coal is preferred to gas.

In synthesis, as Vision 1 is a vision with a lower rate of consumption growth and a medium increase on RES penetration, no major issues were identified in terms of voltage constraints and overloads. Nevertheless, some transmission projects are needed in order to accommodate new generation and higher flows across certain boundaries (e.g the Spain-France interconnection).

Regarding interconnections, the French-Spanish border requires reinforcements in order to try to accommodate the flows obtained in the market studies and resulting from the most economical dispatch in the system. Also the Portuguese-Spanish border requires reinforcements in order to achieve the political goals of the MIBEL.

In Portugal and Spain, the accommodation of new hydro power plants (some of them with pumping) requires new transmission reinforcements. On the other hand, also the connection of some new RES and the accommodation of higher flows in certain boundaries inside the Iberian Peninsula, especially the connection of the Aragón area to Catalonia and Castellón require reinforcements of some paths already identified in the 2020 horizon. In France, apart from the cross-border interconnections, only limited grid development of pan-European significance is economically justified for this vision, as both load growth and RES generation development pace are very low. The only internal project of pan-European significance that would be needed is the grid development in the southern part of the Massif Central, necessary to cope with new generation, especially wind, in the area.

Figure 3-19 illustrates, as an example of the network studies performed, the main power flows for some representative points in time in the CSW region. With this map it is possible to highlight the main bulk power flows and the transmission system usage across the region for Vision 1, namely on the interconnections (Portugal-Spain and Spain-France) and on the lines which supply the main cities in the region (e.g. Lisbon, Madrid, Barcelona and Paris).

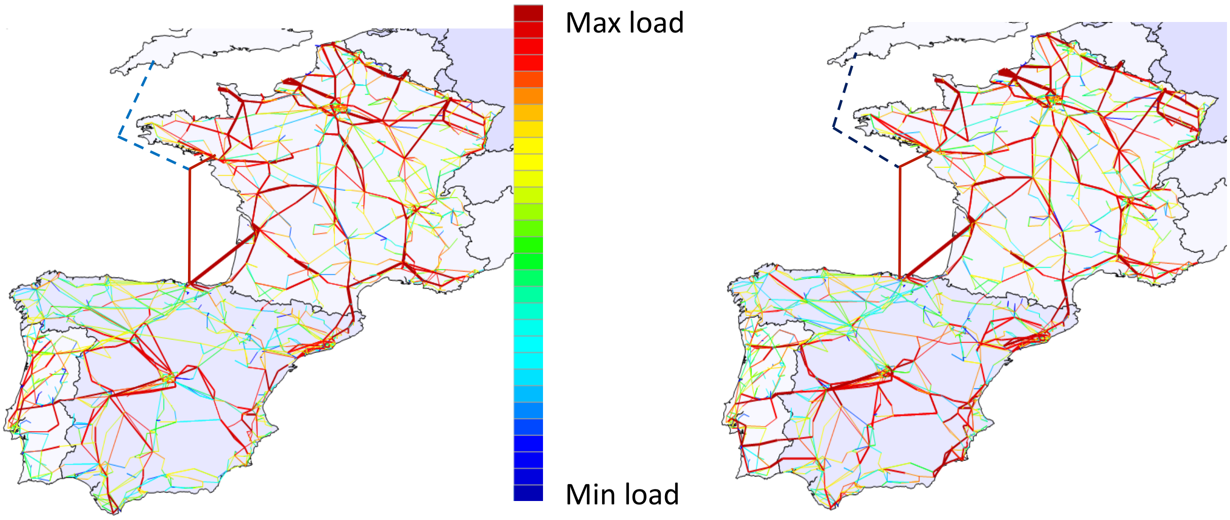

Figure 3-19 Typical Winter (left) and Summer (right) Peak power flow situation for Vision 1

3.3.2 Vision 2 Results

Vision 2 – "Money Rules" – is mainly characterized by

- In terms of demand, the scenario is slightly higher than in Vision 1.
- In terms of generation, the economic and financial conditions in Europe are comparable to the situation in Vision 1 and the resulting generation mix is also comparable to the Vision 1.

As for the region the hypothesis for Vision 2 is very close from the one of Vision 1, with quite the same generation mix and with a slightly higher consumption value, the network studies identified no major issues in terms of voltage and overloads. The needs for consumption and interconnections are the same with only slightly higher values. With more consumption in Portugal and Spain, interconnections will be more used than in Vision 1, but no additional investments will be needed in comparison with Vision 1.

The next figures illustrates, as an example of the network studies performed in the RG, the main power flows in the region for two representative points in time analysed.

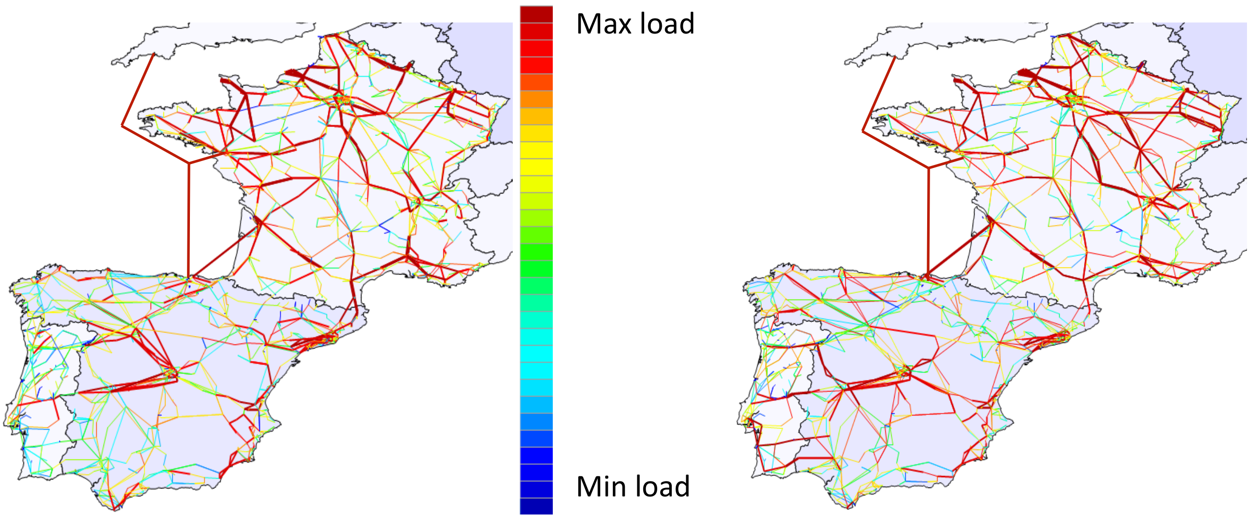

Figure 3-20 Typical Winter (left) and Summer (right) Peak power flow situation for Vision 2

3.3.3 Vision 3 Results

Vision 3 – “Green Transition” – is mainly characterized by:

- In terms of demand, it is between Visions 2 and 4. The smart grid is partially implemented and all the effort for the developments of the new usage of electricity has not yet been completely done. The level of growth consumption is coherent with internal studies of TSO, studying scenarios of green transition.
- In terms of generation, there are favourable economic and financial conditions to develop the generation mix with more RES. In this scenario, must-run obligations are considered for thermal generation.

In Vision 3, with an high level of wind and solar generation and a consumption which is lower than in Vision 4, several constraints and overloads have been identified. Also voltage issues were detected. With such a high volume of solar and wind, the needs for the interconnections between Portugal and Spain and between Spain and France are increased. With more hydro power, including storage, internal reinforcements are needed to accommodate these situations.

Next figure illustrates, as an example of the network studies performed in the RG, the main power flows in the region for two representative points in time in winter and summer. With this map it is possible to highlight the main bulk power flows and the transmission system usage across the region for Vision 3, namely the higher usage not only of the interconnections but also of the overall transmission system to accommodate a high solar generation in the CSW region.

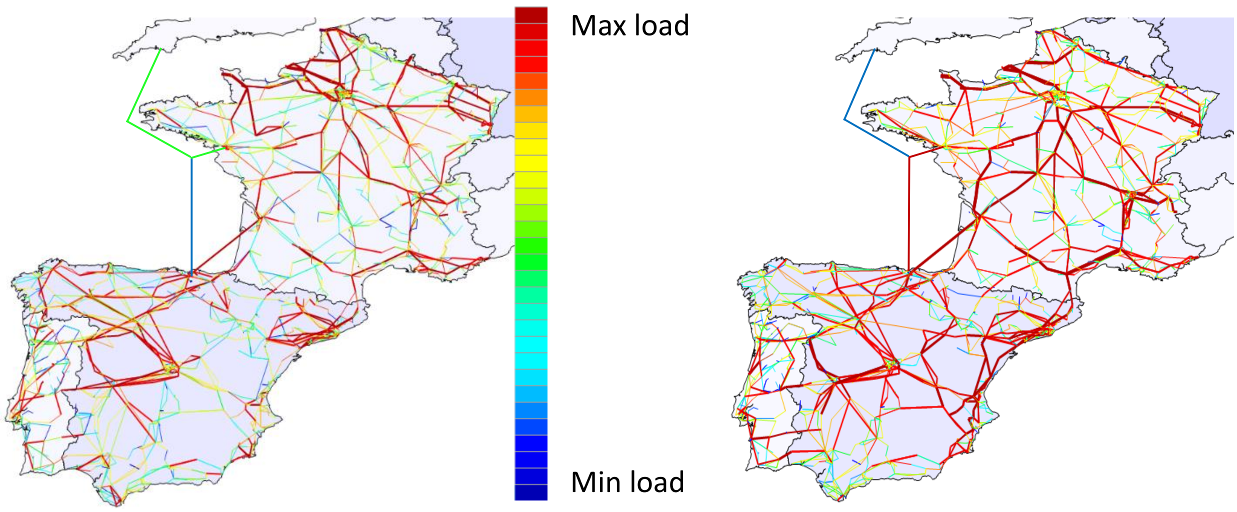

Figure 3-21 Typical Winter (left) and Summer (right) Peak power flow situation for Vision 3

This vision, with a generation mix corresponding to a ‘Green Transition’, can be defined as representing a usual TSO scenario. The internal and the interconnections reinforcements are studied and well defined to face such scenario. With such a level of RES and with its volatility, some issues have to be solved by the electrical sector in order to assure the security of supply and the quality of electricity (margin, frequency).

3.3.4 Vision 4 Results

Vision 4 - “Green Revolution” - is mainly characterized by:

- In terms of demand, efforts in energy efficiency and the developments of the usage of electricity on transport and heating/cooling are intensified. Market designs are adapted in such a way that the highest energy savings are combined with the highest substitution to electricity. As a consequence, electricity demand is expected to grow at a higher pace than in any other vision, due to the fact that the introduction of these new uses of electricity more than compensates for the realized energy efficiency improvements.

- In terms of generation, the future generation mix is on track to reach the decarbonisation objectives for 2050 at least cost. The carbon pricing reaches such levels that base load electricity production based on gas is preferred to hard coal. CCS technology is fully implemented. For this vision also no must-run obligations were considered for the thermal generation in the CSW region.

In synthesis, being Vision 4, a vision with a high rate of consumption growth and a high increase on RES penetration without must-run obligations, several problems in terms of voltage issues and overloads were identified on the regional network studies for the three countries of the region.

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 networks. Some of them are not defined yet, as the location of the new generation has a high impact and there is a high level of uncertainty on it. Therefore, further analysis will be needed on this scenario if Europe commits to a sustainable energy policy. Additionally to the network studies already performed, further stability analysis should also be performed in order to evaluate the network behaviour with a scenario with such high amount of renewable energy sources.

Regarding interconnections, the investment needs are higher compared to Vision 1. In fact, as market studies show higher flows from the Iberian Peninsula to France thanks to the renewable surplus, some internal reinforcements are required in Spain to accommodate them. In the three countries, the accommodation of new hydro power plants (some of them with pumping) is also required. On the other hand, also the connection of new RES and the accommodation of higher flows caused by the new RES in certain boundaries inside the Iberian Peninsula, especially the connection of the Aragón area to Catalonia and Castellón, require reinforcements of some paths already identified in the 2020 horizon.

Also transmission reinforcements are needed in Portugal and Spain to integrate new solar generation in the south of the countries, and also to accommodate the higher flows south-north caused by this new RES. For the same reason, the high level of solar generation in France could create congestions on the internal network, but also voltage issues. With more hydro generation, including also more pumping, the needs for flows North to South are increased in the Massif Central region.

As it was presented for the other visions, the next figure illustrates an example of the network studies performed in the RG CSW, presenting the main power flows in the region for two representative points in time assessed. With this map it is possible to highlight the main bulk power flows and the transmission system usage across the region for Vision 4, namely the higher usage, not only of the interconnections, but also of the overall transmission system to accommodate the huge amounts of RES considered in this scenario.

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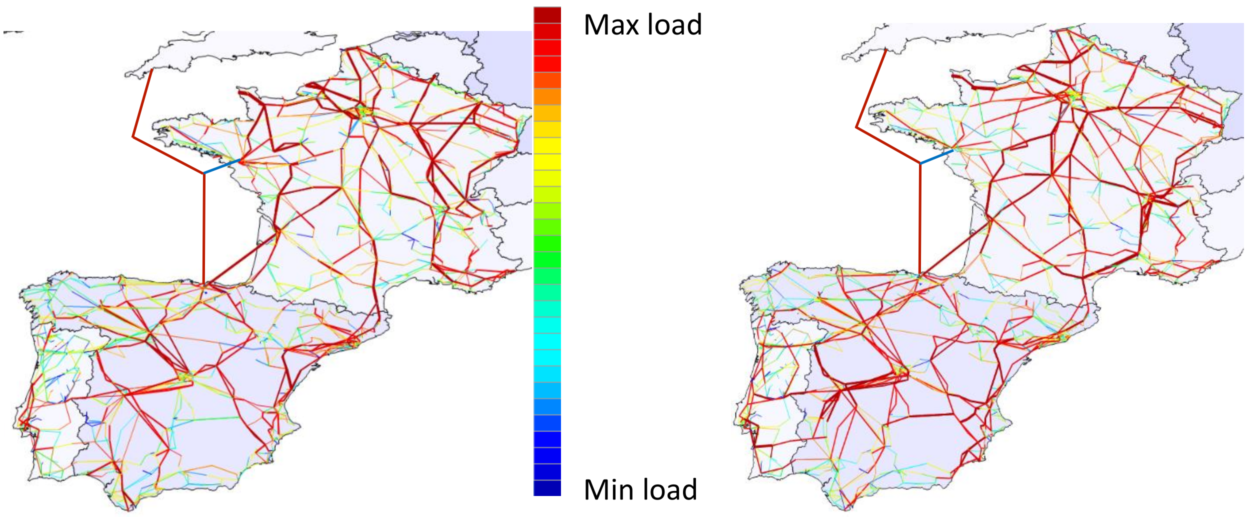

Figure 3-22 Typical Winter (left) and Summer (right) peak power flow situation for Vision 4

Comparing with Vision 1, Vision 4 is much more demanding in terms of transmission usage as well as in terms of power exchanges between countries. In addition, and although the evolution of the electrical systems according the Vision 4 assumptions could have strong benefits in terms of CO_2 emissions, there are still some issues that need to be solved by the electrical sector, namely the accommodation of the volatility of the RES and overall stability of the system. In fact, more flexibility not only from the generation but also from the demand (DSR), is needed to maintain the current levels of security of supply.

3.4 Comparison of the 2030 Visions

As presented above, the four Visions presented consider important differences on the expected evolution of the energy systems from now to 2030, which naturally can have different impacts on the transmission needs. The following sections present the main differences among the Visions analysed, highlighting and comparing in detail the differences among the between the two extreme scenarios assessed under the TYNDP 2014 package, namely the Vision 1 and 4.

Demand

In Vision 1 and 2, there are no major breakthroughs in energy efficiency developments and in the usage of electricity for transportation; as a consequence, electricity demand is expected to grow at a slower rate than in the other Visions. In Vision 3 and 4, energy efficiency developments and the usage of electricity for transport and heating/cooling are intensified.

For Vision 4 market designs are adapted in such a way that the highest energy savings are combined with the highest substitution to electricity. As a consequence, electricity demand is expected to grow at a higher pace than in any other Vision, due to the fact that the introduction of these new uses of electricity more than compensates for the realized energy efficiency improvements. As a consequence the electrical demand in Vision 4 is 17% higher than in Vision 1. The demand for Vision 2 and 3 is between the values considered for Vision 1 and 4.

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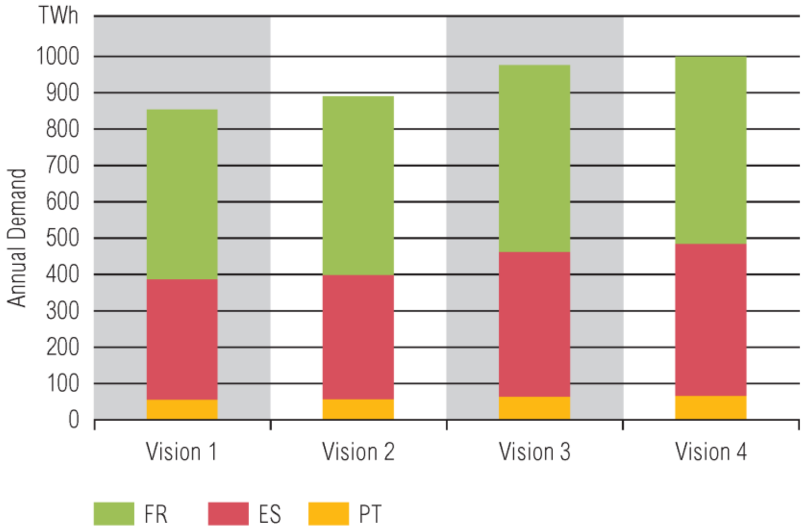

Figure 3-23 Comparison of annual demand in the four Visions

Installed capacity

Basically the main differences on the installed capacity among the Visions are related with:

- Huge increase of wind and solar installed capacity in the green scenarios, namely in Vision 4.
- Reduction of nuclear installed in Vision 3 and 4 capacity in France, depending on the energy transition objectives. The nuclear power plants installed capacity in Spain remains stable in all Visions. The consequence is that the nuclear share in the generation mix decreases from almost 50% in Vision 1 to less than 30% in Vision 4.
- The necessary support of conventional generation in green Visions, mainly in Vision 4, in order to cope with expected volatility of the RES.

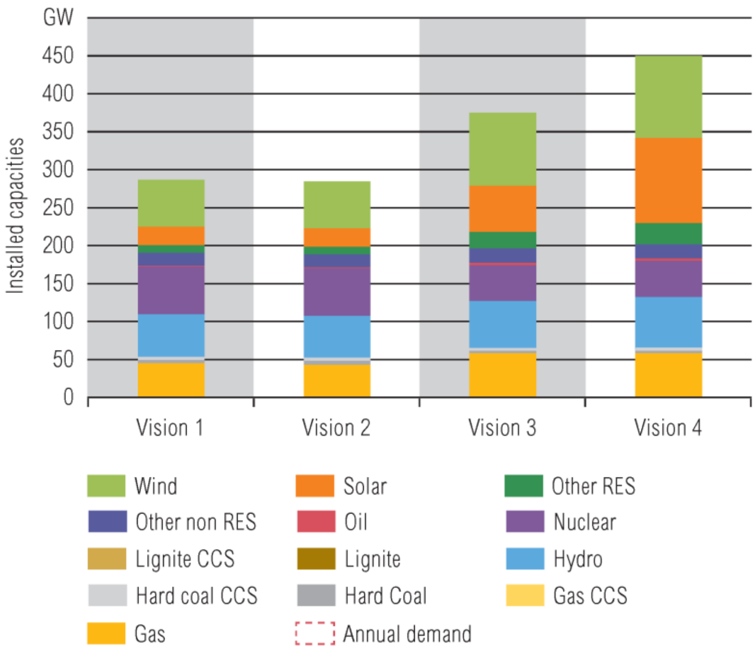

Figure 3-24 Comparison of installed capacity in the four Visions

<u>*Share of RES*</u>

The share of RES varies according with the assumptions already described above. In Vision 4 the penetration of RES reaches around 57% in the region of the total energy produced, namely by the increase of wind and solar installed capacity. In fact, regarding the annual generation production, the evolution of RES is quite big with an increase of 390 % of the solar generation and 190 % of wind power for Vision 4 compared to Vision 1.

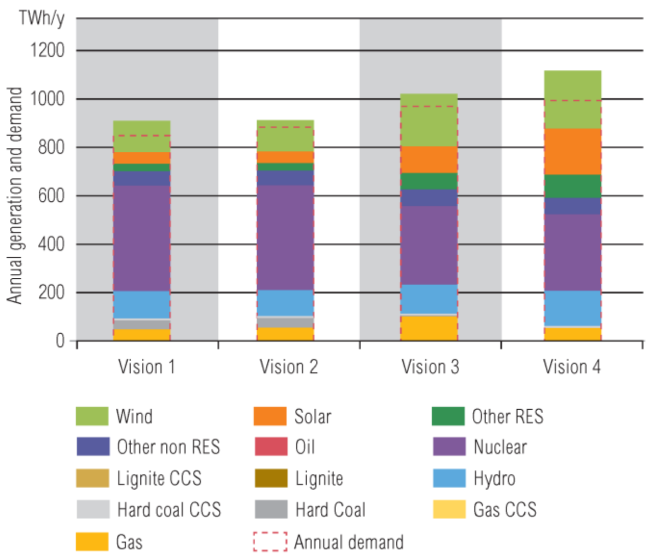

Figure 3-25 Comparison of annual generation in the four Visions

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Balances

With a higher potential of cheap generation, the market studies confirm an increase of the exporting balance of the region to the rest of Europe, from 50 TWh in Vision 1 to 70 TWh in Vision 4.

For Visions 1 and 2 the export of energy towards the rest of Europe is supplied by France, namely due to the nuclear energy. On the contrary, in Visions 3 and 4, the region increases the energy exports as a consequence of the increase of wind and solar energy across the region, namely in Spain.

Going into the national details, France decrease its exports from Visions 1 and 2 to Visions 3 and 4, Portugal increase its imports from Vision 1 to Vision 4 (except of Vision 2 where it has a light decrease), and Spain changes it's importing condition in Visions 1 and 2 to exporting in Visions 3 and 4.

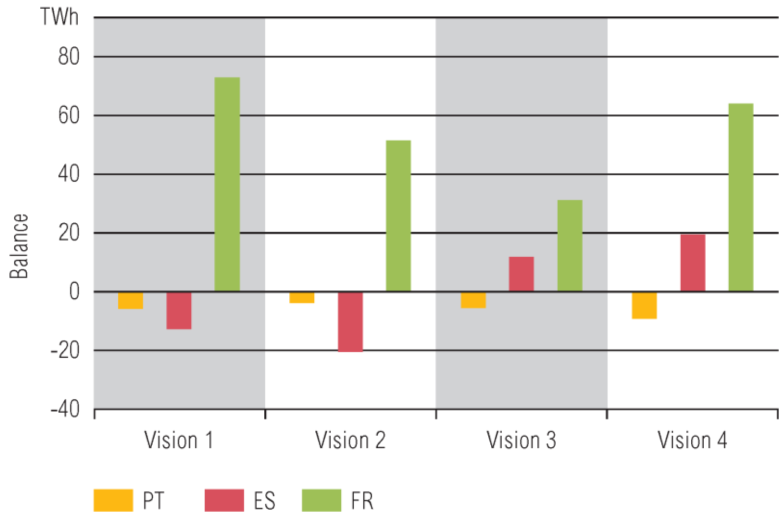

Figure 3-26 Comparison of annual Balance in the four Visions

CO_2 emissions

Considering the high penetration of RES in the region in Visions 3 and 4 and the higher CO_2 cost, the regional market study results show that, if the green scenarios become a reality in 2030, the CO_2 emissions in the region can be reduced more than a half, when compared with the CO_2 emissions expected for Vision 1 or 2, especially in Spain. In addition, the CO_2 intensity is 20 tons/GWh for Vision 4, and 60 tons/GWh in Vision 1.

The rationale behind these numbers is that in Vision 1 and in Vision 2, CCGTs in the region are pushed out of the merit order by coal units inside and outside the region, which have a lower cost but also higher emission rate. On the other hand, in Vision 3 and 4, nuclear and RES provide around 80% of the generation in the region with no CO_2 emission, the rest being mainly CCGTs with low CO_2 emission rate.

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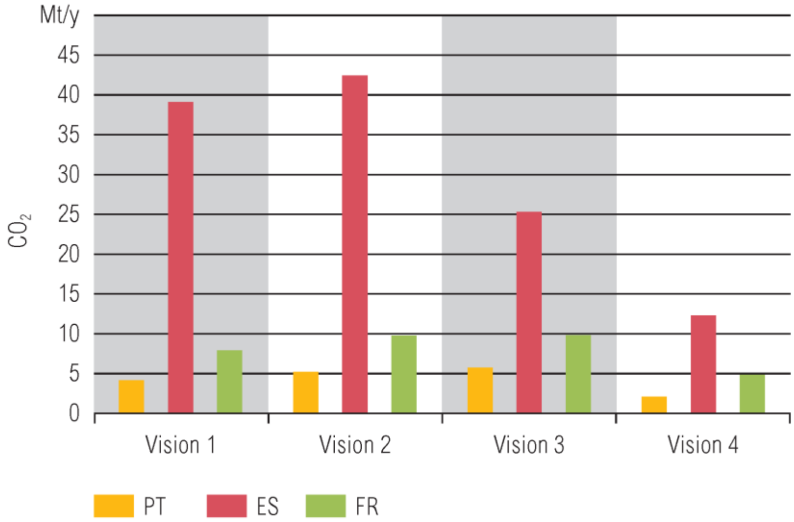

Figure 3-27 Comparison of annual CO_2 emissions in the four Visions

Network studies

The four Visions have been studied and the investment needs have been identified. For all the Visions, the interconnections between France and Spain and between Portugal and Spain require reinforcements. Interconnection between France and Spain needs further reinforcement in all Visions while interconnection between Portugal and Spain needs further reinforcement in some Visions.

In Vision 1, although no major issues were identified, some projects are needed to accommodate new generation and the increase of the power flow on the boundaries. In these sense, these projects were included to CSW project portfolio and assessed in the TYNDP 2014 framework. In Vision 2, with a slightly higher consumption than in Vision 1, no additional investments were needed. In Vision 3 and 4, with high development of renewables and storage in the three countries, new investment needs have been identified. With such a level of RES, namely for Vision 4, some issues have to be solved in order to assure the security of supply and the quality of electricity.

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4 Investment needs

4.1 Present Situation

The map below shows different levels of Net Transfer Capacities (NTC) in the Continental South West region. The NTC is the maximum total exchange program between two adjacent control areas that is compatible with security standards and applicable in all synchronous areas, whilst taking into account the technical uncertainties on future network conditions.

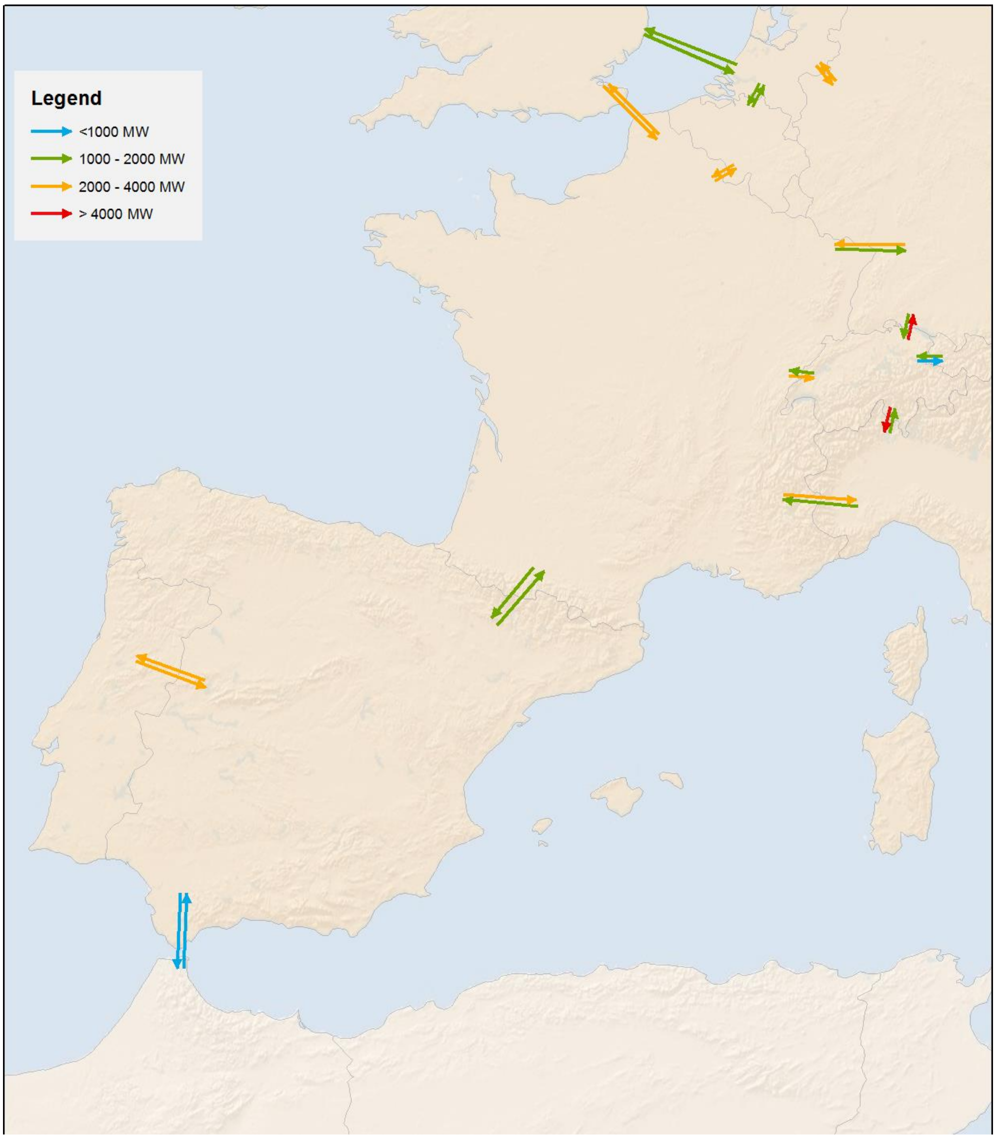


Figure 4-1 Illustration of Net Transfer Capacities in CSW region (2013)

Currently, the NTC values between France and Spain in 2013 are in the range of 1200-1400 MW from France to Spain, and 900-1100 MW from Spain to France. The exchange capacity value from Spain to France has recently experienced an increase, due to some internal reinforcements in Spain. However, these values are considerably lower than the requirements of the market, as can be seen by the 62% rate of congestion on this border in 2013. It should be noted that the Iberian Peninsula (Portugal and Spain) is almost an electrical island, with only four interconnectors between France and Spain, where the latest was constructed in 1982.

Although the 2013 NTC values between Portugal and Spain (1800-2200 MW from Portugal to Spain and 1800-2200 MW from Spain to Portugal) are higher than those between France and Spain, some constraints still occur (in 2013 the congestion rate was 12%) and additional investments are needed to achieve the main political goals established for reaching a complete operational Iberian Electricity Market (MIBEL). Included on these set of reinforcements, in 2014 has entered into operation the new interconnection Puebla de Guzman (ES) – Tavira (PT), reinforcing the capacity, mainly on the direction Portugal to Spain.

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 flows from Spain to Morocco for almost all the hours of the year.

Also an important effort has been made in the CSW region to integrate new RES generation, namely the development of new transmission investments in the Iberia. By the end of 2013, the total RES installed capacity (including hydro) was around 90 GW.

4.2 Drivers of Grid Development

Recent developments in electricity sector, such as the implementation of market mechanisms and integration of renewable generation on a large scale, have significantly changed system operation conditions in Europe. This poses significant challenges to the peripheral regions of Europe, particularly for those which are not sufficiently interconnected with Central Europe, as it is the case of the Iberian Peninsula. Nevertheless, the Iberian Peninsula, both Portugal and Spain, has already wide experience in the integration of high amounts of RES, as the boom of wind power already started several years ago. For instance, in Spain, wind power represented in 2013, a 22% of the installed power and contributed in a 21% to covering the demand, becoming by the first time the main technology. In addition, the 42% of share of RES in 2013 is being handled efficiently thanks to the Renewable Control Centre (CECRE) of the Spanish TSO that allows communication and control of RES. In Portugal, wind power represented in 2013, a 25% of the installed power and contributed in a 24% to covering the demand.

In the Regional Group Continental South West, the following main needs drivers for system evolution can be briefly summarized:

- **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 evacuation**: areas where existing generation cannot be evacuated reliably in all situations as a result of a change in surrounding power flow patterns; In fact, in some particular operation conditions there is some RES spillage in Iberian Peninsula due to the insufficient cross-border capacity between this region and the rest of the Europe.
- **Future generation evacuation**: areas where new generation facilities have been asked (or are likely to be asked) for connection, as it may be the case of large power plants and/or distributed generation, RES or not, as the existing network does not assure conditions for an adequate evacuation (e.g, hydro generation in North of Portugal and solar energy in South of Portugal and Spain);
- **Security of Supply of some specific areas**: power supply of some cities and local bottlenecks created the need for some regional investment needs.

Figure 4-2 to Figure 4-8 depict the main grid development drivers in the CSW region.

4.3 Main Bottlenecks Location and Typology

As a result of the market and network study process, several bottlenecks have been identified for the European electricity system from now to 2030 (unless new transmission assets are developed). Figure 4-2 shows their location, i.e. the grid sections (the "boundaries") where the transfer capability may not be large enough to accommodate the likely power flows that will need to cross them, unless new transmission assets are developed.

In order to ease the understanding, the likely bottlenecks are presented in three areas:

- Security of supply; when some specific area may not be supplied according to expected quality standards and no other issue related to generation or market is at stake.
- Direct connection of generation; both thermal and renewable facilities.
- Market integration; if inter-area balancing is at stake, distinguishing what is internal to a price zone and what is between price zones (cross-border).

When a boundary can be flagged with more than one concern, market integration prevails over generation connection and security of supply. In the CSW region 50% of the boundaries are primarily related to this issue with 29% cross-border and 21% internal.

The most characteristic market-related bottleneck of the region is at the French-Spanish border. The project currently under construction in the eastern part of the border will alleviate but not eliminate congestion, so that additional developments are still needed. Between Spain and Portugal, two projects have been recently commissioned, but some congestion still remains till the northern interconnection is commissioned in the medium term.

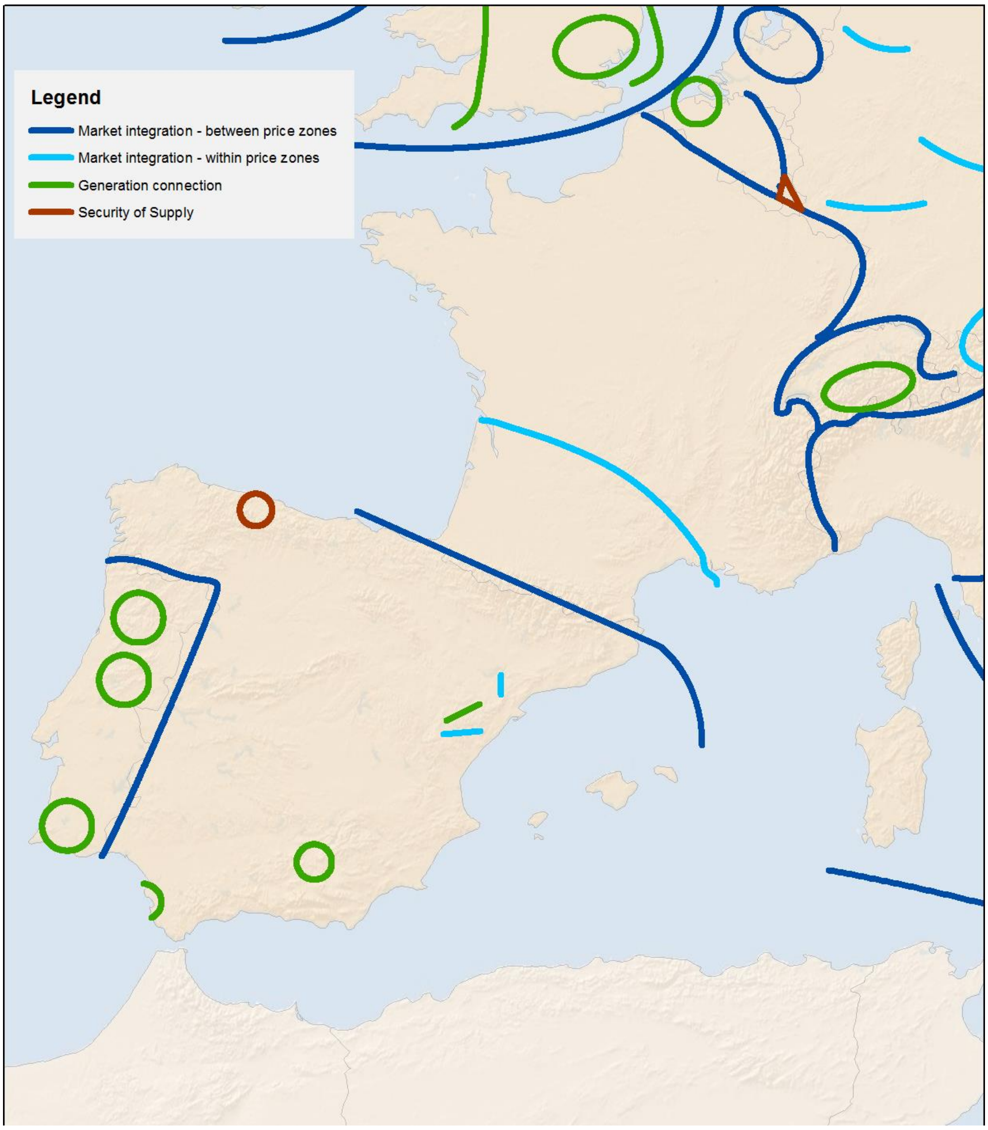


Figure 4-2 Maps with remaining bottlenecks in the region

Generation connection is another main driver in the CSW region concerning primarily 43% of the boundaries. The displayed boundaries relate to the already mature applications for connection of large generation plants, or areas where more than 1 GW of RES / 1000 km2 is expected. (Many additional generation projects, of national relevance are hence not reported in this report). Most of these power plants are RES generators and are located in the Iberian Peninsula. Since RES generation areas are generally far away from densely populated load areas, scenarios with higher RES and higher load like Visions 3 and 4 create additional transmission needs with respect to Vision 1.

Therefore, grid development will be needed for connecting or integrating new RES generation in Spain and northern Portugal. Consequently, north to south congestion is expected in the Portuguese network, and also in Spain, towards Madrid, mainly from the South and the Northwest (this last also toward the East and Mediterranean area), and North-South flows in the Mediterranean coast. Vision 1In France, grid development between the South West and the rest of the country will be needed to accommodate the significant flows due to RES installation in south-western France combined with higher flows from and to the Iberian Peninsula.

Last, it must be pointed out that decommissioning big units, like nuclear units in France, may completely change the power flows on the transmission grid and even trigger the need for additional transmission capacity in some areas. It is hard to predict more without knowing which units will be concerned. The consequences may be limited in Vision 1 as only a dozen of units are concerned (provided decommissioned units are not concentrated in the same area), but a major impact on grid development is expected for Visions 3 and 4 where there is a dramatic decrease of nuclear capacity on top of a large penetration of RES generation.

In Vision 4, the prediction of the location of the generation is more difficult due to the type of new generation: solar and wind. The grid will be more constrained but will face more different situations, as the location of the production will be more variable. The high level of RES could also change the use of the storage, creating a need to pump during the day with high solar generation.

Finally, the construction of the scenarios, the four Visions assuming that generation is sufficient to balance load, lead that security of supply may remain a local concern; investments of pan-European significance may contribute to enhance security of supply but only seldom may it show up as a primary driver for project of pan-European significance by 2030.

4.4 Bulk Power Flows in 2030

A Bulk Power Flow (BPF) is the most representative power flow triggering grid development across a boundary. They are quantified in the following sections for every concern: market integration, generation direct connection and security of supply. Bulk Power Flows usually ranges from about 500 MW to more than 10000 MW.

4.4.1 Generation Connections

The figures below show the main Bulk Power Flows in the CSW region related with the connection of new generating facilities. The Bulk Power Flows are presented only for Vision 1 and 4 which according the study results are the extreme ones.

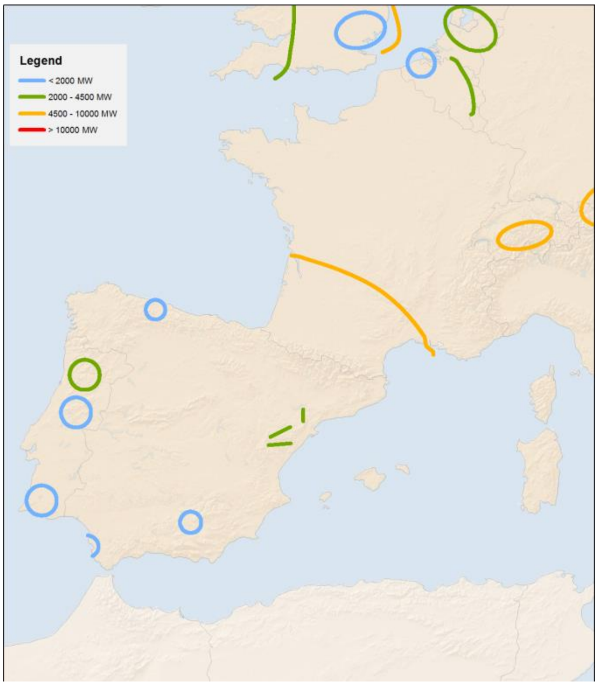


Figure 4-3 Map of Bulk Power Flows related to generation connections – Vision 1

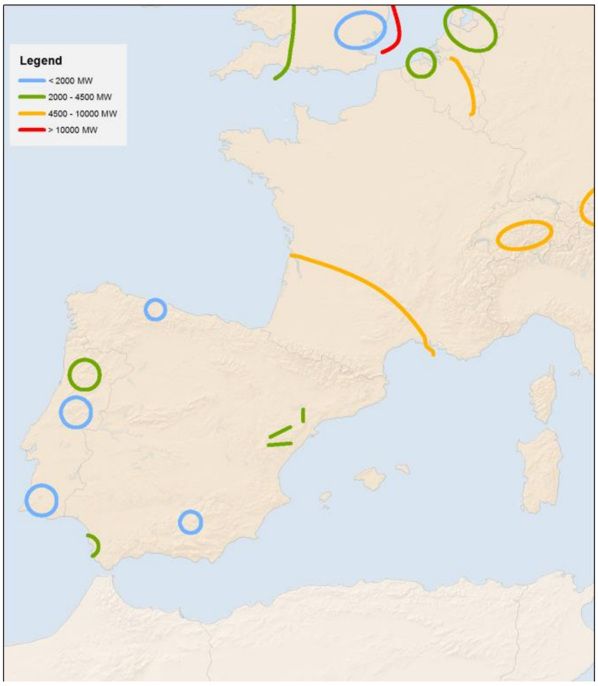


Figure 4-4 Map of Bulk Power Flows related to generation connections – Vision 4

Generally, the main concern regarding generation connection in the region is related to new renewable energy generation, mainly the on-shore-wind and the solar but also hydro, including pumping storage in northern

Portugal and different areas in Spain. Both maps display basically the same set of boundaries, only the magnitude of RES is different, and therefore the Bulk Power Flows change from one Vision to another.

The major Bulk Power Flows in the region are observed between the south-western part of France and the rest of the country. This Bulk Power Flow is highly dependent on the combination among the local load level, the output from RES generation in the area (mainly solar in the whole region but also wind in the south of Massif Central) and also the cross-border flows from and to the Iberian Peninsula. Of course, also the cross-border flows are highly linked to RES generation. These combined phenomena together result in highly volatile flows that may reach more than 5 GW in both directions.

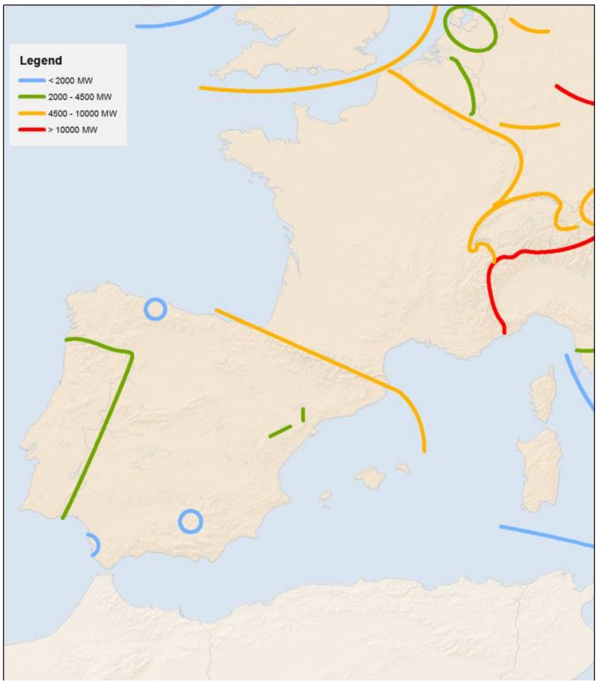
Connection and integration of wind energy and hydro generation in northern Portugal also trigger development in the transmission grid, not only inside the country but also on the border with Spain.

In Spain new projects are required in Jaen and Cadiz areas for the connection of high amount of RES while the rest of RES can be accommodated in already existing or planned transmission paths, possibly with new substations and causing some congestions mainly in the Cantabric-Mediterranean axis and in the paths from Aragón towards the Catalonia and Levante regions.

In Vision 4, the high level of RES in the region and the addition of new storage facilities increase the flows in the grid. In summer, with high solar generation in the three countries, the major Bulk Power Flow is a South to North flow in France up to 10 000 MW. The increase of the other RES will also increase the needs of capacity of the transmission grid, including the interconnection between Portugal and Spain and between Spain and France.

4.4.2 Market integration

The creation of the Internal Electricity Market (IEM) will eventually require the harmonisation of all cross border market rules so that electricity can flow freely in response to price signals. Market integration is leading to more and larger power flows across Europe and it is therefore a major driver of grid development. The flows that trigger grid development (BPF) in 2030 for CSW region, under Visions 1 and Vision 4, are shown in Figure 4-5 and Figure 4-6 with the boundaries related to market integration.



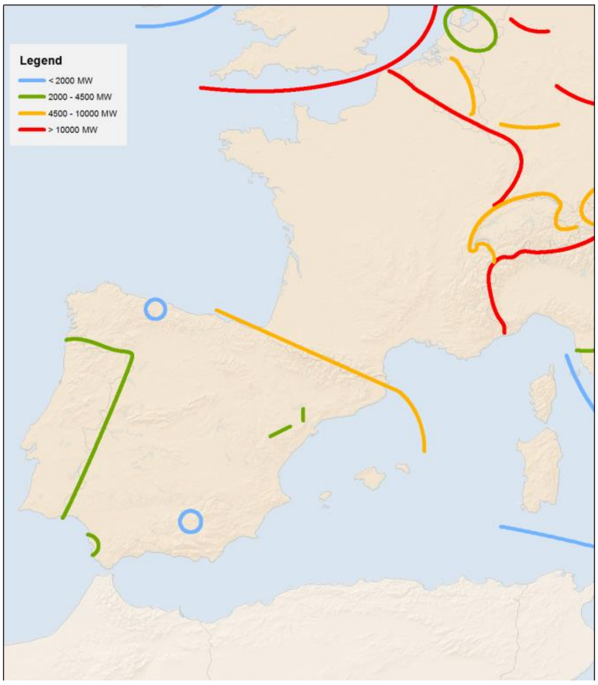


Figure 4-5 Map of Bulk Power Flows related to market integration connections – Vision 1

Figure 4-6 Map of Bulk Power Flows related to market integration connections – Vision 4

In fact for 2030, for both Vision 1 and Vision 4, a high bulk power flow (~6.000 MW) is expected in the boundary between the Iberian Peninsula and the rest of the Europe. For Vision1, where it is expected a slow progress in RES evolution, the most representative flow is from France to the Iberian Peninsula. For Vision 4, with a 57% of RES penetration, the expected power flow is in the opposite direction. Also important Bulk Power Flows are identified in the South Western of France, which are directly dependent not only on the RES generation, but also on the power exchanges between Spain and France.

Somewhat smaller Bulk Power Flows are identified in the interconnection between Portugal and Spain, being higher from Spain to Portugal than in the opposite direction (2700-3200 MW) and also higher with high RES penetration.

Then, considering the BPF identified, the studies conclude that the reinforcement of the cross-border capacity between the Iberian Peninsula and the rest of the Europe is critical for the creation of the Internal Electricity Market (IEM) in Europe and increase the competiveness in the CSW region.

To conclude, the Bulk Power Flows in the CSW region related to market integration are heavily dependent on the RES production. As a result, the power flows are large, but also more volatile than today. Moreover, they are limited to the projects considered in the plan, which in the case of the French-Spanish border are still not able to eliminate the congestion, as it is explained in chapter 6.

4.4.3 Security of Supply

The figures below display the Bulk Power Flows related to the security of supply concerns in the CSW region.

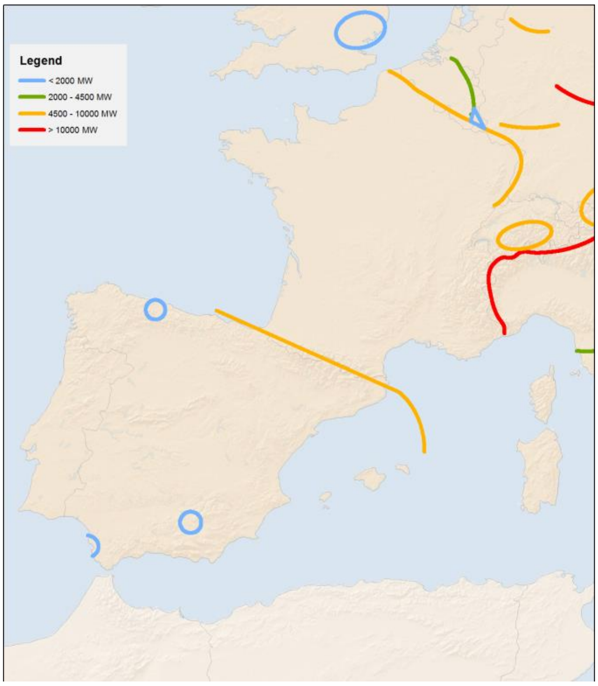


Figure 4-7 Map of Bulk Power Flows related to SoS connections – Vision 1

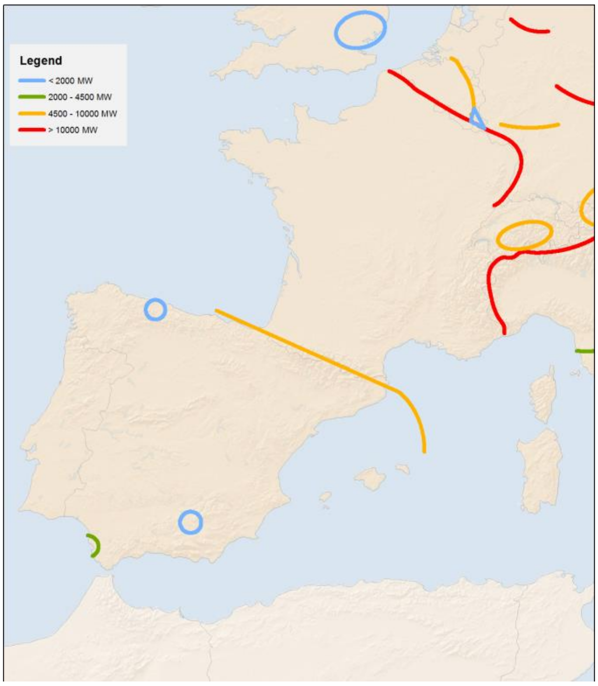


Figure 4-8 Map of Bulk Power Flows related to SoS connections – Vision 4

Due to the low growth rate in Vision 1, the need for additional projects of pan-European significance till 2030 time horizon is limited to Asturias area, in northern Spain. On the other hand the situation of the Iberian Peninsula, considered as an electric island due to its low interconnection capacity to the rest of Europe compared to the high dimension of the Iberian system, can be also considered a security of supply issue.

Nevertheless, it is worth reminding that security of supply issues concern, in most of the cases, to restricted areas and are therefore most efficiently mitigated by investments with local/national importance, that are not reported here.

5 Investments - Project Portfolio

5.1 Criteria for Projects Inclusion

5.1.1 Projects of pan-European significance

A project of pan-European significance is a set of Extra High Voltage assets, matching the following criteria:

- The main equipment is at least 220 kV if it is an overhead line AC or at least 150 kV otherwise and is, at least partially, located in one of the 32 countries represented in TYNDP.
- Altogether, these assets contribute to a grid transfer capability increase across a network boundary within the ENTSO-E interconnected network (e.g. additional NTC between two market areas) or at its borders (i.e. increasing the import and/or export capability of ENTSO-E countries vis-à-vis others).
- An estimate of the abovementioned Grid Transfer Capability increase is explicitly provided in MW in the application.
- The Grid Transfer Capability increase meets at least one of the following minimums:
- At least 500 MW of additional NTC; or
- Connecting or securing output of at least 1 GW / 1000 km² of generation; or
- Securing load growth for at least 10 years for an area representing a level of consumption greater than 3 TWh / yr.
-

Or a storage project, matching the following criteria:

- be an electricity storage facility used for storing electricity on a permanent or temporary basis in above-ground or underground infrastructure or geological sites, provided it is directly connected to high-voltage transmission lines designed for a voltage of 110 kV or more;
- provide at least 225 MW installed capacity and has a storage capacity that allows a net annual electricity generation of 250 GWh/year .

5.1.2 ENTSO-E and non ENTSO-E members projects (Third Party Projects)

Most of the development transmission projects are proposed by licensed TSOs, who are members of ENTSO-E. In the framework of transmission system development, it is possible, however, that some transmission projects would be proposed by 'third party' promoters. In light of Regulation (EU) 347/2013, entered into force on 15 May 2013, which makes the TYNDP the sole basis for the electricity Projects of Common Interest (PCI) selection, ENTSO-E has developed in 2013 the "Procedure for inclusion of Third Party Projects – transmission and storage – in the 2014 release of the TYNDP[23]", hereafter the Third Party Procedure.

In the Third Party Procedure[24], ENTSO-E categorizes Third Party Projects, which must be projects of pan-European significance, in three different forms promoted by:

- Promoter of transmission infrastructure projects within a regulated environment, which can be either: Promoters who hold a transmission operating license and operates in a country not represented within ENTSO-E; or any other promoter.

[23] https://www.entsoe.eu/major-projects/ten-year-network-development-plan/tyndp-2014/

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- Promoters of transmission infrastructure projects within a non-regulated environment: promoters of which investments are exempted in accordance with Article 17 of Regulation (EC) No 714/2009
- Promoters of storage projects.

Projects proposed by either third parties or non-ENTSO-E TSOs are assessed simultaneously by ENTSO-E according to the same cost-benefit analysis methodology adopted for TSOs projects.

All Projects of Common Interest in the CSW region that make part in the 2013 list, including the already commissioned ones, have been assessed and are presented in this report.

5.1.3 Regional investments

Regional investments are investments which have an effect on the grid at a regional level, even though they are not necessarily cross- border. They are not included in the TYNDP as such, but some can support TYNDP projects when regional grid reinforcements are needed for the commissioning of a pan-European project.

5.1.4 3RD party projects

Two 3rd party projects were received with affection to the CSW region, although only one was accepted as it was the only fulfilling the criteria established in the ENTSO-E Procedure for inclusion of 3rd party projects. This accepted project is named BRITIB (number 182) consists in a multi-terminal HVDC interconnection between Spain, France and Great Britain, with 2 sections and 3 terminals of 1000 MW each.

This project was assessed and the results are presented in appendix 0.1.

5.2 Projects portfolio

The next two maps will display geographically all the projects proposed in the region, divided into two time periods: the first five years or ”mid-term” (2014 – 2018) and the following twelve years or “long term” (2019 and beyond). The maps show basic information regarding locations, routes and technology. When the precise location of an investment is not yet clear, then a bubble shows where the investment is likely to occur.

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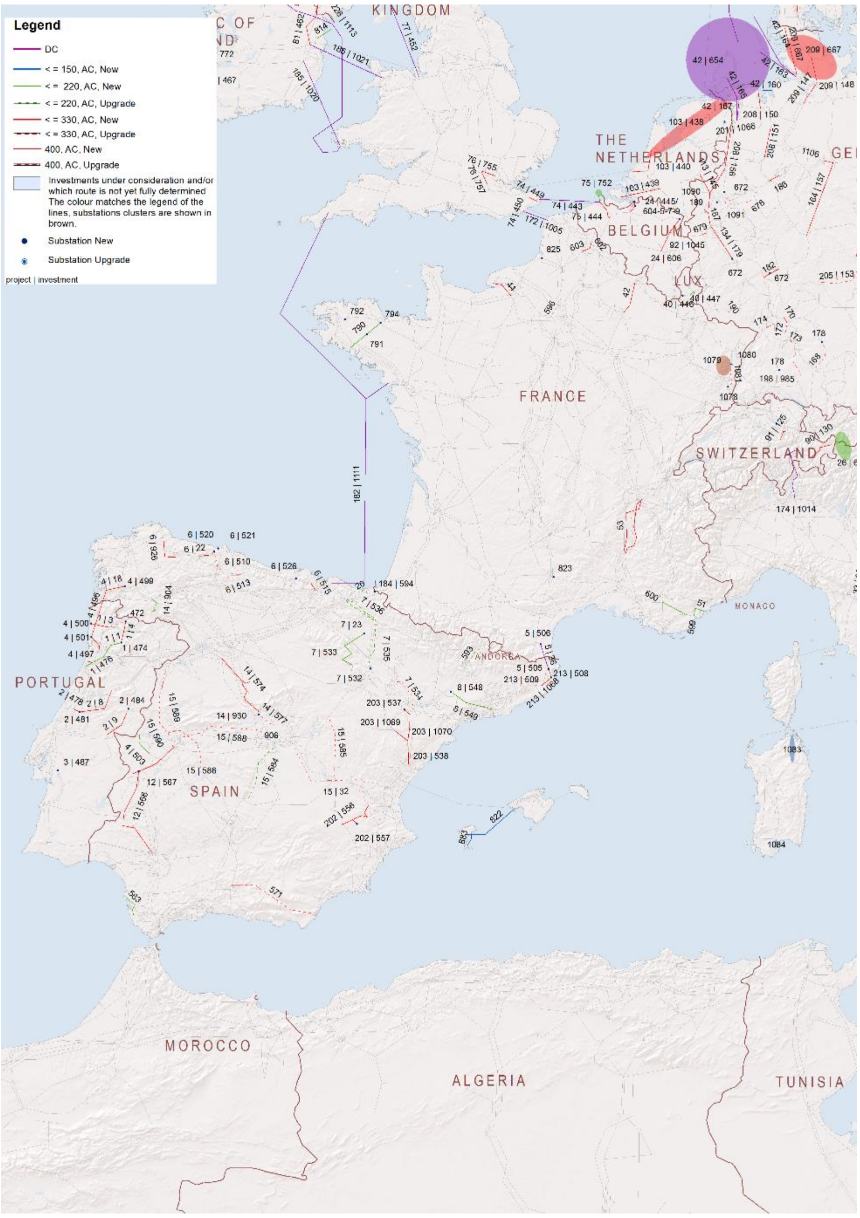

Figure 5-1 Pan-European Significance and Regional investments – Mid-term horizon (<2019)

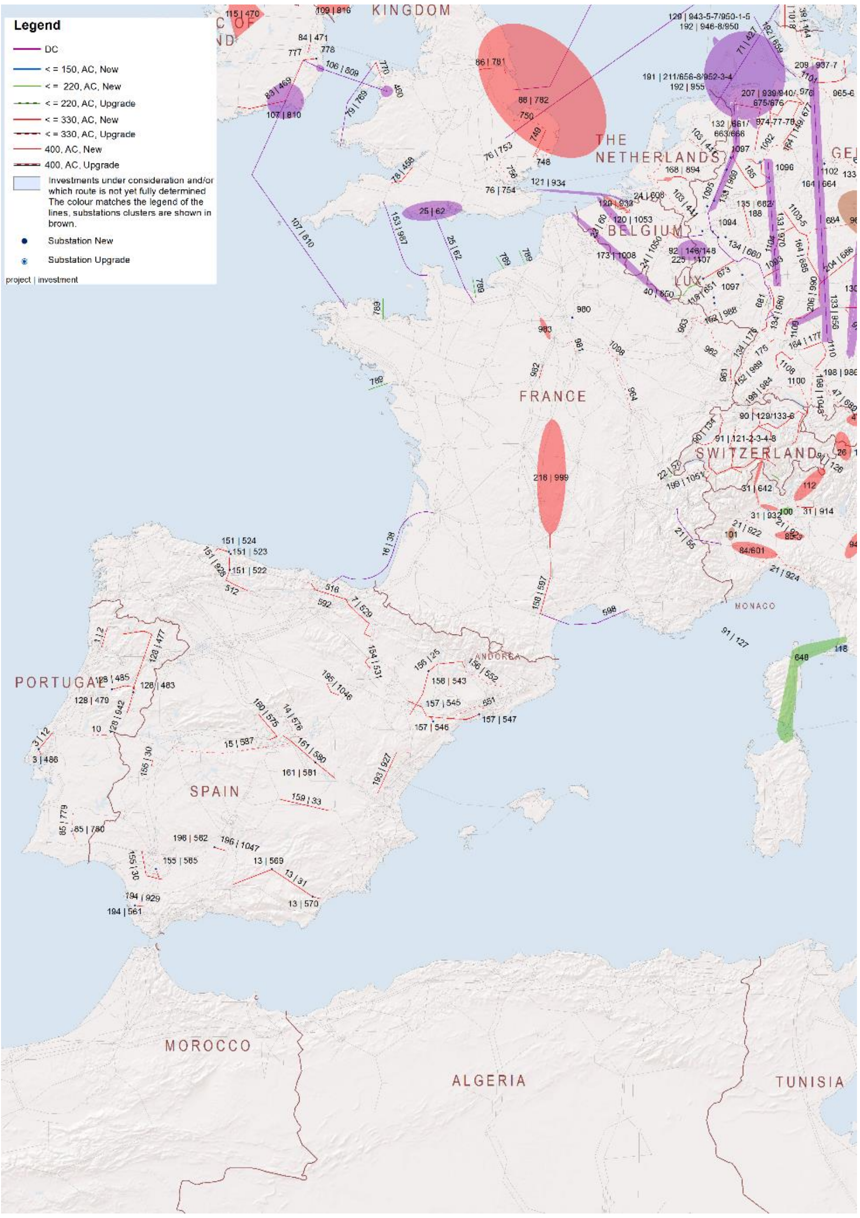

Figure 5-2 Pan-European Significance and Regional investments – Long-term horizon (>=2019)

5.2.1 Projects of common interest.

There are 10 Projects of Common Interest (PCIs) in the CSW region, selected in 2013 by the European Commission in the region North-South Interconnection West Electricity, according to the regulation (EU) No 347/2013[25]. On one hand, with affection to the Portuguese-Spanish border, there is the so-called Northern Interconnection, and on the other hand, related with the Spanish-French border, there are a Phase-Shifter transformer in Arkale substation in Spain, the 400 kV development in Spain required to connect the HVDC Eastern interconnection Santa Llogaia-Baixas to the existing network and secure the load in the area of Gerona, already under construction, and the Western Interconnection-HVDC Biscay Gulf project.

Still related with the Portuguese-Spanish border there are also an internal Portuguese project which includes the some internal investments elected as PCIs, namely the intenal 400kV lines Pedralva-Alfena, Pedralva-V. Castelo (V. Fria B) and V. Minho (Frades B)-Ribeira de Pena-Feira, is critical to achieve the political goal

[25] A 2013 PCIs interactive map can be consulted in http://ec.europa.eu/energy/infrastructure/transparency_platform/map-viewer/

for cross border capacity between Portugal and Spain and accommodate the new RES generation in the Northern of Portugal.-

In addition, 5 PCIs are HVDC interconnections between RG CSW and its neighbours: 1 project between France and Italy ("Savoie-Piemont" project), 1 project between France and Ireland (Celtic Interconnector) and 3 projects between France and United Kingdom : IFA2, France-Alderney-Britain and Eleclink.

5.2.2 Projects of pan-European Significance.

The projects of pan-European Significance in the CSW region can be classified in cross-border projects and in internal projects, which are related with market and generation integration, this last mainly RES, and to a lesser extent with security of supply.

The investment plan proposed sums up almost 14000 km of new circuits, 71% of them on overhead AC lines. It includes 3 cross-border lines within the region (1 on the PT-ES border and 2 on the ES-FR border), 11 interconnection projects between the region and the rest of Europe (10 of them are interconnections between France and the rest of the Europe which are being assessed in other ENTSO-E regional groups), and 13 internal projects.The plan shows a big effort to make the best of existing assets in order to minimize grid extension and avoid creating new routes, as 27% of the AC projects are upgrades, uprates or change of conductor, including the use of High Temperature conductors. Moreover, FACTS and Phase Shifter Transformers are considered, to control active power flows in some parts of the network. In addition, new and efficient but usually expensive technologies are considered in certain project definition, such as VSC in HVDC.

Most of the new DC projects are subsea cables (88%), while the rest are underground cables (12%). Regarding AC, 93% of the investment items relates to overhead lines, while 6% with subsea AC lines and only 2% with AC underground cables. (see figure below).

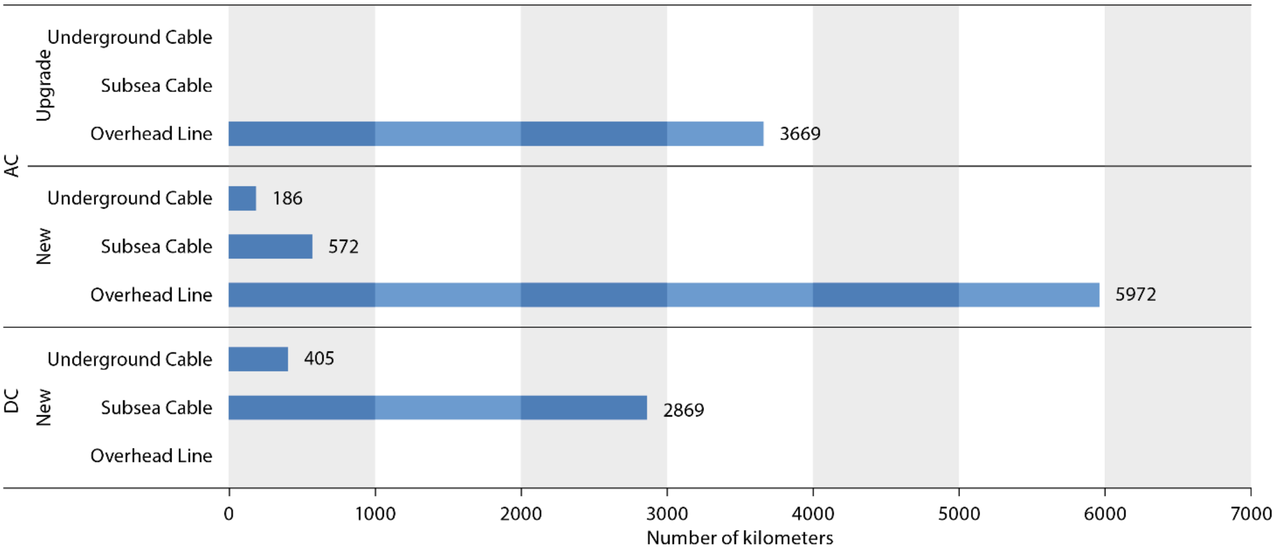

Figure 5-3 Project of pan-EU significance in CSW region - breakdown per technology

The investment cost in the CSW region is around €13.4 billion (see Table 2), of which around 35% refers to interconnections in the region, 40% to interconnections of the region (France) with the rest of Europe, and 25% to internal projects. This expenditure splits rather equally between the first 5 year (2014-2018) and the following 12 year (2019-2030) sub-periods, the investment being a bit higher in the long term. Long term includes some more expensive projects, especially regarding interconnections, as some of them are submarine and include HVDC technology.

Detailed information on projects of pan-European Significance can be found in Appendix 0.1.

Table 3 Total investment cost of CSW project portfolio

Countrys	Total cost (bn Euros)
ES (Spain)	4.3
FR (France)	8.4
PT (Portugal)	0.7

Regarding the status of the projects, 11% are already under construction, around the half of them are in a design and permitting process, the 10% are being planned and the 26% are under consideration for being planned, as we can see in figure below.

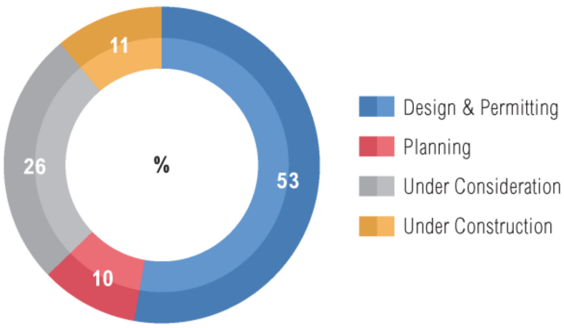

Figure 5-4 Projects in CSW region – Status of the investments

In respect to the expected commissioning dates of the CSW project portfolio presented in this RgIP, it is possible to conclude in the figure below that it quite balanced between the long and mid-term projects. 54% of the projects are expected to be concluded until 2019, and 46% between 2019 and 2030.

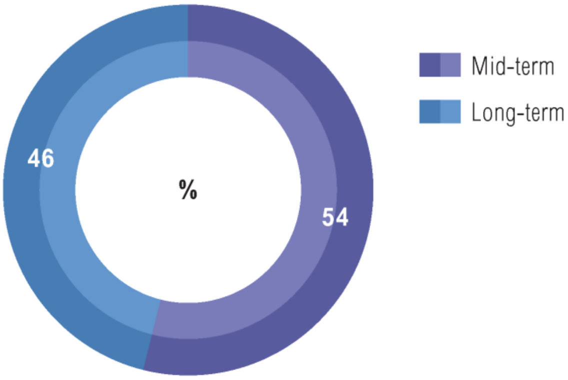

Figure 5-5 Projects in CSW region – Breakthrough per commission horizon

5.2.3 Investments of Regional Importance

In general regional portfolio contains projects which, or complement the pan-European ones or are projects that do not fulfil the rules to be included in the TYNDP 2014 (have no pan-European relevance), but they addresses some particular issues important for the region. They mainly address three main issues: local reinforcement which allows improving cross-border capacity, connection of new RES generation and local security of supply issues.

The most common driver is the connection of new RES generation which do not comply with criteria to be elected as pan-European project. An example is the connection of wind farms in the centre of Portugal.

5.2.4 Investments of National Importance

In every country of the CSW region there are a lot of more projects and investments that are needed at a national level for a secure, sustainable and competitive market, but even so, they do not fulfil the criteria of Regional or European significance. They are included in the National Development Plans (see appendix 1.2).

5.2.5 Storage Projects

There is no specific TYNDP storage project in the CSW region, as any storage promoter has contacted ENTSO-E for such a purpose. However, the scenarios built by the TSOs consider an increase of pumping storage in the region, according to the stakeholder applications received at national level. For instance, in Spain and Portugal (the more relevant for this issue), from the current values there is an increase of 5.9 GW in Vision 1 and 14.9 GW in Vision 4.

5.3 Assessment of the portfolio

As described in the chapter 2, the TYNDP 2014 project portfolio is assessed on four different 2030 Visions using the CBA methodology. This section provides an overview of the assessment results, for every CBA indicator. More details for each project can be found in the appendix 0.1.

5.3.1 Grid Transfer Capacity globally increase

In order to facilitate the pan-European electricity exchanges and to integrate the European energy market in accordance to EC goals it is necessary to increase existing cross-border and some internal transmission capacities. Therefore the challenge for coming decades is to facilitate high power flows over large distances in across Europe. The new projects are increasing the Grid Transfer Capacity (GTC) among main generation areas and consumption areas.

The GTC increase is wanted on many boundaries within Europe and promotes market integration in Europe. The values of gained GTC are oriented by needs and cover a huge range of transmission capacity increase efforts: projects of pan-European significance are very diverse, adapting to the very specific geography they are inserted in. The GTC has been developed from a few hundreds of MW to more some GW. Globally, greater GTC increases are developed basically where higher power exchanges are expected.

The GTC reflects the ability of the grid to transport electricity across a boundary, i.e. from one bidding area (area within a country or a TSO) to another, or at any other relevant cross-section of the same transmission corridor having the effect of increasing this cross-border GTC. However, GTC variation may also be within a country, integrating renewable energies, increasing security of supply or generation accommodation capacity over an internal boundary.

Looking at the CSW region project portfolio (Figure below), it is possible to see that most of the projects (around 50%) have a GTC increase less than 1 GW, generally internal projects for direct connection of new RES generation which usually only requires around 1 GW of new transfer capacity. On the other hand, 37% percent of the CSW projects increases the GTC in the region between 1 and 2 GW. In this set of projects there are internal projects in the Iberian Peninsula which main driver is to increase capacity in certain boundaries due to higher flows caused by RES. Also the mid-term interconnection reinforcements in the region are in this range.

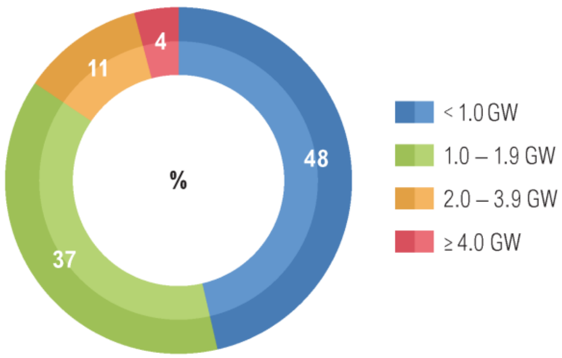

Figure 5-6 Increase of Grid Transfer Capacity on CSW region

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Only 15% of the CSW projects allow a GTC increase greater than 2000 MW. In this region, this type of GTC increase corresponds for instance to the Western Interconnection project between France and Spain. In addition, it is also related to the integration of huge amounts of new generation in some particular areas , such as the new hydro and wind generation in Northern of Portugal.

5.3.2 Grid reinforcements increase the Social and Economic Welfare (SEW)

By relieving congestion, new reinforcements may enable sustainable and cheaper generation to generate more electricity, thus replacing thermal power plants with higher cost The socio-economic welfare benefit is calculated as the savings in variable generation costs comparing the situation with and without a certain the project (generation cost approach).

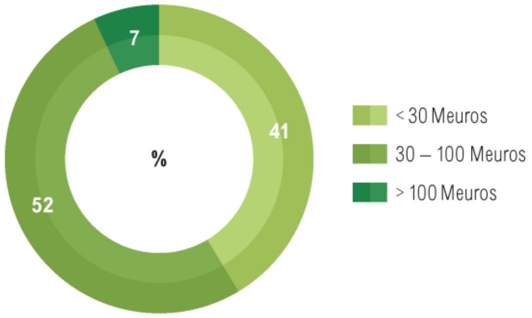

Figure 5-7 SEW for Vision 1

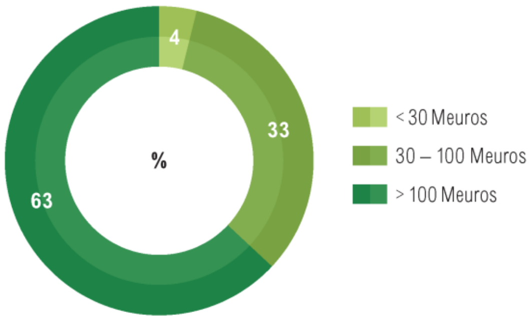

Figure 5-8 SEW for Vision 4

The figures above present the results for socio-economic welfare for the CSW project portfolio for Vision 1 and for Vision 4. They show that the greater is the RES installed capacity in scenarios analysed, the greater is the economic benefit across Europe. This is a consequence of the replacement of conventional thermal generation by RES with zero marginal costs. As in Vision 4 there is a higher penetration of RES (57% in CSW region compared to 35% in Vision1), the SEW related with CSW project portfolio is greater than in Vision 1. In fact, for Vision 4, 63% of the CSW transmission projects show a SEW greater that 100M€, while in Vision 1 only 7% of the CSW projects have this level of benefit.

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Nevertheless, and independently from the Visions assessed, CSW results demonstrate that the project portfolio proposed for this region can be 'profitable' in a 10-15 years period, when comparing its costs to only to the socio-economic welfare .

5.3.3 Project portfolio contributes for RES development

RES integration is defined as the ability of the power system to allow connection of new renewable power plants and unlock existing and future "green" generation, while minimizing curtailments. The RES-indicator is either calculating the RES-effect for either direct connection of RES or avoiding RES spillage. The RES-indicator intends to provide a standalone value showing additional RES available for the system, although it economic assessment is already included in the socio-economic welfare indicator. The indicator measures the influence new grid-investments have on this RES-integration.

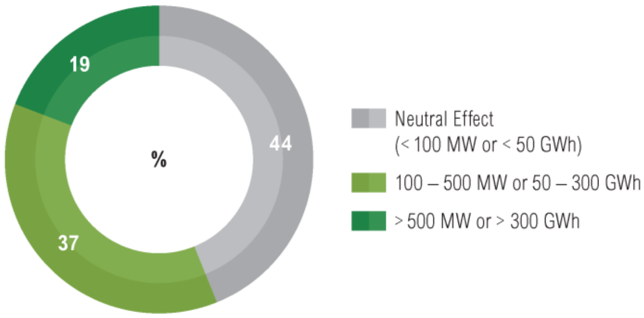

Figure 5-9 RES indicator for Vision 1

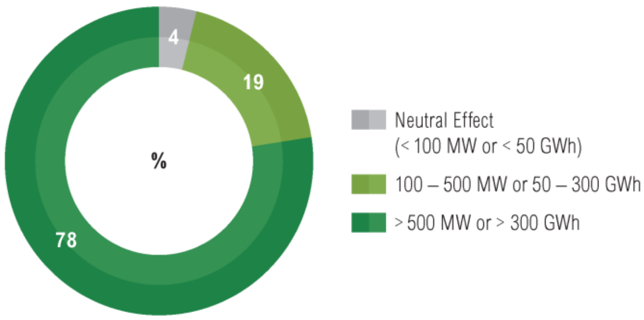

Figure 5-10 RES indicator for Vision 4

As stated before in this report, the RES integration is one of the main drivers for new transmission projects in the RG CSW, namely the accommodation of new hydro, wind and solar energy in the Iberian Peninsula.

Even considering a slow progress of the energy system in the region, in Vision 1 more than a half (56%) of the CSW project portfolio contributes to directly accommodate new RES installed capacity or to facilitate the integrating of new RES power plants. For Vision 4, 96% of the transmission projects included in the CSW region contributes to accommodate or facilitate new RES generation.

The integration of new solar power plants in the South of the countries and the accommodation of new wind farms and hydro power plants in Portugal and Spain are main drivers to these statistics for the CSW region.

5.3.4 Project portfolio contribute to mitigate CO_2 emissions

By relieving congestion, reinforcements may enable low-carbon generation to generate more electricity, thus replacing conventional plants with higher carbon emissions. Considering the annual production of each power plant and a standard emission rate per generation-technology, the annual emissions at regional level have been computed. Generation dispatch and unit commitment used for calculation of socio-economic welfare benefit with and without the project have been used to compute the CO_2 impact, taking into account the standard emission rates.

In Vision 1 around 44% of the projects of CSW region have a positive effect on CO_2 emissions. Those projects generally aim at integrating RES generation. Nevertheless, and considering the nature of Vision 1 some projects in CSW region tend to increase CO_2 emissions due to the fact that RES development is quite low in the region in this scenario, that Carbon Capture and Storage Systems (CCS) are not supposed very common and that coal-fired power plants rank better in the merit order than gas-fired units that have a higher emission rate. Also due to a light decrease of nuclear energy in France, almost all increase in interconnection capacity will result in a coal/gas substitution for Vision 1 and therefore an increase of CO_2 emissions.

Nevertheless, and even for Vision1, the CO_2 emissions, compared to the level of 1990, are reduced by 83% in the CSW region.

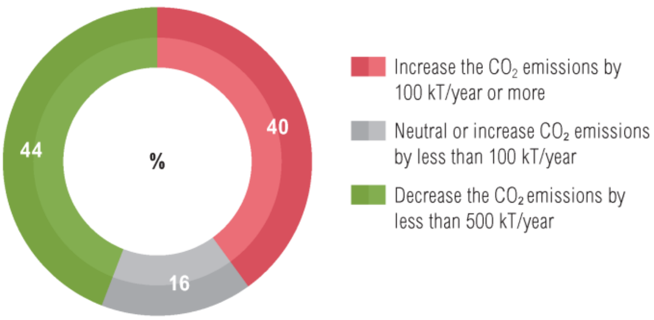

Figure 5-11 Contribution of CSW portfolio for CO_2 emission in Vision 1

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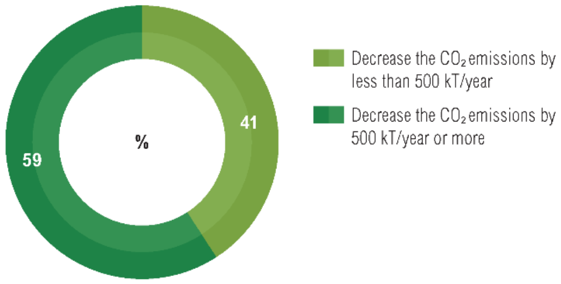

Figure 5-12 Contribution of CSW portfolio for CO_2 emission in Vision 4

Due to its totally different nature, Vision 4 when compared with Vision 1 gives a totally different picture: all projects have a positive impact on CO_2 emissions, among which 59% strongly decrease CO_2 emissions (by more than 500 kt/year each). Vision 4 assumptions result in high penetration of RES generation, a wide use of CCS systems and gas before coal in the merit order due to the considered CO_2 price. In almost all of the cases, grid development in this scenario will result in higher RES integration and/or higher gas generation substituting to coal generation.

For Vision 4, the CO_2 emissions, compared to the level of 1990, are reduced by 93% in the CSW region.

5.3.5 The TYNDP methodology fails to capture benefits of projects regarding Security of Supply

Security of Supply is the ability of a power system to provide an adequate and secure supply of electricity in ordinary conditions, in a specific area. The CBA criterion measures the improvement to security of supply when introducing a transmission project. Similarly to TYNDP 2012, very few projects are reported in the CSW with a mark greater than 0 for this indicator in the TYNDP 2014. Nevertheless, the indicator must be completed in order to get the full picture of the benefit of projects with respect to security of supply: projects of pan-European significance may incidentally be also key to solve local SoS issues.

However, the pan-European modelling is too high level to capture these effects and underestimates the benefits:

- By construction of the scenarios, the four Visions assume generation is sufficient to balance load in all countries, resulting in no energy not supplied in the market studies, and hence none that the projects can prevent. The hedging benefits of the projects in case the assumed generation mix develops more slowly, with tensions on the power supply is here not measured.
- By nature, the TOOT method, which consists of measuring the marginal benefit of a project, also leads to limiting any energy not supplied valuation

Nevertheless, and to ensure that we are giving the full picture of the benefit of projects, whenever the project has an explicit, although possibly local, benefit regarding the security of supply, it is mentioned as a comment in the project assessment sheet.

Then, due to the reasons stated above, only 3 projects out of 27 in the CSW region fulfil the requirement and show a significant increase on the Security of supply in a large enough area. One of these includes the Santa Llogaia-Bescanó 400kV line and the associated Eastern ES-FR interconnection that will secure the supply of the Gerone area, for which already today, the tripping of the only transmission project supplying the region would result in Energy Not Supplied .

Another project is the installation of a new 225 kV phase shifter in Arkale (ES) (Project 184), that will secure the load mainly in the French part of the border (Bayonne-Anglet-Biarritz area on French side, Irún and San Sebastián on the Spanish side).

The last project is Project 151 (Asturian Ring) that allows to secure the consumption in the central area of Asturias, with a very few thermal production. Up to recently, this area has been an exporting area because of a high amount of conventional generation (mainly coal and gas). However, in the long term, if renewable energy sources lay away conventional generation, this area can face security of supply issues.

5.3.6 TYNDP projects have globally a neutral impact on losses

Variation of electrical losses intends to be an indicator of energy efficiency for a power system. For the same consumption and generation dispatch, network development generally decreases losses, thus increasing energy efficiency. Specific projects may also lead to a better load flow pattern when they decrease the distance between production and consumption. Increasing the voltage level and the use of more efficient conductors also reduce losses. However, the main driver for transmission projects is currently the higher need for transit over long distances, leading often to increased losses. The charts below show that transmission losses in the long term are not expected to vary significantly in the coming 15 years with the implementation of the TYNDP project portfolio:

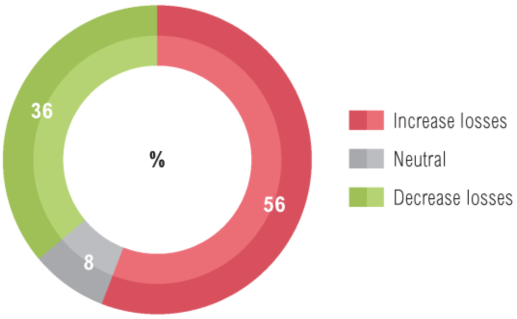

Figure 5-13 Losses variation for Vision 1

For Vision 1, with a penetration of RES of around 40% in the energy mix, 56% of the CSW project contributes to increase the losses in the system while 36% of the projects allow a reduction on the losses. This situation reflects that, even for Vision 1, the RES generation has a strong rule in this region contributing to increase the losses in electrical system. Also the high level of power exchanges among the countries contributes to increase the transit over long distances and as a consequence increase the losses in the system. Nevertheless, and considering the RES and cross-border targets for Vision1, the new transmission projects proposed to 2030 allows remaining the losses in transmission system stable.

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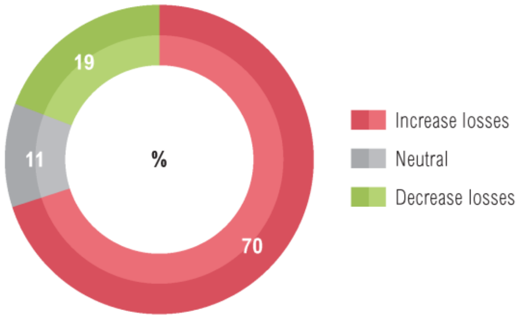

Figure 5-14 Losses variation for Vision 4

In Vision 4, and as consequence of the very high penetration of RES in the energy mix and also the huge amount of power exchanges between the Iberian Peninsula and the rest of the Europe, 70% of all the CSW projects contribute to increase the losses in the system, while only 19% contribute to reduce them.

5.3.7 The Project portfolio is meant to face extreme system situations.

Making provision for resilience while planning transmission systems, contributes to system security during contingencies and extreme scenarios. This improves a project's ability to deal with the uncertainties in relation to the final development and operation of future transmission systems. Factoring resilience into projects will impact positively on future efficiencies and on ensuring security of supply in the European Union.

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

Among the benefit indicators calculated through the CBA methodology, the B6 indicator is called "Technical resilience/system safety". This indicator shows the ability of the system to withstand increasingly extreme system conditions (exceptional contingencies). This indicator measures the different projects ability to comply with (1) failures combined with maintenance (N-1 during maintenance), (2) ability to cope with steady state criteria in case of exceptional contingencies and (3) ability to cope with voltage collapse criteria. The scale is divided from 0 to 6 whereas 0 is the worst value and 6 is the best value.

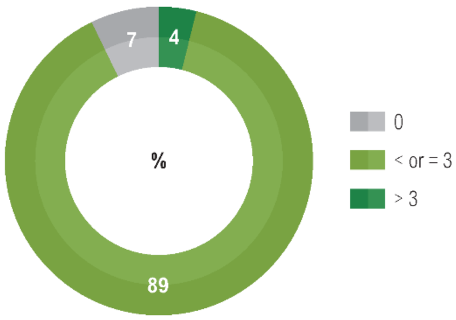

Figure 5-15 Technical resilience/system safety margin indicator

The projects in the CSW RG increase the meshing of the transmission system. However, although they improve the behaviour of the system in case of a failure of a line having in maintenance in another part of the system, CSW RG projects are not built explicitly to solve critical issues of this type that would lead to energy not supply or redispatched generation.

Nevertheless, the results of the CBA application confirms that the strategy defined in this RgIP for the CSW region strength the transmission system to cope with steady state and voltage collapse criteria in case of exceptional contingencies beyond the conventional N-1 criteria. Specifically, the increase of interconnection between the Iberian Peninsula and rest of the Europe allows not only making stronger the market integration of this region with the mainland Europe but also enhancing the operation of the system in extreme situation due the complementarities between the two areas.

5.3.8 The project portfolio is adapted to all possible futures

The CBA indicator B7, called "Robustness and Flexibility" shows the ability of the system to withstand increasingly extreme system conditions. This indicator measures the different projects ability to comply with (1) important sensitivities, (2) ability to comply with commissioning delays and local objection to the construction of the infrastructure (3) ability to share balancing services in a wider geographical area (including between synchronous areas). The scale is divided from 0 to 6 whereas 0 is the worst value and 6 is the best value.

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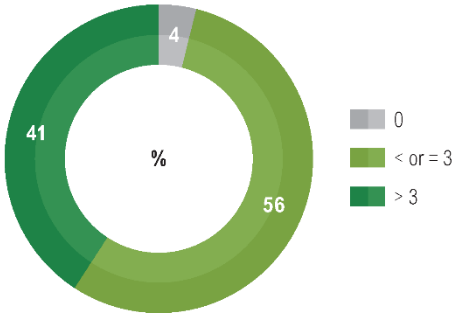

Figure 5-16 Robustness/Flexibility indicator

A set of projects in the CSW RG has a good flexibility to sensitivities and are profitable and useful in every Vision although to different extent (e.g interconnection between Spain and France is useful whatever is the scenario under analysis). Others that are heavily dependent on new power plants and its benefit depend on a concrete unit are considered less flexible (e.g. connection of new generation).

On the other hand, the ability to comply with potential delays does not specially increase the robustness of many CSW region projects because they are in general projects with one main investment or several investments in series, and if the main investment or one of the investments in series is delayed, it makes very difficult to get significant benefits.

5.3.9 A limited impact on protected and urbanized areas

As addressed in the TYNDP 2014 and in this report, the main objective of transmission system planning is to ensure the development of an adequate transmission system which enables a safety system operation, contributes to a sustainable energy supply, facilitates the internal market integration, as well as contributes to improving the energy efficiency of the system.

Nevertheless, new infrastructure needs to be carefully implemented though appropriate public participation at different stages of the project, dealing with the potential negative social and environmental effects of a project wherever possible. Most of the time steps are also taken to minimise impacts through routing decisions or mitigation measures. In some instances, compensatory measures, such as wildlife habitat creation, may be a legal requirement.

In this sense, the CBA indicators “Protected area” and “Urban area”, designed with the input of stakeholders, aim to provide a meaningful yet simple and quantifiable measure for these impacts for the planning phase. Protected area indicator estimates the number of kilometres of a new line that might have to be located in an area that is sensitive for its nature or biodiversity (environmental impact). Urban area indicator estimates the number of kilometres of a new line that might have to be located in an area that crosses urban areas (social impact).

The uncertainty associated to the TYNDP 2014 long term planning exercise, namely the routes of the proposed transmission projects and their social and environmental potential impacts is high. The quantification on these CBA indicators will thus be presented in the form of a range. For the same reason, projects under consideration are not assessed; they are to be scored only in a successive version of the TYNDP when further studies have been done.

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In figures below the results for these indicators are presented for the CSW region. They have been calculated based on TSO's inputs regarding the right of way of the projects and on data from the European Environment Agency (Common Database for Designated Areas and Corine Land Cover Urban Morphological Zones[26]).

5.3.10 Protected area indicator

From Figure 5-17 it is possible to conclude that most of the projects in the CSW region cross a limited number of kilometres on protected areas. In fact 94% of the projects have a negligible impact in protected areas or cross less than 15 km in a protected area, and only 6% cross more than 50 km.

In line with the results presented in the TYNDP 2014 for the all the pan-European projects, the protected area indicator for the CSW region shows that most of the projects cross less than 15 km of a protected area, which reflects the care that TSOs have to minimize the environmental impacts of their activity. Nevertheless, as the RES generation is usually located far away from the demand in this region, the integration of the new power plants leads to a longer transmission lines with higher probability of crossing a protected area. In this sense, round 6% of the new transmission lines kilometres in the CSW region are indicated as potential crossing protected areas.

Whenever possible, the implementation of the necessary new transmission lines are constructed by uprating existent transmission corridors in order to minimize the environmental impacts. This information is presented specifically for each project in the chapter 'project description'.

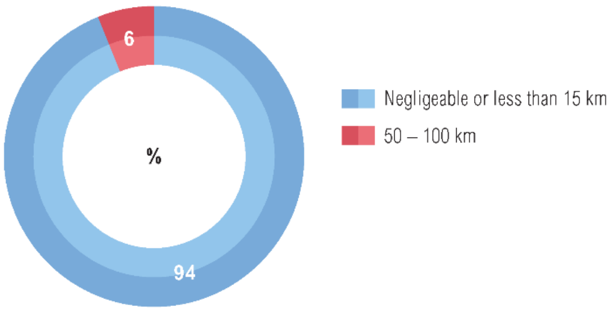

Figure 5-17 Breakdown of projects depending on their length across sensitive (protected) areas

[26] http://www.eea.europa.eu/data-and-maps/data/urban-morphological-zones-2006
http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-8

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5.3.11 Urban area indicator

From Figure 5-18 we can conclude that 94% of the projects have a negligible impact in urban areas or cross less than 15 km in urban areas and that only 6% cross more than 15 km in these zones.

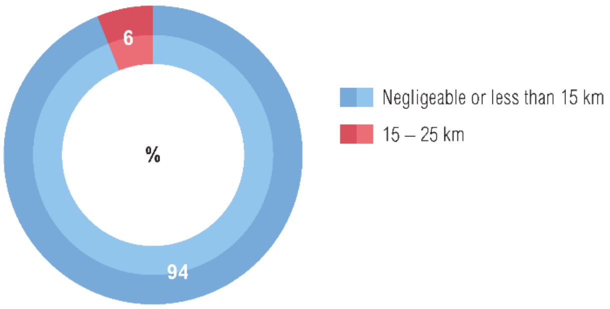

Figure 5-18 Breakdown of projects depending on their length across sensitive (urbanized) areas

5.4 Project expenditures

This chapter describe the project expenditures associated to the CSW project portfolio. In fact, these projects represent a total cost of € 13.4 billion distributed per country according the Table 3 in the chapter 5.2.2.chapter

Regarding the CSW project portfolio, most of the projects (59%) cost less than 300 M€. Usually, these are the internal projects mainly related with the connection of new RES generation. Nevertheless, for some CSW projects the environmental constraints, the difficulties in public acceptance or the use of new technologies (e.g. HVDC) lead to an important raise on the costs.

Around 15% of the projects in the region have a cost higher than €1 billion. They are mainly HVDC interconnections such as the future Western Interconnection between France and Spain or many of the projects between France and its other neighbours.

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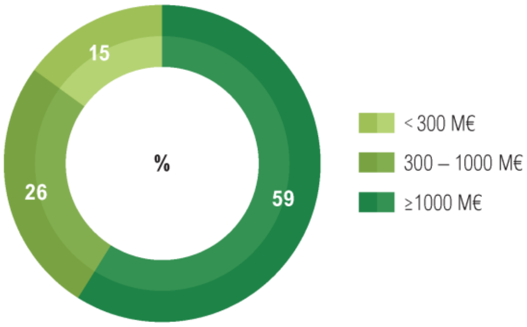

Figure 5-19 Breakdown of project portfolio per costs

5.4.1 Challenges of financing transmission grid development

Today, the Iberian Peninsula is provided with an electrical transmission system which not only has promoted and allowed a high penetration of RES generation, but also has gradually created the physical conditions to implement the Iberian Electricity Market (last significant planned reinforcements are now in the permitting phase in order to be commissioned by 2016). These achievements are the consequence of the Portuguese and Spanish political commitment in pursuing the EU energy policy goals, namely the development of the IEM and the implementation of the climate and energy targets for 2020.

Nevertheless, the Iberian Peninsula is still considered an electrical island due to the transmission bottleneck existent in the interconnection between Iberian Peninsula and the rest of Europe. The current TYNDP 2014 shows that, even with the future projects expected in this boundary (which allow to reach approximately 6 GW of cross-border transfer capacity between Spain and France - more than double of the existing capacity), additional investments are needed in order to enable the full integration of the Iberian Peninsula in the IEM and to take advantage of the renewable generation potential that exists in this area. Considering the RES potential in the region, also some important internal investments are necessary to accommodate this generation.

Concerning the financeability of projects and besides what is said in section 5.4 of TYNDP 2014, the incentives and regulatory frameworks should also take into account the economic/financial reality of TSOs, not only to preserve its financial capabilities, but also to ensure a regular and efficient access to funding. Also gaps of diverse nature between TSOs call for specific incentive measures of different magnitude in order to ensure an adequate risk-reward balance, so that each TSO is able to carry on its investment plans. This is crucial to attract new financing providers and investors into the electricity sector.

In the CSW region, TSO´s financial ratios could deteriorate where remuneration is delayed until the end of the construction or even further. This can prove to be meaningful given the large size and recurrence of the TSOs' investment effort. Transmission investments should be remunerated as soon as they are commissioned and also, where necessary, during the construction phase, thus avoiding potential deteriorations in TSO´s financial ratios during the construction period.

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6 2030 target capacities and transmission adequacy

This chapter confronts investment needs and projects assessments to derive target capacities for every cross border boundary in 2030. Then, comparing the target capacity and the project portfolio for every boundary, a transmission adequacy index can be supplied.

6.1 Target capacities by 2030

Target capacities are computed, fundamentally based on the following conditions:

-
- They take into account (or consider) the "EU 10% objective"[27] which was defined in 2002 and confirmed in the EU Parliament conclusions of 20 and 21 March 2014
- According to current studies, additional capacity above the target capacity would not be profitable, i.e. the economic value derived from additional capacity quantum cannot outweigh the corresponding cost. Profitability depends on the final characteristics of the specific projects which contribute to increase the capacity.
-

Synthesizing the investment needs and projects assessments, target capacities can be sketched for every boundary in every Vision. The practical evaluation however is complex; for instance:

- In a meshed grid, parallel boundaries are interdependent and for a very similar optimum, different set of values can be envisaged although only one is displayed.
- The value of additional capacity derives directly by nature on the scenario. A totally different perspective for or the generation mix in one country compared to presented Visions may give a very result for target capacities beyond this country's borders.
- The computation is also undermined by the assumptions that must be made for the cost of an additional project on the boundary wherever no feasibility studies are available. Similar costs to former or similar projects could then be considered.

Overall, target capacities are not simultaneously achievable, i.e. building such transmission capacity would not imply they could be saturated all at the same time.

The outcome of such computation must hence be considered carefully. Target capacities are displayed as ranges as accurate values can only be misleading. Globally, the maps displayed in this section should be considered rather as illustrative.

[27] EUCO 7/1/14, Brussels European Council, 20 and 21 March 2014. This criterion was firstly proposed by the European Council in the Barcelona European Council, 15 and 16 March 2002, after the Communication COM(2001) 775 final from the Commission to the European Parliament and the Council

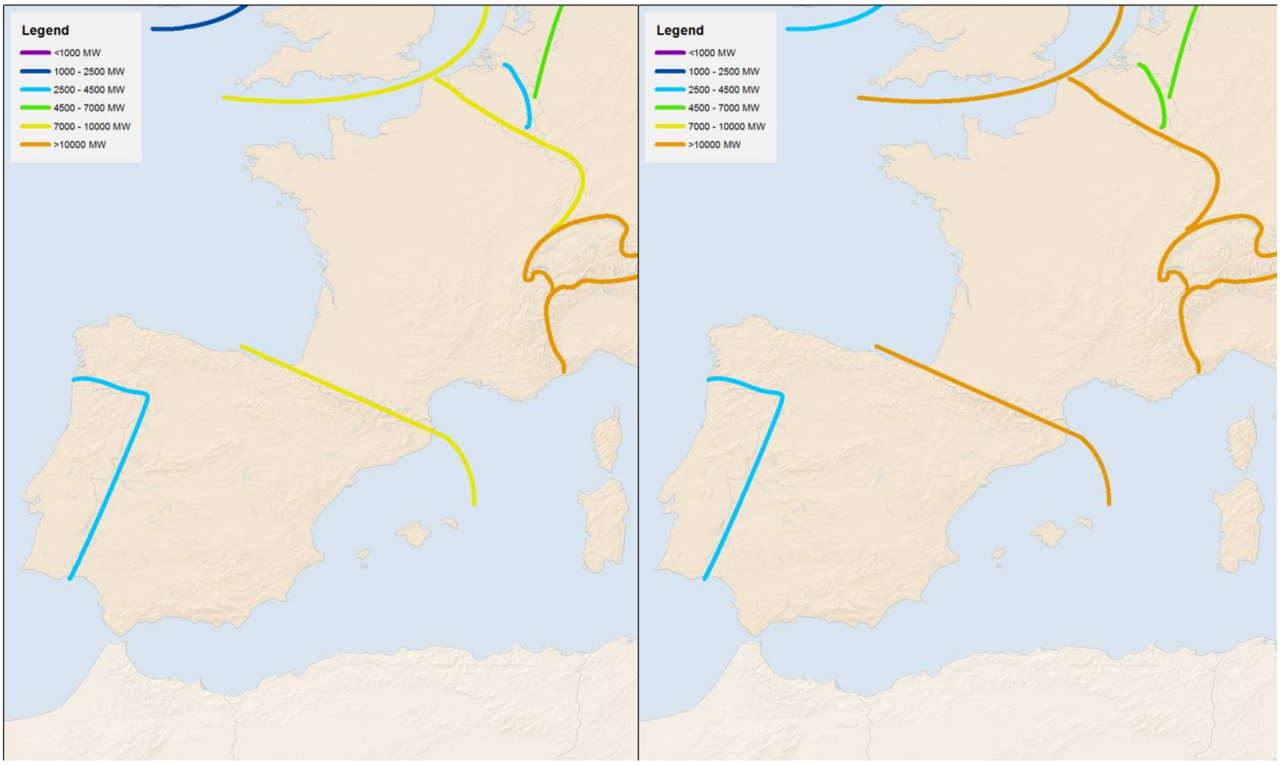

Figure 6-1 Target capacities by 2030 in Vision 1 (left) and in Vision 4 (right)

As it can be seen from the figures above, the project portfolio included in the TYNDP 2014 for the interconnection between Portugal and Spain (new northern Interconnection) seems to fit with the target capacity, once it allows reaching the 3.2 GW between these two countries. Nevertheless, as it is explained in next chapter, further investigations could be needed for Vision 4.

For the interconnection between the Iberian Peninsula and the rest of the Europe, and considering the conclusions from the EU Council of 20 and 21 March 2014, the target capacity should be in the range between 7 to 10 GW for Vision 1 and greater than 10 GW for Vision 4.

6.2 Transmission adequacy by 2030

Transmission Adequacy shows how adequate the interconnected transmission system is in the future in the analysed scenarios, considering that the presented projects are already commissioned. In fact, it answers the question: “is the problem fully solved after the projects are built?”

The assessment of adequacy merely compares the capacity developed by the present infrastructure and the additional projects of pan-European significance with the target capacities. The result for the CSW region is synthetically displayed on the following map: the boundaries where the project portfolio is sufficient to cover the target capacity in all Visions are in green; in no Vision at all in red; otherwise, in orange.

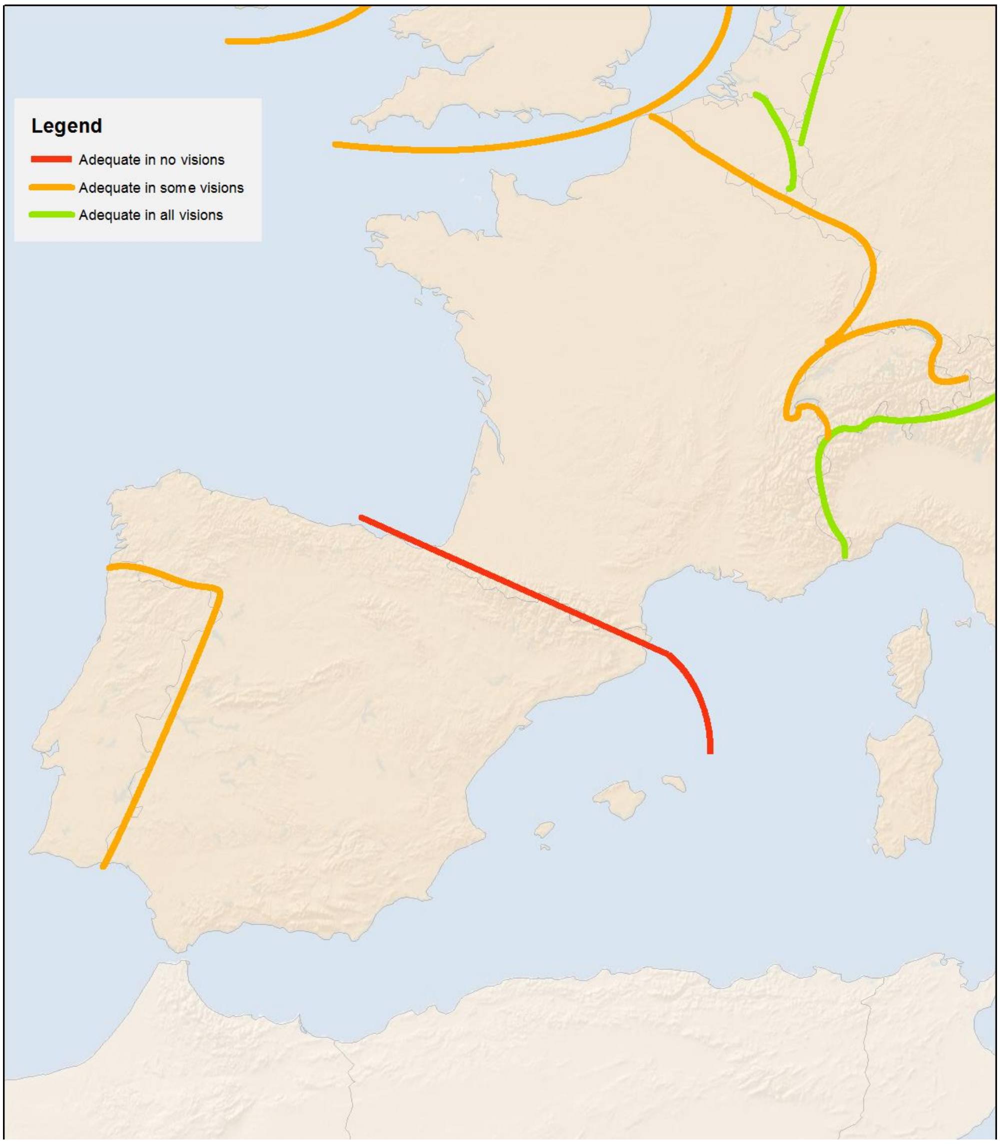

Figure 6-2 Transmission adequacy by 2030

In the RG CSW the interconnection capacity between Spain and France is currently very low (slightly above 1 GW). It will drastically increase with Project 5 (Eastern HVDC reinforcement Santa Llogaia-Baixas), already under construction, that will be commissioned in 2015 and with project 16 (Western HVDC reinforcement along the Biscay Gulf), subject to advanced feasibility studies, and Project 184 (Phase Shifter Transformer in Arkale substation) it will reach 5 GW, which means almost three times the current value. Project 182 (3rd party BRITIB project) could add additional GW in this boundary.

Considering the target capacities presented in section 6.1 above, this means that the current project portfolio does not reach the target capacity for vision 1 and clearly needs to be extended for Visions 3 and 4. Especially for Vision 4, with all projects included in this Plan it is still expected that the interconnection will have congestions more than 50% of the time, with project portfolio presented in this report.

The map clearly highlights the boundary between the Iberian Peninsula and the rest of Europe as major bottleneck in Europe, even with all projects in the plan. However, the presently foreseen projects are quite complex from the technical point of view, and according to the experience they should be implemented step by step, so in spite of the necessity it will be a challenge to implement additional capacities by 2030. Then, planning studies will continue in the framework of the Regional Group Continental South West in order to come up with the adequate network solutions for this boundary.

On the other hand, the interconnection between Portugal and Spain is adequate to the market needs for Visions 1, 2 and 3. For Vision 4, further analyses are needed as the market studies show the level of congestions between the both countries could reach almost 25%. Therefore the transmission adequacy for the Portuguese-Spanish border is displayed in orange.

In fact, especially investment needs investigation in the Vision 4 requires additional input and feedback from stakeholders (more precise location of generation especially) so that a more comprehensive picture of the grid infrastructure can be supplied. Such interaction and continuous adaptation is normal, considering uncertainties regarding the realisation of the challenging transformation of the generation mix, and in addition potential interconnections of Europe with Africa from this region.

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7 Environmental assessment

This chapter supplies a synthetic overview of the environmental assessment of the grid development depicted in the Continental South West region. Detailed environmental assessments are run for every pan-European project by their promoters and more information is supplied in the National Development Plans.

Compared to the TYNDP 2012, the methodology for assessing the projects has been improved through a fruitful dialog with ENTSOE TYNDP's stakeholders, especially in the framework of the Long Term Network Development Stakeholders Group over the last two years. The outcome is a specific appraisal of the benefits of the projects with respect to potential spillage of RES generation and the replacement of the former social and environmental indicator by two more specific indicators with respect to crossing of urbanized areas and protected areas.

This enhanced methodology enables to demonstrate strong conclusions: the projects of pan-European significance are key to make an energy transition in Europe – i.e. a significant increase of power generated from RES, CO_2 emissions mitigation and a major shift in the generation pattern – possible, with optimised resorting to natural resources.

7.1 Grid Development is key for RES development

The shift of the generation mix, with a reduction of conventional power generation capacity and with a RES development, is the first driver for grid development in the CSW region. Depending on the Visions, RES is expected to develop in large amounts by 2030, compared to the today's situation. In fact, the installed RES capacity ranges from 150 GW in Vision 1 to 320 GW in Vision 4, which could represent about 15% and 22% of total European RES production in these visions. With these figures, the share of the load covered by RES in the region increases from 35 % in Vision 1 to 57 % in Vision 4

The reason for such high volumes of installed capacity in the green Visions (e.g Vision 4) is that wind and photovoltaic imply a variable and not steerable output and a higher installed capacity is required compared to conventional generation to supply the same amount of electricity all over the year, in addition to maintain some back-up thermal capacity for those moments with very low RES production.

In addition, projects improving market integration, developing especially new interconnection capacity, actually help to integrate RES: basically they enable any RES surplus in one area to find outlets in a neighbouring one, and make market more resilient and less subject to price tensions.

As a result, on average and depending on the Visions, around 80% of the projects in the CSW region help to integrate RES, especially in Portugal and Spain, either by directly connecting RES or either by facilitating RES transmission on the cross-border.

In addition, regional simulations demonstrate that the CSW Project portfolio gives an important support on avoiding RES spillage, depending on the Vision considered. In fact, the more is the RES installed capacity, the more is RES spillage avoided by the projects in the region. In practical terms the RES spillage avoided in Vision 4 is around 13 times that the RES spillage avoided in Vision 1.

Then the CSW project portfolio gives a strong contribution to accommodate the significant increase of RES generation in Europe.

7.2 Project portfolio makes ambitious CO_2 emissions mitigation targets possible

Mitigating CO_2 emissions in the power sector requires above all measures on the generating fleet. The following picture shows the CO_2 emissions decrease for the CSW region power sector, as a percentage of the 1990 level, in the different ENTSO-E Visions.

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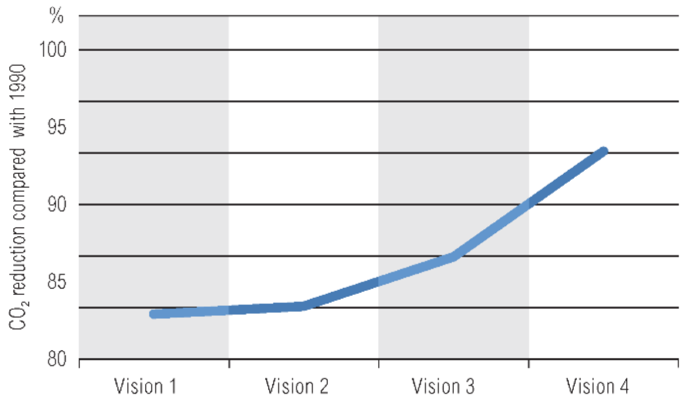

Figure 7-1 CO_2 emissions decrease for the CSW region power sector, as a percentage of the 1990 level, in all Visions

The average CO_2 content of electricity in the whole Europe is about 220 tons/GWh in Vision 1 and 70 tons/GWh in Vision 4, whereas in the CSW region is about 60 tons/GWh in Vision 1 and 20 tons/GWh in Vision 4, compared to about 190 tons/GWh in 2010[28]. This situation makes from the CSW region a region with an important rule for the CO_2 mitigation in Europe, mainly thanks to the high share of nuclear power energy and RES in the generation mix. In addition, in the 2030 horizon the development of carbon-free technology (RES, and carbon capture and storage mainly...) instead of fossil fuel technology without carbon capture and storage is the main key to reducing CO_2 emissions in the power industry.

In particular, the interconnection projects in the region increase the exchange capacity between Portugal and Spain and between Spain and the rest of Europe and have an important impact not only in the production profile in the region but also in the whole Europe. In Vision 1, the consequence of the interconnection projects in the CSW region is an increase of 5 Mtons/y of CO_2 in the region, and in Vision 4, a reduction of CO_2 emission of 13 Mtons/y.

The rationale behind these numbers is that in Vision 1 CCGTs in the region are replaced by coal inside and outside the region, which although have a lower cost have a higher emission rate. On the other hand, in Vision 4, CCGTs and coal in France and Central Europe are replaced by nuclear, renewable energy sources and CCGTs in the region which have a lower emission rate.

7.3 A neutral effect on transmission losses

Transmission losses are not expected to vary significantly in the coming 15 years with the implementation of the TYNDP project portfolio, as multiple effects neutralise each other:

- Building new transmission facilities reduce the overall resistance of the network, and this will tend reduce the overall amount of transmission losses. This positive effect would be measurable if the generation fleet (and load profile) had remained the same.
- The new generation assets tend to be built farther to load centres than they are presently, and the transmission distance hence increase, and therefore the losses.
- Increasing the interconnection capacity aims at improved competition where more desirable generators can prevail over less preferred ones. It results in cheaper electricity, a more reliable and optimised supply but also, by essence it tends to enable longer power exchanges and induce therefore higher losses.

[28] 1990 and 2010 CO_2 emissions were obtained from the IEA (International Energy Agency)

Incidentally, one can also remark that resorting to a large share of HVDCs does not result in significant savings in transmission losses. In essence, HVDC lines show lower transmission losses compared to HVAC lines to transport the same amount of power at the same voltage. However, HVDC projects are hindered by the losses at their converter stations. Additionally, these projects aim precisely at connecting offshore wind farms or increasing interconnection capacities, and, as explained above, contribute indirectly to increase the amount of losses in Europe overall

7.4 New transmission capacities with optimised routes

TSOs optimize the routes of the proposed projects so as to avoid interferences with urbanized or protected areas as much as possible. In line with the results presented in the TYNDP 2014 for the all the pan-European projects, the protected area indicator for the CSW region shows that most of the projects have a negligible impact or cross less than 15 km of a protected area, which reflects the care that TSOs have to minimize the environmental impacts of their activity. Nevertheless, as the RES generation is usually located far away from the demand in this region, the integration of these new power plants leads to a longer transmission lines with higher probability of crossing protected area. In this sense round 6% of the new transmission lines kilometres in the CSW region are indicated as potential crossing protected areas.

Also the urban area indicator results for the CSW region are aligned with the results for the all the projects included in the TYNDP 2014, and generally show that more than a half of the projects in RG CSW have a negligible impact or cross less than 15 km of urban area. This gives a clear indication that TSOs have strong concern on minimizing the social impacts of their activity. Also in this field and whenever possible, the reinforcement of transmission system in urban areas is done by constructing underground cables which help to minimize this social impacts.

Whenever possible, the implementation of the necessary new transmission lines is constructed by uprating existent transmission corridors in order to minimize the environmental impacts. Besides, among the new assets, around 30% are subsea, with by nature a limited length crossing protected or urbanized areas. This information is presented specifically for each project in the chapter ‘project description’.

7.5 Specific Mitigation measures

For the grid development, the integration on the environment of the new transmission projects is an important subject for the TSOs of the region. Not only National Master Plans are submitted to a Strategic Environmental Assessment (SEA), but also, every project requires its specific Environmental Impact Assessment (EIA). In these processes, projects for new power transmission infrastructure are carefully designed to avoid, mitigate or compensate any undesirable impacts on the environment and people in general. Adequate track design based on environmental criteria improves the social acceptance of the new projects.

TSOs work in this respect in close cooperation with authorities and stakeholders in general (universities, NGOs, landowners, councils, etc.) about the proposed options to find the best solutions and to define the measures to be taken in order to avoid, reduce or eventually compensate the negative effects of the development plan. In order to integrate them in the best way, a big effort is made from the beginning of the conception to minimize the impact.

For instance, upgrading solutions are always studied in order to optimise the existing network, and when it is possible, the global investment allow the reduction of the total length of the overhead lines. As an example, in France, the project Haute Durance will reduce by 100 km the total length of overhead lines in the concerning area. However, every project requires to be analyzed on a case-by-case basis.

8 Assessment of resilience

High voltage investments are expensive infrastructure projects, with a long lifetime, setting precedence of standards for coming projects, and require years to be carried out. To this aim, TSOs evaluate the resilience of their investment projects in order to avoid stranded costs, and to meet grid user's expectations over time with appropriate solutions.

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

8.1 A robust plan to fit all reasonably likely situations

In order to investigate the future network needs of the CSW Region for the 2030 horizon, the four Visions devised by ENTSO-E have been used as the basis for the market studies In order to ensure consistency across ENTSO-E, a pan-European market study has been performed for every Vision, setting the pan-European patterns (but with a limited modelling of the regional specific features). On top of it, market studies have been performed at the regional level, taking advantage of the existing competence and tools, and including some regional specificity (e.g. In the CSW region the wind and solar profiles were updated). Two simulation programs have been used in the CSW region for the regional market analysis: ANTARES, a tool developed by RTE, and UPLAN, a commercial tool used by REE.

For each Vision 8760 hours were simulated, which means ca. 35000 situations. In addition, ANTARES allow probabilistic simulations, with 48 monte-carlo years considering different climate conditions (triplet wind/solar/load) being randomly combined with forced outages, which multiplies the analyzed situations. This approach allows to take into account certain regional features such as the sensitivity to temperature in the region, namely in France. Cross analysis showed that results with both tools were quite similar and thus confirmed the robustness of the main conclusions.

For each interconnection project, market simulations with and without the project were performed, resulting in millions of hourly market situations tested for this TYNDP 2014. Also, depending on the analysed Vision, additional simulations were made considering additional capacities between countries.

As market studies provide a big amount of cases (8760 for one year) and only a small number of cases could be considered for detailed AC network studies, a selection had to be done to find out the points in time that should be assessed for further detail and for checking the performance of the proposed projects. The selection was performed based on TSO expertise, considering both situations, stressful network conditions and representative/probable situations. Then the representative and the extreme planning cases per Vision have been built in common grid models and analyzed for a more detailed network analysis. Network studies involves common network simulations with and without every project for each of the four Visions assessed (around 350 different network cases in CSW region).

For the these network simulation three different software tools have been used in the CSW region to construct the national network cases which support the common grid model.. Two tools allow AC load flow analysis (CONVERGENCE, a tool developed by RTE, and PSSE, a commercial tool used by REN and REE). Moreover, UPLAN, a commercial tool used by REE allows an integrated market and network analysis considering a DC load flow for the 8760 hours of the year. Studies performed with UPLAN, result for each project in 17520 situations analysed (hourly annual simulation with and without a project). This DC simulations are very useful to robust the conclusions of the AC analysis (in terms of transmission capacity) which are made considering a limited number of cases. Then, considering the technical analysis performed in the CSW region, it is possible to conclude that the project portfolio presented in this report strength the resilience of the transmission system, namely to cope with steady state and voltage collapse criteria in case of exceptional contingencies beyond the conventional N-1 criteria. In addition and very specifically, the simulations demonstrated that the increase of interconnection between the Iberian Peninsula and rest of the Europe, despite of allowing a stronger market integration, it also robust the operation of the overall system in extreme situations due the complementarities between the Iberian Peninsula and the rest of the Europe.

9 Monitoring of the Regional Investment Plan 2012

9.1 Portfolio

The current release of the TYNDP not only monitors the evolution of the projects included in the TYNDP 2012, but also identifies the main transmission needs for 2030. In the TYNDP 2014, and for the RG CSW, around 160 investments (in total) are considered necessary to comply with the four Visions analysed. In this region 9 investments have been cancelled and several are depicted now only in the Regional Investment Plan, and not in TYNDP, in order to fulfil the requirements and clustering rules of the TYNDP projects.

Aiming to comply with the planning targets analysed in this TYNDP edition, 24 investments were added in the RG CSW. In addition, 49 are already commissioned or will be commissioned until the end of 2014.

This chapter presents an overview of the evolution of the investments since the TYNDP 2012, including statistics. The current status of the projects in the TYNDP is given in the table of projects (Table and map of pan-European Projects).

9.2 Monitoring statistics

From the TYNDP published in 2012 to the present TYNDP 2014, some changes have been introduced to the list of regional projects, taking into consideration the meantime developments, either on project implementation or on network needs.

Next figure summarizes the current project status on the CSW region and ENTSO-E in terms of the TYNDP 2014 compared to the TYNDP 2012 release.

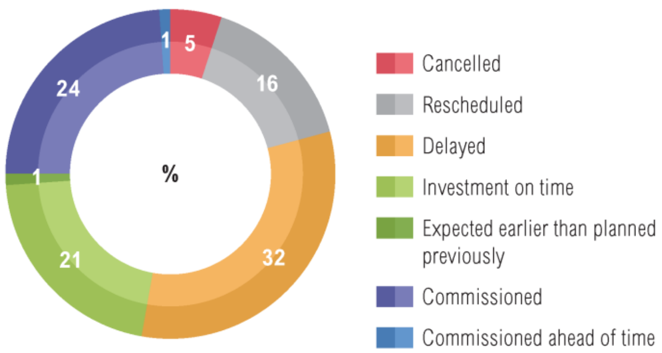

Figure 9-1 Evolution of the investments included in the pan-EU significance projects of the CSW region

As shown in this diagram, an important amount of the investments in RG CSW are delayed, namely 32% for the investments included in the pan-EU significance projects specifically. In average the investments in this region are delayed from (2 to 3 years), mainly due to permitting/constructing issues or due to downward revisions on some National Development Plans.

Nevertheless, the statistics also show that around 22% of the investments are on track with the planned commissioning date. With respect to the investments that were planned for, 25% of them are already commissioned and even 1% of the total investments were commissioned ahead of the time.

9.2.1 Delayed investments

As it was already highlighted, the main reasons for commissioning delays in CSW region are related with permitting, licensing or constructing issues, seeking for public consent, and with downward of some National Development Plants (e.g Spain). Difficulties in the authorization and permitting processes, generally due to consultation results or environmental issues, forces sometimes to project revision in order to introduce some changes in its definition, or even, in more extreme cases, to look for an alternative solution (new project/investment). For instance, the permitting process in the interconnection between Portugal and Spain (V.Fria B (PT) – Fontefria (ES)) led to a change of route and a re-definition of the original project.

Also the current adverse economic situation lead to some delays, namely, as referred, by the downward revision on some National Development Plans. The current situation of permitting in Spain since the last TYNDP is worth a specific comment, due to the national Royal Decree Law RDL 13/2012. This law is having an important impact in the permitting of most of the Spanish transmission projects, as if the authorization processes were not enough advanced by the time of the publication of this law, they were blocked until the next National Development Plan is published. The ongoing Master Plan is expected to be approved and published by the Spanish Government in late 2014. This situation implies that many permits cannot be obtained in these 2 years period, delaying the commissioning dates of many projects at least 2 to 3 years.

9.2.2 Rescheduled investments

The "rescheduled" category is included in this monitoring update to highlight the uncertainty of long term investments. In particular, investments which meet some of the criteria below are displayed in this monitoring as rescheduled:

- To be commissioned after 2020 in the current report
- Still under consideration or planning
- Postponed

The objective is to give a more comprehensive picture of the investments evolution in relation to their maturity. Indeed, the status "rescheduled" corresponds to long term or conceptual investments, at the early stage of the planning process, on which further studies have allowed the provision of more accurate date of commissioning, based for instance on a better understanding of the technical challenges or of the socio-economic environment. In addition, investments which were postponed due to delays on their external driver (e.g. connection of new RES postponed) are also reported into this category. Besides, some delays are not only because of a delay of the need that triggers the project, but also because of the need to secure financing or to perform additional studies for preparing an optical technical design coherent with the new needs and which takes longer than expected. Most of these investments see a delay on their commissioning date longer than 3 years and are mostly related to important changes in the new generation connection expectations.

Regarding the CSW region, the statistics also show that 16% of the investments are rescheduled as a consequence of a relaxation of the need that triggers it. The main justification for this is the adverse current economic situation that Europe is facing and specially in the Iberian Peninsula, which affects both the previous forecasted demand trends and the plans from stakeholders for new generation, also influenced by certain regulatory changes.

In fact, both in Portugal and Spain, some important transmission projects which should accommodate new RES generation are now rescheduled because the project promoters of these power plants have temporary frozen their investment decisions.

9.2.3 Commissioned investments

As mentioned, in last two years 24% of the planned investments in CSW region have been commissioned and even 1% of the total investments were commissioned ahead of the time.

Regarding the interconnection projects, the southern interconnection between Spain and Portugal (Guillena - Puebla de Guzmán (ES) – Tavira - Portimão (PT)) was commissioned in 2014, allowing an increase of exchange capacity, mainly in the direction from Portugal to Spain. Also, the uprate of the overhead line Aldeadávila-Villarino 400 kV commissioned in 2013 allows avoiding constraints in the area of this border.

In Spain, some investments, considered as partial sections of former TYNDP 2012 projects were also commissioned in the last years, such as the Salas-Grado 400 kV and the Penagos/Aguayo-Abanto 400 kV in the North Axis project, the Trives-Tordesilla 400 kV & 220 kV axis in the SUMA project, the Manzanares-Brazatortas 400 kV axis in the Transmanchega project, the S. Servan-Brovales 400 kV line South-North axis in Southwestern Spain and the uprate of the Hueneja-Tabernas-Litoral 400 kV axis in the Baza project. Other regional investments, such as the Santa Engracia-El Sequero 220 kV line was also commissioned in 2012. Last, some substations belonging to TYNDP 2012 projects, which main driver is generation connection, and where development of RES is expected in the next decade, has been also commissioned recently (f.i. Muniesa 400 kV and Els Aubals 220 kV) .

Also in Portugal several investments considered in TYNDP 20212 were already commissioned. In the Minho / Trás-os-Montes axis, the 220 kV link Macedo de Cavaleiros-Valpaços-Vila Pouca de Aguiar was already commissioned after the entering into service, in 2013, of the section Valpaços-Vila pouca de Aguiar entering into service, in 2013, of the section Valpaços-Vila pouca de Aguiar (the section Macedo de Cavaleiros-Valpaços was already commissioned in 2011); At the Douro region, the 400 kV line Armamar Recarei was commissioned, in 2014, after some delays in the permitting process, allowing the conclusion of the new 400 kV Douro Interconnection project; In the West-Littoral axis, one section of the future 400 kV line Falagueira-Fundão was commissioned between Falagueira and Castelo Branco, in 2013, and is, temporarily, being operated at a lower voltage (150 kV), till the construction of the remaining section between Castelo Branco and Fundão; In the network near Lisbon area, the expansion of Fernão Ferro substation to in¬clude the 400 kV was concluded in 2013 and the new 400 kV line "Marateca"-Fanhões was commissioned in 2012. In this area, the new 400 kV Pegões substation was delayed; In the South, reinforcing the interconnection between Portugal and Spain, the new 400 kV line Tavira (PT) – Puebla de Guzman (ES) has entered into service, in 2014 .

In France, some investments have been commissioned in the last years. For instance, the upgrade of the 400 kV lines between Baixas and La Gaudière and on the axis between Rueyres and La Gaudière have been commissioned on time, according to the TYNDP 2012. Also the new 400 kV line Cotentin Maine between Taute and Oudon have been commissioned in 2013.

9.2.4 Cancelled investments

Some projects were cancelled from the last TYNDP 2012 to the present release, mainly in Spain. Some of them are related to a decrease of the demand increase expectations, such as the Aznalcollar 400 kV substation in the Sevilla Ring project, the Carmonita 400 kV substation in the South-North axis in Southwestern Spain or the Catadau-Jijona-Benejama 400 kV axis to the supply of the Costablanca and Levante area. Also related to this, the Godelleta-Platea 400 kV axis have been cancelled as other remaining projects such as the Castellón-Valencia project in the present report is considered enough to cope with future constraints. Others are related to changes in the certainty of location of future RES which implies that some reinforcements are not required, such as the Mudarra-Tordesilllas 400 kV or the P.Sta.Maria-Facinas 220 kV.

In Portugal only the project of the new Arganil/Gois substation was cancelled. This project was related with connection of new RES, which now is not expected to be built in this zone.

In France, due to evolution on the hypothesis for the location of generation and to a decrease of the demand growth, a long term project from TYNDP 2012 has been cancelled in the north of Paris. More efficient reinforcements have been proposed on a regional basis.

These cancelled investments in the CSW region show the importance of a high interaction with stakeholders in order to increase the certainty and confidence level of some inputs, such as the location of future RES, and also the importance of having a process which include periodic updates.

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10 Conclusion

This Regional Investment Plan aims to describe the investment needs and associated planned projects for 2030 in the Continental South West (CSW) region, which covers Portugal, Spain and France, located in a peripheral area of Europe. It assesses cross-border and internal projects of European significance that support the European targets to be met, with particular regard to the development of the Internal Electricity Market (IEM) and the integration of Renewable Energy Sources (RES). The security of supply (SoS) is also addressed, namely at the local level, once the construction of the scenarios assumes that the foreseen generation mix is sufficient to balance load in all countries for the four Visions. Moreover, this RgIP provides information for monitoring the progress of TYNDP projects that were included in the 2012 release.

10.1 The TYNDP 2014 confirms the conclusions of the TYNDP 2012

Looking further forwards to 2030, the TYNDP 2014 confirms the conclusions of the TYNDP 2012. In fact, and of course ranging with the Visions as the electricity system is more aligned with the Energy Roadmap 2050, it is more probable that the generation fleet experiences a major shift by 2030, with the replacement of existing capacities by new ones, probably located differently and further to load centres and involving high RES development. This renewal of the generation infrastructure in the region and neighbouring regions is the major challenge for grid planning and operation.

Around 80% of the proposed regional investments address RES integration issues, either because direct connection of RES is at stake or because the network section or corridor is a key element between RES and large demand areas in order to avoid spillage of RES.

TYNDP 2014 studies also confirmed that there is insufficient cross-border capacity between the Iberian Peninsula (in particular Spain) and the rest of the European Continent for all Visions.

Regarding the interconnection between Portugal and Spain, the reinforcements included in this TYNDP release, which increase this cross-border capacity up to 3200 MW, seems to be adequate for Visions 1, 2 and 3. For Vision 4, studies have shown that further reinforcements should be analysed in the future.

The project portfolio in this RgIP is a pre-requisite to ensure the energy transition and to achieve an adequate level of interconnection between the peripheral area of Iberia and the rest of Europe. It amounts to about €13.4 billion, of which €9 billion is for subsea cables, being the main part to connect the CSW region, mainly France, with the rest of Europe. This effort is significant for the financing of TSOs project portfolio, but it is critical to accommodate the European goals for the decarbonisation of electricity. In this sense, it is crucial that the regulation ensures adequate rates of return on the investments in order to make it possible to put in place the required project portfolio. The simplification of the permitting procedures is also crucial for the planned projects to be implemented in time.

10.2 ENTSO-E supports the EIP implementation

All pan-European projects in the TYNDP 2014, including the ones published in this RgIP, have been assessed according to a standard methodology: the CBA. The CBA has been prepared, shared and discussed with stakeholders since 2012. It is implemented in the TYNDP 2014 Package for the four 2030 Visions. This choice has been made based on stakeholder feedback, preferring a large scope of contrasting scenarios instead of a more limited number and an intermediate horizon of 2020. An assessment is also now available for all transmission and storage Projects of Common Interest (PCIs). Nevertheless, and although several hydro power plants with pumping are expected in the region by the 2030 horizon, no storage projects were submitted for inclusion in the TYNDP 2014 in the CSW region, and therefore no project assessment for storage is presented in this report.

For future TYNDPs and correspondent assessments, ENTSO-E plans to evolve the CBA in cooperation with all interested stakeholders as far as needed to better match the decision makers' needs. In particular, it is already foreseen that the current methodology can be improved with respect to ancillary services and other generation investments. Storage projects in particular bring greater capacity and flexibility to the power system and in future TYNDP releases this will be better reflected in their assessment.

10.3 The European Internal Market and the energy transition requires the grid and the grid requires everyone's support

The major challenges in the CSW region are: (1) the planned grid development will be insufficient to achieve an adequate interconnection capacity between the Iberian Peninsula (in particular Spain) and the rest of Europe by 2030 and (2) the project portfolio may not be completed in time considering the RES targets by 2030. Then, if market, energy and climate objectives have to be achieved, it is of upmost importance to smooth the authorisation processes and ensure a proper regulation and economic framework.

Regarding the permitting processes, ENTSO-E and the RG CSW welcome Regulation (EU) No 347/2013, as it addresses many positive elements in the permitting section which will facilitate the fast tracking of transmission infrastructure projects, including the proposal of one stop shop and defined timelines.

Nevertheless, the financial supporting schemes to ensure the necessary development of the grid, namely those for the Project of Common Interest, are considered limited, whereas there are many significant national transmission projects which are crucial to the achievement of Europe's targets for climate change, renewables and market integration.

10.4 General findings from the RG CSW studies

In the CSW region the two main drivers for investment are cross-border reinforcement and the integration of RES (onshore wind, solar and hydro generation), namely in the Iberian Peninsula (Portugal and Spain). Some of the projects associated with the cross-border investments also include internal reinforcements in order to create the necessary conditions to allow the transmission of the expected power flow increases.

Market studies have shown that the CSW region is expected to be a net exporter region in 2030, supported by the nuclear generation in France in the more conservative scenarios (e.g. Visions 1 and 2) and by the RES generation, mainly in the Iberian Peninsula, for the green scenarios (Vision 3 and 4). Focusing on the three countries' net balances, it is expected that Portugal continues to be a net importer, France a net exporter and Spain a net importer for Visions 1 and 2 and a net exporter for Visions 3 and 4. These differences in net balances, particularly in Spain, lead to a huge volatility in the north-south power flows in the region which create several challenges for the CSW transmission system.

All the interconnection projects considered show important benefits for the European system, increasing Social Economic Welfare, helping RESs integration, reducing CO_2 emissions (in Visions 3 and 4) and reducing the isolation of the Iberian Peninsula. The projects between the Iberian Peninsula and the rest of Europe have an important impact on flows and generation outside the CSW region.

The studies show also that there is still a significant level of congestion in the interconnection between the Iberian Peninsula and the rest of Europe (40-60%), even considering the implementation of the projects under study. In order to solve these congestions and to fulfil the EC objective for the interconnection ratio (10%), there is the need for further increases in this interconnection capacity to values in the range of 7-10 GW in Visions 1 and 2 and greater than 10 GW in Visions 3 and 4. In fact the reinforcement of this interconnection is critical to fully integrate the Iberian Peninsula in the Internal European Market in 2030 and to avoid that Portugal and Spain remain outside of this market and acting only in the peripheral Iberian Electrical Market. However, the currently planned projects are quite complex from the technical perspective and according to the experience they should be implemented step by step, so in spite of the necessity it will be a challenge to implement additional capacities by 2030.

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In addition, specifically for Visions 3 and 4, where it is expected a RES penetration of approximately 50% and 57% of total generation for CSW region, network studies have highlighted the potential need for important investments at the national level, which are not yet defined as the location of the new generation has a high impact and there is high uncertainty involved.

However, this high RES penetration sets additional challenges for the system as a whole, with respect to its dynamic behaviour (how can frequency be maintained if the system inertia is dramatically reduced? What voltage supporting equipment would be needed and where when power plants close to load centres and traditionally contributing to voltage control are massively shut-down? How will long distance bulk power flows be managed on AC grids? How will several HVDC installations working in parallel actually interact with each other? How will embedded generation on distribution system behave? Etc.). Therefore, although the CSW region already has good experience and good results in terms of integrating RES in the system further studies are needed in future TYNDP releases in order to assess the security, stability and operability of the overall future European electrical system. The support from stakeholders in this task is of vital importance (to provide realistic forecasts, data and models).

With more precise inputs in this respect, additional investment needs may be identified and a more comprehensive picture of the grid infrastructure required by 2030 in this context will be supplied in future releases of the TYNDP.

This regional investment plan presents 27 projects necessary to meet the main mid- and long-term needs of the region. However, other additional investments will be needed to accommodate this strategy for the evolution of the transmission system at a local level. These investments are presented in the national development plans of each country.

Finally, it is worth mentioning that transmission planning is a continuous living process and that an updated RgIP will be published every two years. In accordance, the scenarios assessed in this plan are updated every two years, taking into consideration stakeholder feedback in order to make the optimisation of the strategy for the evolution of the electrical transmission system in the region possible. In fact, the preparation of the TYNDP 2016 has already started.

Appendices

1 Appendix 1: technical description of projects

All detailed information about this assessment of projects is displayed in this Appendix. The organisation of Appendix 1 reflects the various roles and evolution of the TYNDP package since 2012:

- Section 1.1 displays the detailed assessment of Projects of Pan-European significance within the Continental South West region, i.e. transmission projects stemming from ENTSO-E analyses or submitted by third parties, and matching the criteria of pan-European significance, be they eventually PCIs or not;
- Section 1.2 displays the list of all projects and investments within the Continental South West region, including latest information on the evolution of each investment since TYNDP and RgIPs 2012.
- Section 1.3 displays the list of all commissioned investments within the Continental South West region.
- Section 1.4 displays the list of all cancelled investments within the Continental South West region.
- Section 1.5 displays the assessment of storage projects within the Continental South West region, complying with Reg 314/2013.

1.1 Transmission projects of pan-European significance

This section displays all assessments sheets for projects of pan-European significance within the Continental South West region. It gives a synthetic description of each project with some factual information as well as the expected projects impacts and commissioning information.

1.1.1 Transmission projects of pan-European significance

All projects (but one) presented in Section 1.1 are matching the criteria for projects of pan-European significance, set as of the TYNDP 2012.

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

- The main equipment is at least 220 kV if it is an overhead line AC or at least 150 kV otherwise and is, at least partially, located in one of the 32 countries represented in TYNDP.
- Altogether, these assets contribute to a grid transfer capability increase across a network boundary within the ENTSO-E interconnected network (e.g. additional NTC between two market areas) or at its borders (i.e. increasing the import and/or export capability of ENTSO-E countries vis-à-vis others).
- An estimate of the abovementioned grid transfer capability increase is explicitly provided in MW in the application.
- The grid transfer capability increase meets least one of the following minimums:
    - At least 500 MW of additional NTC; or
    - Connecting or securing output of at least 1 GW/1000 km² of generation; or
    - Securing load growth for at least 10 years for an area representing consumption greater than 3 TWh/yr.

NB: Regional Investment Plans and National Development Plans can complement the development perspective with respect to other projects than Projects of Pan-European Significance.

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1.1.2 Corridors, Projects, and investment items

Complying with the CBA methodology, a **project** in the TYNDP 2014 package can 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.

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.

As far as possible, every project is assessed individually. However, the rationale behind the grid reinforcement strategy invited sometimes to assess some projects jointly (e.g. the two phases of Nordbalt, the transbalkan corridor, etc.), or even a whole corridor at once (e.g. German corridors from north to south of Germany).

One investment item may contribute to more than one project. It is then depicted in the investment table of each of the projects it belongs to.

1.1.3 Labelling

Labelling of investment items and projects started with the first TYNDP, in 2010. They got a reference number as soon as they were identified, regardless where (in Europe) and why (a promising prospect? a mere option among others to solve a specific problem?) they were proposed, and with what destination (pan-European significance or regional project?). Projects are also lively objects (with commissioning of investment items, evolution of consistency, etc.). Hence, now, there is simply no logic in the present labelling. It is a mere reference number to locate projects on maps and track their assessments.

Since the TYNDP 2010, the TYNDP contains

- Projects with reference numbers between 1 to 227;
- Investment items with individual reference numbers from 1 to about 1200. On maps, the reference numbers are Project_ref|Investment_Item_ref (e.g. 79|459 designates the investment item with the label 459, contributing to project 79).

Corridors have no reference number.

1.1.4 How to read every assessment sheet

Every project of pan-European significance is displayed in an **assessment sheet, i.e. 1-3 pages of standard information** structured in the following way:

- A short description of the consistency and rationale of the project;
- A table listing all constituting investment items, with their technical description, commissioning date, status, evolution and evolution drivers since last TYNDP, and its contribution to the Grid Transfer Capability of the project.
- The project's CBA assessment, in two parts,
  - on the one hand, the CBA indicators that are independent from the scenarios: GTC increase, resilience, flexibility, length across protected areas, length across urbanised areas, costs;
  - on the other hand, the CBA Vision-dependent indicators: SoS, SEW, RES, Losses variation, CO_2 emissions variations;
- Additional comments, especially regarding the computation of CBA indicators.

Remarks

- Uncertainties are attached to these forecasts, hence assessment figures are presented as ranges.
- In the same respect, a ‘0’ for losses or CO_2 emissions variations means a neutral impact, sometimes positive or negative and not a strict absence of variation.
- Some projects of pan-European significance build on already commissioned investment that were mentioned in the TYNDP (as well as they all build on the existing grid assets), or other investments that are of regional importance. This is mentioned in the ‘additional comments’ as the case may be.

1.1.5 Assessment of projects of pan-European significance

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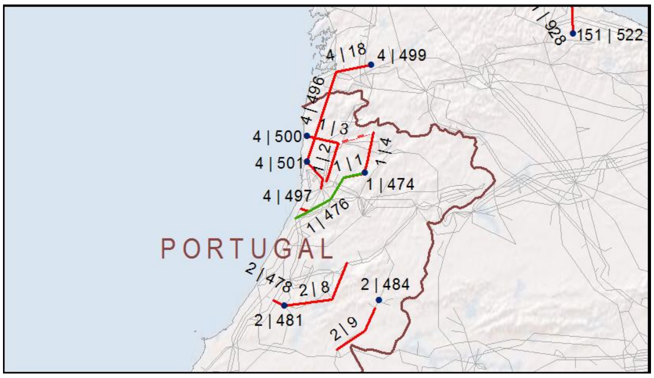
Project 4: Interconnection Portugal-Spain

Description of the project

This project increases the interconnection capacity between Portugal and Spain. Larger and more volatile flows are expected between both countries due to the huge increase of volatile sources and the market interchanges. The project includes two 400kV interconnection routes, besides the 400kV internal reinforcements required, one in the North (Fontefría - V.Conde) and other in the South (P.Guzman – Tavira that will be commissioned in 2014), due to the important loop flows between the two countries. Only with these both new 400kV interconnections is possible to reach the interconnection capacity of 3200 MW agreed between Portugal and Spain.
This project will also have a benefit in reducing the spilled energy in the Iberian Peninsula.

PCI 2.17



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
18	Beariz (ES)	Fontefria (ES)	New northern interconnection. New double circuit 400kV OHL between Beariz (ES) - Fontefria (ES).	1000	Design & Permitting	2016	Delayed	Delays in authorization process due to a change on the route and on the location of substations, induced by environmental concerns
496	Fontefría (ES)	Vila do Conde (PT) (By Viana do Castelo)	New northern interconnection. New 400kV OHL Fontefría (ES) - Viana do Castelo (PT) - Vila do Conde (PT).	1000	Design & Permitting	2016	Delayed	Delays in authorization process due to a change on the route and on the location of substations were induced by environmental concerns
497	Vila do Conde (PT)	Recarei/Vermoim (PT)	New double circuit 400kV OHL between Vila do Conde (PT) - Recarei/Vermoim (PT).	1000	Design & Permitting	2015	Delayed	Partial sections from the line found environmental problems in his original route. The problems are being solved with the identification of new routes, prompting a delay in the commissioning date.
498	Fontefria (ES)		New northern interconnection. New 400kV substation	1000	Design & Permitting	2016	Delayed	Delays in the authorization process, due to a change of

			Fontefria (ES), previously O Covelo.					location of the substation. Timing correlated to investment 18
499	Beariz (ES)		New northern interconnection. New 400kV substation Beariz (ES), previously Boboras	1000	Design & Permitting	2016	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 18
500	V. Castelo (PT)		New 400/150kV substation V.Castelo (PT).	1000	Design & Permitting	2016	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 496.
501	Vila do Conde (PT)		New 400kV substation Vila do Conde (PT).	1000	Design & Permitting	2015	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 497.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
PT=>ES: 400	ES=>PT: 1000	3	4	Negligible or less than 15km	Negligible or less than 15km	130-160

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[4;30]	[7200;8800] MWh	[-14000;-12000]	[180;220]
Scenario Vision 2 - 2030	-	[3;33]	[7900;9600] MWh	[-13000;-11000]	[160;200]
Scenario Vision 3 - 2030	-	[20;50]	[160000;200000] MWh	[3600;4400]	[-110;-90]
Scenario Vision 4 - 2030	-	[64;130]	[630000;770000] MWh	[8100;9900]	[-330;-270]

Additional comments

Comment on the security of supply: Increasing the interconnection capacity between Portugal and Spain allows to better accommodate the volatility associated to the RES generation which is predicted for these two countries of the Iberia Peninsula in 2030 increasing in this sense the overall security of supply of the electrical systems. The project increases the interconnection ratio of Spain in 0,2 - 0,3% in 2030, depending on the scenario.

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Comment on the RES integration: This project facilitates the integration of new RES generation, mainly in the North of Portugal and in the Galiza (Spain), by increasing the interconnection capacity between Portugal and Spain and as a consequence take advantage of the complementarity of the both Iberian electrical systems. This project will also reduce the spilled energy in the Iberian Peninsula.

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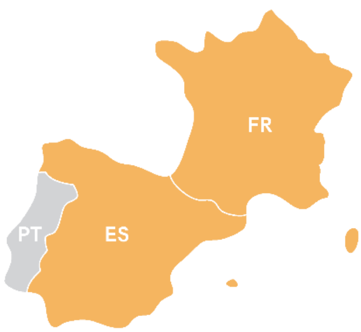
Project 5: Eastern interconnection ES-FR

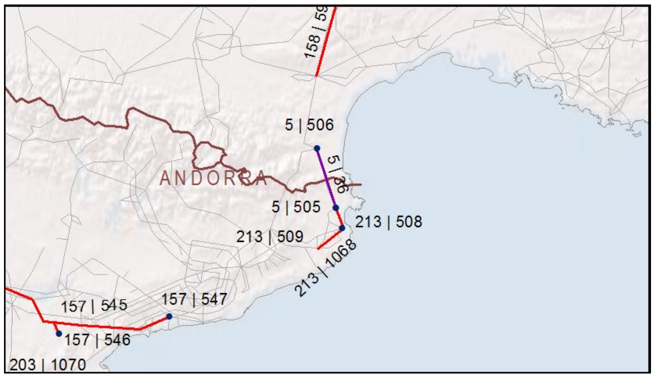
Description of the project

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

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

Some internal reinforcements, both in Spain and France, are required. In France, the uprate of Baixas –Gaudiere 400kV is already commissioned. In Spain, reinforcements are included in project 213 in addition to certain individual investments of regional relevance.
The project allows important Social Economic Welfare, as it allows the use of more efficient and cheaper technologies, and avoids spillage of RES, especially in the Iberian Peninsula.





Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
36	Sta.Llogaia (ES)	Baixas (FR)	New HVDC (VSC) bipolar interconnection in the Eastern part of the border, via 320kV DC underground cable using existing infrastructures corridors and converters in both ending points.	1400	Under Construction	2015	Delayed	Answering all concerns expressed during the authorization process in Spain and environmental issues in France led to postponing the investment. Both issues are solved by now.
505	Sta.Llogaia (ES)		Converter station of the new HVDC (VSC) bipolar interconnection in the Eastern part of the border, via 320kV DC underground cable using existing infrastructures corridors.	1400	Under Construction	2015	Delayed	Works completed in 2014; commercial operation expected after test period at the same time as the cable (investment 36).

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506	Baixas (FR)		Converter station of the new HVDC (VSC) bipolar interconnection in the Eastern part of the border, via 320kV DC underground cable using existing infrastructures corridors.	1400	Under Construction		2015	Delayed	Works completed in 2014; commercial operation expected after test period at the same time as the cable (investment 36).

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific*						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
ES=>FR: 1200	FR=>ES: 1400	1	4	Negligible or less than 15km	Negligible or less than 15km	700

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	[100;250]	[20;130]	[110000;130000] MWh	[450000;550000]	[1600;2000]
Scenario Vision 2 - 2030	[110;260]	[22;140]	[120000;150000] MWh	[280000;380000]	[1800;2200]
Scenario Vision 3 - 2030	[120;270]	[70;150]	[590000;720000] MWh	[180000;280000]	[-1100;-870]
Scenario Vision 4 - 2030	[120;280]	[210;280]	[1300000;1500000] MWh	[360000;460000]	[-1500;-1300]

Additional comments

Comment on the security of supply: The project avoids potential Energy Not Supplied in the area of Gerona (Spain). In addition, the project increases the interconnection ratio of Spain in 0,6-1,05% in 2030 depending on the scenario.

Comment on the RES integration: Values of spillage are results from market studies without considering internal network constraints. Avoided spillage concerns RES in Iberian peninsula as a whole.

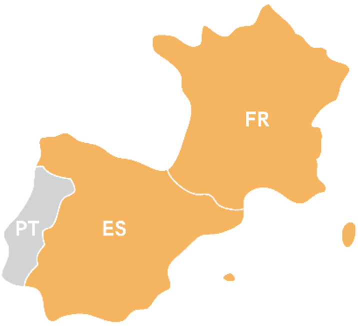
Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES.

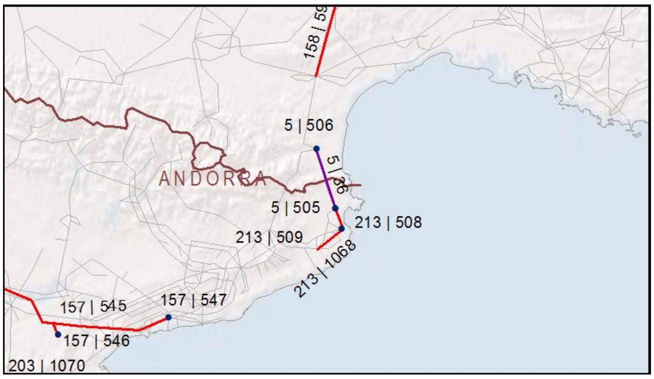
* Compared to the version sent to ACER, a mismatch in the GTC figures has been corrected after ACER had been informed.

Project 213: Santa Llogaia - Bescano

Description of the project

This project consists of a double 400kV circuit from Santa Llogaia to Bescanó which first is needed to connect the Spain-France Eastern HVDC interconnection project (project 5) to the existing transmission network in Spain. Secondly, the projects contributes to improve the security of supply of the area of Gerona with the new injection from the new 400 kV Ramis and Santa Llogaia substations to the distribution network. Therefore, the benefits attached to this project join the cross border benefits and the local benefits.
This project have been included in the 2013 PCI list.





Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
508	Ramis (ES)		New 400kV substation in Ramis with two 400/220kV transformers; connection as input/output in Santa Llogaia - Bescano line	1400	Design & Permitting	2015	Delayed	Answering all concerns expressed during the authorization process led to postponing the investment.
509	Santa Llogaia (ES)		New 400kV substation Sta.Llogaia.	1400	Under Construction	2014	Delayed	Answering all concerns expressed during the authorization process led to postponing the investment.
1068	Bescanó	Santa Llogaia	New OHL 400kV AC double circuit Bescano-Santa Llogaia, required to connect the new HVDC interconnection to the existing network and secure the supply in the area of Gerona	1400	Under Construction	2014	Investment on time	Progress as planned

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CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
ES=>FR: 1400	FR=>ES: 1200	1	4	Negligible or less than 15km	Negligible or less than 15km	50-56

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	[100;250]	[20;130]	[110000;130000] MWh	[19000;23000]	[1600;2000]
Scenario Vision 2 - 2030	[110;260]	[22;140]	[120000;150000] MWh	[21000;26000]	[1800;2200]
Scenario Vision 3 - 2030	[120;270]	[70;150]	[590000;720000] MWh	[18000;22000]	[-1100;-870]
Scenario Vision 4 - 2030	[120;280]	[210;280]	[1300000;1500000] MWh	[26000;32000]	[-1500;-1300]

Additional comments

Comment on the security of supply: The project avoids potential Energy Not Supplied in the area of Gerona (Spain). In addition, the project increases the interconnection ratio of Spain in 0,6-1,05% in 2030 depending on the scenario.

Comment on the RES integration: Values of spillage are results from market studies without considering internal network constraints. Avoided spillage concerns RES in Iberian peninsula as a whole.

Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES (by bringing it to load centers or to and from storage facilities)

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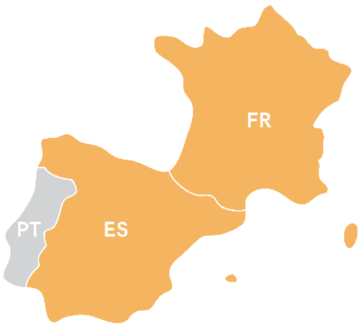
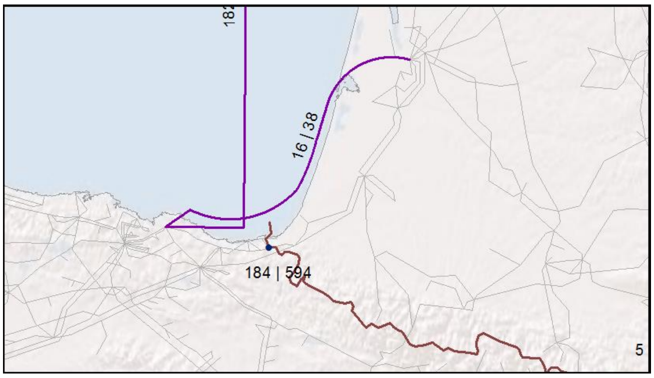
Project 184: PST Arkale

Description of the project

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 (projects 5 and 16), 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 – 2.8





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
594	Arkale (ES)		New PST in Arkale-Argia 220 kV interconnection line	-	Planning	2016	Investment on time	Draft NDP expected to be published during the preparation of TYNDP 2012 was not finally approved and published, so the investment is yet in a planning stage. If the new NDP is published by 2014, as expected, commissioning date would not be affected.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
ES=>FR: 500-900	FR=>ES: 100-500	3	3	Negligible or less than 15km	Negligible or less than 15km	19-23

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	[22;27]	[5;13]	[8700;11000] MWh	[7000;11000]	[210;250]
Scenario Vision 2 - 2030	[23;28]	[7;15]	[8900;11000] MWh	[7500;12000]	[230;290]
Scenario Vision 3 - 2030	[27;33]	[12;26]	[54000;66000] MWh	[10000;14000]	[-190;-150]
Scenario Vision 4 - 2030	[36;45]	[33;53]	[150000;190000] MWh	[14000;18000]	[-280;-230]

Additional comments

Comment on the security of supply: The project increases the interconnection ratio of Spain in 0.2-0,4% in 2030 depending on the scenario. This project improves the security of supply in the French Basque Country
Comment on the RES integration: Values of spillage are results from market studies without considering internal network constraints. Avoided spillage concerns RES in the Iberian peninsula.

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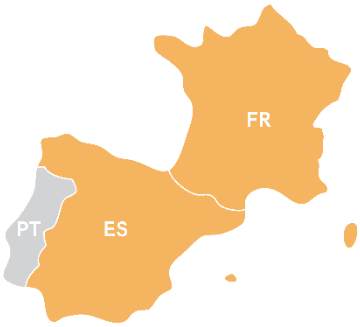
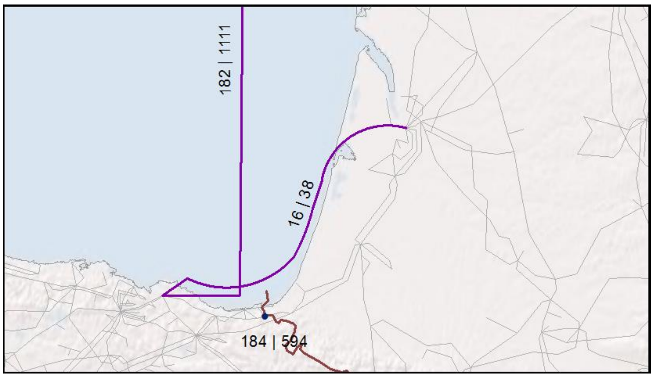
Project 16: Western interconnection FR-ES

Description of the project

In order to fulfil the governmental long term objective of exchange capacity between France-Spain, the Western interconnection is under analysis.
Deep technical and environmental prefeasibility studies across the whole French-Spanish border showed that the preferential strategy was a new HVDC submarine interconnection through the Biscay/Gascogne Bay from the Basque Country in Spain to the Aquitaine area in France.
Since the last TYNDP the analysis on technical feasibility and environmental aspects, especially for the subsea route have had good process. However, the project is still under analysis and final definition is in progress.
The project allows important Social Economic Welfare, as it allows the use of more efficient and cheaper technologies, avoids spillage of RES, especially in the Iberian Peninsula and reduces the consideration of Spain as an electric island.

PCI 2.7





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
38	Gatica (ES)	Aquitaine (FR)	New HVDC interconnection in the western part of the border via DC subsea cable in the Biscay Gulf.	-	Planning	2023	Investment on time	The technical consistency of the project progresses and the commissioning date is now defined more accurately.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
ES=>FR: 2500	FR=>ES: 2200	2	4	Negligible or less than 15km	Negligible or less than 15km	1600-1900

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[90;210]	[130000;160000] MWh	[200000;300000]	[3300;4000]
Scenario Vision 2 - 2030	-	[95;220]	[140000;170000] MWh	[210000;310000]	[3500;4300]
Scenario Vision 3 - 2030	-	[90;250]	[900000;1100000] MWh	[240000;340000]	[-1900;-1500]
Scenario Vision 4 - 2030	-	[310;470]	[2100000;2600000] MWh	[390000;490000]	[-2400;-2000]

Additional comments

Comment on the security of supply: The project increases the interconnection ratio of Spain in 1-1,6% in 2030 depending on the scenario.

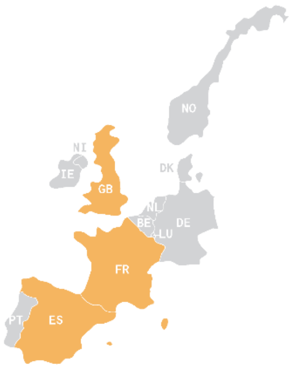
Comment on the RES integration: Values of spillage are results from market studies without considering internal network constraints. Avoided spillage concerns RES in Iberian peninsula as a whole.

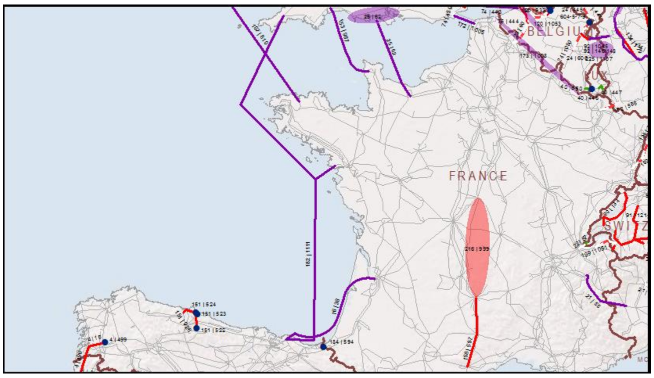
Project 182: BRITIB (GB-FR-ES)

Description of the project

Project promoted by COBRA (ACS Group)

Interconnection project between Indian Queens (Great Britain), Cordemais (France) and Gatica (Spain) in a multiterminal HVDC configuration with 2 sections of 1000 MW each, and a submarine route from Spain to Great Britain along the French coast. It is proposed to take advantage of complementarity of resources in the three countries involved in the project.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1111	Gatica	Indian Queens	Interconnection project between Indian Queens (Great Britain), Cordemais (France) and Gatica (Spain) in a multiterminal HVDC configuration with 2 sections and 3 terminals of at least 1000MW each, that allows for direct exchange of electricity between ES-FR, FR-UK and UK-ES.	-	Under Consideration	2018	New Investment	Project application to TYNDP 2014.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
Multiterminal configuration (MT): From/to ES; From/to FR; From/to GB: 1000		2	5	50-100km	Negligible or less than 15km	1700-2800

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[65;130]	[93000;110000] MWh	[200000;300000]	[900;1100]
Scenario Vision 2 - 2030	-	[75;140]	[110000;130000] MWh	[230000;330000]	[780;960]
Scenario Vision 3 - 2030	-	[200;280]	[1800000;2200000] MWh	[430000;530000]	[-1700;-1400]
Scenario Vision 4 - 2030	-	[280;350]	[2100000;2500000] MWh	[510000;610000]	[-1800;-1400]

Additional comments

Comment on the security of supply: The project increases the interconnection ratio of Spain in 0,4-0,8% in 2030 depending on the scenario

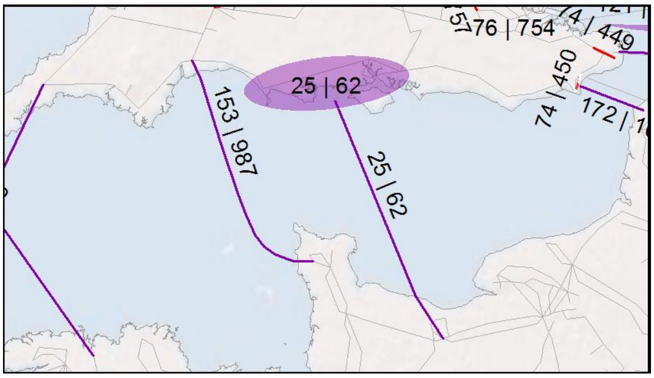
Comment on the RES integration: avoided spillage concerns RES both in the Iberian peninsula on the one hand and Great-Britain and Ireland on the other hand.

Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES

Project 25: IFA2

Description of the project

IFA2 is a new subsea HVDC VSC interconnection that will develop between the area of Caen in France and the region of Southampton in Great Britain. The objective is to increase the interconnection capacity between Great Britain and continent and to integrate RES generation, especially wind in Great Britain. It has been selected as PCI 1.7.2 in the NSCOG corridor on 14/10/13. Some mutual support is also expected but this is not reflected in the security of supply indicator assessed according to the CBA rules.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
62	Tourbe (FR)	Chilling (GB)	New subsea HVDC VSC link between the UK and France with a capacity around 1000 MW. PCI 1.7.2 (NSCOG corridor)	-	Design & Permitting	2020	Investment on time	Extensive feasibility studies (e.g. seabed surveys) have been conducted to determine the most suitable route; on the French side, the ministry of energy acknowledged the notification of the investment on 08/04/14.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>GB: 1000	GB=>FR: 1000	1	4	15-50 km	Negligible or less than 15km	540-830

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[35;75]	[230000;280000] MWh	[200000;240000]	[170;210]
Scenario Vision 2 - 2030	-	[0;60]	[36000;44000] MWh	[200000;240000]	[220;260]
Scenario Vision 3 - 2030	-	[170;250]	[1700000;2000000] MWh	[190000;240000]	[-1400;-1200]
Scenario Vision 4 - 2030	-	[180;210]	[1500000;1800000] MWh	[190000;240000]	[-1100;-940]

Additional comments

Comment on the RES integration: Avoided spillage concerns RES in Great-Britain and Ireland mostly, but also France.

Comment on the CO2 indicator: The very high scores reflect that the project enables a better use of RES

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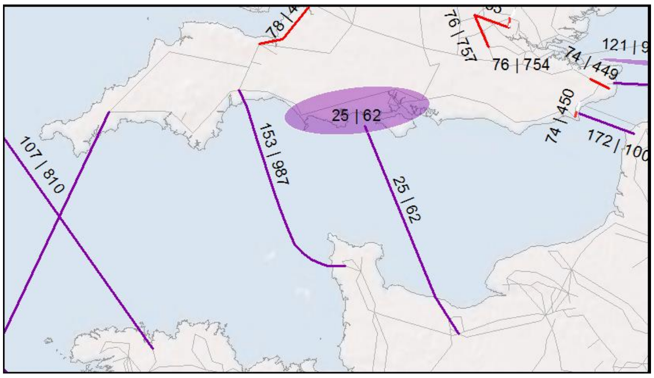
Project 153: France-Alderney-Britain

Description of the project

France-Alderney-Britain (FAB) is a new HVDC subsea interconnector between Exeter (UK) and Cotentin Nord (France) with 1.4 GW capacity.
The project will not only increase the interconnection between Great Britain and continent but also integrate additional RES (especially wind generation from Great Britain); 2.8 GW of future tidal generation could also be connected to this link when it develops off the Cotentin coasts.
The investment has been selected as PCI 1.7.1 in the NSCOG Corridor.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
987	Cotentin Nord	Exeter	France-Alderney-Britain (FAB) is a new 220km-long HVDC subsea interconnection between Exeter (UK) and Cotentin Nord (France) with VSC converter station at both ends. Expected rated capacity is 2*700 MW.	-	Planning	2022	New Investment	Studies conducted after TYNDP2012 release have shown the economic viability of this interconnection and lead to develop this investment. Feasibility studies (marine surveys) are starting to find a suitable subsea route.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>GB: 1400	GB=>FR: 1400	1	4	Negligible or less than 15km	Negligible or less than 15km	470-1100

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[40;100]	[300000;360000] MWh	[270000;340000]	[260;310]
Scenario Vision 2 - 2030	-	[0;90]	[59000;72000] MWh	[270000;340000]	[270;340]
Scenario Vision 3 - 2030	-	[230;350]	[2400000;2900000] MWh	[260000;320000]	[-2000;-1600]
Scenario Vision 4 - 2030	-	[260;300]	[2100000;2500000] MWh	[260000;320000]	[-1700;-1400]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in Great-Britain and Ireland mostly, but also France.

Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES

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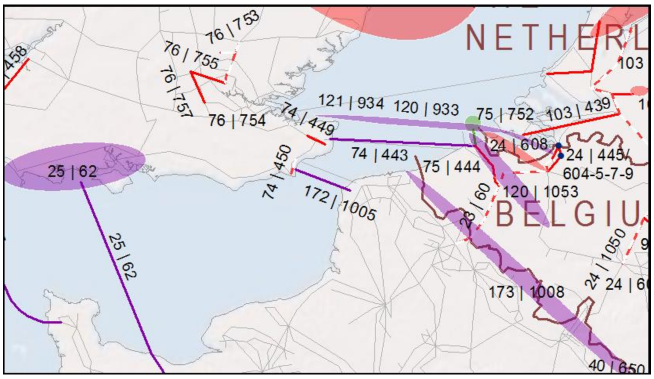
Project 172: ElecLink

Description of the project

Eleclink is a new HVDC interconnection between France and the United Kingdom with 1000 MW capacity through the Channel tunnel. This project has been selected as PCI n°1.7.3 in the NSCOG Corridor on 14/10/13.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1005	Sellindge (UK)	Le Mandarins (FR)	Eleclink is a new FR – UK interconnection cable thought the channel Tunnel between Selindge (UK) and Mandarins (FR). Converter stations will be located on Eurotunnel concession at Folkestone and Coquelles. This HVDC interconnection is a PCI project (Project of common interest). It will increase by 1GW the interconnection capacity between UK and FR by 2016.	-	Design & Permitting	2016	New Investment	Project application to TYNDP 2014.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>GB: 1000	GB=>FR: 1000	1	4	Negligible or less than 15km	Negligible or less than 15km	260-440

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[35;75]	[230000;280000] MWh	[200000;240000]	[170;210]
Scenario Vision 2 - 2030	-	[0;60]	[36000;44000] MWh	[200000;240000]	[220;260]
Scenario Vision 3 - 2030	-	[170;250]	[1700000;2000000] MWh	[140000;170000]	[-1400;-1200]
Scenario Vision 4 - 2030	-	[180;210]	[1500000;1800000] MWh	[140000;170000]	[-1100;-940]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in Great-Britain and Ireland mostly, but also France.

Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES

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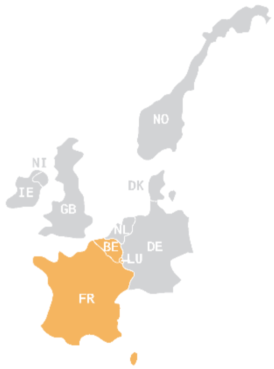
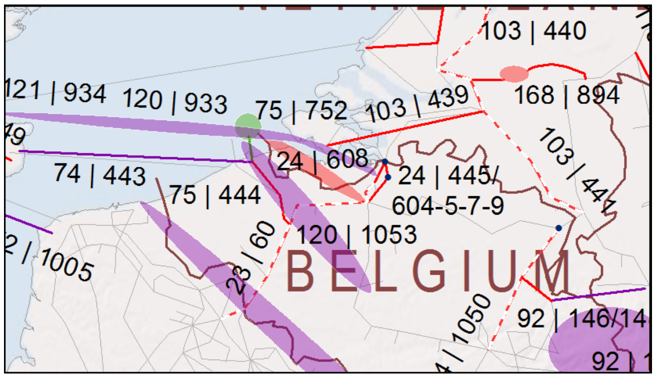
Project 23: France-Belgium Interconnection Phase 1

Description of the project

The project aims at ensuring reliable grid operation to cope with more volatile south-north flows, and at increasing the exchange capacities between France & Belgium to sustain an adequate level of market integration.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
60	Avelin/Mastaing (FR)	Horta (new 400-kV substation) (BE)	Replacement of the current conductors on the axis Avelin/Mastaing - Avelgem - Horta with high performance conductors (HTLS = High Temperature Low Sag)	-	Planning	2021	Rescheduled	Investment was at conceptual stage in TYNDP2012; on-going feasibility studies lead to a more accurate commissioning date.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
FR=>BE: 600-1300	BE=>FR: 600-1300	1	3	Negligible or less than 15km	Negligible or less than 15km	110-170

CBA results	for each scenario				
Scenario	B1 SoS (MWh/year)	B2 SEW (MEuros/year)	B3 RES integration	B4 Losses (MWh)	B5 CO2 Emissions (kT/year)
Scenario Vision 1 - 2030	-	[5;15]	[18000;22000] MWh	0	[-120;-99]
Scenario Vision 2 - 2030	-	[0;10]	[19000;23000] MWh	0	[27;33]
Scenario Vision 3 - 2030	-	[10;20]	[77000;94000] MWh	0	[-130;-100]
Scenario Vision 4 - 2030	-	[20;60]	[200000;240000] MWh	0	[-240;-200]

Additional comments

Comment on the security of supply: a reinforced interconnector contributes to the security of supply of Belgium as a whole, since it offers market players additional import capacity which they can use to balance their portfolio provided that excess generation is available abroad. Given the changing production mix with ongoing nuclear phase out and decommissioning of old power plants, this benefit materializes itself as soon as the project is realized.

Comment on the RES integration: avoided spillage concerns RES in France and Belgium mostly.

Comment on the Losses indicator: basically, the project enables power exchanges over greater distances (increasing losses), and conversely reduce the overall resistance of the grid. Losses variation is hence symbolically 0, with depending on the point in times losses being lower or greater, with variation close to the model accuracy range.

Comment on the S1 and S2 indicators: by definition, the reconductoring implies no new route, hence the indicators value is negligible.

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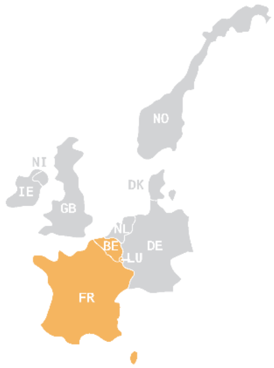
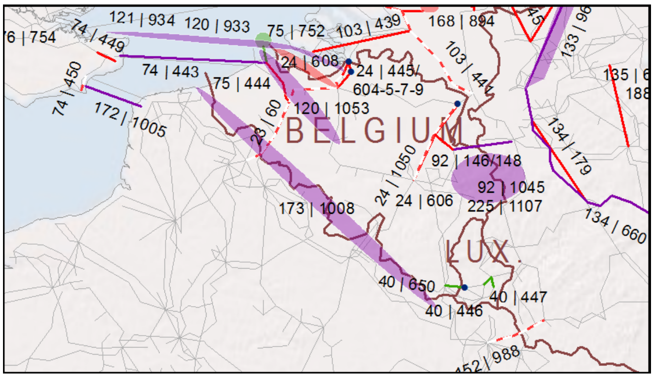
Project 173: FR-BE phase 2

Description of the project

Preliminary analyses show the need for an additional reinforcement in visions 3&4 between France & Belgium, complementary to project # 23.

The determination of the amount of additional market exchange that can be secured with this project, its optimal location & technology are subject to further studies.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1008	tbd(FR)	tbd(BE)	The following (combination of) options are envisioned and will be further studied: - Lonny-Achène-Gramme (reconductoring with High Temperature Low Sag conductors or HVDC) - Capelle-Courcelles (HVDC) - Warande-Zeebrugge/Alfa (HVDC)	-	Under Consideration	2030	New Investment	Preliminary analyses show the need for an additional reinforcement in visions 3 & 4 (2030) between France & Belgium, complementary to project # 23.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>BE: 1400	BE=>FR: 1400	2	1	NA	NA	150-450

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CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 3 - 2030	-	[20;30]	[160000;200000] MWh	0	[-210;-180]
Scenario Vision 4 - 2030	-	[60;100]	[360000;430000] MWh	0	[-540;-450]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in France and Belgium mostly.

Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES

Comment on the Losses indicator: basically, the project enables power exchanges over greater distances (increasing losses), and conversely reduce the overall resistance of the grid. Losses variation is hence symbolically 0, with depending on the point in times losses being lower or greater, with variation close to the model accuracy range.

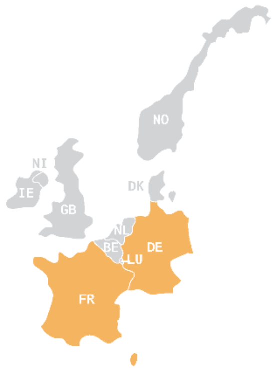
Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

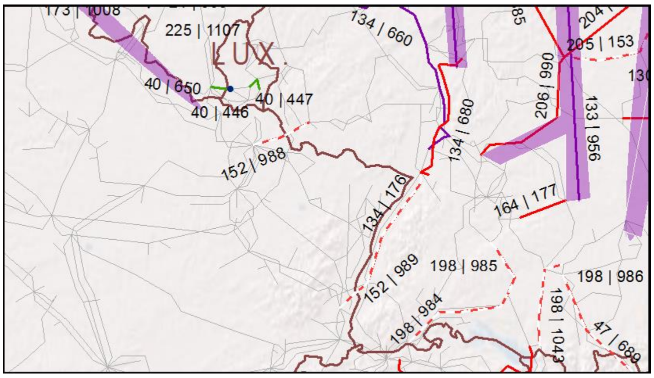
Project 152: France Germany Interconnection

Description of the project

The project aims at increasing the cross-border capacity between Germany and France by reinforcing the existing axes in Lorraine-Saar and Alsace-Baden areas. Studies in progress showed positive impact, with main benefits in terms of market and RES generation integration.

Detailed timeline is under discussion between RTE, Amprion and TransnetBW.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
988	Vigy	Ensdorf or further (tbd)	Upgrade of the existing transmission axis between Vigy and Ensdorf (Uchtelfangen) to increase its capacity.	1500	Under Consideration	2030	New Investment	Studies in progress showed positive impact on FR-DE exchange capacity (investment contribution to GTC highly dependent on the scenario and on generation/load pattern). Technical feasibility under investigation. Commissioning date depends on the scope of the investment.
989	Muhlbach	Eichstetten	Operation at 400 kV of the second circuit of a 400kV double circuit OHL currently operated at 225 kV; some restructuration of the existing grid may be necessary in the area.	300	Under Consideration	2026	New Investment	Studies in progress showed the feasibility of upgrading the existing asset in order to provide mutual support to increase exchange capacity between FR and DE.. The detailed timeline of the investment is under definition.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>DE: 1000-2000	DE=>FR: 1000-2000	1	4	NA	NA	100-140

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[18;22]	0	0	0
Scenario Vision 2 - 2030	-	[48;59]	0	0	[1200;1400]
Scenario Vision 3 - 2030	-	[140;170]	[130000;160000] MWh	0	[-860;-700]
Scenario Vision 4 - 2030	-	[220;270]	[200000;250000] MWh	0	[-1400;-1100]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in Germany and France mostly.

Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES

Comment on the Losses indicator: basically, the project enables power exchanges over greater distances (increasing losses), and conversely reduce the overall resistance of the grid. Losses variation is hence symbolically 0, with depending on the point in times losses being lower or greater, with variation close to the model accuracy range.

Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

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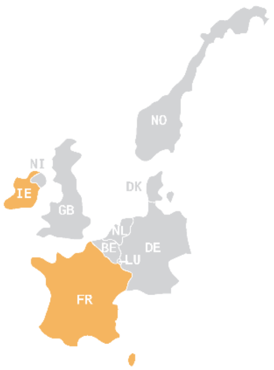
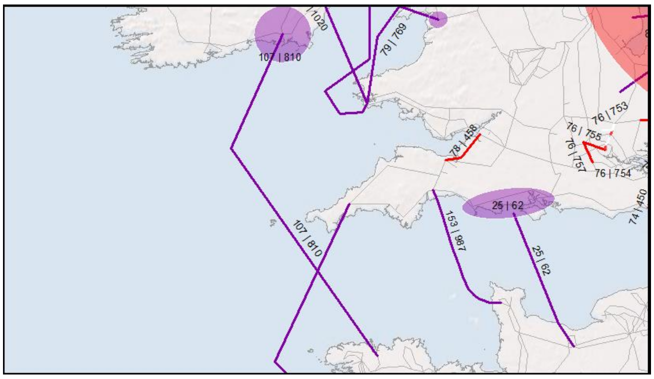
Project 107: Celtic Interconnector

Description of the project

Celtic Interconnector will be the first interconnection between Ireland and France. This HVDC (VSC) link with 700 MW capacity will connect Great Island or Knockraha (Ireland) to the Finistère in France. It will not only create a direct link between the French and Irish markets, but also increase RES integration, especially wind in Ireland. Some positive impact on the security of supply is also expected, in particular for Brittany, although this is not shown by the corresponding indicator assessed according to the CBA rules. The project has been selected as PCI 1.6 in the NSCOG corridor on 14/10/13.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
810	Great Island or Knockraha (IE)	La Martyre (FR)	A new HVDC subsea connection between Ireland and France	-	Under Consideration	2025	Investment on time	Feasibility studies are progressing

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>IE: 700	IE=>FR: 700	1	4	NA	NA	900-1200

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[30;70]	[270000;320000] MWh	[200000;300000]	[63;77]
Scenario Vision 2 - 2030	-	[20;30]	[170000;200000] MWh	[200000;300000]	[-33;-27]
Scenario Vision 3 - 2030	-	[140;170]	[1300000;1600000] MWh	[170000;270000]	[-970;-790]
Scenario Vision 4 - 2030	-	[150;200]	[1500000;1800000] MWh	[170000;270000]	[-920;-760]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in Ireland mostly.

Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

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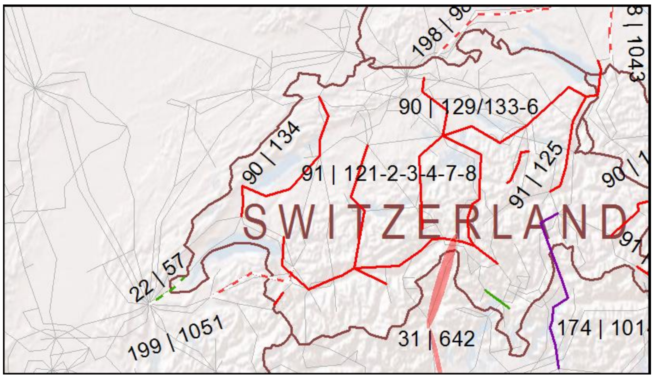
Project 22: Lake Geneva West

Description of the project

The project will increase the France-Switzerland cross-border capacity and secure the supply to Geneva by uprating the existing 225kV cross-border line Genissiat (FR)-Verbois (CH).



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
57	Genissiat (FR)	Verbois (CH)	Reconductoring of the existing 225kV double circuit line Genissiat-Verbois with high temperature conductors.	-	Planning	2020	Investment on time	Progress as planned.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>CH: 500	CH=>FR: 200	1	3	Negligible or less than 15km	Negligible or less than 15km	8-12

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[3;4]	0	[9000;11000]	0
Scenario Vision 2 - 2030	-	[4;5]	0	[9000;11000]	0
Scenario Vision 3 - 2030	-	[27;33]	[16000;19000] MWh	[9000;11000]	[-190;-160]
Scenario Vision 4 - 2030	-	[72;89]	[90000;110000] MWh	[23000;28000]	[-510;-420]

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Additional comments

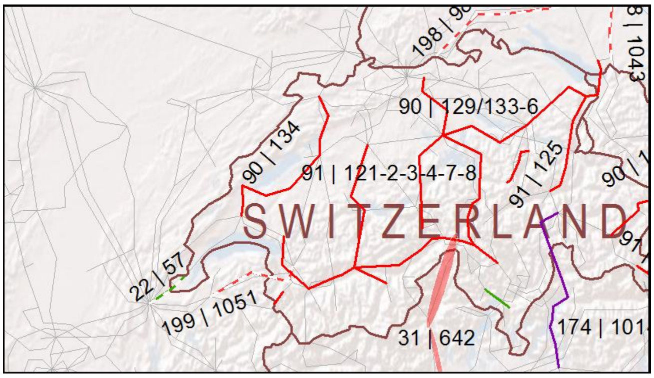
Comment on the RES integration: avoided spillage concerns RES in France mostly.

Comment on the S1 and S2 indicators: by definition, the reconductoring implies no new route, hence the indicators value is negligible.

Project 199: Lake Geneva South

Description of the project

This project comes on top of the Lake Geneva West project and will further increase the France-Switzerland cross-border capacity by upgrading to 400 kV the existing 225kV line south of Lake Geneva; some grid restructuration in Genissiat area will allow taking full benefit of this new axis. Main benefits are expected in terms of market integration and better integration of Swiss hydro generation, especially storage.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1051	CORNIER (FR)	CHAVALON (CH)	Upgrade of the double circuit 225 kV line between Cornier (France) and Riddes and Saint Triphon (Switzerland) to a single circuit 400 kV line between Cornier and Chavalon (Switzerland). In order to take most benefit from this, the existing 400 kV Genissiat substation will be connected in/out to the existing line Cornier-Montagny.	-	Under Consideration	2025	New Investment	grid studies conducted after TYNDP2012 release allowed to define the investment

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>CH: 1000	CH=>FR: 1500	0	3	NA	NA	110-140

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[8;9]	0	[-39000;-32000]	[-130;-100]
Scenario Vision 2 - 2030	-	[7;8]	0	[-37000;-31000]	[700;860]
Scenario Vision 3 - 2030	-	[63;77]	[36000;44000] MWh	[-33000;-27000]	[-430;-350]
Scenario Vision 4 - 2030	-	[150;180]	[180000;220000] MWh	[9000;11000]	[-1000;-840]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in France mostly.

Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

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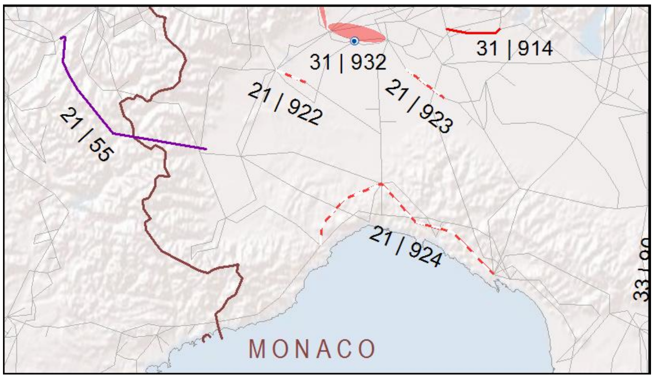
Project 21: Italy-France

Description of the project

The Project comprises a new HVDC interconnection between France and Italy as well as the removing of limitations on existing 380 kV internal Italian lines. The removing of limitation is necessary to take full advantage of the increase of interconnection capacity provided by the cross-border line. The project favours the market integration between Italy and France as well as the use of the most efficient generation capacity; it also increases possible mutual support of both countries. In addition, the project can contribute to RES integration in the European interconnected system by improving cross border exchanges. Such benefits are ensured within different future scenarios.

PCI 2.5.1



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
55	Grande Ile (FR)	Piossasco (IT)	"Savoie - Piémont" Project : New 190km HVDC (VSC) interconnection FR-IT via underground cable and converter stations at both ends (two poles, each of them with 600MW capacity). The cables will be laid in the security gallery of the Frejus motorway tunnel and also along the existing motorways' right-of-way.	1200	Under Construction	2019	Delayed	After some delay in the works of the Frejus service gallery of the motorway, in which the cables will be installed, the project timeline has been updated. Works are already in progress.
922	Rondissone (IT)	Trino (IT)	Removing limitations on the existing 380 kV Rondissone-Trino	300	Planning	2019	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the Italian National Development Plan 2013
923	Lacchiarella(IT)	Chignolo Po(IT)	Removing limitations on the existing 380 kV Lacchiarella-Chignolo Po	300	Planning	2019	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the Italian National Development Plan 2013

924	Vado (IT)	La Spezia (IT)	Removing limitations on the existing 380 kV Vado-Vignole and Vignole-Spezia	300	Planning	2019	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the Italian National Development Plan 2013

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>IT: 1200	IT=>FR: 1000	1	4	Negligible or less than 15km	Negligible or less than 15km	1100-1300

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[43;53]	0	[250000;310000]	[220;260]
Scenario Vision 2 - 2030	-	[29;36]	0	[250000;300000]	0
Scenario Vision 3 - 2030	-	[94;120]	[49000;60000] MWh	[8100;9900]	[-440;-360]
Scenario Vision 4 - 2030	-	[190;230]	[290000;350000] MWh	[36000;44000]	[-1200;-970]

Additional comments

Comment on the security of supply: the new HVDC cable link can help to reduce risks of energy not supplied mainly in northern Italy.

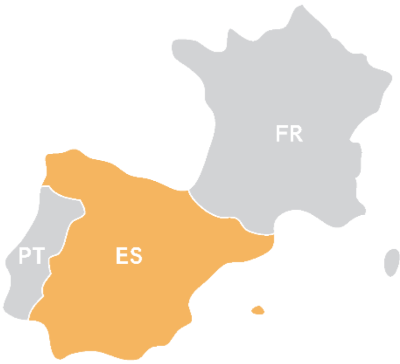
Comment on the RES integration:
Benefits in terms of RES integration are possible even in V1 and V2 because the new interconnection improves the balance capacity of the system. This kind of benefits is not captured in all visions by market simulations because it is sometimes beyond the accuracy of the tool. Avoided spillage concerns RES in France and Italy mostly.

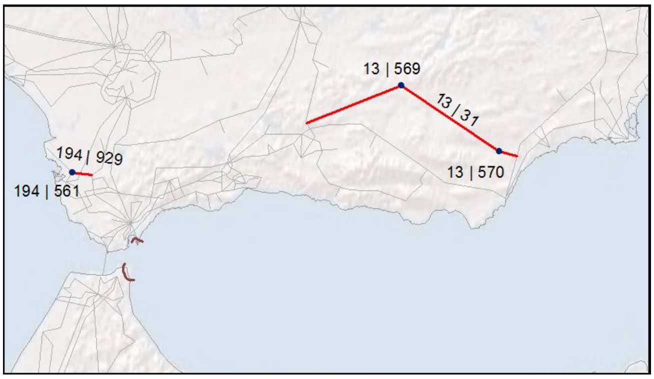
Comment on the Losses indicator: The flows on the Italian North border (Import of Italy) are more often very high in Visions 1 and 2 compared to Vision 3 and 4.

Project 13: Baza project

Description of the project

A new double circuit Caparacena-Baza-La Ribina 400 kV OHL, with two new 400 kV substations in Baza and La Ribina, will allow integrating an important contingent of wind and solar generation, both at transmission and distribution level in 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.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
31	Caparacena (ES)	La Ribina (ES)	New double circuit Caparacena-Baza-La Ribina 400kV OHL.	2060	Under Consideration	2025	Rescheduled	Investment rescheduled due to, and in accordance with, delayed development of new power plant, as considered in the Master Plan 2020 in progress
569	Baza (ES)		New 400kV substation in Baza	2060	Under Consideration	2025	Rescheduled	Investment rescheduled due to, and in accordance with, delayed development of new power plant, as considered in the Master Plan 2020 in progress
570	La Ribina (ES)		New 400kV substation in La Ribina (will be connected as an input/output in Carril-Litoral 400kV line).	2060	Under Consideration	2025	Rescheduled	Investment rescheduled due to, and in accordance with, delayed development of new power plant, as considered in the Master Plan 2020 in progress

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>outside: 550-770	outside=>inside: 3280-3630	2	3	Negligible or less than 15km	Negligible or less than 15km	110-140

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[33;40]	[380000;470000] MWh	[-18000;-14000]	[-180;-140]
Scenario Vision 2 - 2030	-	[35;42]	[400000;490000] MWh	[-18000;-15000]	[-190;-150]
Scenario Vision 3 - 2030	-	[180;230]	[2000000;2500000] MWh	[-20000;-16000]	[-870;-710]
Scenario Vision 4 - 2030	-	[230;280]	[2400000;3000000] MWh	[-20000;-16000]	[-790;-640]

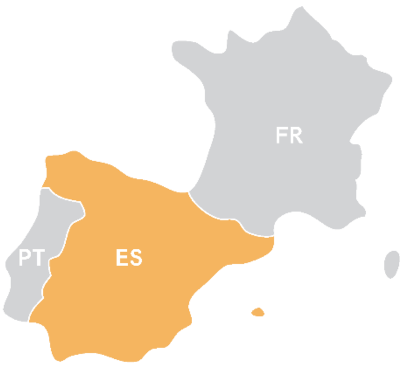
Additional comments

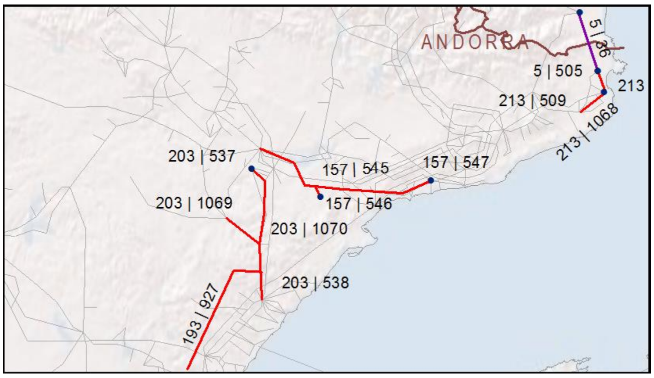
Comment on the RES integration: In Vision 1, 400kV Baza substation considered 150 MW of wind, 275 MW of pumping and 35 MW of solar. In Vision 4, 400kV Baza substation considered 490 MW of wind, 500 MW of pumping and 1100 MW of solar.

Project 157: Aragón-Catalonia south

Description of the project

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 consist 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).





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
545	Escatron (ES)	La Secuita (ES)	New single circuit Escatrón-Els Aubals-La Secuita 400kV OHL.	200	Under Consideration	2027	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)
546	Els Aubals (ES)		New 400kV substation in Els Aubals.	200	Under Consideration	2027	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)
547	La Secuita (ES)		New 400kV substation in La Secuita with 400/220kV transformer.	200	Under Consideration	2027	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
East=>West: 0-30	West=>East: 0-500	2	2	Negligible or less than 15km	Negligible or less than 15km	97-120

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[37;46]	[370000;450000] MWh	[-32000;-26000]	[-180;-150]
Scenario Vision 2 - 2030	-	[41;50]	[400000;490000] MWh	[-35000;-29000]	[-200;-160]
Scenario Vision 3 - 2030	-	[84;100]	[590000;730000] MWh	[-30000;-24000]	[-270;-220]
Scenario Vision 4 - 2030	-	[110;140]	[840000;1000000] MWh	[-30000;-24000]	[-310;-250]

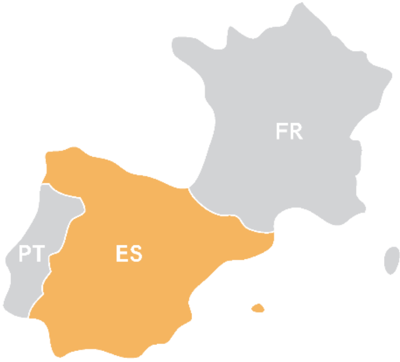
Additional comments

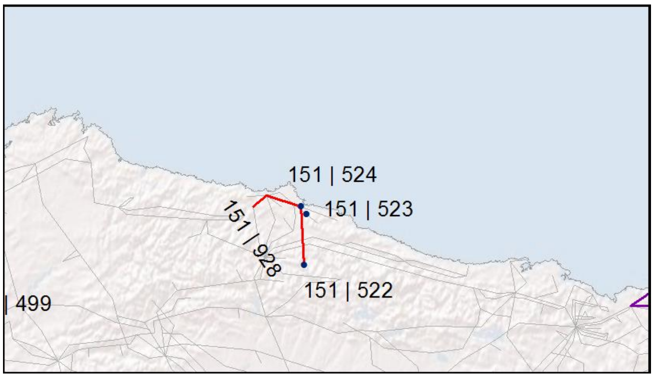
Comment on the RES integration: required to solve restrictions that cause spillage of RES energy (onshore wind but mainly solar) in the areas of Navarra, Aragón and Tarragona. In addition, the project directly connects RES in Els Aubals

Project 151: Asturian Ring

Description of the project

This project consist of closing the 400kV Asturias Ring in the northern part of Spain, and comprises a new 400 kV 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.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
522	Sama (ES)		New 400kV substation Sama in the new Asturias Ring with connection to Lada and a new reactance.	1220	Under Consideration	2026	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)
523	Reboria (ES)		New 400kV substation Reboria in the Asturian ring with 2 transformers 400/220 kV	1220	Under Consideration	2026	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)
524	Costa Verde (ES)		New 400kV substation Costa Verde in the Asturian Ring with 2 new transformer units 400/220 kV	1220	Under Consideration	2026	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)
928	GOZON (ES)	SAMA (ES)	Asturian Ring. New double circuit Gozon-Reboria-Costa Verde-Sama 400 kV	1220	Under Consideration	2026	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in standby)

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
outside=>inside: 400-500	inside=>outside: 700-700	2	2	Negligible or less than 15km	Negligible or less than 15km	53-65

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	[2300;2800]	[1;2]	0	[-17000;-14000]	0
Scenario Vision 2 - 2030	[2300;2800]	[1;2]	0	[-17000;-14000]	0
Scenario Vision 3 - 2030	[2600;3200]	[18;23]	0	[-34000;-28000]	[-11;-9]
Scenario Vision 4 - 2030	[3000;3700]	[20;25]	0	[-34000;-28000]	[-12;-9]

Additional comments

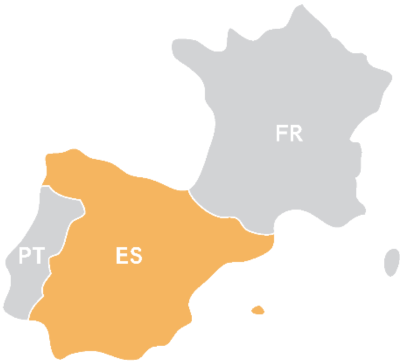
Comment on the security of supply: It is required to secure the supply in the central area of Asturias creating a 400kV ring This project contributes to the security of supply of the Asturias area

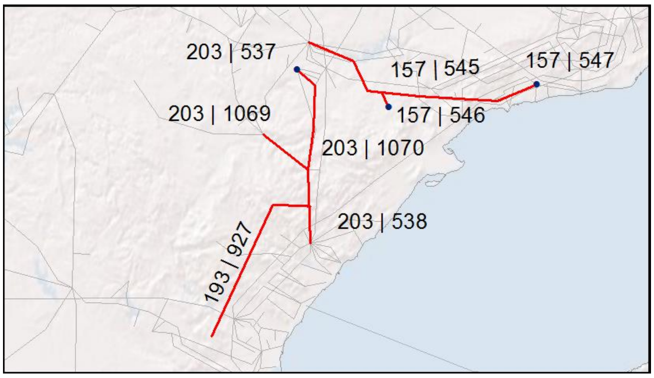
Comment on the RES integration: the effect on RES integration is negligible (hence, a value=0 is given for the RES contribution)

Project 193: Godelleta-Morella/La Plana

Description of the project

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.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
927	La Plana/Morella	Godelleta	New 400 kV axis Godelleta-Morella/La Plana (Spain)	-	Under Consideration	2023	Rescheduled	Investment rescheduled as a result of changes in planning data inputs.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 670-850	South=>North: 1400-1500	2	2	Negligible or less than 15km	Negligible or less than 15km	81-99

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[11;14]	[23000;28000] MWh	[23000;28000]	[-14;-11]
Scenario Vision 2 - 2030	-	[12;15]	[25000;30000] MWh	[25000;30000]	[-15;-12]
Scenario Vision 3 - 2030	-	[120;140]	[880000;1100000] MWh	[350000;430000]	[-210;-170]
Scenario Vision 4 - 2030	-	[290;350]	[3800000;4700000] MWh	[290000;350000]	[-1400;-1200]

Additional comments

Comment on the RES integration: required to solve restrictions that cause spillage of RES energy (onshore wind but mainly solar) in the central eastern part of Spain

Comment on the CO2 indicator: the very high score in Vision 4 reflects that the project directly connects RES sources

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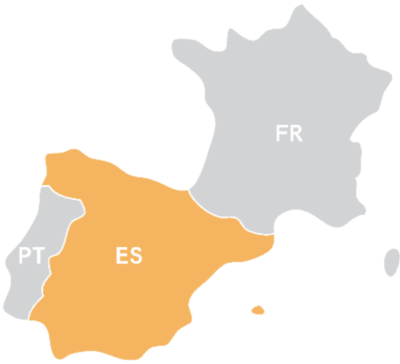
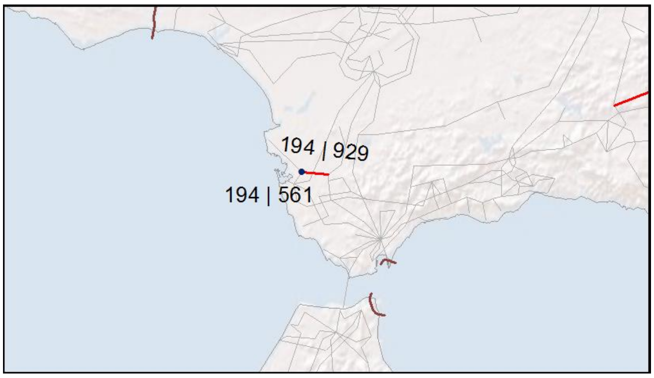
Project 194: Cartuja

Description of the project

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.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
561	Cartuja (ES)		New 400kV substation Cartuja with a 400/220kV transformer.	1320	Under Consideration	2022	Rescheduled	Investment rescheduled as the associated new wind power plants have been postponed
929	Cartuja	Arcos	New double circuit Cartuja-Arcos 400 kV	1320	Under Consideration	2022	Rescheduled	Investment rescheduled as the associated new wind power plants have been postponed

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
South=>North: 425-600	North=>South: 1560-2700	1	2	Negligible or less than 15km	Negligible or less than 15km	31-38

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CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[77;94]	[95000;120000] MWh	[-35000;-29000]	[-420;-340]
Scenario Vision 2 - 2030	-	[81;99]	[100000;120000] MWh	[-37000;-30000]	[-440;-360]
Scenario Vision 3 - 2030	-	[96;120]	[1100000;1400000] MWh	[-1100;-900]	[-460;-380]
Scenario Vision 4 - 2030	-	[99;120]	[1200000;1500000] MWh	[3600;4400]	[-390;-320]

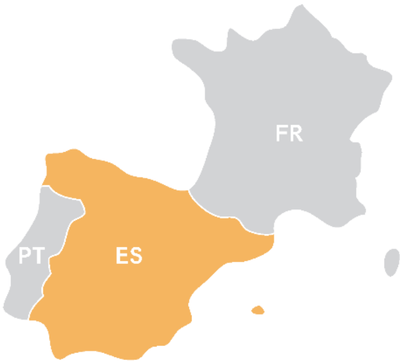
Additional comments

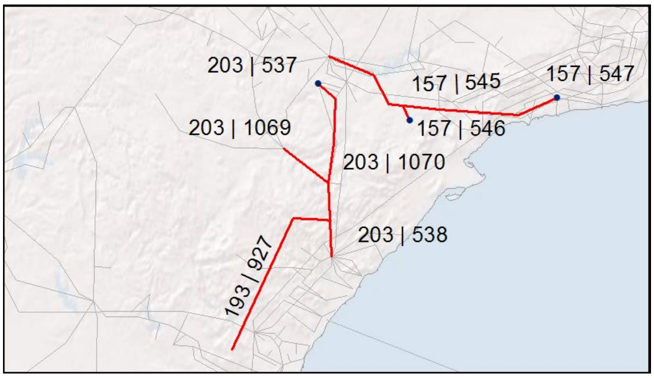
Comment on the RES integration: 400kV Cartuja substation considered direct connection of 400 MW of wind in Vision 1 and 1000 MW in Vision 4

Project 203: Aragón-Castellón

Description of the project

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.
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).





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
537	Mudejar (ES)		New 400kV substation Mudejar and connection to the axis Aragón-Teruel	1420	Design & Permitting	2016	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
538	Morella (ES)	La Plana(ES)	Southern part of the new Cantabric-Mediterranean axis. New double circuit Morella-la Plana 400kV-OHL.	1420	Design & Permitting	2018	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
1069	Mezquita	Morella	Mezquita-Morella 400 kV line	1420	Design & Permitting	2017	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
1070	Mudejar	Morella	OHL 400kV AC Mudejar-Morella	1420	Design & Permitting	2017	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
West=>East: 100-900	East=>West: 1900-2600	2	2	15-50 km	Negligible or less than 15km	150-180

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[52;63]	[25000;30000] MWh	[-89000;-73000]	[-58;-47]
Scenario Vision 2 - 2030	-	[57;70]	[27000;33000] MWh	[-98000;-80000]	[-63;-52]
Scenario Vision 3 - 2030	-	[87;110]	[920000;1100000] MWh	[310000;380000]	[-210;-170]
Scenario Vision 4 - 2030	-	[380;470]	[4800000;5900000] MWh	[490000;600000]	[-1800;-1500]

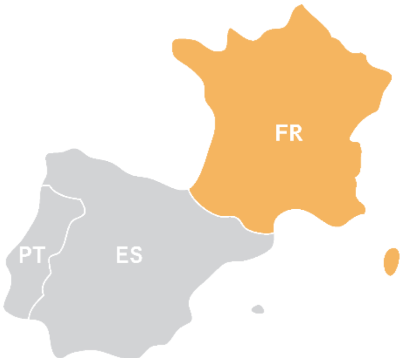
Additional comments

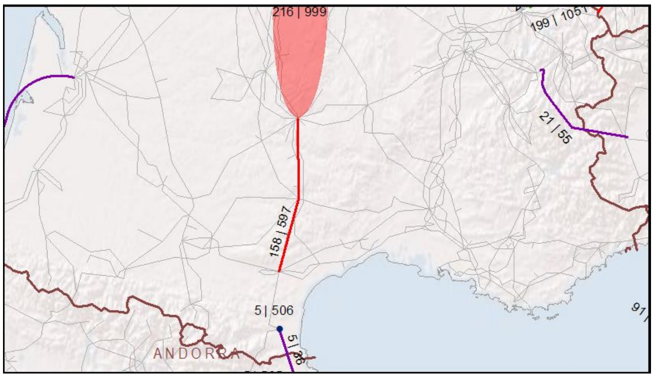
Comment on the RES integration: required to solve restrictions that cause spillage of RES energy (onshore wind and solar) in the areas of Navarra, Aragón and Valencia

Project 158: Massif Central South

Description of the project

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. The project will develop in the north-south direction, mainly consisting of a new 400kV line substituting to the existing one. For visions 3&4, it will be complemented by a northern part (project 216). In TYNDP2012, both parts were described as a single investment.





Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
597	La Gaudière (FR)	Rueyres (FR)	New 175-km 400kV double circuit OHL Gaudière-Rueyres substituting to the existing single circuit 400kV OHL	-	Under Consideration	2023	Investment on time	Studies conducted after TYNDP2012 release have led to better investment definition.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 3300	South=>North: 3800	2	2	NA	NA	300-400

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[18;22]	[90000;110000] MWh	[-41000;-33000]	[-220;-180]
Scenario Vision 2 - 2030	-	[18;22]	[90000;110000] MWh	[-41000;-33000]	[-220;-180]
Scenario Vision 3 - 2030	-	[85;100]	[540000;660000] MWh	[-99000;-81000]	[-770;-630]
Scenario Vision 4 - 2030	-	[85;100]	[540000;660000] MWh	[-99000;-81000]	[-770;-630]

Additional comments

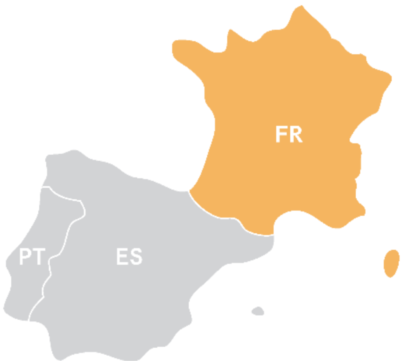
Comment on the RES integration: avoided spillage concerns RES in Massif central, wind farms and hydro.

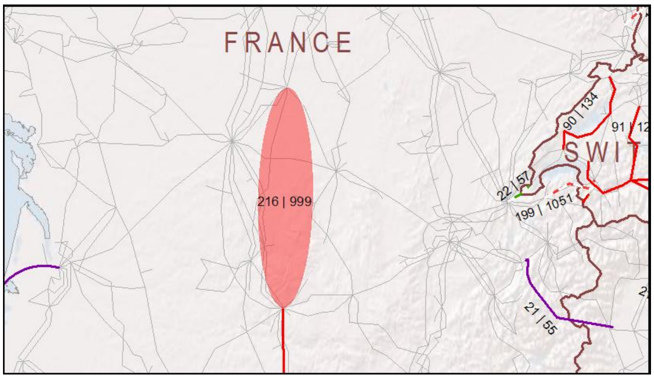
Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

Project 216: Massif Central North

Description of the project

The main driver of the project is the integration of existing and new wind&hydro generation in the Massif Central (France) including possible pump storage. The project will develop in the north to south direction, north of project 158 that it complements.
It is needed only for visions 3 and 4. Studies are ongoing to define the scope of the project.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
999	Marmagne	Rueyres	Erection of a new 400-kV double circuit line substituting an existing 400-kV single circuit line.	-	Under Consideration	2030	Investment on time	This long term investment is only needed for scenarios with high RES development in the area, especially wind and hydro; additional studies are needed for better investment definition.

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 3300	South=>North: 3800	2	2	NA	NA	440-660

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 3 - 2030	-	[85;100]	[540000;660000] MWh	[-230000;-190000]	[-770;-630]
Scenario Vision 4 - 2030	-	[85;100]	[540000;660000] MWh	[-230000;-190000]	[-770;-630]

Additional comments

Comment on the RES integration: voided spillage relates directly to new hydro power plants in Massif central.

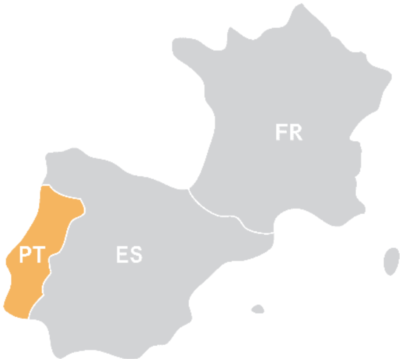
Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

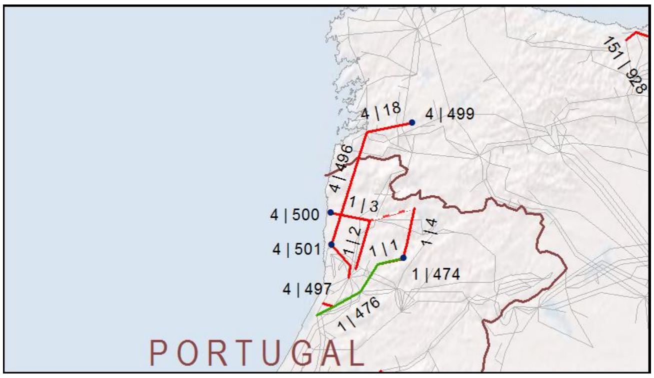
Project 1: RES in north of Portugal

Description of the project

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.

PCI 2.16.1, 2.16.2 and 2.16.3





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1	V.Minho (PT)	Pedralva (PT)	Connection of the new 400kV substation V.Minho to Pedralva substation by means of two new 400kV lines (2x43) km. The realization of this two connections can take advantage of some already existing 150kV single lines, which will be reconstructed as double circuit lines 400+150kV line and partially sharing towers with those 400kV circuits.	1650	Under Construction	2015	Delayed	Although the investment is already under construction some constraints regarding environmental issues led the commissioning date to delay
2	Pedralva (PT)	Sobrado (PT)	New 47km double circuit Pedralva (PT) - Sobrado (PT) 400kV OHL, (only one circuit installed in a first step).	830	Planning	2020	Delayed	Due to the expected delay of the connection of new RES generation in North of Portugal, the commissioning date of this investment item is delayed
3	Pedralva (PT)	V. Castelo (PT)	New 57,5km double circuit Pedralva - V. Castelo 400kV OHL (one circuit installed).	680	Design & Permitting	2015	Investment on time	Progress as planned.
4	V.Minho (by Ribeira de	Feira (by Ribeira de	New 129km double-circuit 400kV OHL V.Minho (PT) -	890	Design & Permitting	2018	Delayed	Due to the expected delay of the connection of new

	Pena and Fridão)	Pena and Fridão)	Ribeira de Pena (PT) - Fridão (PT) - Feira (PT) (one circuit operated at 220kV between V.P. Aguiar and Estarreja) with a new 400/60kV substation in Rib. Pena. In a first step, only the 139km section Rib. de Pena (PT) - Feira (PT) will be constructed and operated at 220kV as Vila Pouca Aguiar (PT) - Carrapatelo (PT) - Estarreja (PT). In a second step, one circuit of this line will be operated at 400kV.					hydro power plants, the commissioning date of this investment item was delayed.
474	Ribeira de Pena (PT)		New 400/60kV substation in Rib. Pena.	890	Design & Permitting	2017	Delayed	Due to the expected delay of the connection of new hydro power plants, the commissioning date of this investment item was delayed.
476	V. P. Aguiar (by Carrapatelo)	Estarreja (by Carrapatelo)	New 400+220kV double circuit OHL (initially only used at 220kV) Vila Pouca Aguiar - (Rib. Pena) - Carrapatelo - Estarreja . Total length of line: 2x (96+49) km. 220kV circuit.	600	Design & Permitting	2017	Delayed	Due to the expected delay of the connection of new RES generation in Portugal, the commissioning date of this investment item is delayed
941	Fridão		New substation to connect a new hydro power plant.	890	Planning	2017	New Investment	No changes expected

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>outside: 3700-5100	outside=>inside: 0-0	1	3	Negligible or less than 15km	15-25km	230-300

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[110;130]	2432 MW	[46000;56000]	[-410;-340]
Scenario Vision 2 - 2030	-	[110;130]	2432 MW	[50000;61000]	[-410;-340]
Scenario Vision 3 - 2030	-	[120;150]	2900 MW	[55000;68000]	[-500;-410]
Scenario Vision 4 - 2030	-	[92;110]	3000 MW	[4100;5100]	[-390;-320]

Additional comments

Comment on the clustering: the project also takes advantage of investment item n°472 depicted in the Regional investment plan.

Comment on the RES integration: This project directly connect connects around 2700MW of new hydro generation (part of them with pumping) in the North of Portugal (Cávado and Tâmega rivers)

Comment on the S1 and S2 indicators: In order to minimize the social and environmental impacts, part of this project is implemented taking advantage of some already existing 150kV single lines, which will be reconstructed as double circuit lines 400+150kV and partially sharing towers with those 400kV circuits.

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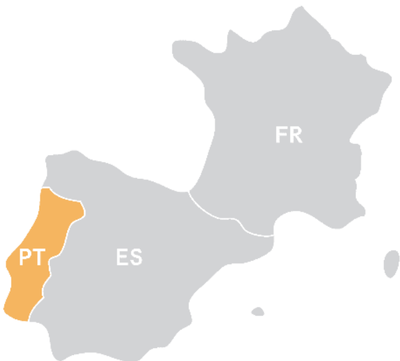
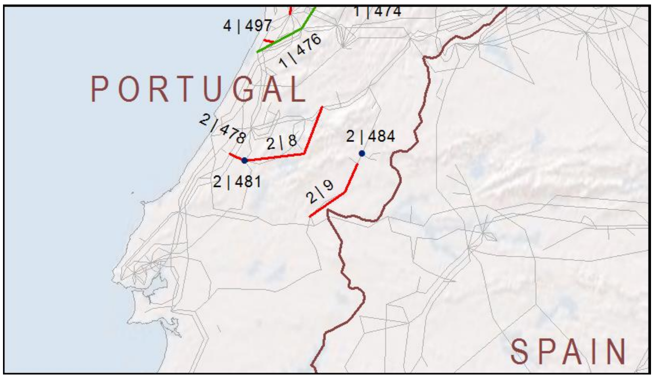
Project 2: RES in centre of Portugal

Description of the project

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).





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
8	Seia	Penela	New single circuit 400kV OHL Seia-Penela (90km).	1780	Design & Permitting	2016	Investment on time	Project on time
9	Fundão (PT)	Falagueira (PT)	New 400kV double circuit OHL Fundão (PT) -'Castelo Branco zone'-Falagueira (PT)	450	Design & Permitting	2017	Delayed	Adjustments resulting from the new date of renewables projects.
478	Penela (PT)	Paraimo / Batalha (PT)	New double circuit 400kV OHL (15km) to connect Penela substation to Paraimo-Batalha line.	1780	Design & Permitting	2016	Investment on time	design & permitting
481	Penela (PT)		Expansion of the existing Penela substation to include 400kV facilities.	1780	Design & Permitting	2016	Investment on time	Design & Permitting
484	Fundão (PT)		New 400/220kV substations in Fundão.	450	Design & Permitting	2017	Delayed	Due to the expected delay on the connection of new RES generation in the centre of Portugal, the commissioning date of this investment item is delayed

CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
upstream=>downstream: 1200-1600	downstream=>upstream: 0-0	1	3	Negligible or less than 15km	Negligible or less than 15km	90-120

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[29;36]	576 MW	[9200;11000]	[-110;-90]
Scenario Vision 2 - 2030	-	[29;36]	576 MW	[10000;12000]	[-110;-90]
Scenario Vision 3 - 2030	-	[76;93]	1000 MW	[17000;21000]	[-320;-260]
Scenario Vision 4 - 2030	-	[63;77]	1050 MW	[1400;1700]	[-260;-210]

Additional comments

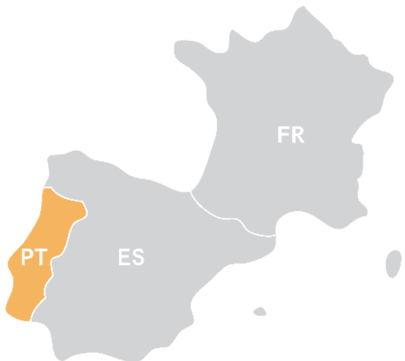
Comment on the clustering:
the project also takes advantage of investment item n°10 now commissioned, and depicted in the Regional investment plan.

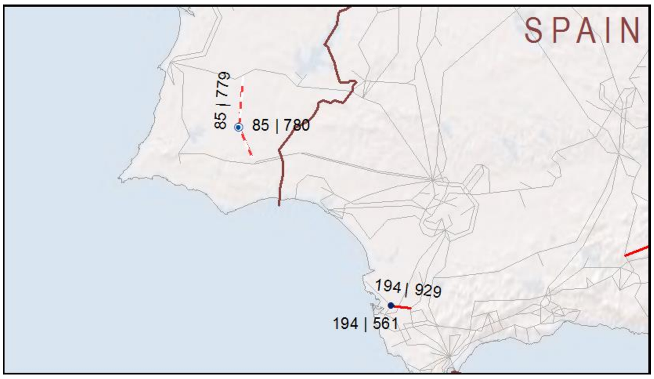
Comment on the RES integration: This project directly connects around 700MW of new hydro generation (part of them with pumping) in the Centre of Portugal (Mondego and Ocreza rivers)

Project 85: Integration of RES in Alentejo

Description of the project

This project integrates new amounts of solar (and also some wind) generation in the south of Portugal. The existing network of 150 kV is not sufficient to integrate these amounts of power and a new 400 kV axis should be launched in this region, establishing a connection between the two Southern interconnections between Portugal and Spain, the Ferreira do Alentejo-Alqueva-Brovales and Tavira-Puebla de Gusman. This axis will also close a ring of 400 kV in the Southern part of Portugal that will guarantee the load growth in the region (Algarve is one of the regions that presents the biggest growth rate in Portugal) in a safe, secure and quality way.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
779	F. Alentejo (by Ourique)	Tavira (by Ourique)	New 122km double-circuit 400+150 kV OHL F. Alentejo-Ourique-Tavira. The realization of this connection can take advantage of some already existing 150kV single lines, which can be reconstructed as double circuit line 400+150kV, investments needs the investment which consist of the extension of existing Ourique substation to include 400 kV facilities.	1400	Planning	2025	Rescheduled	Due to the expected delay on the connection of new RES in Portugal, the commissioning date of this project is delayed
780	Ourique (PT)		Extension of existing Ourique substation to include 400 kV facilities.	1400	Planning	2025	Rescheduled	Due to the expected delay on the connection of new RES in Portugal, the commissioning date of this project is delayed

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CBA results

The tables below summarize the Cost Benefits Analysis results of this project.

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>outside: 1400	outside=>inside: 0	1	2	Negligible or less than 15km	Negligible or less than 15km	50-100

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[22;27]	150 MW	[-9800;-8000]	[-89;-72]
Scenario Vision 2 - 2030	-	[22;27]	150 MW	[-11000;-8800]	[-89;-72]
Scenario Vision 3 - 2030	-	[37;46]	350 MW	[-15000;-13000]	[-150;-120]
Scenario Vision 4 - 2030	-	[120;150]	1350 MW	[41000;50000]	[-490;-400]

Additional comments

Comment on the RES integration: This project directly connect more than 1000MW of new solar generation in the South of Portugal, namely on the Ourique, Ferreira do Alentejo and Tavira area in Vision 4.

Comment on the S1 and S2 indicators: In order to minimize the social and environmental impacts, this project takes advantage of some already existing 150kV single lines, which can be reconstructed as double circuit line 400+150kV

1.2 List of projects and investments

The table below depicts all projects and investments of pan-European and Regional significance within the Continental South West region. The evolution of each investment is monitored since the TYNDP and RgIPs 2012 with updated commissioning dates, status and description of the evolution.

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Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
1	**RES in north of Portugal**								
		941	Fridão		New substation to connect a new hydro power plant.	2017	Planning	New Investment	No changes expected
		1	V.Minho (PT)	Pedralva (PT)	Connection of the new 400kV substation V.Minho to Pedralva substation by means of two new 400kV lines(2x43)km. The realization of this two connections can take advantage of some already existing 150kV single lines, which will be reconstructed as double circuit lines 400+150kV line and partially sharing towers with those 400kV circuits.	2015	Under Construction	Delayed	Although the investment is already under construction some constraints regarding environmental issues led the commissioning date to delay
		2	Pedralva (PT)	Sobrado (PT)	New 47km double circuit Pedralva (PT) - Sobrado (PT) 400kV OHL, (only one circuit installed in a first step).	2020	Planning	Delayed	Due to the expected delay of the connection of new RES generation in North of Portugal, the commissioning date of this investment item is delayed
		3	Pedralva (PT)	V. Castelo (PT)	New 57,5km double circuit Pedralva - V. Castelo 400kV OHL (one circuit installed).	2015	Design & Permitting	Investment on time	Investment on time
		4	V.Minho (by Ribeira de Pena and Fridão)	Feira (by Ribeira de Pena and Fridão)	New 129km double-circuit 400kV OHL V.Minho (PT) - Ribeira de Pena (PT) - Fridão (PT) - Feira (PT) (one circuit operated at 220kV between V.P. Aguiar and Estarreja) with a new 400/60kV substation in Rib. Pena. In a first step, only the 139km section Rib. de Pena (PT) - Feira (PT) will be constructed and operated at 220kV as Vila Pouca Aguiar (PT) - Carrapatelo (PT) - Estarreja (PT). In a second step, one circuit of this line will be operated at 400kV.	2018	Design & Permitting	Delayed	Due to the expected delay of the connection of new hydro power plants, the commissioning date of this investment item was delayed.
		474	Ribeira de Pena (PT)		New 400/60kV substation in Rib. Pena.	2017	Design & Permitting	Delayed	Due to the expected delay of the connection of new hydro power plants, the commissioning date of this investment item was delayed.

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		476	V. P. Aguiar (by Carrapatelo)	Estarreja (by Carrapatelo)	New 400+220kV double circuit OHL (initially only used at 220kV) Vila Pouca Aguiar - (Rib. Pena) - Carrapatelo - Estarreja . Total length of line: 2x(96+49)km. 220kV circuit.	2017	Design & Permitting	Delayed	Due to the expected delay of the connection of new RES generation in Portugal, the commissioning date of this investment item is delayed
2	RES in center of Portugal								
		8	Seia	Penela	New single circuit 400kV OHL Seia-Penela (90km).	2016	Design & Permitting	Investment on time	Project on time
		478	Penela (PT)	Paraimo / Batalha (PT)	New double circuit 400kV OHL (15km) to connect Penela substation to Paraimo-Batalha line.	2016	Design & Permitting	Investment on time	design & permitting
		481	Penela (PT)		Expansion of the existing Penela substation to include 400kV facilities.	2016	Design & Permitting	Investment on time	Design & Permitting
		9	Fundão (PT)	Falagueira (PT)	New 400kV double circuit OHL Fundão (PT) -'Castelo Branco zone'-Falagueira (PT)	2017	Design & Permitting	Delayed	Adjustements resulting from the new date of renewables projects.
		484	Fundão (PT)		New 400/220kV substations in Fundão.	2017	Design & Permitting	Delayed	Due to the expected delay on the connection of new RES generation in the center of Portugal, the commissioning date of this investment item is delayed
3	SoS of Lisbon area								
		12	Rio Maior (by A.Bispo)	Fanhões (by A.Bispo)	New 88km double circuit 400kV OHL feeding Lisbon area from north. A section of this reinforcement (between Rio Maior and Carvoeira zone) will be finished earlier included on a 400+220kV double circuit line linking Rio Maior and Carregado substations.	2021	Planning	Rescheduled	Due to the downward review of the electrical consumption in Portugal, the commissioning date of this project is delayed
		486	Alm. Bispo (PT)		Creation of a 400/220/60kV substation in Almargem do Bispo.	2021	Planning	Rescheduled	Due to the downward review of the electrical consumption in Portugal, the commissioning date of this project is delayed

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		487	Pegões (PT)		New 400/60kV substations in Pegoes.	2018	Design & Permitting	Delayed	Due to the downward review of the electrical consumption in Portugal, the commissioning date of this project is delayed
4	**Interconnection Portugal-Spain**								
		18	Beariz (ES)	Fontefria (ES)	New northern interconnection. New double circuit 400kV OHL between Beariz (ES) - Fontefria (ES).	2016	Design & Permitting	Delayed	Delays in authorization process due to a change on the route and on the location of substations, induced by environmental concerns
		496	Fontefría (ES)	Vila do Conde (PT) (By Viana do Castelo)	New northern interconnection. New 400kV OHL Fontefría (ES) - Viana do Castelo (PT) - Vila do Conde (PT).	2016	Design & Permitting	Delayed	Delays in authorization process due to a change on the route and on the location of substations were induced by environmental concerns
		497	Vila do Conde (PT)	Recarei/Vermoim (PT)	New double circuit 400kV OHL between Vila do Conde (PT) - Recarei/Vermoim (PT).	2015	Design & Permitting	Delayed	Partial sections from the line found environmental problems in his original route. The problems are being solved with the identification of new routes, prompting a delay in the commissioning date.
		498	Fontefria (ES)		New northern interconnection. New 400kV substation Fontefria (ES), previously O Covelo.	2016	Design & Permitting	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 18
		499	Beariz (ES)		New northern interconnection. New 400kV substation Beariz (ES), previously Boboras	2016	Design & Permitting	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 18

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		500	V. Castelo (PT)		New 400/150kV substation V.Castelo (PT).	2016	Design & Permitting	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 496.
		501	Vila do Conde (PT)		New 400kV substation Vila do Conde (PT).	2015	Design & Permitting	Delayed	Delays in the authorization process, due to a change of location of the substation. Timing correlated to investment 497.
5	**Eastern interconnection ES-FR**								
		36	Sta.Llogaia (ES)	Baixas (FR)	New HVDC (VSC) bipolar interconnection in the Eastern part of the border, via 320kV DC underground cable using existing infrastructures corridors and converters in both ending points.	2015	Under Construction	Delayed	Answering all concerns expressed during the authorization process in Spain and environmental issues in France led to postponing the investment. Both issues are solved by now.
		505	Sta.Llogaia (ES)		Converter station of the new HVDC (VSC) bipolar interconnection in the Eastern part of the border, via 320kV DC underground cable using existing infrastructures corridors.	2015	Under Construction	Delayed	Works completed in 2014; commercial operation expected after test period at the same time as the cable (investment 36).

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		506	Baixas (FR)		Converter station of the new HVDC (VSC) bipolar interconnection in the Eastern part of the border, via 320kV DC underground cable using existing infrastructures corridors.	2015	Under Construction	Delayed	Works completed in 2014; commercial operation expected after test period at the same time as the cable (investment 36).
6	North axis project								
		22	Pesoz (ES)	Grado (ES)	North axis Project between Galicia and the Basque Country. New double circuit Pesoz-Salas-Grado 400kV OHL. New input/output in El Palo for RES integration	2014	Design & Permitting	Investment on time	Section Pesoz-Salas. El Palo connection commissioned.
		510	Soto (ES)	Gozon (ES)	North axis Project between Galicia and the Basque Country. Part of the project is considered as the Asturias Ring. Change of voltage level of the existing Soto-Tabiella single circuit from 220kV to 400kV, and connection to Gozon and input/output in Grado.	2017	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		520	Grado (ES)		North axis Project between Galicia and the Basque Country. Part of the project is considered as the Asturias Ring. It includes new 400kV substation Grado.	2014	Design & Permitting	Investment on time	On time
		521	Gozón (ES)		North axis Project between Galicia and the Basque Country. Part of the project is considered as the Asturias Ring. It includes new 400kV substation Gozón, previously Tabiella.	2016	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		526	Solorzano (ES)		North axis Project between Galicia and the Basque Country. New 400kV substation Solorzano.	2015	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		926	PESOZ (ES)	BOIMENTE (ES)	North axis Project between Galicia and the Basque Country. New double circuit Boimente-Pesoz 400 kV OHL	2016	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
7	Cantabric-Mediterranean axis								

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		23	Dicastillo (ES)		Northern part of the new Cantabric-Mediterranean axis. New 400kV substation in Dicastillo with 400/220kV transformer.	2018	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		529	Ichaso (ES)	Castejón (ES)	Northern part of the new Cantabric-Mediterranean axis. New double circuit Castejón-Muruarte-Dicastillo-Ichaso 400kV OHL. Section Castejón-Muruarte 400kV already in service.	2020	Design & Permitting	Delayed	Partly commissioned (Castejón-Muruarte). National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		534	Aragón (ES)	Peñaflor (ES)	Uprating the existing Aragón-Peñaflor 400kV OHL.	2016	Design & Permitting	Delayed	Difficulties in the authorization process and to find suitable periods to carry out the works
		535	Tudela (ES)	Magallón (ES)	Uprating the existing Tudela-Magallón 220kV.	2018	Design & Permitting	Delayed	Reschedule of works due to the commissioning of the FACTs in Magallon-Entrerrios 220 kV
		536	La Serna (ES)	Ichaso (ES)	Uprating the existing axis La Serna-Olite-Tafalla-Orcoyen-Ichaso 220kV.	2017	Design & Permitting	Delayed	Difficulties in the authorization process and to find suitable periods to carry out the works
		532	Magallón (ES)		New CCRS (Combination of Reactors step by step) in Magallón 220 kV, for the Magallón-Entrerios 220kV line.	2014	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		533	Dicastillo (ES)	Moncayo (ES)	New double circuit Dicastillo-El Sequero-Santa Engracia-Magaña-Moncayo 220kV OHL.	2017	Design & Permitting	Investment on time	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
8	**Aragón-Cataluña project**								
		548	Torres del Segre(ES)		New SSSC (Static Synchronous Series Compensator) in Torres del Segre-Mequinenza 220kV.	2014	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP

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		549	Mangraners (ES)	Begues (ES)	New Double circuit Mangraners-Espluga-Montblanc-Penedes-Begues and Mangraners-Juneda-Perafort-Puigpelat-Gove-Viladecans 220 kV	2017	Design & Permitting	Delayed	Delays in the authorization process due to the high number of municipalities affected. National law RDL 13/2012 has frozen the permitting process until publication of the next NDP.
12	**South-North Extremadura axis**								
		566	Guillena (ES)	Almaraz (ES)	New double circuit 400kV OHL Guillena-Brovales-Arroyo S.Servan-Carmonita-Almaraz.	2014	Under Construction	Delayed	Although permitting is already concluded, there were delays in the authorization process due to the high number of the municipalities affected
		567	Arroyo S.Servan (ES)		New 400kV substation in Arroyo S.Servan with 400/220kV transformer.	2014	Under Construction	Delayed	Although permitting is already concluded, there were delays in the authorization process due to high number of municipalities affected
13	**Baza project**								
		31	Caparacena (ES)	La Ribina (ES)	New double circuit Caparacena-Baza-La Ribina 400kV OHL.	2025	Under Consideration	Rescheduled	Investment rescheduled due to, and in accordance with, delayed development of new power plant, as considered in the Master Plan 2020 in progress
		569	Baza (ES)		New 400kV substation in Baza	2025	Under Consideration	Rescheduled	Investment rescheduled due to, and in accordance with, delayed development of new power plant, as considered in the Master Plan 2020 in progress

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		570	La Ribina (ES)		New 400kV substation in La Ribina (will be connected as an input/output in Carril-Litoral 400kV line).	2025	Under Consideration	Rescheduled	Investment rescheduled due to, and in accordance with, delayed development of new power plant, as considered in the Master Plan 2020 in progress
14	**North SuMa project**								
		904	Trives (ES)	Conso (ES)	New circuit Trives-Puente Bibey-Conso	2015	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP.
		574	Tordesillas (ES)	Galapagar (ES)	New double circuit Tordesillas-La Cereal and Tordesillas-Segovia- Galapagar 400kV OHL.	2016	Under Construction	Delayed	Partly commisioned. National law RDL 13/2012 has frozen the permitting process until publication of the next NDP. Concerns in the permitting in Galapagar access
		930	GALAPAGAR (ES)		New PST in Galapagar-Moraleja 400 kV	2016	Design & Permitting	Investment on time	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP.
		576	Loeches (ES)	SSReyes (ES)	Upgrade of the existing 21km single circuit Loeches-SS Reyes 220kV OHL to 400kV in order to increase its capacity.	2019	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP. Necessity of the investment is postponed
		577	Fuencarral (ES)	Galapagar (ES)	Uprate Galapagar-Fuencarral 400kV.	2017	Design & Permitting	Delayed	Investment adapted to the new schedule of some 220 kV works in the area of Madrid
15	**South SuMa project**								
		32	Cofrentes (ES)	Morata (ES)	Uprate Cofrentes-Minglanilla-Belinchon-Morata 400kV.	2017	Design & Permitting	Investment on time	Progress as planned
		584	Picon (ES)	T.Velasco (ES)	Uprate Picon-Aceca-Los Pradillos-Torrejon de Velasco 220 kV.	2016	Design & Permitting	Investment on time	Progress as planned

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		585	Trillo (ES)	Belinchon (ES)	Uprate double circuit Trillo-Villanueva Escuderos-Olmedilla-Belinchon 400kV.	2016	Design & Permitting	Investment on time	Progress as planned
		586	Valdecaballeros (ES)	Arañuelo (ES)	Uprate double circuit Valdecaballeros-Arañuelo 400 kV.	2017	Design & Permitting	Investment on time	Progress as planned
		587	Morata (ES)	Almaraz (ES)	Uprate double circuit Morata-Villamiel-Almaraz 400 kV.	2020	Design & Permitting	Delayed	Investment rescheduled as a result of changes in palnning date inputs (Delays in new CCGTs)
		588	Villaviciosa (ES)	Almaraz (ES)	Uprate double circuit Villaviciosa- Almaraz 400 kV.	2016	Design & Permitting	Investment on time	Progress as planned
		589	Aldeadavila (ES)	Arañuelo (ES)	Uprate double circuit Aldeadavila-Arañuelo 400kV.	2016	Design & Permitting	Investment on time	Progres as planned
		590	Aldeadavila (ES)	Almaraz (ES)	Uprate double circuit Aldeadavila-Hinojosa-Almaraz 400kV.	2016	Design & Permitting	Investment on time	Progress as planned
		591	Añover (ES)	Villaverde (ES)	Uprate Añover-T.Velasco-Pinto Ayuden-El Hornillo-Villaverde 220 kV.	2016	Design & Permitting	Investment on time	Progress as planned
16	**Western interconnection FR-ES**								
		38	Gatica (ES)	Aquitaine (FR)	New HVDC interconnection in the western part of the border via DC subsea cable in the Biscay Gulf.	2022	Planning	Investment on time	The technical consistency of the project progresses and the commissioning date is now defined more accurately.
21	**Italy-France**								
		922	Rondissone (IT)	Trino (IT)	Removing limitations on the existing 380 kV Rondissone-Trino	2019	Planning	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the italian National Development Plan 2013
		923	Lacchiarella(IT)	Chignolo Po(IT)	Removing limitations on the existing 380 kV Lacchiarella-Chignolo Po	2019	Planning	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the italian National Development Plan 2013

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		924	Vado (IT)	Vignole (IT)	Removing limitations on the existing 380 kV Vado-Vignole and Vignole-Spezia	2019	Planning	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the italian National Development Plan 2013
		55	Grande Ile (FR)	Piossasco (IT)	"Savoie - Piémont" Project : New 190km HVDC (VSC) interconnection FR-IT via underground cable and converter stations at both ends (two poles, each of them with 600MW capacity). The cables will be laid in the security gallery of the Frejus motorway tunnel and also along the existing motorways' right-of-way.	2019	Under Construction	Delayed	After some delay in the works of the Frejus service gallery of the motorway, in which the cables will be installed, the project timeline has been updated. Works are already in progress.
22	**Lake Geneva West**								
		57	Genissiat (FR)	Verbois (CH)	Reconductoring of the exisiting 225kV double circuit line Genissiat-Verbois with high temperature conductors.	2020	Planning	Investment on time	-
23	**France-Belgium Phase 1**								
		60	Avelin/Mastaing (FR)	Horta (new 400-kV substation) (BE)	Replacement of the current conductors on the axis Avelin/Mastaing - Avelgem - Horta with high performance conductors (HTLS = High Temperature Low Sag)	2023	Planning	Rescheduled	Investment was at conceptual stage in TYNDP2012; on-going feasibility studies lead to a more accurate commissioning date.
25	**IFA2**								
		62	Tourbe (FR)	Chilling (GB)	New subsea HVDC VSC link between the UK and France with a capacity around 1000 MW. PCI 1.7.2 (NSCOG corridor)	2020	Design & Permitting	Investment on time	Extensive feasibility studies (e.g. seabed surveys) have been conducted to determine the most suitable route; on the French side, the ministry of energy acknowledged the notification of the investment on 08/04/14.
85	**Integration of RES in Alentejo**								

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		779	F. Alentejo (by Ourique)	Tavira (by Ourique)	New 122km double-circuit 400+150 kV OHL F. Alentejo-Ourique-Tavira. The realization of this connection can take advantage of some already existing 150kV single lines, which can be reconstructed as double circuit line 400+150kV, investments needs the investment which consist of the extension of existing Ourique substation to include 400 kV facilities.	2025	Planning	Rescheduled	Due to the expected delay on the connection of new RES in Portugal, the commissioning date of this project is delayed
		780	Ourique (PT)		Extension of existing Ourique substation to include 400 kV facilities.	2025	Planning	Rescheduled	Due to the expected delay on the connection of new RES in Portugal, the commissioning date of this project is delayed
107	**Celtic Interconnector**								
		810	Great Island or Knockraha (IE)	La Martyre (FR)	A new HVDC subsea connection between Ireland and France	2025	Under Consideration	Investment on time	Feasibiliity studies are progressing
128	**RES in center of PT**								
		942	Guarda (PT)	Fundão (PT)	New 400KV OHL between Guarda and Fundão (70Km)	2022	Planning	New Investment	No changes
		477	Ribeira de Pena (PT)	Guarda (PT)	New 192km double/single-circuit 400kV OHL Ribeira de Pena (PT) - Guarda (PT). In a first step, only 75 km will be constructed and operated at 220 kV between Vila Pouca de Aguiar and Macedo de Cavaleiros, in a second step one circuit of this line will be operated at 400 kV. A single line will be constructed between Macedo de Cavaleiros zone and Pocinho zone also between Pocinho zone and Chafariz zone a double circuit 400 kV OHL will be constructed (only one circuit installed in a first step), this last line will use one circuit of the line Seia - Guarda to establish the line Ribeira de Pena (PT) - Guarda (PT).	2025	Planning	Rescheduled	Due to the expected delay of the connection of new RES generation in North and Center of Portugal, the commissioning date of this project is delayed

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		479	Seia (PT)		New 400/60kV substation at Seia.	2021	Design & Permitting	Delayed	Due to the expected delay on the connection of new RES generation in the Center of Portugal, the commissioning date of this project is delayed
		483	Guarda (PT)		New 400/60kV substations in Guarda.	2022	Design & Permitting	Delayed	Due to the expected delay on the connection of new RES generation in the Center of Portugal, the commissioning date of this project is delayed
		485	Seia (PT)	Guarda (PT)	New double circuit 400kV OHL Seia-Guarda (55km)	2025	Planning	Rescheduled	Due to the expected delay on the connection of new RES generation in the Center of Portugal, the commissioning date of this project is delayed
151	**Asturian Ring**								
		522	Sama (ES)		New 400kV substation Sama in the new Asturias Ring with connection to Lada and a new reactance.	2026	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		523	Reboria (ES)		New 400kV substation Reboria in the Asturian ring with 2 transformers 400/220 kV	2026	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		524	Costa Verde (ES)		New 400kV substation Costa Verde in the Asturian Ring with 2 new transformer units 400/220 kV	2026	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)

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		928	GOZON (ES)	SAMA (ES)	Asturian Ring. New double circuit Gozon-Reboria-Costa Verde-Sama 400 kV	2026	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
152	**France Germany Interconnection**								
		988	Vigy	Ensdorf or further (tbd)	Upgrade of the existing Vigy Ensdorf (Uchtelfangen) 400 kV double circuit OHL to increase its capacity.	2030	Under Consideration	New Investment	Commissioning date will result from the on-going technical feasibility under investigation.
		989	Muhlbach	Eichstetten	Operation at 400 kV of the second circuit of a 400kV double circuit OHL currently operated at 225 kV ; some restructuration of the existing grid may be necessary in the area.	2026	Under Consideration	New Investment	Studies in progress showed the feasibility of upgrading the existing asset in order to provide mutual support to Alsace and Baden and some exchange capacity increase between France and Germany. The detailed timeline of the investment is under definition.
153	**France-Alderney-Britain**								
		987	Cotentin Nord	Exeter	France-Alderney-Britain (FAB) is a new 220km-long HVDC subsea interconnection between Exeter (UK) and Cotentin Nord (France) with VSC converter station at both ends. Expected rated capacity is 2*700 MW.	2022	Planning	New Investment	Studies conducted after TYNDP2012 release have shown the economic viability of this interconnection and lead to develop this investment. Feasibility studies (marine surveys)are starting to find a suitable subsea route.
154	**La Serna-Magallón**								
		531	La Serna (ES)	Magallón (ES)	New double circuit La Serna-Magallón 400kV OHL.	2028	Under Consideration	Rescheduled	not profitable by 2020. Other projects in project portfolio, such as investment 535 and 532, evaluated as more critical.
155	**Sevilla Ring**								

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		30	Don Rodrigo (ES)	Guadaira (ES)	New double circuit 400kV OHL: Guadaira-Don Rodrigo.	2029	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction)
		565	Guadaira (ES)		New 400kV substations in Guadaira with 400/220kV transformer.	3029	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction)
156	**Aragón-Catalonia north**								
		25	Aragón (ES)	Isona (ES)	New double circuit Aragón/Peñalba-Arnero-Isona 400kV OHL.	2029	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		543	Arnero (ES)		New 400kV substation Arnero with a 400/220kV transformer.	2029	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		552	Isona (ES)	Calders (ES)	Uprate Isona-Calders single circuit 400kV OHL	2029	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
157	**Aragón-Catalonia south**								
		545	Escatron (ES)	La Secuita (ES)	New single circuit Escatrón-Els Aubals-La Secuita 400kV OHL.	2027	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)

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		546	Els Aubals (ES)		New 400kV substation in Els Aubals.	2027	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		547	La Secuita (ES)		New 400kV substation in La Secuita with 400/220kV transformer.	2027	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
158	**Massif Central South**								
		597	La Gaudière (FR)	Rueyres (FR)	New 175-km 400kV double circuit OHL Gaudière-Rueyres substituting to the existing single circuit 400kV OHL	2023	Under Consideration	Investment on time	Studies conducted after TYNDP2012 release have led to better investment definition.
159	**Transmanchega phase2**								
		33	Romica (ES)	Manzanares (ES)	Transmanchega project;phase 2. New double circuit line Romica-Manzanares 400kV OHL.	2030	Under Consideration	Rescheduled	Investment postponed as a result of changes in planning data inputs(need delayed attached to new RES delays, at least in vision 1)
160	**Madrid Ring Reinforcement**								
		575	Moraleja	Galapagar-Segovia	New input/output of Moraleja in Segovia-Galapagar 400kV OHL	2030	Under Consideration	Rescheduled	Investments postponed as a result of changes in planning data inputs (need delayed, at least in vision 1)
161	**Olmedilla-Valdemingomez**								
		580	Olmedilla (ES)	Morata (ES)	New double circuit Olmedilla-Villares-Morata-Valdemingomez 400kV OHL.	2030	Under Consideration	Rescheduled	Investment rescheduled as result of changes in planning data inputs (Delays in new power plants and demand reduction)

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		581	Valdemingomez (ES)		New substation Valdemingomez 400/220kV, with 2 transformers 400/220 KV and connections Valdemingomez-Villaverde 220 KV with underground cables	2030	Under Consideration	Rescheduled	30% GTC of the main investment
172	**ElecLink**								
		1005	Sellindge (UK)	Le Mandarins (FR)	Eleclink is a new FR – UK interconnection cable thought the channel Tunnel between Selindge (UK) and Mandarins (FR). Converter stations will be located on Eurotunnel concession at Folkestone and Coquelles. This HVDC interconnection is a PCI project (Project of common interest). It will increase by 1GW the interconnection capacity between UK and FR by 2016.	2016	Design & Permitting	New Investment	
173	**FR-BE phase 2**								
		1008	tbd(FR)	tbd(BE)	The following (combination of) options are envisioned and will be further studied: - Lonny-Achène-Gramme (reconductoring with High Temperature Low Sag conductors or HVDC) - Capelle-Courcelles (HVDC) - Warande-Zeebrugge/Alfa (HVDC)	2030	Under Consideration	New Investment	Preliminary analyses show the need for an additional reinforcement in visions 3 & 4 (2030) between France & Belgium , complementary to project # 23.
182	**BRITIB (GB-FR-ES)**								
		1111	Gatica	Indian Queens	Interconnection project between Indian Queens (Great Britain), Cordemais (France) and Gatica (Spain) in a multiterminal HVDC configuration with 3 sections of 1000 MW each, and a submarine route from Spain to Great Britain along the french coast.	2017	Under Consideration	New Investment	Project application to TYNDP 2014.
184	**PST Arkale**								

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		594	Arkale (ES)		New PST in Arkale-Argia 220 kV interconnection line	2016	Planning	Investment on time	Draft NDP expected to be published during the preparation of TYNDP 2012 was not finally approved and published, so the investment is yet in a planning stage. If the new NDP is published by 2014, as expected, commissioning date would not be affected.
193	**Godelleta-Morella/La Plana**								
		927	La Plana/Morella	Godelleta	New 400 kV axis Godelleta-Morella/La Plana (Spain)	2023	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs.
194	**Cartuja**								
		561	Cartuja (ES)		New 400kV substation Cartuja with a 400/220kV transformer.	2022	Under Consideration	Rescheduled	Investment rescheduled as the associated new wind power plants have been postponed
		929	Cartuja	Arcos	New double circuit Cartuja-Arcos 400 kV	2022	Under Consideration	Rescheduled	Investment rescheduled as the associated new wind power plants have been postponed
195	**Almazan-Medinaceli**								
		1046	Almazan	Medinaceli	new 400kV axis Almazan-Medinaceli	2028	Under Consideration	New Investment	new requirement attached to RES flow integration
196	**Supply to Cordoba**								
		1047	Cordoba	Cordoba	input/output of Cordoba subestation in the 400 kV line Cabra -Guadame	2023	Under Consideration	New Investment	need of support the demand in Cordoba
		562	Cordoba (ES)		New 400kV substation Cordoba with a 400/220kV transformer.	2023	Design & Permitting	Delayed	Cordoba connection postponed in the national Master Plan as need for demand is not inmminent.
199	**Lake Geneva South**								

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		1051	CORNIER (FR)	CHAVALON (CH)	Upgrade of the double circuit 225 kV line between Cornier (France) and Riddes and Saint Triphon (Switzerland) to a single circuit 400 kV line between Cornier and Chavalon (Switzerland). In order to take most benefit from this, the existing 400 kV Genissiat substation will be connected in/out to the existing line Cornier-Montagny.	2025	Under Consideration	New Investment	grid studies conducted after TYNDP2012 release allowed to define the investment
202	**Cofrentes-Pinilla**								
		28	Cofrentes (ES)	Ayora (ES)	New single circuit Cofrentes-Ayora 400kV OHL.	2016	Design & Permitting	Delayed	Delays in the authorization process due to rearrangement of the project (sharing of towers with an existing line, to avoid new ROW in protected areas).
		556	Ayora (ES)	Pinilla (ES)	New single circuit Ayora-Campanario-Pinilla 400kV OHL.	2016	Design & Permitting	Delayed	Delays in the authorization process due to rearrangement of the project (sharing of towers with an existing line, to avoid new ROW in protected areas).
		557	Campanario (ES)		New 400kV substation in Campanario.	2016	Design & Permitting	Delayed	Timing correlated to investment 556
203	**Aragón-Castellón**								
		1069	Mezquita	Morella	Mezquita-Morella 400 kV line	2017	Design & Permitting	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		1070	Mudejar	Morella	OHL 400kV AC Mudejar-Morella	2017	Design & Permitting	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		537	Mudejar (ES)		New 400kV substation Mudejar and connection to the axis Aragón-Teruel	2016	Design & Permitting	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		538	Morella (ES)	La Plana(ES)	Southern part of the new Cantabric-Mediterranean axis. New double circuit Morella-la Plana 400kV-OHL.	2018	Design & Permitting	Delayed	Delayed because National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
213	**Santa Llogaia - Bescano**								
		1068	Bescanó	Santa Llogaia	New OHL 400kV AC double circuit Bescano-Santa Llogaia, required to connect the new HVDC interconnection to the existing network and secure the supply in the area of Gerona	2014	Under Construction	Investment on time	Progress as planned
		508	Ramis (ES)		New 400kV substation in Ramis with two 400/220kV transformers; connection as input/output in Santa Llogaia - Bescano line	2015	Design & Permitting	Delayed	Answering all concerns expressed during the authorization process led to postponing the investment.
		509	Santa Llogaia (ES)		New 400kV substation Sta.Llogaia.	2014	Under Construction	Delayed	Answering all concerns expressed during the authorization process led to postponing the investment.
216	**Massif Central North**								
		999	Marmagne	Rueyres	Erection of a new 400-kV double circuit line substituting an existing 400-kV single circuit line.	2030	Under Consideration	Investment on time	This long term investment is only needed for scenarios with high RES development in the area, especially wind and hydro; additional studies are needed for better investment definition.

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		503	JM Oriol (ES)	Arenales - Caceres (ES)	New 220kV JM Oriol-Arenales-Caceres	2017	Design & Permitting	Delayed	Delays due to change of the definition of the project. National law RDL 13/2012 has frozen the permitting process until publication of the next NDP.
		504	Arenales (ES)		New Arenales substation.	2017	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		906	Galapagar		Phase Shifter Transformer Galapagar 400kV, affecting to the line Galapagar-Moraleja 400kV	2013	Design & Permitting	Investment on time	Progress as planned
		961	Muhlbach	Scheer	New 400kV line substituting to existing 225kV line in Alsace area. Several solutions are under consideration and some restructuration of the 225 kV grid may be needed in the area. This investment is only needed in vision 4.	2030	Under Consideration	New Investment	This investment is needed only in vision4; triggered by high north-west to south-east flows in eastern France (from Lorraine and northern border to Alsace, southern Germany and Switzerland)
		962	Vigy	Marleinheim	Operation at 400kV of the second circuit of a 112-km existing 400 kV line currently operated at 225kV, with some restructuration of the 225-kV grid in the area.	2030	Under Consideration	New Investment	This investment is needed only in vision4; triggered by high north-west to south-east flows in eastern France (from Lorraine and northern border to Alsace, southern Germany ans Switzerland)
		963	Vigy	Bezaumont	Operation at 400 kV of the second circuit of a 40-km existing 400 kV line currently operated at 225 kV.	2030	Under Consideration	New Investment	This investment is needed only in vision4; triggered by high north-west to south-east flows in eastern France (from Lorraine and northern border to Alsace, southern Germany ans Switzerland)

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		964	Creney	Vielmoulin	Upgrade of an existing single-circuit 400 kV line in Bourgogne. Accurate scope of the investment should be defined taking into account congestion in specific scenarios (visions 3 & 4) and refurbishment needed on existing assets in the area.	2030	Under Consideration	New Investment	Increase of grid capacity is needed only in visions 3 & 4, triggered by high north-west to south-east flows in eastern France; also possible needs for refurbishment of existing assets in the area.
		980	Rossignol		New 400kV substation east of Paris and associated connections to existing grid. This investment is needed only in visions 3 & 4, in order to balance flows on the north-eastern Paris 400-kV ring.	2030	Under Consideration	New Investment	new investment needed in the long run for visions 3 & 4 to balnce flows on the north-eastern Paris 400-kV ring.
		981	Chesnoy (FR)	Cirolliers (FR)	Reconductoring Chesnoy-Cirolliers existing 400kV OHL with high temperature conductors in order to strengthen the south-western part of Parsi 400-kV ring. This long term investment is needed only in visions 3&4.	2030	Under Consideration	New Investment	This long term investment is needed only in visions 3 & 4 in order to strentgthen the south-western part of Paris 400-kV ring.
		982	Chaingy (FR)	Dambron (FR)	New 26-km double circuit 400kV line in Loiret department, substituting to two existing 225kV lines. this investment is needed in order to cope with south-north flows to Paris area.	2030	Under Consideration	New Investment	recent studies showed the need to strengthen the grid in the area in order to cope with south-north flows to Paris area.
		1078	Muhlbach		Two 400 kV phase-shifters will be installed in an existing substation in order to mitigate the flows when decommissioning Fessenheim nuclear power station.	2016	Design & Permitting	New Investment	these PST are part of the grid restructuration following the decommissioning of Fessenheim nuclear power plant.
		1079	Alsace		Installation of 320 MVARs of capacitors and 2 reactances of 64-MVAR in Alsace for voltage support after decommissioning Fessenheim nuclear power station.	2016	Design & Permitting	New Investment	The investment is triggered by the decommisioning of Fessenheim nuclear power station.
		1080	Scheer		in-out connection of Scheer 400kV existing substation to the existing line Bezaumont-Muhlbach. This investment is needed for securing the area after the decomissioning of Fessenheim power station.	2017	Design & Permitting	New Investment	this investment is needed after Fessenheim nuclear power station decommisioning.

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		1081	Muhlbach	Scheer	Ampacity increase of existing 400 kV Muhlbach-Scheer line	2016	Design & Permitting	New Investment	This investement is needed after the decommisioning of Fessenheim power station.
		1098	Creney (FR)	Mery-sur-Seine (FR)	Reconductoring an existing 25-km single circuit 400 kV line in Bourgogne area.	2030	Under Consideration	New Investment	Accurate scope of the investment to be defined taking into account congestion in specific scenario (visions 3 & 4) and refurbishment needed on existing asset.
		983	tbd	tbd	Restructuration/development of the 400kV grid south of Paris area, needed for visions 3 & 4. Several solutions are under consideration inlvolving either new axis or reconductoring of existing assets.	2030	Under Consideration	New Investment	Recent studies for visions 3 & 4 have shown the need for strengthening the southern part of the Paris 400 kV ring, either by creating a new line or by increasing the capacity of the exisitng assets.
		472	V. Minho (PT)		New 400kV station in V. Minho	2014	Under Construction	Investment on time	Under construction
		563	Cartuja-Pto Sta Maria (ES)	Facinas (ES)	New 52km axis 220 kV OHL Cartuja/Puerto Sta Maria-Pto.Real-Parralejo	2017	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP)
		571	Caparacena (ES)	Litoral (ES)	The existing single circuit Litoral-Tabernas-Hueneja-Caparacena 400kV line will be uprated in order to increase its capacity .	2017	Under Construction	Delayed	Final phase of permiting, although there are difficulties to find a suitable period for a planned outages to carry out the work
		592	Amorebieta (ES)	Gueñes (ES)	Uprates required in basque country in order to use fully the benefit of the longterm ES-FR interconnection.	2022	Planning	Rescheduled	investment correlated to the Long Term reinforcement ES-FR
		593	Adrall (ES)	La Pobla (ES)	Uprates required in Catalonia in order to integrate RES and avoid restrictions in the ES-FR exchange capacity.	2018	Design & Permitting	Delayed	Investment rescheduled as a result of changes in planning data inputs
		42	Lonny (FR)	Vesle (FR)	Reconstruction of the existing 70km single circuit 400kV OHL as double circuit OHL.	2016	Design & Permitting	Investment on time	-

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		44	Havre (FR)	Rougemontier (FR)	Reconductoring of existing 54km double circuit 400kV OHL to increase its capacity in order to integrate new generation.	2018	Under Construction	Investment on time	the investment progresses according to the pace of new generation installation in the area.
		596	Cergy (FR)	Terrier (FR)	Upgrade of an existing 35-km 225 kV line to 400-kV between Cergy and Persan (north-western Paris area) and connection to Terrier via an existing 400kV line.	2018	Design & Permitting	Investment on time	In TYNDP2012, project consisted in a new 400kV line between Cergy and Terrier but further found out upgrade and restructuration of existing assets as the most feasible solution.
		598	La Gaudière (FR)	Bouches du Rhone area (FR)	New 220-km subsea HVDC link between Marseille area and Languedoc.	2020	Design & Permitting	Delayed	investment is delayed by 2 years due to longer than expected permitting process regarding converter stations location; also cable qualification longer than expected.
		51	Biancon (FR)	La Bocca (FR)	Part of the PACA "Safety net" project: construction of a new AC 220kV underground cable Biançon - La Bocca.	2015	Under Construction	Investment on time	Investment progresses as planned.
		599	Biancon (FR)	Frejus (FR)	Part of the PACA "safety net" project: new 24-km 220-kV AC underground cable Biancon - Fréjus	2015	Under Construction	Investment on time	Investment progressesas planned.
		600	Trans (FR)	Boutre (FR)	Part of the PACA "safety net" project: new 65-km 220-kV AC underground cable Boutre-Trans	2015	Under Construction	Investment on time	Investment progresses as planned.
		10	Falagueira (PT)	Pego (PT)	To be moved to RgIP - New 40km double circuit 400+150kV OHL Falagueira-Pego 2, substituting an existing 150kV line.	2019	Design & Permitting	Delayed	Due to the expected delay on the connection of new RES generation in the Center of Portugal, the commissioning date of this project is delayed
		53	Coulange (FR)	Le Chaffard (FR)	Reconductoring (with ACCS / ACCR) of two existing double circuit 400kV OHL (Coulange - Pivoz-Cordier - Le Chaffard and Coulange - Beaumont-Monteux - Le Chaffard). Total length of both lines: 275km	2016	Under Construction	Investment on time	Investment progresses as planned.

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		602	Avelin (FR)	Mastaing (FR)	Operation at 400 kV of existing line currently operated at 220 kV	2017	Design & Permitting	Investment on time	investment progresses as planned
		603	Avelin (FR)	Gavrelle (FR)	An existing 30-km 400-kV single circuit OHL in Lille area will be substituted by a new double-circuit 400kV OHL.	2017	Design & Permitting	Investment on time	progresses as planned.
		27	Santa Ponsa (ES)	Torrent (ES)	Connection of Balearic Islands to Mainland Mallorca will be connected to Ibiza with a new AC submarine line 120km link between Santa Ponsa (Mallorca) and Torrent (Ibiza).	2014	Design & Permitting	Investment on time	Mallorca-Mainland commissioned. Rest progress as planned
		822	Mallorca (ES)	Ibiza (ES)	2 AC 132 kV connections between Mallorca and Ibiza (120km)	2016	Design & Permitting	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP
		823	Sud-Aveyron (FR)		New 400-kV substation connected to existing 400-kV grid in Massif Central area and equipped with 400/225 transformers	2018	Design & Permitting	Delayed	some delay in the permitting process due to in-situ technical studies postponment
		825	Somme (FR)		New 400-kV substation connected to existing 400-kV network and equipped with transformers to 220 kV or high voltage networks in order to connec new on-shore wind generation.	2015	Under Construction	Investment on time	investment progresses as planned.
		20	Arkale (ES)	Hernani (ES)	Uprating the existing single circuit Arkale-Hernani n°2 220kV OHL in order to increase its capacity up to 640 MVA.	2015	Design & Permitting	Delayed	progress as planned
		512	Sama (ES)	Velilla (ES)	New OHL 400 kV ACdouble circuit Sama-Velilla (Spain), required to solve restrictions of the lines between Asturias and the central part of the country.	2026	Under Consideration	Rescheduled	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		516	Gueñes (ES)	Ichaso (ES)	New OHL 400Kv ac double circuit Gueñes/Abanto-Ichaso (Spain). required to strenght the network for higher NTC ES-FR and finalize the north axis required for internal market issues.	2020	Planning	Delayed	National law RDL 13/2012 has frozen the permitting process until publication of the next NDP

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		551	Garraf (ES)	Vandellos (ES)	Uprate axis Garraf-La Secuita-Vandellos 400kV	2027	Design & Permitting	Delayed	Investment rescheduled as a result of changes in planning data inputs (demand reduction and projects of new thermal units are in stand by)
		789	offshore wind farms (FR)	several French substations (FR)	AC 225-kV subsea cables and substations works for connecting to shore French offshore windfarms in order to comply with the 2020 objective.	2020	Design & Permitting	Investment on time	Investment will develop step by step according to the pace of offshore wind generation installation; two calls for tenders have already been issued.
		790	Calan (FR)	Plaine-Haute (FR)	Part of "Brittany safety net" : new 80km single circuit 220kV underground cable between existing stations Calan and Plaine Haute, with T-connection in Mur de Bretagne (existing HV substation where 220-kV voltage will be implemented)	2017	Design & Permitting	Investment on time	Investment progresses as planned.
		791	Mur de Bretagne (FR)		New 220 kV phase shifter in Mur de Bretagne, part of the "Brittany safety net".	2017	Design & Permitting	Investment on time	In TYNDP 2012 this investment was included in the 89.A24 investment.
		792	Brennilis (FR)		New 220 kV phase shifter in Brennilis ; part of "Brittany safety net".	2014	Design & Permitting	Expected earlier than planned previously	The investment develops in time : in TYNDP 2012 several investments were merged in 89.A24; 2017 was the commisioning date of the last piece of investment.
		794	Plaine-Haute (FR)		New transformer 400/220kV in existing substation ; part of "Brittany safety net".	2015	Design & Permitting	Expected earlier than planned previously	In TYNDP2012, this investment was included in investment 89.A24 and only the date of the last piece of investment was given.
		883	Torernte (Ibiza)	Formentera	New double circuit Ibiza-Formentera 132 kV	2016	Design & Permitting	Investment on time	Progress as planned

1.3 List of commissioned investments from TYNDP and RgIPs 2012

Investment ID	TYNDP 2012 index	from substation name	to substation name	short description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
5	1. 5	Macedo de Cavaleiros (By Valpaços)	Vila Pouca de Aguiar (By Valpaços)	Macedo de Cavaleiros (PT) -Valpaços (PT) - Vila Pouca de Aguiar (PT)	2013	Commissioned	Commissioned	Project commissioned
29	11. 29	Arcos (ES)	Guadame (ES)	New double circuit Arcos de la Frontera-La Roda-Cabra-Cordoba-Guadame 400kV OHL (partly already commissioned).	2013	Commissioned	Commissioned	Investment on time
45	17. 45	Taute (FR)	Oudon (FR)	"Cotentin-Maine "Project : new 163km double circuit 400kV OHL connected to existing network via two new substations in Cotentin and Maine regions.	2013	Commissioned	Commissioned	-
48	18. 48	Gaudière (FR)	Rueyres (FR)	Reconductoring with ACCS	2012	Commissioned	Commissioned	investment commisioned as expected.
54	21. 54	Cornier (FR)	Piossasco (IT)	Replacement of conductors (by ACCS) on existing grid	2013	Commissioned	Commissioned	Investment commissioned on time.
821	27	Morvedre (ES)	Santa Ponsa (ES)	TO BE DELETED- COMMISSIONED FOR TYNDP 2012	2011	Commissioned	Commissioned	commissioned
41	41	Fruges (FR)		New 400-kV substation connected to existing grid	2013	Commissioned	Commissioned	investment commisioned as planned
19	5. 19	Vic (ES)	Pierola (ES)	Uprating the single circuit Vic-Pierola 400kV line in order to increase its capacity from 1360 MVA to 1710 MVA.	2012	Commissioned	Commissioned	Commissioned
52	52	Feuillane (FR)	Realtor	Operation at 400 kV of existing 220-kV line	2012	Commissioned	Commissioned	Works are completed, as the line was already designed for operation at 400-kV ; the line will be commissiond at 400kV after some operational measures.
61	61	Moulaine (FR)	Belval (LU)	Connection of SOTEL to the French grid	2013	Commissioned	Commissioned	The permitting process came to an end in Luxembourg so that the investment was completed and commissioned.The French part was already built when TYNDP2012 was released.

793	89. A24	Brittany (FR)		Installation of more than 1000 MVARs of capacitors and SVC.	2013	Commissioned	Commissioned	In TYNDP2012, this investment was included in Brittany saftey net (89.A24); the commissioning date was that of the last piece of investment.
554	9. 26	Catadau (ES)		A transformer will be installed in Catadau.	2013	Commissioned	Commissioned ahead of time	Real time needs forced to bring the project forward.
550	8. A8	Puigpelat (ES)	Penedes (ES)	Uprate axis Puigpelat-Penedes 220kV OHL	2013	Commissioned	Commissioned	Commissioned
530	7. 23	Muruarte (ES)		Northern part of the new Cantabric-Mediterranean axis. New 400kV substation in Muruarte with 400/220kV transformer.	2012	Commissioned	Commissioned ahead of time	Comissioning date TYNDP2012 referred to the full completion of the project. As set in the description: "Section Castejón-Muruarte 400 kV is already in service"
540	7. 24	Mezquita (ES)		Southern part of the new Cantabric-Mediterranean axis. New 400kV substation Mezquita.	2013	Commissioned	Commissioned	Commissioned
542	7. 24	Muniesa (ES)		Southern part of the new Cantabric-Mediterranean axis. New 400kV substation Muniesa.	2013	Commissioned	Commissioned	Commissioned
24	7. 24	Fuendetodos (ES)	Mezquita (ES)	Fuendetodos-Mezquita.	2013	Commissioned	Commissioned	progress as planned
46	5. 46	Baixas (FR)	Gaudière (FR)	Reconductoring of existing line	2013	Commissioned	Commissioned	Investment commisioned on time.
488	4. 16	Lagoaça (PT)		New Lagoaça substation (PT).	2010	Commissioned	Commissioned	Commissioned
489	4. 16	Lagoaça (PT) (By Armamar)	Recarei (PT) (By Armamar)	Lagoaça-Armamar-Recarei 400kV in PT.	2013	Commissioned	Commissioned	Lagoaca-Armamar was already commissioned in 2010. Armamar-Recarei was commissioned in 2013.
490	4. 16	Armamar (PT)		New Armamar (PT) 400/220kV substation.	2010	Commissioned	Commissioned	Commissioned
491	4. 16	Aldeadávila (ES)	Lagoaça (PT) - Armamar (PT) - Recarei (P	Douro 200 kV interconnections	2010	Commissioned	Commissioned	Commissioned
16	4. 16	Aldeadávila (ES)	Lagoaça (PT)	New 400kV OHL interconnection Aldeadávila (ES) - Lagoaça (PT).	2010	Commissioned	Commissioned	Commissioned

492	4. 17	Puebla de Guzman (ES)	Tavira (PT)	Interconnection 400kV OHL Puebla de Guzman (ES) - Tavira (PT).	2014	Commissioned	Commissioned	Portuguese section was concluded in 2011. In the Spanish part there were delays in the authorization process and on the construction due to a biological stoppage. The interconnection was commissioned in May 2014.
493	4. 17	Tavira (PT)	Portimao (PT)	New 400kV OHL double-circuit line between Tavira (PT) - Portimão (PT).	2011	Commissioned	Commissioned	Comissioned
494	4. 17	Tavira (PT)		Tavira (PT) 400kV substation.	2011	Commissioned	Commissioned	Commissioned
495	4. 17	P.Guzman (ES)		New Southern Interconnection. New P.Guzman (ES) 400kV substation.	2014	Commissioned	Commissioned	Timing correlated to investments 17 and 492
17	4. 17	Guillena (ES)	Puebla de Guzman (ES)	New Southern Interconnection. New 400kV OHL double-circuit line between Guillena (ES)-Puebla de Guzman (ES)	2014	Commissioned	Commissioned	Line in service at 220 kV. Connection to Guillena 400 kV had had constraints in permitting, now solved
502	4. 21	JM Oriol (ES)	Caceres (ES)	Uprating the existing line JM Oriol-Caceres 220 kV.	2014	Commissioned	Commissioned	Commissioned
21	4. 21	Aldeadavila (ES)	Villarino (ES)	Uprating the existing Aldeadávila-Villarino 400kV OHL in order to increase its capacity from 1350MVA to 1690MVA.	2013	Commissioned	Commissioned	The investment has been commissioned
514	6. 22	Penagos/Aguayo (ES)	Abanto (ES)	North axis Project between Galicia and the Basque Country. Part of the project is considered as the Asturias Ring. New double circuit Aguayo/Penagos-Abanto 400kV OHL.	2013	Commissioned	Commissioned	From Penagos/Aguayo to Udalla commisioned. The connection from Udalla to Abanto has delays in authorization process, due to enviromental issues that led to change part of the route.
517	6. 22	Pesoz (ES)		North axis Project between Galicia and the Basque Country. New 400kV substation Pesoz.	2012	Commissioned	Commissioned	Commissioned
518	6. 22	El Palo (ES)		North axis Project between Galicia and the Basque Country. New 400kV substation El Palo.	2012	Commissioned	Commissioned	Commissioned
519	6. 22	Salas (ES)		North axis Project between Galicia and the Basque Country. It includes new 400kV substation Salas.	2012	Commissioned	Commissioned	Commissioned
525	6. 22	Penagos (ES)		TO BE DELETED. COMMISSIONED BEFORE TYNDP 2012.North axis	2012	Commissioned	Commissioned	Commissioned

				Project between Galicia and the Basque Country. New 400kV substation Penagos.				
527	6. 22	Udalla (ES)		North axis Project between Galicia and the Basque Country. New 400kV substation Udalla.	2012	Commissioned	Commissioned	Commisioned
528	6. 22	Abanto(ES)		North axis Project between Galicia and the Basque Country. New 400kV substation Abanto.	2012	Commissioned	Commissioned	Commissioned
572	14. 34	Trives (ES)	Tordesillas (ES)	New line Conso-Valparaiso-Tordesillas 220kV OHL.	2012	Commissioned	Commissioned	Commissioned
573	14. 34	Aparecida (ES)		New 400kV substation in Aparecida.	2012	Commissioned	Commissioned	Commissioned
34	14. 34	Trives (ES)	Tordesillas (ES)	New line Trives-Aparecida-Arbillera-Tordesillas 400kV OHL.	2012	Commissioned	Commissioned	Progress as planned. Trives-Tordesillas 400kV axis shares towers with the Trives-Tordesillas 220kV line.
579	14. 34e	Mudarra (ES)	Tordesillas (ES)	Uprate the existing single-circuit Mudarra-Tordesillas 400kV line in order to increase its capacity.	2013	Commissioned	Commissioned ahead of time	Real time needs forced to bring the project forward
507	5. 37	Bescano (ES)		New 400kV substation in Bescano with 400/220kV transformer.	2012	Commissioned	Commissioned	Commissioned
37	5. 37	Santa Llogaia (ES)	Bescanó (ES)	New double circuit Bescanó-Ramis-Bescano-Vic/ Senmenat 400kV OHL (single circuit in some sections)	2013	Commissioned	Commissioned	Commissioned
902		F.Ferro		Expansion of F.Ferro substation to include the 400kV	2013	Commissioned	Commissioned	Under construction
13	3. 13	Palmela (by F.Ferro)	Ribatejo (by F.Ferro)	New 25km double-circuit 400kV OHL.	2011	Commissioned	Commissioned	Commissioned
14	3. 14	"Marateca"	Fanhões	New 95km double-circuit 400kV OHL "Marateca"-Fanhões	2012	Commissioned	Commissioned	Commissioned
558	10. 33	Manzanares (ES)		Transmanchega project ;phase1. New substation Manzanares with a 400/220kV transformer unit.	2012	Commissioned	Commissioned	Commissioned
559	10. 33a	Manzanares (ES)	Brazatortas (ES)	Transmanchega project; phase 1. New double circuit line Manzanares-Brazatortas 400kV OHL.	2012	Commissioned	Commissioned	Commissioned
560	10. 33a	Brazatortas (ES)		Transmanchega project; phase1. The new 400kV substation Brazatortas will be connected to the existing line Guadame-Valdecaballeros.	2012	Commissioned	Commissioned	Commissioned

1.4 List of cancelled investments from TYNDP and RgIPs 2012

Investment ID	TYNDP 2012 index	from substation name	to substation name	short description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
833	168a	Region South-West Bavaria (DE)	Region South-West Bavaria (DE)	Upgrading the existing 220kV OHL to 380kV,length 100km and the extension of existing substations, erection of 380/110kV-transformers.	-	Cancelled	Cancelled	Originally the investment was very unprecise. It has been replaced by more precise OHL upgrade investments
198	198	Wuhlheide (DE)	Thyrow (DE)	Berlin South Ring: replacement of an existing old 220kV double-circuit OHL by a 380kV double-circuit OHL. Length: 50km.	-	Cancelled	Cancelled	Project is cancelled because at present no necessity is seen.
64	26. 64	Bressanone (IT)	New substation near Innsbruck (AT)	New double circuit 400kV interconnection through the pilot tunnel of the planned Brenner Base Tunnel.	-	Cancelled	Cancelled	Further studies led to abandone the scheme from Bressanone to Innsbruck via the Brenner tunnel (previous investment 26.64 in TYNDP 2012)
282	282	Detk (HU)		New substation Detk with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Sajoszoged-God.	-	Cancelled	Cancelled	Investment cancelled as a result of changes in planning input data (need gone)
288	288	Százhalombatta (HU)		New substation Szazhalombatta is connected by splitting and extending existing line Albertirsa-Martonvasar.	-	Cancelled	Cancelled	Generator connection request cancelled
844	289	Sajóivánka (HU)		Installation of the 2nd transformer in substation Sajoivanka.	-	Cancelled	Cancelled	-
289	289	Felsozsolca (HU)	Sajóivánka (HU)	Reconstruction of line to double circuit. Line length: 29km.	-	Cancelled	Cancelled	-
291	291	Sajószöged (HU)		New 400/120kV 250MVA transformer with PST.	-	Cancelled	Cancelled	-
341	341	Patnów (PL)	Wloclawek (PL)	Upgrading of sag limitations OHL 220kV (389 MVA).	-	Cancelled	Cancelled	Cancelled.
346	346	Halemba (PL)		Halemba substation is connected by splitting and extending of existing 220kV lines Kopanina - Katowice.	-	Cancelled	Cancelled	Cancelled
137	35. 137	Vitkov (CZ)	Mechlenreuth (DE)	New 400kV single circuit tie-line between new (CZ) substation and existing (DE) substation. Length: 70km.	-	Cancelled	Cancelled	Project was cancelled due to unfeasibility to built the project (enviromental aspects and technical difficulty to connect to existing grid).

171	44. 171	Hüffenhardt (DE)	Neurott (DE)	Upgrade of the line from 220kV to 380kV. Length: 11km. Included with the investment : 1 new 380kV substation.	-	Cancelled	Cancelled	The need for this long-term investment was not confirmed by the German Network development Plan 2012 and therefore it has been cancelled. The Plan 2012 has set up more global solutions for long-term
154	45. 154	Redwitz (DE)		New 500 MVAr SVC in substation Redwitz.	-	Cancelled	Cancelled	new concept
155	45. 155	Raitersaich (DE)		New 500 MVAr SVC in substation Raitersaich.	-	Cancelled	Cancelled	new concept
694	48. A125	Velký Dur (SK)	Levice (SK)	The erection of new 1x400 kV line between two important Veľký Ďur and Levice substations, including extension of the V.Ďur and Levice substation. The driver for this project is expected connection of to new generation units in Veľký Ďur area.	-	Cancelled	Cancelled	The decision to omit this investment has been confirmed by the internal network analysis. The added value of this line has been shown as low as the desired network reinforcement in this area will be sufficiently obtained by the project Nr. 48.298.
310	55. 310	Vyskov (CZ)	Reporyje (CZ)	New 400kV OHL	-	Cancelled	Cancelled	This line was cancelled due to the unfeasibility to built it caused by enviromental reasons.
798	94. A70	Krajnik (PL)		PST in Krajnik	-	Cancelled	Cancelled	The PST on the interconnector Krajnik-Vierraden will be instaled by 50Hertz Transmission GmbH in substation Vierraden.
320	57. 320	Dargoleza (PL)		A new AC 400/110kV substation	-	Cancelled	Cancelled	The investment's driver was RES connection. The investment was removed from the plans due to change on generation (RES) side.

1.5 Storage projects

Complying with Regulation EC 347/2013, ENTSO-E proposed to PCIs storage promoters to assess their projects according to the CBA methodology.

No third party projects was submitted to ENTSO-E within the Continental South West region for inclusion in the TYNDP 2014 package.

2 National Plans

France

For further information about the projects of national interest in France, the French TSO (RTE) has published on his website the National Development Plan, “Schema Decennal de Développement du Réseau de Transport d’electricité”[29], edition 2013.

Portugal

For further information about the projects of national interest in Portugal, complete information is available in the official Master Plan “Plano de Desenvolvimento e Investimento da Rede de Transporte de Electricidade 2012-2017 (2022)”[30], published in July 2011 and approved by the government in December 2011. A new plan for 2014-2023 is in progress, but it has not been published yet.

Spain

For further information about the projects of national interest in Spain, the last official Master Plan "Planificación de los Sectores de Electricidad y Gas 2008-2016: Desarrollo de las Redes de Transporte“[31] was approved by the government in May 2008 and it is published by the Spanish Ministry of Industry. A new plan for 2014-2020 is in progress, but it has not been published yet. Therefore, the content in the TYNDP 2014 is consistent with a draft Spanish Master Plan of December 2013.

[29] http://www.rte-france.com/fr/mediatheque/documents/l-electricite-en-france-donnees-et-analyses-16-fr/publications-annuelles-ou-saisonnieres-98-fr/schema-decennal-de-developpement-du-reseau-170-fr

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

[31] http://www.minetur.gob.es/energia/planificacion/Planificacionelectricidadygas/desarrollo2008-2016/DocTransportes/planificacion2008_2016.pdf

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3 Abbreviations

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

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