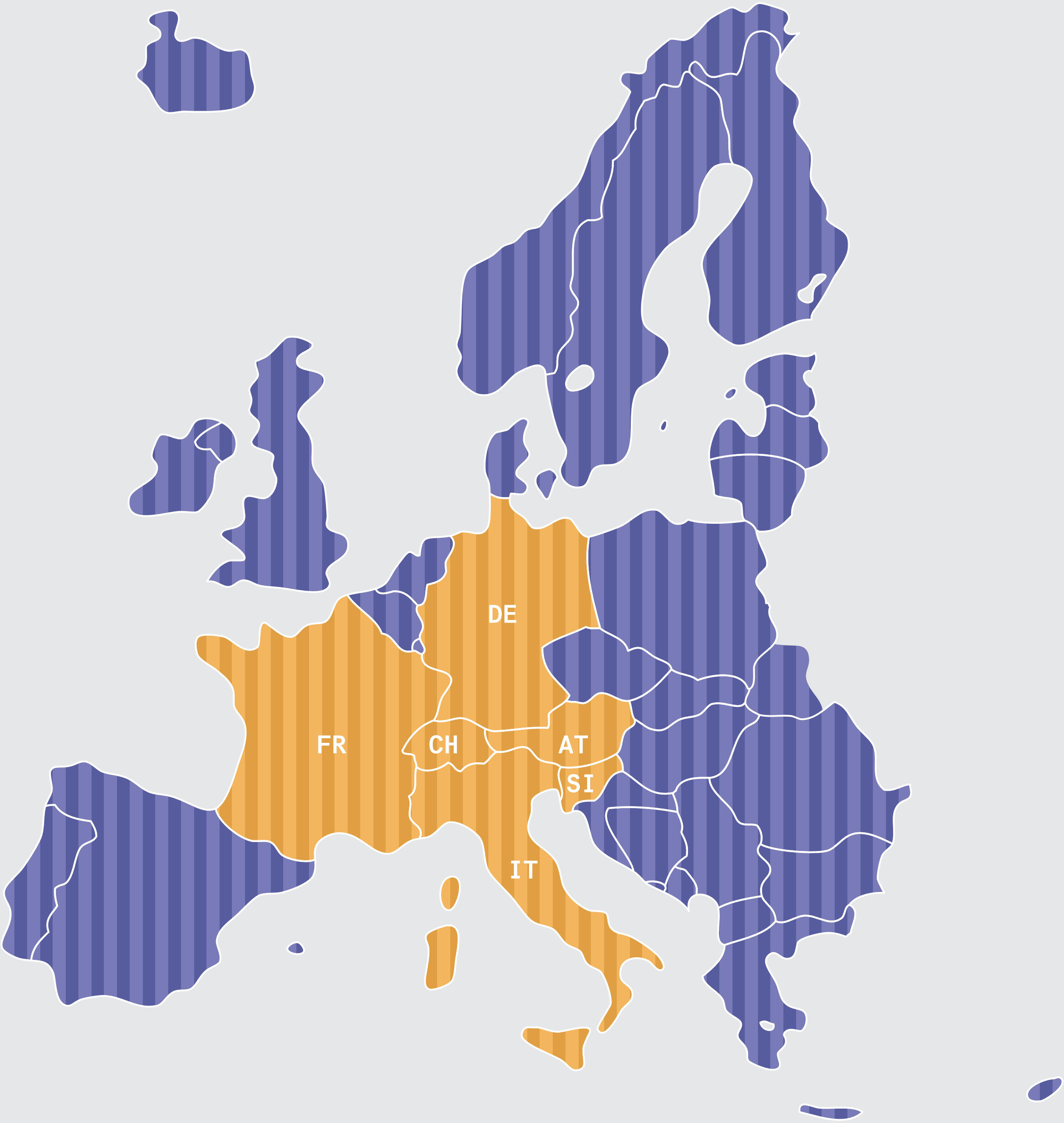
REGIONAL INVESTMENT PLAN 2014 CONTINENTAL CENTRAL SOUTH Final



European Network of
Transmission System Operators
for Electricity

<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.

Table of content

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1 Executive Summary

1.1 RG CCS delivers the RgIP 2014 - part of the ENTSO-E TYNDP 2014 Package

The Regional Group Continental Central South (RG CCS) under the scope of the European Network of Transmission System Operators for Electricity (ENTSO-E) provides herewith the 2014 release of the Continental Central South Regional Investment Plan (hereinafter “CCS RgIP 2014”), as part of the community-wide Ten-Year Network Development Plan (TYNDP) 2014 Package. The CCS RgIP 2014 is the proposed plan covering the necessary network development in Austria, France, Germany, Italy, Slovenia and Switzerland within the next ten years and beyond and supersedes the CCS RgIP 2012.

This present publication of the RgIP 2014 complies with the requirements of Regulation (EC) No 714/2009, in force since March 2010 whereby “ENTSO-E shall adopt a non-binding Community-wide 10 year network development plan, including a European generation adequacy outlook, every two years”. The TYNDP 2014 is released as a package including this CCS RgIP 2014, five other Regional Investment Plans and the Scenario Outlook and Adequacy Forecast (SOAF).

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

The CCS RgIP and TYNDP 2014 at large are a result of a tight and active two year period, during which extensive improvements have been completed in terms of scenario development, stakeholder involvement and cost and benefit assessment methodology.

The development of the transmission infrastructure is crucial for reaching European energy and climate targets, with particular regard to security of supply (SoS), development of the European internal energy market (IEM) and integration of renewable energy sources (RES). It is the statutory requirement of the TYNDP and the RgIPs 2014, to consider all relevant aspects for the development of the transmission infrastructure.

In addition, action from the European Commission to boost the necessary investments 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 Package the issues and goals are widened and deepened and there is growing interest from stakeholders regarding the TYNDP Package. Through the collaboration with stakeholders, ENTSO-E will further develop the process and content of the TYNDP Package.

1.2 Stakeholders actively contributed to the TYNDP 2014 Package

ENTSO-E welcomes and encourages stakeholder involvement in the TYNDP process. During the two-year period, ENTSO-E has both provided information and asked for input from stakeholders during several phases of the process via open European and regional workshops, public web-consultations and bilateral meetings[1].

In addition to the common TYNDP workshops, the RG CCS organised one regional workshop in Rome during the preparation process in March 2014. The workshop between members of RG CCS and stakeholders was important as it involved them into the preparation process of the CCS RgIP, informed them and allowed for discussion of the preliminary results. The outcome of the discussion supported the improvement of the CCS RgIP.

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

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Later, during preparation of the four different scenarios, spanning possible future developments, several workshops and consultations were held, in which stakeholder input was used to improve the scenario content. The same process was applied for the preparation of the Cost Benefit Analysis methodology (CBA) used. A dedicated stakeholder group was also established by ENTSO-E, gathering European organisations to provide views on long term grid development related issues[2].

Regarding the inclusion of third party projects in the TYNDP and RgIPs 2014, a transparent and fair process was created in which non-TSO promoters had the possibility to include their transmission and storage projects, which fulfilled pan-European significance requirements. Focusing on the CCS Region, four storage and four interconnection transmission projects were assessed and included in the RgIP. Three of those storage projects are located in Austria and one in Germany. The four third party transmission projects are aimed at an increase of the interconnection capacity among the following transmission systems:

- Italy and Switzerland
- Italy and Austria
- France and United Kingdom
- Spain, France and United Kingdom

1.3 How was the TYNDP 2014 Package achieved and what improvements have been made since 2012

ENTSO-E strives to improve both the process and content of the TYNDP with each release. Some of the improvements were initiated by the Energy Infrastructure Package (Regulation (EU) No 347/2013) and some are based on stakeholder consultation either for the previous release or during the preparation of TYNDP 2014:

- The exploration of a longer run horizon, namely 2030, beyond the ten-year horizon, with four contrasting “Visions”, encompassing the futures that stakeholders required ENTSO-E to consider.
- New clustering rules to define projects of pan-European significance, focusing on the few core investment items. The regionally significant supporting investments are presented in the RgIPs as the case may be.
- A numerical quantification of every project’s benefits assessment according to the consulted CBA methodology, with refined definitions for the security of supply, RES integration, socioeconomic welfare, resilience, flexibility and robustness, and social and environmental indicators.
- A synthetic appraisal of the interconnection target capacities in the different Visions.
- Easier and more frequent opportunities for stakeholders to take part, especially for transmission or storage project promoters that are not members of ENTSO-E.

With the TYNDP 2014 Package, the RG CCS also improves its study tools and processes compared to the RgIP 2012, speeding up and strengthening data collection, model calibration, consistency checks and the merging of pan-European and regional results. The quality of the market and network modelling relies on knowledge of all of the specific features of the local power system, a detailed grid description and the resulting ability to master and aptly cut through numerous parameters of high uncertainty. Thus, about 50 projects of pan-European significance in the region have been investigated and assessed in a limited timeframe of two years.

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

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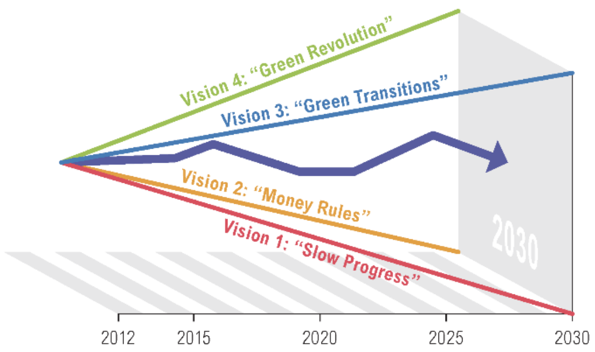
Overall, the TYNDP 2014 Package presents a more holistic view of grid development, combining power transmission issues with environmental and resilience concerns.

1.4 The TYNDP 2014 Package explores a large span of possible futures by 2030



The 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 contrasting longer-run scenarios instead of a more limited number and an intermediate horizon of 2020.

The basis for the TYNDP 2014 analysis is four Visions for 2030. These 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 the stakeholders, differing mainly with respect to:

- The trajectory toward the Energy roadmap 2050: Visions 3 and 4 maintain a regular pace from now on until 2050, whereas Visions 1 and 2 assume a slower start then acceleration after 2030. Fuel and CO2 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 build from the bottom-up on each country's energy policies; Visions 2 and 4 assume a top-down approach, with a more harmonised European integration.

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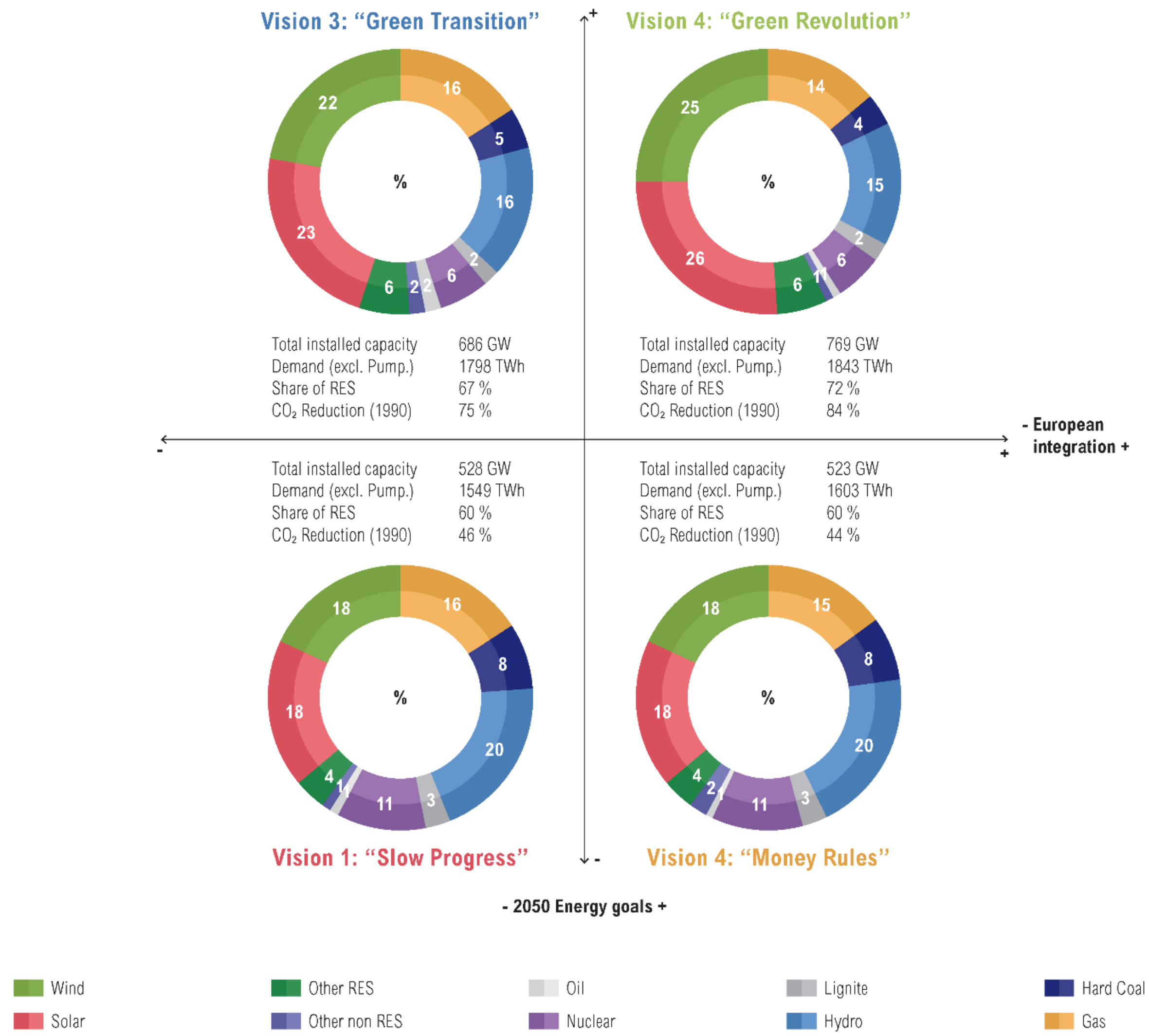

Figure 1-1 Overview of installed capacities in the CCS region for all Visions

All the scenarios assume a large development of RES generation. The share of RES capacity ranges from 60 % in Visions 1 and 2 to 67 % in Vision 3 and 72 % in Vision 4. In Vision 4 the installed capacity of wind and solar increases by a factor of nearly four in comparison with the current value (102 GW in 2012). In the same Vision the installed nuclear capacity decreases by nearly 50 % in comparison with the figures of 2012.

1.5 The CCS RgIP 2014 confirms and enriches the key findings of the RgIP 2012

The CCS RgIP 2012 analysed the first steps towards an energy transition by 2020, characterised by RES development. The CCS RgIP 2014 confirms the trends identified in 2012 up to 2030.

The €82 billion grid expansion proposed by the CCS RgIP has a significant positive environmental impact: enable up to 84 % of the CO2 emissions in power sector to be mitigated by 2030 (compared to 1990) and make the expected major shift in the generation pattern featuring a high development of RES, with only a limited length of the proposed projects crossing protected and urbanised areas. More than 50 % of the projects crossing no or less than 15 km of protected areas and nearly 80 % of the projects crossing no or less than 15 km of urbanised areas.

Main Investment Drivers in the CCS Region

The CCS Region is characterised by strong interaction and interrelation between the countries of the region and their neighbours as the transmission networks are particularly highly meshed. Developments, as they are assumed in the different Visions - even if they are concentrated in a specific part of the region - therefore strongly influence the whole CCS regional area and are considered as such within the regional studies. The main drivers for power system evolution identified during these studies are summarised as follows:

- **Massive RES integration:**
  The main driver for power system evolution in the CCS Region is the connection and integration of RES on a large scale (mainly wind power and photovoltaic). The increasing penetration of variable renewable generation leads to fluctuate and high utilisation of the transmission network and a more flexible transmission grid is needed as result. In particular the geographical concentration of the RES development at the corners of the region (mainly in DE, FR and IT) far away from the centres of consumption and the Alpine storages leads to a wide area of power transmission.

- **Integration of storage plants, mainly hydro in the Alps region, facilitates the efficient use of RES:**
  The divergence in the generation time and demand resulting from the integration of volatile RES is another rising and sustainable challenge for the overall power system, leading to the necessity for additional transport and storages capacities as well as other innovative measures. Considerable storage potential is available in the very centre of the region, particularly in the form of existing and planned hydro pumped storage power plants located mainly in the Alps.

- **Nuclear phase-out:**
  The nuclear phase-out, specifically the reduction of the share of nuclear capacities in the generation mix – according to the assumptions of the different Visions mainly in Germany, Switzerland and France – has a significant structural impact on the electricity systems and therefore the countries' power and energy balances. The availability of an adequate grid infrastructure constitutes the basis for coping with those structural changes.

- **Wide area power flows:**
  The progressing divergence in the time and location of generation and consumption, especially the integration of RES at the corners of the region and storage in the Alps, as well as structural market congestion between price zones will lead to wide area power flows through the region, requiring investment within the countries and at the borders.

- **System security and security of supply:**
  Due to the fundamental changes in the entire electricity system (e.g. massive RES integration, nuclear phase-out, limited - and in the longer run uncertain - availability of conventional power plants caused by changing market conditions) security of supply investigations into single demand centres are no longer sufficient. The whole system security has become a key issue and a broad consideration of all relevant parameters is necessary. Numerous projects in the CCS RgIP are being supported to ensure a secure electricity system in this changing environment.

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Key findings

Caused by the main investment drivers explained above, the key findings of the CCS RgIP 2014 are:

- **In the CCS RgIP 2014, 53 projects of pan-European significance are depicted**, 13 of which are interconnection projects between CCS countries. The proposed projects in the plan at hand contain 44 investments to be completed in the mid-term (2014 – 2018) and 90 long-term investments (2019 – 2030). In addition 127 investments of regional significance are covered by this plan.

- **Projects of pan-European and regional significance represent roughly 32.000 km of new or refurbished network routes**, of which 26 % are expected in the mid-term (2014-2018). Approximately 15.400 km of new overhead lines (approximately 70% AC and 30 % DC overhead lines). Additionally, around 4.150 km of existing AC lines are expected to be refurbished in order to minimise grid extension and avoid the construction of new routes demonstrating a concerted effort with regards to making the best use of existing assets.

- **The market studies show that the CCS Region will generally be importing** from the rest of Europe. From Vision 1 to Vision 4, the imports increase from over 60 TWh to around 120 TWh.

- **€82 billion of investment by 2030, with a positive effect on the European social economic welfare:** The total investment costs for the portfolio of projects of pan-European, regional and national significance amount to about €82 billion.
  However, increased market integration, thanks to projects in the region leads to levelling electricity prices throughout Europe, mitigating electricity prices on average from 2 (in Vision 1) to 10 €/MWh (in Vision 4). Investing in the project portfolio represents a global pay-back after 19 years in the most conservative case.

- **The project portfolio has a positive environmental impact:** The reinforcement of the grid infrastructure has an indirect, but essential positive effect on CO_2 emissions as it is a prerequisite to implementing clean generation technologies. Either by directly connecting RES, avoiding spillage or enabling more climate friendly units to run, the project portfolio contributes to about 95 Mt/a of the CO_2 decrease by 2030.

Grid extensions foreseen in the Plan represent an increase in the total network length by less than 1.7 %/yr. The figure is relatively low compared to the up to 4 %/yr growth rate of generation capacity. Moreover, one third of the new grid assets are subsea and 13 % are upgrades of existing equipment.

TSOs optimise the routes to avoid interferences with urbanised or protected areas as much as possible. In densely populated countries as well as in areas with a great share of land protection this can be challenging, globally however, the CCS projects cross urbanised (resp. protected) areas over less than 5 % (resp. 10 %) of the total routes.

Transmission losses are not expected to vary significantly in the coming 15 years with the implementation of the plan as multiple effects neutralise each other: on the one hand, new transmission facilities further or shifting voltage levels upwards reduces the overall resistance of the network; on the other hand the relocation of generation facilities farther from load centres, specifically for wind or hydro energy, and HVDC subsea interconnections increase the transmission distance and therefore the losses.

The projects in the region are the key to mark an energy transition in Europe possible, with a minimum impact to the environment.

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1.6 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 if the RES targets are met as planned by 2030. At present, many stakeholders support grid development to facilitate the changes in the energy system, however at the same time stakeholders that are directly affected by new lines or new plants show only a limited level of acceptance for the new infrastructure. This resistance plus lengthy permit granting procedures often cause commissioning delays. As a result, many projects depicted in the TYNDP 2014 Package are experiencing delays with respect to the commissioning dates shown in TYNDP 2012.

If energy and climate objectives have to be achieved, it is of utmost importance to smooth the authorisation processes and gain political support on all levels. In this respect, ENTSO-E welcomes Regulation 347/2013 as there are many positive elements included regarding the permitting process which will facilitate the fast tracking of transmission infrastructure projects, including the proposal on one stop shop and defined timelines.

More thorough analysis is however required to ensure the measure can be successfully implemented, in particular in relation to whether the timelines proposed are achievable in terms of 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 PCIs, whereas there are many significant regional and national transmission projects that are crucial for the achievement of Europe's targets for climate change, renewables and market integration.

Finally, a stable regulatory framework is also essential to ensure grid reinforcement can be completed in time. Although grid projects will prove beneficial for the European community as a whole, they still represent large investments and financing them remains an issue for TSOs in times of limited public finances. Securing the perspectives of investors is key for success.

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2 Introduction

2.1 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 Europe-wide Ten-Year Network Development Plan (TYNDP) Package.

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. As part of the pan-European package, the Regional Investment Plans (RgIP) are the most comprehensive and up-to-date regional and European-wide reference for the transmission network. They point to significant investments in the European power grid in order to help achieve European energy policy goals.

Since the 2012 release, ENTSO-E has supplied a TYNDP "package", a suitegroup 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 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 only synthetic information regarding concerns and projects of pan-European significance. ENTSO-E hopes to meet the various expectations of their stakeholders with respect to the necessary development of the grid infrastructure.

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.

2.2 Regulation EC 347/2013 sets a new role for the TYNDP

The present publication complies with the requirements of Regulation EC 714/2009 (the Regulation), in force since March 2011, whereby "ENTSO-E shall adopt a non-binding Community-wide 10 Year Network Development Plan, including a European generation adequacy outlook, every two years".

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

The present TYNDP Package also paves the way for the implementation of Regulation EC 347/2013 (the **Energy Infrastructure Regulation**), in force since April 2013 and normally applying to the TYNDP 2016. **This regulation** organises a new framework to foster transmission grid development in Europe. Regulation EC 37/2013 defines the status of **Projects of Common Interest** (PCIs), foresees various supporting tools regarding 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 is therefore not only a framework for planning the European grid and supplying a long-term Vision; it also now serves as the assessment for every PCI candidate. The preparation of the TYNDP Package

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will be all the more demanding that the two roles complement each other more than they match and therefore additional resources are required.

2.3 A top-down, open and constantly improving process

The first TYNDP was published by ENTSO-E on a voluntary basis in Spring 2010, in anticipation of the Directive 72/2009 and the Regulation 714/2009. The 2012 release built on this experience and the feedback received from stakeholders, proposing a first systematic CBA sketch. For the 2014 release, ENTSO-E launched a large project founded on three main pillars: **the inputs and expectations from their 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 exchanges with stakeholders at four levels to ensure transparency as much as possible:

- Public workshops and consultations[3]: non-specific conferences and events, which ENTSO-E has been invited to, in total 17 dedicated workshops, in Brussels or regional, and six consultations paved 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[4]", gathering 15 members, aiming at debating and finalising the methodology (scenarios, CBA) improvements regarding the TYNDP itself or grid development more generally. The group contributed in particular to refining the social and environmental indicator 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 shared concerns, jointly developed more and more harmonised methodologies and allowed the expected outcomes of the process to be agreed.

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

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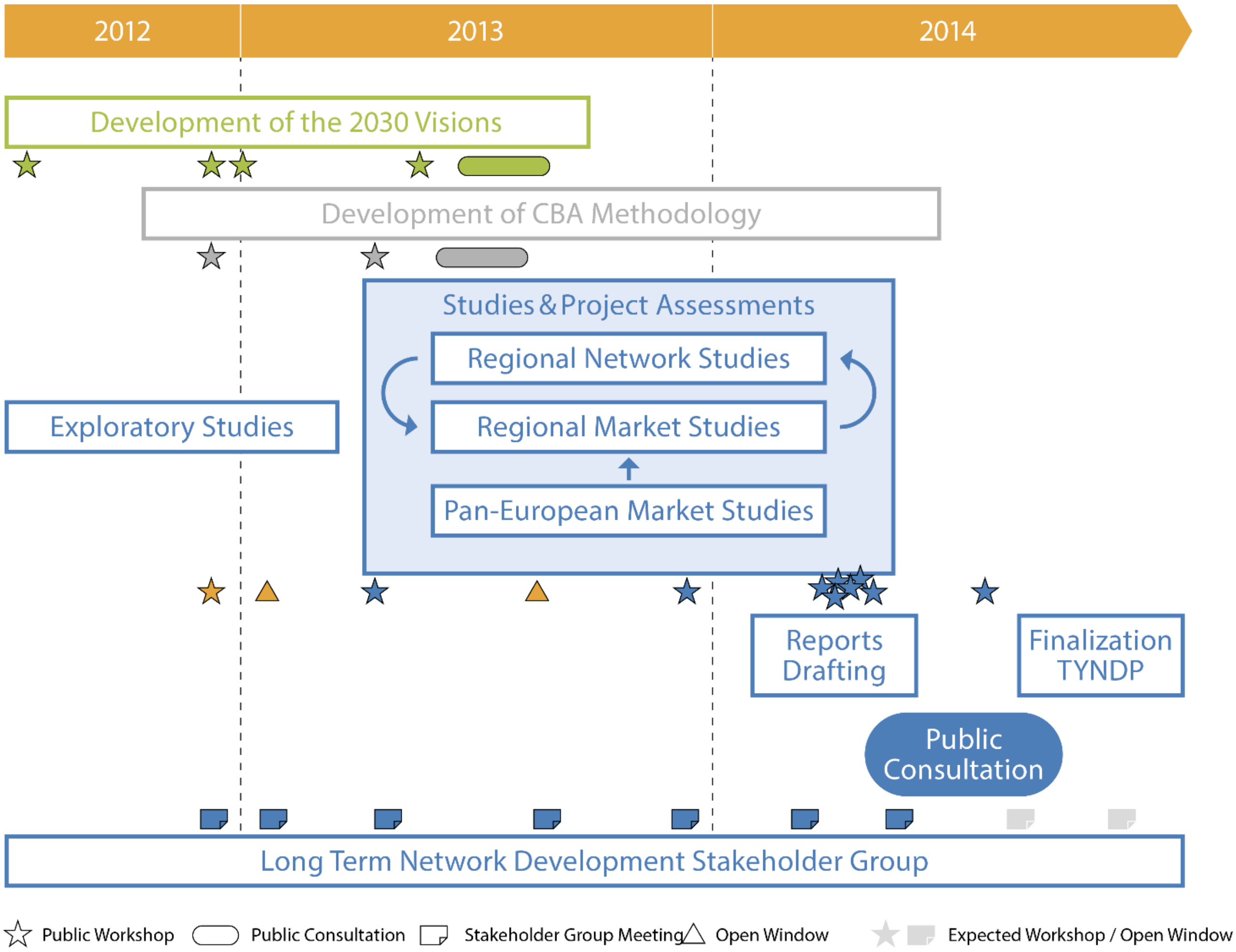

Figure 2-1 Overview of the TYNDP 2014 process

The preparation of the TYNDP 2014 was a bigger challenge as **ENTSO-E decided to anticipate the implementation of the Energy Infrastructure Regulation** and support DG Energy in beginning 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 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.
- ENTSO-E invited non-ENTSO-E Members to submit transmission and storage project candidates for assessment, with the latest submission window in September 2013.
- ENTSO-E included an assessment of storage projects in the TYNDP 2014 in addition to transmission projects.

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

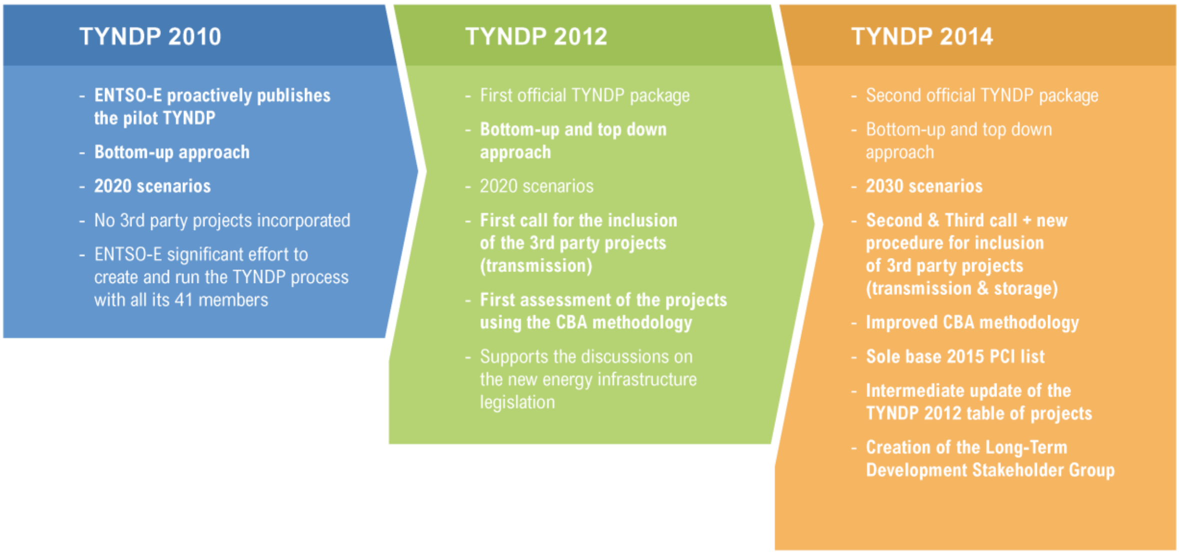

Figure 2-2 Overview of the TYNDP development over the versions

2.4 Regional Investment Plan Continental Central South

With the report at hand, the Regional Group Continental Central South (RG CCS) of the ENTSO-E System Development Committee provides the 2014 release of the Continental Central South Regional Investment Plan.

This is an integrative part of the 2014 Package, 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). While the community-wide TYNDP reports only synthetic information for concerns and projects of pan-European significance, the RgIPs focus on the specific conditions and developments, investment needs and hence the necessary grid development at the regional level and all projects of European and Regional importance are comprehensively depicted. An overview of the ENTSO-E Regional Groups is provided in Figure 2-3. ENTSO-E considers the regional approach to be the most appropriate framework for grid development in Europe, and it contains numerous instances of overlapping to ensure overall consistency in the Regional Investment Plans.

The RG CCS is composed of Austria, France, Germany, Italy, Slovenia and Switzerland. This region covers an area that ranges from the North Sea via the Alps in the very heart of continental Europe to the Mediterranean area. The already ongoing transformation of the electricity system with huge developments of volatile wind power and partly photovoltaic at the corners of the CCS region, the nuclear phase-out and the pump storage potentials in the Alps are some of the outstanding characteristics of the region that will challenge the whole future electricity system and especially the transmission system. On the basis of pan-European and regional electricity Market and Network Studies, this RgIP will capture these developments within four different Visions and define and assess the necessary grid developments to ensure a secure and effective electricity supply for the future.

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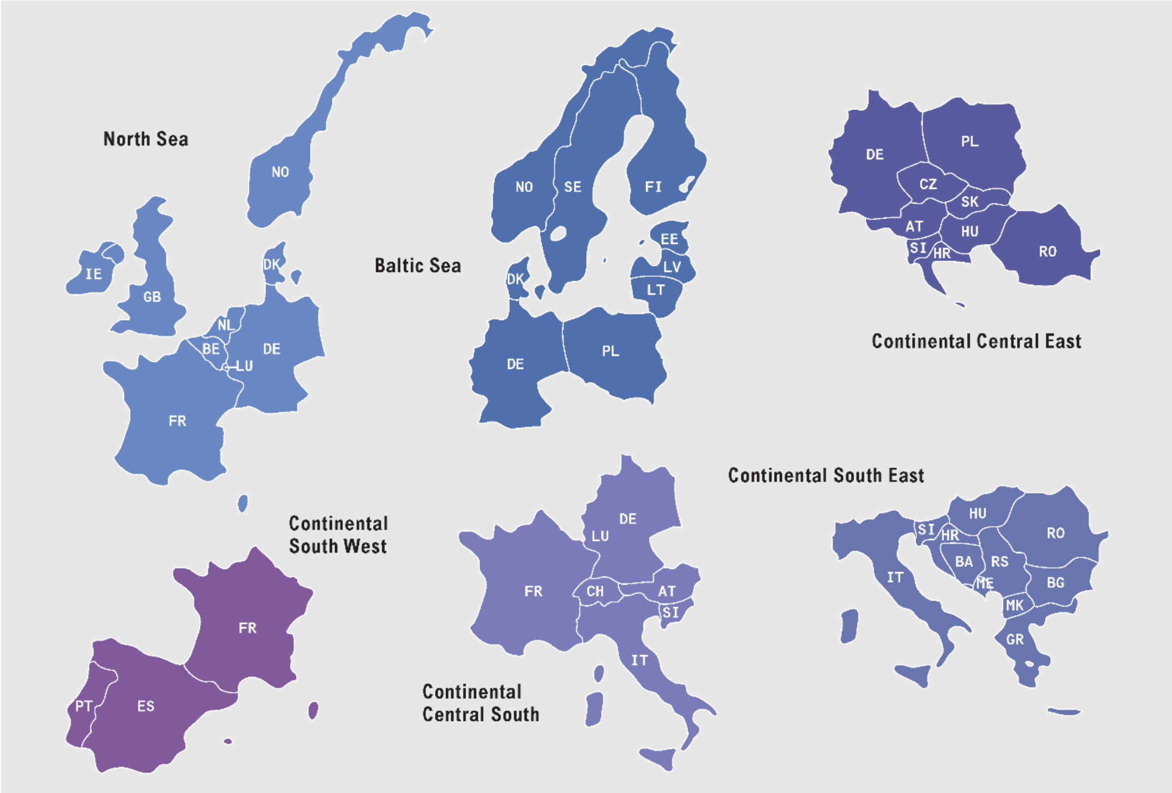

Figure 2-3 ENTSO-E regions (System Development Committee)

2.5 How to read the Regional Investment Plan

This Regional Investment Plan is structured in the following way:

- Chapter 0: “Executive summary”.
- Chapter 1: The present “Introduction”.
- Chapter 2: “Methodology and Assumptions” describes the overall process and specific methods used to elaborate the TYNDP 2014 Package and especially this Regional Investment Plan.
- Chapter 3: "Scenarios and Study Results” gives a purely synthetic overview of the basic scenarios underlying the present Regional Investment Plan consistent with the whole TYNDP Package.
- Chapter 4: “Investment needs” exposes the evolution of the European grid capacity from the present situation, highlighting the drivers of grid development, the location of grid bottlenecks until 2030 and the bulk power flows across these bottlenecks.
- Chapter 5: “Projects portfolio” presents a synthetic overview of all planned projects of pan-European and regional significance (The technical details of the projects are in Appendix 1).
- Chapter 6: “Transmission adequacy” sums up the improved situation in the 2030 time horizon with all projects of pan-European and regional significance implemented, providing the target capacities for 2030 in every Vision.
- Chapter 7: “Environmental assessment” summarises the environmental impact of the planned projects.
- Chapter 8: “Assessment of resilience” resets the planned projects from a larger and more expansive perspective.

- Chapter 9: “Monitoring of the Regional Investment Plan 2012” points out the main changes that have occurred with respect to the investments presented in the Regional Investment Plan 2012
- Chapter 10: “Conclusion”.
- Appendix 1: Sums up all the information regarding projects of pan-European significance. Among them, ‘Transmission’ PCIs are specifically marked and can be easily located thanks to a specific correspondence table. ‘Storage’ PCIs are grouped in a separate list. ‘Smart grid’ PCIs are also highlighted in a separate list (but are not subject to assessment in the TYNDP Package).
- Appendix 2: Supplies the definitions of key-concepts and a glossary.
- Appendix 3: Describes the CBA methodology standards.
- Appendix 4: Sums up the state of the art regarding transmission technologies.
- Appendix 5: Deals with new dynamic concerns to address to secure the energy transition.
- Appendix 6: Sums up the status of the E-Highways project.

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3 Methodology and Assumptions

3.1 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 3-1 provides an overview of the TYNDP 2014 process; the yellow stars represent stakeholder workshops held during this two-year process.

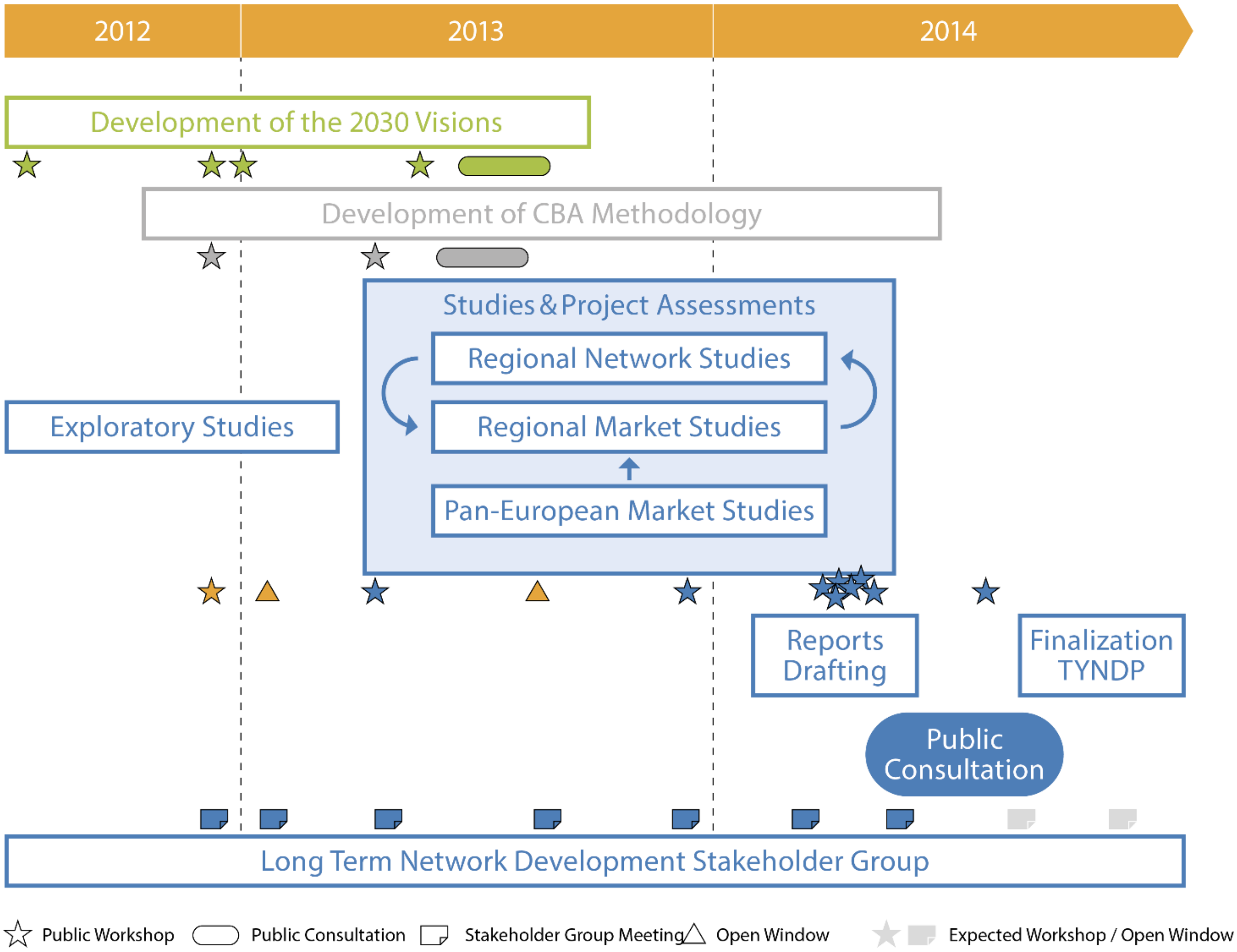

Figure 3-1 Overview of the TYNDP 2014 process

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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 acceleration after 2030. Fuel and CO2 price 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 chapter 3 of the present report.

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 prior to 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.

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.

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 are described in Figure 3-2 and in the following section.

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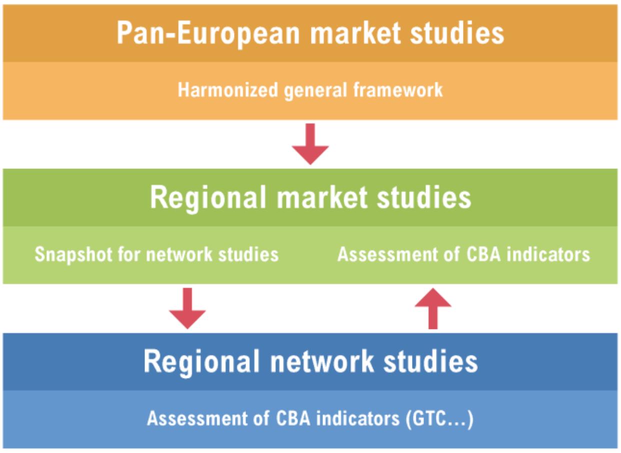

Figure 3-2 an iterative process towards the preparation of TYNDP 2014

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 the 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 each Regional Investment Plan.

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:

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Table 3-1 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. The report is published together with the TYNDP 2014 Package[5].

3.2 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 and means 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.

[5] Link to the report

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

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 detailed in Annex 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.

Scope of Cost Benefit Analysis

Regulation (EU) No 347/2013, in force since 15 May 2013, aims to ensure strategic energy networks[6] 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[7] with the following goals:

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

[6] Recital 20, Regulation (EU) 347/2013 : http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:115:0039:0075:EN:PDF

[7] Article 11, Regulation (EU) 347/2013

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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[8], 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 has 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 3-3), while others are measured through physical units such as tons or kWh (outer ring of Figure 3-3).

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 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.

A multicriteria assessment

The cost benefit analysis framework is a multi-criteria assessment, complying with Article 11 and Annexes IV and V of Regulation (EU) 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, CO2).
- 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.
- To provide a measurement of project costs and feasibility (especially environmental and social viability).

[8] Reg. (EU) 347/2013, Annexes IV and V

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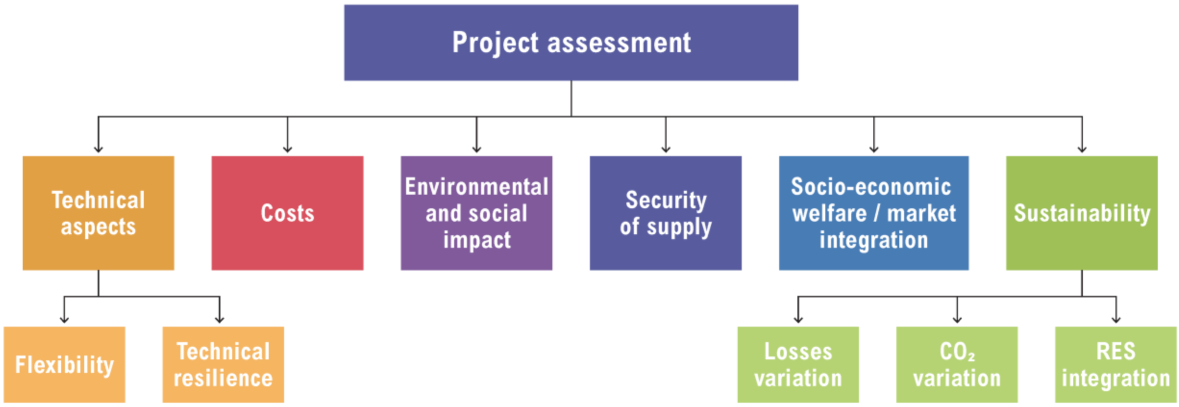

Figure 3-4 Main categories of the project assessment methodology

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 surrounding areas and Grid Transfer Capability.

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

B1. Improved security of supply[9] (SoS) is the ability of a power system to provide an adequate and secure supply of electricity under ordinary conditions[10].

B2. Socio-economic welfare (SEW)[11] 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[12].

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[13].

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[14] and is correlated with SEW.

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[9] 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.
[10] This category covers criteria 2b of Annex IV of the EU Regulation 347/2013, namely "secure system operation and interoperability".
[11] 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).
[12] 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".
[13] This category corresponds to criterion 2a of Article 4, namely "sustainability", and covers criteria 2b of Annex IV.
[14] 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)[15].

B6. Technical resilience/system safety is the ability of the system to withstand increasingly extreme system conditions (exceptional contingencies)[16].

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[17].

The **project costs**[18] 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 surrounding areas** 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.

More details on the CBA methodology are available in the Appendix.

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

[15] This category contributes to the criterion « sustainability » set out in Article 4, 2b and to criteria 6b of Annex V, namely " greenhouse gas emissions"".
[16] 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).
[17] 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).
[18] Project costs, as with all other monetised values, are pre-tax.

in order to get the full picture of the benefits of projects with respect to RES integration or security of supply; 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 or technically implementing NPV computation.

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.

3.3 Market Studies Methodology

For every Vision, a market study (MS) answers the question “which generation (location/type) is going to serve which demand (location) in any future instant?”. Their outcome is market balances in every country/price zone and especially generation and exchange patterns (“bulk power flows”).

The purpose of the market studies is to investigate the impact of the new interconnection projects by comparing two different grid situations in terms of economic efficiency; the ability of the system to schedule plants accordingly to their intrinsic merit-order, the overall resulting variable generation costs as well as the overall amount of CO_2 emission, and volumes of spilled energy. 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 profiles and uncertainties, and transmission capacity between countries.

The pan-European market studies results are used as boundary conditions to ensure overall consistency of the regional market studies. The CBA assessment of TYNDP projects is then performed using regional market and network studies.

System Modelling

The main focus of RG CCS was on modelling the entire ENTSO-E area. Therefore the data from common PEMMDB were used for every country.

For the market studies each country is modelled as one single bidding area (all generation and load data being aggregated to this single node), considering that there is no internal constraint within the country and expected transmission capacity between countries. The expected market capacity is a directional value, between two countries or bidding areas.

In the case of Italy, respecting the way the model is described in the PEMMDB, six additional areas are defined in the regional model in order to take into account the current structure and to be able to assess the impact of Italian internal congestions and the main benefits of internal reinforcements within the market studies. (see Figure 3-6).

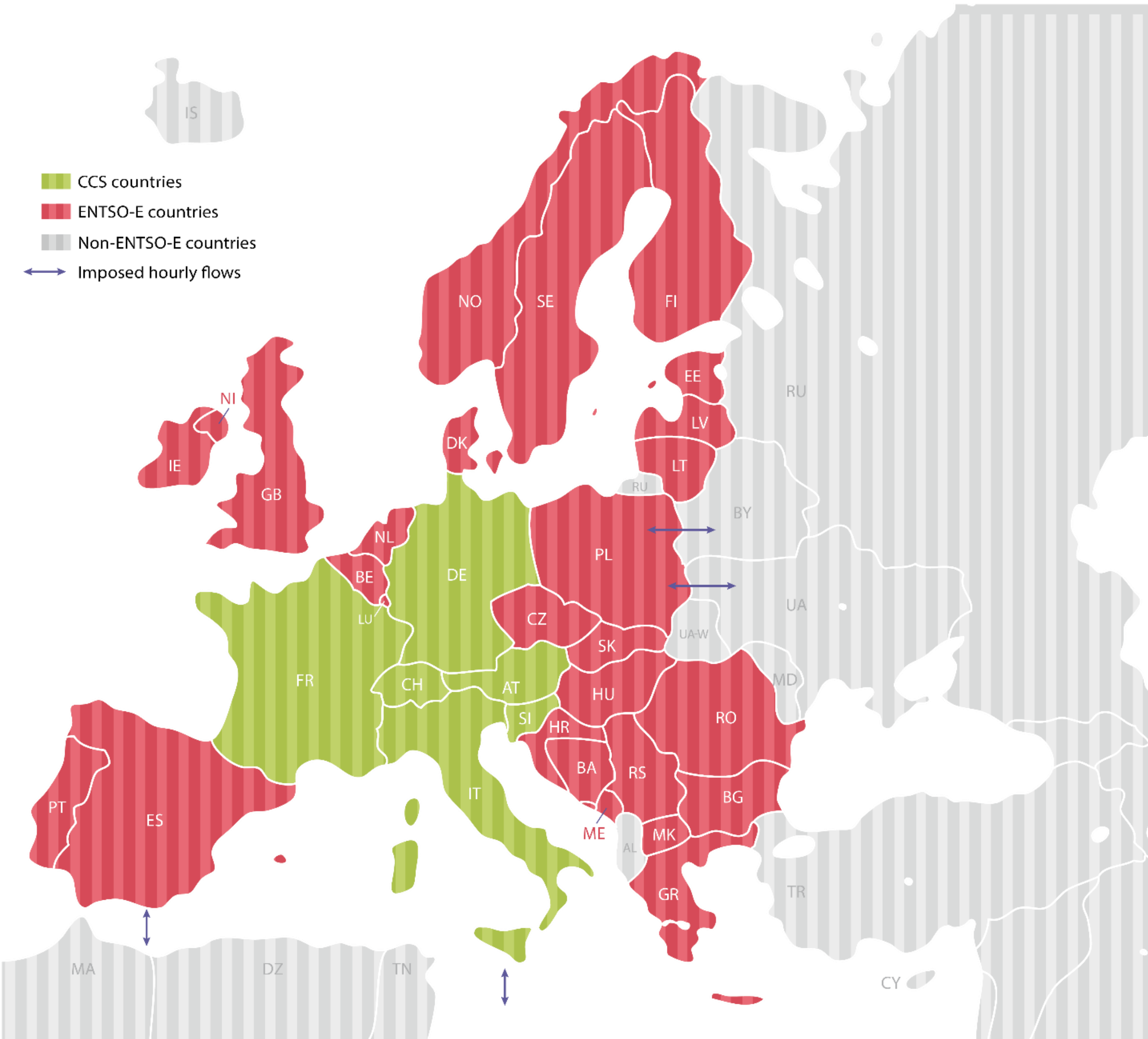

Figure 3-5 Overview Map System Modelling

Some countries, like Italy, have connections with Non-ENTSO-E countries. In this case, exchanges are considered as hourly time series provided directly by the respective TSOs.

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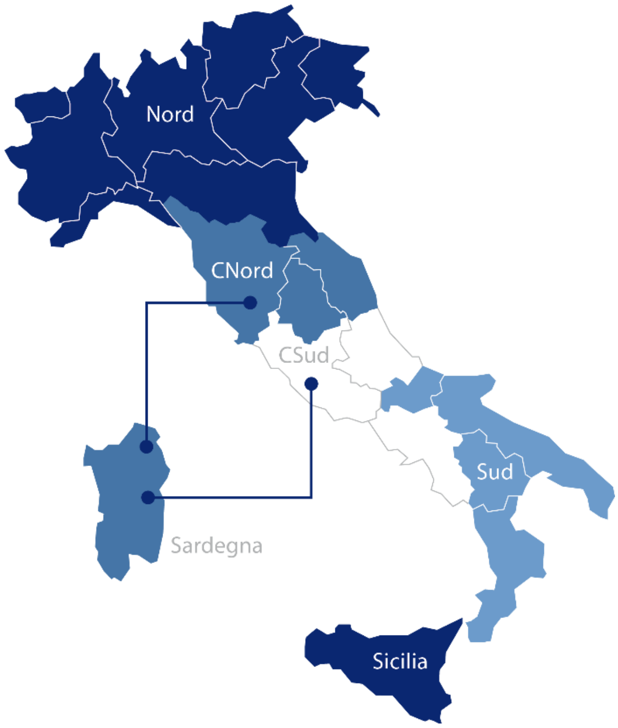

Figure 3-6 Italian Market Areas

The main elements of the electric system were modelled as described hereafter:

- **Load**: hourly time series out of the PEMMDB were used. Those time series were derived based on the assumptions of common ENTSO-E Visions.
- **Thermal generation**: modelled by their main relevant characteristics: installed capacity, fuel type (incl. fuel and CO_2 price), start-up costs, efficiency, must-run obligations, minimum up and down times, availabilities, etc..
- **Hydro generation**: was subdivided into three kinds of power plants: run of river, storage and pump storage. The behaviour of hydro pump storages (pumping, turbining) was internally implemented using the simulation tool.
- **Non dispatchable generation** (wind, solar, etc.) are being considered by scaled per unit time-series based on common ENTSO-E climate database.

Tools used for Market and Adequacy Studies

The basis for the performed market and adequacy studies is provided by three market simulation tools POWRSYM4 (developed by Operation Simulation Associates, Inc. and used by Swissgrid), PROMED (developed by CESI spa and used by Terna) and ANTARES (developed and used by RTE). The results of these three simulation tools were compared in depth enabling RG CCS to verify the results and to increase the quality and the robustness of the market analysis.

Following a short description for each of the tools used in RG CCS MS is reported:

PowrSym4
The basic assumption of the market model is a perfect energy-only market and perfect forecast of the wind and solar generation. This simulation tool optimises power plant dispatch on the basis of the generation costs and implicitly modelling energy storages. Unavailability and outages of generation capacity are solved by Monte Carlo simulation. Forced generation - as wind or solar - can be simulated deterministic or probabilistic.

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PROMED
The PROMED software is a simulator of the electricity market applied to a whole yearly period. PROMED performs an optimal coordinated hydrothermal hourly scheduling of the generation set, pursuing the objective of "minimum marginal costs" where generation companies compete by signing physical bilateral contracts or bidding on the power exchange.

ANTARES
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 out of the question. The basis of the model is an optimizer connected in output of random simulators.

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.

Generally the study process made it unavoidable to encounter a number of limitations that need to be clearly stated and which are, by growing importance the following.

- 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)

- Regarding economy, the fuel and operating costs taken into account for each cluster of thermal plants were realistic enough (in particular regarding the general merit-order to which they lead) but should not in any way be considered as accurate. Whenever energy figures are converted into monetary figures, it should be remembered that the confidence interval of the estimation may be very wide.

- Even if NTCs are assumed to integrate the effect of domestic constraints, the use of an extremely simplified modelling for the network (all the plants of each country having the same "ability" to access the cross-border capacities) tends to over-estimate the overall economic performance of the interconnected system. The assumption of a NTC approach is an approximation of the reality of physical and commercial exchanges; the resulting bias may be either an over-or an under-estimation of the real flows

- The assumption of a perfect forecast for the renewables reduce the need for the balancing

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3.4 Network Studies Methodology

The main goal of the network studies is to answer the following questions:

- Will the initial transmission system be adequate for the dispatch of generation and load given in every hour from the market study in normal operation conditions, i.e. N-0, and observing the well-known N-1 rule?
- If not, then additional transmission system investments are proposed, compared and evaluated for all relevant cases until the planning criteria of the transmission system are fulfilled. By the studied cases a variety of dispatch situations has been explored: frequent ones, as well as rare ones which result in particularly extreme flow patterns.

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

Network models used in regional network studies include a detailed modelling of the transmission system with all lines, busbars and transformers and the generation and demand at their location. In terms of complexity, a model of Continental Europe for example includes more than 6.000 nodes and 10.000 grid elements.

By the means of steady-state load flow analysis the power flows on every grid element resulting from a specific generation dispatch are simulated. To ensure secure operational conditions voltage levels at every node and currents in every branch need to remain within secured ranges. This check is performed with all grid elements available as well as under consideration of an outage of every grid element and power unit (N-1 criterion), for every point in time and possibly considering several options for grid topology and testing remedial measures.

Market Studies as an Input to the Network Studies

In order to provide a proper assessment of the projects, the results of the market study have to be transferred into the network model to achieve a physical load flow, which can be interpreted and analysed.

The market simulations are calculated for every Vision and for every hour of the selected time horizon 2030. This means for 8760 points in time for every Vision the generation dispatch and market flows between market areas are derived, which result in 8760 operational states of the grid represented by power flows on each single grid element. As market flows show a very vague and inaccurate image of those operational states of the transmission system, detailed network studies follow the market simulations to check if the grid is able to handle the simulated generation dispatch. Hence the analysis work is done based on selected relevant cases, which are implemented manually and studied in detail (Figure 3-7).

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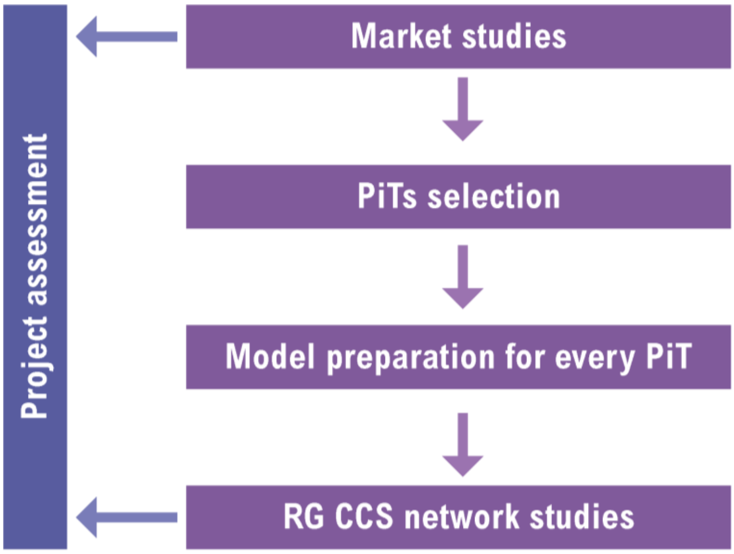

Figure 3-7 Overview process and link between Market Studies and Network Studies

The used cases are selected individually based on the type and area of the analysis. While there are some rather high load cases relevant for calculations as well as for the general understanding and study of extreme load flow situations in the grid, some moderate points in time with a clear and high representation of the majority of situations per year are used also for variation of losses calculations.

The selection and identification of the points in time is done by the use of different approaches. Rather high load situations are selected commonly within the subgroup based on expert knowledge and by making use of duration curves representing the market study results. For the selection of moderate points in time a statistical selection process is used based on relevant criteria for the regional group and the observed borders/projects. In case of the RG CCS parameters like wind in the northern part of Germany, pumping in the Alps and solar in the south of the RG were respected. In addition market exchanges between countries as well as country balances were also considered as relevant criteria.

In order to be able to do a detailed assessment of each project, four to eight points in time per Vision are needed. This guarantees that the optimal range of situations is used for every project to do a high quality analysis.

Network Studies Tools

The basis of the network studies are the load flow calculation tools that are used by all the TSOs of the RG CCS. It has to be mentioned, that there is a high diversity of different tools, what can cause some increase of coordination work but also increases the reliability of the results. All the exchanges of power system models are done in a common format called CIM (Common Information Model).

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TSO	Software	Vendor
RTE	Convergence	RTE
TERNA	SPIRA	CESI
Swissgrid	ISPEN PSSE/ODMS	EPS/Intercompro Siemens
Amprion/Transnet BW/ TenneT	Integral7	FGH
APG	Integral7	FGH
ELES	Neplan	BCP

All the mentioned tools are just focusing at network modelling - today there is no direct integration of market simulations. This leads to the situation that the whole network study process has to be done on the basis of selected cases.

During the assessment, some of the calculations are done with more than one tool in order to ensure to validate the results and ensure consistency. As soon as the results are in a comparable range, the calculations are divided among the Sub Group Grid Studies members to increase the efficiency and the assessment phase is mostly performed without redundant calculations.

4 Scenarios and study results

4.1 Description of the scenarios

This section describes qualitatively the scenario approach used for the preparation of the TYNDP 2014 and the CCS RgIP. A quantitative description of the scenarios is provided in the Scenario Outlook and Adequacy Forecast 2014-2030 and specifically for the CCS region in the following chapters as a part of the market study results.

The analysis of the RgIP is based on a large exploration of the 2030 horizon within four Visions for 2030. The year 2030 is used as a bridge between the European energy targets for 2020 and 2050. The Visions are not to be understood as forecasts and there is no probability attached to them. The aim of the "2030 Visions approach" used for the TYNDP 2014 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 within several workshops and a formal consultation during summer 2013[19]

This is a markedly different concept from that taken for the Scenarios until 2020 used in the TYNDP 2012, which aimed to estimate the evolution of system 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 uses 4 extreme scenarios to assess the project portfolio on the Cost Benefit Analysis methodology:

- 2 bottom-up (Vision 1 and 3): result from the input received from the involved TSOs based on the common European guidelines.
- 2 top down (Vision 2 and 4): are developed at the European level. These Visions are based on data provided by the TSOs for the bottom-up Visions which are further modified to reflect the assumptions[20] established for the studied Visions in order to achieve the relevant targets.

[19] Further details on the process to build the scenario is available in the appendix.
[20] For a further insight on the assumptions please see the presentations from the 3rd 2030 Visions workshop

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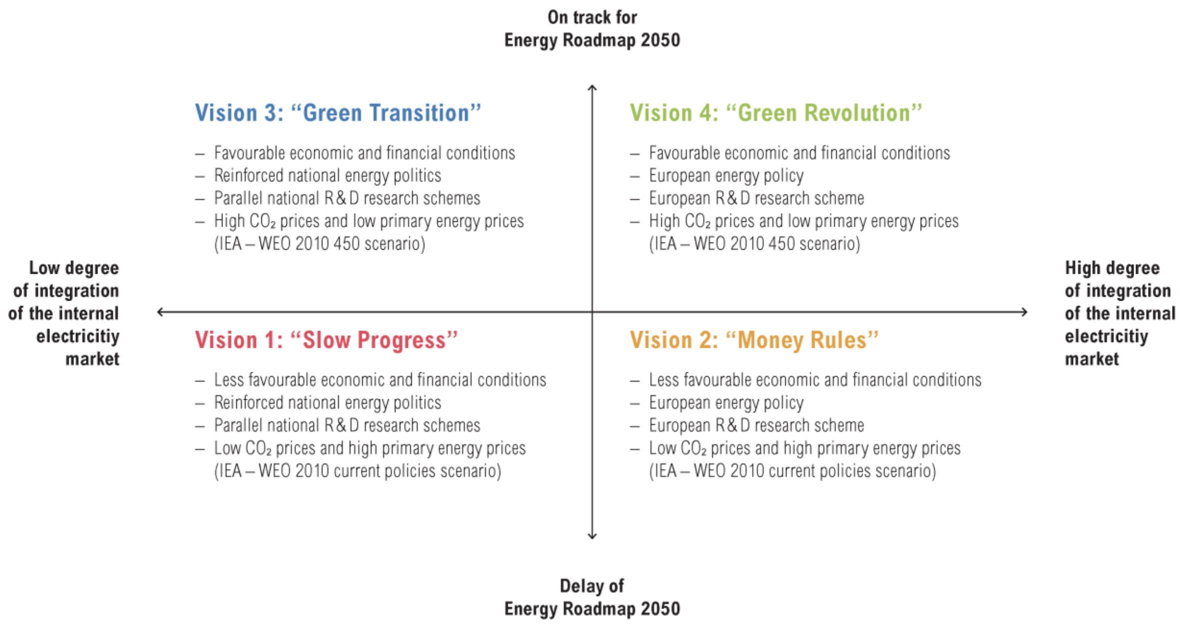

Figure 4-1 Overview of the political and economic frameworks of the four Visions

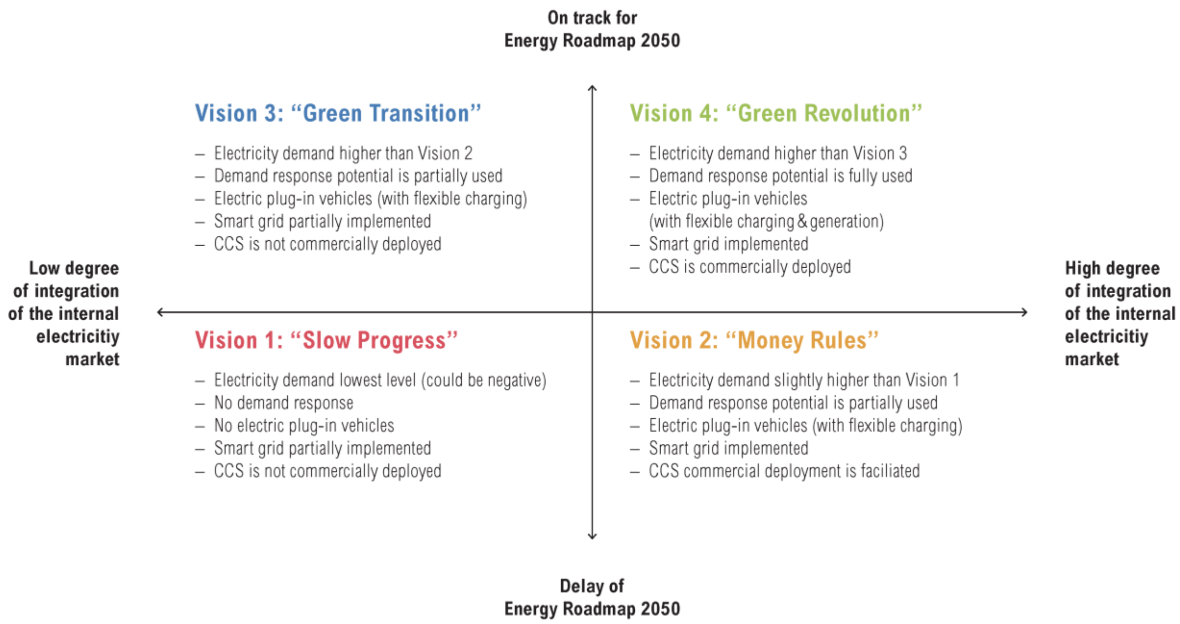

Figure 4-2 Overview of the generation and load frameworks of the four Visions

Differences in the high-level assumptions of the Visions are manifested among others in considerably higher CO_2 prices, but slightly lower (fossil) fuel prices in Vision 3 and 4, compared to Vision 1 and 2.

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Most relevant system evolution drivers in the CCS region, which are depicted in these scenarios, are quite low load growth, huge RES development concentrated especially at the corners of the region (DE, FR and IT), the prosecution of the nuclear phase out [21], and the development of hydro pumping storage power plants in the Alps.

Expected RES development in the region regards mainly intermittent generation (in Vision 4, 2030 total photovoltaic and wind capacity nearly triples the present amount), meaning also to additional challenges in terms of system balance, stability and security. In this respect the increase of storage capacity (up to nearly 35% in Vision 4) together with the development of the relevant transmission infrastructures.

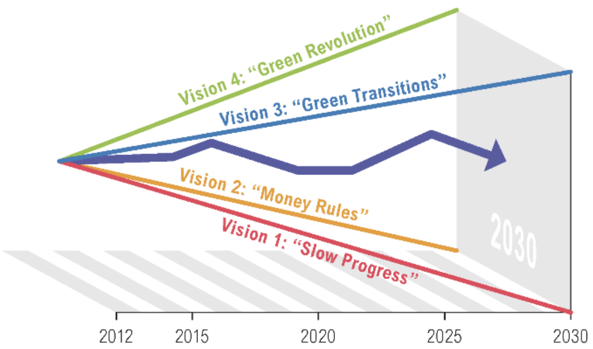
Nuclear capacity is expected to be significantly reduced in the CCS region (from 20 to 40%) depending on assumptions of the different 2030 Visions.

These drivers are particularly important, taking also into account the central position of the CCS region within the pan-EU system and the strong interaction and interrelation of the different countries and markets within the region and with its neighbours, leading to potentially high needs in terms of market and RES integration.

4.2 Consistency of the 4 Visions for 2030

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

The TYNDP 2014 analysis is based on a large 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 stakeholders' feedback, preferring a large scope of contrasted longer-run scenarios instead of a more limited number and an intermediate horizon 2020.



The basis for the TYNDP 2014 analysis is 4 Visions for 2030. The Visions are less forecasts of the future than selected as possible corners 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. In addition, these Visions are not optimized scenarios (e.g. no assessment was performed of where the solar development would be the most economically viable). The Visions have been formulated taking into account the results of an extensive consultation with several workshops and a formal consultation during summer 2013[22].

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 4 Visions differ mainly with respect to:

[21] Already decided in Germany and Switzerland, with some decrease under discussion in France depending also on the considered Visions.
[22] Further details on the process to build the scenario is available in the appendix xx

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- The trajectory toward the Energy roadmap 2050: Visions 3 and 4 maintaining a regular pace from now on until 2050, Visions 1 and 2 assuming a slower start then acceleration after 2030. Fuels and CO2 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 building bottom up on every country energy policies; Visions 2 and 4 assuming a top-down approach, with a more harmonised European integration.

The top-down approach used to build Vision 2 and 4 has been designed with stakeholders and consulted beginning of 2013[23]: Vision 2 and 4 are derived from Vision 1 and 3, in view of greater harmonisation of all countries' data.

4.3 Vision 1

As introduced in Chapter 4.1, projects 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 energy. The level of demand grows with a slow annual rate.

In this paragraph, the main data, with special regard about load, balance and generation for Continental Central South countries as obtained in Vision 1 is reported (details of tools used and system modelling are provided in Chapter 3).

The details of the generation mix, in terms of installed capacity and annual generation are reported in Figure 4-3 and Figure 4-4.

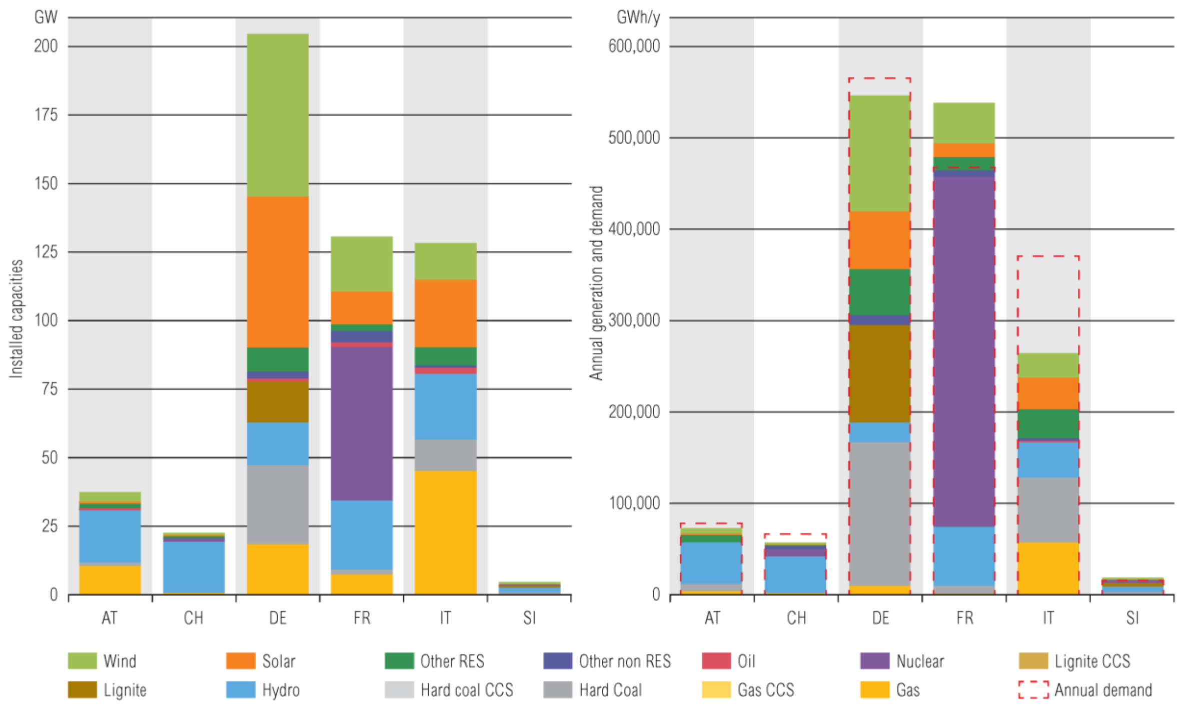

Figure 4-3 Installed capacity in Vision 1 in RG CCS (GW)

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

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

Figure 4-3 represents the installed generation capacities for the RG CCS countries. In the region about 40 % of the installed capacities are from new renewable sources, 20 % from hydro and the rest from fossil fuel and nuclear sources.

Compared to the installed capacities reported in the Yearly Statistics & Adequacy Retrospect 2012, in Vision 1 the installed capacities in the CCS region increases by about 60 GW; especially Wind and Solar are doubled, while, due to the nuclear phase out, the installed nuclear capacity decreases by about 30 %. The installed storage capacities increase by about 25 %.

The figures are consistent with the general hypothesis of Vision 1. Indeed the growth of RES generation is rather limited and not compliant with the Energy Roadmap 2050 and no additional policies have been considered after 2020 to stimulate the commissioning of additional RES generation.

Figure 4-4 represents the annual generation and demand (red dotted lines) for the RG CCS countries. The demand results greater than generation within many CCS countries such as Italy, Germany, Switzerland and Austria while France and Slovenia balances show a generation surplus respect to the local demand.

About the demand, Vision 1 does neither consider major breakthroughs in the development of energy efficiency measures, nor major developments of the usage of electricity in the transport and heating/cooling fields.

In Vision 1, considering still a low CO2 price, about 57 % of generation comes from fossil fuel (especially from coal) and nuclear source, while about 43 % is produced by RES (wind, solar and hydro sources). Concerning the fossil fuel sources, the different shares showed in figure 4 reflect the general assumptions about the merit order of power plants, with the coal source providing the main contribution to the thermal generation mix (excluding nuclear).

Highest generation costs differences are about 5 €/MWh on average between Italy and the northern border neighbouring countries, and about 10 €/MWh on average between Italy and Balkan countries. The differences among the rest of CCS countries are on average lower than 2 €/MWh.

It means that in terms of market integration the considered grid development projects are consistent with the general hypotheses of the scenario (no major bottlenecks).

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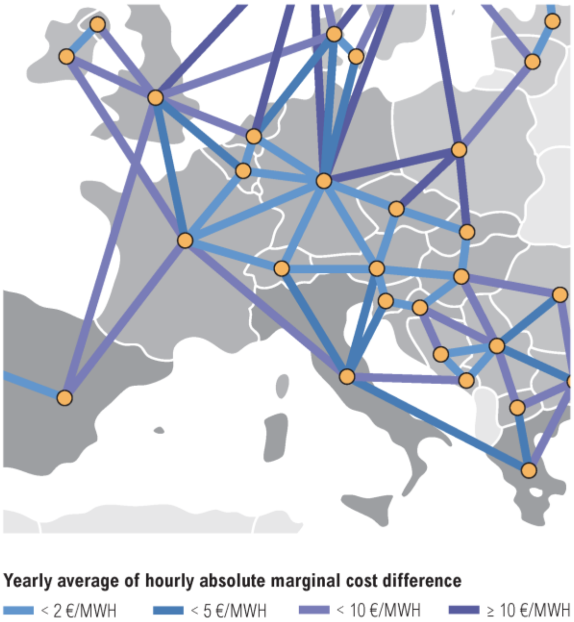

Figure 4-5 Yearly average marginal cost difference in Vision 1 in RG CSS

Figure 4-6 depicts the CO2 emissions in Vision 1 both in terms of yearly CO2 emissions per country (MTons/y) and in terms of CO2 intensity of electricity generation (Tons/GWh). Compared to the level of 1990, the emissions are reduced by 50% in the CCS region.

The different values of CO2 emissions expressed as MTons/y depend on the size of the country, on the assumed generation mix and its production, while the intensity values expressed as Tons/GWh y are only dependent on the production.

The largest emitters are Germany and Italy due to high installed capacity in fossil fuel thermal power plants and the low CO2 emission cost, on the basis of the assumptions for this scenario.

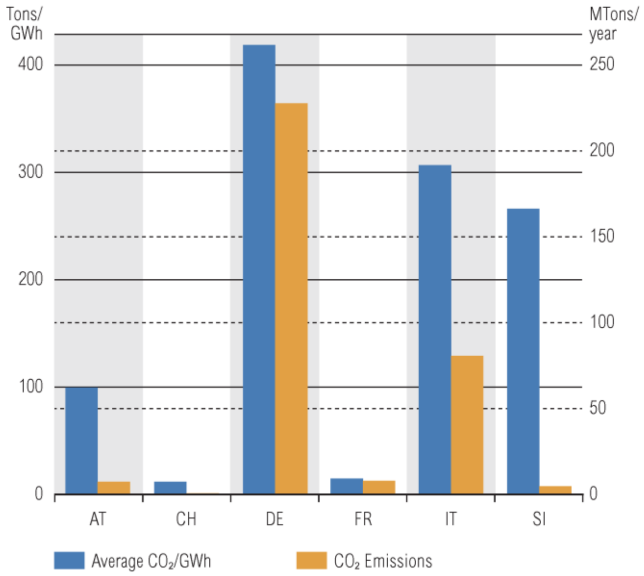

Figure 4-6 CO2 emissions in RG CCS (Mtons/year) & CO2 emissions in Vision 1 in RG CCS per MWh (Tons/GWh year)

4.4 Vision 2

The second scenario is headed with “Money rules” (following Vision 2). It reflects more favourable economic and financial conditions for the energy system development. The level of demand grows with a slow annual rate.

In this subchapter the main figures with special regard about load, balance and generation for Continental Central South countries are reported, as obtained in Vision 2 (details of tools used and system modelling reported in Chapter 3).

The details of the generation mix, in terms of installed capacity and annual generation are reported in Figure 4-7 and Figure 4-8.

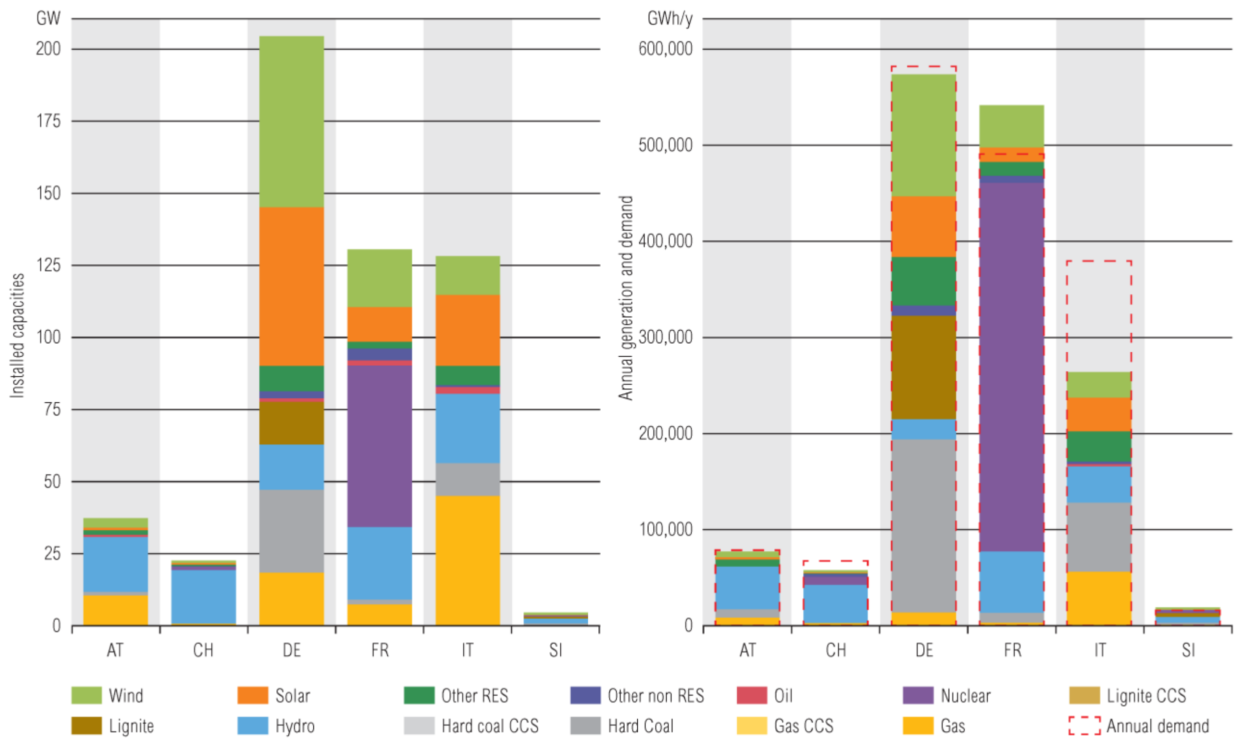

Figure 4-7 Installed capacity in Vision 2 in RG CCS (GW)

Figure 4-8 Annual generation and demand in Vision 2 in RG CCS (GWh/year)

Figure 4-7 represents the installed capacity for the RG CCS countries. In the region about 40% of the installed capacity is from new renewable sources, 21% from hydro while the remaining part is from fossil fuel and nuclear sources.

As in Vision 1, in the Vision 2 the installed capacity in the RG CCS increase by about 60 GW, compared to the installed capacities reported in the Yearly Statistics & Adequacy Retrospect 2012. In particular the installed capacities from Wind and Solar are doubled while, on the basis of the nuclear phase out, the installed nuclear capacities decrease about 30 %. The installed storage capacities increase about 25 %.

The figures are consistent to the general hypothesis of Vision 2. Indeed the growth of RES generation is rather limited and not compliant with the Energy Roadmap 2050 as well as no additional policies have been considered after 2020 to stimulate the commissioning of additional RES generation.

Figure 3-8 represents the annual generation and demand (red dotted lines) for the RG CCS countries. The demand results greater than generation within many CCS countries, in particular Italy and Germany, while France has the greatest surplus in generation respect to the local demand even in V2.

The demand in Vision 2 considers breakthroughs in energy efficiency development, as well as the developments of the usage of electricity transport and heating/cooling, driven by possible economic benefits.

In Vision 2, considering a low CO_2 price, 57 % of generation comes from fossil fuel and nuclear source, while 42% is from RES source. Especially concerning the fossil fuel sources, the different shares - as showed in Figure 4-8 - reflects the general hypothesis about the merit order which foresees coal as the major contributor to the thermal mix (excluding "0" cost generation as nuclear).

Like the Vision 1, on the base of the generation costs, the grid development considered is consistent with the general hypothesis of the scenario (no major bottlenecks).

Figure 4-9 Yearly average marginal cost difference in Vision 2 in RG CSS

Figures 3-10 depicts the CO2 emissions in Vision 2 both in terms of yearly CO2 emissions per country (MTons/y) and in terms of CO2 intensity of electricity generation (Tons/GWh y). Compared to the level of 1990, the emissions are reduced by 40 % in the CCS region.

The different values of MTons/y depend on the size of the country and the generation mix and its production, while the values of Tons/GWh y are only dependent on the production.

The largest emitters are Germany and Italy due to high installed capacity in fossil fuel thermal power plants and the low CO2 emission cost, assumed on the basis of the scenario hypothesis.

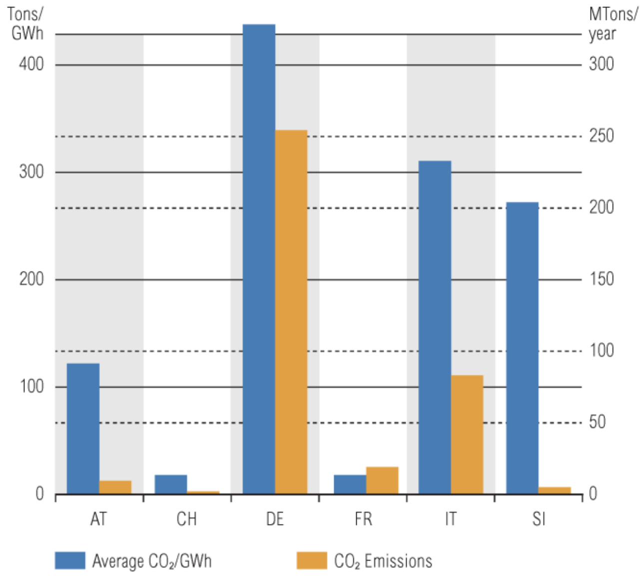

Figure 4-10 CO2 emissions in RG CCS (Mtons/year) & CO2 emissions in Vision 2 in RG CCS per GWh (Tons/GWh year)

4.5 Vision 3

The third of the analysed scenarios is the "Green transition" scenario (following Vision 3). It reflects a green transition in energy system development with more favourable economic and financial conditions. Vision 3 assumes high increase of green energy. The level of demand grows with a higher annual rate compared to the first two Visions.

In this paragraph the main figures with special regard to load, balance and generation for Continental Central South countries as obtained in Vision 3 are reported (details of tools used and system modelling reported in Chapter 3).

The details of the generation mix, in terms of installed capacity and annual generation are reported in Figure 4-11 and Figure 4-12.

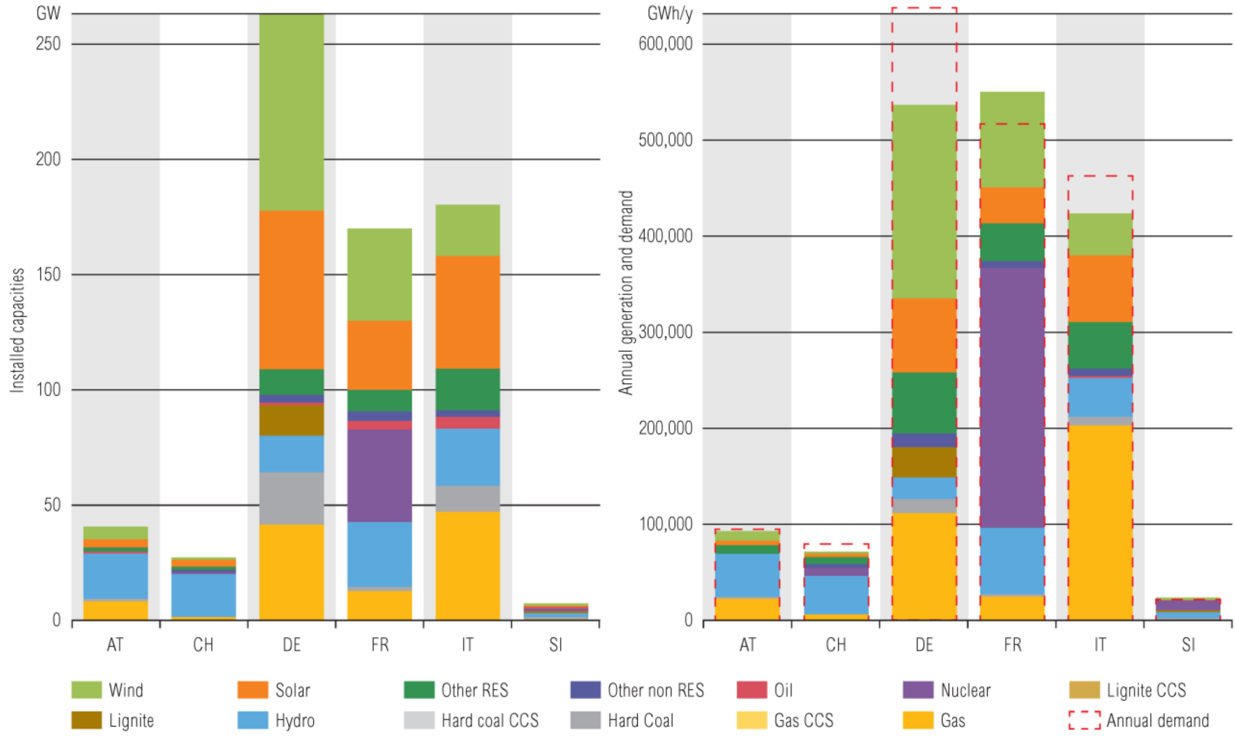

Figure 4-11 Installed capacity in Vision 3 in RG CCS (GW)

Figure 4-12 Annual generation and demand in Vision 3 in RG CCS (GWh/year)

Figure 4-11 represents the installed capacity for the RG CCS countries. In the region about 51 % of the installed capacity is from new renewable sources, 16% from hydro and the rest from fossil and nuclear sources.

Compared to the installed capacities reported in the Yearly Statistics & Adequacy Retrospect 2012 the installed capacity in the RG CCS increase by about 200 GW, especially the installed wind and solar capacities are three times the 2012 value, while, on the basis of the nuclear phase out, the installed nuclear capacities decrease by about 45 %. The installed storage capacities increase by about 30 %.

The figures are consistent to the general hypothesis of Vision 3. The growth of RES generation is compliant with the Energy Roadmap 2050 to realize the decarbonisation objectives.

Figure 4-12 represents the annual generation and demand (red dotted lines) for the RG CCS countries. The demand results greater than generation within many CCS countries, in particular Germany and Italy, while France keep the greatest surplus in generation respect to the local demand.

The demand Vision 3 considers efforts in energy efficiency development, as well as the developments of the usage of electricity transport and heating/cooling are intensified to minimize the ecological footprint.

In Vision 3, due to high CO2 prices, about 43 % of generation comes from fossil fuel and nuclear source, while 55 % is produced by renewable sources. Especially concerning the fossil fuel sources, the different shares - as showed in Figure 4-12 - reflect the general hypothesis about the merit order which have foreseen the gas source as the major contributor to the generation mix (excluding “0” cost generation as nuclear and RES).

Concerning the average marginal costs among the CCS countries the main differences are between France and Germany, France and Italy and Italy and Balkan countries with about 10 €/MWh, while the rest of the CCS borders are about 5 €/MWh.

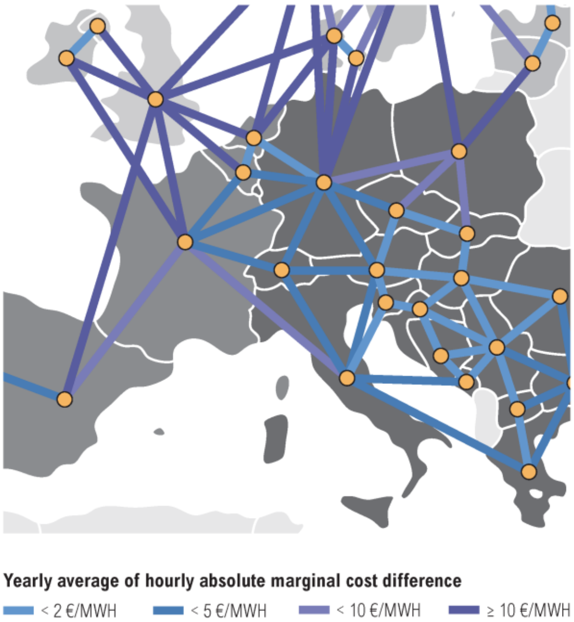

Figure 4-13 Yearly average marginal cost difference in Vision 3 in RG CSS

Figure 3-14 depicts the CO2 emissions in Vision 4 both in terms of yearly CO2 emissions per country (MTons/y) and in terms of CO2 intensity of electricity generation (Tons/GWh y). Compared to the level of 1990, the emissions are reduced by 74 % in the CCS region.

The different values of MTons/y depend on the size of the country and the generation mix and its production, while the values of Tons/GWh/y are only dependent on the production.

The largest emitters are again Germany and Italy due to high installed capacity in fossil fuel thermal power plants. For all CCS countries and especially for Germany the increase of the installed RES capacities and the higher CO2 price leads to a decrease of the CO2 emissions respect to V1 and V2.

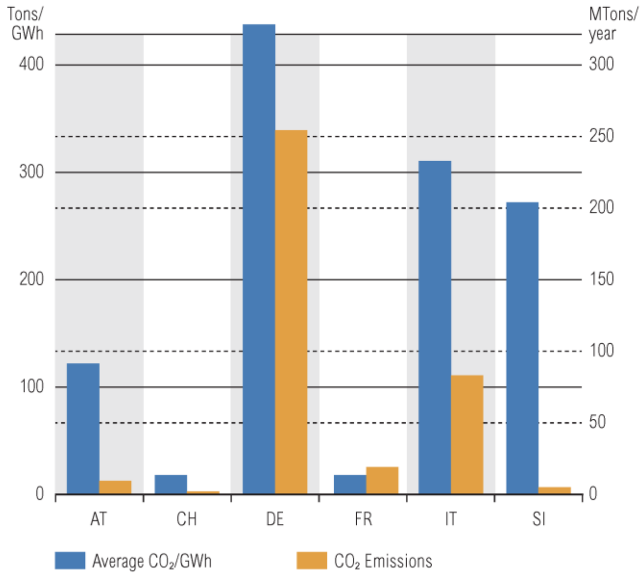

Figure 4-14 CO2 emissions in RG CCS (Mtons/year) & CO2 emissions in Vision 3 in RG CCS per GWh (Tons/GWh year)

4.6 Vision 4

The fourth of the investigated scenarios has the title "Green Revolution" (hereafter Vision 4). It reflects a green revolution in energy system development with favourable economic and financial conditions. Vision 4 is also the Vision with the highest increase of green energy. The electricity demand is the highest in all four Visions as the dissemination of the usage of electricity transport and heating/cooling have been considered, that exceeds the strong efforts in energy efficiency improvement.

In this paragraph the main data, with special regard about load, balance and generation for Continental Central South countries as obtained in Vision 4, are reported (details of tools used and system modelling are provided in Chapter 3).

The details of the generation mix, in terms of installed capacity and annual generation are reported in Figure 4-15 and Figure 4-16.

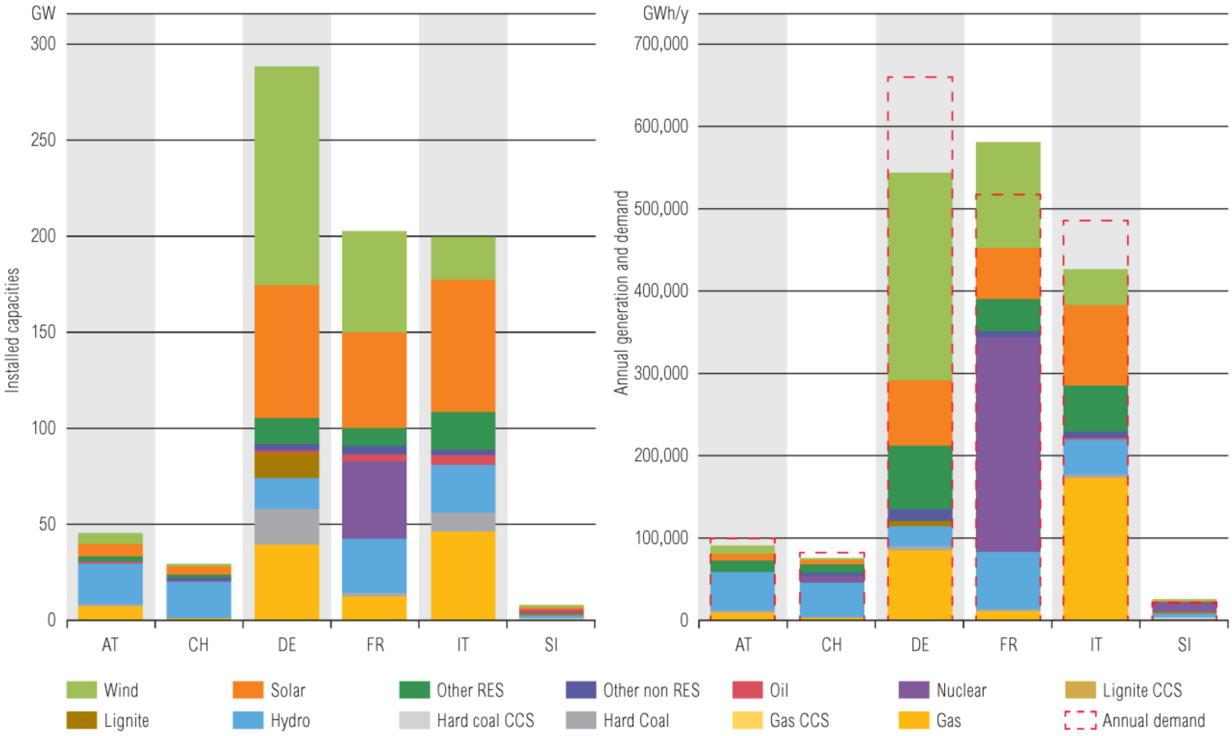

Figure 4-15 Installed capacity in Vision 4 in RG CCS (GW)

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

Figure 4-15 represents the installed capacity for the RG CCS countries. In the region about 72 % of the installed capacity is from new renewable sources, and about 28 % came from fossil and nuclear sources.

Compared to the installed capacities reported in the Yearly Statistics & Adequacy Retrospect 2012, in the Vision 4 the installed capacity in the RG CCS increases by about 300 GW. The installed capacities from wind and solar nearly triple, while on the basis of the nuclear phase out in the region the installed nuclear capacity decreases by about 50 %. Regarding the installed storage capacities an increase of about 35 % is considered.

The figures are consistent to the general hypothesis of Vision 4. The growth of RES generation is fully compliant with the Energy Roadmap 2050 to realize the complete decarbonisation objectives at the lowest cost.

Figure 4-16 represents the annual generation and demand (red dotted lines) for the RG CCS countries. The demand results greater than generation within many CCS countries such as Italy, Germany, Switzerland and Austria while France and Slovenia balances show a generation surplus respect to the local demand.

In the Vision 4 framework, considering the high CO2 price, about 64 % of the total generation comes from RES (wind, solar and hydro sources), while 36 % of generation comes from fossil fuels (mainly from gas) and nuclear (almost 16 % of the generation is produced with nuclear power plants).

Concerning the fossil fuel sources, as showed in Figure 4-16, the different shares reflects the general assumptions about the merit order, with the gas source being the major contributor to the thermal generation mix (nuclear).

Concerning the cost differences among the CCS countries, there are about 5-10 €/MWh on average between France and Eastern countries and less than 2 €/MWh on the Italian northern border between Italy and North-Eastern countries. Among the central countries of CCS the average differences are between 5 and 10 €/MWh.

Also in Vision 4, considering the additional transmission capacities due to the planned network development projects markets are significantly integrated in CCS region.

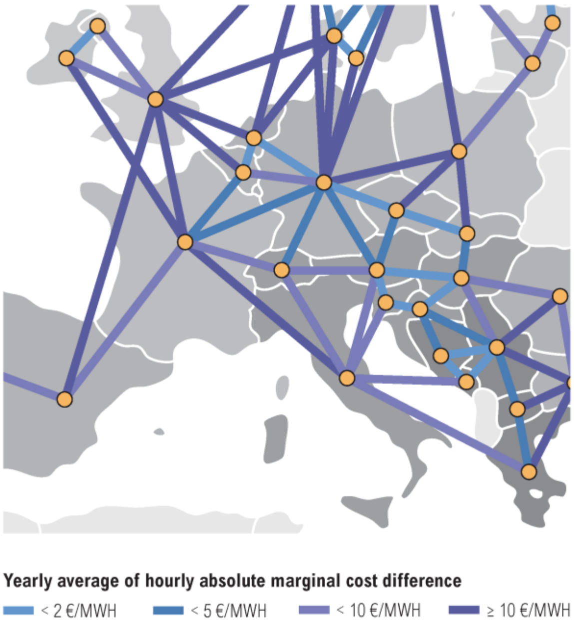

Figure 4-17 Yearly average marginal cost difference in Vision 4 in RG CSS

Figure 4-17 depicts the CO2 emissions in Vision 1 both in terms of yearly CO2 emissions per country (MTons/y) and in terms of CO2 intensity of electricity generation (Tons/GWh y). Compared to the level of 1990, the emissions are reduced by 84 % in the CCS region.

The different values of CO2 emissions expressed as MTons/y depend on the size of the country, on the assumed generation mix and its production, while the intensity values expressed as Tons/GWh y are only dependent on the production.

The largest emitters are again Germany and Italy due to high installed fossil fuel based generation capacities. For all CCS countries and especially for Germany the increase of the installed RES capacities leads to a huge decrease of the CO2 emissions respect to the other Visions, including V3.

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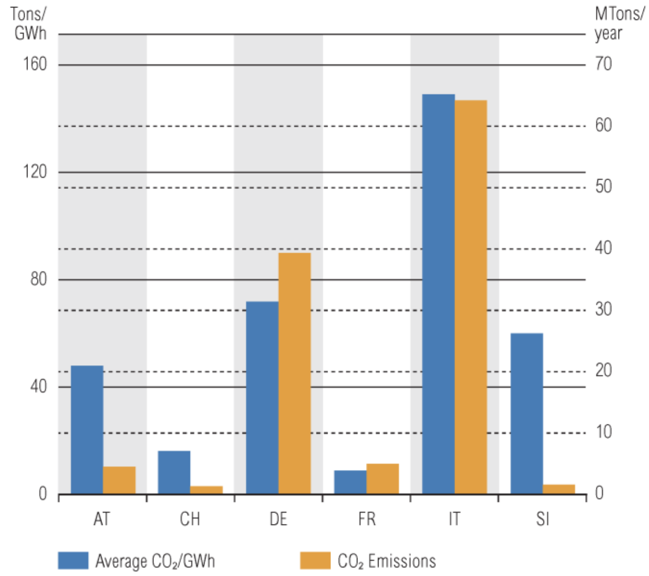

Figure 4-18 CO2 emissions in RG CCS (Mtons/year) & CO2 emissions in Vision 1 in RG CCS per GWh (Tons/GWh year)

4.7 Network Studies Results

As mentioned in the chapters above, the development of installed RES capacities as well as the reduction of nuclear capacities has a significant impact on the load flows. Certain market situations and patterns can be recognized, which are not common today and quite demanding for the grid.

To analyse this impact, several relevant typical and also extreme situations are modelled within the network calculation tools on the basis of the market study results.

During the analysis of the four Visions, different characteristic load flow situations were found in variable magnitude. Some of them (by far not exhaustive) are reported and analysed in the following sections with the aim of illustrating the methodology adopted and evidences raised from network studies activities.

Vision 1

As already mentioned in the paragraph “Market Studies as an Input to the Network Studies”, different points in time are used and needed for the proper analysis of various aspects of possible load flow situations in the grid. Representative for the whole calculation process, a situation in the PSM is illustrated subsequently.

For the analysis and the assessment of the CBA indicators of the projects on the eastern border of France, amongst others, the situation shown on the map below was used as one common situation in Vision 1.

In that specific case, the total export of France, Spain, Portugal and Great Britain is around 19 GW, whereas Switzerland, Italy and Austria are importing (Germany and Slovenia are quite neutral). This causes a West – South-East flow in the whole region what can be found very frequently.

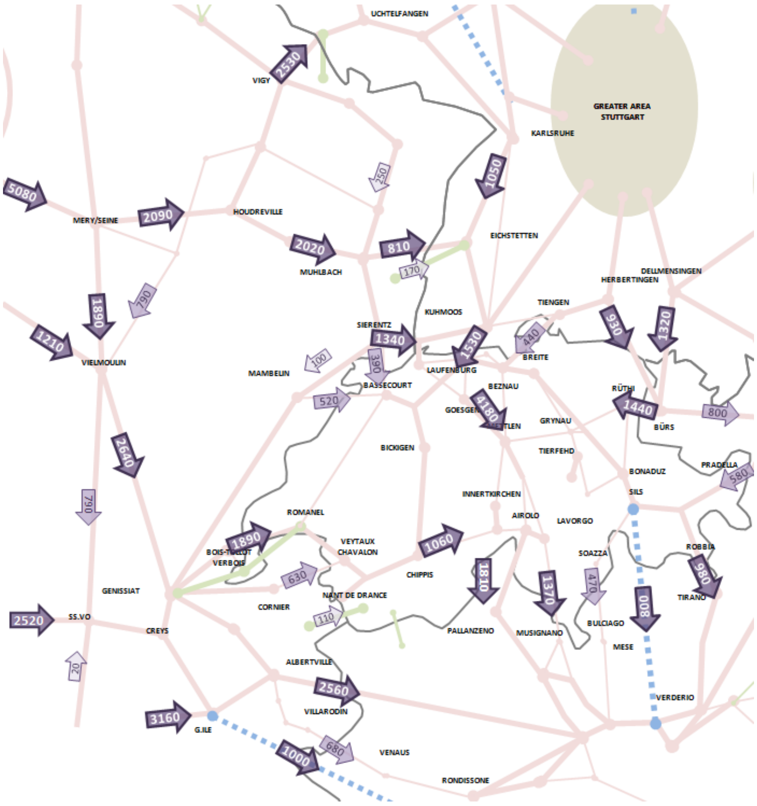

Figure 4-19 Example of Load Flow in Vision 1: export of FR[24]

Based on this information, the projects on the French border can be assessed in detail. Besides that, the point in time also meets also the requirements for the assessment of different other projects and plausibility checks. Due to the fact, that the implementation of a point in time is coupled with a high workload, this leads to a very efficient usage and a necessity of only a limited amount of realized hours. The saved time can be efficiently used to do a detailed assessment of the CBA indicators.

Vision 4

Based on the assumptions in Vision 4, the effects of the developed generation mix are obvious. In situations with high wind generation, a load flow from Germany to France can be observed. In times with less renewable generation, the opposite flow direction of the power is existent, caused by the high imports of Germany.

The map below shows the load flows during high renewable infeed in Germany of about 50 GW. France and Italy are importing, Germany and Switzerland are exporting. The flows are quite high in the Switzerland – Italy border and also in the France - Germany border.

Based on this information, this point in time is used (among others) of the assessment of the affected areas and gives an idea about the Vision 4 assumptions affecting the grid.

[24] The selected PiT is not representative for all projects.

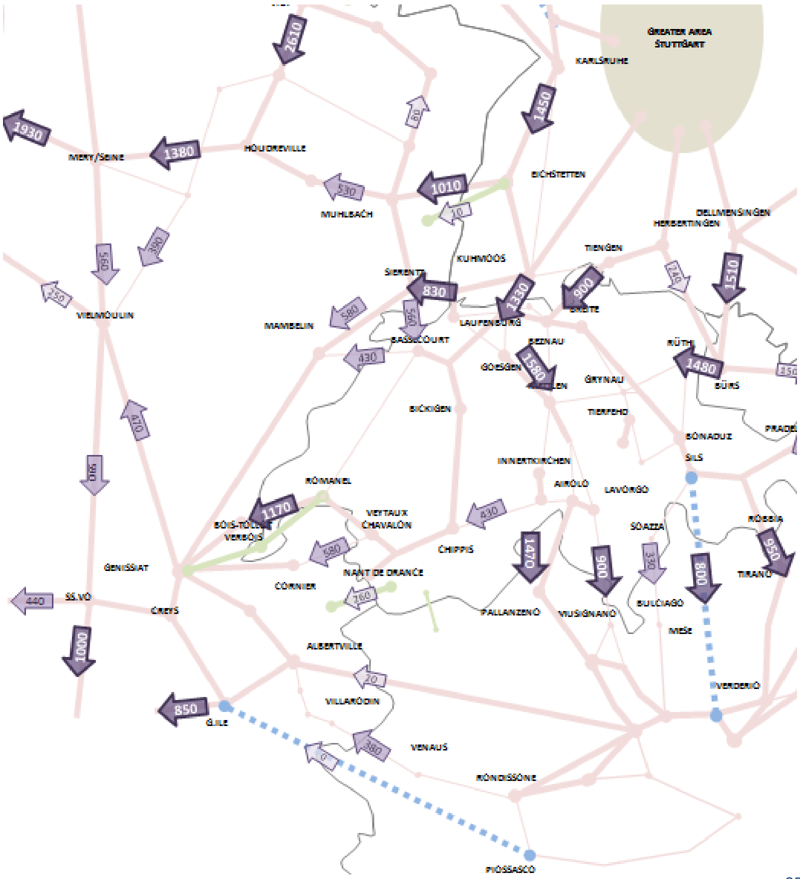

Figure 4-20 Example of Load Flow in Vision 4: export of DE with high RES[25]

Vision 2&3

In general the calculation results show that Vision 2 and Vision 3 do not represent a completely new characteristic in respect to the load flow situations and their magnitude. Vision 2 can be described – in terms of load flow situations – similar to Vision 1 whereas Vision 3 represents a more moderate Vision 4. Due to these similarities these two Visions are not illustrated here in a detailed way.

4.8 Comparison of the assumptions and results of the studies in the Visions

The aim of this section is to provide the reader with a synthetic view of the assumption and outcomes of the regional studies in the four Visions, by comparing their main characteristics, especially in terms of load and generation pattern, with a focus on CCS perimeter.

According to the general hypothesis at the basis of the scenario building, the CCS native demand varies between about 1.550 TWh (in 2030, Vision 1) and about 1.850 TWh (in 2030, Vision 4). With respect to the extent of demand registered in the CCS Region in 2012 (close to 1.505 TWh), the increase expected in 2030 in V1 is about 3 % in total, while in V4 it is about 23 %.

[25] The selected PiT is not representative for all projects.

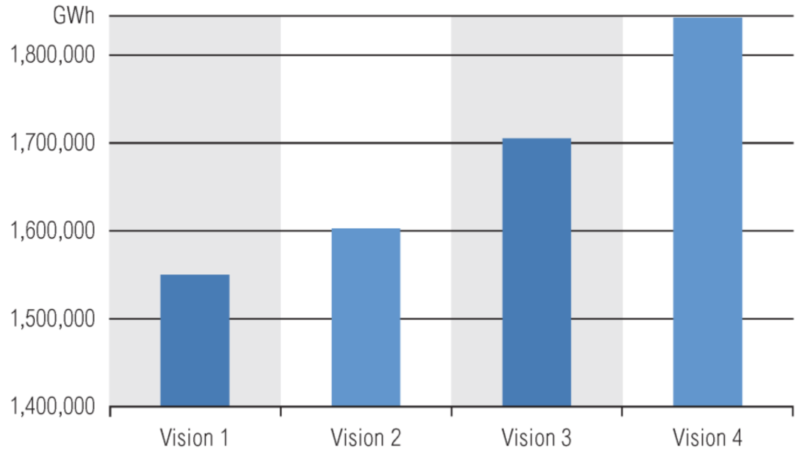

Figure 4-21 Native demand in CCS area [GWh]

In the CCS area, expected trends of the installed generation capacity are not strictly correlated with the increase of the demand.

Major differences in the CCS Region are between Vision 1 and Vision 4, especially concerning RES (in V4 total capacity from RES is over 250 GW higher than V1). Wind and Solar capacities in 2030 are expected to double the present amount in Vision 1 and to quadruplicate it in Vision 4.

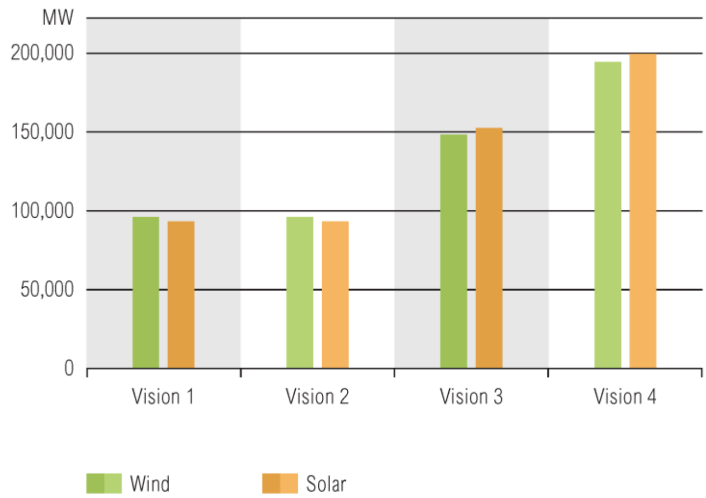

Figure 4-22 Wind and PV installed capacity in CCS area [MW]

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While, concerning nuclear generation, the CCS region shows a decrease of about 15 GW from Vision 1 and Vision 2 to Vision 3 and Vision 4, due to the nuclear phase-out policies assumed in some countries.

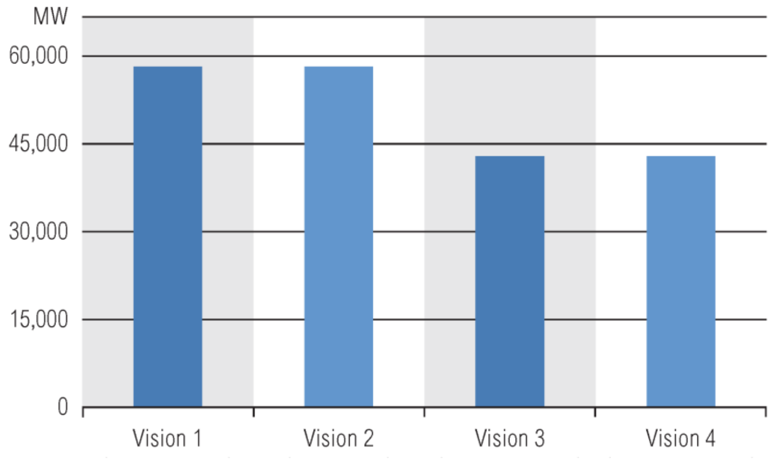

Figure 4-23 Nuclear installed capacity [MW]

About fossil fuels generation capacities, the trends are correlated to the CO2 price scenario assumptions leading to a coal power decrease of about 6 GW (mainly the old power plants category), while the Gas power, especially form CCGT technology, increases of about 30 GW from Vision 1 to Vision 4.

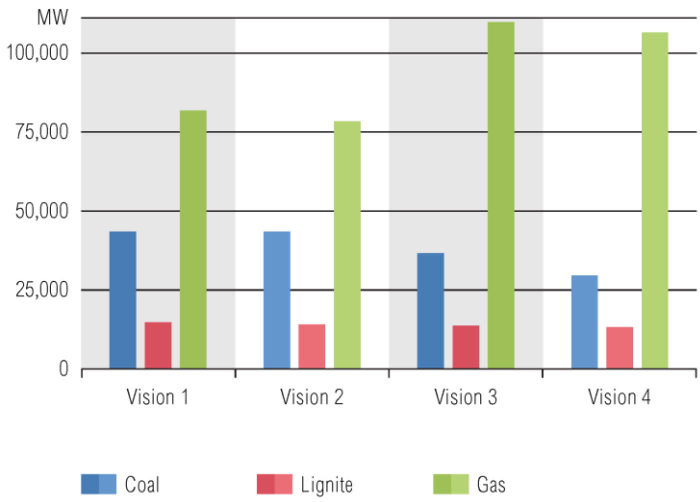

Figure 4-24 Fossil fuels installed capacity [MW]

As mentioned within the market studies section, in Vision 1 a still high amount of the annual generation comes from hard coal and lignite. This is due to the cheap production costs resulting of a low CO2 price that has a huge effect on the CO2 emissions. An increasing of the CO2 costs (as well as the higher installed RES capacity) shows its beneficiary effects on an expected massive reduction of the CO2 emissions. This is possible because of a switch of positions in the merit order (coal vs. gas) and a higher production provided by wind and solar. It is an important fact that this positive effect on the CO2 emissions is not outweighed by the higher loads in Vision 4, which is due to a higher penetration of electric mobility and an increase of electrical heating/cooling consumption.

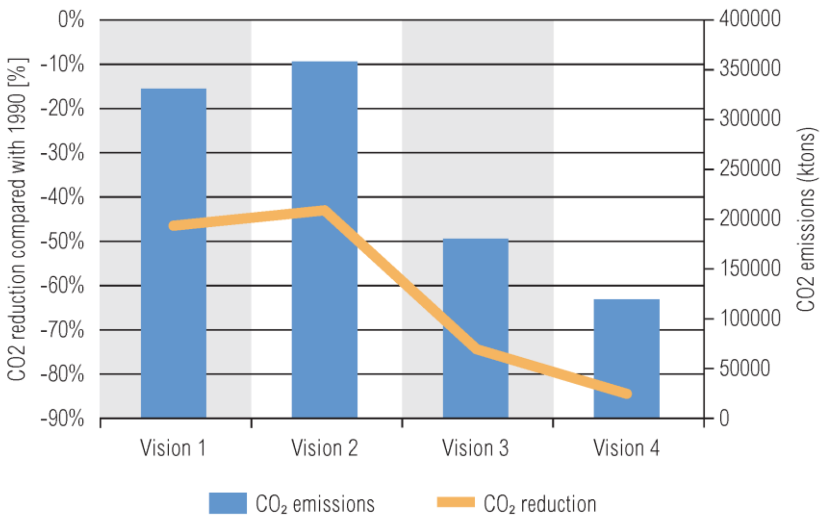

Figure 4-25 CO2 Emissions in each Vision

The generation mix characterizing the four Visions leads to different use of the grid which affected the losses as well. A general decrease of losses could be reached among the four Visions, as showed in the Figure 4-26. The sum of the losses variation does not change very much among Vision 1 two 2 (approx. 4000GWh/a) whereas the reduction in Vision 3 and 4 is significantly higher (approx. 13000GWh/a). This is a result of the throughout higher flows in these Visions.

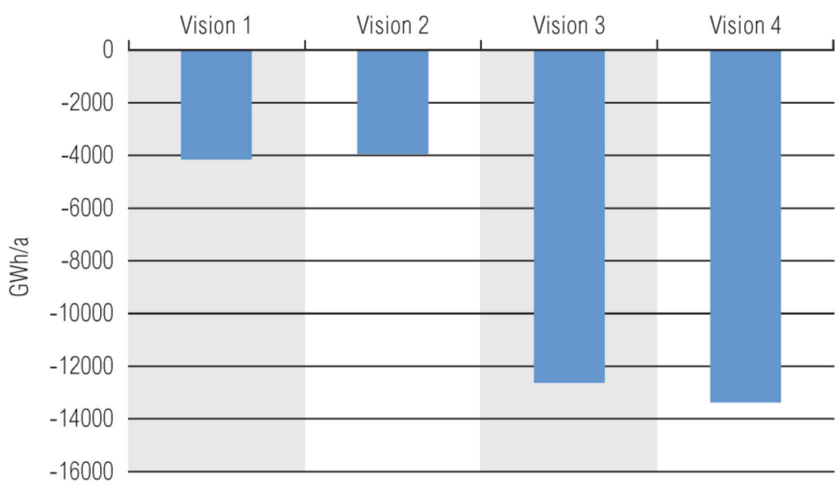

Figure 4-26 Losses variation in each Vision (decrease)

Given the above, market and network studies performed by the Regional Group CCS highlighted different system operational conditions in the four Visions analysed. More in detail, the outcomes of the studies showed:

- the need to integrate an increasing production from RES against the four Visions (from over 40% in Vision 2 up to more than 60% in Vision 4);
- the opportunity to increase transmission capacity in order to allow higher efficiency in the market and to achieve required CO2 emission reduction in all the investigated scenarios, where the merit order of generation changes significantly (in Vision 1 coal source provides the main contribution to the thermal generation mix, while in Vision 4 it is replaced by gas);
- the necessity to manage different power transits across the Region, taking into account the RES penetration and changes in the generation merit order, leading to different balances in the national systems (with Italy reducing its dependence in Vision 4).
- a general decrease in losses, with reference to the operational conditions simulated according to the four Visions scenario, which have highlighted a losses reduction up to 13000 GWh (Vision 4).

5 Investment needs

5.1 Present Situation

In Figure 5-1 the current levels of Net Transfer Capacities (NTC) in the Continental Central South region are illustrated. The NTC is the maximum total exchange program between two adjacent control areas that is compatible with security standards and applicable in all control areas of the synchronous area, whilst taking into account the technical uncertainties on future network conditions. The values are representing the maximum capacity. In operation values can vary hour by hour based on the availability of grid elements (reconstruction, revision, etc.) and expected unplanned flows. Such deviations between planned and realised programs (e.g. caused by inaccuracy in the forecasts) are happening already today and one can expect even higher variation in the future due to expected higher variability of electricity generation.

NTC values for the same border and the same grid change according to different conditions, e.g. the topology of the network or the generation and load pattern for the considered point in time.

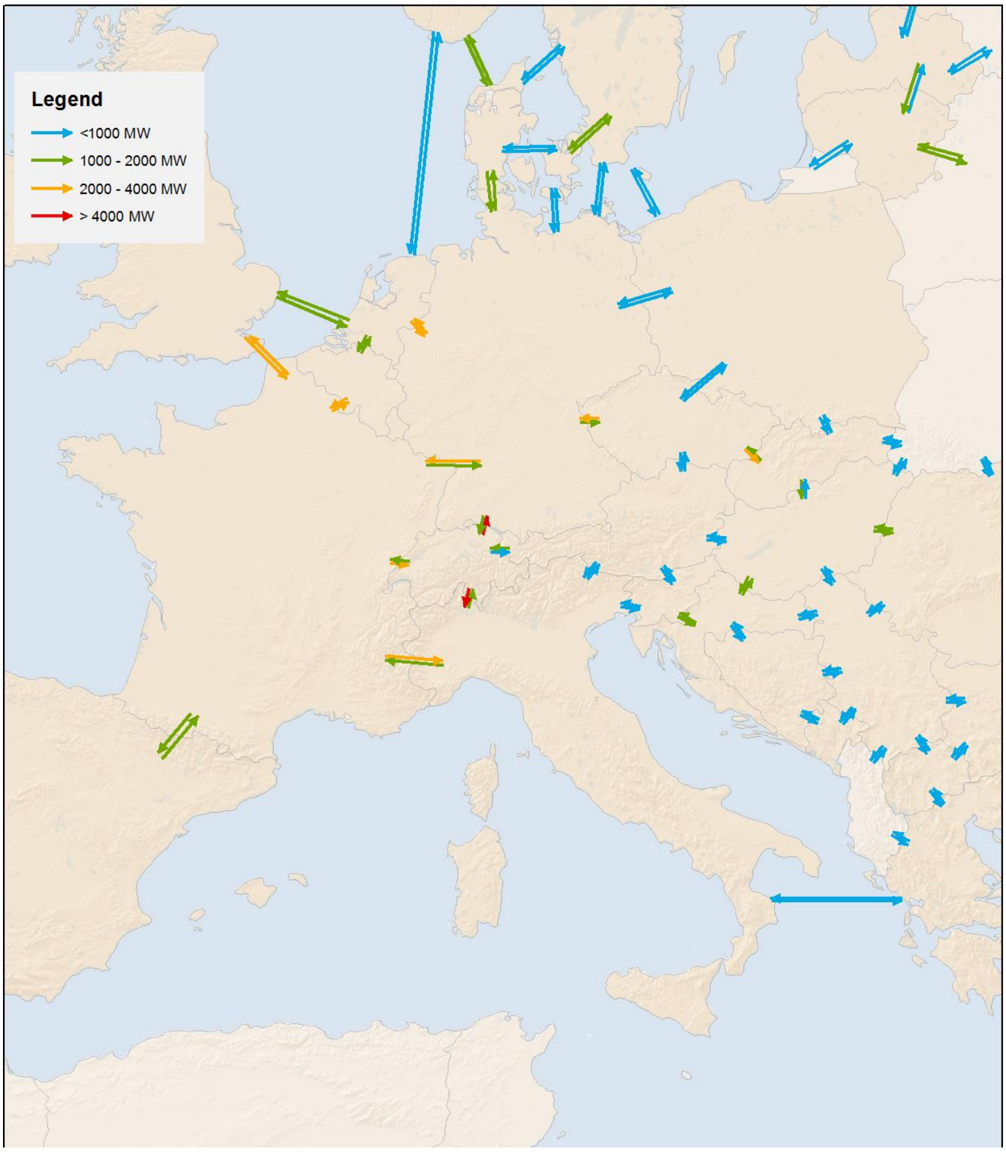

Figure 5-1 Illustration of Net Transfer Capacities in CCS region (2013)

Looking at recent development of interconnection capacities, it is important to highlight the increase of capacity on the northern Italian borders with respect to what was depicted by TYNDP 2012. Actually due to reconductoring of the existing interconnection between France and Italy, commissioning the new double circuit line Trino-Lacchiarella and the works in Slovenia, more potential exchange capacity has been allowed by beginning of 2014.

At present time highest NTC values are located in Central-West part of CCS area.

5.2 Drivers for power system evolution

Drivers for power system evolution directly derive from EU energy policy goals, security of supply, internal electricity market integration, climate change mitigation and RES integration.

In the Continental Central South Region five main categories of transmission needs can be briefly summarized:

- **Massive RES integration:**

  The main driver for grid development in the CCS Region is the connection and integration of RES on a large scale (mainly wind power and photovoltaic). The increasing penetration of variable renewable generation leads to fluctuation and high utilisation of the transmission network, and a more flexible transmission grid is needed as a result. In particular, the geographical concentration of the RES development at the corners of the region (mainly in DE, FR and IT) far away from the centres of consumption and the Alpine storages leads to a wide area of power transmission.

- **Integration of storage plants, mainly hydro in the Alps region, facilitates the efficient use of RES:**

  The divergence in the generation time and demand resulting from the integration of volatile RES is another rising and sustainable challenge for the overall power system, leading to the necessity for additional transport and storages capacities as well as other innovative measures. Considerable storage potential is available in the very centre of the region, particularly in the form of existing and planned hydro pumped storage power plants located mainly in the Alps.

- **Nuclear phase out:**

  The nuclear phase out, specifically the reduction of the share of nuclear energy in the generation mix- according to the assumptions of the different Visions mainly in Germany, Switzerland and France – has a significant structural impact on the electricity systems and therefore the countries' power and energy balances. The availability of an adequate grid infrastructure constitutes the basis for coping with those structural changes.

- **Wide area power flows:**

  The progressing divergence in the time and location of generation and consumption, especially the integration of RES at the corners of the region and storage in the Alps, as well as structural market congestion between price zones will lead to wide area power flows through the region, requiring investment within the countries and at the borders.

- **System security and security of supply**:

  Due to the fundamental changes in the entire electricity system (e.g. massive RES integration, nuclear phase-out, limited - and in the longer run uncertain - availability of conventional power plants caused by changing market conditions), security of supply investigations into single demand centres are no longer sufficient. The whole system security has become a key issue and a broad consideration of all relevant parameters is necessary. Numerous projects in the CCS RgIP are being supported to ensure a secure electricity system in this changing environment. The following sections depict the main grid development drivers in the CCS region.

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5.3 Main Bottlenecks location and topology

As a result of the market and network study process, 22 bottlenecks have been identified for the CCS region power system in the 15 coming years (unless new transmission assets are developed). Figure 5-2 shows their location, i.e. the grid sections (the "boundaries"), the transfer capability of which may not be large enough to accommodate the likely power flows that will need to cross them unless new transmission assets are developed.

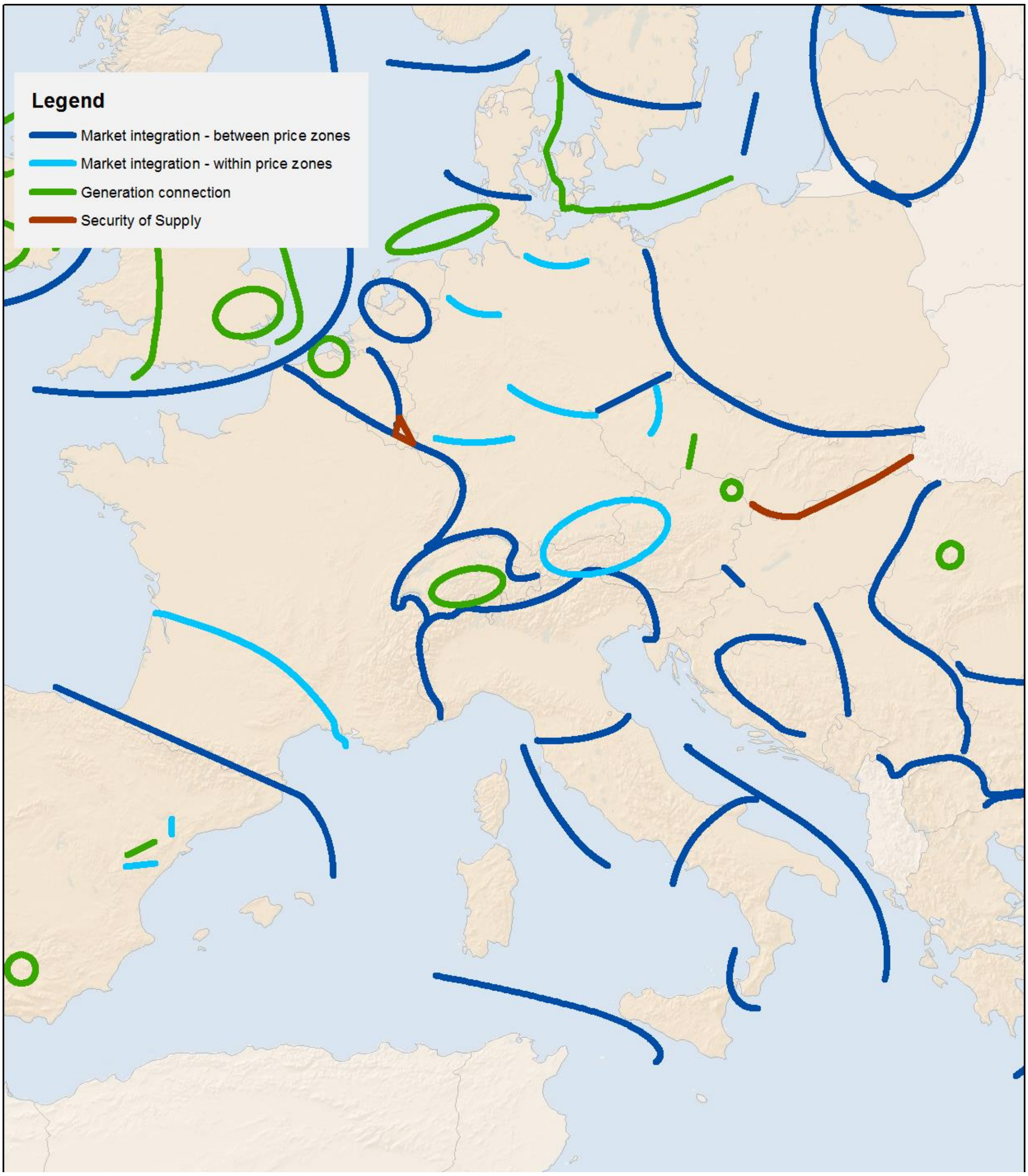

Figure 5-2 Map of main bottlenecks in CCS Region perimeter[26]

[26] If a boundary can be flagged with more than one concern, market integration prevails over generation connection and security of supply

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

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

20 boundaries are primarily related to market integration of which 14 are located on a border. But instead of focusing on a specific border between two countries, actual interconnection concerns must often be addressed at a larger scale:

- Italian northern borders,
- Swiss roof
- French north-eastern border
- Boundary between Italy and Greece and Balkans area.

Internal bottlenecks with respect to market integration are e.g. observed within Italy (6 price zones).

During the assessment activities a demand for an increase of the transmission capacity within the same price zone can be recognized in Germany (due to high north to south flows), in the south-western part of France and at the Austrian-German border, the last one being also a concern of RES generation connection (both wind and pumped storage) and security of supply (containing the Austrian 380-kV-Security Ring).

Generation connection is the second main driver in the region. The displayed boundaries relate to already public and mature applications for connecting large generation plants; storage PCIs; or areas where more than 1 GW of RES / 1.000 km² are planned. 4 boundaries of the region are primarily concerned: the connection of offshore wind in North Sea and Baltic Sea in Germany and the connection of additional hydro power plants in Switzerland and the connection of wind in eastern part of Austria.

Generation connection at lower scale is not reported in this chapter, but some projects of regional importance are included in the regional part of the plan.

Integration of renewable generation is also a main driver for grid development in CCS area. New wind power plants are expected in the north of the region, mainly in Germany and France (onshore and offshore), solar in the southern part of Germany, France and Italy. Hydro, especially pumped storage is developing in the Alps (Austria and Switzerland).

By construction of the scenarios, the four Visions assume generation is sufficient to balance load; nevertheless, security of supply may remain a concern locally. Most of transmission projects in the region have a positive impact on the security of supply; but only seldom does it show up as main driver for development of projects of pan-European significance.

5.4 Bulk Power Flows in 2030

A Bulk Power Flow is the typical power flow that has been determined by TYNDP studies and is expected to trigger grid development across a boundary. Bulk Power Flows range from approximately 500 MW to more than 10.000 MW. The Bulk Power Flows that are the outputs of the TYNDP studies undertaken for 2030 under each of the four Visions are presented in the following sections. For clarity, the presentation will focus on the two extreme Visions, Vision 1 and Vision 4.

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Generation Connections

The figure below show the expected boundaries based on connection of new generating facilities.

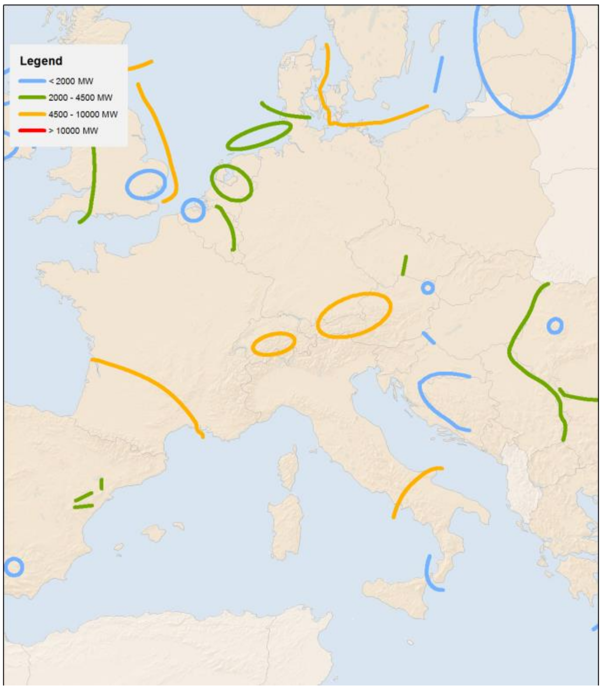

Figure 5-3 - Map of bulk power flows related to generation connection in Vision 1

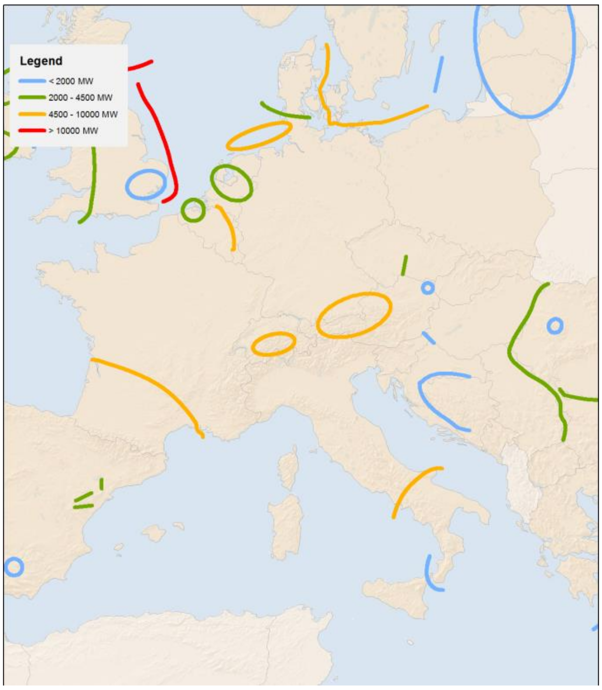

Figure 5-4 - Map of bulk power flows related to generation connection in Vision 4

In the next 15 years many new generation units in the CCS area have to be integrated to the transmission grid. As can be seen on the map new wind power plants are planned to be built at the coastal areas of the CCS region. Especially in the north of Germany (North Sea and Baltic Sea) new offshore wind-farms will are planned with installed capacities up to 23.6 GW. These wind farms are also one of the main drivers for the necessity of grid expansion. In addition to offshore related investments also onshore wind-farms are planned in the eastern part of Austria. The close interaction between wind farms, existing and also planned pump storage plants require the reinforcement of both interconnection and internal transmission lines in Austria. In this respect and in order to ensure security of supply it is essential to close the 380-kV-Ring in Austria. In Switzerland there are plans and decisions to build new hydro and pump storage plants

In Vision 4, development of RES generation in CCS area is much higher than in Visions 1, mainly wind (in Germany and France) and solar (in Italy, France and Germany) -each of them by around 100 GW in Vision 4 with respect to Vision 1. The boundaries are the same as in Vision 1, but with higher bulk power flows, especially from offshore wind in Germany (+14 GW) of installed capacity with respect to Vision 1).

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, it is therefore a driver of grid development. The flows that trigger grid development (BPF) in 2030, under Vision 1 and 4, are shown in the following figures with the boundaries related to market integration.

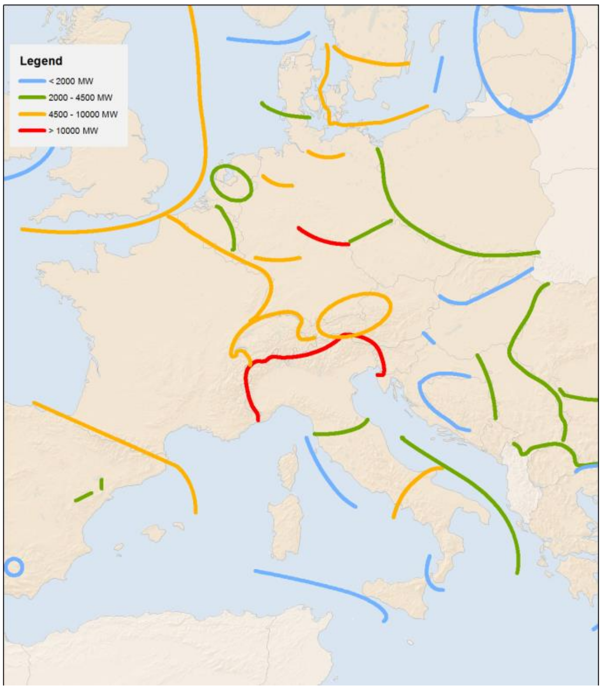

Figure 5-5 Map of bulk power flows related to market integration in Vision 1

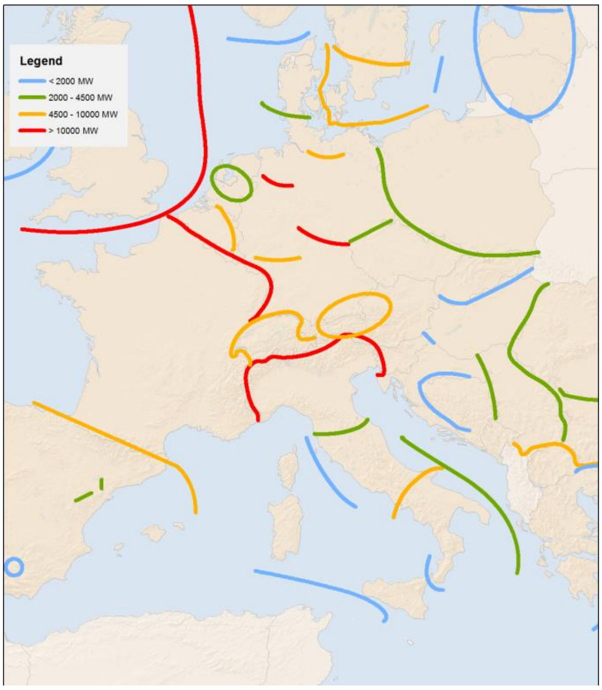

Figure 5-6 Map of bulk power flows related to market integration in Vision 4

Even in Vision 1, the main bulk power flows appear from the market integration of RES, especially Wind, in the northern part of the region and solar in the South. The load is in the centre of the region, including pumped storage in the Alps. This leads to market exchange on the German border towards Austria, Switzerland and France and the northern borders of Italy, which is the main importer in the region for Vision 1.

Within Germany, the flows will stress the internal transmission lines in north-south direction towards the borders. In Austria and Switzerland, these flows will add some stress inside the country. In Italy, flows will converge in the south-north direction to the load areas in the central/north of the country, especially for low load periods with high solar generation. Based on these conditions, internal grid congestion would occur without the planned grid extensions. Accommodating these flows triggers further investment needs not only on the borders but also inside the countries.

In Vision 4, due to the huge RES development, the power flows become even higher and more volatile than depicted for Vision 1, triggering the need for further grid development, especially for interconnections. (Figure 5-6) The borders between Great Britain and mainland become heavily stressed, but also the French north-eastern border (with Benelux and Germany), as well as the boundaries in northern Germany. For this Vision, the size and volatility of the power flows in the region may not only trigger additional grid development, but also raise specific problems regarding voltage and frequency control as well as grid stability and operability.

Security of Supply

The figure below show the expected boundaries related to the security of supply concerns.

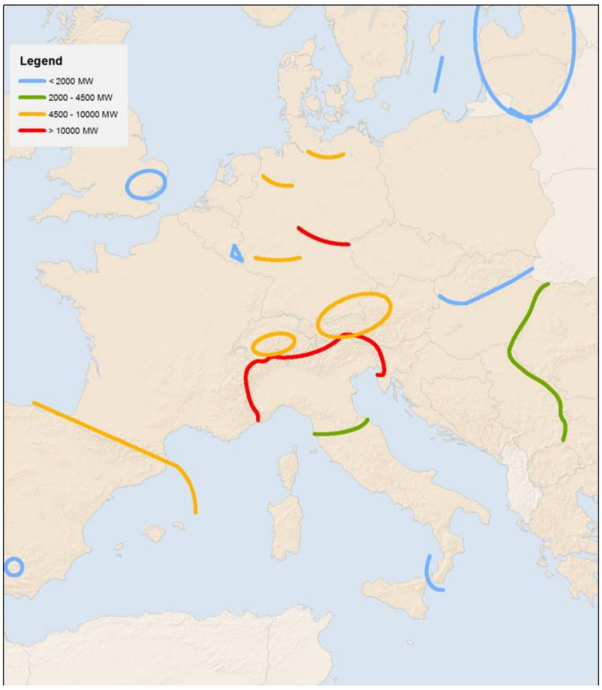

Figure 5-7 Map of bulk power flows related to security of supply in Vision 1

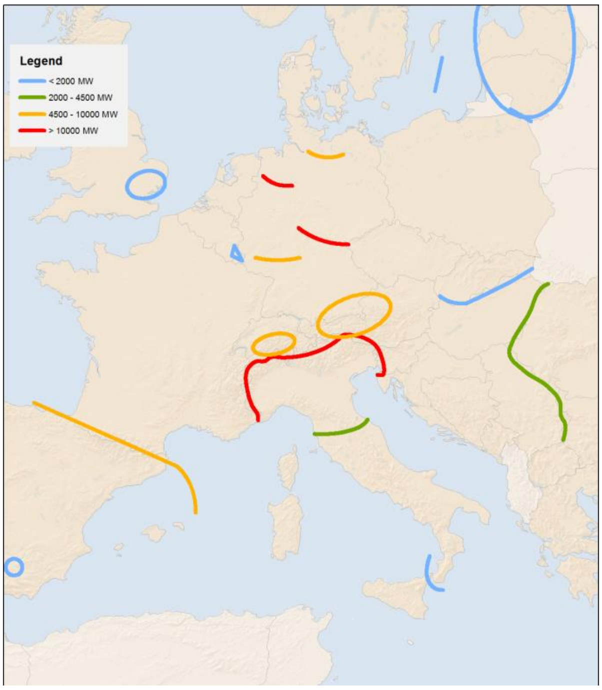

Figure 5-8 Map of bulk power flows related to security of supply in Vision 4

Preventing a rupture of the energy supply is naturally a crucial matter in the region.

The energy transition of the regional power system leads to increased high north-south power flows. In order to ensure security of supply and to improve system stability not only new DC and AC grid expansion measures are needed, but also additional reinforcements such as VAR-compensation. In order to prevent a lack of supply it is essential to increase cross boarder capacities between European countries. Especially the increase of interconnection capacity between France, Germany and Benelux will provide these countries with mutual support. Besides that, internal reinforcements are of major importance to guarantee the security of supply, especially where the grid is rather scarce like between Sicily and southern Italy,

The issues mentioned above mainly concern Vision 4, due to higher load and RES generation and higher unbalances between the distribution of load and generation in time and space, which bring not only specific need for grid development, but also new stability and operability concerns that were not experienced before.

6 Investments - Project Portfolio

6.1 Criteria for Projects Inclusion

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

A refined project definition and a substantial evolution of the portfolio

Around 30% of the investments from TYNDP 2012 are now only depicted in the Regional Investment Plans.

First, as highlighted in section 2.2.3, the stricter CBA clustering rules led to a refined list of projects in the TYNDP 2014. Some TYNDP 2012 projects included investments with a commissioning gap of longer than five years. Some secondary investments are hence presented only in the Regional Investment Plans and their supporting role for the project of pan-European significance is recalled in the comments on the latter in the TYNDP.

Besides, the new focus on 2030 and the time constraints of systematically assessing all projects with the CBA methodology and the four Visions validated quite late in 2014 has led ENTSO-E to focus on the longer-run projects and mitigate assessments efforts for mid-term projects. Decisions for these projects have already been made; construction works may have even started so their assessment is of limited interest for all stakeholders. As a result, most mid-term projects, except when they have a PCI label or when their assessment is relevant, are only presented in the Regional Investment Plans, whereas projects to be completed after 2020 have been given priority, taking advantage of the limited resources.

ENTSO-E and Non ENTSO-E Member Projects

Most of the 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 are proposed by 'third party' promoters. In light of Regulation (EU) 347/2013, entered into force on 15 May 2013, which makes the ENTSO-E TYNDP the sole basis for the electricity Projects of Common Interest

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(PCI) selection, in 2013 ENTSO-E developed the “Procedure for inclusion of third party projects – transmission and storage – in the 2014 release of the TYNDP[27]”, hereafter called the Third Party Procedure.

In the Third Party Procedure, ENTSO-E categorises third party projects, which must be projects of pan-European significance, into three different forms promoted by:

- Promoters of transmission infrastructure projects within a regulated environment, which can be either promoters who hold a transmission -operating license and operate in a country not represented within ENTSO-E, or any other promoter.
- Promoters of transmission infrastructure projects within a non-regulated environment: promoters of these investments are exempted in accordance with Article 17 of Regulation (EC) No 714/2009
- Promoters of storage projects.

Projects proposed by non-ENTSO-E promoters are assessed simultaneously by ENTSO-E according to the same cost benefit analysis methodology adopted for TSO projects.

ENTSO-E received 33 applications and in total the TYNPD 2014 assesses 24 projects proposed by non-ENTSO-E Members (13 transmissions projects and 11 storage projects). Out of the 24 projects accepted in the TYNDP 2014, 19 are listed as Projects of Common Interest (nine transmission and 10 storage projects).

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 some but can support TYNDP projects when regional grid reinforcements are needed for the commissioning of a pan-European project.

6.2 Project portfolio

The next two maps will display geographically all projects proposed in the region, divided into two periods: mid-term (2014 – 2018) and long-term (2019 – 2030). The maps show basic information regarding locations, routes and technology. When the precise location of an investment is not yet clear, a bubble then shows where the investment is likely to occur.

[27] https://www.ENTSO-E.eu/major-projects/ten-year-network-development-plan/tyndp-2014/

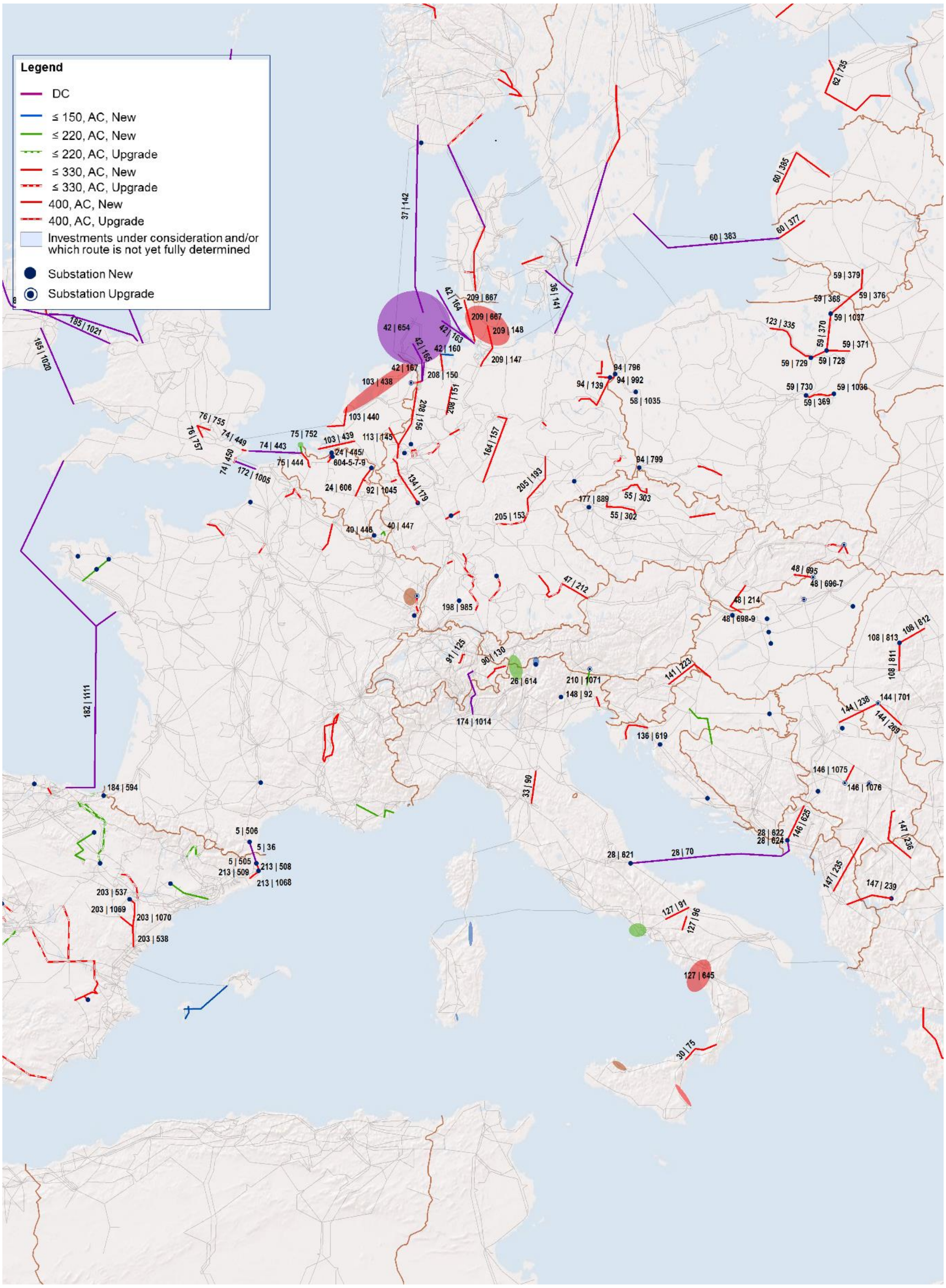

Figure 6-1 Mid-term project map RG CCS

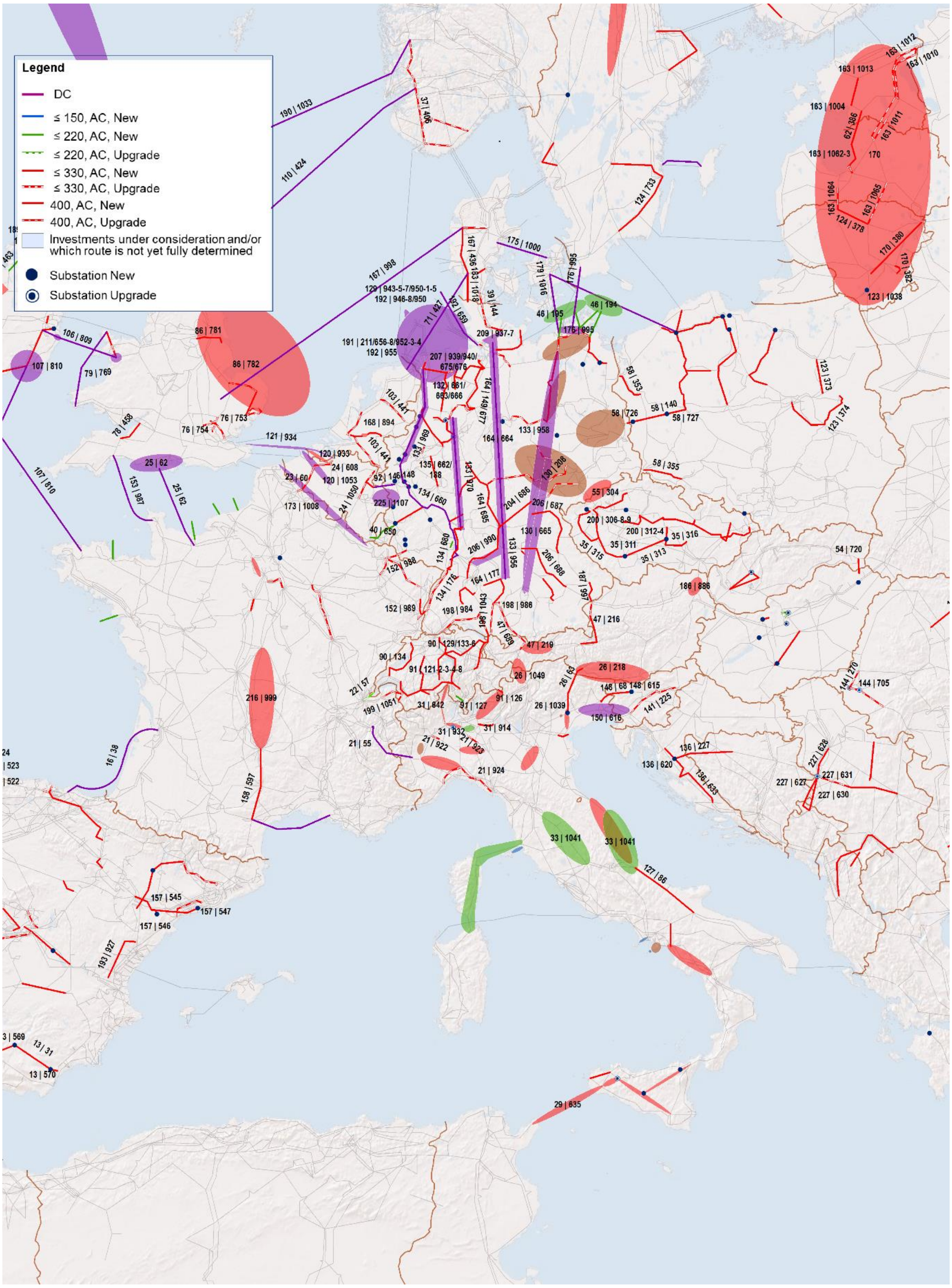

Figure 6-2 Long-term project map RG CCS

The project portfolio can be separated into four different types of projects (see Figure 6-3)

- Projects of Common Interest (PCIs)
- Projects of Pan-European significance
- Projects of Regional Significance
- Projects of National Importance

An overview of the different project types in the region CCS will be given in following sections.

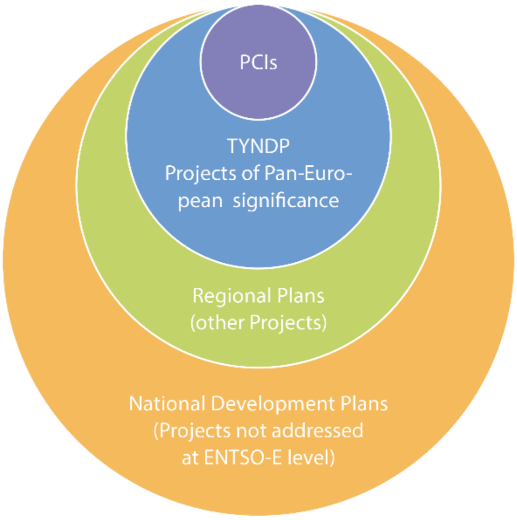

Figure 6-3 Portfolio of projects

Projects of Common Interest

Projects of Common Interest (PCIs) in the CCS region concerning cross-border transmission lines and relevant internal reinforcements are: Italy-France interconnection, three France-Great Britain interconnections, three Italy-Austria interconnections (one TPP), the interconnection between Italy and the Balkan area, two Italy-Switzerland interconnections (one TPP), Austria-Germany interconnection, two Italy-Slovenia interconnections, reinforcement in the area of Bodensee and two internal German projects. Additional items concerning long-term projects are also mentioned as investments under consideration in the CCS regions. Storage projects are also planned.

Projects of Pan-European Significance

The projects of Pan-European Significance in the CCS region concern interconnections contributing to a common energy market and internal projects, which are related mainly to market and RES integration, together with improved security of supply.

The RgIP proposed, sums up over 24400 km of Projects of Pan-EU Significance. 57% of which are overhead lines and about 39% are subsea cables (see Figure 6-4) whereas most of the subsea cables are HVDC projects. The plan shows a significant effort to bring out the best of the existing assets in order to minimize grid extension and avoid creating new routes, as about 10 % of the projects are upgrades able to remove present transport capacity limitations on existing AC overhead lines.

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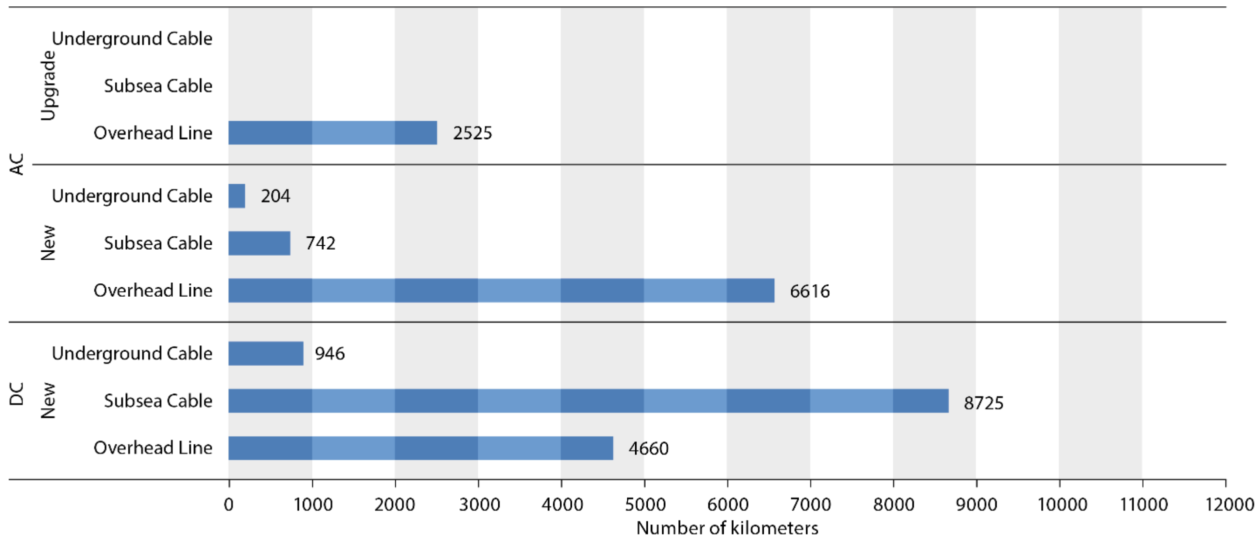

Figure 6-4 Projects of pan-EU significance - breakdown per technology

A very small amount of all projects is under construction (13%) what is caused by this being a long term planning report which focuses on a long term objectives.

A high share of projects is under consideration (28%) what also means that almost one third of all projects are in the first stage of project development including the uncertainty in planning which comes along at this immature state. This implicates the possibility that a considerable amount of projects could be changed in content or time schedule or may even be cancelled or replaced by another project later in the planning process.

In contrast to that, more than half of the projects are under design & permitting (28%) and planning phases (31 %) what makes them more stable so that a further development of them are much more feasible (see Figure 6-5).

Considering the commissioning date more than 76% of investments are planned in the long-term horizon, while about 24% are planned in the mid-term (see Figure 6-6).

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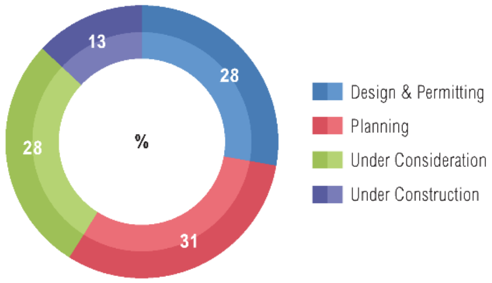

Figure 6-5 CCS RgIP investment portfolio of pan-EU significance - breakdown by status

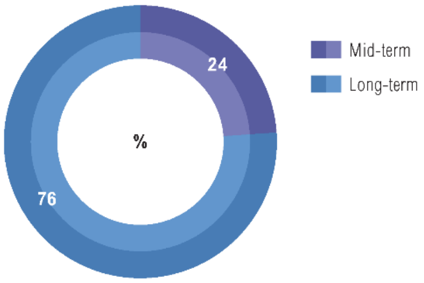

Figure 6-6 CCS RgIP 2014 investment portfolio of pan-EU significance – breakdown

Investments in the Regional plan

The projects in the Regional plan of the CCS region (include also the projects of Pan-European Significance and investments of Regional Importance) concern interconnections contributing to a common energy market and internal projects, which are also related mainly to market and RES integration, together with improved security of supply.

The regional plan proposed sums up about 32000 km, 62% of which are overhead lines and about 33% subsea cables (see Figure 6-4), which are mainly HVDC projects. The plan shows a significant effort to make the best of existing assets in order to minimize grid extension and avoid creating new routes, as about 13% of the projects are upgrades able to remove present transport capacity limitations on existing overhead AC lines.

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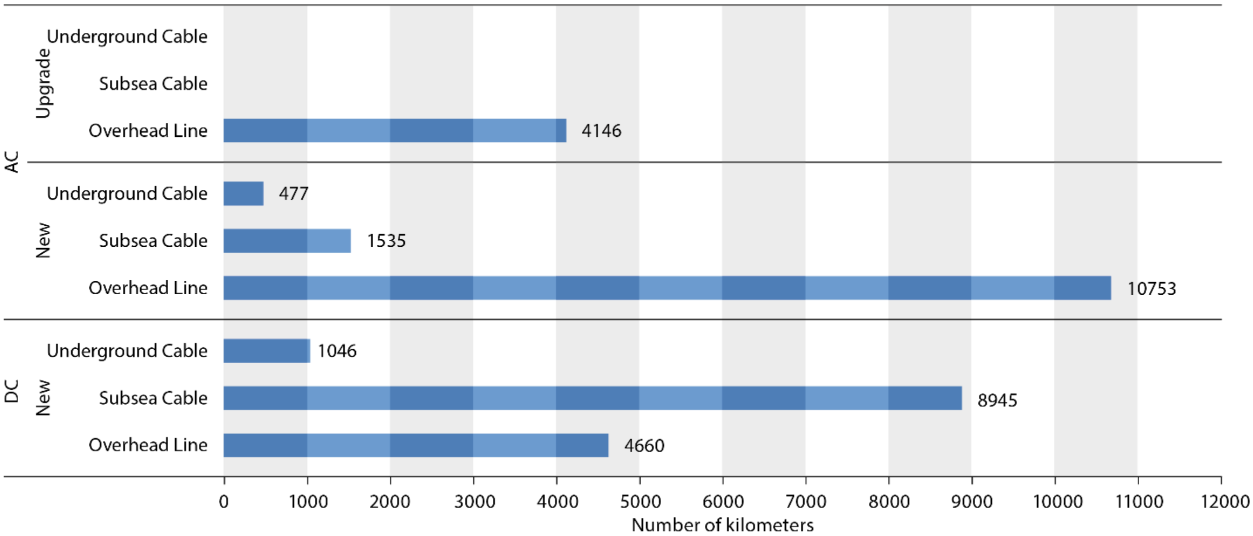

Figure 6-7 Projects in the RgIP - breakdown per technology

A high share of projects is under consideration (29%) what also means that almost one third of all projects are in the first stage of project development including the uncertainty in planning which comes along at this immature state. This implicates the possibility that a considerable amount of projects could be changed in content or time schedule or may even be cancelled or replaced by another project later in the planning process.

In contrast to that, more than half of the projects are under design & permitting (30%) and planning phases (27%) what makes them more stable so that a further development of them are much more feasible (see Figure 6-5).

Considering commissioning date more than 75% of investments are planned in the long-term horizon, while about 25% are planned in the mid-term (see Figure 6-9).

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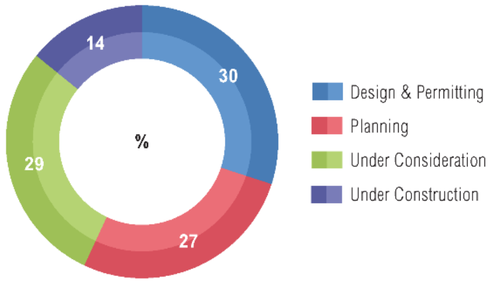

Figure 6-8 CCS RgIP investment portfolio in the RgIP - breakdown by status

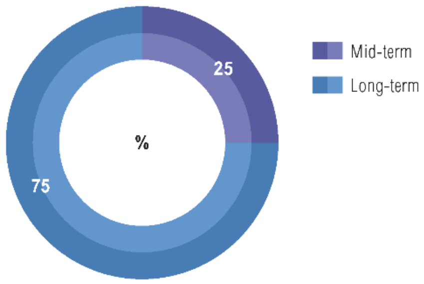

Figure 6-9 CCS RgIP 2014 investment portfolio in the RgIP- breakdown

Investments of National Importance

In every country of the CCS region many additional projects and investments are needed at national level for a secure, sustainable energy supply as well as a competitive market, but even so, they do not fulfil the criteria of regional or European significance. They are included in the National Development Plans.

Third party interconnection projects

A transparent process for the inclusion of third party projects into the TYNDP and RgIPs was created where non TSO promoter had the possibility to introduce their transmission and storage projects. Concerning the CCS Region four third party transmission projects increase the interconnection capacity of the region.

Third party storage projects

The integration of storage plants is a main driver of grid development and reduces the divergence in time between generation and demand. In all Visions, a significant increase of the installed HSPP capacities is assumed (especially in the Alps).

In the region CCS four HSPP projects from third party promoters have been investigated - three projects in Austria and one in Germany. These projects were assessed in line with the Third Party Procedure for promoters of storage projects. The detailed descriptions of the projects and the assessment results are published in the appendix.

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Moreover in Italy the development of electrochemical storage is planned by Terna to integrate RES in local HV systems (due to its high level of innovation, the development of the project is subject to a first experimental phase involving the realization of 35 MW of batteries in southern Italy).

6.3 Assessment of the Portfolio

Social and Economic Welfare

A project that increases transmission capacity between bidding areas allows generators in the lower price area to export power to the higher-price area, leading to a reduction of the total cost of electricity supply. Therefore this project can increase socio-economic welfare (SEW).

The SEW is calculated as the reduction in total generation costs associated with the project (generation cost approach) based on the calculations of the market simulation tools. This indicator intends to point out the generation shift in ENTSO-E perimeter allowed by the evaluated network reinforcement.

Subsequently a summary about the estimated SEW for the projects in the CCS perimeter is given for each Vision.

The majority of the projects assessed for Vision 1, about 38%, show an SEW increase of less than 30 Meuros/year. All other projects are equally distributed between the ranges 30-100 Meuros/year (34%) and more than 100 Meuros/year (28%).

The low benefits identified in terms of SEW are consistent with the limited development of generation (especially RES) and demand compared to the present situation.

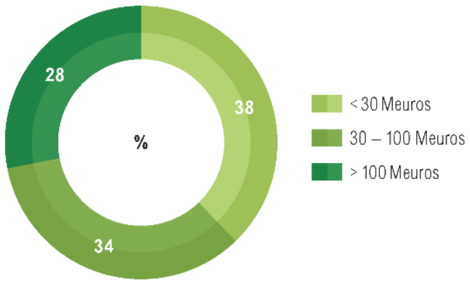

Figure 6-10 SEW increase Vision 1

The project assessment in Vision 2, due to the similar scenario assumptions, showed also about 36% of the network reinforcements result in an increase of SEW under 30 Meuros/year, the rest of the projects are distributed between the ranges 30-100 Meuros/year (30%) and more than 100 Meuros/year (34%). In summary, this means that there is a slightly higher increase of the SEW in Vision 2 compared to Vision 1.

Moving from the “low CO2 price” scenarios (Vision 1 and Vision 2) to the “high CO2 price” (Vision 3 and Vision 4) including the difference in installed RES capacities, it is possible to highlight a consistent increase of the SEW of the projects evaluated in CCS.

Especially the category of the projects with SEW-values under 30 Meuros/year decreases to about 19% of all projects in Vision 3, while the other two ranges of SEW-values in the range 30-100 Meuros/year and over 100 Meuros/years, change to 25% and 56%.

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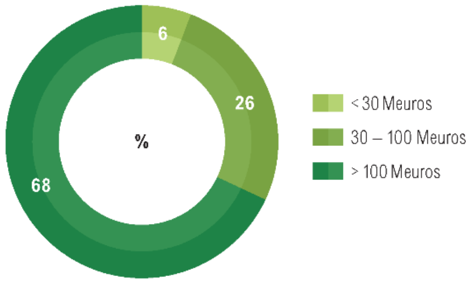

Figure 6-11 SEW increase Vision 4

In Vision 4, the general increase of SEW already highlighted in Vision 3, becomes more pronounced. About 68% of the assessed projects show an increase of SEW of more than 100 Meuros/year, while only small percentage of the projects have SEW-values lower than 30 Meuros/year.

CO2 emissions

By relieving congestions, reinforcements may enable low-carbon generation to generate more electricity, thus replacing conventional plants with higher carbon emissions.

Considering the specific emissions of CO2 and the annual production of each plant, the annual emissions at power plant level and perimeter level have been calculated by using a standard emission rate established per generation-technology.

In the following paragraphs a summary of the CO2 emission variation estimated for the interconnection and internal projects in the CCS region is given.

The Vision 1 project assessment calculations show that about 49% of the analysed investments have a negative effect on the CO2-indicator i.e. they lead to an increase of CO2-emissions. About one third of the projects is neutral with respect to this particular indicator or has a small positive effect on CO2-emissions. Only 21% of the projects reduce CO2-emissions significantly.

The reason for this is partly the limited development of renewable energy compared to Vision 4 and, even more important, the assumption of a low CO2-price in Vision 1. This leads to a high generation of thermal power plants, particularly coal fired units.

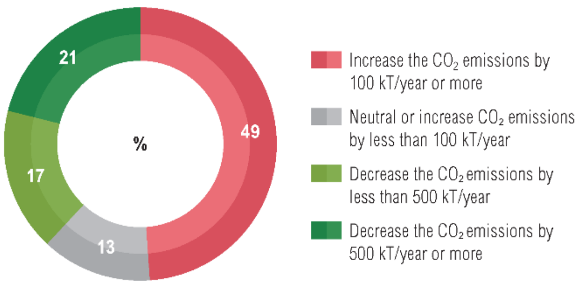

Figure 6-12 reduction of CO2 emissions Vision 1

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In Vision 2, the percentage of investments which increase carbon emissions drops considerably whereas about half of all projects have either a neutral or a small positive effect on this indicator. The share of projects with highly positive influence on CO2-emissions is about the same as in Vision 1.

In Vision 3 and Vision 4 the CO2 emissions are drastically decreased. The main reason is the combination of high RES installed capacity and high CO2 price. This leads to a generation shift from thermal power towards renewable production and a trade-off in the merit order between gas and coal fired power plants.

Indeed in Vision 3 about 62% of the assessed projects lead to a general decrease of CO2 emission (more than 500 kton/year per project), while only 2% of all projects cause an increase of CO2 emission.

Finally, the Vision 4 project assessment shows that 75% of the analysed investments have a positive effect on the CO2-indicator and lead to a decrease of CO2-emissions.

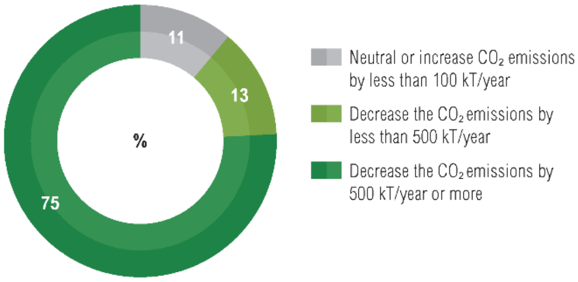

Figure 6-13 reduction of CO2 emissions Vision 4

RES integration

RES integration is defined as the ability of the power system to allow connection of new renewable power plants and to unlock existing and future “green” generation while minimising curtailments. The RES-indicator is calculating the RES-effect both for:

1. Direct connection of RES generation to a power system
2. Increasing the transmission capacity between price areas with high RES generation and other areas, in order to facilitate higher level of RES penetration.

The RES indicator intends to provide a standalone value showing additional RES available in the system. The indicator measures the influence of new grid investments on RES integration.

This section presents an overview of the values of the RES indicator for each Vision estimated for the projects in the CCS region.

According to the results of the project evaluation in Vision 1, more than half of all projects are not contributing to RES integration significantly. Due to the limited RES development assumed in this scenario, the majority of projects seem not to have a particular effect on the utilization of RES generation.

Nonetheless, 23% of the projects, located mainly in the Northern part of the region, are contributing to RES integration through the direct connection of more than 500 MW of RES or the increase of RES production by more than 300 GWh.

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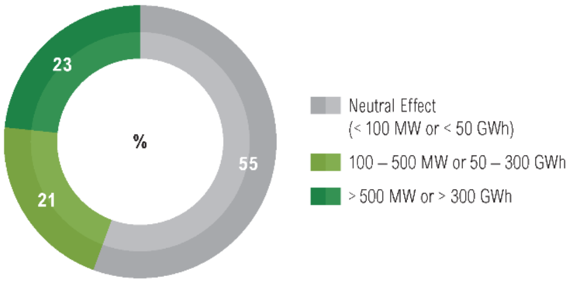

Figure 6-14 RES integration Vision 1

From Vision 1 to Vision 2, due to similar assumptions of these two scenarios, there are only slight differences.

As already explained for the CO2-indicator statistics, the combination of high RES installed capacity and high CO2 price in Visions 3 and 4 allow a strong increase also in the RES integration indicator. Indeed, in Vision 3 the projects with a high value for RES integration increase by about 30%, with a similar decrease of the proportion of projects with neutral effect.

In Vision 4 there is completely a different picture. Due to the high amount of installed RES capacity, the projects are having a far higher contribution on the usage of this energy. More than half, of the projects contribute to direct connection of RES above 500 MW or allow increasing RES production by more than 300 GWh. 80% of all projects do have a significant impact on RES integration whereas about 20% have a neutral effect regarding this criterion.

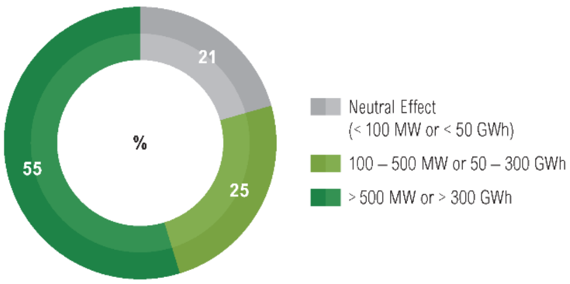

Figure 6-15 Vision 4

Security of Supply – The TYNDP methodology fails to capture the benefits of projects regarding SoS

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 criterion measures the improvement of security of supply when introducing a transmission project (generation or network adequacy). The indicator is calculated as the difference between the cases with and without the project, and was supposed to be defined through either Expected Energy Not Supplied (EENS) or the Loss of Load Expectation (LOLE).

The Security of Supply indicator has in the TYNDP 2014 in general only been calculated by using ordinary market models. For this reason the indicator is more demanding than in the TYNDP 2012, leading to value equal to zero for most of the projects.

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The security of supply (SoS) indicator is to be understood in the way it is defined within the Cost Benefit Analysis methodology which focuses merely on the connection of partly isolated grid areas (see Figure 6-16). In general in rather meshed parts of the transmission grids other aspects are more significant for the security of supply (e.g. n-1-margin, cascade effects, etc.) and therefore the project benefit indicator on SoS according to the CBA methodology underestimates the real value of the projects.

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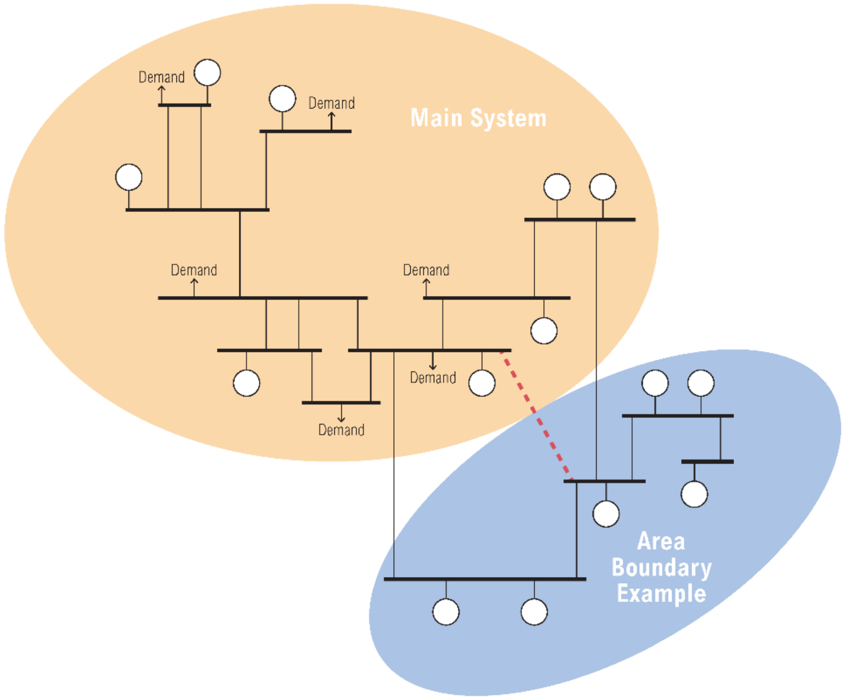

Figure 6-16 semi isolated area connected to the main system

In general, of course, all projects in the CCS region are improving the security of supply in different ways (some investments are even dedicated to this criteria). The erection of additional lines, the increase of transmission capacity of certain existing lines, the construction of new substations, etc. – all these measures are increasing the transmission capacity and the meshing grade of the grid and can therefore provide additional transmission capacities, flexibility and n-1 reserves in case of outages and other threats.

An increase of the security of supply in this perspective is obvious and has not to be confused with the criteria used in the assessment of the projects.

Having this in mind, in Figure 6-17 the relative amount of projects contributing to the Security of Supply in Vision 1 and Vision 4 is displayed.

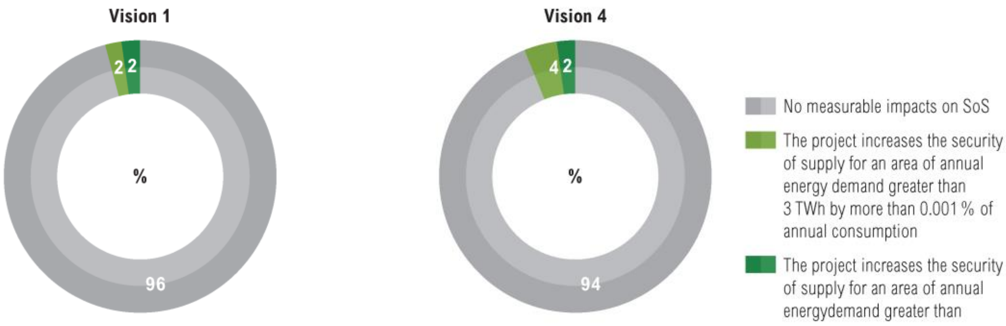

Figure 6-17 Variation of Security of Supply in Vision 1 and Vision 4

Losses

The losses are a direct consequence of the flows transported through the overall grid. The level of losses is linked with the dispatch of the generation: if the equivalent electrical distance between the demand and the generation is lower with a new project, then the losses will decrease. As a consequence of the market integration, new projects often increase the losses (cheaper power plants are not always closed to the demand).

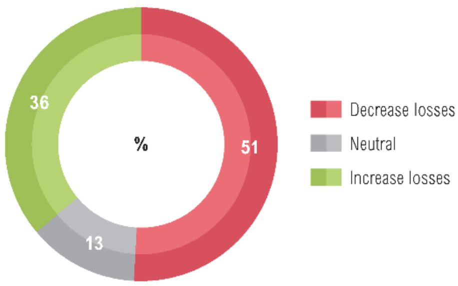

Figure 6-18 Losses variation in the Vision 1

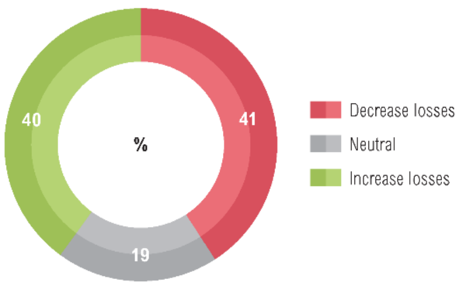

Figure 6-19 Losses variation in the Vision 4

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Almost half of the projects reduce the losses in the project assessment in Vision 1, meaning that their main benefit is to add new elements to the grid, therefore providing additional paths for the power flows and additional meshing to the grid, which results in lower flows in each element and lower losses. On the contrary around one quarter of the projects increase the losses. Most of those projects are HVDC interconnections for which the losses in the installation itself (mainly in the converters) are not compensated by a decrease of losses in the rest of the grid.

In Vision 4, there are almost as many projects reported to decrease as to increase the losses. This is due to the fact that in this scenario generation (mainly RES) is located very far from the load and storage centres, triggering high power flows on the grid.

About 20% of the projects have no significant impact on the losses in either Vision.

GTC increases

In order to facilitate pan-European electricity exchanges and to integrate the European energy market in accordance to EC goals it is necessary to increase existing cross-border transmission capacities. Therefore the challenge for the coming decades is to facilitate high power flows over large distances across Europe.

The new projects are increasing the Grid Transfer Capacity (GTC) among main generation and consumption areas. The GTC increase is wanted on many boundaries and promotes market integration in Europe. The values of gained GTC are oriented on needs and cover a huge range of efforts to increase transmission capacity.

The GTC has been developed from a few hundreds of MW to some GW. Globally, greater GTC increases are developed where higher power exchanges are expected. Larger GTC increases correspond to situations where parallel investments combine their efforts across a large boundary where high Bulk Power Flows are expected. Lower amounts correspond to more specific situations (new power plant connections for instance).

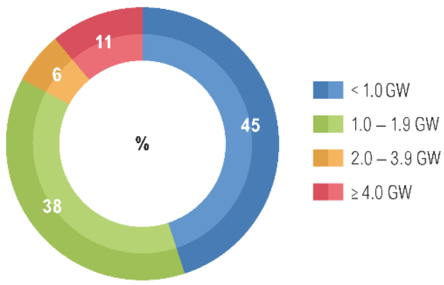

Figure 6-20 GTC increases brought by the TYNDP 2014 projects in CCS region

Resilience

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 Europe.

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 indicator B6 is called "Technical resilience/system safety". This indicator shows the ability of the system to withstand increasingly extreme

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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.

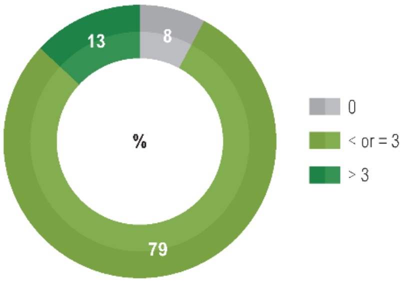

Figure 6-21 Technical resilience/system safety margin indicator

Although all projects contribute to release congestion during maintenance, or give more flexibility to selected periods of the year in which the neighbouring facilities can be put out of service for maintenance, no project in the region is built specifically for this issue. Therefore, most of the projects have an average score for the first KPI.

Projects scoring high for the stability and voltage indicators are projects that have been built specifically for these issues. This is not common in the region. However all projects provide some improvements regarding these issues. The CBA introduces a rather strict rule for scoring the projects in this respect, i.e. only projects with a relevant impact on voltage or stability issues can get a value of 1 or more in this indicator.

As a result, very few projects show a high score on the overall resilience indicator (B6>3). For Germany, as an example, the so called "Energiewende" is the most important driver for grid extensions. "Energiewende" means the ongoing process to transform a generation system based on nuclear and conventional power plants to a system without nuclear power plants and a big amount of RES. To manage this process, internal grid extensions in Germany are necessary. Additionally to AC-lines, the German Corridors includes also VSC-DC-Links, which are necessary for (n-1)-security, voltage control and system stability. On the contrary most of the projects score relatively low (B6< or = 3, and very often only 1 or 2) with even some cases for which B6=0.

Flexibility

The indicator B7, called "Robustness and flexibility" 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) important sensitivities, (2) ability to comply with commissioning delays and local objection to the construction of the infrastructure, and (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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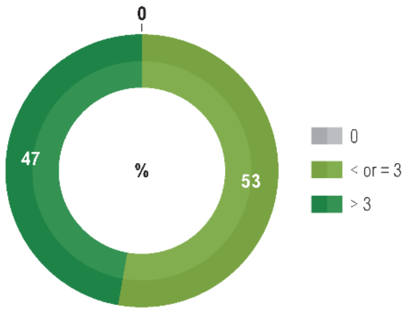

Figure 6-22 Robustness and flexibility indicator

The realisation of most projects in the region does not depend on the Vision, therefore projects generally score high for the first item. Only projects that are tightly linked to a specific assumption (e.g. connection of a specific generation plant) score 0.

All projects including single investments or several investments in series have a low score regarding the ability to withstand delays, because all investments in the project are needed to get the benefits. Most of the projects in the region have an intermediate score as they consist of one main investment complemented with some others that increase the grid transfer capacity: the main investment is needed to get the benefit, but the project is robust towards delay of the other investments.

Only cross-border projects allow sharing of balancing services and among them, only projects in the corners of the region, which connect non-synchronous areas, get the maximum score (from CCS to UK or IE; or to Scandinavia; or to northern Africa).

In line with the rather strict rule introduced by the CBA, no project gets a score higher than 4 for this indicator.

S1-S2 indicators

The indicators “protected areas” (S1) and “urbanised areas” (S2) are used to show:

- where potential impacts have not yet been internalized i.e. where additional expenditures may be necessary to avoid, mitigate and/or compensate for impacts, but where these cannot yet be estimated with enough accuracy for the costs to be included in indicator C.1.
- the *residual* social and environmental effects of projects, i.e. effects which may not be fully mitigated in final project design, and cannot be objectively monetised;

The two indicators replace the former “social and environmental indicator” of the TYNDP 2012. They have been developed in the framework of the Long Term Network Development Stakeholders Group over the last two years. In order to provide a meaningful yet simple and quantifiable measure for these impacts, these indicators give an estimate of the length (number of kilometres) of a new project that might have to be located in an area that is sensitive for its nature or biodiversity (“protected areas”), or rather densely populated (“urbanised areas”).

It is often difficult in the early stages of a project to assess its social and environmental consequences, since precise routing decisions are taken later. The quantification of these indicators is hence 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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The S1 and S2 indicators have been calculated based on TSOs' input regarding the routing of projects and on data from the European Environment Agency (Common Database for Designated Areas and Corine Land Cover Urban Morphological Zones[28]).

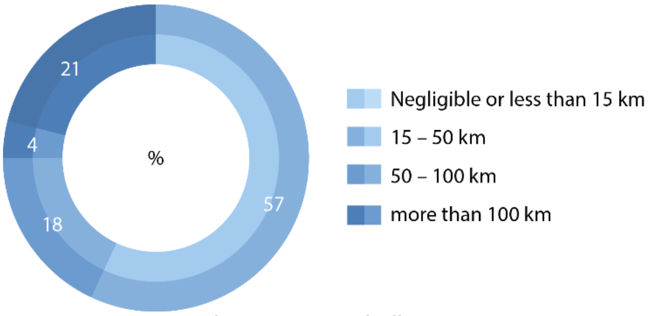

Figure 6-23 S1 indicator

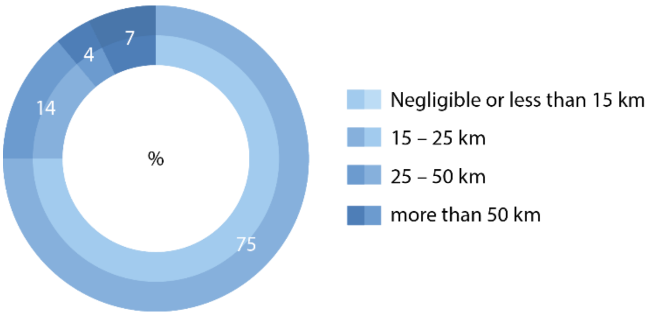

Figure 6-24 S2 indicator

According to the whole perimeter of the new infrastructures assed, generally a much more significant environmental impact can be observed, in absolute value, compared to the urban impact.

In general, these statistics do not take into account some projects under consideration, because they are in a very early stage and there are large uncertainties about their characteristics, location and possible impacts. Concerning CCS, the investment items under consideration are about 30% of the total number of investment items. Although these projects could have a potential impact, it should be considered that limiting environmental impact will be a driver in the next grid planning and design process. Therefore the correct value for these indicators cannot be given before of the end of the design and permitting phase.

6.4 Project expenditures

Most of the described power system investments are purely infrastructure projects. The main driver is the increasing development of renewable energy sources in order to achieve climate goals. Further on the projects are needed both to operate the system within an adequate security of supply and to fully integrate the market.

[28] 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

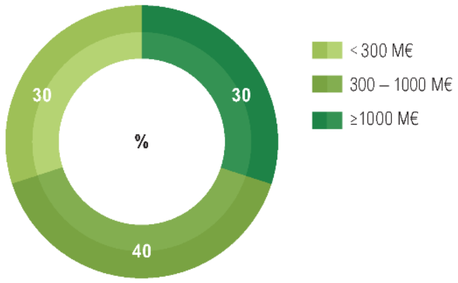

Figure 6-25 Total project expenditures V1

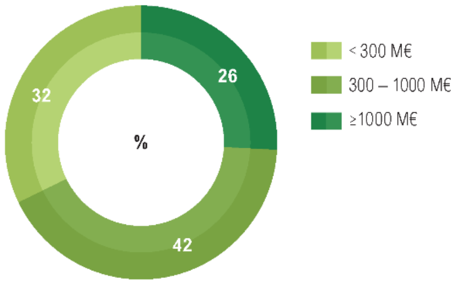

Figure 6-26 Total project expenditures V4

The graphs above only refer to projects of pan-European significance. Regional projects, which are not included in the figures, constitute further vital investments on regional level for achieving the targets mentioned above. In the CCS Region not all projects are presented in all four Visions. Some additional infrastructure may also be required to completely support a Vision 4 environment (e.g. massive RES connection). In the CCS region four additional projects for the Vision 4 are necessary.

It must also be pointed out that all projects of the TSOs belonging to the RG are included even if the project mainly concerns another regional group (e.g. FR-UK interconnections are included)

Figure 6-26 highlights that most of the projects cost individually more than 300 million Euros, while 32% show an investment cost higher than 1 billion Euros (e.g. subsea HVDC interconnections). About a quarter of the portfolio kilometres are investments in HVDC subsea interconnections, with a cost per km approximately from 7 up to 10 time higher as the cost of the AC overhead lines.

The total investment cost of the TYNDP 2014 Package portfolio amounts to €125 billion in the Vision 1 and about €150 billion in the Vision 4. The regional projects all together represent in Vision 1 €63 billion and in Vision 4 amounts to almost €82 billion.

The main part of the additional costs are located in Germany (€35 billion to €55 billion) the rest in France (about €10 billion). On the whole, Vision 3 and 4 need additional grid development (and therefore higher expenditure) compared to Vision 1 and 2. Last, it should be reminded that Vision 4, which supposes that the 2050 goals of European energy policy are already reached in 2030, is very demanding in terms of grid development: all the projects that would be needed are not identified yet, so that the figures above would be only a minimum.

To solve the challenges of Vision 4 additional grid reinforcements all over Europe are required and in order to identify these further detailed grid studies are needed.

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Country	Cost v1 (bnEuros)	Cost v4 (bnEuros)
AT	1,9	1,9
CH	1,6	1,6
DE	34,8	54,2
FR	8,4	8,4
IT	5,9	5,9
SI	0,6	0,6

Stricter rules were introduced in the CBA to cluster investments into projects. Hence, the portfolio of the TYNDP 2014 is not directly comparable with the TYNDP 2012 portfolio as several investments have been shifted to the Regional Plans. Beyond this technical discrepancy, the cost of the TYNDP 2014 portfolio is much higher than the TYNDP 2012 portfolio, despite them not being fully comparable. The main reasons for this increase can be summarised as:

- A focus in the TYNDP 2014 on a longer term horizon, 2030 instead of 2020
- The integration of more RES (41% of the electricity generation in Vision 1, 60% in Vision 4), especially the costly offshore production
- The interconnection of different regions via long distance cables (e.g. Norway to the UK)
- The use of cutting edge technologies (e.g. HVDC VSC) mainly to enable more power to be shifted over a longer distance

Challenges of financing transmission grid development

In the CCS region the investments are to be financed through ordinary financial systems, e.g. financed by grid tariffs. However, the changing mix in the future power system, including deployment of renewables and decommissioning of some thermal and nuclear power plant capacity drives the grid investment.

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7 2030 transmission capacities and adequacy

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

7.1 Target capacities by 2030

For every boundary, the target capacities correspond in essence to the capacity above which additional capacity development would not be profitable, i.e. the economic value derived from an additional capacity quantum cannot outweigh the corresponding costs.

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 very different perspective for the generation mix in one country compared to present 2030 Visions may give a very different 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 must 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.

Additionally, ENTSO-E checked whether the interconnection capacity of every country meets the criterion set by the European Council[29] for interconnection development, asking from every Member States a minimum import capacity level equivalent to 10% of its installed production by 2005. Meeting this criterion led to lift up the target capacity between Spain on the one hand and France and UK on the other hand.

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.

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

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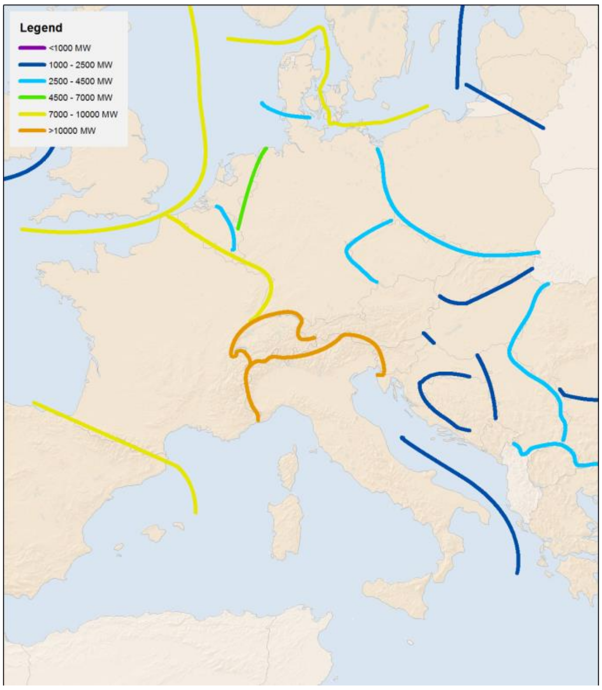

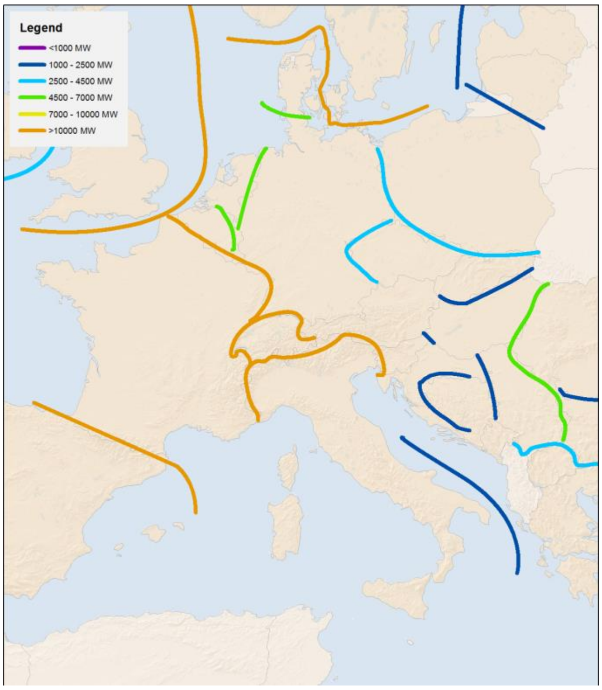

Figure 7-1 Target capacities by 2030 in Vision 1 (left) and in Vision 4 (right)

Both maps show similar patterns: the magnitude of the target capacities in the RG CCS are in the same range in Vision 1 and Vision 4 for most of the boundaries. Inside the region the only exception is formed on the border between Germany and France. Based on the integration of RES the intensified interaction between the market areas lead to a higher usage of the profile and therefore to a higher target capacity.

7.2 Transmission adequacy by 2030

Transmission Adequacy shows how adequate the transmission system is in the future in the analysed scenarios, considering that the presented projects are already commissioned. 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 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.

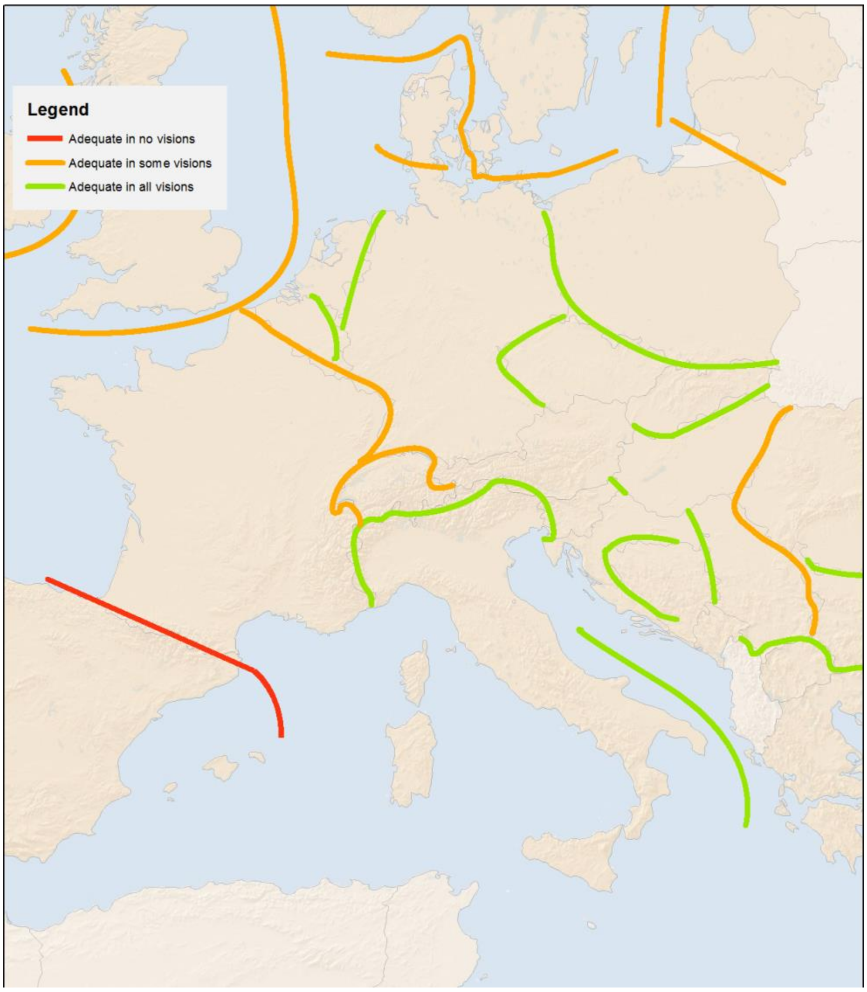

Figure 7-2 Transmission adequacy by 2030

Figure 7-2 shows that for some of the boundaries, the project portfolio provides the appropriate solution to meet the target capacity. These boundaries correspond to the boundaries where the uncertainties regarding RES development are relatively lower, and the target capacity in Vision 1 and 4 are close one to the other.

Concerning the orange boundaries, all the listed projects are prerequisite to meet target capacities goals, but some additional grid reinforcements are required to cover investment needs specific to the most ambitious scenarios of RES development by 2030. This affects in particular the boundary between Germany and France as well as the Swiss roof.

In the CCS Region, no boundary is red. This underlines the adequacy of the given project portfolio within the assumed ENTSO-E scenarios.

8 Environmental assessment

This chapter supplies a synthetic overview of the environmental assessment of the grid development depicted in the Plan. Detailed environmental assessments are run for every 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 urbanised 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, CO2 emissions mitigation and a major shift in the generation pattern – possible, with optimised resorting to natural resources.

8.1 Grid development is key for RES development in Europe

RES development is the first driver for grid development, and depending on the Visions, RES are expected to develop in large amounts by 2030: compared to 197 GW today, installed RES capacity ranges from 315 GW in Visions 1 and 2 to 460 GW in Vision 3 and 553 GW in Vision 4. The share of the load covered by RES increases from Vision 2 (42 %) to Vision 4 (64 %). The reason for such high volumes of installed capacity is that wind and photovoltaic imply a variable and not steerable output and a higher installed capacity compared to conventional generation to supply the same amount of electricity all over the year.

As a result, in Vision 4, about 80 % of the projects of pan-European significance in CCS area help integrate RES.

First of all, 4 projects in Vision 1 and 6 projects in Vision 4 projects of pan-European significance directly connect RES (for a total volume of 10 GW in Vision 1 and 25 GW in Vision 4).Besides, projects improving market integration, developing especially new interconnection capacity, help actually 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 (e.g. prices equal to zero).

Most of the projects of pan-European significance avoid RES spillage. The German corridors show the largest benefits with respect to avoiding RES spillage (from 6 TWh/yr in Vision 2 to 16 TWh/yr in Vision 4).

8.2 Project portfolio makes ambitious CO2 emissions mitigation target possible

Mitigating CO2 emissions in the power sector requires above all measures on the generating fleet. The following picture shows the CO2 emissions decrease for the Continental Central South power sector, as a percentage of the 1990 level, in the different ENTSOE Visions:

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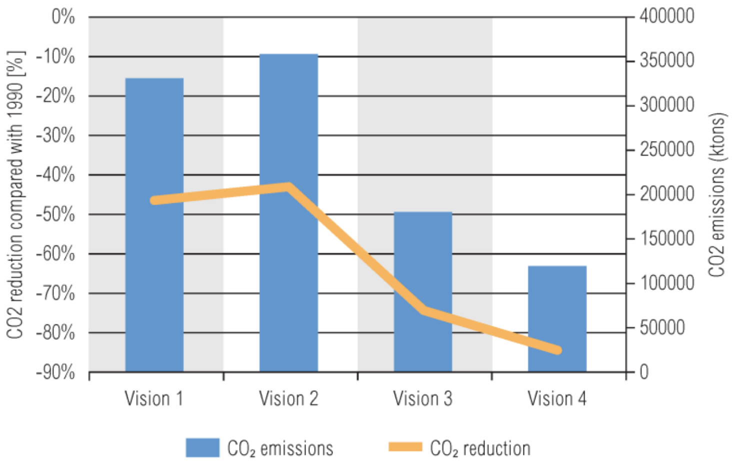

Figure 8-1 CO2 Emissions in each Vision

The average CO2 content of electricity is about 220 kg/MWh in Visions 1 and 2, 100 kg/MWh in Vision 3 and 60 kg/MWh in Vision 4, compared to about 400 kg/MWh in 1990, before the crisis. In Vision 1 and 2, France has decreased the CO2 content of generation by more than 80 % with respect of 1990 values Austria and Italy by around 50 % and Germany by around 30 %. In Vision 4 however, the reduction is of about 80 % for almost all countries.

The development of carbon-free technology (especially RES) instead of fossil fuel technology is the key to reducing CO2 emissions in the power industry.

The grid has an indirect but essential positive effect on CO2 emissions as it is a prerequisite to implement clean generation technologies: the grid gives them outlets possibly far from the load centres, for instance wind in the northern part of the region, including offshore, wind and solar in the South of Italy and France, hydro in the mountains; the grid enables the market mechanisms to kick out of the merit order the most expensive, fossil-fuel-fired power plants. Hence, either by directly connecting RES, avoiding RES spillage or enabling more climate friendly units to run, the portfolio of projects of pan-European significance contributes to CO2 emissions reduction: the share of the projects in CCS area that contribute to reduce CO2 emission varies from more than 6 Mt in Vision 2 to about 95 Mt in Visions 3 and 4.

8.3 A neutral effect on transmission losses

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

- Building new transmission facilities reduces the overall resistance of the network, and this will tend to 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 from load centres than they are presently, hence the transmission distance increases, and therefore the losses increase too.
- Increasing the interconnection capacity aims at improving competition where more desirable generators can prevail over less preferred ones. This results in cheaper electricity and a more reliable and optimised supply but also, by essence, it tends to enable longer power exchanges and therefore to induce higher losses.

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 cause lower transmission losses than HVAC lines if they transport the same amount of power at the same voltage. However, HVDC projects are hindered by the losses at their converter stations (about 2% of the transported flow). Additionally, in the CCS region, these projects precisely aim at connecting offshore wind farms, transmitting power from northern Germany to load centres in the south of the country or increasing interconnection capacities at Italian borders, and, as explained above, contribute indirectly to increase the overall amount of losses in Europe.

8.4 A relatively limited network growth despite major shifts in the generation mix

By 2030, the generation fleet will experience a major shift. The net generating capacity is expected to grow from 473 GW today up to 523 GW in Vision 2 and 769 GW in Vision 4. The construction effort will have to account not only for the net increase but also for the replacement of almost half of the present units, which will come to the end of their life-time within the coming 15 years. This represents for the adaptation of the generation fleet a rate of 0.7 %/yr in Vision 1 and up to 4 %/yr in Vision 4.

On the other hand climate change mitigation and competition will require energy efficiency measures (including in the power sector) but also transfer from fossil-fuel based end-uses to CO2-free energy sources (i.e. more trains, electric vehicles and heat pumps for instance).The major driver for grid development is hence generation. New generating capacities are almost all located further away from load centres, RES especially (wind generation develops mostly as large wind farms, also offshore). The major shift in generation mix will hence induce a massive relocation of generation means and, with large wind and solar capacities, more volatile flows, requiring the grid to adapt. Still, in comparison to the generation adaptation rate above, the grid's growth rate looks relatively modest, with about 1.7 %/yr. This illustrates once more the "network effect", where the output developed by all elements together is greater than the summated output of every individual element.

8.5 New transmission capacities with optimised routes

The European high voltage transmission network in CCS area consists presently of ca. 117.000 km of routes. Completing the projects of pan-European significance leads to refurbishing about 4.100 km of existing assets, with a limited if not neutral impact on the surrounding area, and build 27.400 km of new assets by 2030[30].

TSOs optimise the routes so as to avoid interferences with urbanised or protected areas as much as possible. In densely populated countries, or in countries where a great share of the land is protected, such as Germany, this is a challenge.

Globally however, the projects of pan-European significance in CCS region cross urbanised (resp. protected) areas for less than 5 % (resp. 10 %) of the total routes.

Quite a few projects appear to cross neither urbanised nor protected areas. They often consist of substation works.

Besides, among the new projects, about one third are subsea, with by nature a limited length crossing protected or urbanised areas About 915 km of subsea cables will increase the overseas interconnection capacities (375 km DC in the Adriatic and 540 km AC in the Mediterranean).

Onshore, more than 2.300 km of projects of pan-European significance are upgrade of existing corridors. They have hence a neutral or very limited impact on the surrounding areas.

[30] The set of projects of pan-European significance is still to be completed in order to meet the energy transition proposed in Vision 4. With its validation only in October 2013, the Vision 4 scenario could only be used to assess the already identified projects' portfolio. 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.

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8.6 Appropriate measures are adopted to mitigate any disturbance on the environment.

Project 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.

Actually TSOs integrate the minimization of the social and environmental impact as a major concern into the grid development process as from the very early stages. Efficient use of existing assets is privileged, potentially using novel technologies (e.g. High Temperature Low Sag Conductors, ampacity monitoring) or better controlling the flows (with phase shifters) in order to better match the physical capacities of the lines. In specific cases, it is possible to upgrade existing lines to a higher voltage while keeping most of the existing towers.

Environmental impact is thoroughly assessed so that protected or densely populated areas can be avoided; mitigation measures (as specific design of towers to limit electromagnetic fields or visual impact, partial undergrounding in highly densely populated areas, installing transformers in buildings to limit the noise outside) can be developed for specific conditions on a case-by-case basis. The stakeholders are of course very much involved in the process. Public meetings are organised all along the development of the projects and in most cases, websites are open to gather possible comments from the public.

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9 Assessment of resilience

9.1 The general framework

High voltage grid investments are expensive infrastructure projects with a long lifetime, setting a precedence of standards for coming projects and requiring years to be completed. Therefore, TSOs evaluate the resilience of their investment projects in order to avoid stranded costs and to meet grid users' expectations over time with appropriate solutions, TSOs assess the resilience of their investment projects. This assessment is performed in 4 major directions:

- **Sustainable and safe operation**: investment should contribute to an improved quality of service and not put the reliability of the system at risk,
- **Economic performance**: investments should prove useful and profitable in as many future situations as possible, bringing more benefits to the European population than they cost,
- **Technical sustainability**: as long lasting expensive infrastructure components, investments should take advantage of technological evolution so as to optimize their performance and ensure they do not become obsolete in the course of their expected lifetime; TSOs strive to make the best use of existing assets considering technologies such as HDVC, FACTS, PST in order to optimize grid development or as an interim measure where grid extension cannot be realized in a timely manner,
- **Compatibility** with longer run challenges looking ahead to 2050: present projects must be appropriate steps to meet future challenges and fit into wider and longer term perspectives.

Methodologies and criteria developed by TSOs focus on risk assessment and mitigation. They assess the resilience of the system in whatever situation it may realistically have to face: high/low demand growth, different generation dispatch patterns, adverse climatic conditions, contingencies and so on. With increased market integration and stochastic, climate-dependent RES generation, it becomes increasingly important to use scenarios for boundary conditions with respect to power exchanges with neighbouring systems.

9.2 Resilience to severe contingencies

More severe contingencies than those included in the standard (N-1) criterion can be assessed in some cases defined by the TSOs based on the probability of occurrence and/or the severity of consequences:

- **Examination of rare, but severe failures**: In some cases, rare but severe failures, like those leading to the loss of a busbar or busbar section, or multiple independent failures, may be assessed in order to prevent serious interruption of supply within a wide-spread area. This kind of assessment is carried out for specific cases chosen by the TSO depending on probability of occurrence and consequences.
- **Examination of multiple failures due to common cause:** The so-called common-mode failures include the failure of several elements due to one single cause. The potential outage of lines with double or multiple circuits will most probably become increasingly relevant over the next years, as more and more power lines are set to be bundled onto already existent routes (several circuits on the same tower) and as conductors with higher thermal ratings will also be used, allowing for higher power flows.
- **Failures combined with maintenance:** Certain combinations of possible failures and non-availabilities of transmission elements are considered in some situations. Maintenance related non-availability of one element combined with the failure of another one are assessed. Such investigations are conducted by the TSO based on the probability of occurrence and/or based on the severity of the consequences. These investigations are of particular relevance for network equipment which may be unavailable for a considerable period of time due to a failure, maintenance or overhaul.

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9.3 Mitigation measures

Grid planning mitigation measures, in essence, fall into one of the following three categories:

- System protection schemes,
- Upgrading of the existing components,
- Installing new grid components, and possibly creating new transmission routes.

As the public acceptance of new transmission assets can be problematic, TSOs are encouraged to take advantage of existing power line corridors or other infrastructure routes. However, to reduce the risk of large common mode faults, the size of the substations should be acceptable in relation to the power in-feed and the number of power lines or circuits in one right-of-way should not be too high.

9.4 New or efficient technologies

The easiest step required in order to increase the capacity of an existing grid is partly the optimization of the present system components - reallocate power flows on power lines, for example with the implementation of FACTs, HDVC and PSTs.

PSTs, HDVC and FACTs can help to allocate the flows from high loaded elements in the grid to lower loaded ones and can contribute to the capacity of the existing grid being used in an optimal way. Both technologies are available and well researched. These technologies are complementary to grid expansion since they only add limited transfer capacity through the control of power flows but they do not cancel the need for new transmission lines.

9.5 Visions, model used and cases

The Transmission grid is being designed for future requirements, as well as present conditions. To meet this aim, several future scenarios or sensitivity cases are required as a basis for the TYNDP 2014 Package. The new infrastructure that is planned should fit in with the existing infrastructure, whilst promoting potential future development. To this end, ENTSO-E developed the four Visions, which is a framework of four scenarios. Regional specifies are also taken into account within each of the Regional Groups.

Within the Continental Central South Regional Group, several models were used. For the market studies, there were two main simulators used, PowerSym from Switzerland and Promed from Italy. For the network studies, three main calculation tools were used; Spira which is used by Italy, Convergence which is used by France and Integral7, which is used by Germany and Austria.

For each Vision market simulators provided results from a yearly calculation over 8760 hours. Based on the market detailed yearly outputs, the Regional Group selected some relevant hours to be analysed in the network study. In order to test the system behaviour, both rather common situations and under more extreme conditions were analysed. For example high load cases, low load cases, as well as high and low renewable production cases.

For each Vision at least two points-in-time were considered as reference to assess the projects on the Italian North Border, one with a quite high import of Italy and the other in the opposite direction. Two other hours were defined to analyse projects on the northern border of Switzerland, known as the Swiss-roof. Different hours were also used for the assessment of the internal German projects.

10 Monitoring of the Regional Investment Plan 2012

10.1 Portfolio

The project portfolio of the CCS Region includes the internal and interconnector projects of Pan European significance and regional interest from all regional member states Austria, France, Germany, Italy, Slovenia and Switzerland. Moreover some projects have been reconsidered in the CCS RgIP 2014 in order to support the main TYNDP projects and thus guarantee the achievement of necessary grid development, and maximize the benefits for the users and for the power system. Some investments had to be included only into the RgIP in order to fulfil the requirements and clustering rules of the TYNDP projects.

Except for third party projects, only a few new projects were added to the TYNDP 2014 compared with 2012. Some investment items had to be changed because of the development of more efficient solutions for meeting the requirements of the grid and to reach the planned targets.

10.2 Monitoring statistics

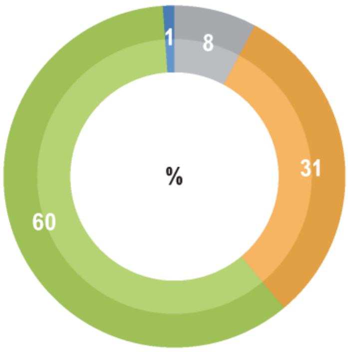

Figure 10-1 Evolution of the pan-EU significance projects of the CCS region

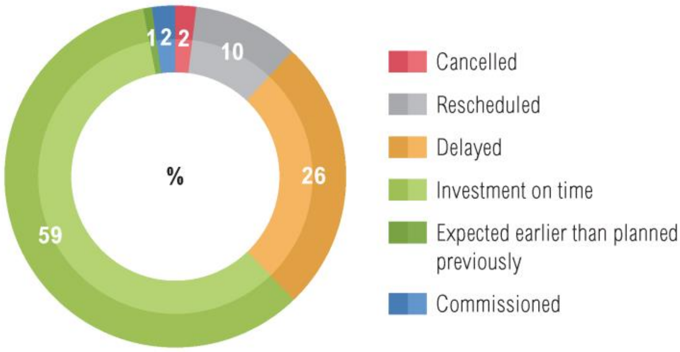

Figure 10-2 Evolution of the CCS region investments portfolio (including pan-EU and regional significance investments)

In general it can be said that the planning forecasts for Pan-European projects have been met for most of the projects. As can be seen in Figure 10-1 and Figure 10-2, the percentage of projects which maintained the time schedule or will be commissioned in the planned timeframe is high. Projects with status “Investments on time”, “Expected earlier than planned” and “Commissioned” represent more than 60 % of all projects.

Approximate 35 % of all projects are experiencing a delay or even a rescheduling or a cancellation due to unforeseen developments in the framework of the project (e.g. external factors, different internal situations, etc.)

In order to get an overview about the detailed investments, those TYNDP2012 projects which are already commissioned are listed in the Appendix.

Delayed investments

As mentioned in the chapter before, approx. 24% of the investment items in the RG CCS are delayed and behind their time schedule (see Figure 10-2).

The main reason for that is related to the social acceptance of the projects. This leads to an extended duration of authorization procedures which result in a general delay of the project. The resistance against some projects even prevents the implementation phase of being started although the project is already permitted.

Besides that, technical or other unexpected issues appearing during the construction can also have effects on the planned time schedule. Finally, some projects are still in a planning status and can be delayed due to change in the political environment.

Rescheduled investments

A new category "rescheduled" is introduced compared to TYNDP 2012 to highlight the uncertainty of long terms investment. In particular, investments which meet all the criteria below are displayed as rescheduled:

- To be commissioned after 2020 in the current report
- Still under consideration or planning
- If the need of the project has been delayed (e.g. power plant commissioning delayed)

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 postponed due to their external driver being delayed (e.g. connection of new RES postponed…) are also reported into this category.

Commissioned investments

As already mentioned in the previous chapter several projects have been commissioned since TYNDP2012. In total 25 projects were commissioned since last TYNDP, 23 projects of regional significance and 2 projects of pan European significance. The two projects of pan-European significance are "Riffgat" in Germany and "Baixas-Gaudière" in France.

Cancelled investments

In the CCS Region only very few internal investments were cancelled from the last TYNDP2012 to the present release. Some of them could not be realized due to unforeseen environmental aspects and technical difficulties.

For example if a planned route crosses protected areas and alternative routes cannot be found the project can maybe not be realized in the first planned way. In this case additional grid analyses are necessary in order to develop alternative grid concepts. In addition technical issues such as connection problems to the existing grid can occur and can also lead to a cancellation. Other project concepts have been changed due to the fact that more efficient solutions are developed in the last two years.

For instance the new 400kV line from Normandy to South Paris (investment item 595) was cancelled after more detailed studies proved investment item 983 more efficient than the solution initially envisaged. Others are obsolete due to changes in the certainty of location of future RES which implies that some reinforcements are not required anymore.

For example the necessity of the 400kV substation "Marne-Sud" (investment item 824) in France is no longer given as studies have shown that the current perspective of new RES generation installation in the area can be accommodated via lower voltage grid development.

Moreover, feasibility assessment of interconnection project like the electrical link planned in the pilot tunnel of the Brenner Base Tunnel (previous ID 26.64 Bressanone - Innsbruck) showed technical obstacles and increased financial costs, together with higher environmental impacts due to additional necessary investments on the internal networks.

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11 Conclusion

This Regional Investment Plan aims to describe the investment needs and associated planned projects for 2030 in the RG Continental Central South (CCS), which covers Austria, France, Germany, Italy, Slovenia and Switzerland. This region covers an area that spans from the North Sea via the Alps in the very heart of continental Europe to the Mediterranean Sea. It contains cross-border and internal projects of regional and/or pan-European significance, which constitute the basis for reaching the European energy and climate targets. The integration of renewable energy sources (RES) and the security of supply (SoS) are respected, particularly regarding the development of the internal electricity market (IEM). Moreover, the RgIP provides information for monitoring the progress of TYNDP 2012 projects.

The basis for the analysis developed in the CCS RgIP 2014 and the TYNDP 2014 Package consists of four Visions for 2030. These Visions are selected as possible corners of the future so that the realised pathway 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.

11.1 With the TYNDP 2014 Package, ENTSO-E supports the EIP implementation

Considering the late finalisation of the Visions, the CBA methodology, and third party project submissions in autumn 2013, completing the TYNDP 2014 Package for consultation in summer 2014 was a challenge. The timely delivery is however expected as an important input to the EU Energy Infrastructure Package (EIP) process.

All projects in the TYNDP 2014 Package, regardless whether they are proposed by ENTSO-E members or by other promoters, have been systematically assessed according to a standard methodology: the ENTSO-E Cost Benefit Analysis (CBA). The CBA has been prepared, shared and consulted since 2012. It is applied in the TYNDP 2014 Package to each project of pan-EU significance against the four 2030 Visions.

Furthermore, based on non-discriminatory procedures, six third party projects with pan-European significance fulfilling the requirements outlined in the Regulation (EU) 347/2013 were assessed by the RG CCS like other ENTSO-E projects and are depicted in the CCS RgIP 2014. Focusing on the CCS Region, four storage and four interconnection transmission projects were assessed and included in the RgIP. Three of those storage projects are located in Austria and one in Germany. The four third party transmission projects are aiming at an increase of the interconnection capacity among the following transmission systems:

- Italy and Switzerland
- Italy and Austria
- France and United Kingdom
- Spain, France and United Kingdom

For the future TYNDP Packages and assessments, ENTSO-E and all interested stakeholders plan to evolve the CBA as far as needed to obtain more detailed and robust assessments of transmission investments. This will provide a basis to help the decisions makers to outline the best strategies and priorities. In particular, it is already foreseen that the present methodology can be improved, integrating the present "energy" value with the so-called "capacity" value of assets (mirroring the future organisation of markets). In addition to transmission expansions, storage projects can also bring greater capacity and flexibility to the power system which will be better reflected in their assessment in the future.

11.2 The CCS RgIP 2014 confirms the conclusions of the CCS RgIP 2012

Looking further forwards to 2030, the CCS RgIP 2014 confirms the conclusions of the CCS RgIP 2012, making them even more robust.

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In the CCS Region, the generation portfolio is being affected by a massive RES development especially in the corners of the region, leading to fundamental changes in the electricity system. This deep restructuring of the generation infrastructure is a major challenge for the transmission grid. As a result, CCS RgIP forecasts larger and more variable wide area power flows, making it even more important in the future for the strengthening of the transmission system.

The huge power flows will have a significant impact on the security of the system. In particular, new dynamic phenomena will make the system operation (balancing, frequency control, reserve management, voltage control, etc.) more complex. From the Security of Supply perspective, for areas like Germany and Italy, adequacy problems due to lack of dispatchable generation capacity near major load centres and the excess of variable generation in other parts can be challenging and a trigger for grid investments.

In the CCS Region the five main drivers for investment are:

- Massive RES integration
- The Integration of storage plants, mainly hydro in the Alps region, facilitates efficient use of RES
- Wide area energy flows
- Nuclear (and old conventional generation) reduction
- The system security and Security of Supply of some European cities and regions

These main drivers can't be considered individually as they are strongly interrelated with each other. Their combination in particular is a critical factor for the development of the power system.

The rising geographical and temporal divergence between generation and demand caused by the massive RES integration in the corners of the region, the integration of storages to compensate imbalances in the system and the further developments assumed within the different Visions will be a significant challenge for the transmission infrastructure in the region. As the plan shows, a comprehensive reinforcement both of the internal and cross border infrastructure is necessary to cope with the change of paradigms in the electricity sector, and this is already ongoing.

The market studies show that the CCS Region will generally be importing from the rest of Europe. From Vision 1 to Vision 4 the imports increase from over 60 TWh to around 120 TWh, which makes the cross regional and cross border transmission development strategies even more important in the long-term planning horizon.

Based on the drivers mentioned above, the CCS RgIP 2014 presents 53 projects of pan-European Significance as well as 133 regional investments, which are necessary to meet the main medium and long term needs of the region. However, additional investments will be necessary to accommodate this strategy for the evolution of the transmission system at local level. These investments are presented in the national development plans of each country.

In total, approximately 32.000 km of projects of pan-European and regional significance are necessary in the CCS Region up to the year 2030 (compared to 25.000 km explored in the CCS RgIP 2012 up to 2020), which should either be new or refurbished existing extra high voltage routes (AC and DC).

The project portfolio in the CCS RgIP 2014 is a prerequisite for any energy transition. The realisation of the RgIP 2014 costs about €82 billion, which is a huge financial target for TSOs.

The analysis of the TYNDP 2014 Package in the CCS region show that the project portfolio has a positive impact concerning the achievement of the European and national energy and climate targets as it supports the integration of renewable energy sources and the European internal energy market. In addition to this a contribution to the reduction of CO2 emissions as well as to the increase the social economic welfare is also beneficial. It is evident that the further integration of renewables requires even higher investment to allow development of an optimal supply and demand system.

11.3 General findings from the RG CCS studies

An adequate and reliable transmission network is a crucial prerequisite for achieving the EU energy policy goals and coping with the forthcoming challenges. In this sense, the market and network studies performed by the RG CCS highlight different system operational conditions in the four Visions analysed, including a statement about the flexibility and robustness of the planned development projects. In more details, the outcomes of the studies show:

- the need to integrate increasing production from RES in all four Visions (from over 40% in Vision 2 to more than 60% in Vision 4);
- the opportunity to increase transmission capacity in order to allow higher efficiency in the market and to achieve the required CO2 emission reduction in all the investigated scenarios, although the merit order of generation changes significantly (in Vision 1 and 2 coal sources provides the main contribution to the thermal generation mix, while in Vision 3 and 4 this is replaced by gas);
- the necessity of managing different varying wide area power flows across the region, taking into account high RES penetration and changes in the generation merit order, leading to different generation patterns and hence county imbalances in the region.

With respect to these aspects, the assessment of the projects planned in the mid and long term horizons show significant benefits in the CCS Region with the increasing ability to integrate RES and the EU internal market and therewith reduce generation costs. The four contrasting Visions have been investigated within thousands of market situations and the relevant ones have been examined with detailed grid analysis to prove the flexibility and robustness of the network planning performed.

The proposed projects cover most investment needs. Conversely, some additional reinforcements are still to be designed to cover investment needs specific to the most ambitious RES development scenarios 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.

However, the achievement of the above mentioned benefits is strictly dependent on the timely implementation of the projects planned in the RgIP. A major regional concern is that generally the grid development may not be completed in time if the RES targets are met as planned by 2020 and 2030. Currently many stakeholders support grid development to facilitate the changes of the energy system; however, at the same time stakeholders that are directly affected by new lines or new plants show only a low level of acceptance for the new infrastructure. This resistance as well as lengthy and complex permitting procedures often cause commissioning delays.

If energy and climate objectives have to be achieved, it is of upmost importance to smooth the authorisation processes and to gain political support at all levels. In this respect the RG CCS welcomes the adoption of Regulation (EU) No 347/2013, as it contains many positive elements which aim at facilitating the fast tracking of transmission infrastructure projects, including the proposals on one stop shop and defined time lines. However, its positive effects to the grid development process will mainly depend on how the implementation is carried out by the member states. More thorough analyses are required so as to ensure the measure can be successfully implemented, in particular in relation to whether the timelines proposed are achievable, especially in the context of the public participation process and the potential for legal delays. Moreover, one must also note that the supporting schemes outlined in the regulation are limited to the Projects of Common Interest (PCIs) whereas there are many significant regional and national transmission projects which are crucial for the timely achievement of Europe's energy and climate targets. It is evident that commissioning delays result in additional costs for the European society.

It is important for the RG CCS to convey an understanding to the public regarding the need of transmission infrastructure investments. For the affected stakeholders the liberalised pan-European electricity market is not perceived as necessary and does not contain any benefits. This lack of understanding leads to a strong local perspective instead of a broader European thinking. Therefore, one goal of the CCS RgIP 2014 is to fill this information gap to create a better public understanding of why we all need a strong and resilient European transmission gird for a successful future.

Finally, a stable regulatory framework is also essential to ensure that grid reinforcements 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.

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Appendices

12 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 12.1 displays the detailed assessment of Projects of Pan-European significance within the Continental Central South 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 12.2 displays the list of all projects and investments within the Continental Central South region, including latest information on the evolution of each investment since TYNDP and RgIPs 2012.
- Section 12.3 displays the list of all commissioned investments within the Continental Central South region.
- Section 12.4 displays the list of all cancelled investments within the Continental Central South region.
- Section 12.5 displays the assessment of storage projects within the Continental Central South region, complying with Reg 314/2013.
- Section 12.6 reminds the smart grid projects, complying with Reg 314/2013, but these are not to be assessed using the CBA methodology.

12.1 Transmission projects of pan-European significance

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

12.1.1 Transmission projects of pan-European significance

All projects (but one) presented in Section 12.1 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.

12.1.2 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.

12.1.3 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.

12.1.4 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,

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- 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, CO2 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 CO2 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.

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12.1.5 Assessment of projects of pan-European significance

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Project 5: Eastern interconnection ES-FR

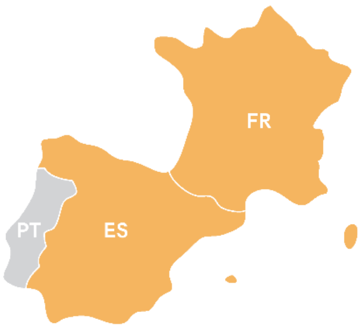
Description of the project

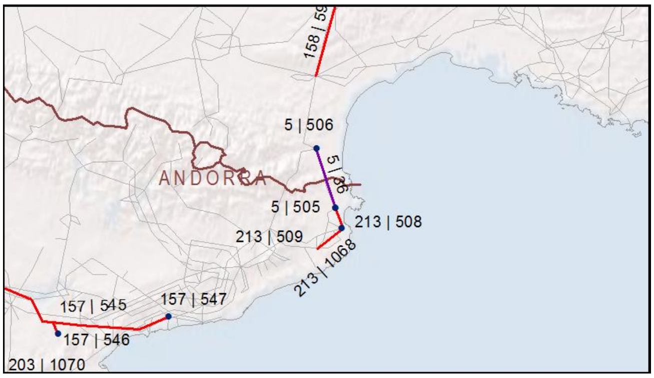
In order to fulfil the governmental 2800 MW objective of exchange capacity between France-Spain, the Eastern interconnection was planned. After being classified as a Priority Project by the European Commission, and after the involvement of Prof. Monti as European Coordinator, it was stated that the unique 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.

PCI 2.6





Investment index	Substation 1	Substation 2	Description	GTC contribution (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	1400	Under Construction	2015	Delayed	Works completed in 2014; commercial operation expected after test period at the same time as the cable (investment 36).

			existing infrastructures corridors.					
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: 1400	FR=>ES: 1200	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.

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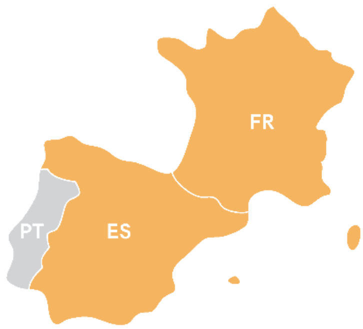
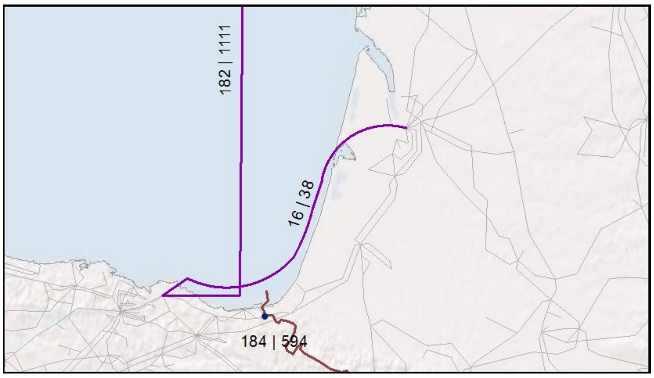
Project 16: Western interconnection FR-ES

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 contri bution (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.

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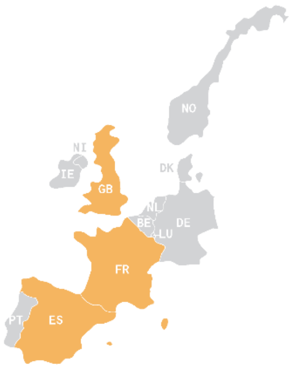
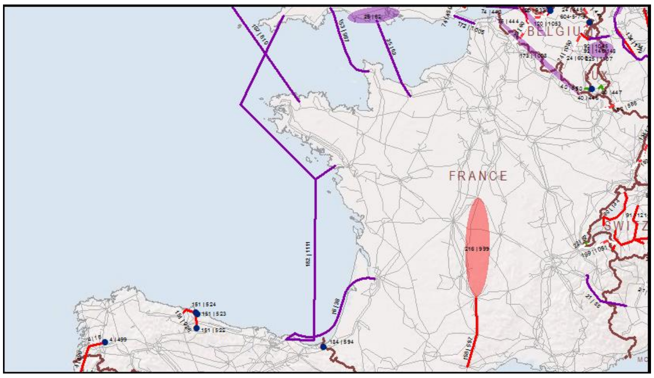
Project 182: BRITIB (GB-FR-ES)

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

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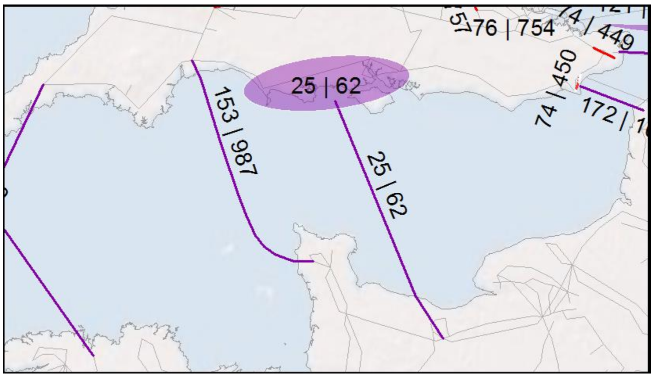
Project 25: IFA2

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 contri bution (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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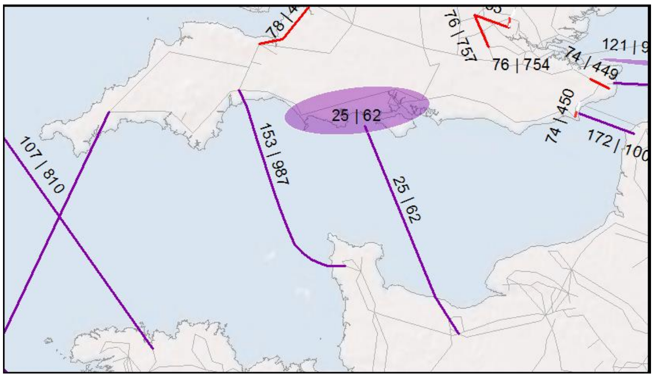
Project 153: France-Alderney-Britain

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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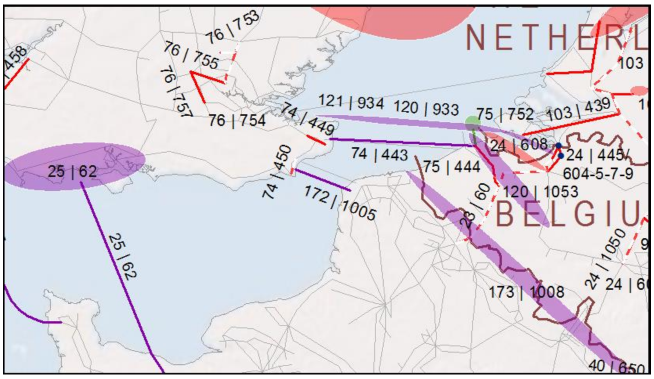
Project 172: ElecLink

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

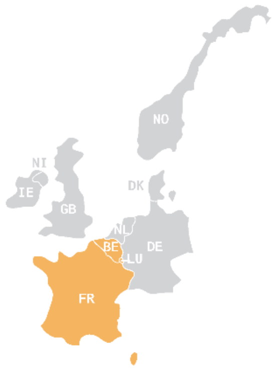
Comment on the RES integration: avoided spillage concerns RES in Great-Britain and Ireland mostly, but also France.

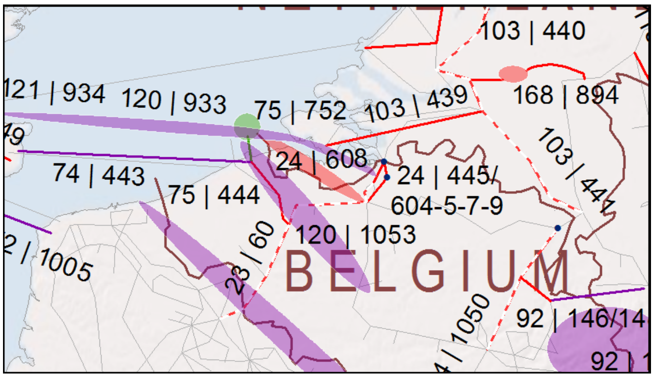
Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES

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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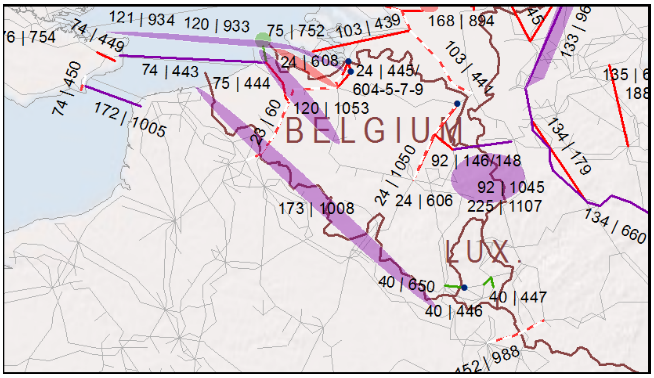
Project 173: FR-BE phase 2

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 contri bution (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

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.

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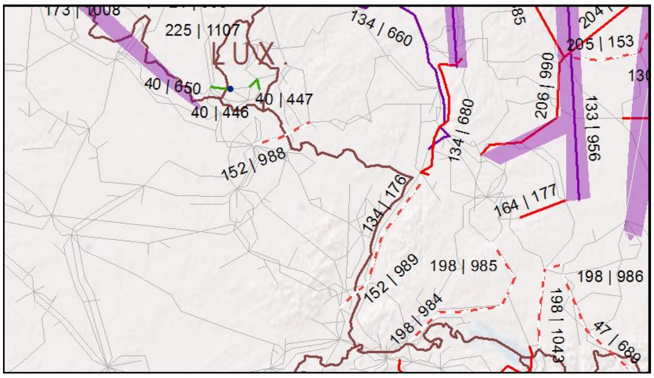
Project 152: France Germany Interconnection

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

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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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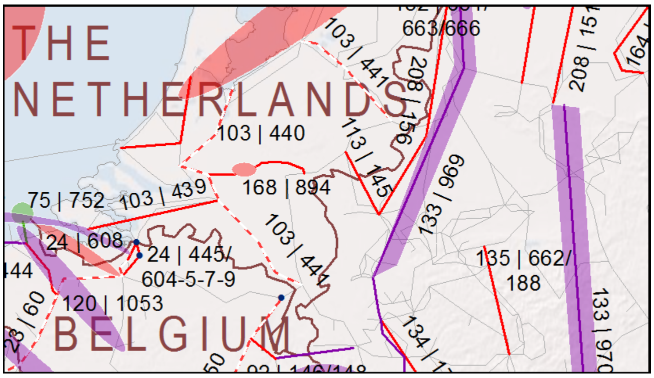
Project 113: Doetinchem - Niederrhein

Description of the project

This new AC 400-kV double circuit overhead line will interconnect The Netherlands and Germany (Ruhr-Rhein area). Upon realization of the project, the border between The Netherlands and Germany will consist of four double circuit interconnections in total. The project will increase the cross border capacity and will facilitate the further integration of the European Energy market especially in Central West Europe.

PCI 2.12



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
145	Niederrhein (DE)	Doetinchem (NL)	New 400kV line double circuit DE-NL interconnection line. Length: 57km.	-	Design & Permitting	2016	Delayed	Permitting procedures take longer than 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)
NL=>DE: 1400	DE=>NL: 1400	3	3	15-50km	25-50km	190-220

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	-	[0;10]	[4500;5500] MWh	[-39000;-32000]	[-11;-9]
Scenario Vision 2 - 2030	-	[4;5]	0	[-39000;-32000]	[-27;-22]
Scenario Vision 3 - 2030	-	[15;65]	[100000;130000] MWh	[-180000;-150000]	[-770;-630]
Scenario Vision 4 - 2030	-	[40;60]	[63000;77000] MWh	[-180000;-150000]	[-1000;-1200]

Additional comments

Comment on the security of supply: The new capacity will also contribute to the Security of Supply by providing new energy exchange channels which increases the system flexibility.

Comment on the RES integration: facilitate the further integration of RES in the Netherlands and Germany

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Project 92: ALEGrO

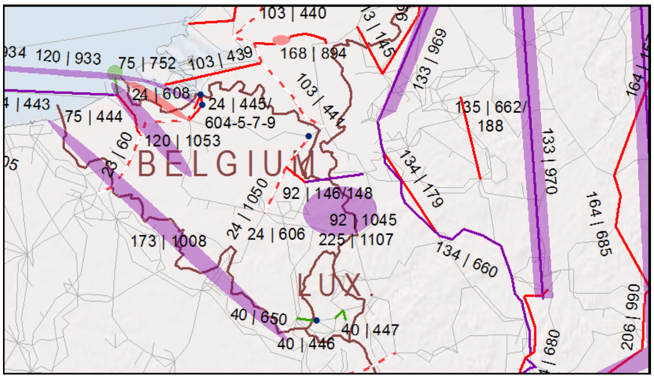
Description of the project

The ALEGrO (Aachen Liège Electricity Grid Overlay) project involves the realization of a HVDC link with a bidirectional rated power of approximately 1.000 MW capacity, as the first interconnection between Belgium and Germany.

First of all, it enhances the internal market integration by enabling direct power exchanges between these countries

Secondly, the new interconnection will play a major role for the transition to a generation mix which is undergoing structural changes in the region (high penetration of RES, nuclear phase-out, commissioning and decommissioning of conventional power plants etc.). Given these major changes in the production mix, the new interconnection also contributes to the security of supply in facing the arising challenges for secure system operation.

The project has been selected as PCI 2.2.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
146	Area of Oberzier - Aachen/Düren (DE)	Area of Lixhe - Liège (BE)	ALEGrO Connection between Germany and Belgium including new 100 km HVDC underground cable with convertor stations and extension of existing 380 kV substations. The assessment of the Final Investment Decision is planned in 2015.	1000	Design & Permitting	2019	Delayed	BE: Several months delay due to authorization procedure in Belgium longer than expected (modification of "Plan de secteur" in Wallonia). DE: Delay due to unclear permitting framework (legal framework for planning approval is presently under development
1045	Lixhe	Herderen	AC BE Reinforcements Internal reinforcements in AC network in Belgium have started in the context of securing infeed from the 380kV	1000	Design & Permitting	2017	Investment on time	This investment item is split off from the generic Alegro investment item which up to now included also

			network into the Limburg & Liège area's. These reinforcements are also needed to facilitate the integration of ALEGrO into the Belgian grid. The reinforcements consist of - extension of an existing single 380 kV connection between Lixhe and Herderen by adding an additional circuit with high performance conductors (HTLS) - creation of 380kV substation in Lixhe, including a 380/150 transformator - creation of 380kV substation in Genk (André Dumont), including a 380/150 kV traformator					the internal reinforcements
1048	Lixhe	Herderen	Potentially additional AC BE Reinforcements Envisions the installation of a second 380 kV overhead line between Herderen to Lixhe. And the installation of a 2nd 380/150 transformator in Limburg area (probably substation André Dumont). These reinforcements are conditional to the evolution of production in the Limburg-Liège area and to the evolution of the physical (transit)flux towards 2020-2025.	900	Under Consideration	2020	New Investment	Evolution of generation in the Limburg-Liège must be accounted for in the perimeter of the Alegro project. This conditional project has a commissioning date set to 2020 as indication for further monitoring of the need.

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)**
BE=>DE: 1000	DE=>BE: 1000	3	3	Negligible or less than 15km	Negligible or less than 15km	450-570

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]	[9000;11000] MWh	[150000;180000]	[140;170]
Scenario Vision 2 - 2030	-	[5;15]	[4500;5500] MWh	[150000;180000]	[-22;-18]
Scenario Vision 3 - 2030	-	[35;45]	[100000;130000] MWh	[120000;140000]	[-800;-650]
Scenario Vision 4 - 2030	-	[45;75]	[180000;210000] MWh	[120000;140000]	[-1100;-900]

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Additional comments

Comment on the security of supply: A new interconnector contributes to the security of supply of Belgium as a whole, due to the diversification it offers to the market players to import energy from countries where excess generation could be available. 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.

The internal reinforcements in the Belgian grid which are part of this project also contribute to the security of supply from a more local perspective, namely by securing in feed from 380kV to 220kV/150kV in Liège & Limburg.

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

Comment on the S1 and S2 indicators: Definitive route to be determined, but taking perspective of minimizing impact.

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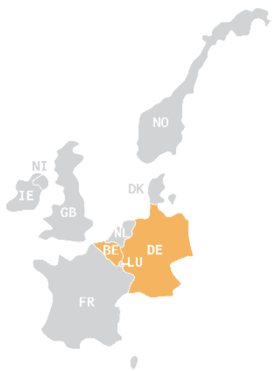
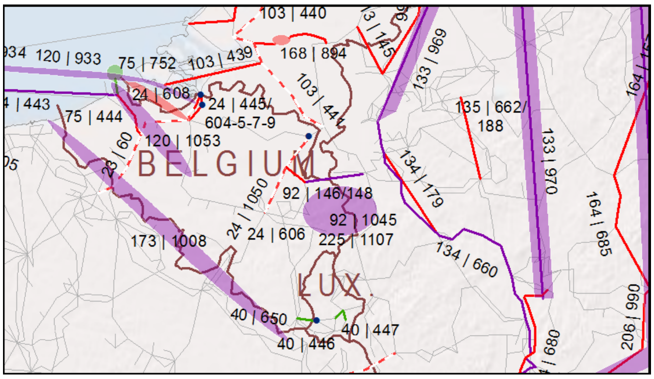
Project 225: 2nd Interconnector Belgium – Germany

Description of the project

This is a conceptual project that could be considered as an investment option, triggered by high RES scenario's. Preliminary analysis shows potential of justifying additional regional welfare & RES integration increase via the construction of an additional +- 1000MW interconnection between Germany and Belgium.
The determination of the optimal capacity, timing (2025-2030), location, technology, and potential needed internal grid reinforcements are subject of further studies.





Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1107	BE (TBD)	DE (TBD)	This investment item envisions the possibility of a second 1 GW interconnection between Belgium and Germany. Subject to further studies.	-	Under Consideration	2030	New Investment	Preliminary studies on high RES scenario's have indicated potential for further regional welfare & RES integration increase by further increasing the interconnection capacity between Belgium & Germany towards time horizon 2025-2030.

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)**
BE=>DE: 1000	DE=>BE: 1000	2	1	NA	NA	400-600

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 4 - 2030	-	[45;55]	[150000;180000] MWh	[120000;140000]	[-850;-690]

Additional comments

Comment on the RES integration: avoided spillage concerns wind farms offshore Belgium mostly.

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

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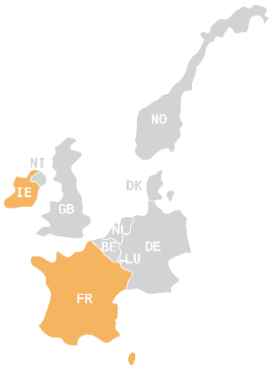
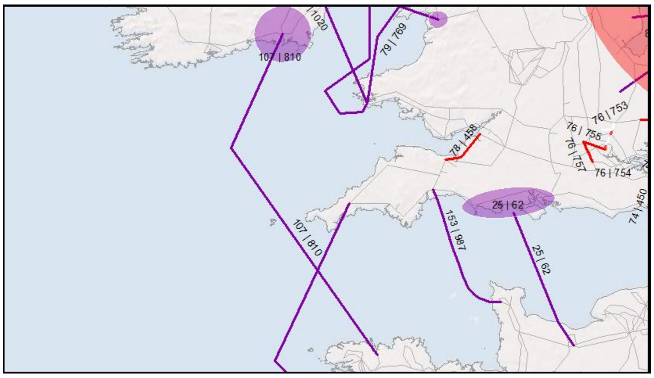
Project 107: Celtic Interconnector

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

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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	-	[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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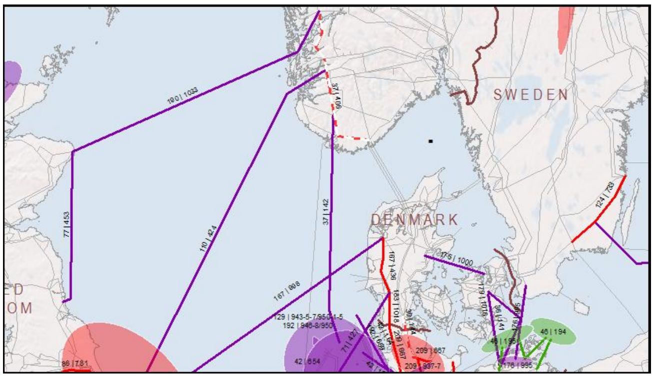
Project 37: Southern Norway - Germany

Description of the project

A 514 km long subsea interconnector between Norway and Germany is planned to be realized in 2018. The main driver for the project is to integrate the hydro-based Norwegian system with the thermal/wind/solar-based Continental system. The interconnector will improve security of supply both in Norway in dry years and in Germany in periods with negative power balance (low wind, low solar, high demand etc.). Additional the interconnector will be positive both for the European market integration, for facilitating renewable energy and also for preparing for a power system with lower CO2-emission. The interconnector is planned to be a 500 kV 1400 MW HVDC subsea interconnector between southern Norway and northern Germany.

PCI 1.8



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
142	Tonstad (NO)	Wilster (DE)	A 514 km 500 kV HVDC subsea interconnector between southern Norway and northern Germany.	1400	Design & Permitting	2018	Investment on time	Agreement between the two TSOs on commissioning date.
406	(Southern part of Norway) (NO)	(Southern part of Norway)(NO)	Voltage uprating of existing 300 kV line Sauda/Saurdal - Lyse - Ertsmyra - Feda - 1&2, Feda - Kristiansand; Sauda-Samnanger in long term. Voltage upgrading of existing single circuit 400kV OHL Tonstad-Solhom-Arendal. Reactive power devices in 400kV substations.	1000	Design & Permitting	2020	Delayed	Revised progress due to less flexible system operations in a running system (voltage upgrade of existing lines). Commissioning date expected 2019-2021.

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)
DE=>NO: 1400	NO=>DE: 1400	3	4	50-100 km	Negligible or less than 15km	2500

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	-	[120;140]	[510000;620000] MWh	[910000;1100000]	[-930;-760]
Scenario Vision 2 - 2030	-	[65;110]	[950000;1200000] MWh	[910000;1100000]	[-670;-550]
Scenario Vision 3 - 2030	-	[210;280]	[1500000;1800000] MWh	[910000;1100000]	[-2200;-1800]
Scenario Vision 4 - 2030	-	[350;400]	[1700000;2100000] MWh	[910000;1100000]	[-3400;-2800]

Additional comments

Comment on the RES integration: avoided spillage concerns mainly RES in Germany and Norway.

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

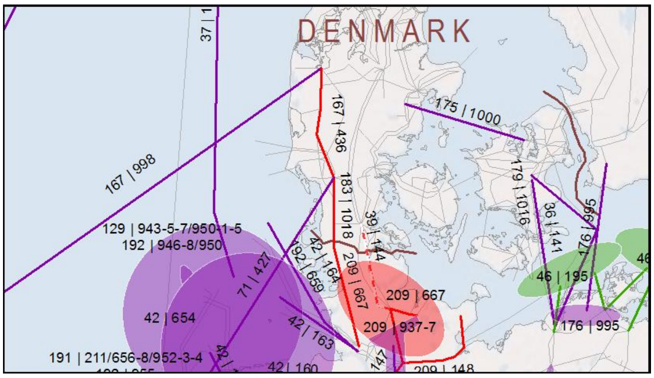
Comment on the Losses indicator: the load factor of the cable is similar in all Visions, leading to the same and very high additional losses.

Comment on the cost of the project: the cost of investment 142 (Nord.Link) is estimated to 1600 MEuros while the cost of investment 406 is estimated to 900 MEuros.

Project 183: DKW-DE, Westcoast

Description of the project

The project consists of a new 400 kV line from Endrup (Denmark) to Niebüll (Germany), adding another 500 MW at the West Coast between these countries. On the Danish side, this project includes the establishment a 400 kV AC underground cable system from the existing 400 kV substation Endrup, via Ribe and Bredebro to the border, from where the interconnector continues to Niebüll. The project helps to integrate RES and to strenghten the connection between the Scandinavian and Continental market. The project is labelled by the EC as project of common interest (PCI 1.3.1).



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1018	Niebüll (DE)	Endrup (DKW)	new 380 kV cross border line DK1-DE for integration of RES and increase of NTC	-	Planning	2022	Investment on time	in TYNDP12 this investment was part of 43.A90

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)**
DKW=>DE: 500	DE=>DKW: 500	2	3	Negligible or less than 15km	Negligible or less than 15km	170-210

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	-	[0;10]	[14000;17000] MWh	[-11000;-9000]	[-88;-72]
Scenario Vision 2 - 2030	-	[4;5]	[14000;17000] MWh	[-11000;-9000]	[-22;-18]
Scenario Vision 3 - 2030	-	[20;60]	[120000;140000] MWh	[-12000;-9900]	[-440;-360]
Scenario Vision 4 - 2030	-	[80;100]	[260000;310000] MWh	[-12000;-9600]	[-830;-680]

Additional comments

Comment on the security of supply: the project improves the SoS of Western Denmark and the area of Schleswig Holstein in Germany.

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

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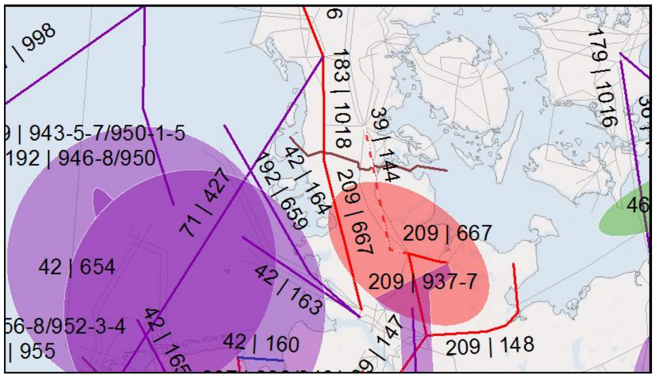
Project 39: DKW-DE, step 3

Description of the project

This project is the third phase in the Danish-German agreement to upgrade the transfer capacity between Denmark West and Germany. The investments of the second phase were included in the TYNDP 2012 edition and have been commissioned in the meantime, thus increasing the cross border capacity since then.
The third-phase project consists of a new 400 kV line from Kassoe (Denmark) to Audorf (Germany). It mainly follows the trace of an existing 220 kV line, which will be substituted by the higher voltage line. The project helps to integrate RES and to strenghten the connection between the Scandinavian and Continental market. The project is labelled by the EC as project of common interest (PCI 1.4.1).



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
144	Audorf (DE)	Kassö (DK)	Step 3 in the Danish-German agreement to upgrade the Jutland-DE transfer capacity. It consists of a new 400kV route in Denmark and In Germany new 400kV line mainly in the trace of an existing 220kV line.	-	Planning	2019	Delayed	Planning ongoing - minor delay due to coordination with project 183.1018

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)**
DKW=>DE: 720	DE=>DKW: 1000	3	3	15-50km	15-25km	220-270

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	-	[10;30]	[54000;66000] MWh	[-46000;-38000]	[-120;-94]
Scenario Vision 2 - 2030	-	[0;10]	[110000;130000] MWh	[32000;39000]	[-38;-31]
Scenario Vision 3 - 2030	-	[35;95]	[190000;230000] MWh	[50000;62000]	[-680;-560]
Scenario Vision 4 - 2030	-	[120;150]	[370000;460000] MWh	[51000;62000]	[-1300;-1000]

Additional comments

Comment on the security of supply: the project improves the SoS of Western Denmark and the area of Schleswig Holstein in Germany.

Comment on the RES integration: The significant increase of RES between Vision 1 and Vision 4 in both countries contributes to an increased number of hours with more volatile prices and thus higher flows in both directions. Additionally, the higher CO2 price in vision 4 causes a shift between coal and gas in the merit order, which increases the price spread between high and low RES hours. This explains the spread of the SEW indicator between these two extreme visions.

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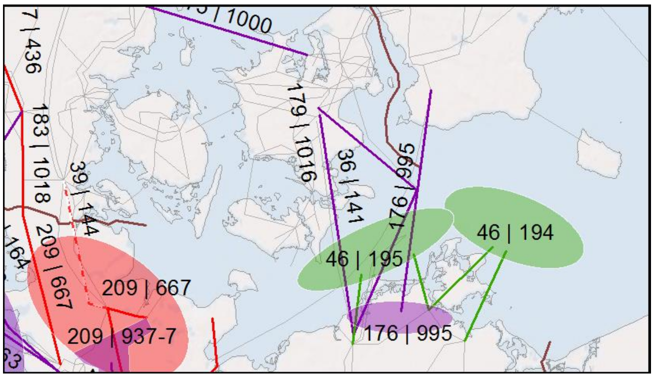
Project 179: DKE - DE

Description of the project

This project includes a 600 MW HVDC subsea interconnector between Denmark-East (DKE) and Germany (DE) and is called Kontek-2. A final grid-connection solution is not prepared yet; one of the possible alternatives could establish the Danish HVDC converter station in the area of Lolland-Falster. This alternative has been investigated for the TYNDP and comprises among other things an HVDC converter station being connected to the existing 400 kV substation Bjæverskov via 400 kV underground cables and/or 400 kV OHL. Some additional investments in eastern Danmark would be necessary, which are not described in detail in this document.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1016	Bjæverskov (DK2)	Bentwisch (DE)	new 600 MW HVDC subsea cable connecting DK2 and DE	-	Under Consideration	2030	New Investment	RGBS common investigations for TYNDP14

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)**
DKE=>DE: 600	DE=>DKE: 600	3	3	NA	NA	500-610

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	-	[31;38]	[54000;66000] MWh	[17000;21000]	[82;100]
Scenario Vision 2 - 2030	-	[22;27]	[54000;66000] MWh	[-2200;-1800]	[73;90]
Scenario Vision 3 - 2030	-	[22;27]	[63000;77000] MWh	[120000;150000]	[-890;-720]
Scenario Vision 4 - 2030	-	[140;170]	[63000;77000] MWh	[120000;150000]	[-1900;-1600]

Additional comments

Comment on the CBA assessment: The significant increase of RES between Vision 1 and Vision 4 in both countries contributes to an increased number of hours with more volatile prices and thus higher flows in both directions. Additionally, the higher CO2 price in vision 4 causes a shift between coal and gas in the merit order, which increases the price spread between high and low RES hours. This explains the spread of the SEW indicator between these two extreme visions.

Comment on the security of supply: the project improves the SoS of Eastern Denmark and the Mecklenburg-Vorpommeranian area in Germany.

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

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

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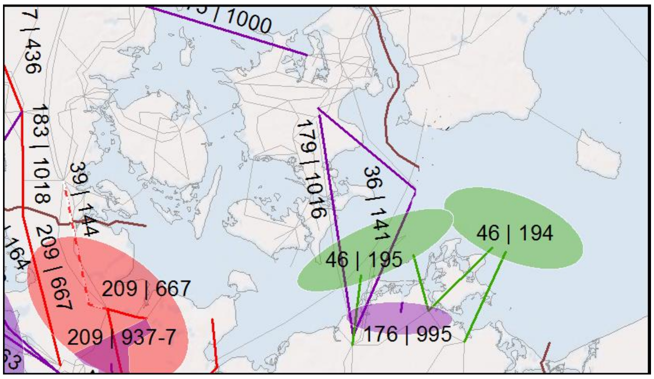
Project 36: Kriegers Flak CGS

Description of the project

The Kriegers Flak Combined Grid Solution (CGS) is a new DC offshore connection between Denmark and Germany. It had been designed and was simulated for this TYNDP as a combined grid connection of the offshore wind farms Kriegers Flak (Denmark), Baltic 1 and 2 (Germany) and a 400 MW interconnection between both countries connecting Ishøj/Bjæverskov (Denmark) and Bentwisch/Güstrow (Germany). The project facilitates RES connection and increased trade of electricity. The modelling results refer to the infrastructure part only, not to the benefit of the involved offshore wind farms, which would be an evaluation of the benefit of new generation, which is beyond the scope of the TYNDP. Thus also the cost reflect only the extra cost compared to the usual way of connecting the offshore wind farms to the two systems. The project is supported by the European Energy Programme for Recovery (EEPR) and labelled by the EC as project of common interest (PCI 4.1).



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
141	Ishøj / Bjæverskov (DK)	Bentwisch (DE)	Three offshore wind farms connected to shore combined with 400 MW interconnection between both countries	-	Design & Permitting	2018	Investment on time	Commissioning date must be achieved in order to ensure grid connection for further renewable energy.

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)**
DKE=>DE: 400	DE=>DKE: 400	3	3	Negligible or less than 15km	Negligible or less than 15km	300

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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	-	[19;24]	[54000;66000] MWh	[-62000;-51000]	[-130;-110]
Scenario Vision 2 - 2030	-	[7;8]	[9000;11000] MWh	[-62000;-50000]	[-4;-3]
Scenario Vision 3 - 2030	-	[10;13]	[18000;22000] MWh	[4500;5500]	[-390;-320]
Scenario Vision 4 - 2030	-	[36;44]	[18000;22000] MWh	[4500;5500]	[-760;-620]

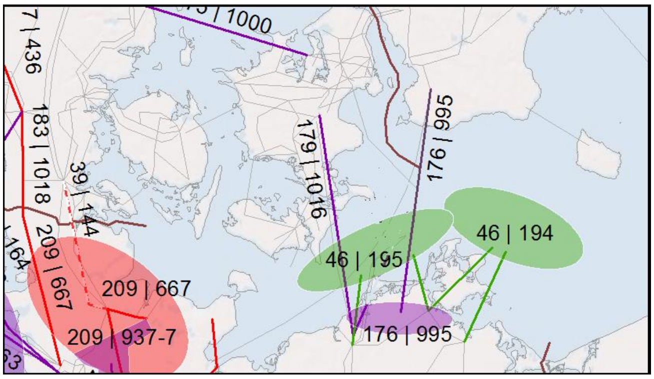
Additional comments

Comment on the security of supply: the project improves the SoS of Eastern Denmark and the Mecklenburg-Vorpommeranian area in Germany.

Project 176: Hansa PowerBridge

Description of the project

New interconnector between Sweden (SE4) and Germany (50 Hertz).
There has been joint studies with 4 options for this project. The other options were new interconnectors Latvia-Sweden, Lithuania-Sweden and Poland-Sweden. CBA indicators are based only on the SE4-DE interconnector.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
995	Station SE4	Station DE	New DC cable interconnector between Sweden and Germany.	-	Under Consideration	2025	New Investment	RGBS common investigations for 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)**
DE=>SE: 600	SE=>DE: 600	3	3	NA	NA	200-400

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	-	[72;88]	[36000;44000] MWh	[420000;520000]	[590;720]
Scenario Vision 2 - 2030	-	[15;18]	[36000;44000] MWh	[190000;230000]	[340;420]
Scenario Vision 3 - 2030	-	[28;35]	[90000;110000] MWh	[62000;75000]	[-710;-580]
Scenario Vision 4 - 2030	-	[220;270]	[90000;110000] MWh	[280000;350000]	[-2200;-1800]

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Additional comments

Comment on the RES integration: The project helps integrating wind power on both sides and improves power balancing.

Comment on the S1 and S2 indicators: The project will have a social and environmental impact. However, the project is in an early stage and there is not enough facts regarding the impact.

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Project 58: GerPol Power Bridge

Description of the project

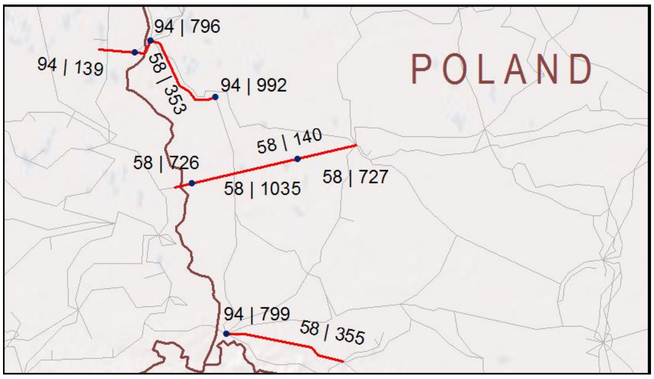
The construction of a new (third) interconnection between Polish and German power systems includes the construction of the interconnector between Eisenhuetenstadt and Plewiska as well as two internal lines (Mikułowa-Świebodzice and Krajnik -Baczyna) and substations Plewiska BIS, Gubin and Zielona Góra to connect the new line in the Polish transmission system and contributes to the following:

• increase of market integration between member states - additional NTC of 1500 import and 500 MW export on PL-DE/SK/CZ synchronous profile;

• integration of additional Renewable Energy Sources on the area of western and north-western Poland as well as eastern part of Germany;

• improving network security - project contributes to increase of security of supply and flexibility of the transmission network (security of supply of Poznań agglomeration area).

PCI 3.14



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
140	Eisenhüttenstadt (DE)	Plewiska (PL)	Construction of new 400 kV double circuit line Plewiska (PL)-Eisenhüttenstadt (DE) creating an interconnector between Poland and Germany.	800	Planning	2030	Rescheduled	Change of the commissioning date – see comment in the next page
353	Krajnik (PL)	Baczyna (PL)	Construction of new 400 kV double circuit line Krajnik – Baczyna.	400	Planning	2020	Investment on time	Investment is in the tendering procedure.
355	Mikulowa (PL)	Swiebodzice (PL)	Construction of new 400 kV double circuit line Mikułowa-Świebodzice in place of existing 220 kV line.	400	Planning	2020	Investment on time	Investment on time.
726	Gubin (PL)		New 400 kV substation Gubin located near the PL-DE border. The substation will be connected by the new	800	Planning	2030	Rescheduled	Change of the commissioning date as the investment is correlated with the investment 140

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			line Plewiska (PL)-Eisenhüttenstadt (DE).					
727	Plewiska (PL)		Construction of new substation Plewiska Bis (PL) to connect the new line Plewiska (PL)-Eisenhüttenstadt (DE).	800	Planning	2020	Investment on time	The project is at the planning stage.
1035	Baczyna		Construction of new 400/220 kV Substation Baczyna to connect the new line Krajnik-Baczyna.	400	Planning	2018	Investment on time	The investment was part of n°58.353 in TYNDP 2012 and is now presented stand alone. It is in the tendering procedure (design and build scheme).

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)**
PL=>DE: 0-500	DE=>PL: 0-1500	1	4	15-50km	Negligible or less than 15km	390-400

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	-	[69;84]	0	[-170000;-140000]	[760;930]
Scenario Vision 2 - 2030	-	[67;82]	0	[-160000;-130000]	[1000;1200]
Scenario Vision 3 - 2030	-	[99;120]	[300000;370000] MWh	[-770000;-630000]	[-81;-66]
Scenario Vision 4 - 2030	-	[98;120]	[650000;800000] MWh	[-910000;-740000]	[87;110]

Additional comments

Comment on the RES integration:
The project, depending on the vision, helps integrating RES in the region of north-west Poland as well as eastern part of Germany.

The analysis evaluating the effectiveness of the construction of the third interconnection with German power system was performed, which took into account the assessment of the technical conditions of the existing highest voltage lines, system conditions as well as domestic needs in the area of transmission network expansion and the need to increase the import capacity.
The analysis was performed using current internal forecasts in terms of demand for power and energy in the Polish Power System, including the assessment of the ability to balance the demand for power by generation sources (conventional and RES) located in the north-western part of the country.
The assessment took into account the intention to improve conditions of the cross-border power exchange over synchronous cross-section considering the installation of phase shifting transformers

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(PSTs) on the Mikułowa-Hagenwerder and Krajnik-Vierraden interconnection lines, and the planned upgrade of Krajnik-Vierraden line to 400 kV.
The results of PSE's analysis show that it is possible to achieve the increase of cross border capacity to 1800-2000 MW with a different approach.
The reinforcements in the internal Polish transmission network, which prove necessary despite the cross border capacity increase needs, yield comparable results with significantly lower costs.
The proposed reinforcements include:

- 2x400 kV line Krajnik-Baczyna (planned currently)
- 2x400 kV line Mikułowa-Świebodzice (planned currently)
- Rebuilding of existing single 400 kV line Mikułowa-Pasikurowice to 2x400 kV (internal replacement)
- 2x400 kV line Baczyna-Plewiska (instead of Eisenhüttenstadt-Plewiska)

Based on the above described conditions PSE and 50Hertz intend to concentrate in a first step on the proposed reinforcements and to consider the construction of the third interconnection line between Poland and Germany in a second step, in 2030 as the earliest date.
The decision on the construction of the third interconnection will be taken after the internal infrastructure development has been completed and after the evaluation of the needs for further development has been performed.

When the project was assessed with the CBA during the TYNDP 2014 assessment phase, the CBA clustering rules were respected. This was reflected in the draft TYNDP 2014 for consultation published in July 2014. Given the changes above-mentioned the project now does not fulfil anymore the CBA clustering rules.

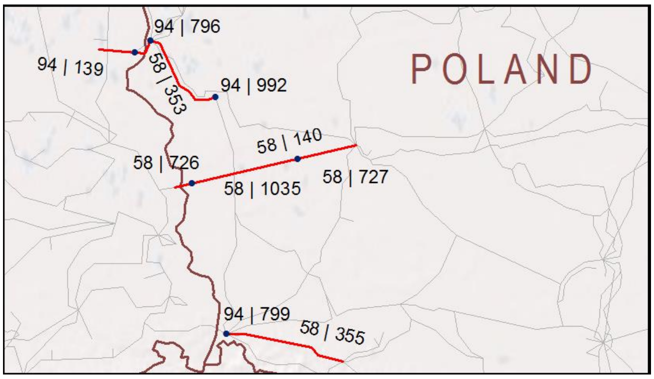
Project 94: GerPol Improvements

Description of the project

Upgrade of the existing 220 kV double interconnection line between Krajnik and Vierraden to 400 kV double line in the same direction together with installation of Phase Shifting Transformers on two existing interconnection lines (Krajnik-Vierraden by 50Hertz Transmission GmbH in Vierraden and Mikułowa-Hagenverder by PSE S.A. in Mikułowa) on the PL/DE border including an upgrade of substations Vierraden, Krajnik and Mikułowa contribute to the following:

• decreasing of unscheduled flow from Germany to Poland, Poland to Czech Republic and Poland to Slovakia by increasing of controllability on entire synchronous profile;
• enhancement of market capacity on Polish synchronous profile - PL/DE as well as PL-CZ/SK border in case of both import and export. The project provides additional capacity (NTC – Net Transfer Capability) of 500 MW in terms of import and 1500 MW export; greater level of safety and reliability of operation of the transmission network in Poland due to enhanced control of power flow.

PCI 3.15



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
139	Vierraden (DE)	Krajnik (PL)	Upgrade of existing 220 kV line Vierraden-Krajnik to double circuit 400 kV OHL.	1500	Design & Permitting	2017	Investment on time	A delay in the permit process for the line Neuenhagen-Bertikow-Vierraden (DE) as a prerequisite caused an adaptation in the time schedule for the line between Vierraden and Krajnik from to 2017.
796	Krajnik (PL)		Upgrade of 400/220 kV switchgear in substation Krajnik (new 400/220 kV switchyard).	1500	Design & Permitting	2017	Delayed	The commissioning time of the investment has been aligned with the schedule for the investment 139.
799	Mikulowa (PL)		Installation of new Phase Shift Transformer in substation Mikułowa and the upgrade of substation Mikułowa for the purpose of PST installation.	1500	Design & Permitting	2015	Delayed	Investment postponed because of prolongation of the tendering process. Due to complexity of the technical solutions more time is needed for the tendering procedure.

992	Vierraden		Installation of new PSTs in Vierraden	1500	Planning	2017	New Investment	Based on a common agreement between PSE and 50Hertz the investment was specified in more detail in close cooperation between PSE and 50Hertz. The common solution consists of PST in Vierraden (DE) and PST in Mikułowa (PL) Investment 799.

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)**
PL=>DE: 0-1500	DE=>PL: 0-500	2	3	Negligible or less than 15km	Negligible or less than 15km	150

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	-	[250;300]	[110000;130000] MWh	[-60000;-49000]	[2000;2400]
Scenario Vision 2 - 2030	-	[240;300]	[41000;50000] MWh	[-49000;-40000]	[2800;3400]
Scenario Vision 3 - 2030	-	[75;92]	[130000;160000] MWh	[-140000;-110000]	[1300;1600]
Scenario Vision 4 - 2030	-	[270;330]	[800000;970000] MWh	[-190000;-150000]	[50;61]

Additional comments

Comment on the security of supply:
By improving the control over the unscheduled flows, which in certain conditions cause severe overload of the system elements, the project has a positive impact on Security of Supply in the region of north-west and south-west Poland as well as eastern part of Germany.

Comment on the RES integration:
The project, depending on the vision, helps integrating RES in the region of north-west Poland as well as eastern part of Germany.

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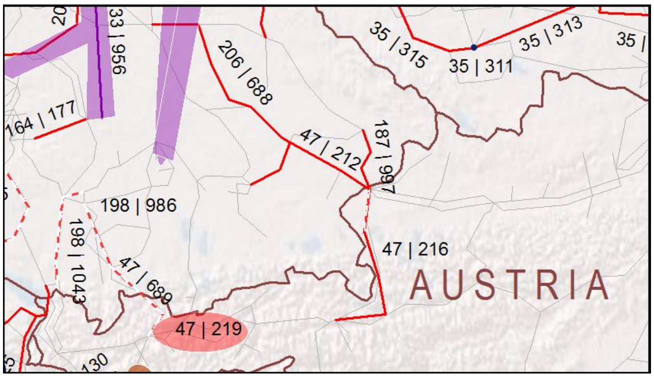
Project 47: AT - DE

Description of the project

This project reinforces the interconnection capacity between Austria and Germany. The national investments comprised are a precondition to achieve the full benefit of the cross border investments and are vital for the Austrian security of supply (e.g. part of the Austrian 380-kV-Security Ring). It supports the interaction of RES in Northern Europe (mainly in Germany) and in the eastern part of Austria with the pump storages in the Austrian Alps and therewith facilitates their utilisation.

PCI 2.1, 3.1.1 and 3.1.2



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
212	Isar (DE)	St. Peter (AT)	New 400kV double circuit OHL Isar - St. Peter including new 400kV switchgears Altheim, Pirach, Simbach and St. Peter. Also including 4. circuit on line Ottenhofen - Isar.	2320	Design & Permitting	2018	Delayed	delayed due to long permitting process
216	St. Peter (AT)	Tauern (AT)	Completion of the 380kV-line St. Peter - Tauern. This contains an upgrade of the existing 380kV-line St. Peter - Salzburg from 220kV-operation to 380kV-operation and the erection of a new internal double circuit 380kV-line connecting the substations Salzburg and Tauern (replacement of existing 220kV-lines on optimized routes). Moreover the erection of the new substations Wagenham and Pongau and the integration of the substations Salzburg and Kaprun is planned.	1740	Design & Permitting	2020	Investment on time	In Sept. 2012 the application for granting the permission (EIA) was submitted to the relevant authorities. According to the experience of similar projects the commissioning is expected for 2020.
219	Westtirol (AT)	Zell-Ziller (AT)	Upgrade of the existing 220kV-line Westtirol - Zell-Ziller and erection of an additional 220/380kV-Transformer. Line length: 105km.	470	Planning	2021	Investment on time	The upgrade of the line and substation Westtirol is currently in the planning process.
689	Vöhringen (DE)	Westtirol (AT)	Upgrade of an existing overhead line to 380 kV, extension of existing and	585	Planning	2020	Investment on time	Progress as planned.

			erecting of new 380-kV-substations including 380/110-kV-transformers. Transmission route Vöhringen (DE) - Westtirol (AT). This project will increase the current power exchange capacity between the DE, AT.					

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)**
DE=>AT: 2900	AT=>DE: 2900	1	4	15-50km	15-25km	830-1400

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	-	[53;64]	0	[-450000;-370000]	[530;650]
Scenario Vision 2 - 2030	-	[110;140]	0	[-420000;-340000]	[390;480]
Scenario Vision 3 - 2030	-	[310;380]	[300000;360000] MWh	[-330000;-270000]	[-1500;-1300]
Scenario Vision 4 - 2030	-	[470;490]	[690000;850000] MWh	[-300000;-330000]	[-1300;-1500]

Additional comments

Comment on the security of supply:
The security of supply (SoS) indicator is to be understood in the way it is defined within the Cost Benefit Analysis methodology which focuses merely on the connection of partly isolated grid areas. In general in rather meshed parts of the transmission grids other aspects are more significant for the security of supply (e.g. n-1-margin, cascade effects, etc.) and therefore the project benefit indicator on SoS according to the CBA methodology underestimates the real value of the project. The considered project is vital for the Austrian SoS. It comprise an important part of the Austrian 380-kV-Security Ring, enforces the east-west connection in Tyrol and improves the connection to distribution grids.

Comment on the RES integration:
The project supports the interaction of RES in Northern Europe (mainly in Germany) and in the eastern part of Austria with the pump storages in the Austrian Alps and therewith facilitates their utilisation.

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

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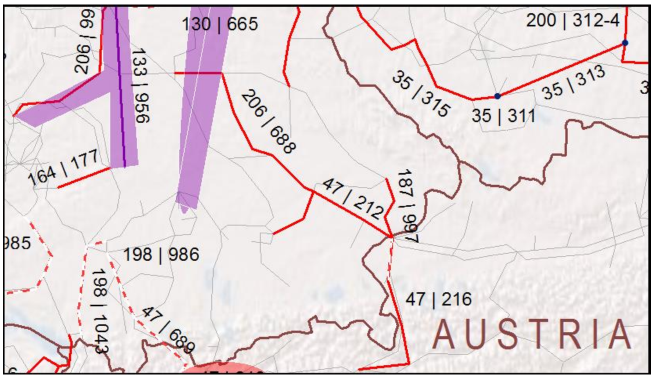
Project 187: St. Peter - Pleinting

Description of the project

Increase of the cross border transmission capacity by erecting a new 380kV line between St. Peter (Austria) and Pleinting (Germany). This leads to an improved connection of the very high amount of RES in Germany and the pump storages in the Austrian Alps.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
997	Pleinting (DE)	St. Peter (AT)	new 380-kV-line Pleinting (DE) - St. Peter (AT) on existing OHL corridor	-	Under Consideration	2022	New Investment	new 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)**
AT=>DE: 1500	DE=>AT: 1500	1	3	Negligible or less than 15km	Negligible or less than 15km	130-190

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	-	[13;16]	0	[-79000;-65000]	[140;170]
Scenario Vision 2 - 2030	-	[15;18]	[4400;5400] MWh	[-83000;-68000]	[560;680]
Scenario Vision 3 - 2030	-	[100;130]	[140000;170000] MWh	[-88000;-72000]	[-520;-420]
Scenario Vision 4 - 2030	-	[190;230]	[220000;260000] MWh	[-110000;-90000]	[-720;-590]

Additional comments

Comment on the RES integration:
The project supports the interaction of RES in Northern Europe (mainly in Germany) and in the eastern part of Austria with the pump storages in the Austrian Alps and therewith facilitates their utilisation.

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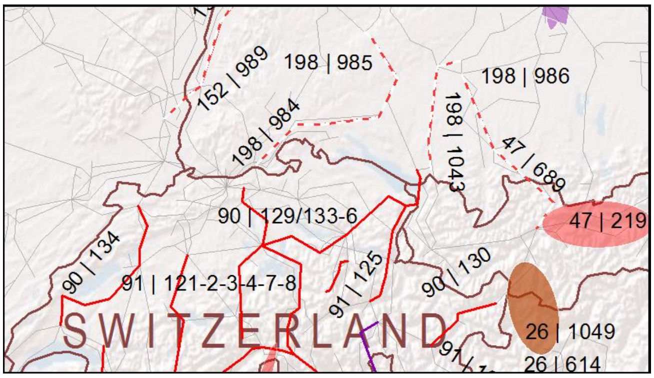
Project 198: Area of Lake Constance

Description of the project

The transmission capacity of the 380-kV-grid in this grid area and especially the cross-border lines between Germany and Austria are extended significantly by this project. Capacity overloads with existing lines are eliminated and therefore connection between the German and the Austrian transportation grid is strengthened.

PCI 2.11.2



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
136	Border area (DE-AT)	Rüthi (CH)	380 kV Rüthi – Meiningen and 380 kV Meiningen - Border Area AT-DE	1200	Planning	2022	Investment on time	Investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.
984	Herbertingen	Tiengen	Herbertingen – Tiengen: Between the two substations Herbertingen and Tiengen a new line will be constructed in an existing corridor. Enhancement of the grid, which will increase transmission capacity noticeably, is needed at the substation Herbertingen.	400	Planning	2020	Investment on time	Progress as planned. This project is a concretion of TYNDP12 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
985	point Rommelsbach	Herbertingen	Rommelsbach – Herbertingen: Between point Rommelsbach and substation Herbertingen a new line will be constructed in an existing corridor. This will significantly increase transmission capacity (grid enhancement).	400	Planning	2018	Investment on time	Progress as planned. This project is a concretion of TYNDP12 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
986	point Wullenstetten (DE)	point Niederwangen (DE)	Point Wullenstetten – Point Niederwangen Between point Wullenstetten and point Niederwangen an upgrade of an	2000	Planning	2020	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. Due to the ongoing

			existing 380-kV-line is necessary (grid enhancement). Thereby, a significantly higher transmission capacity is realized. The 380 kV substation station Dellmensingen is due to be extended (grid enhancement).					planning stage, this section was developed and an own investment item was created.
1043	Neuravensburg	border area (AT)	Point Neuravensburg – Point Austrian National border (AT) Between switching point Neuravensburg and Austrian National border (AT) a new line with a significantly higher transmission capacity will be constructed in an existing corridor (grid enhancement).	2000	Planning	2023	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. This investment is caused by the investment 136 "Bodensee Studie". Due to the ongoing planning stage, this section was developed and an own investment item was created.

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)**
DE=>CH: 3400	CH=>DE: 1400	1	4	50-100km	Negligible or less than 15km	390-530

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;110]	0	[-99000;-81000]	[820;1000]
Scenario Vision 2 - 2030	-	[140;170]	0	[-140000;-110000]	[1900;2400]
Scenario Vision 3 - 2030	-	[310;380]	[450000;550000] MWh	[-91000;-75000]	[-1200;-950]
Scenario Vision 4 - 2030	-	[480;580]	[900000;1100000] MWh	[-180000;-150000]	[-2100;-1700]

Additional comments

Comment on the clustering: the project also takes advantage of investment items n°1100, depicted in the Regional investment plan.

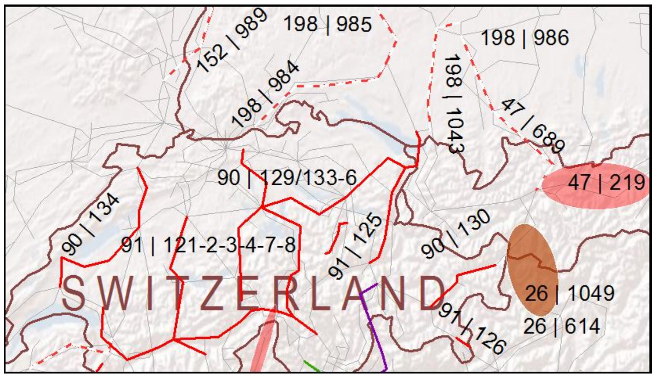
Comment on the RES integration: avoided spillage concerns RES in Germany mostly.

Project 90: Swiss Roof

Description of the project

This project increases the capacity between CH and its neighbours DE and AT. This enables to connect large renewable generation in Northern Europe to pump storage devices in the Alps, thus noticeably increasing the mutual balancing between both regions. Project 90 is completed by Project 198.

PCI 2.11.1



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
129	Beznau (CH)	Mettlen (CH)	Upgrade of the existing 65km double circuit 220kV OHL to 400kV.	800	Design & Permitting	2020	Delayed	Long permitting procedure (comprising several phases). In this case, Federal Court decision for partial cabling.
130	La Punt (CH)	Pradella / Ova Spin (CH)	Installation of the second circuit on existing towers of a double-circuit 400kV OHL (50km).	650	Planning	2017	Investment on time	Progress as planned.
133	Bonaduz (CH)	Mettlen (CH)	Upgrade of the existing 180km double circuit 220kV OHL into 400kV.	340	Under Consideration	2020	Investment on time	Progress as planned.
134	Bassecourt (CH)	Romanel (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV lines; total length: 140km. Construction of a new 400/220 kV substation in Mühleberg (= former investment 132 'Mühleberg Substation')	660	Design & Permitting	2020	Delayed	lines: long permitting procedure (comprising several phases)- Mühleberg substation: under construction
136	Border area (DE-AT)	Rüthi (CH)	380 kV Rüthi – Meiningen and 380 kV Meiningen - Border Area AT-DE	1200	Planning	2022	Investment on time	Investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.

1099	Rüthi	Bonaduz - Grynau	Rüthi - Grynau 2 x 380 kV Rüthi - Bonaduz 1 x 380 kV	1200	Planning	2022	Investment on time	Investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.

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=>upstream: 0	upstream=>upstream: 0	1	4	Negligible or less than 15km	Negligible or less than 15km	490

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;110]	0	[-200000;-160000]	[820;1000]
Scenario Vision 2 - 2030	-	[140;170]	0	[-270000;-220000]	[1900;2400]
Scenario Vision 3 - 2030	-	[310;380]	[450000;550000] MWh	[-180000;-150000]	[-1200;-950]
Scenario Vision 4 - 2030	-	[480;580]	[900000;1100000] MWh	[-360000;-300000]	[-2100;-1700]

Additional comments

Comment on the GTC:
GTC increases, Vision 1, 2, 3 and 4 2030

DE>CH: 3400 MW
AT>CH: 1000 MW
CH>DE: 1400 MW
CH>AT: 1000 MW

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

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

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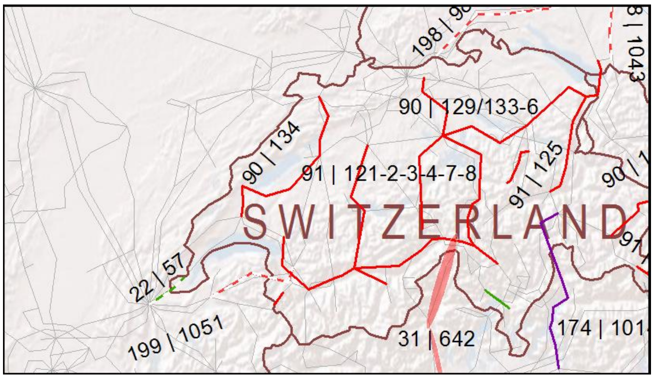
Project 22: Lake Geneva West

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 contri bution (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]

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.

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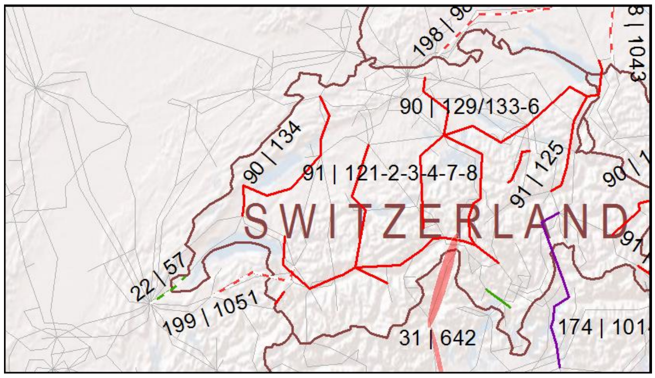
Project 199: Lake Geneva South

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 contri bution (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.

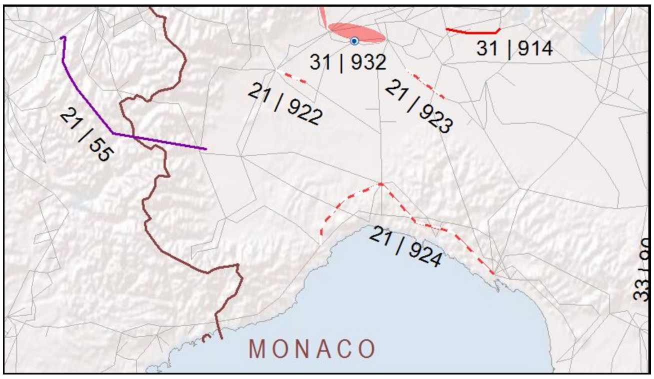
Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

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.

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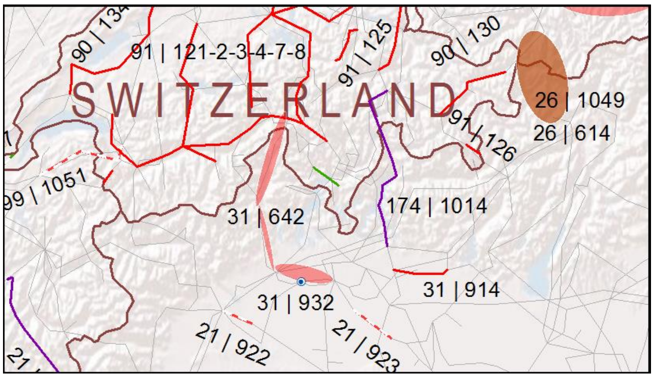
Project 31: Italy-Switzerland

Description of the project

The project consists of a new 400 kV line San Giacomo-Pallanzeno, conversion from AC to DC of the 220 kV line, including the realization of the 2 AC/DC converter stations and 220 kV to 400 KV substation upgrade.
Additional internal lines in Italy and in Switzerland are required to get full advantage from the interconnection capacity provided by the cross-border line. The project significantly increases interconnection capacity between Switzerland and Italy; favours the market integration; helps to use of the most efficient generation capacity and could potentially contribute to RES integration. Such benefits are assured according to different future scenarios.

PCI 2.15.1 and 2.15.2



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
124	Mettlen (CH)	Airolo (CH)	Upgrade of existing 225kV OHL into 400kV. Line length: 90km.	750	Under Consideration	2020	Investment on time	Progress as planned.
642	Airolo (CH)	Pallanzeno(IT)-Baggio(IT)	New interconnection project between Italy and Switzerland;	1000	Design & Permitting	2022	Investment on time	permitting process started on the Italian side since September 2012
914	Cassano (IT)	Chiari (IT)	Upgrade to 380 kV of part of existing 220 kV Cassano Ric.Ovest	500	Design & Permitting	2022	New Investment	The interconnection scheme envisaged in TYNDP 2012 is now defined. The upgrade of Chiari-Cassano is identified as critical to get full advantage of the Giacomo project.
932	Magenta(IT)		new 400 kV section in Magenta substation	1000	Design & Permitting	2020	Investment on time	HVDC link between Pallanzeno and Baggio will be realized using existing 220 kV line connecting the Magenta 220/132 kV substation. Consequently, a new 400 kV section will be needed to reconnect the Magenta substation to

								the 400 kV line Turbigo – Baggio

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)**
CH=>IT: 1000	IT=>CH: 950	1	4	Negligible or less than 15km	Negligible or less than 15km	1080

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	-	[26;31]	0	[230000;290000]	[190;230]
Scenario Vision 2 - 2030	-	[32;39]	0	[230000;290000]	[-340;-280]
Scenario Vision 3 - 2030	-	[26;31]	0	[17000;21000]	0
Scenario Vision 4 - 2030	-	[54;66]	0	[50000;61000]	[-140;-120]

Additional comments

Comment on the RES integration:
Additional benefits in terms of RES integration are possible because the new interconnection improves the balance capacity of the system. This kind of benefits is not captured by market simulations because it is lower than the sensibility threshold of the tool

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.

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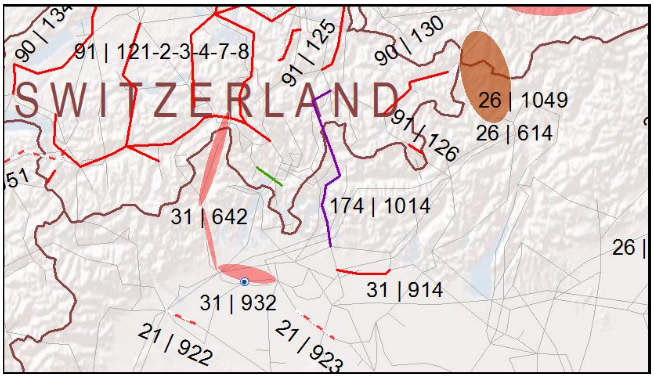
Project 174: Greenconnector

Description of the project

Project promoted by Worldenergy.
The projects consists of a new HVDC interconnection between Italy and Switzerland which will increase the transmission capacity between the two countries. The project, promoted by non-ENTSO-E member, could potentially contribute to market and RES integration in the future European interconnected system.

PCI 2.14



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1014	Verderio (I)	Sils (CH)	New +/- 400 kV DC cable and subsea link between Switzerland and Italy. Very short AC cable (380 kV) between the site of the converter station and the substation of Sils i.D.	-	Design & Permitting	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)
CH=>IT: 800	IT=>CH: 800	1	3	Negligible or less than 15km	Negligible or less than 15km	500

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	-	[19;24]	0	[-20000;-16000]	[170;210]
Scenario Vision 2 - 2030	-	[17;20]	0	[-24000;-20000]	[-500;-410]
Scenario Vision 3 - 2030	-	[18;23]	0	[1800;2200]	0

Scenario Vision 4 - 2030	-	[42;51]	0	[-17000;-14000]	[-120;-99]

Additional comments

Comment on the RES integration:

Additional benefits in terms of RES integration are possible because the new interconnection improves the balance capacity of the system. This kind of benefits is not captured by market simulations because it is lower than the sensibility threshold of the tool

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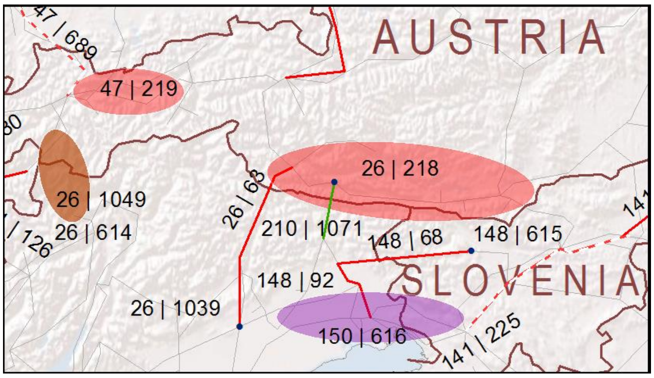
Project 26: Austria - Italy

Description of the project

Reinforcement of the interconnection between Italy and Austria via two new single circuit cross-border lines and closure of the 380-kV-Security Ring in Austria. The project supports the interaction between the RES in Italy and the eastern part of Austria with the pump storage power plants in the Austrian Alps.

PCI 3.3, 3.2.1 and 3.2.2



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
63	Lienz (AT)	Veneto region (IT)	The project foresees the reconstruction of the existing 220kV-interconnection line as 380kV-line on an optimized route to minimize the environmental impact. Total length should be in the range of approx. 140km.	800	Planning	2023	Investment on time	Planning in progress coordinated between TERNA and APG
218	Obersielach (AT)	Lienz (AT)	New 380kV OHL connecting the substations Lienz (AT) and Obersielach (AT) to close the Austrian 380kV-Security Ring in the southern grid area. Line length: 190km.	320	Under Consideration	2023	Investment on time	Progress as planned.
614	Nauders (AT)	Glorenza (IT)	interconnector IT-AT (phase 1)	300	Design & Permitting	2018	Investment on time	Progress as planned.
1039	Volpago (IT)		New 380/220/132 kV substation with related connections to 380 kV Sandrigo Cordignano and 220 KV Soverzene Scorzè where removing limitations are planned	800	Planning	2020	Delayed	The Volpago Substation was included in the TYNDP 2012 as part of the item 26.83 which had as commissioning date 2015. Permitting process delayed due to territorial constraint
1049	tbd (IT)	tbd (AT)	interconnector IT-AT (phase 2)	350	Under Consideration	2023	New Investment	project 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)**
AT=>IT: 1450	IT=>AT: 1350	1	4	Negligible or less than 15km	Negligible or less than 15km	780-1180

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	-	[57;70]	0	[-510000;-410000]	[520;640]
Scenario Vision 2 - 2030	-	[89;110]	[2700;3300] MWh	[-520000;-420000]	[-490;-400]
Scenario Vision 3 - 2030	-	[56;69]	[1100;1300] MWh	[-200000;-160000]	[-130;-100]
Scenario Vision 4 - 2030	-	[100;130]	[11000;14000] MWh	[-280000;-230000]	[-300;-240]

Additional comments

Comment on the security of supply:
The security of supply (SoS) indicator is to be understood in the way it is defined within the Cost Benefit Analysis methodology which focuses merely on the connection of partly isolated grid areas. In general in rather meshed parts of the transmission grids other aspects are more significant for the security of supply (e.g. n-1-margin, cascade effects, etc.) and therefore the project benefit indicator on SoS according to the CBA methodology underestimates the real value of the project. The considered project is vital for the Austrian SoS. It comprises an important part of the Austrian 380-kV-Security Ring, enforces the east-west connection in Carinthia and improves the connection to distribution grids.

Comment on the RES integration:
The considered project improves the transport of renewable energy from Italy and the eastern part of Austria to the alpine pump storage power plants. This leads to a better utilisation of the RES generation. Avoided spillage concerns also RES in Germany.

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.

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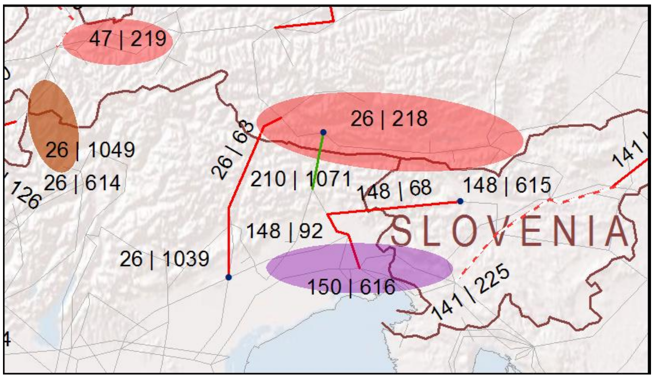
Project 210: E15

Description of the project

A 3rd party project promoted by Alpe Adria Energia SpA - planned 220kV line from Würmlach (Austria) to Somplago (Italy).

PCI 3.4



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1071	Würmlach (AT)	Somplago (IT)	Würmlach - Somplago	-	Design & Permitting	2017	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)**
AT=>IT: 150	IT=>AT: 150	1	3	Negligible or less than 15km	Negligible or less than 15km	45-75

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;5]	0	[-13000;-11000]	0
Scenario Vision 2 - 2030	-	[9;11]	0	[-13000;-11000]	0
Scenario Vision 3 - 2030	-	[2;3]	0	[-2600;-2200]	0
Scenario Vision 4 - 2030	-	[5;6]	0	[-3600;-3000]	0

Additional comments

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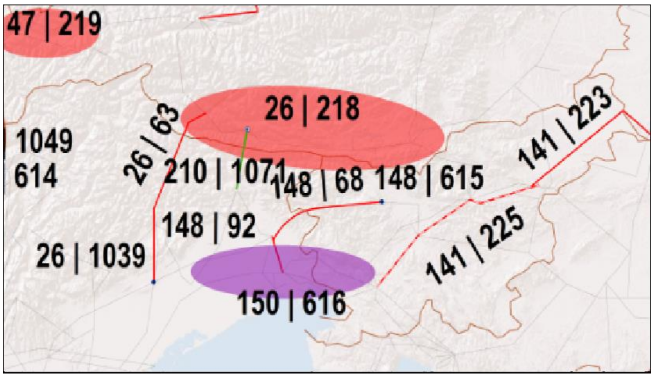
Project 148: CCS new

Description of the project

The project consists in the new 400 kV overhead cross-border line Udine – Okroglo, including a phase-shifter in the Okroglo substation in Slovenia and the 400 kV internal line in Italy. The internal reinforcements are necessary to allow the realization of the interconnection and to take full advantage of the increase of cross-border capacity. The project increases the transmission capacities between Slovenia and Italy and allows stronger market integration between Italy and Slovenia and broader region. Such benefits are ensured according to different future scenarios. The project improves reliability and security of supply by allowing mutual support of both countries. PCI project.

PCI 3.20



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
68	Okroglo (SI)	South Udine (IT)	New 120km double circuit 400kV OHL between Okroglo(SI) and future substation of South Udine (IT) with PST in Okroglo. The thermal rating will be 1870 MVA per circuit.	800	Planning	2021	Investment on time	There are some issues with social acceptance and territorial constraints. End of construction works are planned by the end of 2021.Full operation is expected by end of 2021(beginning of 2022).
92	West Udine (IT)	Redipuglia (IT)	New 40km double circuit 400kV OHL between the existing substations of West Udine and Redipuglia, providing in and out connection to the future 400kV substation of South Udine.	600	Under Construction	2016	Delayed	Permitting only recently completed (March 2013) and construction work had to be rescheduled accordingly. Note that the expected commissioning date for the project is December 2016
615	Okroglo (SI)		Installation of a new 400kV PST in Okroglo which is a part of a double 400 kV OHL Okroglo (SI)-Udine (IT).	800	Planning	2021	Investment on time	End of construction works are planned by the end of 2021. Full operation is expected by end of 2021 (beginning of 2022).

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)**
SI=>IT: 800	IT=>SI: 350	1	4	More than 100km	15-25km	420

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	-	[23;28]	0	[-110000;-90000]	[220;270]
Scenario Vision 2 - 2030	-	[49;60]	0	[-140000;-120000]	[-260;-210]
Scenario Vision 3 - 2030	-	[15;18]	0	[-41000;-33000]	[0;1]
Scenario Vision 4 - 2030	-	[18;23]	0	[-260000;-220000]	0

Additional comments

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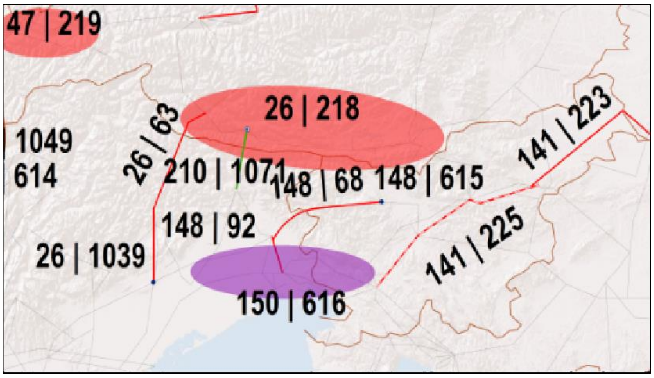
Project 150: CCS new 10

Description of the project

The project consists in a new HVDC link between Salgareda (Italy) and Divača\Beričevo (Slovenia) which will strengthen the connection between Slovenia and Italy. The project increases the transmission capacity between Slovenia and Italy and allows stronger market integration between Italy and Slovenia and broader region. Such benefits are ensured according to different future scenarios. The project could also improve the reliability and security of supply by allowing mutual support of both countries. PCI project 3.21.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
616	Slovenia (SI)	Salgareda (IT)	New HVDC link between Italy and Slovenia.	-	Under Consideration*	2022	Investment on time	Project is under feasibility study*.

* The project is under permitting on the Italian side since 2012. The status under consideration refers only to the Slovenian side, where some project feasibility study is still 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)
SI=>IT: 800	IT=>SI: 700	1	3	NA	NA	870

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]	0	[1800;2200]	[220;270]
Scenario Vision 2 - 2030	-	[49;60]	0	[900;1100]	[-230;-190]
Scenario Vision 3 - 2030	-	[15;18]	0	[3600;4400]	[12;15]
Scenario Vision 4 - 2030	-	[19;24]	0	0	0

Additional comments

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

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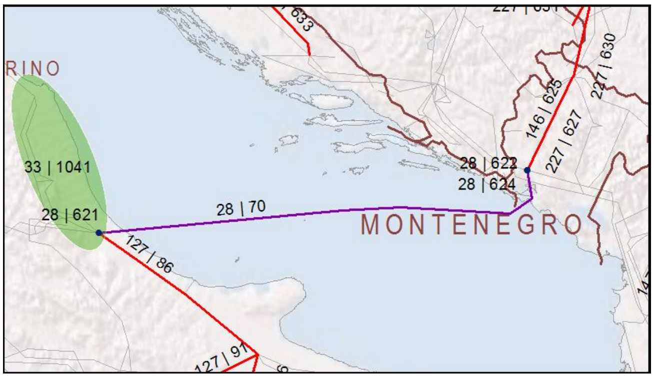
Project 28: 28

Description of the project

The Italy-Montenegro interconnection project includes a new HVDC subsea cable between Villanova (Italy) and Lastva (Montenegro) and the DC converter stations. The project is also correlated to cluster 146 where Montenegrin internal line and Montenegro- Serbia-Bosnia interconnections are planned. The project allows the market development between Italy and the Balkans; increases the transmission capacities; helps to use most efficient generation capacity; enables possible mutual support of Italian and Balkan power systems; contributes to RES integration in the European interconnected system by improving cross border exchanges. Such benefits are ensured within different future scenarios.

PCI 3.19.1



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
70	Villanova (IT)	Lastva (ME)	New 1000MW HVDC interconnection line between Italy and Montenegro via 375km 500kV DC subsea cable and converter stations at both ending points.	1000	Under Construction	2017	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
621	Villanova (IT)		Converter station of the new 1000MW HVDC interconnection line between Italy and Montenegro via 375km 500kV DC subsea cable.	1000	Under Construction	2017	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
622	Lastva (ME)		Converter station in Montenegro of the new 1000MW HVDC sub-sea 500 kV cable between Italy and Montenegro.	1000	Under Construction	2017	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
624	Lastva (ME)		New 400 kV substation Lastva in Montenegro will be connected to the existing line 400kV Podgorica 2(ME)-Trebinje (BA), with two transformers 2X300MVA 400/110kV. This substation will enable secure supply of the	1000	Design & Permitting	2015	Investment on time	Progress as planned.

			Montenegrin coastal network, and connection of the convertor station for the HVDC cable between Montenegro and Italy.					

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)**
IT=>ME: 1000	ME=>IT: 1000	1	3	Negligible or less than 15km	Negligible or less than 15km	1130

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	-	[140;170]	[13000;15000] MWh	[-18000;-14000]	[1400;1700]
Scenario Vision 2 - 2030	-	[110;130]	0	[-18000;-14000]	[1100;1300]
Scenario Vision 3 - 2030	-	[290;360]	[330000;410000] MWh	[1800;2200]	[-650;-530]
Scenario Vision 4 - 2030	-	[290;350]	[990000;1200000] MWh	[3600;4400]	[-1700;-1400]

Additional comments

Comment on the RES integration: benefits in terms of RES integration are possible even in Vision 2 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 mainly RES in the Italian and Balkan peninsulas.

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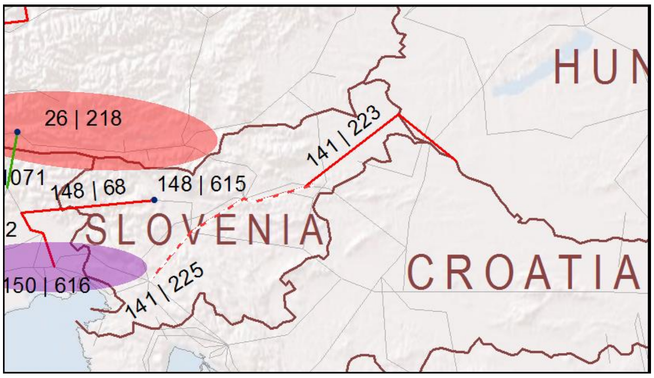
Project 141: CSE3

Description of the project

The project consists of a new double circuit 400 kV line Cirkovce-Pince and a new 400 kV Cirkovce substation (Slovenia) by which a new connection to one circuit of the existing double circuit interconnection line between Hungary and Croatia will be made, thus creating two new cross border interconnection between Slovenia and Hungary and between Slovenia and Croatia. Existing 220 kV lines of the corridor Cirkovce-Divaca will be upgraded to 400 kV level. PCI project 3.9



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
223	Cirkovce (SI)	Heviz (HU) Zerjavenec (HR)	The existing substation of Cirkovce(SI) will be connected to one circuit of the existing Heviz(HU) -Zerjavinec(HR) double circuit 400kV OHL by erecting a new 80km double circuit 400kV OHL in Slovenia. The project will result in two new cross-border circuits: Heviz (HU)-Cirkovce (SI) and Cirkovce (SI)-Žerjavenec (HR).	1085	Design & Permitting	2016	Investment on time	Progresses as planned.
225	Divaca (SI)	Cirkovce (SI)	Upgrading 220kV lines to 400kV in corridor Divaca-Klece-Bericevo-Podlog-Cirkovce.	800	Design & Permitting	2020	Investment on time	Progresses 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)**
HU=>SI: 765	SI=>HU: 1085	0	4	More than 100km	15-25km	240-360

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	-	[42;51]	0	[-120000;-95000]	[-200;-160]
Scenario Vision 2 - 2030	-	[40;49]	0	[-460000;-370000]	[-44;-36]
Scenario Vision 3 - 2030	-	[480;580]	0	[-240000;-190000]	[-3800;-3100]
Scenario Vision 4 - 2030	-	[300;370]	0	[-190000;-150000]	[-1700;-1400]

Additional comments

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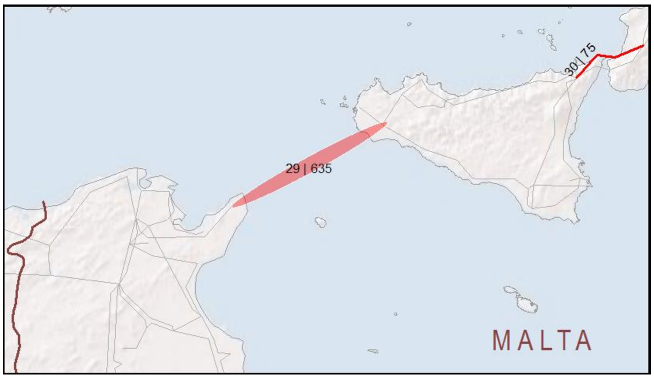
Project 29: Italy-North Africa

Description of the project

The project consists in a new interconnection between Italy and North Africa to be realized through an HVDC submarine cable. The project favours the use of the most efficient capacity in the PAN European interconnected system. The project also increases the system operational flexibility. Such benefits are ensured according to different future scenarios.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
635	Sicily Area (IT)	North Africa node	New interconnection between Italy and North Africa-new DC submarine cable	-	Under Consideration	2030	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)**
IT=>South: 600	South=>IT: 600	1	4	NA	NA	600

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	-	[81;99]	0	[18000;22000]	0
Scenario Vision 2 - 2030	-	[81;99]	0	[18000;22000]	0
Scenario Vision 3 - 2030	-	[81;99]	0	[18000;22000]	0
Scenario Vision 4 - 2030	-	[81;99]	0	[18000;22000]	0

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Additional comments

Comment on the CO2 indicator: the project will mostly substitute thermal based power in Europe with North African, hence a symbolic 0 is supplied.

Comment on the Losses indicator: the load factor of the cable is steady in all Visions, leading to the same and high additional losses.

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

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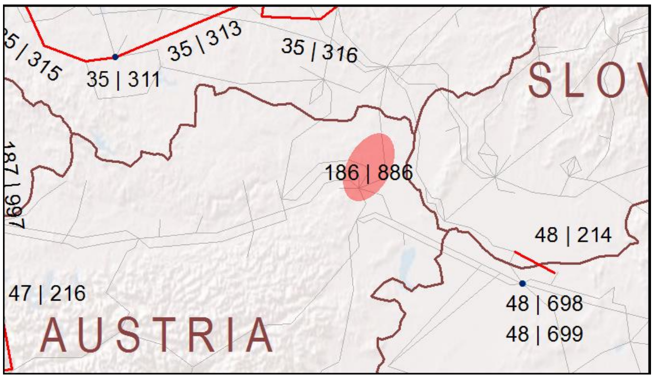
Project 186: east of Austria

Description of the project

To allow the grid integration of the planned renewable energy generation (mainly wind power) in the north-eastern part of Austria ("Weinviertel") the transmission grid infrastructure (currently a rather weak 220kV line) has to be enforced and new substations for the connection need to be erected.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
886	tbd	tbd	To allow the grid integration of the planned renewable energy generation (mainly wind power) in the north-eastern part of Austria ("Weinviertel") and to cover the foreseen load growth in that region the transmission grid infrastructure has to be enforced and new substations for the connection need to be erected	-	Planning	2021	Rescheduled	The development of wind energy in Lower Austria was temporarily stopped by the federal state government to establish a concept for land use. Final concept was published in beginning of 2014 – project now continues with planned commissioning in 2021.

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: 1500	inside=>outside: 1500	1	2	NA	NA	120-280

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	-	[220;260]	1100 MW	[-5500;-4500]	[-1000;-840]
Scenario Vision 2 - 2030	-	[130;160]	1100 MW	[-1100;-900]	[-320;-260]
Scenario Vision 3 - 2030	-	[300;370]	1500 MW	[-2600;-2200]	[-1200;-990]
Scenario Vision 4 - 2030	-	[230;280]	1500 MW	[-7900;-6500]	[-1200;-990]

Additional comments

Comment on the RES integration:
This project facilitates the direct connection of RES in the given amount.

Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

Comment on the S1 and S2 indicators: no indicator can be assessed as no route is defined yet for the project.

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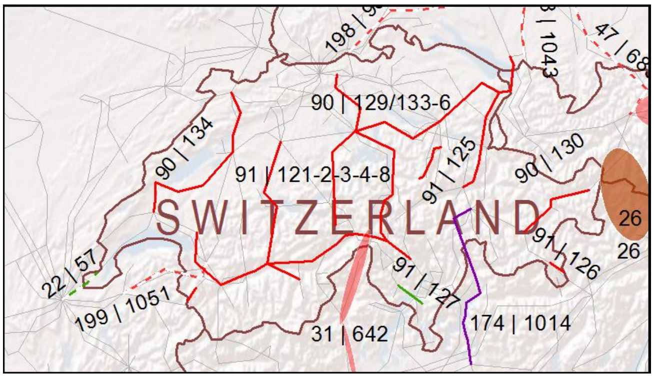
Project 91: Swiss Ellipse

Description of the project

The project helps accommodating new pumping storage units which mainly support the increasing RES generation in the European areas with solar or wind generation.
While importing or exporting, the Swiss Ellipse project uses the capacity of the 'Italy - Switzerland' (31), 'Swiss Roof' (90) and 'France - Switzerland' (22) projects.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
121	Bickigen (CH)	Romanel (CH)	Construction of different new 400kV OHL sections and voltage upgrade of existing 225kV lines into 400kV lines. Total length: 250km.	900	Design & Permitting	2020	Delayed	long permitting procedure (comprising several phases)
122	Chippis (CH)	Lavorgo (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV. Total length: 120km.	680	Design & Permitting	2020	Delayed	long permitting procedure (comprising several phases)
123	Mettlen (CH)	Ulrichen (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV lines. Total length: 90km.	600	Planning	2019	Investment on time	Progress as planned.
125	Schwanden (CH)	Limmern (CH)	New 400kV double circuit (OHL and underground cable) between Schwanden and Limmern. OHL part	1000	Under Construction	2015	Investment on time	Progress as planned.
126	Golbia (CH)	Robbia (CH)	New 2x 400kV cable connection between Golbia and the Bernina line double circuit.	1000	Under Consideration	2019	Investment on time	Progress as planned.
127	Magadino (CH)	Verzasca (CH)	Upgrade of existing 150kV line into 220kV line.	400	Under Consideration	2020	Investment on time	Progress as planned.
128	Bâtiaz (CH)	Nant de Drance (CH)	New 400kV double circuit OHL between Bâtiaz and Châtelard. New 2x 400kV cable connection between Châtelard and Nant de Drance. Total length: 22km.	900	Design & Permitting	2020	Delayed	long permitting procedure (comprising several phases)

795	Schwanden (CH)	Limmern (CH)	New 400kV double circuit (OHL and underground cable) between Schwanden and Limmern. Underground cable part	1000	Under Construction	2015	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)**
inside=>outside: 5000	outside=>inside: 5000	1	3	NA	NA	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	-	[18;23]	[170;200] MWh	0	[730;890]
Scenario Vision 2 - 2030	-	[21;26]	[1000;1300] MWh	0	[440;530]
Scenario Vision 3 - 2030	-	[200;250]	[36000;44000] MWh	0	[-480;-390]
Scenario Vision 4 - 2030	-	[310;380]	[230000;280000] MWh	0	[-800;-650]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in Germany and hydro storage in Switzerland.

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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German Offshore wind parks connection

This section presents alongside the 5 projects (42, 191, 192, 129, 46) foreseen for direct connection of offshore wind park, the first four in the North Sea, the fifth in the Baltic Sea.
Each project has been independently assessed.

Project 42: OWP TenneT Northsea part 1

Description of the project

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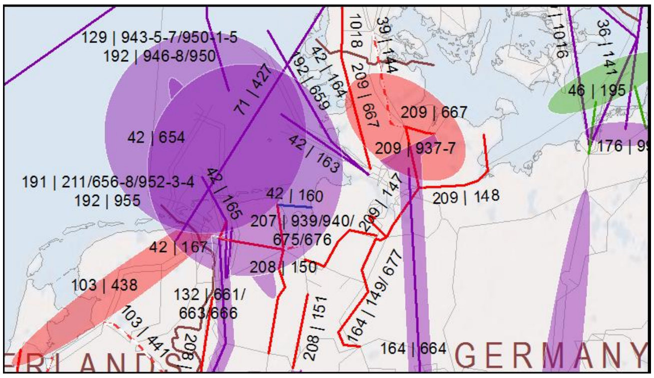
Germany is planning to build a big amount of offshore wind power plants in the Northsea. The OWP will help to reach the European goal of CO2 reduction and RES integration. This project is for the connection of the OWP with the German grid.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
160	Offshore-Wind park Nordergründe (DE)	Inhausen (DE)	New AC-cable connection with a total length of 32km.	111	Under Construction	2016	Delayed	Delay due delay of wind farms
163	Cluster HelWin1 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133km. Line capacity: aprox. 576 MW.	576	Under Construction	2014	Investment on time	Progress as planned.
164	Cluster SylWin1 (DE)	Büttel (DE)	New line consisting of underground +subsea cable with a total length of 206 km. Line capacity: aprox.864MW.	864	Under Construction	2015	Delayed	
165	Cluster DolWin1 (DE)	Dörpen/West (DE)	New line consisting of underground +subsea cable with a total length of 167 km. Line capacity: 800MW.	800	Under Construction	2014	Delayed	
167	Cluster BorWin2 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205km. Line capacity: 800MW.	800	Under Construction	2015	Delayed	
654	Cluster DolWin2 (DE)	Dörpen/West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 138 km. Line capacity: 900 MW	900	Under Construction	2015	Investment on time	Progress as planned.
655	Cluster DolWin3 (DE)	Dörpen/West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 162 km. Line capacity: 900 MW	900	Under Construction	2017	Investment on time	Progress as planned.
657	Cluster HelWin2	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133 km. Line capacity: 690 MW	690	Under Construction	2015	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)**
North=>South: 5750	South=>North: 5750	2	3	More than 100km	Negligible or less than 15km	6000-8000

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	-	[1300;1600]	4033 MW	0	[-13000;-11000]
Scenario Vision 2 - 2030	-	[620;760]	4033 MW	0	[-8500;-7000]
Scenario Vision 3 - 2030	-	[1900;2300]	5748 MW	0	[-10000;-8400]
Scenario Vision 4 - 2030	-	[1600;2000]	5748 MW	0	[-8900;-7300]

Additional comments

Comment on the clustering: for the sake of consistency, and by exception to the rule, the project has been assessed including two investment items connecting wind farms for 111 MW and 108 MW, the latter being commissioned, hence not matching the clustering rule requiring each investment to contribute to more than 20% of the major investment of the project

Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

Comment on the Losses indicator: the losses variation for this direct connection project have not been valuated.

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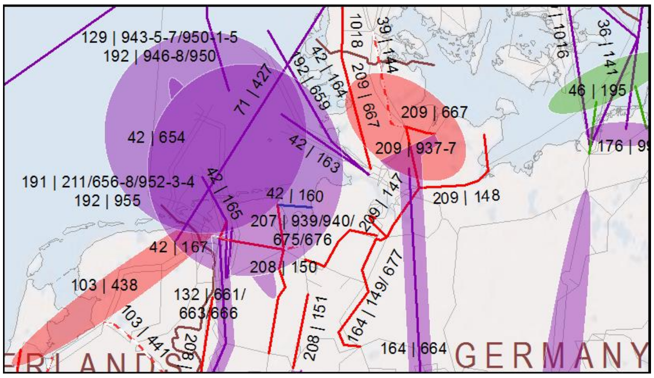
Project 191: OWP TenneT Northsea Part 2

Description of the project

Germany is planning to build a big amount of wind offshore power plants in the Northsea. The OWP will help to reach the European goal of CO2 reduction and RES integration. This project is for the connection of the OWP with the German grid.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
211	Cluster DolWin 4 (NOR 3-2)	Unterweser	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 190km. Line capacity: 900 MW	900	Under Consideration	2020	Investment on time	Progress as planned.
656	Cluster BorWin3	Emden/Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW	900	Design & Permitting	2018	Investment on time	Progress as planned.
658	Cluster BorWin4 (DE)	Emden/Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 172 km. Line capacity: 900 MW	900	Design & Permitting	2019	Investment on time	Progress as planned.
952	Cluster DolWin 5 (NOR-1-1)	Halbemond	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 250 km. Line capacity: 900 MW	900	Under Consideration	2021	New Investment	new investment
953	Cluster DolWin 6 (NOR-3-3)	Halbemond	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 60km. Line capacity: 900 MW	900	Under Consideration	2021	New Investment	new investment
954	Cluster BorWin 5 (NOR-7-1)	Halbemond	Connecton of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	900	Under Consideration	2022	New Investment	new investment

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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=>DE: 5400	DE=>inside: 5400	4	3	More than 100km	Negligible or less than 15km	8000-10000

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	-	[520;640]	3788 MW	0	[-6200;-5100]
Scenario Vision 2 - 2030	-	[330;400]	3788 MW	0	[-5600;-4500]
Scenario Vision 3 - 2030	-	[1700;2100]	5401 MW	0	[-9400;-7700]
Scenario Vision 4 - 2030	-	[1500;1900]	[5300;5500] MW	0	[-8700;-7100]

Additional comments

Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

Comment on the Losses indicator: the losses variation for this direct connection project have not been valued

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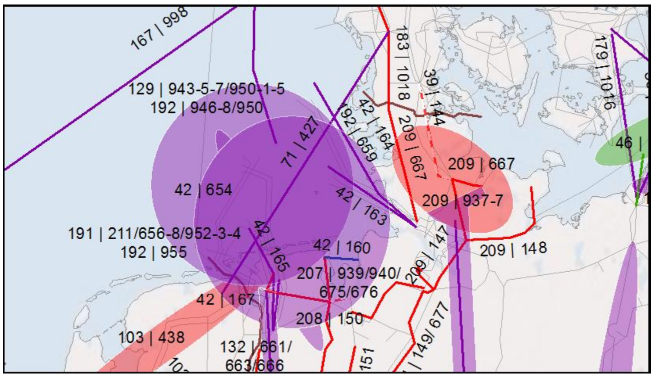
Project 192: OWP Northsea TenneT Part 3

Description of the project

Germany is planning to build a big amount of wind offshore power plants in the Northsea. The OWP will help to reach the European goal of CO2 reduction and RES integration. This project is for the connection of the OWP with the German grid. This project becomes necessary in case of further long-term strong increase in OWP generation like in Vision 3 and 4. The project is not in focus of Vision 1 and 2.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
659	Cluster SylWin2 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 900 MW	900	Under Consideration	2023	Investment on time	Progress as planned.
946	NOR-11-1	Elsfleth/West	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 230km. Line capacity: 900 MW	900	Under Consideration	2026	New Investment	new investment
948	NOR-12-1	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 230km. Line capacity: 900 MW	900	Under Consideration	2027	New Investment	new investment
950	NOR-13-1	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	900	Under Consideration	2025	New Investment	new investment
955	Cluster BorWin6 (NOR-7-2)	Unterweser	Connection of new offshore wind parks.New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 180km. Line capacity: 900 MW	900	Under Consideration	2023	New Investment	new 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)**
inside=>DE: 4500	DE=>inside: 4500	4	3	More than 100km	Negligible or less than 15km	5500-9500

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	-	[1400;1700]	4499 MW	0	[-7400;-6000]
Scenario Vision 4 - 2030	-	[1100;1400]	[4400;4600] MW	0	[-6100;-5000]

Additional comments

Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

Comment on the S1 and S2 indicators: „Detailed values for most lines are not available due to the early state in the planning process“

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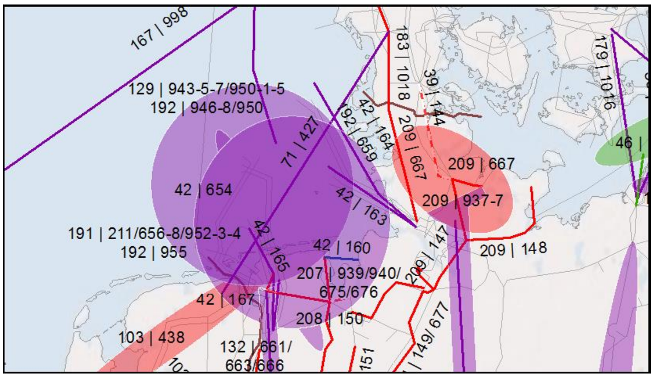
Project 129: OWP Northsea TenneT Part 4

Description of the project

Germany is planning to build a big amount of wind offshore power plants in the Northsea. The OWP will help to reach the European goal of CO2 reduction and RES integration. This project is for the connection of the OWP with the German grid. This project becomes necessary in case of further long-term strong increase in OWP generation like in Vision 3 and 4. The project is not in focus of Vision 1 and 2.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
943	NOR-9-1	Cloppenburg	Connection of new offshore wind park. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 255 km. Line capacity: 900 MW	900	Under Consideration	2028	New Investment	new investment
945	NOR-10-1	Cloppenburg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	900	Under Consideration	2029	New Investment	new investment
947	NOR-11-2	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 270km. Line capacity: 900 MW	900	Under Consideration	2031	New Investment	new investment
951	NOR-13-2	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	900	Under Consideration	2030	New Investment	new 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)**
inside=>DE: 3600	DE=>inside: 3600	2	3	More than 100km	Negligible or less than 15km	4000-8000

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	-	[900;1100]	3074 MW	0	[-4900;-4000]
Scenario Vision 4 - 2030	-	[770;940]	3074 MW	0	[-4300;-3500]

Additional comments

Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

Comment on the Losses indicator: the losses variation for this direct connection project have not been valuated.

Comment on the S1 and S2 indicators: Detailed values for most lines are not available due to the early state in the planning process

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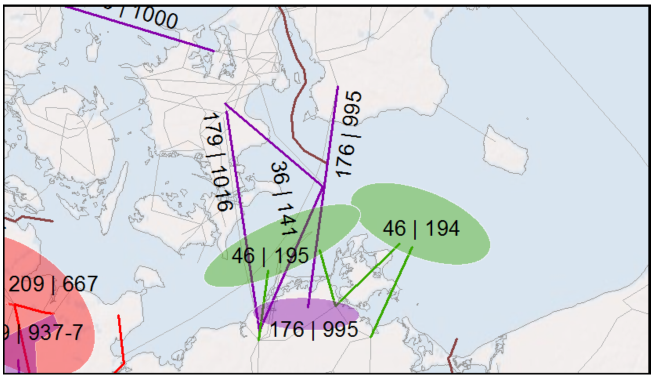
Project 46: Offshore Wind Baltic Sea

Description of the project

Grid connections of offshore wind farms (using AC-technology), connecting offshore wind farms in the Baltic Sea to the German transmission grid in Bentwisch, Lüdershagen and Lubmin. According to German law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
194	OWF Cluster Baltic Sea East (DE)	Lüdershagen/Lubmin (DE)	Grid Connection of offshore wind farms (using AC-technology). According to German law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).	3000	Design & Permitting	2031	Investment on time	The investment is split into different stages with different commissioning dates (starting in 2017) depending on the predicted installed capacity of offshore wind. For further informations see the national "Offshore Grid Development Plan"
195	wind farm cluster Baltic Sea West (DE)	Bentwisch/Lüdershagen (DE)	Grid Connection of offshore wind farms (using AC-technology). According to German law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).	1500	Design & Permitting	2032	Investment on time	The investment is split into different stages with different commissioning dates (starting in 2026) depending on the predicted installed capacity of offshore wind. For further informations see the national "Offshore Grid Development Plan"

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: 4500	South=>North: 4500	0	3	NA	NA	1700-4500

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	-	[300;360]	1568 MW	0	[-3300;-2700]
Scenario Vision 2 - 2030	-	[210;250]	1568 MW	0	[-3000;-2400]
Scenario Vision 3 - 2030	-	[1300;1600]	4342 MW	0	[-7300;-6000]
Scenario Vision 4 - 2030	-	[1100;1400]	4342 MW	0	[-6400;-5200]

Additional comments

Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

Comment on the Losses indicator: the losses variation for this direct connection project have not been valuated.

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North South Eastern German Corridor

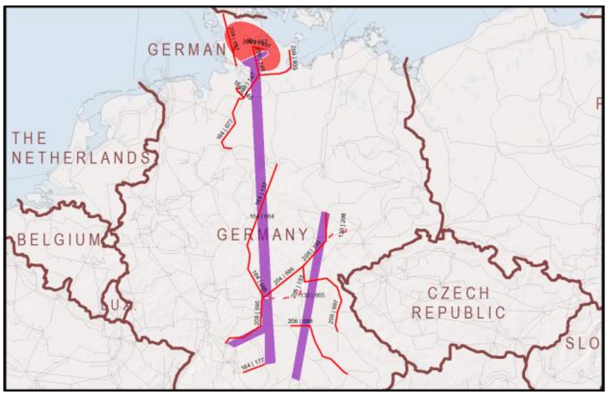
Description of the corridor

This corridor is necessary, due to the strong increase in RES generation, meeting the goals of the European and especially German energy policy. It connects areas with high installed capacities of RES and areas with high consumption and storage capabilities. For this reason the development of new North-South and Northeast-Southwest electricity transmission capacity in Germany is necessary. This corridor begins in the North-East of Germany, an area with high RES generation (planned and existing), conventional generation and connections with Scandinavia (planned and existing).The corridor ends in the South of Germany, an area with high consumptions and connections to Austria and Switzerland (transit to Italy and pump storage in the Alps). Thus, the corridor is an essential element for the integration of renewable energy sources into the German power system and the provision of additional transmission capacities in order to meet the increasing demand of the European electricity market and to avoid unscheduled transit flows to neighboring countries. Moreover, due to the nuclear phase out in Germany, the amount of reliable available capacity in southern Germany decreases and the security of supply of this area require additional transmission capacity to areas with conventional generation units.

The corridor consists of 6 projects:

- project 209 groups all investments needed to collect wind in-feed north east of Germany;
- project 130 and 164 represents the 2 sections of new HVDC lines aiming at transporting this power to the south of the country;
- project 206 groups all investments needed to secure the supply south of Germany in this corridor;
- projects 205 (resp. 204) group all supporting measures on existing assets in the short (resp; longer) term.

Working together, the six projects have been assessed as a whole and share the same common assessment.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver

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Project 209								
147	Dollern (DE)	Hamburg/Nord (DE)	New 380kV double circuit OHL Dollern - Hamburg/Nord. Length: 43km. First circuit 2015, second circuit 2017	2008	Under Construction	2017	Delayed	Delay due to long permitting process
148	Audorf (DE)	Hamburg/Nord (DE)	New 380kV double circuit OHL Audorf - Hamburg/Nord including two new 380/220kV transformers in substation Audorf and new 380 kV Switchgear in Kummerfeld. Length: 65km.	2410	Design & Permitting	2017	Delayed	delay due to long permitting process
667	Brunsbüttel (DE)	Niebüll	About 135 km new 380-kV-lines and around 10 new transformers for integration of onshore Wind in Schleswig-Holstein and increase of NTC between DE and DK	2014	Planning	2018	Delayed	The old investment 43.A90 is now divided in several parts.
935	Kreis Segeberg	Göhl	New 380-kV-lineKreis Segeberg - Lübeck - Siems - Göhl, including five new transformers	4482	Under Consideration	2021	Rescheduled	Investment was part of investment 43.A90 in TYNDP 2012. Now separately
937	Audorf	Kiel	New 380-kV-line in existing OHL corridor including 4 new transformers and new 380-kV-switchgears in Kiel/West and Kiel/Süd	2299	Under Consideration	2021	Rescheduled	In TYNDP 2012 this investment was part of investment 43.A90
Project 130								
208	Pulgar (DE)	Vieselbach (DE)	Construction of new 380kV double-circuit OHL in existing corridor Pulgar-Vieselbach (103 km). Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	2063	Planning	2024	Investment on time	The project is part of the results of the national grid development plan and included in the list of national interest (Bundesbedarfsplan). Within this process the commissioning dates of the included projects have been aligned with the current situation.
665	Lauchstädt (DE)	Meitingen (DE)	New DC- lines to integrate new wind generation from control area 50Hertz especially Mecklenburg-Vorpommern, Brandenburg and Sachsen-Anhalt towards Central/south Europe for consumption and storage.	3583	Planning	2022	Investment on time	Result from National Grid Development Plan
Project 164								
149	Dollern (DE)	Stade (DE)	New 380kV double circuit OHL Dollern - Stade including new 380kV switchgear in Stade. Length: 14km.	3749	Design & Permitting	2022	Delayed	The investment is delayed because of changes in the investment driver
157	Wahle (DE)	Mecklar (DE)	New 380kV double circuit OHL Wahle - Mecklar including two new	2264	Design & Permitting	2018	Delayed	delay due to long permitting process

			substations. Length: 210km.					
177	Goldshöfe (DE)	Bünzwangen (DE)	AC-extension of the "C corridor" at one ending point in Southern Germany towards the consumption areas allowing the existing grid to deal with the additional flows from DC-link	2070	Design & Permitting	2020	Investment on time	Anticipation of design and permitting phase due to foreseen difficulties (protected area in the Swabian Alps)
664	Brunsbüttel, Wilster, Kreis Segeberg	Großgartach, Goldshöfe, Grafenrheinfeld	New DC-lines to integrate new wind generation from Northern Germany towards Southern Germany and Southern Europe for consumption and storage.	3575	Planning	2022	Investment on time	The expected commissioning date is 2017 - 2022
677	Dollern (DE)	Landesbergen (DE)	New 380 kV line in existing OHL corridor Dollern-Sottrum-Wechold-Landesbergen (130 km)	3749	Planning	2022	Investment on time	Progress as planned.
685	Mecklar (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400-kV-line (130 km)	2387	Planning	2022	Investment on time	Progress as planned.
Project 206								
682	Großgartach (DE)	Endersbach (DE)	AC-extension of the "C corridor" at one ending point in Southern Germany towards the consumption areas allowing the existing grid to deal with the additional flows from DC-link	1340	Planning	2019	Investment on time	Standard processing 2018-2019
687	Redwitz (DE)	Schwandorf (DE)	New double circuit OHL 380 kV line in existing OHL corridor Redwitz-Mechlenreuth-Etzenricht-Schwandorf (185 km)	1218	Planning	2020	Investment on time	Progress as planned.
688	Raitersaich (DE)	Isar (DE)	New 380 kV line in existing OHL corridor Raitersaich - Ludersheim - Sittling - Isar or Altheim (160 km)	1902	Under Consideration	2024	Rescheduled	Delay due to missing confirmation by the regulator
990	Grafenrheinfeld (DE)	Großgartach (DE)	AC-extension of the "C corridor" between two of its ending points in Southern Germany allowing the existing grid to deal with the additional flows from DC-link	4310	Planning	2019	New Investment	Standard processing
Project 205								
153	Redwitz (DE)	Grafenrheinfeld (DE)	Upgrade of 220kV connection Redwitz - Grafenrheinfeld to 380kV, including new 380kV switchgear Eltmann. Line length: 97km.	2473	Design & Permitting	2015	Delayed	Delayed due to delayed of related investment 45.193 and unexpected long permitting process of the investment itself
193	Vieselbach (DE)	Redwitz (DE)	New 380kV double-circuit OHL between the substations Vieselbach-Altenfeld-Redwitz with 215km length combined with upgrade between Redwitz and Grafenrheinfeld (see investment 153). The	3583	Design & Permitting	2015	Delayed	Previously "mid-term" is now updated to specific date. Partly under construction (section Vieselbach – Altenfeld). 3rd section (Altenfeld – Redwitz) in permitting process, long permitting process with

			Section Lauchstädt-Vieselbach has already been commissioned. Support of RES integration in Germany, annual redispatching cost reduction, maintaining of security of supply and support of the market development. The line crosses the former border between Eastern and Western Germany and is right downstream in the main load flow direction. The project will help to avoid loop flows through neighbouring grids.					strong public resistance.
Project 204								
686	Schalkau / area of Altenfeld (DE)	area of Grafenrheinfeld (DE)	New double circuit OHL 380-kV-line (130 km)	-	Under Consideration	2024	Rescheduled	Delay due to missing confirmation by the regulator

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: 11800	South=>North: 11800	5	5	More than 100km	More than 50km	6200-8600

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	-	[340;420]	[3100000;3700000] MWh	[-4200000;-3400000]	[-1500;-1200]
Scenario Vision 2 - 2030	-	[310;380]	[3000000;3600000] MWh	[-4300000;-3500000]	[110;130]
Scenario Vision 3 - 2030	-	[1300;1600]	[8700000;11000000] MWh	[-5200000;-4200000]	[-7300;-6000]
Scenario Vision 4 - 2030	-	[2000;2400]	[14000000;17000000] MWh	[-6400000;-5200000]	[-12000;-9700]

Additional comments

Comment on the CBA assessment: As the existing tools are not designed to assess single internal projects within a price zone, the above-mentioned projects are assessed together as one corridor. Additionally the main goal of the corridor is to integrate new RES in Northern and North East Germany and can only be reached with all projects in.

Comment on the security of supply: Market simulations are not able to take internal bottlenecks inside one bidding area into account in a comprehensive way. Therefore, to evaluate the SOS-indicator for internal projects a more detailed and specialized survey is indispensable. In Germany the quick decommissioning of nuclear power plants has led to the "Reservekraftwerksverordnung" regulation, which goal is to ensure the security of supply until the necessary investments for the grid have been realized, especially in Southern Germany. This regulation is only temporary and shall ensure the system security thanks to contracted reserve power plants dedicated to the security of supply. (see also : http://www.bundesnetzagentur.de/)

Comment on the CO2 indicator: the very high scores reflect that the project connects RES sources to load centres

Comment on the Losses indicator: without the project the grid would be overloaded; so the amount of lower losses with compared to without the project is theoretical.

Comment on the S1 and S2 indicators: Detailed values for most lines are not available due to the early state in the planning process

Comment on the technical resilience indicator: The corridor is necessary to enable switch-off of assets for maintenance. The corridor includes VSC-DC-Links, which are necessary for (n-1)-security, voltage control and system stability.

Comment on the flexibility indicator: the project appears useful in all visions, consists of various investments complementing each other, and integrates two control zones

North South Western German Corridor

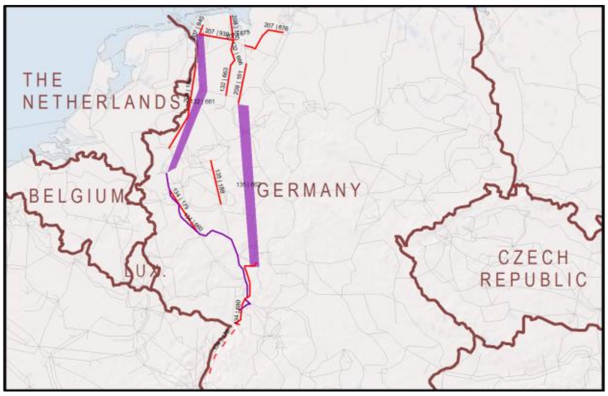
Description of the corridor

This corridor is necessary, due to the strong increase in RES generation, meeting the goals of the European and especially German energy policy. It connects areas with high installed capacities of RES and areas with high consumption and storage capabilities. For this reason the development of new North-South and Northeast-Southwest electricity transmission capacity in Germany is necessary. This corridor begins in the North of Germany, an area with high RES generation (planned and existing), conventional generation and connections with Scandinavia (planned and existing).The corridor ends in the South of Germany, an area with high consumptions and connections to Austria and Switzerland (transit to Italy and pump storage in the Alps). Thus, the corridor is an essential element for the integration of renewable energy sources into the German power system and the provision of additional transmission capacities in order to meet the increasing demand of the European electricity market and to avoid unscheduled transit flow to neighboring countries. Moreover, due to the nuclear phase out in Germany, the amount of reliable available capacity in southern Germany decreases and the security of supply of this area requires additional transmission capacity to areas with conventional generation units.

The Corridor consist of 5 projects:

- project 207 groups all investments needed to collect wind in-feed north west of Germany;
- project 132 and 208 represents the 2 sections of new HVDC lines aiming at transporting this power to the south of the country;
- project 134 groups all investments needed to secure the supply south of Germany in this corridor;
- project 135 group all supporting measures on existing assets.

Working together, the five projects have been assessed as a whole and share the same common assessment.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
Project 208								

150	Conneforde (DE)	Fedderwarden (DE)	New 380kV double circuit (OHL, partly underground) Conneforde - Wilhelmshaven (Fedderwarden, former Maade) including new 400kV switchgear Fedderwarden. Length: 35 km.	3668	Design & Permitting	2018	Investment on time	Progress as planned.
151	Wehrendorf (DE)	Ganderkesee (DE)	New line (length: ca. 95km), extension of existing and erection of substations, erection of 380/110kV-transformers.	3538	Design & Permitting	2017	Delayed	delay due to long permitting process
156	Niederrhein (DE)	Dörpen/West (DE)	New 380 kV double circuit overhead line Dörpen - Niederrhein including extension of existing substations.	988	Design & Permitting	2018	Delayed	The project is delayed due to delays in public-law and civil-law licensing procedures.
Project 132								
661	Emden East (DE)	Osterath (DE)	New HVDC-lines from Emden to Osterath to integrate new wind generation especially from North Sea towards Central Germany for consumption.	3049	Planning	2022	Investment on time	Progress as planned.
663	Cloppenburg East (DE)	Merzen (DE)	New 380-kV double circuit over-head-line Cloppenburg East - Merzen with a total length of ca. 55 km. New erecting of a 380-kV substation Merzen.	3386	Planning	2022	Investment on time	Progress as planned.
666	Conneforde (DE)	Cloppenburg (DE)	New 380-kV-line in existing OHL corridor for integration of on- and offshore Wind generation. Incl. new 380-kV-switchgear in Cloppenburg and new transformers in Cloppenburg	3386	Planning	2022	Investment on time	TYDNP 2012 investment 43.A89 is divided in serveral parts
Project 135								
188	Kruckel (DE)	Dauersberg (DE)	New 380 kV overhead lines in existing rout. Extension of existing and erection of several 380/110kV-substations.	774	Design & Permitting	2020	Investment on time	Progress as planned.
662	Wehrendorf (DE)	Urberach (DE)	New lines in HVDC technology from Wehrendorf to Urberach to integrate new wind generation especially from North Sea towards Central-South Europe for consumption and storage.	2856	Under Consideration	2022	Rescheduled	The need for this long-term investment was not confirmed by the regulatory authority within the national grid development plan 2012. Therefore further studies on this project are ongoing.
680	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 380 kV double circuit overhead line Urberach - Weinheim - Daxlanden. Extension of existing substations are included.	1833	Planning	2021	Investment on time	Progress as planned.
Project 134								
176	Daxlanden (DE)	Eichstetten (DE)	This AC project is necessary in order to evacuate the energy arriving from HVDC	754	Under Consideration	2020	Investment on time	Progress as planned.

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			corridors towards southern Germany and reinforce the interconnection capacity with Switzerland					
179	Rommerskirchen (DE)	Weißenthurm (DE)	New380 kV overhead line in existing route. Extension and erection of substations incl. erection of 380/110kV-transformers.	900	Under Construction	2017	Delayed	The section Rommerskrichen to Sechtem is delayed because the permitting procedures take longer than planned. The 36 km section from Sechtem to Weißenturm is already commissioned.
660	Osterath (DE)	Philippsburg (DE)	New HVDC-lines from Osterath to Philippsburg to integrate new wind generation especially from North Sea towards Central-South Germany for consumption and storage.	3049	Design & Permitting	2019	Investment on time	Progress as planned.
680	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 380 kV double circuit overhead line Urberach - Weinheim - Daxlanden. Extension of existing substations are included.	1833	Planning	2021	Investment on time	Progress as planned.
Project 207								
675	Conneforde (DE)	Unterweser (DE)	Upgrade of 220-kV-circuit Unterweser-Conneforde to 380kV , Line length: 32 km.	4068	Under Consideration	2024	Rescheduled	Delay due to missing confirmation by the regulator
676	Dollern (DE)	Elsfleht/West (DE)	New 380 kV line in existing OHL corridor Dollern - Elsfleht/West Length:100 km	2849	Under Consideration	2024	Rescheduled	Delay due to missing confirmation by the regulator
939	Conneforde	Emden/Ost	New 380-kV-line in existing OHL corridor for integration of RES	3336	Planning	2019	Delayed	In TYNDP 2012 part of investment 43.A89
940	Emden/Ost	Halbemond	New 380-kV-line Emden - Halbemond for RES integration incl. new transformers in Halbemond	3336	Under Consideration	2021	Rescheduled	In TYNDP 2012 part of investment 43.A89

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: 5500	South=>North: 5500	5	4	More than 100km	More than 50km	4900-6600

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	-	[410;500]	[6000000;7300000] MWh	[-2500000;-2100000]	[-4600;-3800]

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Scenario Vision 2 - 2030	-	[290;350]	[5400000;6600000] MWh	[-1200000;-1000000]	[-3600;-2900]
Scenario Vision 3 - 2030	-	[1400;1700]	[14000000;17000000] MWh	[-6200000;-5000000]	[-6700;-5500]
Scenario Vision 4 - 2030	-	[1300;1600]	[15000000;18000000] MWh	[-5100000;-4100000]	[-6500;-5300]

Additional comments

Comment on the CBA assessment:
As the existing tools are not designed to assess single internal projects within a price zone, the above-mentioned projects are assessed together as one corridor. Additionally the main goal of the corridor is to integrate new RES in Northern and North East Germany and can only be reached with all projects in.

Comment on the security of supply:
Market simulations are not able to take internal bottlenecks inside one bidding area into account in a comprehensive way. Therefore, to evaluate the SOS-indicator for internal projects, a more detailed and specialized survey is indispensable. In Germany, the quick decommissioning of nuclear power plants has led to the "Reservekraftwerksverordnung" regulation, which goal is to ensure the security of supply until the necessary investments for the grid have been realised, especially for the reliably power supply of Southern Germany. This regulation is only temporary and shall ensure the system security thanks to contracted reserve power plants dedicated to the security of supply. (see also : http://www.bundesnetzagentur.de/) The necessary reserve capacity is in the range of some GW.

Comment on the CO2 indicator:
the very high scores reflect that the project connects RES sources to load centres

Comment on the Losses indicator: without the project the grid would be overloaded; so the amount of lower losses with compared to without the project is theoretical.
Comment on the S1 and S2 indicators:
Detailed values for most lines are not available due to the early state in the planning process.

Comment on the technical resilience indicator:
The project is necessary to enable switch-off of assets for maintenance. The project includes VSC-DC-Links, which are necessary for (n-1)-security, voltage control and system stability.

Comment on the flexibility indicator: the project appears useful in all visions, consists of various investments complementing each other, and integrates two control zones

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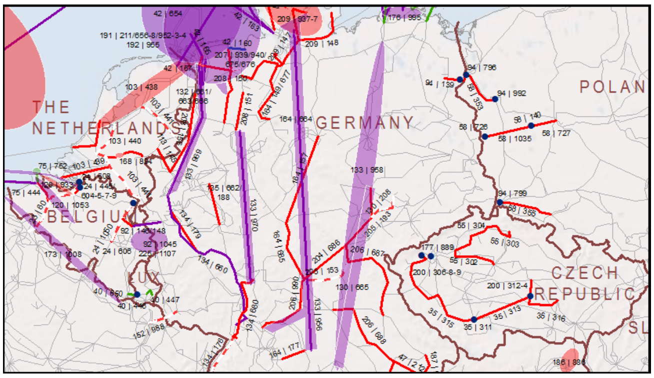
Project 133: Longterm German RES

Description of the project

This project becomes necessary in case of further long-term strong increase in RES generation like in Vision 3 and 4. The project is not in Vision 1 and 2. It connects areas with high installed capacities of RES and areas with high consumption and storage capabilities. For this reason the development of new North-South and Northeast- Southwest electricity transmission capacity in Germany is necessary. This project begins in the North and North-East of Germany, areas with high RES generation (planned and existing) and connections with Scandinavia (planed and existing).The project ends in the South of Germany, an area with high consumptions and connections to Austria and Switzerland (transit to Italy and pump storage in the Alps).



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
956	Schleswig-Hostein	Baden-Würtemberg / Bavaria	New DC- line in HVDC technology to integrate new wind generation from northern Germany toward southern Germany and southern Europe for consumption and storage. Connections points north: Brunsbüttel, Wilster, Kreis Segeberg, Stade, and Alfsted. South: Großgartach, Goldshöfe, Raitersaich, Vöhringen	8000	Under Consideration	2030	New Investment	new investment
958	Güstrow (DE)	Meitingen (DE)	New DC- lines to integrate new wind generation from Baltic Sea and control area 50Hertz especially Mecklenburg-Vorpommern towards Central/south Europe for consumption and storage.	2000	Under Consideration	2034	New Investment	New Investment
969	lower saxony	NRW	New HVDC line to integrate new wind generation especially from North Sea towards Central Germany for consumption and storage. Connections points north: Emden, Conneforde. South: Oberzier, Rommerskirchen	4000	Under Consideration	2030	New Investment	new investment

970	lower saxony	Hessen/Baden-Würtemberg	New HVDC line to integrate new wind generation especially from North Sea towards South Germany for consumption and storage. Connections points north: Cloppenburg, Elsfelth/West. South: Bürstadt, Philipsburg	4000	Under Consideration	2030	New Investment	new 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)**
North=>South: 18000	South=>North: 18000	5	4	NA	NA	5100-6800

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	-	[57;140]	[860000;1000000] MWh	[-3300000;-2700000]	[-380;-310]
Scenario Vision 4 - 2030	-	[180;260]	[1600000;2000000] MWh	[-4000000;-3200000]	[-1200;-960]

Additional comments

Comment on the CO2 indicator: the very high scores reflect that the project connects RES sources to load centres

Comment on the Losses indicator: without the project the grid would be overloaded; so the amount of lower losses with compared to without the project is theoretical.

Comment on the S1 and S2 indicators:
Values for this project are not available due to the early state in the planning process

Comment on the technical resilience indicator:
The project is necessary to enable switch-off of assets for maintenance. The project includes VSC-DC-Links, which are necessary for (n-1)-security, voltage control and system stability.

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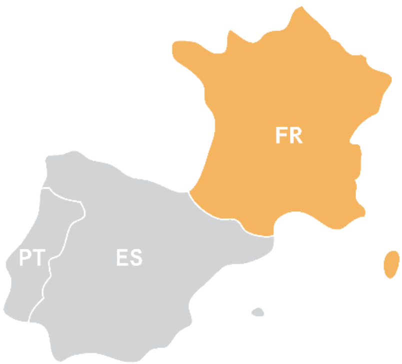
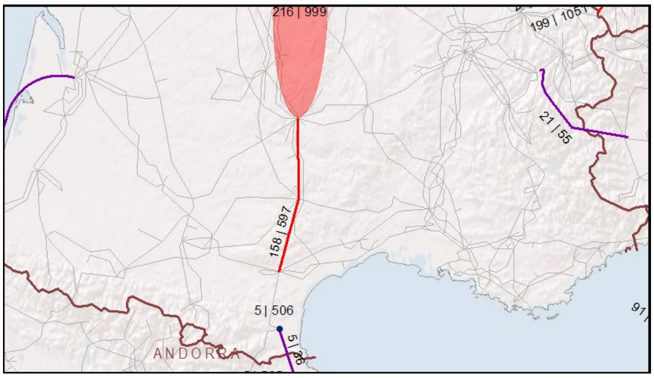
Project 158: Massif Central South

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 contribution (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.

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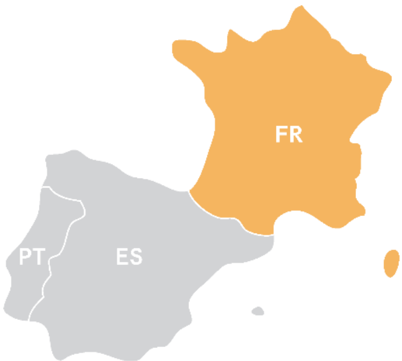
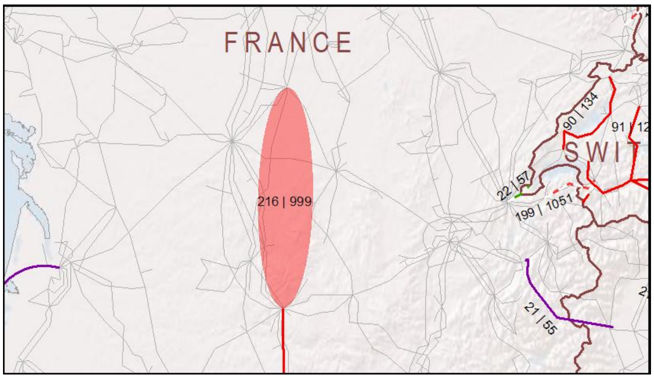
Project 216: Massif Central North

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.

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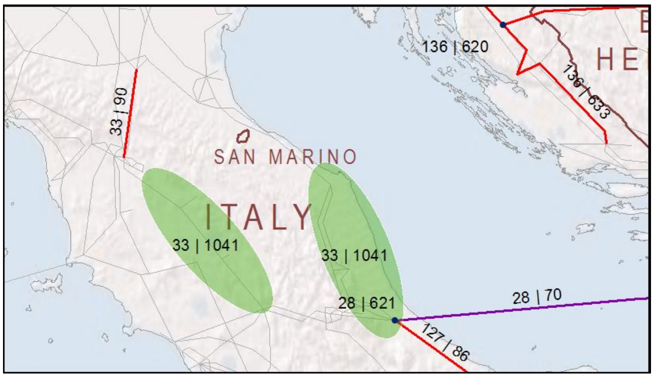
Project 33: 33

Description of the project

The project consists in the strengthening of interconnection between the northern and the central part of Italy. It will involve the upgrading of existing 220 kV over-head line to 400 kV between Colunga and Calenzano substations as well as the removing of limitations on the existing 220 kV network in Central Italy. The projects allows removing internal bottlenecks and increases market and RES integration.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
90	Calenzano (IT)	Colunga (IT)	Voltage upgrade of the existing 80km Calenzano-Colunga 220kV OHL to 400kV, providing in and out connection to the existing 220/150kV substation of S. Benedetto del Querceto (which already complies with 400kV standards).	400	Design & Permitting	2018	Delayed	delay in the permitting process (EIA)
1041	Villanova (IT)	S. Barbara (IT)	Removing limitations on existing 220 kV grid between Villanova e S.Barbara	600	Planning	2020	New Investment	The item 1041 has a significant effect on the grid transfer capacity

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: 600	South=>North: 600	1	3	15-50km	Negligible or less than 15km	280

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]	[1100000;1400000] MWh	[-340000;-280000]	[-680;-550]
Scenario Vision 2 - 2030	-	[100;130]	[1100000;1300000] MWh	[-340000;-280000]	[-640;-520]
Scenario Vision 3 - 2030	-	[170;200]	[1300000;1500000] MWh	[-310000;-260000]	[-940;-770]
Scenario Vision 4 - 2030	-	[180;220]	[1500000;1800000] MWh	[-350000;-290000]	[-1100;-900]

Additional comments

Comment on the RES integration: the project allows to overcome the limitations to RES power plants installed in central part of Italy where in Vision 1 are expected about 9 GW of wind and solar power plants

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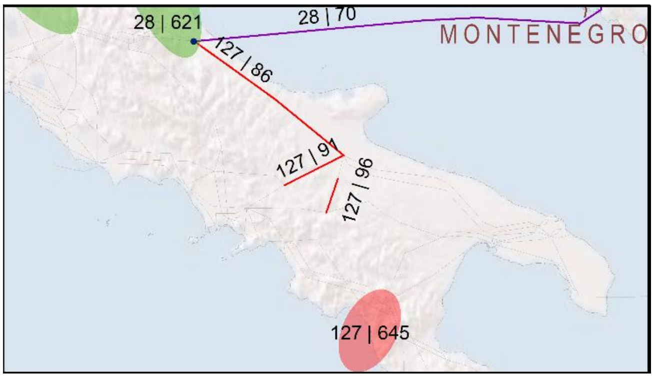
Project 127: 127

Description of the project

The project consists in the reinforcement of southern Italy 400 kV network through new 400 kV lines as well as upgrading of existing assets. The activities will involve the network portions between the substation of Villanova and Foggia, Foggia and Benevento, Deliceto and Bisaccia as well as Laino and Altomonte. The projects allows removing internal bottlenecks and increases market and RES integration.

PCI 3.19.3



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
86	Foggia (IT)	Villanova (IT)	New 178km double circuit 400kV OHL between existing Foggia and Villanova 400kV substations, also connected in and out to the Larino and Gissi substations.	600	Design & Permitting	2019	Delayed	delay in the permitting process (EIA) concerning the part Foggia-Gissi still under authorization; the part Villanova Gissi is already authorized
91	Foggia (IT)	Benevento II (IT)	Upgrade of the existing 85km Foggia-Benevento II 400kV OHL.	250	Under Construction	2014	Investment on time	Progress as planned.
96	Deliceto (IT)	Bisaccia (IT)	New 30km single circuit 400kV OHL between the future substations of Deliceto and Bisaccia, in the Candela area.	400	Design & Permitting	2017	Delayed	delay in the permitting process (EIA)
645	Laino (IT)	Altomonte (IT)	New 400kV OHL between the existing substations of Laino and Altomonte in Calabria.	250	Design & Permitting	2017	Delayed	delay in the permitting process (EIA)

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)**

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North=>South: 0	South=>North: 1250	1	3	Negligible or less than 15km	Negligible or less than 15km	610

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	-	[370;450]	[4600000;5600000] MWh	[-170000;-140000]	[-3100;-2600]
Scenario Vision 2 - 2030	-	[350;420]	[4300000;5300000] MWh	[-170000;-140000]	[-3000;-2400]
Scenario Vision 3 - 2030	-	[460;560]	[5100000;6200000] MWh	[-130000;-110000]	[-3500;-2900]
Scenario Vision 4 - 2030	-	[460;560]	[5100000;6300000] MWh	[-280000;-230000]	[-3500;-2900]

Additional comments

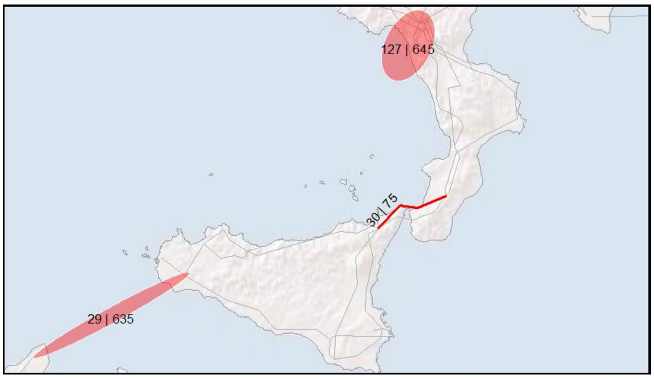
Comment on the RES integration: The considered project allows to overcome the limitations to RES power plants installed in the south of Italy where in Vision 1 are expected about 11 GW of Wind and Solar power plants. The reason of this benefits in terms of RES integration is due to the huge quantity of RES expected in the area (especially in V4) where high power flows from south to north of Italy make necessary additional transmission capacity to evacuate all the generation exceeding local load

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

Project 30: 30

Description of the project

The project consists in the strengthening of Sicily - mainland 400 kV interconnection through a new double circuit line which will be realized partly as a subsea cable as well as over-head line. The activity is part of the wider network reinforcement program which involves the Sicilian 400 kV grid. The project allows removing internal bottlenecks and increases market and RES integration.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
75	Sorgente (IT)	Rizziconi (IT)	New 90km double circuit 400kV line, partly via subsea cable and partly via OHL. This line is part of a larger project that foresees the creation of the future 400kV grid of Sicily.	-	Under Construction	2015	Delayed	rescheduling of 6 months work due to technical issues during construction phase

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=>IT: 1000	IT=>South: 1000	1	2	Negligible or less than 15km	Negligible or less than 15km	780

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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	[18000;22000]	[320;390]	[1500000;1900000] MWh	[-39000;-32000]	[-1400;-1200]
Scenario Vision 2 - 2030	[19000;23000]	[300;370]	[1500000;1800000] MWh	[-39000;-32000]	[-1300;-1100]
Scenario Vision 3 - 2030	[23000;28000]	[490;590]	[2000000;2400000] MWh	[-55000;-45000]	[-2000;-1700]
Scenario Vision 4 - 2030	[37000;45000]	[410;510]	[2000000;2400000] MWh	[-61000;-50000]	[-2000;-1600]

Additional comments

Comment on the security of supply:
The project reinforces the interconnection between Sicily island and the mainland so improves the security of supply and local network security of the island.

Comment on the RES integration:
The considered project allows to overcome the limitations to RES power plants installed in Sicily island where in Vision 1 are expected about 4GW of Wind and Solar power plants

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

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12.2 List of projects and investments within the region

The table below depicts both projects and investments of pan-European and Regional significance within Continental Central South 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
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).
		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).
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

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
		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
		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**								

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
		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 aknowledged the notification of the investment on 08/04/14.
26	**Austria - Italy**								
		1039	Volpago (IT)		New 380/220/132 kV substation with related connections to 380 kV Sandrigo Cordignano and 220 KV Soverzene Scorzè where removing limitations are planned	2020	Planning	Delayed	The Volpago Substation was included in the TYNDP 2012 as part of the item 26.83 which had as commissioning date 2015. Permitting process delayed due to territorial constraint
		1049	tbd (IT)	tbd (AT)	interconnector IT-AT (phase 2)	2023	Under Consideration	New Investment	project progress
		218	Obersielach (AT)	Lienz (AT)	New 380kV OHL connecting the substations Lienz (AT) and Obersielach (AT) to close the Austrian 380kV-Security Ring in the southern grid area. Line length: 190km.	2023	Under Consideration	Investment on time	Progress as planned.
		63	Lienz (AT)	Veneto region (IT)	The project foresees the reconstruction of the existing 220kV-interconnection line as 380kV-line on an optimized route to minimize the environmental impact. Total length should be in the range of approx. 140km.	2023	Planning	Investment on time	Planning in progress coordinatedly between TERNA and APG
		614	Nauders (AT)	Glorenza (IT)	interconnector IT-AT (phase 1)	2018	Design & Permitting	Investment on time	-
28	**28**								

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
		624	Lastva (ME)		New 400 kV substation Lastva in Montenegro will be connected to the existing line 400kV Podgorica 2(ME)-Trebinje(BA), with two transformers 2X300MVA 400/110kV. This substation will enable secure supply of the Montenegrin coastal network, and connection of the convertor station for the HVDC cable between Montenegro and Italy.	2015	Design & Permitting	Investment on time	on time
		70	Villanova (IT)	Lastva (ME)	New 1000MW HVDC interconnection line between Italy and Montenegro via 375km 500kV DC subsea cable and converter stations at both ending points.	2017	Under Construction	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
		621	Villanova (IT)		Converter station of the new 1000MW HVDC interconnection line between Italy and Montenegro via 375km 500kV DC subsea cable.	2017	Under Construction	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
		622	Lastva (ME)		Converter station in Montenegro of the new 1000MW HVDC sub-sea 500 kV cable between Italy and Montenegro.	2017	Under Construction	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
29	**Italy-North Africa**								
		635	Sicily Area (IT)	North Africa node	New interconnection between Italy and North Africa-new DC submarine cable	2030	Under Consideration	Investment on time	-
30	**30**								
		75	Sorgente (IT)	Rizziconi (IT)	New 90km double circuit 400kV line, partly via subsea cable and partly via OHL. This line is part of a larger project that foresees the creation of the future 400kV grid of Sicily.	2015	Under Construction	Delayed	rescheduling of 6 months work due to technical issues during construction phase
31	**Italy-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
		914	Cassano (IT)	Chiari (IT)	Upgrade to 380 kV of part of existing 220 kV Cassano Ric.Ovest	2022	Design & Permitting	New Investment	The interconnection scheme envisaged in TYNDP 2012 is now defined. The upgrade of Chiari-Cassano is identified as critical to get full advantage of the Giacomo project.
		932	Magenta(IT)		new 400 kV section in Magenta substation	2020	Design & Permitting	Investment on time	HVDC link between Pallanzeno and Baggio will be realized using existing 220 kV line connecting the Magenta 220/132 kV substation. Consequently, a new 400 kV section will be needed to reconnect the Magenta substation to the 400 kV line Turbigo – Baggio
		124	Mettlen (CH)	Airolo (CH)	Upgrade of existing 225kV OHL into 400kV. Line length: 90km.	2020	Under Consideration	Investment on time	-
		642	Airolo (CH)	Pallanzeno(IT)-Baggio(IT)	New interconnection project beetween Italy and Switzerland;	2022	Design & Permitting	Investment on time	permitting process started on the Italian side since September 2012
33	**33**								
		1041	Villanova (IT)	S. Barbara (IT)	Removing limitations on existing 220 kV grid between Villanova e S.Barbara	2020	Planning	New Investment	The item 1041 has a significant effect on the grid transfer capacity
		90	Calenzano (IT)	Colunga (IT)	Voltage upgrade of the existing 80km Calenzano-Colunga 220kV OHL to 400kV, providing in and out connection to the existing 220/150kV substation of S. Benedetto del Querceto (which already complies with 400kV standards).	2018	Design & Permitting	Delayed	delay in the permitting process (EIA)
36	**Kriegers Flak CGS**								
		141	Ishøj / Bjæverskov (DK)	Bentwisch (DE)	Three offshore windfarms connected to shore combined with 400 MW interconnection between both countries	2018	Design & Permitting	Investment on time	Commisioning date must be achieved in order to ensure grid connection for further renewable energy.

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
37	**Southern Norway - Germany**								
		142	Tonstad (NO)	Wilster (DE)	A 514 km 500 kV HVDC subsea interconnector between southern Norway and northern Germany.	2018	Design & Permitting	Investment on time	Agreement between the two TSOs on commissioning date.
		406	(Southern part of Norway) (NO)	(Southern part of Norway)(NO)	Voltage uprating of existing 300 kV line Sauda/Saurdal - Lyse - Ertsmyra - Feda - 1&2, Feda - Kristiansand; Sauda-Samnanger in long term. Voltage upgrading of existing single circuit 400kV OHL Tonstad-Solhom-Arendal. Reactive power devices in 400kV substations.	2020	Design & Permitting	Delayed	Revised progress due to less flexible system operations in a running system (voltage upgrade of existing lines). Commissioning date expected 2019-2021.
39	**DKW-DE, step 3**								
		144	Audorf (DE)	Kassö (DK)	Step 3 in the Danish-German agreement to upgrade the Jutland-DE transfer capacity. It consists of a new 400kV route in Denmark and In Germany new 400kV line mainly in the trace of a existing 220kV line.	2019	Planning	Delayed	Planning ongoing - minor delay due to coordination with project 183.1018
40	**Luxembourg-Belgium Interco**								
		446	Schifflange (LU)		As a first interim step a PST is commissioned in 2016 in Schifflange and connected to an existing OH-line with an additional 3.5km cable between Biff(CREOS-LU) and Substation Bascharage (CREOS-LU).	2016	Planning	Investment on time	Studies for interim step are finalized, Investment decision expected by mid of 2014
		447	Heisdorf (LU)	Berchem (LU)	Erection of a new 20km 225kV double-circuit mixed (cable+OHL)line with 1000 MVA capacity in order to create a loop around Luxembourg city including substations for in feed in lower voltage levels.	2017	Design & Permitting	Investment on time	Substation Blooren is authorized and under construction, Authorization for line section is still pending
42	**OWP TenneT Northsea part 1**								
		160	Offshore- Wind park Nordergründe (DE)	Inhausen (DE)	New AC-cable connection with a total length of 32km.	2016	Under Construction	Delayed	Delay due delay of windfarms

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
		163	Cluster HelWin1 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133km. Line capacity: aprox. 576 MW.	2014	Under Construction	Investment on time	
		164	Cluster SylWin1 (DE)	Büttel (DE)	New line consisting of underground +subsea cable with a total length of 206 km. Line capacity: aprox.864MW.	2015	Under Construction	Delayed	
		165	Cluster DolWin1 (DE)	Dörpen/West (DE)	New line consisting of underground +subsea cable with a total length of 167 km. Line capacity: 800MW.	2014	Under Construction	Delayed	
		167	Cluster BorWin2 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205km. Line capacity: 800MW.	2015	Under Construction	Delayed	
		654	Cluster DolWin2 (DE)	Dörpen/West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 138 km. Line capacity: 900 MW	2015	Under Construction	Investment on time	
		655	Cluster DolWin3 (DE)	Dörpen/West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 162 km. Line capacity: 900 MW	2017	Under Construction	Investment on time	
		657	Cluster HelWin2	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133 km. Line capacity: 690 MW	2015	Under Construction	Investment on time	
46	**Offshore Wind Baltic Sea**								
		194	OWF Cluster Baltic Sea East (DE)	Lüdershagen/Lubmin (DE)	Grid Connection of offshore wind farms (using AC-technology). According to german law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).	2031	Design & Permitting	Investment on time	The investment is split into different stages with different commissioning dates (starting in 2017) depending on the predicted installed capacity of offshore wind. For further informations see the national "Offshore Grid Development Plan"

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
		195	wind farm cluster Baltic Sea West (DE)	Bentwisch/Lüdershagen (DE)	Grid Connection of offshore wind farms (using AC-technology). According to german law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).	2032	Design & Permitting	Investment on time	The investment is split into different stages with different commissioning dates (starting in 2026) depending on the predicted installed capacity of offshore wind. For further informations see the national "Offshore Grid Development Plan"
47	**AT - DE**								
		216	St. Peter (AT)	Tauern (AT)	Completion of the 380kV-line St. Peter - Tauern. This contains an upgrade of the existing 380kV-line St. Peter - Salzburg from 220kV-operation to 380kV-operation and the erection of a new internal double circuit 380kV-line connecting the substations Salzburg and Tauern (replacement of existing 220kV-lines on optimized routes). Moreover the erection of the new substations Wagenham and Pongau and the integration of the substations Salzburg and Kaprun is planned.	2020	Design & Permitting	Investment on time	In Sept. 2012 the application for granting the permission (EIA) was submitted to the relevant authorities. According to the experience of similar projects the commissioning is expected for 2020.
		212	Isar (DE)	St. Peter (AT)	New 400kV double circuit OHL Isar - St. Peter including new 400kV switchgears Altheim, Pirach, Simbach and St. Peter. Also including 4. circuit on line Ottenhofen - Isar.	2018	Design & Permitting	Delayed	delaye due to long permitting process
		219	Westtirol (AT)	Zell-Ziller (AT)	Upgrade of the existing 220kV-line Westtirol - Zell-Ziller and erection of an additional 220/380kV-Transformer. Line length: 105km.	2021	Planning	Investment on time	The upgrade of the line and substation Westtirol is currently in the planning process.
		689	Vöhringen (DE)	Westtirol (AT)	Upgrade of an existing over head line to 380 kV, extension of existing and errection of new 380-kV-substations including 380/110-kV-transformers. Transmission route Vöhringen (DE) - Westtirol (AT). This project will increase the current power exchange capacity between the DE, AT.	2020	Planning	Investment on time	Progess 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
58	**GerPol Power Bridge**								
		1035	Baczyna		Construction of new 400/220 kV Substation Baczyna to connect the new line Krajnik-Baczyna.	2018	Planning	Investment on time	The investment was part of n°58.353 in TYNDP 2012 and is now presented stand alone. It is in the tendering procedure (design and build scheme).
		140	Eisenhüttenstadt (DE)	Plewiska (PL)	Construction of new 400 kV double circuit line Plewiska (PL)-Eisenhüttenstadt (DE) creating an interconnector between Poland and Germany.	2022	Planning	Rescheduled	The investment in planning phase. Expected problems with the routing cause adoption of commissioning date.
		727	Plewiska (PL)		Construction of new substation Plewiska Bis (PL) to connect the new line Plewiska (PL)-Eisenhüttenstadt (DE).	2020	Planning	Investment on time	The project is at the planning stage.
		353	Krajnik (PL)	Baczyna (PL)	Construction of new 400 kV double circuit line Krajnik – Baczyna.	2020	Planning	Investment on time	Investment is in the tendering procedure.
		355	Mikulowa (PL)	Swiebodzice (PL)	Construction of new 400 kV double circuit line Mikułowa-Świebodzice in place of existing 220 kV line.	2020	Planning	Investment on time	Investment on time.
		726	Gubin (PL)		New 400 kV substation Gubin located near the PL-DE border. The substation will be conntected by the new line Plewiska (PL)-Eisenhüttenstadt (DE).	2020	Planning	Investment on time	The project is at the planning stage.
90	**Swiss Roof**								
		1099	Rüthi	Bonaduz - Grynau	Rüthi - Grynau 2 x 380 kV Rüthi - Bonaduz 1 x 380 kV	2022	Planning	Investment on time	Investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.
		129	Beznau (CH)	Mettlen (CH)	Upgrade of the existing 65km double circuit 220kV OHL to 400kV.	2020	Design & Permitting	Delayed	long permitting procedure (comprising several phases). In this case, Federal Court decision for partial cabling.

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
		130	La Punt (CH)	Pradella / Ova Spin (CH)	Installation of the second circuit on existing towers of a double-circuit 400kV OHL (50km).	2017	Planning	Investment on time	none
		133	Bonaduz (CH)	Mettlen (CH)	Upgrade of the existing 180km double circuit 220kV OHL into 400kV.	2020	Under Consideration	Investment on time	none
		134	Bassecourt (CH)	Romanel (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV lines; total length: 140km. Construction of a new 400/220 kV substation in Mühleberg (= former investment 132 'Mühleberg Substation')	2020	Design & Permitting	Delayed	lines: long permitting procedure (comprising several phases)- Mühleberg substation: under construction
		136	Border area (DE-AT)	Rüthi (CH)	380 kV Rüthi – Meiningen and 380 kV Meiningen - Border Area AT-DE	2022	Planning	Investment on time	investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.
91	**Swiss Ellipse**								
		121	Bickigen (CH)	Romanel (CH)	Construction of different new 400kV OHL sections and voltage upgrade of existing 225kV lines into 400kV lines. Total length: 250km.	2020	Design & Permitting	Delayed	long permitting procedure (comprising several phases)
		122	Chippis (CH)	Lavorgo (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV. Total length: 120km.	2020	Design & Permitting	Delayed	long permitting procedure (comprising several phases)
		123	Mettlen (CH)	Ulrichen (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV lines. Total length: 90km.	2019	Planning	Investment on time	none
		125	Schwanden (CH)	Limmern (CH)	New 400kV double circuit (OHL and underground cable) between Schwanden and Limmern. OHL part	2015	Under Construction	Investment on time	none
		795	Schwanden (CH)	Limmern (CH)	New 400kV double circuit (OHL and underground cable) between Schwanden and Limmern. Underground cable part	2015	Under Construction	Investment on time	none

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
		126	Golbia (CH)	Robbia (CH)	New 2x 400kV cable connection between Golbia and the Bernina line double circuit.	2019	Under Consideration	Investment on time	none
		127	Magadino (CH)	Verzasca (CH)	Upgrade of existing 150kV line into 220kV line.	2020	Under Consideration	Investment on time	none
		128	Bâtiaz (CH)	Nant de Drance (CH)	New 400kV double circuit OHL between Bâtiaz and Châtelard. New 2x 400kV cable connection between Châtelard and Nant de Drance. Total length: 22km.	2020	Design & Permitting	Delayed	long permitting procedure (comprising several phases)
92	**ALEGrO**								
		1045	Lixhe	Herderen	AC BE Reinforcements Internal reinforcements in AC network in Belgium have started in the context of securing infeed from the 380kV network into the Limburg & Liège area's. These reinforcements are also needed to facilitate the integration of ALEGrO into the Belgian grid. The reinforcements consist of - extension of an existing single 380 kV connection between Lixhe and Herderen by adding an additional circuit with high performance conductors (HTLS) - creation of 380kV substation in Lixhe, including a 380/150 transformator - creation of 380kV substation in Genk (André Dumont), including a 380/150 kV traformator	2017	Design & Permitting	Investment on time	This investment item is split off from the generic Alegro investment item which up to now included also the internal reinforcements

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
		1048	Lixhe	Herderen	Potentially additional AC BE Reinforcements Envisions the installation of a second 380 kV overhead line between Herderen to Lixhe. And the installation of a 2nd 380/150 transformator in Limburg area (probably substation André Dumont). These reinforcements are conditional to the evolution of production in the Limburg-Liège area and to the evolution of the physical (transit)flux towards 2020-2025.	2020	Under Consideration	New Investment	Evolution of generation in the Limburg-Liège must be accounted for in the perimeter of the Alegro project. This conditional project has a commissioning date set to 2020 as indication for further monitoring of the need.
		146	Area of Oberzier - Aachen/Düren (DE)	Area of Lixhe - Liège (BE)	ALEGrO Connection between Germany and Belgium including new 100 km HVDC underground cable with convertor stations and extension of existing 380 kV substations. The assessment of the Final Investment Decision is planned in 2015.	2019	Design & Permitting	Delayed	BE: Several months delay due to authorisation procedure in Belgium longer than expected (modification of "Plan de secteur" in Wallonia). DE: Delay due to unclear permitting framework (legal framework for planning approval is presently under development
94	**GerPol Improvements**								
		992	Vierraden		Installation of new PSTs in Vierraden	2017	Planning	New Investment	Based on a common agreement between PSE and 50Hertz the investment was specified in more detail in close cooperation between PSE and 50Hertz. The common solution consists of PST in Vierraden (DE) and PST in Mikułowa (PL) Investment 799.

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
		139	Vierraden (DE)	Krajnik (PL)	Upgrade of existing 220 kV line Vierraden-Krajnik to double circuit 400 kV OHL.	2017	Design & Permitting	Investment on time	A delay in the permit process for the line Neuenhagen-Bertikow-Vierraden (DE) as a prerequisite caused an adaptation in the time schedule for the line between Vierraden and Krajnik from to 2017.
		796	Krajnik (PL)		Upgrade of 400/220 kV switchgear in substation Krajnik (new 400/220 kV switchyard).	2017	Design & Permitting	Delayed	The comissioning time of the investment has been aligned with the schedule for the investment 139.
		799	Mikulowa (PL)		Installation of new Phase Shift Transformer in substation Mikułowa and the upgrade of substation Mikułowa for the purpose of PST installation.	2015	Design & Permitting	Delayed	Investment postponed because of prolongation of the tendering process. Due to complexity of the technical solutions more time is needed for the tendering procedure.
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
113	**Doetinchem - Niederrhein**								
		145	Niederrhein (DE)	Doetinchem (NL)	New 400kV line double circuit DE-NL interconnection line. Length:57km.	2016	Design & Permitting	Delayed	Permitting procedures take longer than expected
116	**LUXEMBOURG 400 KV**								
		446	Schifflange (LU)		As a first interim step a PST is commissioned in 2016 in Schifflange and connected to an existing OH-line with an additional 3.5km cable between Biff(CREOS-LU) and Substation Bascharage (CREOS-LU).	2016	Planning	Investment on time	Studies for interim step are finalized, Investment decision expected by mid of 2014
		447	Heisdorf (LU)	Berchem (LU)	Erection of a new 20km 225kV double-circuit mixed (cable+OHL)line with 1000 MVA capacity in order to create a loop around Luxembourg city including substations for in feed in lower voltage levels.	2017	Design & Permitting	Investment on time	Substation Blooren is authorized and under construction, Authorization for line section is still pending

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
		651	Bascharage (LU)	Niederstedem (DE) or tbd (DE)	Upgrading and new construction of an interconnector to DE, in conjunction with the interconnector in the south of LU; Partial upgrading of existing 220kV lines and partial new construction of lines; With power transformer station in LU	2032	Under Consideration	Rescheduled	Further market studies after 2018 needed
127	**127**								
		86	Foggia (IT)	Villanova (IT)	New 178km double circuit 400kV OHL between existing Foggia and Villanova 400kV substations, also connected in and out to the Larino and Gissi substations.	2019	Design & Permitting	Delayed	delay in the permetting process (EIA) concerning the part Foggia-Gissi still under authorization; the part Villanova Gissi is already authorized
		91	Foggia (IT)	Benevento II (IT)	Upgrade of the existing 85km Foggia-Benevento II 400kV OHL.	2014	Under Construction	Investment on time	No changes
		96	Deliceto (IT)	Bisaccia (IT)	New 30km single circuit 400kV OHL between the future substations of Deliceto and Bisaccia, in the Candela area.	2017	Design & Permitting	Delayed	delay in the permitting process (EIA)
		645	Laino (IT)	Altomonte (IT)	New 400kV OHL between the existing substations of Laino and Altomonte in Calabria.	2017	Design & Permitting	Delayed	delay in the permitting process (EIA)
129	**OWP Northsea TenneT Part 4**								
		943	NOR-9-1	Cloppenburg	Connection of new offshore wind park. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 255 km. Line capacity: 900 MW	2028	Under Consideration	New Investment	new investment
		945	NOR-10-1	Cloppenburg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	2029	Under Consideration	New Investment	new investment
		947	NOR-11-2	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 270km. Line capacity: 900 MW	2031	Under Consideration	New Investment	new investment

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
		951	NOR-13-2	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	2030	Under Consideration	New Investment	new investment
130	**N-S Eastern DE_section East**								
		665	Lauchstädt (DE)	Meitingen (DE)	New DC- lines to integrate new wind generation from control area 50Hertz especially Mecklenburg-Vorpommern, Brandenburg and Sachsen-Anhalt towards Central/south Europe for consumption and storage.	2022	Planning	Investment on time	Result from National Grid Development Plan
		208	Pulgar (DE)	Vieselbach (DE)	Construction of new 380kV double-circuit OHL in existing corridor Pulgar-Vieselbach (103 km). Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	2024	Planning	Investment on time	The project is part of the results of the national grid development plan and included in the list of national interest (Bundesbedarfsplan). With in this process the commissioning dates of the included projects have been aligned with the current situation.
132	**N-S Western DE_section North_2**								
		661	Emden East (DE)	Osterath (DE)	New HVDC-lines from Emden to Osterath to integrate new wind generation especially from North Sea towards Central Germany for consumption.	2022	Planning	Investment on time	Progess as planned.
		663	Cloppenburg East (DE)	Merzen (DE)	New 380-kV double circuit over-head-line Cloppenburg East - Merzen with a total length of ca. 55 km. New errection of a 380-kV substation Merzen.	2022	Planning	Investment on time	Progess as planned.
		666	Conneforde (DE)	Cloppenburg (DE)	New 380-kV-line in existing OHL corridor for integration of on- and offshore Wind generation. Incl. new 380-kV-switchgear in Cloppenburg and new transformers in Cloppenburg	2022	Planning	Investment on time	TYDNP 2012 investment 43.A89 is divided in serveral parts
133	**Longterm German RES**								

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
		956	Schleswig-Hostein	Baden-Würtemberg / Bavaria	new DC- line in HVDC technology to integrate new wind generation from northern Germany toward soutern Germany and southern Europe for consumption and storage. Connections points north: Brunsbüttel, Wilster, Kreis Segeberg, Stade, Alfsted. South: Großgartach, Goldshöfe, Raitersaich, Vöhringen	2030	Under Consideration	New Investment	new investment
		969	lower saxony	NRW	New HVDC line to integrate new wind gerneration especially from North Sea towards Central Germany for consumption and storage. connections points north: Emden, Conneforde. South: Oberzier, Rommerskirchen	2030	Under Consideration	New Investment	new investment
		970	lower saxony	Hessen/Baden-Würtemberg	New HVDC line to integrate new wind gerneration especially from North Sea towards South Germany for consumption and storage. Connectionspoints north: Cloppenburg, Elsfelth/West. South: Bürstadt, Philipsburg	2030	Under Consideration	New Investment	new investment
		958	Güstrow (DE)	Meitingen (DE)	New DC- lines to integrate new wind generation from Baltic Sea and control area 50Hertz especially Mecklenburg-Vorpommern towards Central/south Europe for consumption and storage.	2034	Under Consideration	New Investment	New Investment
134	**N-S Western DE_section South**								
		660	Osterath (DE)	Philippsburg (DE)	New HVDC-lines from Osterath to Philippsburg to integrate new wind generation especially from North Sea towards Central-South Germany for consumption and storage.	2019	Design & Permitting	Investment on time	Progess as planned.
		179	Rommerskirchen (DE)	Weißenthurm (DE)	New380 kV overhead line in existing route. Extension and erection of substations incl. erection of 380/110kV-transformers.	2017	Under Construction	Delayed	The section Rommerskrichen to Sechtem is delayed because the permitting procedures take longer than planned. The 36 km section from Sechtem to

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
									Weißenturm is already commissioned.
		680	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 380 kV double circuit overhead line Urberach - Weinheim - Daxlanden. Extension of existing substations are included.	2021	Planning	Investment on time	Progess as planned.
		176	Daxlanden (DE)	Eichstetten (DE)	This AC project is necessary in order to evacuate the energy arriving from HVDC corridors towards southern Germany and reinforce the interconnection capacity with Switzerland	2020	Under Consideration	Investment on time	No significant change
135	**N-S Western DE_parallel lines**								
		662	Wehrendorf (DE)	Urberach (DE)	New lines in HVDC technology from Wehrendorf to Urberach to integrate new wind generation especially from North Sea towards Central-South Europe for consumption and storage.	2022	Under Consideration	Rescheduled	The need for this long-term investment was not confirmed by the regulatory authority within the national grid development plan 2012. Therefore further studies on this project are ongoing.
		188	Kruckel (DE)	Dauersberg (DE)	New 380 kV over head lines in existing rout. Extension of existing and erection of several 380/110kV-substations.	2020	Design & Permitting	Investment on time	Progress as planned.
		680	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 380 kV double circuit overhead line Urberach - Weinheim - Daxlanden. Extension of existing substations are included.	2021	Planning	Investment on time	Progess as planned.
141	**CSE3**								

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
		223	Cirkovce (SI)	Heviz (HU) Zerjavenec (HR)	The existing substation of Cirkovce(SI) will be connected to one circuit of the existing Heviz(HU) -Zerjavinec(HR) double circuit 400kV OHL by erecting a new 80km double circuit 400kV OHL in Slovenia. The project will result in two new cross-border circuits: Heviz(HU)-Cirkovce(SI) and Cirkovce (SI)-Žerjavenec (HR).	2016	Design & Permitting	Investment on time	Progresses as planned.
		225	Divaca (SI)	Cirkovce (SI)	Upgrading 220kV lines to 400kV in corridor Divaca-Klece-Bericevo-Podlog-Cirkovce.	2020	Design & Permitting	Investment on time	Progresses as planed.
148	**CCS new**								
		68	Okroglo (SI)	South Udine (IT)	New 120km double circuit 400kV OHL between Okroglo(SI) and future substation of South Udine (IT) with PST in Okroglo	2021	Planning	Investment on time	There are some issues with social acceptance and teritorial constraints. End of construction works are planned by the end of 2021.Full operation is expected by end of 2021(beginning of 2022).
		615	Okroglo (SI)		Installation of a new 400kV PST in Okroglo which is a part of a double 400 kV OHL Okroglo(SI)-Udine(IT).	2021	Planning	Investment on time	End of construction works are planned by the end of 2021. Full operation is expected by end of 2021 (beginning of 2022).
		92	West Udine (IT)	Redipuglia (IT)	New 40km double circuit 400kV OHL between the existing substations of West Udine and Redipuglia, providing in and out connection to the future 400kV substation of South Udine.	2016	Under Construction	Delayed	permitting only recently completed (March 2013) and construction work had to be rescheduled accordingly. Note that the expected commissioning date for the project is december 2016
150	**CCS new 10**								
		616	Slovenia (SI)	Salgareda (IT)	New HVDC link between Italy and Slovenia.	2022	Under Consideration	Investment on time	Project is under feasibility study.
152	**France Germany Interconnection**								

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		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.
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.
164	**N-S Eastern DE_central section**								
		149	Dollern (DE)	Stade (DE)	New 380kV double circuit OHL Dollern - Stade including new 380kV switchgear in Stade. Length:14km.	2022	Design & Permitting	Delayed	The investment is delayed because of changes in the investment driver
		664	Brunsbüttel, Wilster, Kreis Segeberg	Großgartach, Goldshöfe, Grafenrheinfeld	New DC-lines to integrate new wind generation from Northern Germany towards Southern Germany and	2022	Planning	Investment on time	The expected commissioning date is 2017 - 2022

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
					Southern Europe for consumption and storage.				
		157	Wahle (DE)	Mecklar (DE)	New 380kV double circuit OHL Wahle - Mecklar including two new substations. Length: 210km.	2018	Design & Permitting	Delayed	delay due to long permitting process
		677	Dollern (DE)	Landesbergen (DE)	New 380 kV line in existing OHL corridor Dollern-Sottrum-Wechold-Landesbergen (130 km)	2022	Planning	Investment on time	
		177	Goldshöfe (DE)	Bünzwangen (DE)	AC-extension of the "C corridor" at one ending point in Southern Germany towards the consumption areas allowing the existing grid to deal with the additionnal flows from DC-link	2020	Design & Permitting	Investment on time	Anticipation of design and permitting phase due to foreseen difficulties (protected area in the Swabian Alps)
		685	Mecklar (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400-kV-line (130 km)	2022	Planning	Investment on time	
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.
174	**Greenconnector**								

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		1014	Verderio (I)	Sils (CH)	New +/- 400 kV DC cable and subsea link between Switzerland and Italy. Very short AC cable (380 kV) between the site of the converter station and the substation of Sils i.D.	2018	Design & Permitting	New Investment	Project application to TYNDP 2014.
176	**Hansa PowerBridge**								
		995	Station SE4	Station DE	New DC cable interconnector between Sweden and Germany.	2025	Under Consideration	New Investment	RGBS common investigations for TYNDP 2014
179	**DKE - DE**								
		1016	Bjæverskov (DK2)	Bentwisch (DE)	new 600 MW HVDC subsea cable connecting DK2 and DE	2030	Under Consideration	New Investment	RGBS common investigations for TYNDP14
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.
183	**DKW-DE, Westcoast**								
		1018	Niebüll (DE)	Endrup (DKW)	new 380 kV cross border line DK1-DE for integration of RES and increase of NTC	2022	Planning	Investment on time	in TYNDP12 this investment was part of 43.A90
184	**PST Arkale**								
		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.
186	**east of Austria**								

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
		886	tbd	tbd	To allow the grid integration of the planned renewable energy generation (mainly wind power) in the north-eastern part of Austria ("Weinviertel") and to cover the foreseen load growth in that region the transmission grid infrastructure has to be enforced and new substations for the connection need to be erected	2021	Planning	Rescheduled	The development of wind energy in Lower Austria was temporarily stopped by the federal state government to establish a concept for land use. Final concept was published in beginning of 2014 – project now continues with planned commissioning in 2021.
187	**St. Peter - Pleinting**								
		997	Pleinting (DE)	St. Peter (AT)	new 380-kV-line Pleinting (DE) - St. Peter (AT) on exting OHL corridor	2022	Under Consideration	New Investment	new investment
191	**OWP TenneT Northsea Part 2**								
		952	Cluster DolWin 5 (NOR-1-1)	Halbemond	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 250 km. Line capacity: 900 MW	2021	Under Consideration	New Investment	new investment
		953	Cluster DolWin 6 (NOR-3-3)	Halbemond	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 60km. Line capacity: 900 MW	2021	Under Consideration	New Investment	new investment
		954	Cluster BorWin 5 (NOR-7-1)	Halbemond	Connecton of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	2022	Under Consideration	New Investment	new investment
		211	Cluster DolWin 4 (NOR 3-2)	Unterweser	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 190km. Line capacity: 900 MW	2020	Under Consideration	Investment on time	on time
		656	Cluster BorWin3	Emden/Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW	2018	Design & Permitting	Investment on time	
		658	Cluster BorWin4 (DE)	Emden/Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 172 km. Line capacity: 900 MW	2019	Design & Permitting	Investment on time	
192	**OWP Northsea TenneT Part 3**								

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
		946	NOR-11-1	Elsfleth/West	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 230km. Line capacity: 900 MW	2026	Under Consideration	New Investment	new investment
		948	NOR-12-1	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 230km. Line capacity: 900 MW	2027	Under Consideration	New Investment	new investment
		950	NOR-13-1	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	2025	Under Consideration	New Investment	new investment
		955	Cluster BorWin6 (NOR-7-2)	Unterweser	Connection of new offshore wind parks.New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 180km. Line capacity: 900 MW	2023	Under Consideration	New Investment	new investment
		659	Cluster SylWin2 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 900 MW	2023	Under Consideration	Investment on time	
198	**Area of Lake Constance**								
		984	Herbertingen	Tiengen	Herbertingen – Tiengen: Between the two substations Herbertingen and Tiengen a new line will be constructed in an existing corridor. Enhancement of the grid, which will increase transmission capacity noticeably, is needed at the substation Herbertingen.	2020	Planning	Investment on time	Progess as planned. This project is a concretion of TYNDP12 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
		985	point Rommelsbach	Herbertingen	Rommelsbach – Herbertingen: Between point Rommelsbach and substation Herbertingen a new line will be constructed in an existing corridor. This will significantly increase transmission capacity (grid enhancement).	2018	Planning	Investment on time	Progess as planned. This project is a concretion of TYNDP12 project 44.A77. Due to the ongoing planning stage, this section was developed and an own

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
									investment item was created.
		986	point Wullenstetten (DE)	point Niederwangen (DE)	Point Wullenstetten – Point Niederwangen Between point Wullenstetten and point Niederwangen an upgrade of an existing 380-kV-line is necessary (grid enhancement). Thereby, a significantly higher transmission capacity is realized. The 380 kV substation station Dellmensingen is due to be extended (grid enhancement).	2020	Planning	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
		1043	Neuravensburg	border area (AT)	Point Neuravensburg – Point Austrian National border (AT) Between switching point Neuravensburg and Austrian National border (AT) a new line with a significantly higher transmission capacity will be constructed in an existing corridor (grid enhancement).	2023	Planning	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. This investment is caused by the investment 136 "Bodensee Studie". Due to the ongoing planning stage, this section was developed and an own investment item was created.
		136	Border area (DE-AT)	Rüthi (CH)	380 kV Rüthi – Meiningen and 380 kV Meiningen - Border Area AT-DE	2022	Planning	Investment on time	investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.
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
201	**Upgrade Meeden - Diele**								
		1066	Meeden		Increase of the interconection capacity between NL and DE by approximately 1000 MW by adding two new phase shifting transformers and upgrade of an existing tie line between Meeden and Dielen	2018	Planning	New Investment	In a crossborder study the investment along the existing Meeden - Diele corridor has been identified as feasible and cost effective
204	**N-S transmission DE_par_line_2**								
		686	Schalkau / area of Altenfeld (DE)	area of Grafenrheinfeld (DE)	New double circuit OHL 380-kV-line (130 km)	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
205	**N-S transmission DE_par_line_1**								
		153	Redwitz (DE)	Grafenrheinfeld (DE)	Upgrade of 220kV connection Redwitz - Grafenrheinfeld to 380kV, including new 380kV switchgear Eltmann. Line length: 97km.	2015	Design & Permitting	Delayed	Delayed due to delaye of related investment 45.193 and unexspected long permitting process of the investment itself
		193	Vieselbach (DE)	Redwitz (DE)	New 380kV double-circuit OHL between the substations Vieselbach-Altenfeld-Redwitz with 215km length combined with upgrade between Redwitz and Grafenrheinfeld (see investment 153). The Section Lauchstädt-Vieselbach has already been commissioned. Support of RES integration in Germany, annual redispatching cost reduction, maintaining of security of supply and support of the market development. The line crosses the former border between Eastern and Western Germany and is right downstream in	2015	Design & Permitting	Delayed	Previously "mid term" is now updated to specific date. Partly under construction (section Vieselbach – Altenfeld). 3rd section (Altenfeld – Redwitz) in permitting process, long permitting process with strong public resistance.

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
					the main load flow direction. The project will help to avoid loop flows through neighboring grids.				
206	Reinforcement Southern DE								
		682	Großgartach (DE)	Endersbach (DE)	AC-extension of the "C corridor" at one ending point in Southern Germany towards the consumption areas allowing the existing grid to deal with the additionnal flows from DC-link	2019	Planning	Investment on time	Standard processing 2018-2019
		687	Redwitz (DE)	Schwandorf (DE)	New double circuit OHL 380 kV line in existing OHL corridor Redwitz-Mechlenreuth-Etzenricht-Schwandorf (185 km)	2020	Planning	Investment on time	
		688	Raitersaich (DE)	Isar (DE)	New 380 kV line in existing OHL corridor Raitersaich - Ludersheim - Sittling - Isar or Altheim (160 km)	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
		990	Grafenrheinfeld (DE)	Großgartach (DE)	AC-extension of the "C corridor" between two of its ending points in Southern Germany allowing the existing grid to deal with the additionnal flows from DC-link	2019	Planning	New Investment	Standard processing
207	Reinforcement Northwestern DE								
		939	Conneforde	Emden/Ost	New 380-kV-line in existing OHL corridor for integration of RES	2019	Planning	Delayed	In TYNDP 2012 part of investment 43.A89
		940	Emden/Ost	Halbemond	New 380-kV-line Emden - Halbemond for RES integration incl. new transformers in Halbemond	2021	Under Consideration	Rescheduled	In TYNDP 2012 part of investment 43.A89

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
		675	Conneforde (DE)	Unterweser (DE)	Upgrade of 220-kV-circuit Unterweser-Conneforde to 380kV , Line length: 32 km.	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
		676	Dollern (DE)	Elsfleht/West (DE)	New 380 kV line in existing OHL corridor Dollern - Elsfleht/West Length:100 km	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
208	**N-S Western DE_section North_1**								
		150	Conneforde (DE)	Fedderwarden (DE)	New 380kV double circuit (OHL, partly underground) Conneforde - Wilhelmshaven (Fedderwarden, former Maade) including new 400kV switchgear Fedderwarden. Length: 35 km.	2018	Design & Permitting	Investment on time	
		151	Wehrendorf (DE)	Ganderkesee (DE)	New line (length: ca. 95km), extension of existing and erection of substations, erection of 380/110kV-transformers.	2017	Design & Permitting	Delayed	delay due to long permitting process
		156	Niederrhein (DE)	Dörpen/West (DE)	New 380 kV double circuit overhead line Dörpen - Niederrhein including extension of existing substations.	2018	Design & Permitting	Delayed	The project is delayed due to delays in public-law and civil-law licensing procedures.
209	**Reinforcement Northeastern DE**								
		935	Kreis Segeberg	Göhl	New 380-kV-lineKreis Segeberg - Lübeck - Siems - Göhl, including five new transformers	2021	Under Consideration	Rescheduled	Investment was part of investment 43.A90 in TYNDP 2012. Now seperatly
		937	Audorf	Kiel	New 380-kV-line in existing OHL corridor including 4 new transformers and new 380-kV-switchgears in Kiel/West and Kiel/Süd	2021	Under Consideration	Rescheduled	In TYNDP 2012 this investment was part of investment 43.A90
		667	Brunsbüttel (DE)	Niebüll	About 135 km new 380-kV-lines and around 10 new transformers for integration of onshore Wind in Schleswig-Holstein and increase of NTC between DE and DK	2018	Planning	Delayed	The old investment 43.A90 is now divided in several parts.
		147	Dollern (DE)	Hamburg/Nord (DE)	New 380kV double circuit OHL Dollern - Hamburg/Nord. Length:43km. First circuit 2015, second cicuit 2017	2017	Under Construction	Delayed	Delay due to long permitting process
		148	Audorf (DE)	Hamburg/Nord (DE)	New 380kV double circuit OHL Audorf - Hamburg/Nord including two new 380/220kV transformers in substation	2017	Design & Permitting	Delayed	delay due to long permitting process

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
					Audorf and new 380 kV Switchgear in Kummerfeld. Length: 65km.				
210	**E15**								
		1071	Würmlach (AT)	Somplago (IT)	Würmlach - Somplago	2017	Design & Permitting	New Investment	Project application to TYNDP 2014.
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.
225	**2nd Interconnector Belgium – Germany**								
		1107	BE (TBD)	DE (TBD)	This investment item envisions the possibility of a second 1 GW interconnection between Belgium and Germany. Subject to further studies.	2030	Under Consideration	New Investment	Preliminary studies on high RES scenario's have indicated potential for further regional welfare & RES integration increase by further increasing the interconnection capacity between Belgium & Germany towards time horizon 2025-2030.
		959	Lubmin (DE)	Güstrow (DE)	380-kV-grid enhancement and structural change Lubmin-Lüdershagen-Bentwisch-Güstrow	2024	Under Consideration	New Investment	New Investment
		960	Lubmin (DE)	Pasewalk (DE)	380-kV-grid enhancement and structural change area Lubmin-Iven-Pasewalk.	2030	Under Consideration	New Investment	New Investment

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		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)
		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.
		965	Hamburg/Nord (DE)	Hamburg/Ost (DE)	AC Enhancement Hamburg	2024	Under Consideration	New Investment	New Investment
		966	Krümmel (DE)	Hamburg/Nord (DE)	AC Enhancement Krümmel	2024	Under Consideration	New Investment	New Investment
		967	control area 50Hertz		Contructions of new substations, Var-compensation and extension of existing substations for integration of newly build power plants and RES in 50HzT control area	2023	Planning	New Investment	Commisioning date for different substations varies from 2015 to 2023 depending on local increase of RES or commisioning of power plants.

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									It includes the previous investments 204 and 205.
		974	Elsfleht/West	Ganderkesee	new 380 kV OHL in existing corridor for RES integration between Elsfleth/West, Niedervieland and Ganderkesee	2030	Under Consideration	New Investment	new investment
		975	Irsching	Ottenhofen	new 380-kV-OHL in existing corridor between Irsching and Ottenhofen	2030	Under Consideration	New Investment	new investment
		976	Dollern	Alfstedt	new 380-kV-OHL in existing corridor in Northern Lower Saxony for RES integration	2030	Under Consideration	New Investment	new investment
		977	Unterweser	Elsfleth/West	new 380-kV-OHL in existing corridor for RES integration in Lower Saxony	2030	Under Consideration	New Investment	new investment
		978	Conneforde	Unterweser	new 380-kV-OHL in existing corridor for RES integration in Lower Saxony	2030	Under Consideration	New Investment	new investment
		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.
		993	Röhrsdorf (DE)		Installation of new PSTs in Röhrsdorf	2016	Planning	New Investment	New Investment. Commissioning date between 2016-2023.
		1067	Klostermannsfeld (DE)	Lauchstädt (DE)	TBA	2024	Planning	New Investment	New Investment

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		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.
		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.
		1083	S.Teresa (IT)	Budduso (IT)	New 150 kV line connecting the substation of S.Teresa, Tempio and Buddusò, allowing the realization of a new 150 kV backbone in Sardinia	2018	Design & Permitting	New Investment	-
		1084	Cagliari Sud (IT)	Rumianca (IT)	New 150 kV cable connecting the substation of Cagliari Sud and Rumianca	2015	Under Construction	New Investment	-
		1088	Mengede (DE)	Wanne (DE)	Reconductering of existing 380kV line Mengede - Herne - Wanne.	2014	Under Construction	Investment on time	Progress as planned
		1089	Point Ackerstraße	Point Mattlerbusch	Reconductering of existing 380kV line between Point Ackerstraße-Mattlerbusch	2014	Under Construction	Investment on time	Progress as planned
		1090	Niederhein (DE)	Utfort (DE)	New lines and installation of additional circuits, extension of existing and erection of several 380/110kV-substations.	2018	Design & Permitting	Investment on time	Progess as planned
		1091	Günnigfeld (DE)	Wanne (DE)	Reconductering of existing 380kV line	2018	Design & Permitting	Investment on time	Progress as planned

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		1092	Landesbergen (DE)	Wehrendorf (DE)	Installation of an additional 380-kV circuit between Landesbergen and Wehrendorf	2023	Planning	New Investment	Due to high RES infeed in the north of Germany additional grid reinforcements are necessary.
		1093	Point Okriftel	Farbwerke Höchst-Süd	The 220kV substation Farbwerke Höchst-Süd will be upgraded to 380kV and integrated into the existing grid.	2022	Planning	Investment on time	Progress as planned
		1094	Several		This investment includes new 380/220kV transformes in Walsum, Sechtem, Siegburg, Mettmann and Brauweiler.	2024	Planning	New Investment	In order to avoid bottlenecks within transmission grid new 380/220kV transformes are needed in Walsum, Sechtem, Siegburg, Mettmann and Brauweiler.
		1095	Lippe (DE)	Mengede (DE)	Reconductering of existing 380kV line between Lippe and Mengede.	2024	Under Consideration	New Investment	Additional grid reinforcements between Lippe and Mengede are needed.
		1096	Lüstingen and Gütersloh	Gütersloh	The subsations Lüstingen to Güthersloh will be upgrade to use the line Lüstingen to Güthersloh with 380 kV.	2024	Planning	New Investment	New Investment.
		1097	Several		This investment includes several new 380/110kV transformers in order to integrate RES in Erbach, Gusenburg, Kottigerhook, Niederstedem, Öchtel, Prüm and Wadern. In addition a new 380kV substation and transformers in Krefeld Uerdingen are included.	2019	Planning	New Investment	In order to integrate RES several new 380/110kV transformers are needed in Erbach, Gusenburg, Kottigerhook, Niederstedem, Öchtel, Prüm and Wadern. In addition a new 380kV substation and transformers in Krefeld Uerdingen are included.
		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.

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		1100	Herbertingen (DE)	point Neuravensburg (DE)	Between the 380-kv-station Herbertingen and point Neuravensburg a new line with a significantly higher transmission capacity will be constructed (Grid enhancement).	2034	Under Consideration	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. The need for this long-term investment was not confirmed by the regulatory authority within the national grid development plan 2012. Therefore further studies on this project are ongoing.
		1101	Büttel	Wilster	new 380-kV-line in extisting corridor in Schleswig - Holstein for integration of RES especially wind on- and offshore	2021	Under Consideration	New Investment	new investment due to German NDP 2014
		1102	junction Mehrum	Mehrum	new 380-kV-line junction Mehrum (line Wahle - Grohnde) - Mehrum including a 380/220-kV-transformer in Mehrum	2019	Under Consideration	New Investment	new investment due to German NDP 2014
		1103	Borken	Mecklar	new 380-kV-line Borken - Mecklar in existing corridor for RES integration	2021	Under Consideration	New Investment	new investment due to German NDP 2014
		1104	Borken	Gießen	new 380-kV-line Borken - Gießen in existing corridor for RES integration	2022	Under Consideration	New Investment	new investment due to German NDP 2014
		1105	Borken	Twistetal	new 380-kV-line Borken - Twistetal in existing corridor for RES integration	2021	Under Consideration	New Investment	new investment due to German NDP 2014
		1106	Wahle	Klein Ilsede	new 380-kV-line Wahle - Klein Ilsede in existing corridor for RES integration	2018	Under Consideration	New Investment	new investment due to German NDP 2014
		1108	Metzingen-Oberjettingen	Oberjettingen-Engstlatt	New 380kV OHL Metzingen-Oberjettingen (32 km) and new 380kV OHL Oberjettingen-Engstlatt (34 km)	2020	Planning	New Investment	New investment
		1109	Großgartach	Pulverdingen	New circuit 380kV OHL Großgartach-Pulverdingen (30 km) combined with reconductering existing circuit 380kV OHL Großgartach-Pulverdingen (30 km)	2024	Planning	New Investment	New investment
		1110	Dellmensingen	Rotensohl-Niederstotzingen	New circuit 380kV OHL Dellmensingen-Rothensohl (67 km) combined with reconductering existing circuit 380kV OHL Dellmensingen-Niederstotzingen (41 km)	2024	Planning	New Investment	New investment

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
		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.
		110	Restructuring of Sorrento Peninsula netw		It is planned a new 380/220/150kV substation in East Vesuvius area (near Naples) connected in and out to the existing 380 and 220kV lines “Montecorvino-S. Sofia” and "Nola-S. Valentino". Related to this project, it has been programmed also some reinforcements and restructuring of the existing 220kV and 150 kV network in the area of Sorrento Peninsula.	2020	Design & Permitting	Delayed	Delay to the authorization process
		105	Treviso (IT)		New 380/132kV substation in Treviso area, connected in and out to the existing 380kV line “Sandrigo - Cordignano".	2022	Design & Permitting	Delayed	Long permitting process(request for building and operation)
		118	Porto Ferraio (Elba Island)(IT)	Colmata (IT)	New 40km 132kV connection via subsea cable between the existing substation of Porto Ferraio and Colmata.	2020	Design & Permitting	Delayed	Delays due to authorization process
		119	Capri, Ischia, Procida (IT)	Missing data	New 150kV subsea connection between the Capri, Ischia and Procida islands to the existing substations of Cuma and Torre Annunziata (mainland Italy). New 150 kV substation in Capri island.	2020	Design & Permitting	Delayed	Delay due to authorization process. At present only one connection from Capri to mainland is permitted (commissioning date 2016)
		135	220kV nodes (CH)	Missing data	Many 220kV reinforcement around the urban areas.				
		168	Goldshöfe (DE)	Dellmensigen (DE)	Upgrade the line Goldshöfe - Dellmensigen from 220kV to 380kV . Line length:114km. Included in the investment : 3x 380kV substations, 2 transformers.	2014	Under Construction	Investment on time	No change to be reported
		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.
		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.
		101	Turin (IT)		Restructuring of the 220kV network in the urban area of Turin. Some new 220kV cables, some new 220/132kV substations and some reinforcements of existing assets are planned.	2019	Under Construction	Investment on time	-

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		84	Casanova (IT)	Vignole (IT)	Voltage upgrade of the existing 100km Casanova-Vignole 220kV OHL to 400kV.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		601	Asti area (IT)		New 400/220/150kV substation in Asti area.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		217	Dürnrohr (AT)	Sarasdorf (AT)	Installation of the 3rd and 4th circuit on the existing line Dürnrohr - Sarasdorf. Total length: 100km.	2014	Under Construction	Investment on time	No status change since TYNDP 2012; the construction process is on time
		222	Silz (AT)	Zell-Ziller (AT)	Upgrade of the existing 220kV-double circuit- OHL Zell-Ziller - Silz. Line length: 42km.				
		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.
		66	Brennero (IT)		New 132 kV substation with a 110/132kV PST.	2016	Design & Permitting	Delayed	Investment scheme reviewed (former Prati di Vizze)
		613	Prati di Vizze (IT)	Steinach (AT)	Upgrade of the existing 44km Prati di Vizze (IT) – Steinach (AT) single circuit 110/132kV OHL, currently operated at medium voltage.	2016	Design & Permitting	Investment on time	-
		83	Volpago (IT)	North Venezia (IT)	Realization of a new 380kV line between the existing substation of North Venezia and the future 380kV substation of Volpago, connected in and out to the 380kV "Sandrigo - Cordignano" .	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		93	Dolo (IT)	Camin (IT)	New 15km double circuit 400kV OHL between existing Dolo and Camin 400kV substations, to be built in parallel with the existing line.	2025	Design & Permitting	Delayed	The authorization granted in 2013 was canceled by a State Council Resolution

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
		97	Polpet (IT)		Restructuring of the existing 220 and 132 kV network in the Media Valle del Piave with the realization of a new 220/132 kV substation. The substation will be connected by two shorts links to the existing Soverzene-Lienz 220kV line.	2017	Design & Permitting	Delayed	delay in the permetting process due to the request of several integrations, during EIA, by the Authorities involved
		89	Fano (IT)	Teramo (IT)	New 200km single circuit 400kV OHL between the existing 400kV substations of Fano and Teramo, providing the connection in and out to the future substation to be built in Macerata area.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		76	Partanna (IT)	Ciminna (IT)	New 65km single circuit 400kV OHL in Sicily between existing Partanna and Ciminna substations.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		74	Ciminna area (IT)		For the realization of 400kV grid reinforcement, it will be realized the voltage upgrade of the existing Ciminna substation up to 400kV.	2019	Design & Permitting	Investment on time	-
		636	Assoro (IT)		For the realization of 400kV grid reinforcement, it will be realized a new 400/150kV substation Assoro.	2019	Planning	Investment on time	-
		637	Chiaramonte Gulfi (IT)	Ciminna (IT)	Realization of new 400 kV line: "Chiaramonte Gulfi -new station of Assoro- Ciminna"	2019	Design & Permitting	Investment on time	-
		638	Sorgente 2 (IT)		New 400/150 kV substation in Sorgente area will be temporally connected in and out to the existing 400 line kV "Paterno - Sorgente" and to the local 220 kV and 150 kV network.	2019	Planning	Investment on time	-
		916	Assoro (IT)	Villafranca (IT)	Realization of new 400 kV line "Assoro-Sorgente2-Villafranca"	2019	Planning	New Investment	-
		917	Paternò (IT)	Priolo (IT)	Realization of new 400 kV line: "Paternò-Pantano-Priolo"	2017	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
		77	Partinico (IT)	Fulgatore (IT)	New 45km single circuit 400kV OHL between Partinico and Fulgatore in Western Sicily.	2020	Planning	Delayed	rescheduling of permitting process: discussion of preliminary localization with local Authorities
		100	Milan (IT)	-	Restructuring of the 220kV network in the urban area of Milan. Some new 220kV cables (33km), a new 220kV substation (Musocco) and some reinforcements of existing assets (35km) are planned.	2019	Design & Permitting	Delayed	Rescheduling of work to guarantee, during construction phase, the continuity of service in metropolitan area of Milan
		112	Tirano (IT)	Verderio(IT)	New 140km single circuit 400kV OHL between Tirano and Verderio substations connecting also the new 400kV substation Grosio/Piateda.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		85	Pavia area (IT)	Piacenza area (IT)	New 45km double circuit 400kV OHL between 2 substations in the Pavia area and Piacenza.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		102	Naples (IT)	-	Restructuring of the 220kV network in the urban area of Naples. Some new 220kV cables and some reinforcements of existing assets are planned. Total length: 36km.	2018	Design & Permitting	Investment on time	-
		644	Aliano (IT)	Montecorvino (IT)	New connection OHL 400 kV between north Basilicata and Campania region.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		88	Montecorvino (IT)	Benevento (IT)	New 70km double circuit 400kV OHL between the existing 400kV substations of Montecorvino and Benevento II, providing in and out connection to the future substation to be build in Avellino North area, which will be also connected to the existing "Matera-S. Sofia" 400kV line.	2021	Design & Permitting	Delayed	delay in the permitting process (EIA) related to part Montecorvino Avellino Nord; discussion of preliminary localization with local Authorities for Avellino Nord Benevento

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
		94	Mantova area (IT)	Modena area (IT)	New 35km 400kV OHL between the 2 substations in Modena and Mantova area.	2030	Under Consideration	Investment on time	-
		648	Codrongianos (IT)	Suvereto (IT)	Repowering of existing HVDC interconnection between Sardinia, Corse and mainland Italy via 220kV DC subsea cable (358km). The first connection is in operation since 1970.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		138	tbd (CZ)	tbd (DE) - South-Eastern 50 Hertz	Possible increase of interconnection capacity between CEPS and 50Hertz Transmission is under consideration: either a new 400kV tie-line (OHL on new route) or a reinforcement of the existing 400kV tie-line Hradec (CEPS) – Röhrsdorf (50Hertz Transmission).	2032	Under Consideration	Investment on time	Thisinvestment item is possible after all projects in CZ area related to the are commissioned - still under consideration
		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.
		174	Bruchsal Kändelweg (DE)	Ubstadt (DE)	A new 380kV OHL Bruchsal Kändelweg - Ubstadt. Length:6km.	2014	Under Construction	Investment on time	The permitting procedure has allowed the beginning of the construction
		175	Birkenfeld (DE)	Ötisheim (DE)	A new 380kV OHL Birkenfeld-Ötisheim (Mast 115A). Length:11km.	2020	Planning	Investment on time	No change to be reported
		178	Goldshöffe and Engstlatt		Installation of 2x250 MVAr 380kV capacitance banks (1x250 MVar Goldshöfe and 1x250MVar Engstlatt).	2014	Under Construction	Investment on time	No significant change
		182	Kriftel (DE)	Obererlenbach (DE)	New 400 kV double circuit OHL Kriftel - Obererlebenbach in existing OHL corridor.	2015	Design & Permitting	Delayed	The project is delayed due to delays in public-law and civil-law licensing procedures.

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
		185	Hanekenfähr (DE) and Ibbenbüren (DE)	Uentrop (DE)	In order to facilitate the integration of RES (especially wind) several grid reinforcements in the area of Münsterland/Westphalia are needed. This project will affect mainly the following substations: Hanekenfähr, Uentrop, Gütersloh, Wehrendorf, Lüstringen, Westerkappeln and Ibbenbüren. Within this area new lines and installation of additional circuits are planned. In addition the necessity for extension of existing and erection of several 380/110kV-substations is given.	2020	Design & Permitting	Investment on time	Major section will be commissoned in 2014. Last sections are planned to be commissoned 2020.
		186	Gütersloh (DE)	Bechterdissen (DE)	New lines and installation of additional circuits, extension of existing and erection of 380/110kV-substation.	2014	Under Construction	Investment on time	Progess as planned.
		187	Utfort (DE)	Rommerskirchen (DE)	New lines and installation of additional circuits, extension of existing and erection of several 380/110kV-substations.	2018	Under Construction	Delayed	The investment is delayed due to delays in public-law and civil-law licensing procedures. Serveral section will be commissioned before 2018.
		189	Niederrhein (DE)	Utfort (DE)	New 400 kV double-circuit OHL Niederrhein-Utfort	2017	Design & Permitting	Investment on time	In the moment no delays are known.
		190	St. Barbara (DE)	Mittelbexbach (DE)	New lins, extension of existing and erection of several 380/110kV-substations	2014	Design & Permitting	Investment on time	Progress as planned.
		170	Großgartach (DE)	Hüffenhardt (DE)	New 380kV OHL Großgartach Hüffenhardt. Length: 23km. Included in the project : 1 new 380kV substation, 2 transformers.	2013	Under Construction	Delayed	Delay in the authorization process due to protest from local landowners
		172	Mühlhausen (DE)	Großgartach (DE)	Upgrade of the line Mühlhausen-Großgartach from 220kV to 380kV. Length: 45km.	2014	Under Construction	Investment on time	The permitting has allowed the beginning of the construction
		173	Hoheneck (DE)	Endersbach (DE)	Upgrade of the line Hoheneck-Endersbach from 220kV to 380kV. Length:20km.	2014	Under Construction	Investment on time	The permitting procedure has allowed the construction to begin

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
		678	Hamm/Uentrop (DE)	Kruckel (DE)	Extension of existing line to a 400 kV single circuit OHL Hamm/Uentrop - Kruckel and extension of existing substations.	2018	Planning	Investment on time	Progess as planned.
		679	Pkt. Blatzheim (DE)	Oberzier (DE)	New 400 kV double circuit OHL Pkt. Blatzheim - Oberzier including extension of existing substations.	2018	Under Consideration	Investment on time	The need for this investment was not confirmed by the German Network development Plan 2012. Therefore further studies on this project are ongoing.
		681	Bürstadt (DE)	BASF (DE)	New line and extension of existing line to 400 kV double circuit OHL Bürstadt - BASF including extension of existing substations.	2024	Planning	Rescheduled	Rescheduled: Investemt was not confirmed by the national regulatory authority within the national grid development plan 2012. Further studies are ongoing.
		673	Pkt. Metternich (DE)	Niederstedem (DE)	Construction of new 380kV double-circuit OHLs, decommissioning of existing old 220kV double-circuit OHLs, extension of existing and erection of several 380/110kV-substations. Length: 108km.	2021	Planning	Investment on time	Progress as planned.
		672	Area of West Germany (DE)		Installation of reactive power compensation (eg. MSCDN, SVC, phase shifter). Devices are planned in Kusenhorst, Büscherhof, Weißenthurm and Kriftel. Additional reactive power devices will be evaluated.	2016	Planning	Investment on time	Progess as planned.
		191	Neuenhagen (DE)	Vierraden (DE)	Project of new 380kV double-circuit OHL Neuenhagen-Vierraden-Bertikow with 125km length as prerequisite for the planned upgrading of the existing 220kV double-circuit interconnection Krajnik (PL) – Vierraden (DE Hertz Transmission).	2017	Design & Permitting	Delayed	longer than expected permitting procedure

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
		197	Neuenhagen (DE)	Wustermark (DE)	Construction of new 380kV double-circuit OHL between the substations Wustermark-Neuenhagen with 75km length. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	2018	Under Construction	Investment on time	Previously "mid-term" updated to specific date.
		199	Lubmin (DE)	Bertikow (DE)	Construction of new 380kV double-circuit OHLs in North-Eastern part of 50HzT control area and decommissioning of existing old 220kV double-circuit OHLs, incl. 380-kV-line Bertikow-Pasewalk (30 km). Length: 135km.Support of RES and conventional generation integration in North Germany, maintaining of security of supply and support of market development.	2018	Design & Permitting	Delayed	The investment is split into two investments with different commissioning dates. From Lubmin to Pasewalk long term. From Pasewalk to Bertikow in 2018.
		200	Güstrow (DE)	Wolmirstedt (DE)	380-kV-grid enhancement and structural change Magdeburg/Wolmirstedt, incl. 380-kV-line Gustrow-Wolmirstedt (195 km).	2020	Planning	Investment on time	Investment on time
		202	Bärwalde (DE)	Schmölln (DE)	Upgrading existing double-circuit 380kV OHL in the South-Eastern part of the control area of 50Hertz Transmission. Bärwalde-Schmölln length approx. 50km. Support of RES and conventional generation integration in North-Eastern Germany, maintaining of security of supply and support of market development.	2015	Under Construction	Expected earlier than planned previously	Investment is needed earlier, commissioning is being prepared.
		206	Röhrsdorf (DE)	Remptendorf (DE)	Construction of new double-circuit 380-kV-overhead line in existing corridor Röhrsdorf-Remptendorf (103 km)	2021	Planning	Delayed	
		158	Irsching (DE)	Ottenhofen (DE)	Upgrade of 220kV connection Irsching - Ottenhofen to 380kV, including new 380kV switchgear Zolling. Length 76km.	2017	Planning	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
		683	Wolmirstedt (DE)	Wahle (DE)	New double circuit OHL 380 kV; Line length 111 km	2022	Planning	Investment on time	
		684	Vieselbach (DE)	Mecklar (DE)	New double circuit OHL 400 kV line in existing OHL corridor . (129 km)	2022	Planning	Investment on time	
		78	Palermo area (IT)		Restructuring of the network in the Palermo area. The work consists of a new 220/150kV substation, complying with 400kV standards, connected to the Ciminna substation with a new 400kV line and in & out the existing Bellolampo-Caracoli 400kV line, and also the connection of 15 kV lines "Casuzze - Monreale" and "Casuzze - Guadalami" and a repowering of the existing Casuzze 150/MV substation. It is foreseen also large a restructuring of the 150kV network in the palermo area in order to increase the security and the quality of supply.	2016	Design & Permitting	Delayed	Delay in the permitting procedure
		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.

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
		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.

12.3 List of commissioned investments from TYNDP and RgIPs 2012 within the region

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
931		Foggia (IT)		PST installed on the new 400kV line Foggia-Benevento (splitted from 32.91)	2012	Commissioned	Commissioned	the previous date was referred to the completion of all work included in the item 32.91; the commissioning of PST is on time with the previous forecast
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.
180	180	Mengede (DE)	Kruckel (DE)	Installation of a second circuit 380kV OHL from Mengede to Kruckel	2012	Commissioned	Commissioned	Investment is commissioned.
192	192	Hamburg/Krümmel (DE)	Schwerin (DE)	This 380kV double-circuit OHL project will close the missing gap in North-East German grid infrastructure. Only 65km of new line must be constructed, 22km already exist.	2012	Commissioned	Commissioned	Project is completed and now in service. Could be removed from TYNDP projects list.
54	21. 54	Cornier (FR)	Piossasco (IT)	Replacement of conductors (by ACCS) on existing grid	2013	Commissioned	Commissioned	Investment commissioned on time.
81	21. 81	Trino (IT)	Lacchiarella (IT)	A new 380kV double circuit OHL between the existing 380kV substations of Trino and Lacchiarella in North West Italy area. Total line length: 95km	2014	Commissioned	Commissioned	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
220	26. 47. 220	Lienz (AT)		Erection of a new 220/220kV- PST in the substation Lienz (AT)	2012	Commissioned	Commissioned	PST commissioned on 23.05.2012
224	27. 224	Krsko (SI)	Bericevo (SI)	New 400kV double circuit OHL between Krsko and Bericevo.	2014	Commissioned	Commissioned	Progresses as planned.
623	28. 86	Villanova (IT)		A PST will be installed on the new 400kV line Foggia-Villanova	2012	Commissioned	Commissioned	the previous date was referred to the completion of all work included in the item 28.86 of TYNDP 2012; the commissioning of PST is on time with the previous forecast

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
87	30. 87	Feroleto (IT)	Maida (IT)	New 400kV OHL across Calabria between the substation of Feroleto and the substation of Maida	2013	Commissioned	Commissioned	-
646	32. A99	Aliano (IT)		New 400/150 kV substation in Aliano connected in and out to the existing 400 line kV "Matera - Laino" and to the local HV network.	2012	Commissioned	Commissioned	-
41	41	Fruges (FR)		New 400-kV substation connected to existing grid	2013	Commissioned	Commissioned	investment commisioned as planned
152	42. 152	Dörpen/West (DE)		New substation for connection of offshore wind farms.	2013	Commissioned	Commissioned	
159	42. 159	Cluster BorWin1 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205km. Line capacity: 400MW.	2013	Commissioned	Commissioned	
653	42. 163	Büttel (DE)		New substation Büttel and connection of this new substation with the existing OHL Brünsbüttel - Wilster.	2013	Commissioned	Commissioned	
181	44. 181	Dauersberg (DE)	Limburg (DE)	New line from Dauersberg to point Fehl-Ritzhausen	2012	Commissioned	Commissioned	Investment is commissioned.
221	47. 221	St. Peter (AT)	Ernsthofen (AT)	Upgrade from 220kV-operation to 380kV.	2014	Commissioned	Commissioned	Due to some technical problems, the commissioning date was shifted from 2013 to mid 2014.
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.
56	56	Camporosso (IT)		New 450 MVA PST in Camporosso (IT) 220kV substation on Camporosso (IT) - Menton (FR) - Trinité-Victor (FR) OHL.	2012	Commissioned	Commissioned	-
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.

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
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.
131	90. 131	Bickigen (CH)		Addition of a second 400/220kV transformer in an existing substation.	2013	Commissioned	Commissioned	technical problem with the regulating phase shifter device
46	5. 46	Baixas (FR)	Gaudière (FR)	Reconductoring of existing line	2013	Commissioned	Commissioned	Investment commisioned on time.
166	42. 166	Offshore Wind park Riffgat (DE)	Emden /Borßum(DE)	New AC-cable connection	2014	Commissioned	Commissioned	

12.4 List of cancelled investments from TYNDP and RgIPs 2012 within the region

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
595	17. A18	tbd (FR)	tbd (FR)	New network reinforcement between Haute Normandy and the south of Paris area. Length about 160 km.	-	Cancelled	Cancelled	After more detailed studies,investment n°983 proved more efficient than the solution initially envisaged.
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)
73	29. 73	El Aouaria (TU)	Partanna (IT)	New 350km 1000 MW HVDC line between Tunisia and Italy via Sicily with 400kV DC subsea cable and converters stations at both ends.	-	Cancelled	Cancelled	The previous items 29.A97 and 29.73 of TYNDP 2012 have been merged in 29.635
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).
824	41	Marne-Sud (FR)		New 400-kV substation connected to existing grid	-	Cancelled	Cancelled	Studies showed that the current perspective of new RES generation installation in the area can be accomodated via lower voltage grid development and does not need the creation of a new 400 kV substation.

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
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

12.5 Storage projects

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

Caveats

- This section displays the assessment of storage projects, when their promoters sent the input data to ENTSO-E. Eventually, some are indeed listed as PCIs; some are not. Conversely, when PCIs promoters have not sent any data to ENTSO-E, no assessment can be displayed.
- The economic benefits of projects in the SEW focus on the "energy only" part of the total economic benefits. **The SEW must be completed with an appraisal of the "capacity" part of the benefits (i.e. the availability of net power generating capacity) and the "flexibility" part of the benefits (i.e. the capability of adapt quickly the power output to the system needs).** "Flexibility" issues relate to real time phenomena that the 60-minute quantum used in the TYNDP market studies and steady state load flows in networks studies fails to capture:
  - Expanding wide area market modelling with a resolution beneath one hour to address close to real time phenomena is challenging with respect to computations capabilities and would rather involve complementary tools
  - Moreover common definitions of such close to real time benefits among all stakeholders must be first agreed upon.
- **The SEW presented in the TYNDP 2014 is thus a conservative assessment of the economic benefits**. This remark is valid both for transmission and storage projects, but is all the more important for storage projects that the investment costs are larger. **Profitability of storage projects can never be concluded upon with the present assessment**.
- The definition of technical resilience and flexibility (B6 and B7) for storage projects also only partially capture their benefits. Presently the application of assessment rules result in quite low numbers compared to intuitive expectations. They must be revised with the involvement of stakeholders for the TYNDP 2016.
- S1 and S2 indicators must be re-defined for storage and the final release of the TYNDP will bear for storage projects "NA" (instead of "less than 15 km"; the latter does indeed not reflect the environmental impact of storage projects).

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Project index	Project description	GTC (MW)	S1	S2	b6 technical resilience	b7 flexibility	scenario	SoS (MWh/yr)	SEW (Meuros/yr)	RES avoided spillage (MWh/yr)	Losses variation (MWh/yr)	CO2 emissions variation (kT/yr)
222	Extension of the pump storage powerplant Kaunertal[31]	900	NA	NA	2	3	Scenario Vision 1 - 2030	-	[48;58]	0	[-44000;-36000]	[-450;-370]
							Scenario Vision 2 - 2030	-	[47;57]	0	[-54000;-44000]	[-410;-340]
							Scenario Vision 3 - 2030	-	[81;99]	[1350;1650]	[-61000;-50000]	[-345;-280]
							Scenario Vision 4 - 2030	-	[79;97]	[12960;15480]]	[-58000;-48000]	-240;-300]
223	capacity increase of hydro-pumped storage in Austria - Limberg III, Salzburg	480	NA	NA	2	3	Scenario Vision 1 - 2030	-	[0;1]	[73;90]	[-25000;-20000]	[29;36]
							Scenario Vision 2 - 2030	-	[0;1]	[130;160]	[-29000;-23000]	[52;63]
							Scenario Vision 3 - 2030	-	[1;2]	[1800;2200]	[-33000;-27000]	[7;8]
							Scenario Vision 4 - 2030	-	[3;4]	[9900;12000]	[-32000;-26000]	[7;8]
224	hydro-pumped storage in Austria	313	NA	NA	2	3	Scenario Vision 1 - 2030	-	[0;1]	[0;1]	[-14000;-12000]	[44;53]
							Scenario Vision 2 - 2030	-	[1;2]	[83;100]	[-19000;-15000]	[33;40]
							Scenario Vision 3 - 2030	-	[0;1]	[1100;1300]	[-21000;-17000]	[8;9]
							Scenario Vision 4 - 2030	-	[2;3]	[5900;7200]	[-20000;-16000]	[2;3]
226	hydro-pumped storage in Germany - Riedl	300	NA	NA	1	3	Scenario Vision 1 - 2030	-	[0;1]	[73;90]	[-6400;-5200]	[37;46]
							Scenario Vision 2 - 2030	-	[1;2]	[84;100]	[-7700;-6300]	[44;53]
							Scenario Vision 3 - 2030	-	[0;1]	[1100;1400]	[-8500;-6900]	[8;9]
							Scenario Vision 4 - 2030	-	[2;3]	[5500;6700]	[-8300;-6800]	[2;3]

[31] The assessment of the Storage 222 has been updated after submission of the report to ACER, to correct a misprint of its GTC and of the RES indicators for Visions 2 and 3

12.6 Smart Grid PCIs

Smart grid PCIs are not assessed according to the Cost Benefit Analysis rules applied for the TYNDP 2014 and here only mentioned, complying with Article 3.6 of Reg. EU 347/2013.

10.2. Green-Me (France, Italy): Enhance RES integration by implementing automation, control and monitoring systems in HV and HV/MV substations, advanced communicating with the renewable generators and storage in primary substations

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