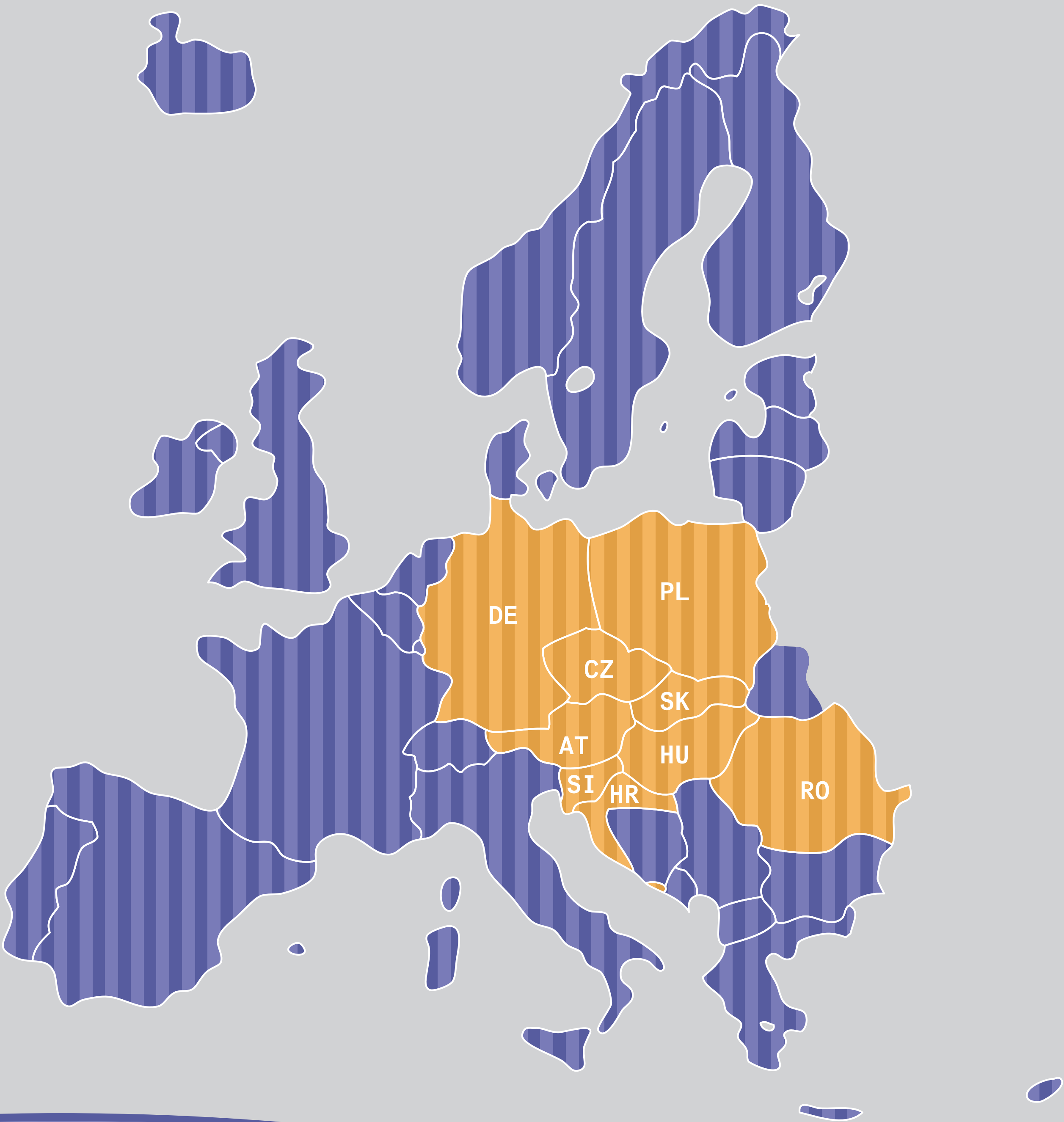
Regional Investment Plan Continental Central East

Final



European Network of
Transmission System Operators
for Electricity

entsoe

Regional Investment Plan Continental Central East

Final

5 July 2012

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1 Executive Summary

Infrastructure developments are crucial for achieving the European energy policy objectives of competitiveness, sustainability and security of supply and the European Commission's action to boost the necessary investments is urgently needed. More efforts are necessary in order to modernize and expand Europe's energy infrastructure and to interconnect electricity networks across borders in order to meet these objectives.

The priorities identified in the EC Communication on Infrastructure are in line with those which can be found in the Ten Year Network Development Plan (TYNDP) and 6 Regional Investment Plans (RgIP) released by ENTSO-E. As the common plan of all European TSOs, with a firm legal basis in Regulation (EC) 714/2009, the TYNDPs will summarize in their updates every 2 years which new transmission infrastructures are necessary in the respective rolling 10-year horizons. Starting with the 2012 TYNDP, ENTSO-E describes not only how the hundreds of projects are justified from regional and pan-European perspectives, but also how they relate to the Commission's priority corridors, with the possible identification of new ones.

The share of renewable energy sources (RES) in the European electricity mix is continuously increasing and is expected to become an important source of electricity in 2020 (according to the EU's goals defined in the respective legislation documents). It is also predicted that in 2050 RES will cover a significant portion of electricity consumption. This will contribute to the reduction of CO_2 emissions from power generation and will also contribute to reducing the dependency of the European Union on imported fuels. An optimized deployment of renewable resources throughout Europe should be in line with grid infrastructure development in order to assure that high RES shares and low-carbon electricity goals are met.

This Regional Investment Plan report supports the key objectives of the TYNDP, namely to ensure transparency concerning the electricity transmission network development and to proactively contribute to decision-making processes concerning electricity at European level in general and at the Continental Central East (CCE) regional level in particular. The report highlights the significant investments in the CCE power grid. Moreover, it identifies and explains the main changes which have occurred in the investments included in the TYNDP 2010 submission. This report outlines the present congestion and the evolution over the ten year plan period whilst also identifying the main challenges and needs of the region. Additionally the report covers a description of the specific methods used in the regional market and network studies, justifications of the models used in the studies, scenarios considered in developing the RgIP and a summary of regional specific scenarios. It also discusses present congestion and its evolution over the ten year plan period as well as identifying the main challenges and needs of the region.

This report identifies "Projects of European significance" and "National projects of interest". Other issues which can be found in the report pertain to the overall adequacy of the transmission network after the proposed investments, the identification of other remaining challenges, and a review of the process of environmental assessment and resilience principles highlighted in the TYNDP 2012-2022.

The Regional Investment Plan in CCE, together with the other five RgIPs, with the Scenario Outlook and Adequacy Forecast (SOAF) and TYNDP, contributes to achieving the energy policy goals and to fulfilling the requirements of Articles 8.3(b), 8.4 and 8.10 of The Regulation 714/2009.

However, leveraging geographic synergies for the deployment of RES in Continental Central East (CCE) Europe requires electricity transports from often remotely located windy or sunny regions to the residential and industrial load areas as well as to the pump storage capacities in the Alps which foster the efficient integration of intermittent RES. Furthermore, an extension of the electricity transmission grid in this region facilitates the integration of significantly fluctuating RES generation. Therefore, further large scale penetration of renewable energies in the CCE region can only be realized along with the extension of transmission networks' infrastructure.

Market studies and network studies have been performed at the CCE regional level while taking into consideration Europe in its entirety. The aim of these studies was to justify the already planned grid infrastructures in the region but also to identify other necessary transmission grid reinforcements for both the medium- and long-term period from the perspective of the EU's goal achievement. The demand forecast for each Member State and the generation applied in merit order 1) were used as input for defining the expected bulk flow patterns across the region. Market studies looked for the most efficient generation (taking into account the merit order) to cover the expected demand and also took into account the expected future capacity between TSOs. Other aspects, which were taken into account, include: differences in political and economic conditions (e.g. Nuclear Phase Out etc.), investment in new power plants, and so on.

The results of these market studies are given in terms of a possible generation dispatch profile according to the ENTSO-E scenarios. This information was then used by a Regional Group to choose the most representative cases (Points in Time) to be studied in Network studies.

The results were then compared and the transmission adequacy was further measured allowing for the iterative process of identifying the required reinforcement projects for supporting the bulk flow patterns identified in the market study. The newly identified projects are compiled in the network studies and the study is reiterated in order to legitimate the proposed project.

The two scenarios which have been used as a basis for the TYNDP 2012 were focused on the RG CCE market studies. These scenarios are:

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1) The merit order applies generation to the network in order from the cheapest to the most expensive, until the total demand is covered. This method leads to the lowest possible unit price for electricity by running the cheapest possible generation mix to meet demand

- The EU 2020 scenario has been built top-down, based on the European 20-20-20 objectives and the NREAPs;
- The SAF-B scenario extrapolates from market players' present investment perspectives in a bottom-up approach.

Moreover, the whole of Europe/ENTSO-E was modeled in the study. This means that all countries from Portugal to Finland to Greece were included in the model. After the consultation of the mentioned scenarios Germany decided to change its nuclear policy. Due to the dramatic impact of the Nuclear Phase Out in Germany, the European grid sensitivity analysis "Scenario B Nuclear Phase Out" and "Scenario EU Nuclear Phase Out (NPO)" were carried out. Additional sensitivities with different price levels for CO_2 were also conducted. The main focus of the analysis was to analyze changes in energy flow patterns across the CCE countries in order to identify a possible range of flow patterns.

From the market simulations some few implications can be drawn:

For scenario EU 2020:

- CCE region as group is net importer of nearly 6 TWh. Main exchanges were investigated between market areas (Germany – Austria, Czech Republic – Slovakia, Slovakia – Hungary, Austria – Hungary and Austria – Slovenia). It is emphasized here that these are purely market exchanges and not physical grid flows/exchanges which were revealed in most borders to be different when these market flows were applied in the network models.
- Importers of the region are Poland, Hungary Croatia and Germany. Exporters with more than 5 TWh are Austria and Czech Republic.
- Upon NPO sensitivity analysis, the CCE region was revealed as a net importer of nearly 30 TWh. An unavailable production of nuclear units (about 60 TWh) was covered half by other technologies in Germany and half by import.

For scenario B:

- CCE region was revealed as a net exporter of nearly 13 TWh. Main exchanges were investigated between market areas (Germany – Austria, Czech Republic – Germany and Poland – Germany).
- Poland, Hungary and Croatia as it was in the EU scenario remain importers of the region, while exporters with more than 5 TWh are Czech Republic, Germany, Austria and Romania.
- On the other hand the region has changed to an importer of nearly 12 TWh in the case of NPO in Germany. Approximately 60 TWh of unavailable production of nuclear units was covered half by other technologies in Germany and half by import.

Figure 1 depicts the main drivers for grid development in CCE region, which are:

- Integration of RES
- Pump storage in the Alps
- Demand growth
- Connection of other conventional generation

About 30 transmission projects of pan-European significance (mid-term/long-term) have been identified to address and solve the concerns of the CCE region and Europe at large in the coming decade. A total of 89 investments are of national or regional relevance.

Approximately 75 % of the investment items of the TYNDP 2012 package were already present in the TYNDP 2010 and are hence confirmed. 25 % of the investment items comprise new projects which have evolved to tackle the concerns of the CCE region. This percentage ratio shows the coherence between the two plans and its continuation as a living process (update) which will always react and address all of the various regional challenges and changes which will be necessary over the long-term.

There is a total of around 23000 km of projects of pan-European and regional significance in the CCE region which should be either newly constructed or refurbished as Extra High Voltage routes (AC and DC).

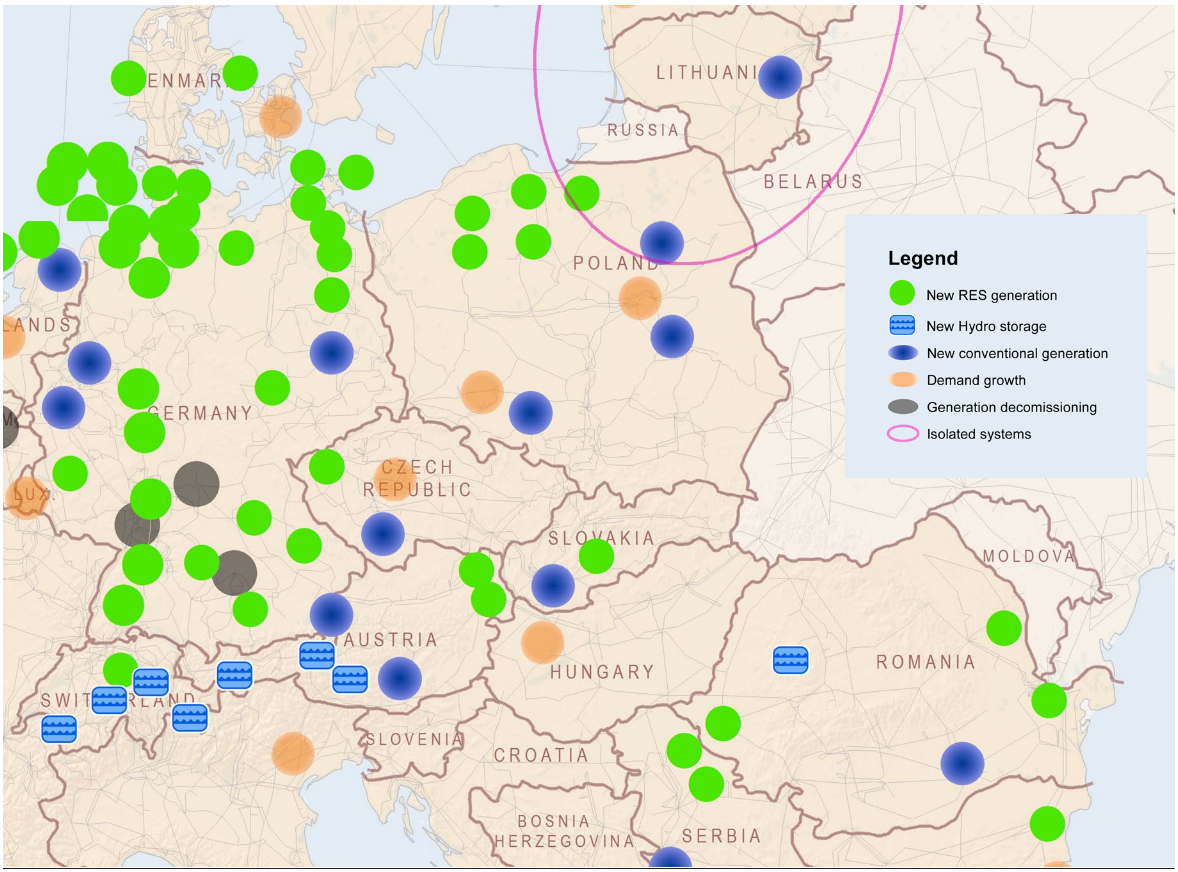

Figure 1:
Main drivers for grid development in next 10 years

Projects of pan-European significance are very diverse, focusing on regional specifics. They develop grid transfer capability (GTC) ranging from a few hundred MW to more than 4 GW.

Total investment costs of countries total around 37 billion €, of which the prevailing share represents the investment costs of Germany, followed by Poland and Czech Republic. Information per country is presented in Table 1. Countries in the CCE region pose about one third of the total investment costs, that is, € 104 billion, as depicted and accounted in TYNDP 2012. The figures are in line with the previous analysis of the TYNDP 2010 and the overall € 100 billion envisaged by the European Commission in their communication on Energy Infrastructure Package on 17th Nov 2011.

Country	billion €
Austria	1,1
Croatia	0,2
Czech Republic	1,7
Germany	30,1
Hungary	0,1
Poland	2,9
Romania	0,7
Slovakia	0,3
Slovenia	0,3

Table 1:
Investments costs per country

Some of the above indicated key indicators are indicated in the figures below.

All investments contribute to significantly mitigating CO_2 emissions in the CCE region.

Key statistic results of the RgIP CCE:

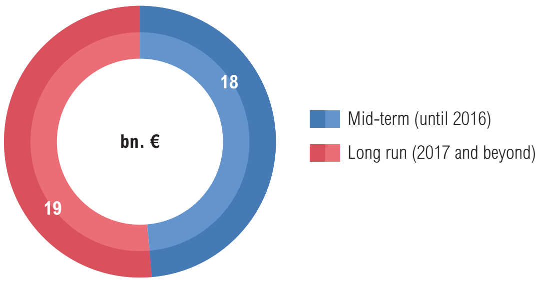

Figure 2:
Investment Costs in billion EUROS according to time horizon

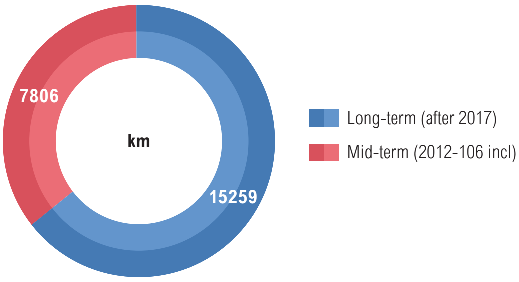

Figure 3:
Length of new and upgradedlines in kms according to time horizon

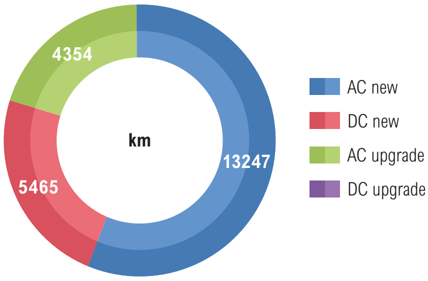

Figure 4:
Length of lines in kms according to technology and type of construction

Europe has defined ambitious targets for the energy sector, including the 20-20-20 targets among others, as clear goals in terms of use of renewable energy sources, energy efficiency and reduction in CO_2. Achieving these goals requires hundreds of billions of Euros of investment in the energy sector. In particular, the investments in the transmission system will constitute the basis for further development.

Regardless of how the CCE region and the European energy mix evolve over the long-term, the transmission network will have to be reinforced and expanded over the next decade. Due to a lack of storage technologies, the transmission network will play a major role in providing the necessary flexibility and connections to strike a balance between generation and demand centers which do not correlate in place or time.

The transmission network is the basis for all actions on the electricity market; it is the "tool" used to optimize the electricity system and will have to cope with a variety of different challenges which are pointed out in the TYNDP and the Regional Investment Plans. The expansion of the transmission network by the proposed projects will increase the security and flexibility of the electric system, taking different scenarios into account. Nevertheless, significant structural changes in the European or regional energy mix will increase the difficulties of fulfilling these tasks and require further development of the transmission infrastructure.

2 Introduction

2.1 Expectations of the 3rd Legislative Package

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

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

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

The relevant text referred to above can also be found in the Ten-Year Network Development Plan 2012 – 2022 document.

An explanation of how the TYNDP package meets these requirements is contained in Section 2.3 of this document.

2.2 ENTSO-E

ENTSO-E was established on a voluntary basis on 19 December 2008 and became fully operational on 1 July 2009, in anticipation of the entry in to force of the 3rd Package on 3 March 2011.

Today, 41 TSOs from 34 European countries are members of ENTSO-E. The working structure of the association consists of Working and Regional

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

Groups, coordinated by three Committees (System Development, System Operations and Markets), supervised by a management Board and the Assembly of ENTSO-E, and supported by the Secretariat, the Legal and Regulatory Group, and Expert Groups. A list of countries and TSO members can be found at the end of this document.

The main purposes of ENTSO-E are:

- to pursue the co-operation of the European TSOs both at the pan-European and regional level;

and

- to have an active and important role in the European rule setting process in compliance with EU legislation.

2.3 Documents in the TYNDP Package

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

The Ten Year Network Development Plan 2012-2022 (TYNDP), the Regional Investment Plans and the Scenario Outlook and Adequacy Forecast combine to meet the above aims and fulfil the requirements of Articles 8.3(b), 8.4, 8.10 and 12.1 of The Regulation as detailed in Section 2.1.

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

1. **Ten Year Network Development Plan 2012 – 2022:**

   The TYNDP focuses specifically on the projects of pan-European significance detailed within each Regional Investment Plan, covering those with significant contributions to cross-border flows and meeting large areas of demand. Further information on the content, methodology and selection criteria can be found in the TYNDP document itself.

2. **Regional Investment Plans:**
   [Comprising 6 individual, regional documents]

   The Regional Investment Plan documents overlap between the National Development Plans which TSOs are bound to publish to their regulatory authority every year (under Article 22 of Directive 2009/72/EC) and the TYNDP document outlined above. It provides a more focused view on the development needs and project planning for all levels of investment at a regional level within Europe (as opposed to those solely of pan-European significance in TYNDP 2012-2022).

3. **Scenario Outlook and Adequacy Forecast:**

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

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

2.4 Regional Groups

As described in Section 2.2, co-operation of the European TSOs both on the pan-European and regional level in order to undertake effective planning is the main requirement of the 3rd package, and therefore one of ENTSO-E's key purposes. To achieve this ENTSO-E has divided itself into 6 regional groups for grid planning and system development tasks. The Member States belonging to each group are shown in Figure 5.

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

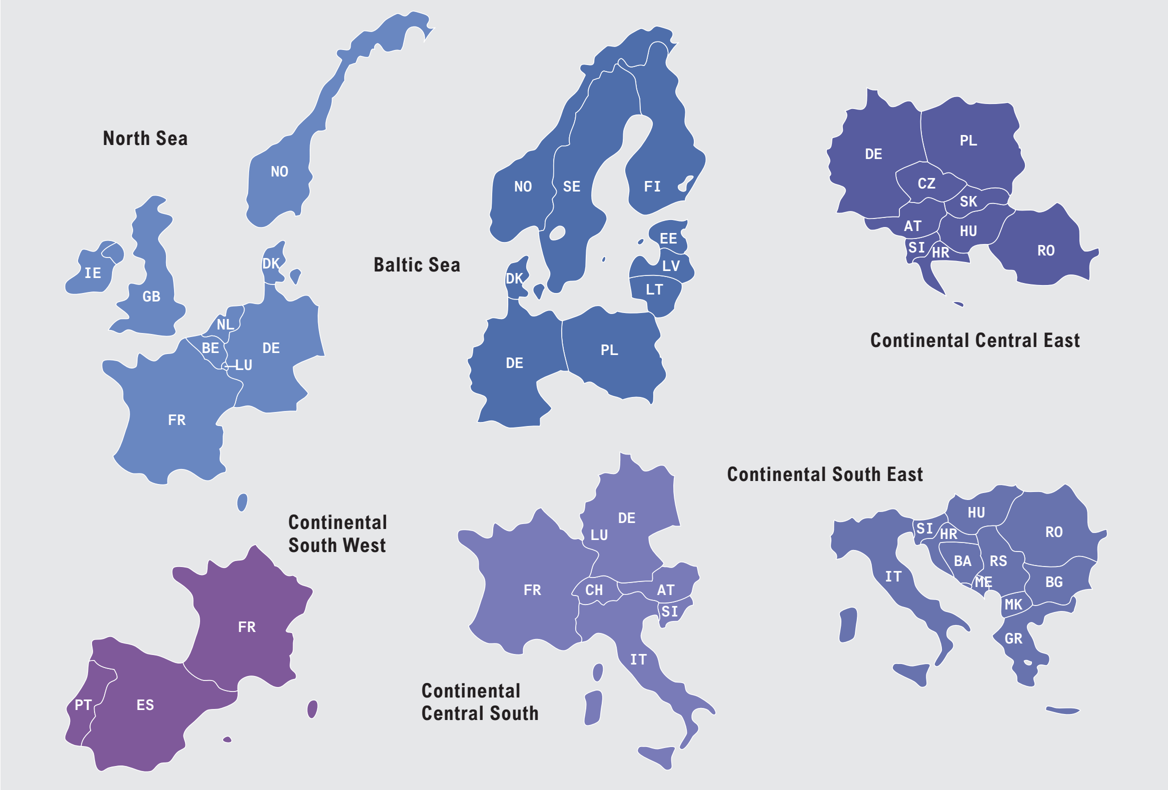


Figure 5:
ENTSO-E regions (System Development Committee)

The Continental Central East Regional Group (CCE RG) under the scope of the ENTSO-E SDC consists of 9 countries: Austria, Croatia, Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and Slovenia; with the involvement of 10 companies/TSOs: APG, HEP-OPS, ČEPS, 50Hertz Transmission GmbH, TenneT TSO GmbH, MAVIR, PSE Operator, Transelectrica, SEPS and ELES. The list of ENTSO-E countries and TSOs in the CCE region outlined above is presented in Table 2 below.

Country	Company
Austria	APG – Austrian Power Grid AG
Croatia	HEP-Operator prijenosnog sustava d.o.o.
Czech Republic	ČEPS, a.s.
Germany	50Hertz Transmission GmbH
	TenneT TSO GmbH
Hungary	MAVIR
Poland	PSE Operator S.A.
Romania	C.N. Transelectrica S.A.
Slovak Republic	Slovenska elektrizacna prenosova sustava, a.s.
Slovenia	Elektro Slovenija d.o.o.

Table 2 ENTSO-E Regional Group CCE Membership

CCE RG is strategically situated at the crossroads of the prevailing North-South and East-West power flowaxes, in the very heart of Europe, between Renewable Energy Sources (RES) such as wind sources in the North and storage capacities in the Alps.

In this respect EIP outlined and identified the North-South Interconnections in Central and South Eastern Europe to be among priority corridors. All 10 TSOs in this regard are facing a very challenging task as they aim to facilitate the implementation of energy infrastructure projects and improve security of supply and market development in the region.

ENTSO-E is fully aware of the advantages brought by the regional approach and considers it as the most appropriate framework for grid development in Europe.

2.5 How to Read the Document

Chapter 3 identifies and explains the main changes which have occurred in the investments included in the TYNDP 2010 submission.

Chapter 4 describes the specific methods used in the regional market and network studies, giving justifications of the models used in the studies.

Chapter 5 looks in detail at the scenarios considered in developing the Regional Investment Plan, looking at the scenarios common to all plans contributing to the TYNDP 2012-2022 but also highlighting any regionally specific scenarios.

Chapter 6 presents the current Net Transfer Capability of the European electricity transmission networks, examining present congestion and experienced flows. It then proceeds to assess how this will evolve over the ten year plan period, and identifies the main challenges and needs of the region.

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

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

Chapter 9, where applicable, underlines the process of environmental assessment utilized in the course of constructing the Regional Investment Plan.

Chapter 10 revisits the resilience principles highlighted in the TYNDP 2012-2022 and justifies the planned investments, as well as highlighting and describing the adverse scenarios which may occur in the region and which may require special attention and possible future investment

Finally, the conclusion presents aggregate figures and statistics for the entire Regional Investment Plan.

3 Assessment of the TYNDP 2010

This chapter presents an overview of the main changes in the project consistency, commissioning date and status compared to the information presented in the TYNDP 2010. More detailed monitoring data on every project is available in Appendix 1.

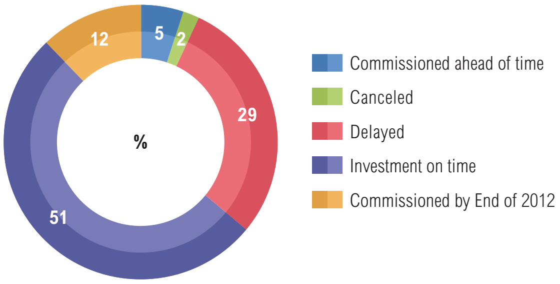


Figure 6:
TYNDP 2010 project monitoring belonging to CCE

3.1 Delays in Commissioning Date

Delays are registered with regards to the commissioning dates for some of the projects presented in the TYNDP 2010. The reasons are similar in most of the countries/TSOs in the region. They are mainly related to lengthy and complicated permitting and granting procedures, local public resistance, lack of financial support or re-prioritization of other projects. In some cases commissioning dates of transmission investments were changed by TSOs in order to harmonize the time lines with those of investors whose projects (e.g. connection of plants) evoked grid infrastructure reinforcements.

Lengthy permitting procedures occur as a consequence of submission of objections at all times and instances throughout the permitting procedure, lack of reasonable and fixed time limits for issuing approvals and conflicts between environmental/society interests. These challenges continue to be an obstacle and a deceleration factor for grid infrastructure development in the region. There is no appropriate evaluation of the relationship between environmental issues and the public interest for security of supply or other aims.

Due to a change in the schedule of new generation connection, 5 investments in Poland have been moved from mid-term to long-term: 400 kV OHL Kozienice Ołtarzew, Pątnów-Grudziądz, Grudziądz-Gdańsk Przyjaźń, Ostrołeka – Olsztyn Mątki, Dobrzeń – Pasikurowice/Wrocław. Regulatory, social and environmental problems resulted in delay of the 400 kV OHL Żydowo-Słupsk and 400 kV OHL Żydowo – Gdańsk Przyjaźń commissioning in Poland.

A large portion German on-shore investment has been delayed, mainly due to permit procedure related issues, namely changes in the legal framework. Local public resistance is another hindering factor for grid development. Besides all of these delays, all commissioning dates remain in the mid-term range.

Complications in the permitting procedures are foreseen for most of the planned projects in the North-western part of the Czech Republic due to the fact that most of these investments, which are overhead lines (e.g. 400 kV lines: Vitkov-Vernerov, Vitkov-Prestice), and their corridors are situated very close to protected areas. Commissioning dates of other planned lines are either harmonized by other priority investments or changed in order to fit external investors' requirements.

Several investments in the East of Romania for connection of RES and conventional generation have been delayed due to financial shortcomings. There is uncertainty for the interconnection between Serbia and Romania but there are efforts on both sides to ensure the realization of the project as expected in the TYNDP 2010.

Moreover, three new 400 kV substations in Hungary needed for the connection of conventional generation will follow the dynamic of investment need and have been postponed to later dates. This situation is also encountered in Poland, Czech Republic and in Croatia for some projects.

3.2 Earlier Commissioning

Earlier commissioning to accommodate investment need is registered in Slovakia. This is due to the earlier erection of the new internal 400 kV line Veľký Ďur – Gabčíkovo which will help to evacuate power from the new NPP in Veľký Ďur area. The new interconnection 2 x 400 kV Gabčíkovo (SK) – Gönyü (HU) has been moved from long-term to an earlier date (2016). In Hungary new 400/120 kV substations Bicske and Szolnok, as well as the upgrade of 400 kV line Albertirsa-Martonvasar to double circuit have been commissioned earlier than indicated in TYNDP 2010.

3.3 Canceled Investments

Implementation of the investment became obsolete due to the implementation of other project(s):

- Investment in additional 400 kV line Konjsko (HR) – Mostar (BA) has been postponed since it must be considered together with the previously planned new HVDC interconnection between Croatia and Italy, which has also been postponed to a later date.
- Investment Wuhlheide (DE) – Thyrow (DE) was cancelled based on CHP investor decision this grid upgrade is not necessary any more.
- Investment substation Halemba (PL) was cancelled due to cancellation of new power plant construction.

Results of the new studies:

- New studies suggest that installation of PST in 400 kV SS Sajoszoged in Hungary is not necessary.

3.4 Changes in Projects' Consistency

Projects to accommodate additional investment require:

- Interconnection line between Romania and Serbia will alleviate the congestion limiting export from East to West and enable integration of RES in both countries.
- Investment in 400 kV interconnection between Croatia and Bosnia and Herzegovina from TYNDP 2010 is defined as 400 kV interconnection line Banja Luka (BA) – Lika (HR), which will enable integration of RES and conventional generation in Croatia, simultaneously strengthening the regional network in East-West direction.

3.5 Completed Projects

Despite problems which are faced by other projects, some projects in the CCE region were fully completed and put into operation in the course of 2010 and 2011.

Interconnection projects: construction of double circuit 400 kV line Ernestinovo (HR) – Pécs (HU), installation of the 2nd circuit on the Austrian side of the 400 kV line Wien SO (AT) – Szombathely (HU), the PST 400/400 kV in SS Divača (SI) on 400 kV interconnection line between Italy and Slovenia is fully completed and has been in operation since 2010.

400 kV substations of Chotejovice and Kletne were both successfully commissioned in the Czech Republic by November 2011. This includes a 400 kV line of around 30 km connecting new substation Chotejovice and existing substation Vyskov which was commissioned on November 2011.

In Poland the following investments have been completed: new substation Morzyczyn and new switch gears in Lagisza and Gdansk I substations.

In Slovakia, a new double circuit 400 kV line between Moldava and Lemešany substations was commissioned in September 2011.

In Austria the first section of the 380 kV Salzburgline (St. Peter – Tauern) between the substations St. Peter and the new substation Salzburg was erected and put into service with 220 kV early in 2011.

3.6 New Projects

New grid infrastructure investments are also foreseen in the TYNDP 2012 in comparison to the TYNDP 2010:

- reinforcement of the existing 400 kV overhead lines between Chodov and Cechy Stred and between Tynec and Krasikov in order to facilitate the power flow in the West-eastern direction caused by the expected power generation increase in the center and North-western part of the CZ country but also RES generation increase particularly from northern DE.
- new investments for an improved security of supply and RES integration are necessary in Germany. A description of the projects is provided in Chapter 7.2.2.1.

- the reconductoring (with HTLS – high temperature low sag wires) of existing single circuit 220 kV OHL Stejaru – Gheorghieni – Fantanele – Ungheni. The investment will enable the transference of power from RES generation in the eastern part of Romania to consumption areas.
- Considerable planned investments in Croatia include new 400 kV OHL replacing the aging 220 kV OHL between substations Brinje and Konjsko, including the construction of two new 400/(220)/110 kV substations Brinje and Lika which will strengthen the 400 kV corridor along the Adriatic coast in Croatia in the LT period, whilst also facilitating the integration of RES in Croatia and relieving the regional congestion at the North-South axis. It will also contribute in accommodation of power transfers due to new IT-ME DC link.

4 Specific RG Methodology and Assumptions

4.1 TYNDP 2012 Methodology

Common main scenarios build the basis for the analysis for the TYNDP and the Regional plans. These scenarios are described in Chapter 5. During the process of preparing the TYNDP and the Regional Investment Plans a common Pan European Market Database (PEMD) has been developed containing scenarios for generation and demand data as well as common data such as fuel prices.

This common data is the basis for Regional analysis; both market model and network analysis.

The results of the market study have also been used to define the benefits of the planned investments. ENTSO-E common guidelines have been defined and used for project assessments.

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

A common grid model is employed in order to assess future grid transfer capability with the planned investments and the resilience in stressed grid situations.

A more detailed description of the common method can be found in the TYNDP 2012.

4.2 Market Studies Methodology

4.2.1 Purpose of Market Studies & System Modeling

The development of the cross-border interconnection capacities, the expansion of the European generation systems and the load evolution during the next ten years were based on a set of pre-determined assumptions which are presented in Chapter 5.

The purpose of the market studies was to investigate the impact of already planned and new projects, by comparing two different grid situations in terms of economic efficiency: the ability of the system to schedule plants according to their intrinsic merit-order, the overall resulting variable generation costs, the overall amount of CO_2 emissions, and volumes of dump energy (not used energy) as well as non-supplied energy. An economic optimization was conducted for every hour of the year, taking into account several constraints such as flexibility and availability of thermal units, wind and solar profiles, load profile, transmission capacity between countries, CO_2 prices and so on.

Regional Group CCE has used the software PowrSym3 for the market simulations. PowrSym3 is a product of OSA (Operation Simulation Associates, Inc., USA).

The main focus of RG CCE was on modeling the entire ENTSO-E area. Therefore the data from common PEMD were used for every country.

Each country for market study purpose is modeled as one single node (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.

Expected capacity is a value between two countries. In the case of Poland there are additional restrictions. The maximum import and export possibilities are much lower than the sum of capacity on the Polish borders. Due to this, the import and export were also limited in the market simulations.

Load:

For the load, hourly time series out of the PEMD were used. There are historical time series for every country scaled to the expected load of the scenario. Due to reasons related to consistency every time series start on a Monday.

Generation:

- Thermal units were modeled with their main relevant characteristics: installed capacity, kind of fuel (incl. fuel and CO_2 price), start costs, efficiency, must-run obligations, minimum up and down times, availabilities and so on.
- The hydraulic system was divided into three kinds of power plant: run of river, storage and pump storage. The behavior of pump hydro (pumping, turbining) was internally implemented using the simulation tool.
- Non dispatchable generation (wind, solar, etc.) are being considered by scaled historical harmonized time series over all of the ENTSO-E countries.

Some countries have connections with Non-ENTSO-E countries. Hungary, Romania and Slovakia are connected to the so called Burshtyn island of West Ukraine. This exchange is considered by an hourly time series.

4.2.2 Valuation of Reinforcements

Benefit assessments have been performed for every project inside RG CCE. There are two different types of project assessment:

The benefits for projects (all necessary investments), with the effect of cross-border capacities increase, can be analyzed by comparing the situation when all projects are finalized (expected cross-border capacity in 2020) with the situation without a particular project.

The benefits for projects which are necessary for connection of new conventional power plants or RES are analyzed by comparing the situation with these additional plants/RES and the situation without them.

This method gives the benefits of one project, as if it is the last investment to be commissioned.

Benefit analysis refers mainly to:

- Social economic welfare
  (in terms of reducing variable generation costs).
- Volume of CO_2 emissions.

Besides this, additional specific analysis of the commercial exchanges duration curves between countries is conducted, in order to help in assessing the bulk power flows indicators.

4.2.3 Network Study's Methodology

The market simulations calculate for every scenario 8736 cases (52 weeks) (= grid situations, points in time). For these cases the generation dispatch, load and market flows between market areas are known. Market flows and physical flows can be very different. This is due to the fact that grid analyses must follow the market simulation to assess whether the grid is able to handle the simulated dispatch.

In terms of time it is not possible to make exact grid calculations for every case. Therefore it is of paramount importance to choose the relevant cases for exact grid studies.

Hourly results of market simulation were analyzed, and based on these analyses several specific points in time were picked out to perform detailed network studies. In case of network studies the security of the system was assessed (N-1 criterion, voltage …).

RG CCE used a PTDF-Matrix to ascertain the most critical and representative cases. Points in time were analyzed based on the production mix in combination with PTDF flows. The critical situations stem from e.g. high production in RES, high PTDF flows or high demand. The most representative cases stem from e.g. prevailing direction of flows, prevailing merit order in the region. However a description of the PTDF Matrix methodology is out of the scope of this RgIP report.

5 Scenarios and Market Results

In this chapter the scenarios which were used in the Regional Investment Plans development and the market simulation results are described. The chapter starts with a description of the two scenarios which are used within all ENTSO-E Regional Groups. Following this the scenarios specific for the Regional Group are addressed. Finally the market simulation results and conclusions are presented.

5.1 Description of Scenarios

Scenario EU 2020 – represents simulation taking into account assumption of EU 20-20-20 targets to reach at least 20 % reduction of greenhouse gases compared to the year 1990, 20 % of EU energy consumption comes from RES, 20 % reduction in primary energy use compared with projected levels by improving energy efficiency.

- Improving energy efficiency in primary energy use was reflected in EU demand of all countries.
- RES installed capacity was derived from National renewables action plans, where a roadmap for achieving EU targets was established and the installed capacity of conventional sources was also in accordance with this plan.
- Fuel prices were set according to the reference scenario of International Energy Agency outlook. A co-ordinated assumption related to the price of CO_2 was made in order to motivate energy sources and to produce as little CO_2 as possible whilst also changing the merit order of power plants to first run gas fired power plants instead of coal fired power plants

Scenario B – represents simulation using the most up-to-date information of TSOs. This scenario is also referred to as "Best estimate".

- Demand outlook is based on quite a different assumption (higher annual growth) resulting in approximately 7 % higher total EU energy consumption than in Scenario EU2020. For CCE this presents an increase of around 10.5 %.
- The RES as well as the installed capacity of conventional sources were assumed according to the number of applications for connection to the grid with respect to feasibility of connection and future outlook of possible new applications.

– Fuel prices were set according to the central scenario of International Energy Agency outlook. Coordinated assumption related to price of CO_2 was made to set up low price level of CO_2.

In addition to these two scenarios a sensitivity analysis called "Nuclear Phase Out (NPO)" was made. In this analysis a portion of the nuclear units in Germany were shut down (the total phase out is expected for 2022). In addition, a small decrease of nuclear power in Switzerland was taken into account. This has been built into both of the scenarios.

For both scenarios and the Nuclear Phase Out analysis, similar data with standard format has been shared among TSOs through the Pan European Market Database (PEMD), in order to allow a simplified modeling of the entire European region. Some additional information is shared among TSOs of one RG when higher detail is needed for the simulated region (must-run constraints of specific units, ramp rates, min time ON/OFF, monthly NTCs between neighbour systems, etc.).

5.2 Regional Specific Scenarios (RG CCE)

Market studies were mainly focused on common scenarios and sensitivity studies and specifically; RG CCE modeled the entire Europe. This means that all countries from Portugal to Finland and to Greece were included in the model.

It was assumed that the impact of Nuclear Phase Out in Germany would be very significant for countries within CCE region. Therefore one of the sensitivity studies was considered the Nuclear Phase Out for both scenarios known as "Scenario B NPO" and "Scenario EU NPO". Other simulations were carried out with different price levels for CO_2, the main driver for such a number of studies was to analyze changes in energy flow patterns across the CCE countries in order to identify a possible range of flow patterns.

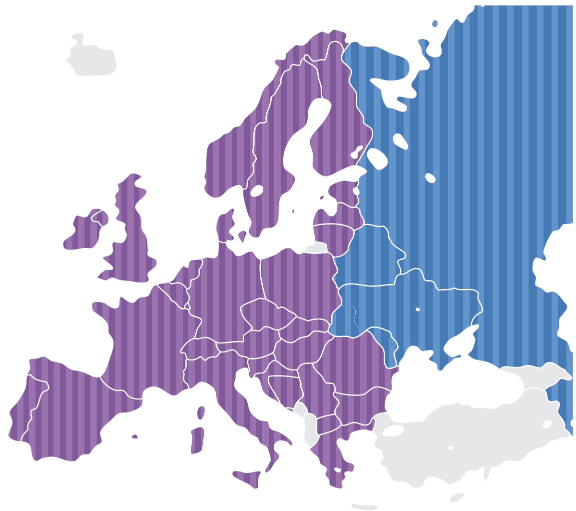


Figure 7:
Installed capacity and technology share (Scenario EU 2020)

The demand was different for two basic scenarios whilst the installed capacity of type of units was also different based on assumptions for these scenarios. In cases of sensitivity study – Nuclear Phase Out – the installed capacity of nuclear units decreased in Germany. For demand see Figure 9 and for installed capacity and with a share of technology see Figure 8 and Figure 10.

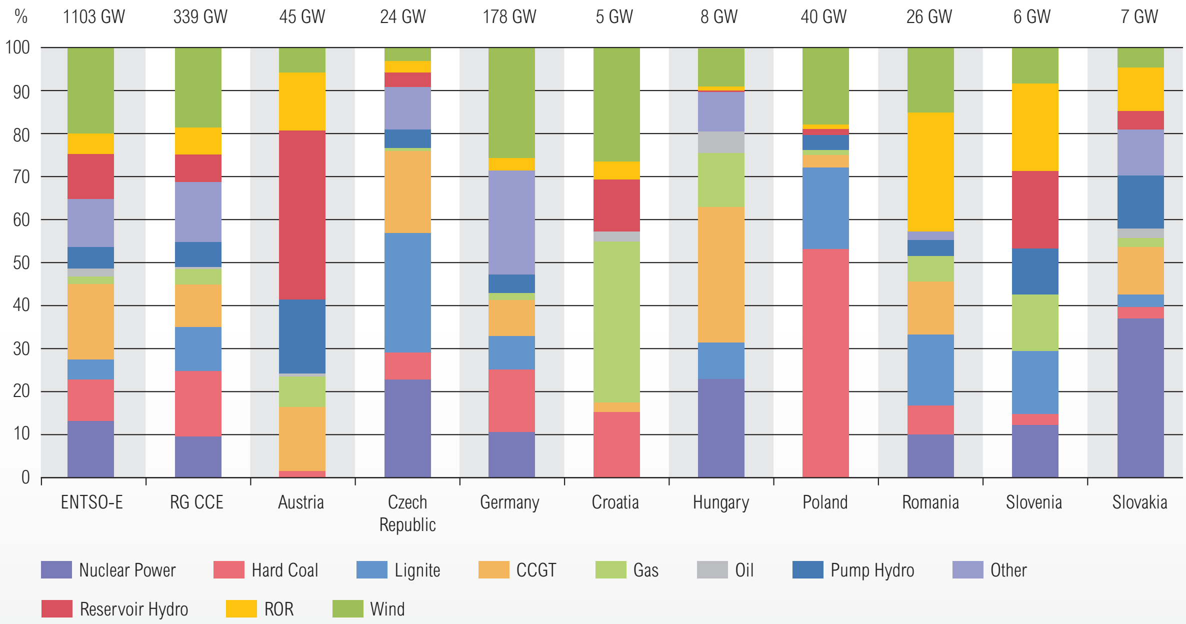


Figure 8:
Installed capacity and technology share (Scenario EU 2020)

5.2.1 Additional Market Scenarios

A number of sensitivity studies were conducted in order to investigate changes in energy exchanges across the CCE region due to the uncertainty of the CO_2 market, although these investigations were carried out in a European context (CCE developed pan-European model). The range of CO_2 prices was investigated (low, medium, high) for a certain number of scenarios including Scenario B NPO.

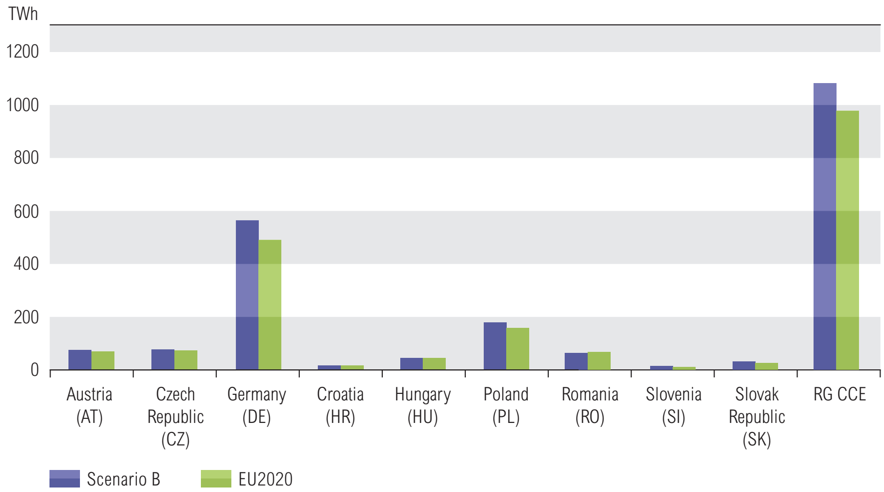


Figure 9:
CCE demand in scenarios

	AT	CZ	DE	HR	HU	PL	RO	SI	SK	RG CCE
	76.8	78.9	565.7	21.1	45.0	180.7	65.5	16.4	31.8	**1081.9**
	73.5	74.9	490.9	21.1	45.1	159.4	67.9	15.3	30.5	**978.6**

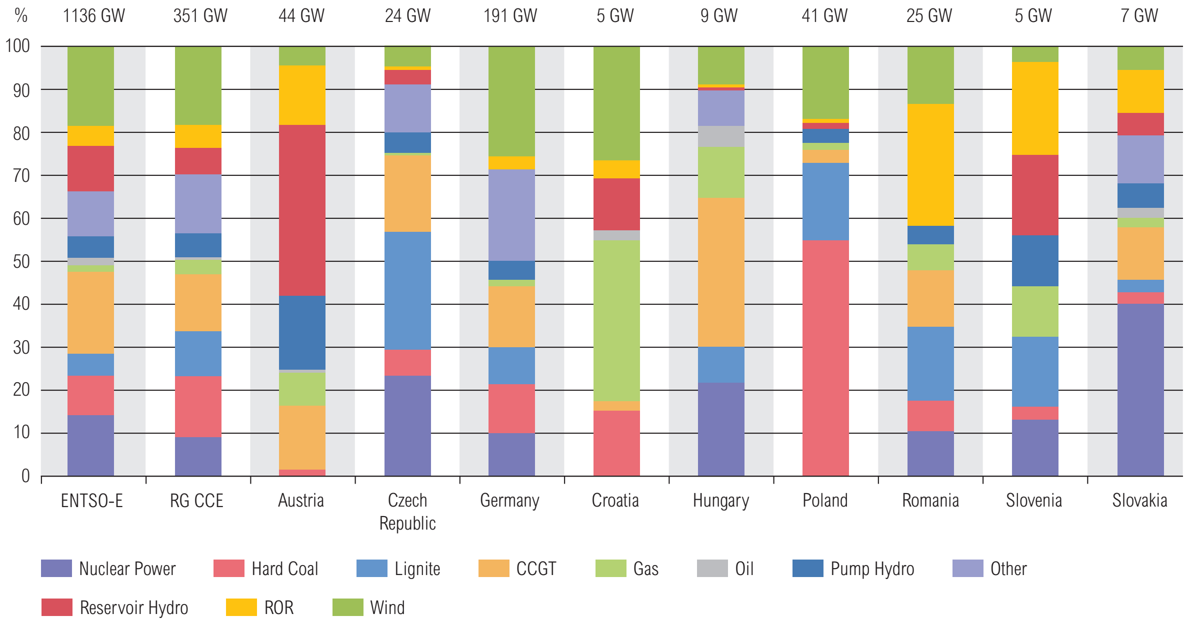


Figure 10:
Installed capacity and technology share (Scenario B)

Assumptions in Scenario B are slightly different (according to actual outlook of market players), as the demand outlook and installed capacity as well as the share of technology are quite distinct from Scenario EU.

5.3 Market Results and Conclusion

In this chapter the significant results of market analysis are described. Based on assumptions, the Scenario B – base case was considered as a reference scenario and other scenarios were compared to this scenario. In the case of sensitivity study Scenario B NPO the change of installed capacity caused in the simulation around 6 % higher production of CO_2 in the CCE region. The impact is also visible on marginal prices which are approximately 10 % higher (the highest impact – Germany around 13 % higher production marginal costs). Scenario EU with its assumption of high CO_2 price presented significant reduction of CO_2 emissions however the impact on prices is extreme, production marginal costs are around 80 % higher and in some countries more than double (Poland and Romania).

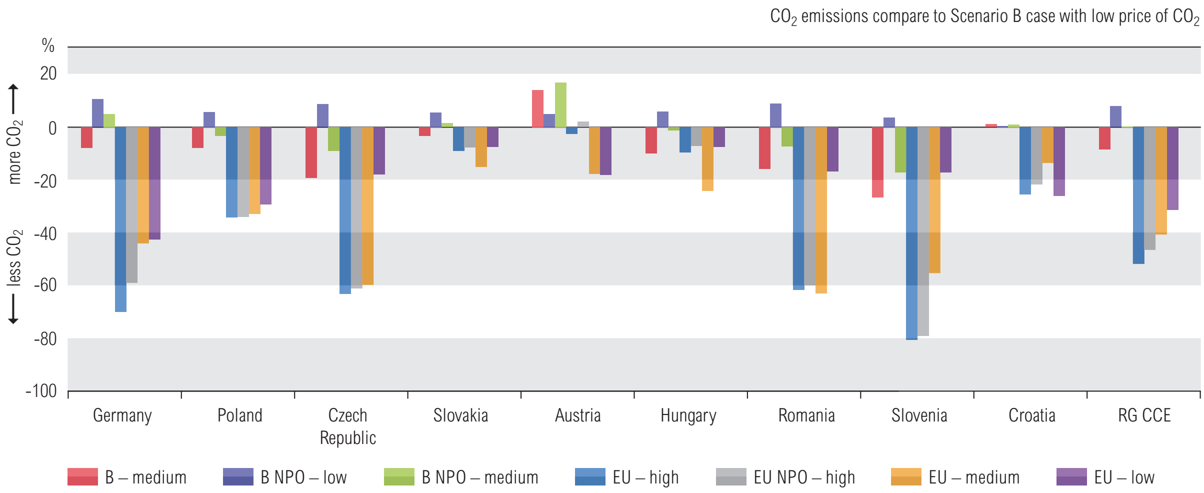


Figure 11:

Comparison of CO_2 production in analyzed market simulation

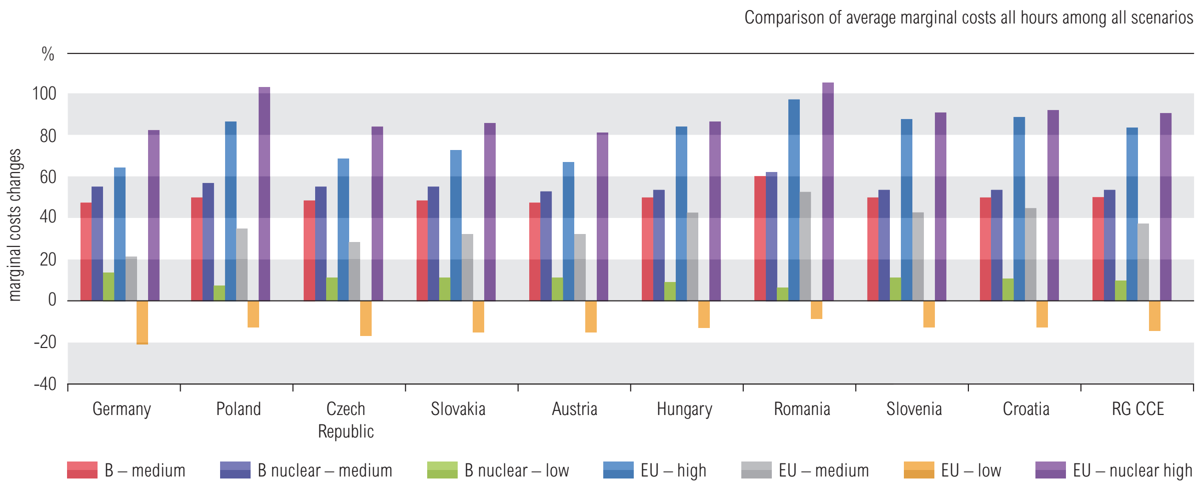


Figure 12

Comparison of different scenarios (price levels – marginal costs)

During the market simulations which were carried out, market exchanges and balances of each country in the CCE region were investigated.

SCENARIO EU: Importers in the region are Poland, Hungary Croatia and Germany. Exporters with more than 5 TWh are Austria and Czech Republic. The CCE region as a group is a net importer of nearly 6 TWh. Main exchanges were investigated between market areas (Germany – Austria, Czech Republic – Slovakia, Slovakia – Hungary, Austria – Hungary and Austria – Slovenia), however at this stage these exchanges in pure market, grid flows and exchanges could be different.

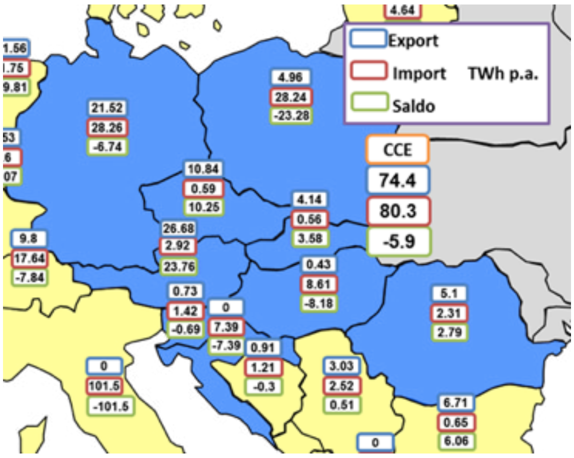


Figure 13:
Scenario EU balances

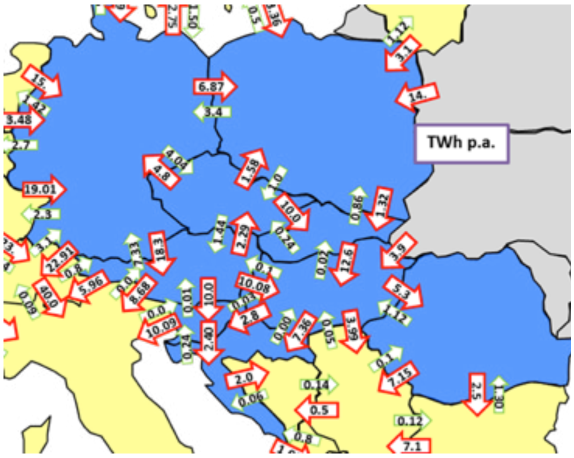


Figure 14:
Scenario EU market exchanges

For Scenario EU 2020 NPO which represents a top-down scenario driven by EU energy targets with Nuclear Phase Out, the CCE region is a net importer of nearly 30 TWh. The unavailable production of nuclear units (about 60 TWh) was covered half by other technologies in Germany and half by import.

SCENARIO B: Importers of the region are Poland, Hungary and Croatia. Exporters with more than 5 TWh are Czech Republic, Germany, Austria and Romania. The CCE region as a group is the net exporter of nearly 13 TWh. Main exchanges were investigated between market areas (Germany – Austria, Czech Republic – Germany and Poland – Germany), however at this stage these exchanges in pure market, grid flows and exchanges could be different.

For Scenario B NPO which represents sensitivity study with Nuclear Phase Out, the CCE region is a net importer of nearly 12 TWh. An unavailable production of nuclear units (about 60 TWh) was covered half by other technologies in Germany and half by import.

RG CCE investigated the impact of higher cross border capacity and also grid extensions which enable the connection of new generation for scenario EU 2020. The first column presents savings created by the enhancement of grid transfer capacity between countries whilst the second column presents savings caused also by planned new generation connected by enhancement of the grid.

	change transfer capacity	change transfer capacity and connection of a new generation
CO_2 reduction (ktons)	-4,553	-57,479
Generation costs savings(M€)	-389	-9,353

Table 3:
CO_2 emissions reduction and production costs savings in RG CCE

As a result of changes in the generation portfolio, an analysis was carried out in the form of market simulation, as to whether the risk from "loss of load" and "undelivered energy" had increased. Based on assumptions for all scenarios and simulated hours in the CCE region there is a low probability of loss of load. The number of hours is not identified when the system was not able to supply load. In the case of the criteria "energy not served" there appears several hours when part of the produced energy was not utilized and in total 0.4 TWh in Germany and 0.16 TWh in Poland for Scenario EU 2020. For Scenario B criteria – "dumped energy" is zero.

6 Investment Needs

As previously described, the recent developments in the electricity sector (implementation of market mechanisms and integration of renewable in feed on a large scale) have significantly changed system operation conditions on the continent, especially in its central area. Although most parts of the transmission networks in the central western and eastern/South eastern parts are highly meshed, they were not structurally constructed to handle today's huge power evacuation. Integration of wind farms and other renewable sources to power systems influences the operation of the latter in many ways, especially if done on a large scale. Among the main concerns seen from the perspective of the interconnected power systems on the continent are transit flows. Specifically, the intermittent nature of wind farms (and to some extent also photovoltaic units) changes the continent wide generation pattern and as a consequence also of the load flows occurring in the highly meshed systems. Over the latest decade, along with the expansion of wind generation in northern Europe, this has been the case on numerous network cross sections between TSOs in the central part of the continent or within their individual power systems.

The current power production from renewable energy sources especially from wind generation in northern Germany, Denmark, the North Sea and the Baltic Sea regions which is physically transported by the internal grids and also via transmission systems of neighboring countries to the southern/South-western parts of the continent has caused high transit flows in parts of the CCE region in certain situations. It is already well recognized that the remarkable progress in inter TSO operational co-operation over the last decade, as well as the efficiency of already developed and future operational remedial actions, regardless of their sophistication level, must be extended and supported by grid extensions in the near future.

Because of the above mentioned points, installation of PST is considered as a possible measure with which to solve congestion in Poland, Czech Republic and possibly also for other countries (TSOs) in the CCE region (e.g. Slovakia). The next step, although more difficult and much more costly shall be the new infrastructure erection mainly in Germany North-South and Northeast/Southwest direction (See Chapter 7).

6.1 Drivers of System Evolution

Transmission System Operators have to develop their grid to accommodate EU policy objectives without trusting the formal integrated planning of generation and consumption. The integration of huge amounts of renewable electricity production, the connection with storage capacities (e.g. pump storage power plants in the Alps) and the creation of a pan European supergrid to enable broad power transmission have been set high on the EU agenda. Wind and solar energy are intended to make a significant contribution; these sources are subject to considerable fluctuations under influence of the climate conditions and suitable regions. The earthquake in Fukushima has led to the decision by the German Government to close immediately (2011) eight nuclear power plants for an amount of 8281 MW and to close all German nuclear power plants by the year 2022. EU countries are undergoing stress-tests which could have an impact on the proportion of nuclear power in their generation mix in the near future. The introduction of massive renewable energy sources requires the re-modeling of the power system in order to make it more flexible.

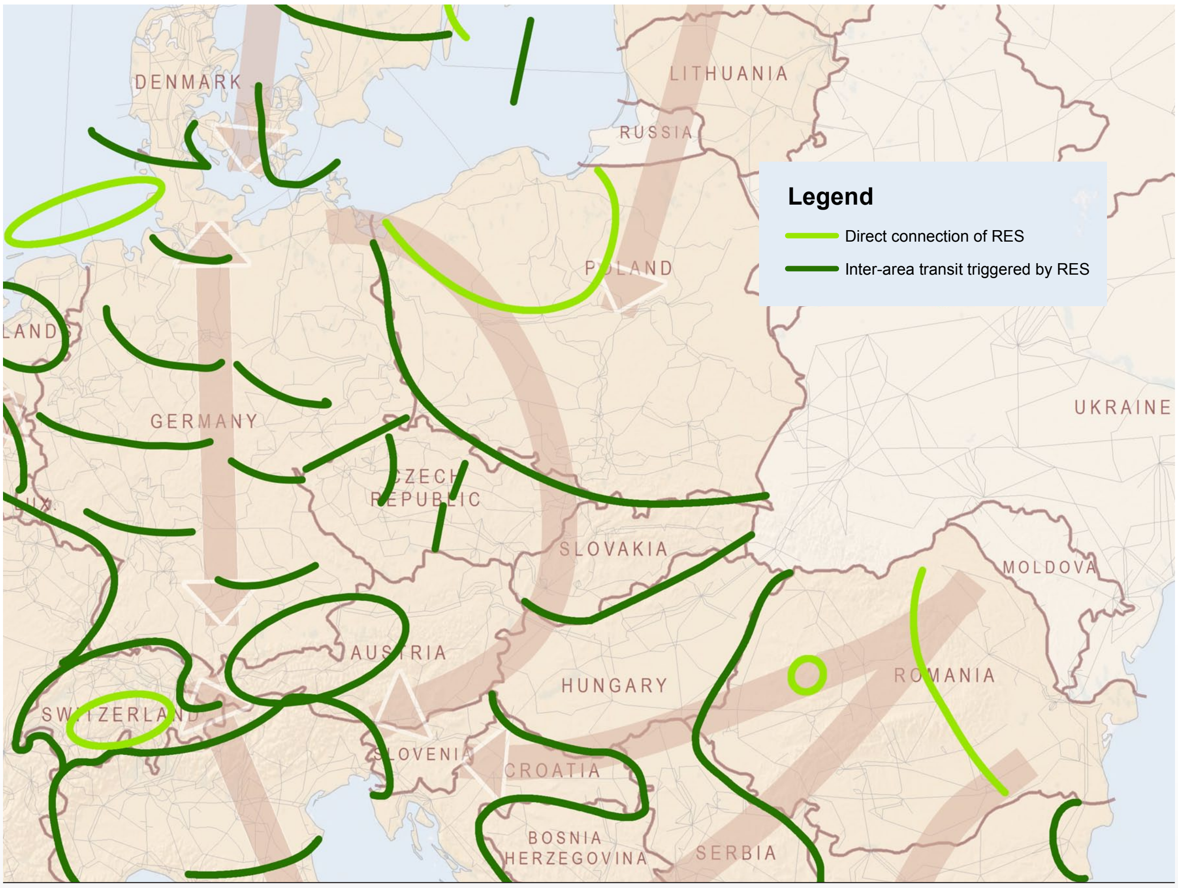


Figure 15:
RES integration impact on grid development in CCE region

As described above, the evolution of the generation mixes has a major impact on volatility and magnitude of the flows transported across the region. It goes from remote areas where low marginal cost production plants and RES are available to load centers crossing regions or countries. In the first stage it mainly impacts North-South and Northeast-Southwest transits. Nevertheless when further integrating the wind offshore in the Baltic Sea and Poland it will also impact the East-West transits.

Within the RG CCE therefore several scenarios were simulated to assess possible future market behavior, as well as the technical needs and options for an adequate future grid.

An overview of the main concerns is depicted in the following diagrams.

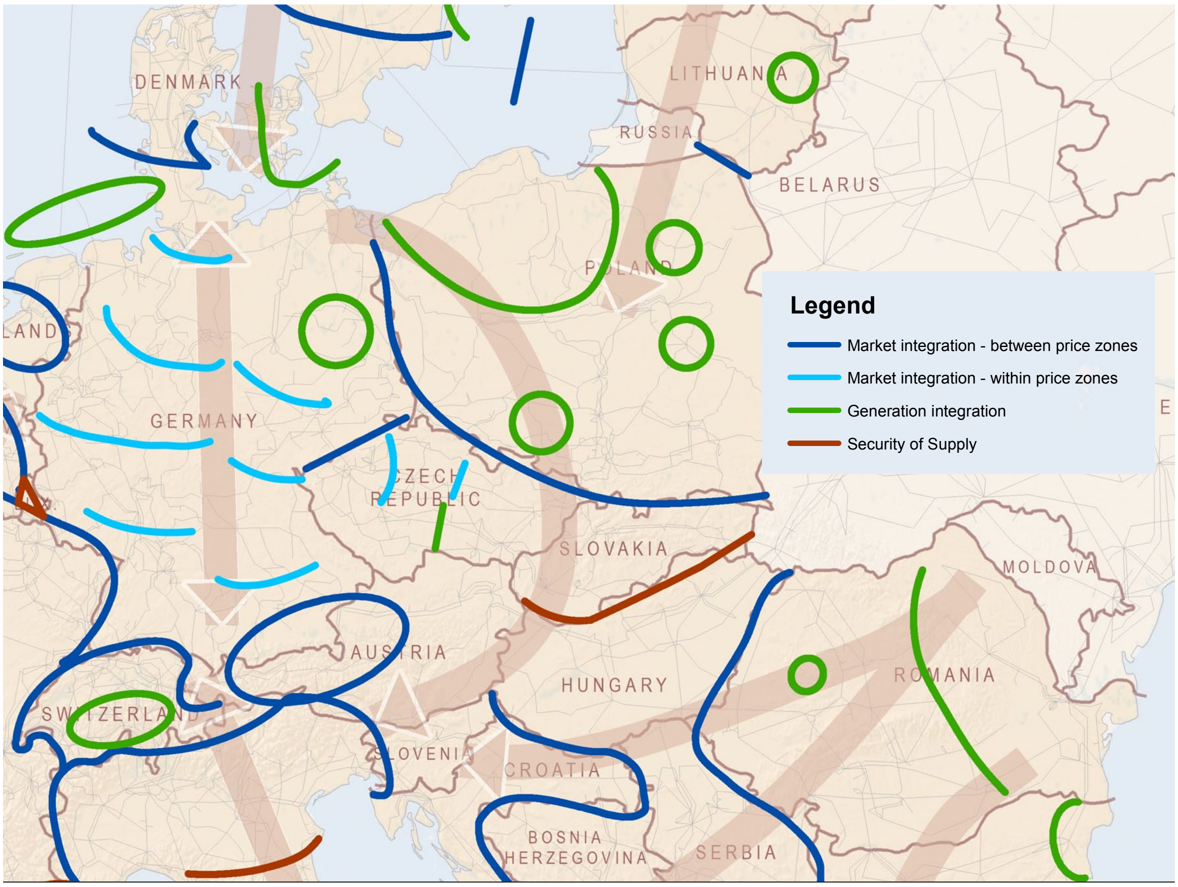


Figure 16:
Main concerns for grid development

The picture above identifies grid boundaries with information regarding what the main driver for grid development is and what kinds of electricity generation will be integrated.

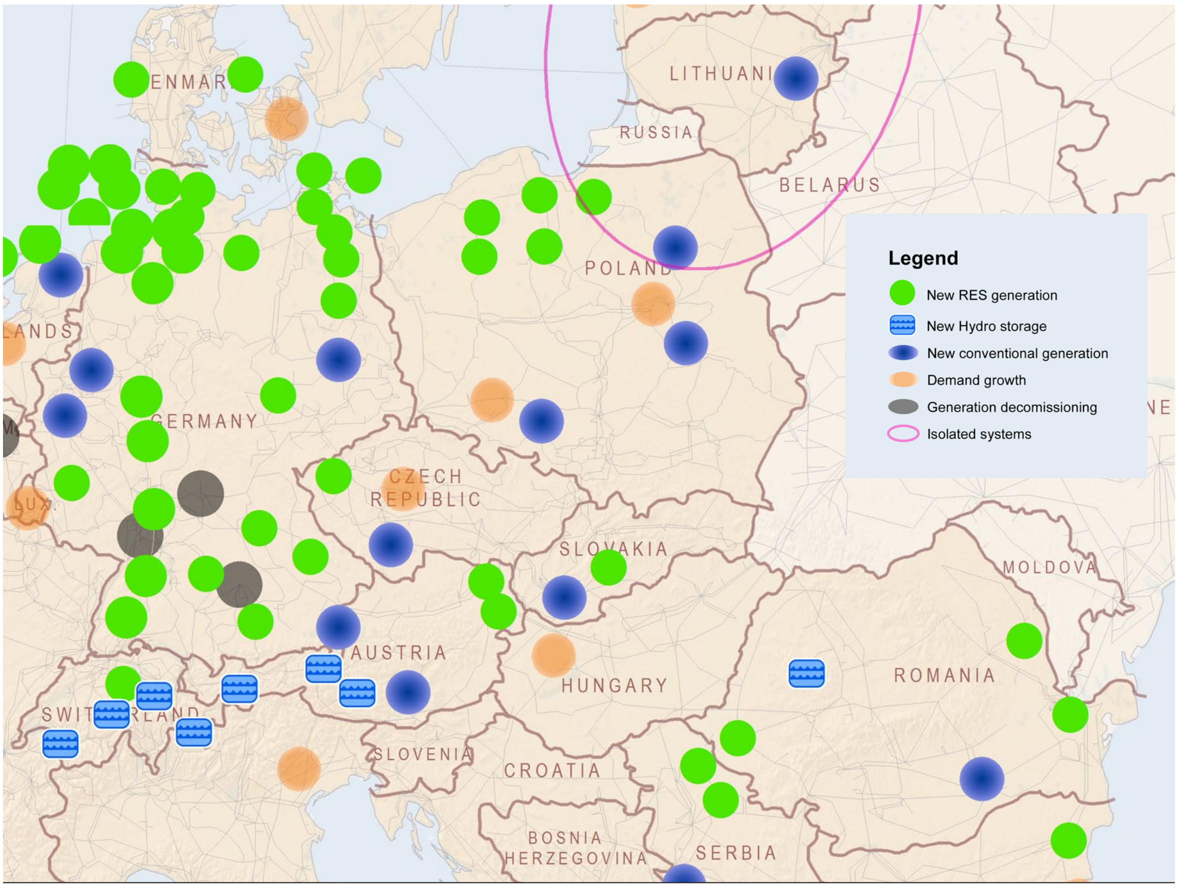


Figure 17:
Main drivers for grid development in next 10 years

The picture depicted above displays the identified boundaries as well as areas with high changes of generation capacity. Generation evacuation as well as decommissioning is also presented.

6.2 Bulk Power Flows in 2020

Looking at long-term developments, in the EU energy roadmap 2050 background paper the state of play and its perspectives is summarized as follows: “The EU has committed to reducing greenhouse gas emissions to 80 – 95 % below 1990 levels by 2050 in the context of necessary reductions by developed countries as a group. The European Council has recognized that this commitment will require a revolution in energy systems, one which must start now, and is looking forward to the elaboration of a low carbon

2050 strategy providing the framework for the longer term action in the energy and other related sectors".

It is quite certain that the gap between the rate of increase of RES in the northern part of the region and its evacuation possibilities in the direction of North-South, Northeast-Southwest and West-East as well as the construction of required grid infrastructure investments shall increase.

The resulting bulk power flows in 2020 are shown in the following map:

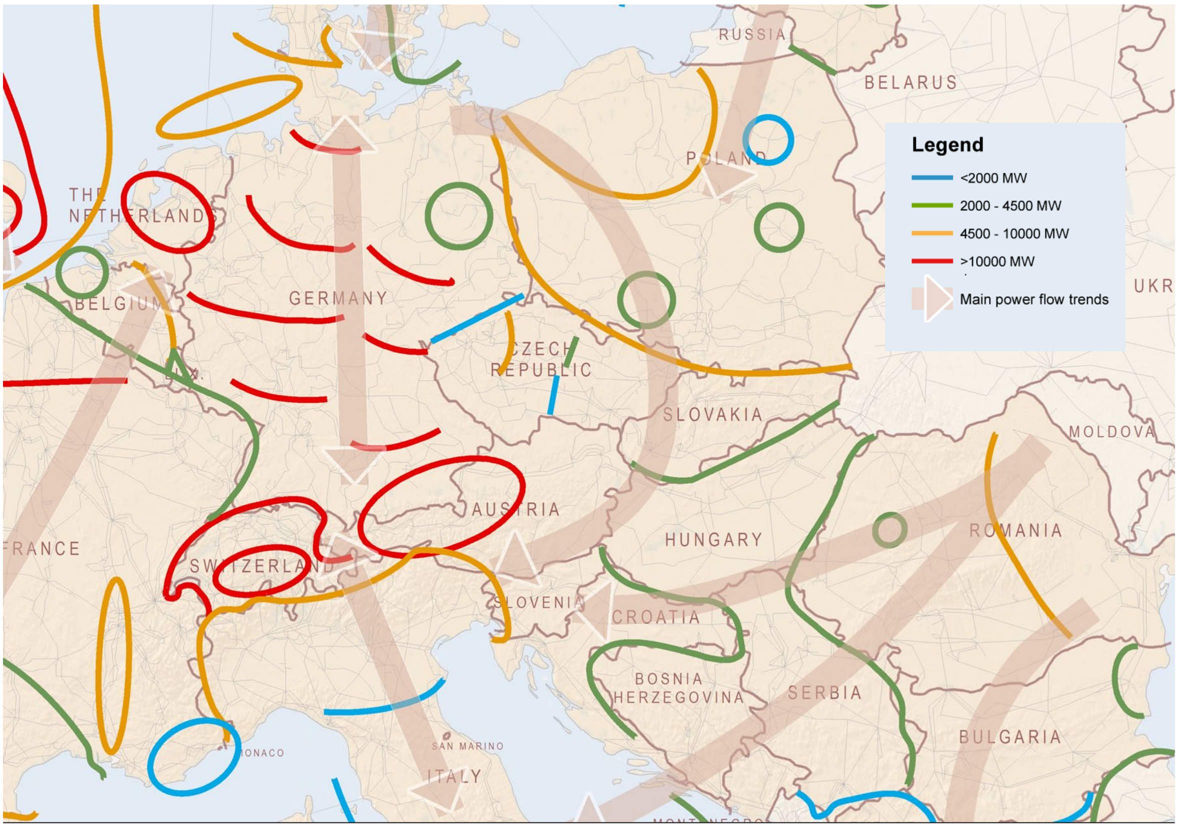


Figure 18:
Expected bulk power flows for year 2020

These bulk power flows will be facilitated by investments as outlined in the next chapter.

7 Investments

Investments in this RgIP are divided into two main categories.

- The first and most important is the category of projects of European significance. A project is assessed as European significant if it basically addresses at least one of the three following pillars of the EU energy policy: Security of Supply; integration of RES and fight against climate change. Social and economic welfare and realization of the Internal Electricity Market. Technical resilience.
- The second category consists of the investments which do not contribute to grid development on a pan European level; however they are important at the local level. This group of investments is further divided into investments of regional importance and investments of national importance.

7.1 Criteria for Including Projects

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

The main equipment is at least 220 kV if it is an overhead line AC or at least 150 kV otherwise and is, at least partially, located in one of the 32 countries represented in TYNDP.

- Altogether, these assets contribute to a grid transfer capability increase across a network boundary within the ENTSO-E interconnected network (e.g. additional NTC between two market areas) or at its borders (i.e. increasing the import and/or export capability of ENTSO-E countries vis-à-vis others).
- An estimate of the abovementioned grid transfer capability increase is explicitly provided in MW in the application.
- The grid transfer capability increase meets at least one of the following minimums:
  - At least 500 MW of additional NTC; or
  - Connecting or securing output of at least 1 GW/1000 km^2 of generation; or
  - Securing load growth for at least 2 years for an area representing consumption greater than 3 TWh/yr.

Projects of Regional and National significance were defined according to the two basic criteria:

- Regional project is the project which affects at least two members of RG CCE.

– National project is the project which concerns only one country.

However, if respective TSOs decide to include any project from one of the previously mentioned categories to in the opposite category (i.e. from Regional to National and vice versa), such change was accepted.

7.2 Projects of pan-European Significance

The Regional Investment Plan of the CCE Region contains 34 projects of Pan–European significance .The most likely benefit stemming from the implementation of these projects is the increase of grid transfer capacity; that is, the ability of the grid to transport electricity across a boundary, from one area (price zone, area within a country or a TSO) to another.

The need for increase in GTC is induced by the integration of renewable and conventional energy sources into the grid and by consequent power evacuation and transmission to enhance the security of the power supply and to support market integration.

CCE Region assesses projects according the project impact indicators:

The **Social and economic welfare** on electricity markets is characterized by the ability of a power system to reduce congestion and thus provide adequate grid transfer capability, reflecting the needs and willingness to pay of market players and consumers:

– Light green: the project represents a minor contribution to the total regional investment plan, that is, it has an annual benefit of < € 30 million;

– Medium green: the project represents a medium contribution to the total regional investment plan, that is, it has an annual benefit of between € 30 and € 100 million;

– Dark green: the project represents a major contribution to the total regional investment plan equal to or greater than € 100 million/year.

– the share of projects which also give access to the grid for a new generation is striped with the corresponding background.

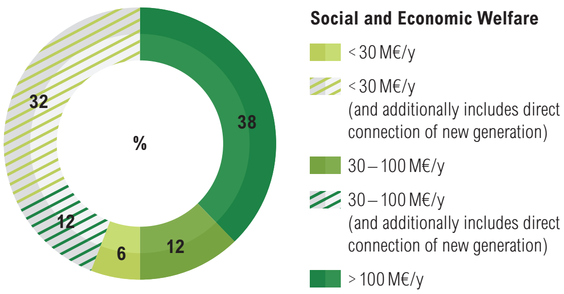


Figure 19:
Impact of CCE projects on the Social and Economic Welfare

The integrating RES production is defined as the ability of the system to allow the connection of new RES plants and to unlock existing "green" generation, while minimizing curtailments. There is a fundamental difference between direct connection of RES lower than 500 MW and more than 500 MW. In addition, the share of projects enables inter-area flows triggered by RES; information regarding which is depicted in the diagram.

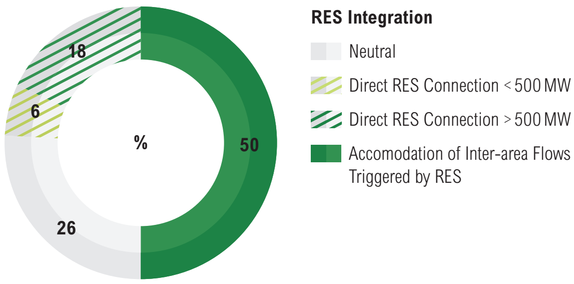


Figure 20:
Impact of CCE Projects on the RES Integration

The reduction of CO_2

- White: the project has no positive effect on CO_2 emission;
- Medium green: the total number of projectsa reduces CO_2 emissions by < 500 kt/year;
- Dark green: the total number of projects reduces CO_2 emissions by > 500 kt/year.

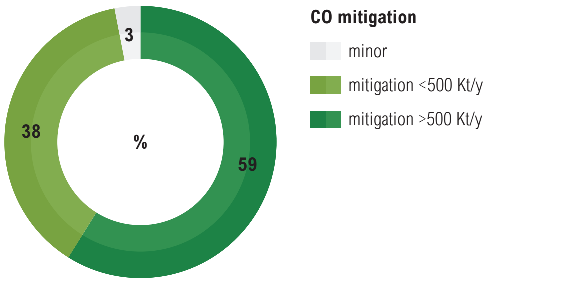


Figure 21:
Impact of CCE Projects on the reduction of CO_2 emission

Losses variation in the transmission grid is the characterization of the evolution of thermal losses in the power system.

- Red: the project contributes to an increase in the volume of losses on the grid;
- White: "neutral = no clear trend" – the project may help to decrease losses on the grid in some situations whilst increasing them in others;
- Green: the project contributes to decreases in the volume of losses on the grid.

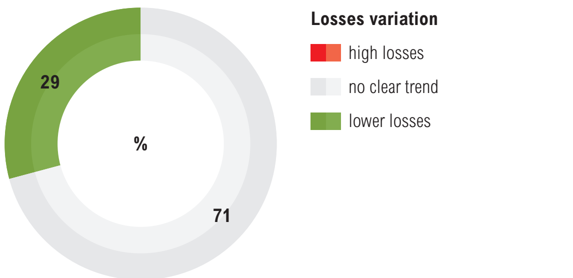


Figure 22:
Impact of CCE Projects on the of thermal losses in the power system

The risk of security of supply demonstrates the ability of a power system to provide an adequate and secure supply of electricity in normal conditions, in a specific area.

- Light green: the project will not improve security of supply with regards to supplying electricity for normal contingencies during the ten years following its commissioning;

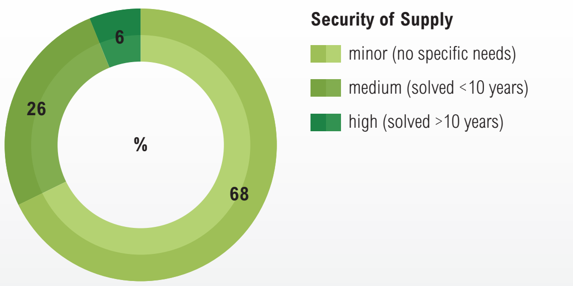


Figure 23:
Impact of CCE Projects on the risk of security of supply

– Medium green: the project improves the security of supply during the ten years following its commissioning;

– Dark green: the project completely eliminates the risk to security of supply during the ten years following its commissioning.

Technical resilience/system safety is the ability of the system to withstand increasingly extreme system conditions, especially exceptional contingencies: failure combined with maintenance, steady state criteria, and voltage collapse criteria.

A quantitative summation of the technical resilience and system safety margin of a project is performed by scoring a number of key performance indicators (KPI) and aggregating these to provide the total impact of the project, resulting in light, medium or dark green flags.

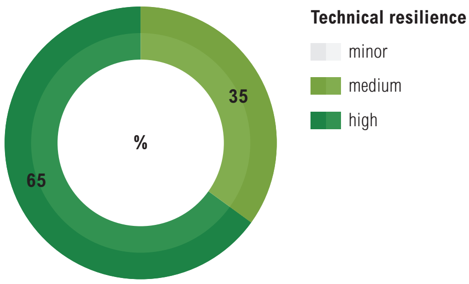


Figure 24:
Impact of CCE Projects on the ability of the system to withstand extreme system conditions

– White: the project makes a minor contribution to the overall technical resilience – the score of KPI's is 0.

– Medium green: the project makes a medium contribution to the overall technical resilience – the score of KPI's is < or = 4+.

– Dark green: the project makes a significant contribution to the overall technical resilience – the score of KPI's is > 4+.

Flexibility is the ability of the proposed projects to serve in different possible future development paths or scenarios: robustness to changes in demand, robustness to changes generation portfolio, compliance with all scenarios, ability to adapt to the project.

A quantitative summation of the flexibility and robustness of a project is performed by scoring a number of key performance indicators (KPIs) and aggregating these to provide a total impact of the project, resulting in light, medium or dark green flags.

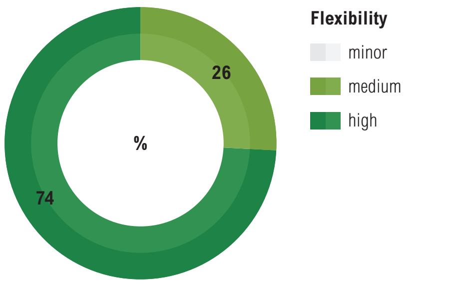


Figure 25:
Impact of CCE Projects on the flexibility of System

– White: the project may result in stranded costs if faced with an adverse scenario – the score of KPI's is 0.

– Medium green: the project is flexible, that is, it should adapt to all likely foreseen situations – the score of KPI's is < or = 9+.

– Dark green: the project demonstrates high flexibility, that is, it can adapt to all foreseen situations, even those with low levels of probability – the score of KPI's is > 9+.

7.2.1 Mid-term (incl. 2016)

Mid-term Investments are all project investments expected to be commissioned by end of year 2016.

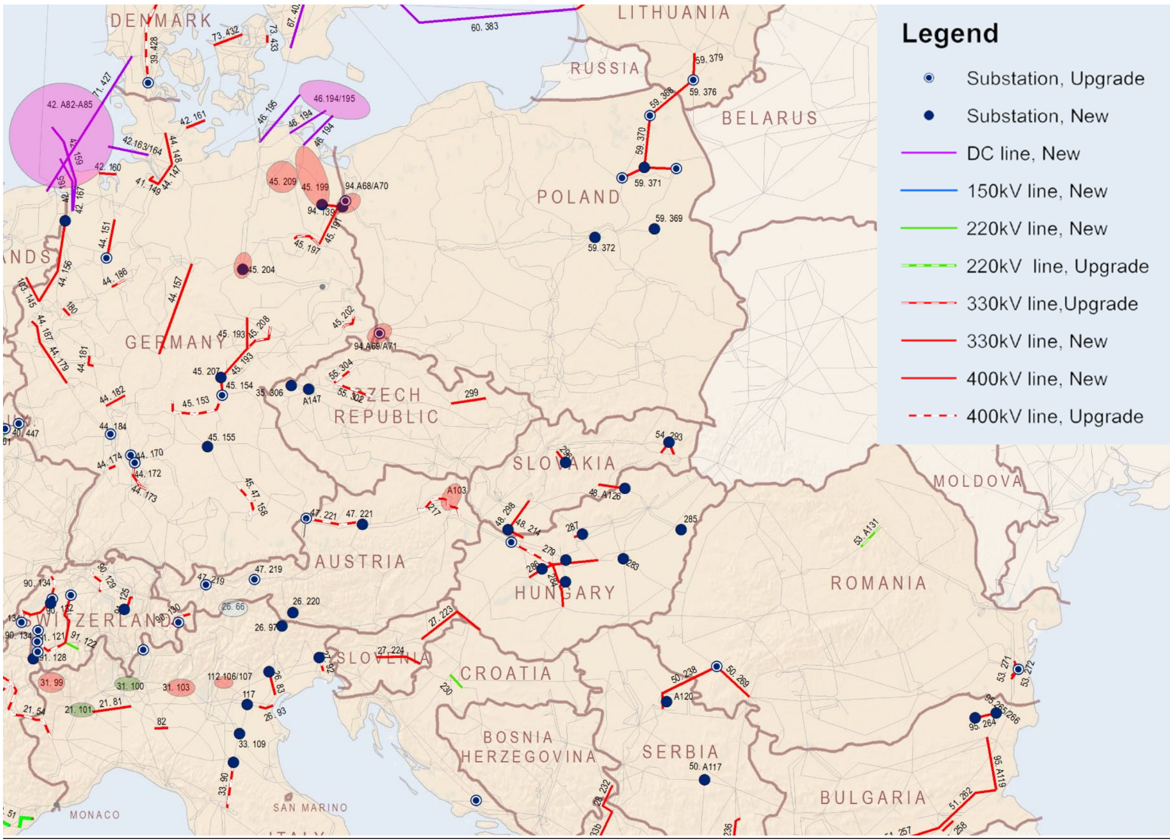


Figure 26:
Particular projects for mid-term horizon in CCE region

7.2.1.1 Czech republic grid infrastructure corridors (MT & LT)

In accordance with its mid- and long-term plans Czech Republic has defined its important corridors which shall facilitate the connection of electricity infrastructure in northern Europe with the electricity infrastructure in Central Eastern Europe in order to be able to transport electricity in a North-South direction and to deal with infrastructure gaps in this region. The three grid infrastructure corridors Northwest, North-south and West-east altogether as identified in Appendix 1 are combinations of projects which either must be upgraded and modernized or be newly-built in order to meet increasing electricity flows due to a major shift in the overall energy value chain and mix.

7.2.1.2 German West and East Corridor (MT)

Due to the strong increase in RES generation, meeting the goals of the new European and especially German energy policy connections between areas with high installed capacities of RES and areas with high consumption and storage capabilities is necessary.

For this reason the development of new North-South and Northeast-Southwest electricity transmission capacity in Germany is necessary. For the mid-term time horizon the necessary gird development in Germany is covered by common projects western and eastern corridor.

The German West corridor starts in the North-West of Germany, an area with high surplus of RES production (planed and existing) and connections with Scandinavia (planed and existing). It continues to the Rhine-Ruhr area (high consumption and a vast amount of a conventional power generation).

The German East corridor begins in the North-East of Germany, an area with high RES generation (planed and existing), conventional generation and connections with Scandinavia (planed and existing).

Both corridors end 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).

7.2.1.3 Poland (MT)

Installation of PSTs on two existing lines (Krajnik-Vierraden and Mikułowa-Hagenverder) on the PL/DE border (Ger-Pol Improvements (94)) together with necessary investments contributes to the following:

- decreasing of transit flow from Germany to Poland, Poland to Czech Republic and Poland to Slovakia; 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 after commissioning in 2014.
- greater level of safety and reliability of operation of the transmission network in Poland due to enhanced control of power flow.
- meeting EU requirements in terms of RES integration.

Analyses have been conducted regarding whether additional investments are necessary in Germany due to this project having not been finished.

7.2.1.4 Romania (MT)

A part of project 50 is planned for MT, namely investment OHL 400 kV Portile de Fier-Resita the rest of it is for LT.

Also, a part of project 53 is planned for MT: OHL Stejaru-Gheorghieni- will pass from 220 kV to 400 kV, and tie lines with Bulgaria, Isaccea-Dobrudja and Isaccea-Varna will pass through 400 kV substation Medgidia Sud.

7.2.1.5 Slovak – Hungarian cross-borders capacity increase (MT)

The main driver of these project investments is a need to increase GTC on the SK – HU profile. This border is highly exposed to loop flows from North to South, thus strengthening this cross-border profile also improves operational security in both countries. The internal investments (lines in SK, transformers in HU) are needed in order to be able to fully utilize the capacity increase provided by the tie-lines.

7.2.1.6 Slovenia (MT)

To ensure safe and reliable operation of the Slovenian power system with the goal of increasing capacity and reliability of electricity transmission between central-southern, central-eastern and South-eastern Europe, the Slovenian transmission system requires considerable reinforcements. In order to strengthen security of supply, increase resilience and flexibility of the transmission network, new investments are necessary to accommodate RES integration and conventional generation which are expected in the related countries. This project will also remove congestion on North-South and East-West axes. The new mid-term investments are; 400 kV double OHL Beričevo – Krško which is under construction. This is followed by the new interconnection lines with Hungary and Croatia (double OHL 400 kV Cirkovce – Hévíz (HU)/Žerjavinec(HR)).

7.2.1.7 Croatia (MT)

All projects from Croatia are in the long-term horizon.

7.2.1.8 Austria (MT)

In the northern part of Austria the existing 380 kV-OHL between St. Peter (AT) and Ernsthofen (AT), which is currently operated with 220 kV, is scheduled to be upgraded to 380 kV. Therefore new 380 kV substations must be erected both in Ernsthofen and in St. Peter. The project is an important step to achieving the planned 380 kV Ring structure as the backbone of the Austrian transmission grid and the basis for the future security of supply. This project constitutes a powerful connection of the grid node St. Peter and is important for the reinforcement of the interconnection between Austria and Germany which is planned for the long-term. As an additional benefit it also strengthens the West-East connection in Austria and therewith facilitates the meaningful interaction between volatile RES-production (mainly Wind) in the eastern areas and pumped storage plants in the region of the Alps.

In the eastern part of Austria, an increase of approximately 2000 MW of the installed wind power capacities is planned. With the existing grid infrastructure this huge increase cannot be integrated. To allow for the connection and efficient integration of the planned wind capacities it is necessary to reinforce the transmission grid in the Weinviertel region and to install the 3rd and 4th system to the existing 380 kV OHL Dürnrohr – Sarasdorf. Moreover, the installation of the 3rd and 4th system is an essential means by which to improve the security of supply for Vienna and allows more flexibility in grid operation.

In the southern part of Austria the installation of a 220/220 kV-phase shifting transformer (PST) in the existing substation Lienz is foreseen. It will mainly be used to achieve a secure and optimized operation of the 220 kV tie-line Lienz (AT) – Soverzene (IT), in particular at peak times. Expected benefits are an improvement of security of supply for the region (no more special circuit switching), a reduction of congestion management costs and an optimized operation of the tie line AT-IT.

Moreover, an upgrade of the existing 110 kV/132 kV single circuit OHL Prati di Vizze (IT) – Steinach (AT), currently operated at medium voltage, and the installation of a 110/132 kV PST in Steinach (AT) is planned to strengthen the interconnection between Austria and Italy. In Austria the line connects to the distribution grid of TIWAG-Netz AG.

7.2.2 Long-Term (2017+)

Long-term Investments are all project investments expected to be commissioned in 2017 and beyond.

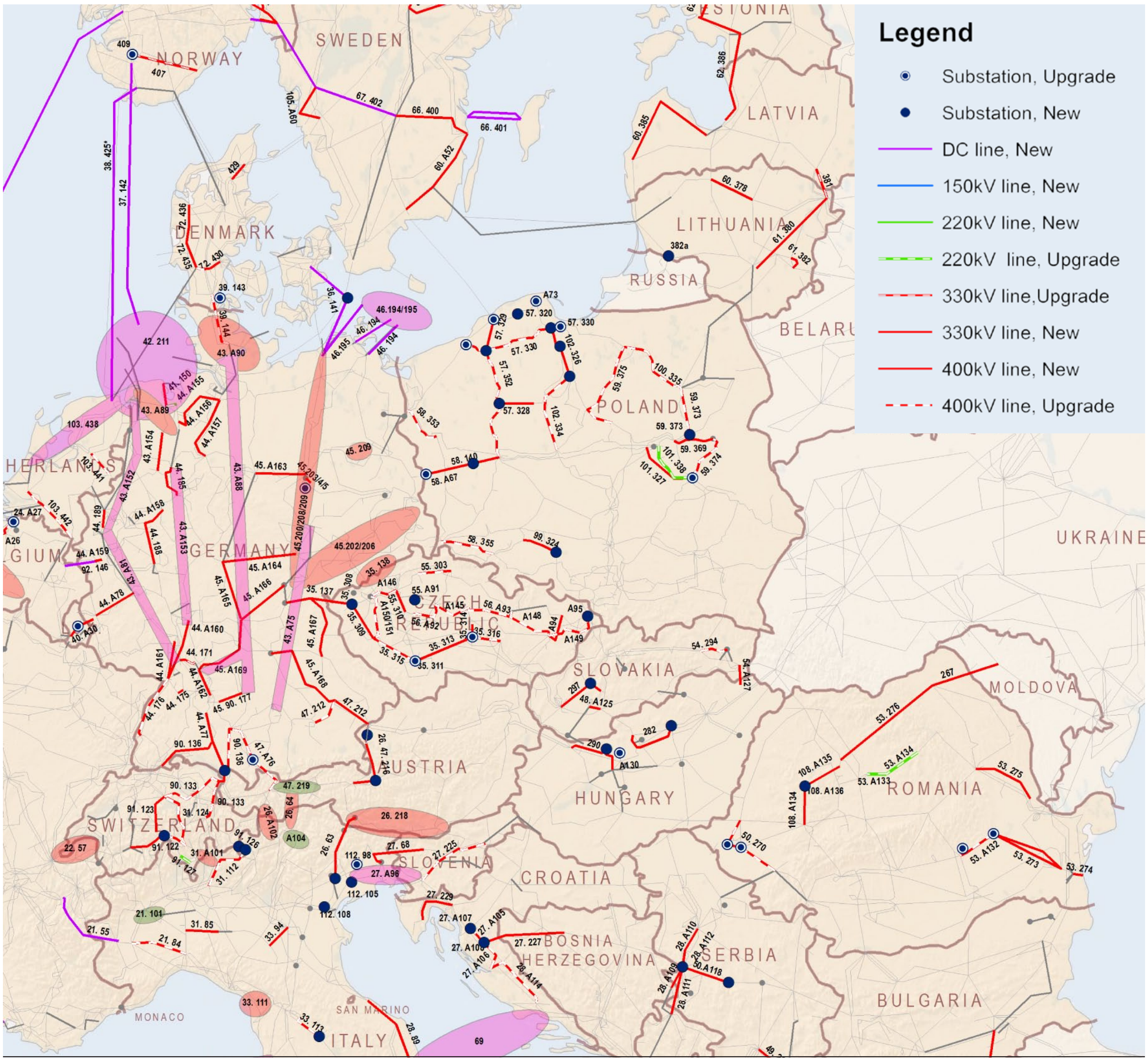


Figure 27:
Particular projects for long-term horizon in CCE region

7.2.2.1 German West and East Corridor (LT)

In addition to the mid-term projects German West and East Corridor, for the long-term time horizon the foreseen RES generation (especially wind) in northern Germany, the increasing geographical imbalance between generation and consumption, as well as the long distances separating generation and consumption regions would require additional grid extension inside Germany. The needs for transportation over long distances, as well as the need to improve the grid stability regarding dynamic and static voltage play in favor of HVDC technology.

For this reason, the German TSOs are considering several DC-connections which allow for North – South and Northeast – Southwest power flow whilst also enhancing the grid stability. These projects are being considered in order to enable future evolution of the generation and consumption patterns.

7.2.2.2 Poland (LT)

The construction of a new (third) interconnection between Polish and German systems (Ger-Pol Power Bridge (58)) contributes to the following:

- increasing market integration between member states – additional NTC of 1500 import and 500 MW export on PL – DE/SK/CZ synchronous profile – compared to current situation (0 MW import and 1000 export).
- improving network security – project contributes to increase of security of supply and flexibility of the transmission network (security of supply of Poznań agglomeration area).

The projects pertaining to the construction of a set of high voltage investments allowing connection of new RES (wind) and conventional generation (Wind Integration (57) and Power Evacuation North (102)) contribute to the following:

- allow for connection and evacuation in the southern direction (to consumption centers) new RES (wind) energy sources as well as conventional energy sources planned to be installed in northern Poland;
- allow for the connection of planned off-shore super-grid to the rest of the network of central Europe and transit RES (wind off- and on-shore) to consumption centers in central Europe.
- increases the cross-border (existing Poland – Sweden DC connection) capabilities. After commissioning of the project it will be possible to build a second (the need indicated in studies) DC link to Sweden and transit RES energy from the Scandinavian power system to consumption centers in continental Europe.
- facilitates the connection of 5000 MW of RES generation (wind) and 2900 MW of conventional generation (2000 MW conventional power plant connected to new, planned Pelplin substation plus 900 MW conventional power plant connected to Gdańsk Błonia substation).

– contributes to supply and demand balance through additional generation capacity in entire region of CCE.

– meets EU requirements in terms of RES integration.

The projects entailing construction of a set of high voltage investments allowing for the connection of new conventional generation for the supply of Wrocław and Warsaw agglomeration areas as well as North-eastern Poland (101, 99, 100) contribute to the following:

– providing secure and reliable power evacuation and improving security of supply for Warsaw (101) and Wrocław agglomeration areas as well as the lower Silesian region bordering with Czech Republic (99).

– allowing export of energy to Czech Republic under normal conditions and in emergency situations – the new generation units are located near the Czech border – (99).

– allowing export power to the Baltic States (Lithuania, Latvia, Estonia). The planned interconnection with Lithuania has NTC equal 1000 MW both directions, increasing the safety and reliability of network operation in the North – eastern part of Poland (100).

– contribution to supply and demand balance through additional generation capacity in the CEE region.

7.2.2.3 Romania (LT)

Project 53 comprises investments in Romania which aim to accommodate the safe integration of a large amount of RES (mainly wind farms) expected in eastern Romania in the areas of Dobrogea and Moldovia. The expected increase in transfer capacity between these areas and the rest of the system is 2000-2500 MW. The completion of all the investments comprising this project will allow for the integration of RES of total installed capacity in the range of 2500 – 3330 MW.

Project 108 is also a purely Romanian project. The completion of the relevant investments allows for the integration of a new pump storage hydro plant of 1000 MW installed capacity in the vicinity of Tarnita. This plant will assist greatly in the safe operation of the Romanian as well as the entire Regional power system.

Project 50 aims to increase the power transfer capacity from Romania to Bulgaria which is the direction of main exports towards Serbia and Hungary. It is worth mentioning that this project combined with Project 31 creates a 400 kV corridor from Romania towards the ME – IT DC cable. Expected increase in transfer capacity across the respective boundary is in the order of 1000 MW upon the completion of all the investments comprising this project. It must also be mentioned that investments comprising this project will allow for the safe integration of around 1500 MW of new RES installations in Serbia and 750 MW of new RES installations in Romania.

7.2.2.4 EAST Slovak – Hungarian cross border capacity increase (LT)

This is a multipurpose project with main targets: GTC increase and operational security. An additional driver is the concern regarding the future of the western Ukrainian grid (Burshtyn Island) which is highly uncertain as Ukraine seems to be reluctant to invest in the development of their grid. The tie-line investment is still bilaterally studied.

7.2.2.5 Slovenia (LT)

The long-term investment will remove the remaining network restrictions by upgrading internal 220 kV network to 400 kV level between Cirkovce and Divača. The new double OHL 400 kV is planned to be built between Slovenia and Italy (Okroglo (SI)-Udine (IT)) in order to increase power exchange capacity. In order to strengthen the IT-SI border connection a new HVDC interconnection is in the pre-feasibility study phase.

7.2.2.6 Croatia (LT)

Long-term investments in Croatia are part of Project 27, which aims predominantly to increase transfer capacity in East-West direction and to accommodate new RES and conventional generation expected in this part of the Region. These investments are also part of Project 28, which is primarily associated with a new DC link Between Italy and Montenegro.

Considerable network reinforcements are foreseen in Croatia – new single circuit 400 kV OHL replacing the aging 220 kV OHL between substations Brinje and Konjsko, interdepending on the construction of two new 400/(220)/110 kV substations Brinje and Lika. These investments also include a new double circuit 400 kV OHL Plomin-Melina, together with a new SS 400/220 kV Plomin, which will enable the connection of a new 500 – 550 MW generation unit in existing thermal power plant Plomin. The establishment of a new 400 kV corridor between Bosnia & Herzegovina and Croatia, new OHL Banja Luka (BA) – Lika(HR) is also foreseen.

At the same time all highlighted investments will facilitate the safe integration of more than 1,5 GW RES in Croatia and neighboring countries whilst also enabling the removal of internal congestion on the North-South axis in order to strengthen security of supply in this part of the Region.

Expected increase in transfer capacity in the respective boundary is in the order of 1700 MW upon the completion of the investments comprising the Project.

Additionally, strengthening of the 400 kV corridor across the Adriatic coast in Croatia in LT will accommodate power transfers from Croatia and Bosnia-Herzegovina to Italy through new DC link between Italy and Montenegro. This set of relevant future investments will support the full utilization of this new DC link capacity.

7.2.2.7 Austria (LT)

Grid reinforcements within Austria are urgently needed in order to cope with the volatility of grid loadings due to changes in electricity generation and load patterns. In particular the huge increase of wind power in North Europe (mainly Germany) and in the eastern part of Austria as well as the close interaction with existing and planned pump storage plants located in the central Alps contribute to these changes.

To strengthen the connection between Austria and Germany a new 380 kV double circuit OHL between St. Peter (AT) and Isar/Ottenhofen (DE) as well as an upgrade of the existing OHL between Westtirol (AT) and Vöhringen/Leupolz (DE) is planned for the long-term period.

In combination with the 380 kV Salzburgline St. Peter (AT) – Tauern (AT) and other internal investments which are planned in the long-term period, the meaningful interaction of the rapidly growing volatile renewable energy production in North-Europe (mainly Germany) and wind power in the eastern area of Austria with the green batteries in the Alps (pumped storage power plants) is facilitated. Another substantial benefit – namely a strong European North-South-axis is realized in combination with the 380 kV cross-border project from Lienz (AT) to the Veneto Region (IT) in the southern part of Austria. In summary, an essential contribution to the internal energy market and a facilitation of the meaningful interaction between RES production and pump storages and therewith the efficient integration of RES can be achieved. Two further interconnection investments between Austria (Tirol) and Italy with a time schedule beyond 2022 are currently under consideration.

A further essential investment is located in the South of Austria (mainly Carinthia). There, a reinforcement of the transmission grid between Lienz (AT) and Obersielach (AT) is planned for the long-term. Together with the mentioned 380 kV Salzburgline St. Peter (AT) – Tauern (AT) the 380 kV Ring structure in Austria can be finalized. The therewith established 380 kV Ring is the planned backbone of the Austrian transmission grid constituting the basis for future security of supply. Moreover, with the reinforcement in Carinthia a further connection between the RES in the eastern areas to the pump storages in the Alps and to the interconnection to Italy can be achieved.

7.2.3 3rd Parties Promoted Projects

The RG CCE does not consider any project or investment including Non-ENTSO-E members in its Regional Investment Plan.

7.3 Investments of National and Regional Importance

7.3.1 Introduction

This chapter includes investments of national and regional importance which have not been included in the projects of Pan-European significance due to the fact that they have not met any criteria set for the projects of pan-European significance. These criteria are summarized in Chapter 7.2. The total number of these investments is 89.

For a detailed description and information about the investments of national and regional importance see Appendix 1.

7.3.2 Criteria for National and Regional Investments Selection

The basic idea for the selection of investments of national and regional importance is the following:

– Realisation of the investments of national importance is considered only within an area of one country within the CCE region.

– Erection of the investments of regional importance is based on the assumption that these represent international connections between two countries. This group mainly comprises cross-border line.

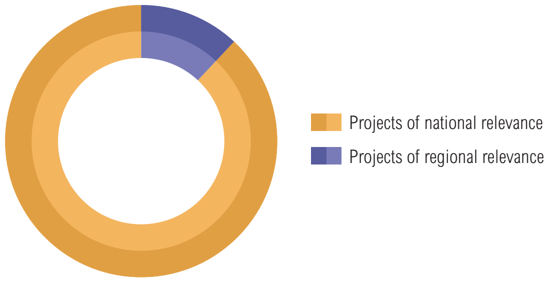


Figure 28:
Investments of national and regional significance

7.3.3 Investments of National Importance

The total number of the investments of national significance is 68.

Mid-term (Incl. 2016)

Sixty-eight investments are included in the middle term period. It represents 61 % of all nationally significant investments. Twenty of these are under construction or are midway through design and permitting procedures. Fourteen investments were already completed, meaning there is a high probability that they have been put into operation. The list also includes two investments which were canceled. They are the following Polish investments: Halemba substation and 400 kV single circuit line between Pątnów and Włocławek substation.

Long-term (2017+)

Twenty-four of these investments will be commissioned in the long-term period and represent 39 % of all nationally important projects.

The list of investments also includes several new projects which were not included in TYNDP 2010. These are projects whose date of commissioning is in the long-term period.

Figure 29 shows the percentage of the national importance projects according to their time horizon of commissioning.

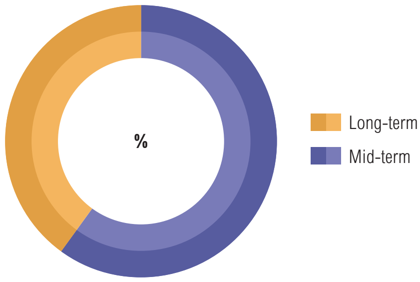


Figure 29:
Investments of national significance

7.3.4 Investments of Regional Importance

The total number of regionally significant investments is 19.

- **Mid-term (Incl. 2016)**
  Five of these investments have already been completed, meaning that they have most likely been put into operation. In addition, one investment, namely TPP Sisak– Mraclin/Prijedor is currently in the permitting process.
- **Long-term (2017+)**
  With regards to the long-term period certain investments are postponed to long-term due to delays in the process of connecting the Ukraine and Moldova system to the European synchronous system.

During the time period of consultation process several new investments in long term were identified as complementary investments to meet increasing electricity flows (especially in Czech Republic). Information is in Appendix 1.

7.3.5 The Expected Benefits of Investments of National and Regional Importance

The investments of national and regional importance are assessed with the benefit indicators likewise those of the pan-European significance. These indicators pinpoint the benefits of national and regional investments in the area of security of supply (SoS indicator), integration of renewable energy sources (RES indicator), and increase in NTC that can have a positive effect in the electricity market integration in some cases (Market indicator).

7.3.5.1 Investments of national significance

Benefits in the area of SoS improvement result from 54 of the national investments.

Benefits in the area of RES integration result from 10 of the national investments.

The investments that support RES integration are mostly in Germany. These investments aim at strengthening or increasing of transmission capacity in north-south direction by erection of new transmission lines or by upgrading of the existing lines.

Benefits in the area of market electricity result from 23 of the investments.

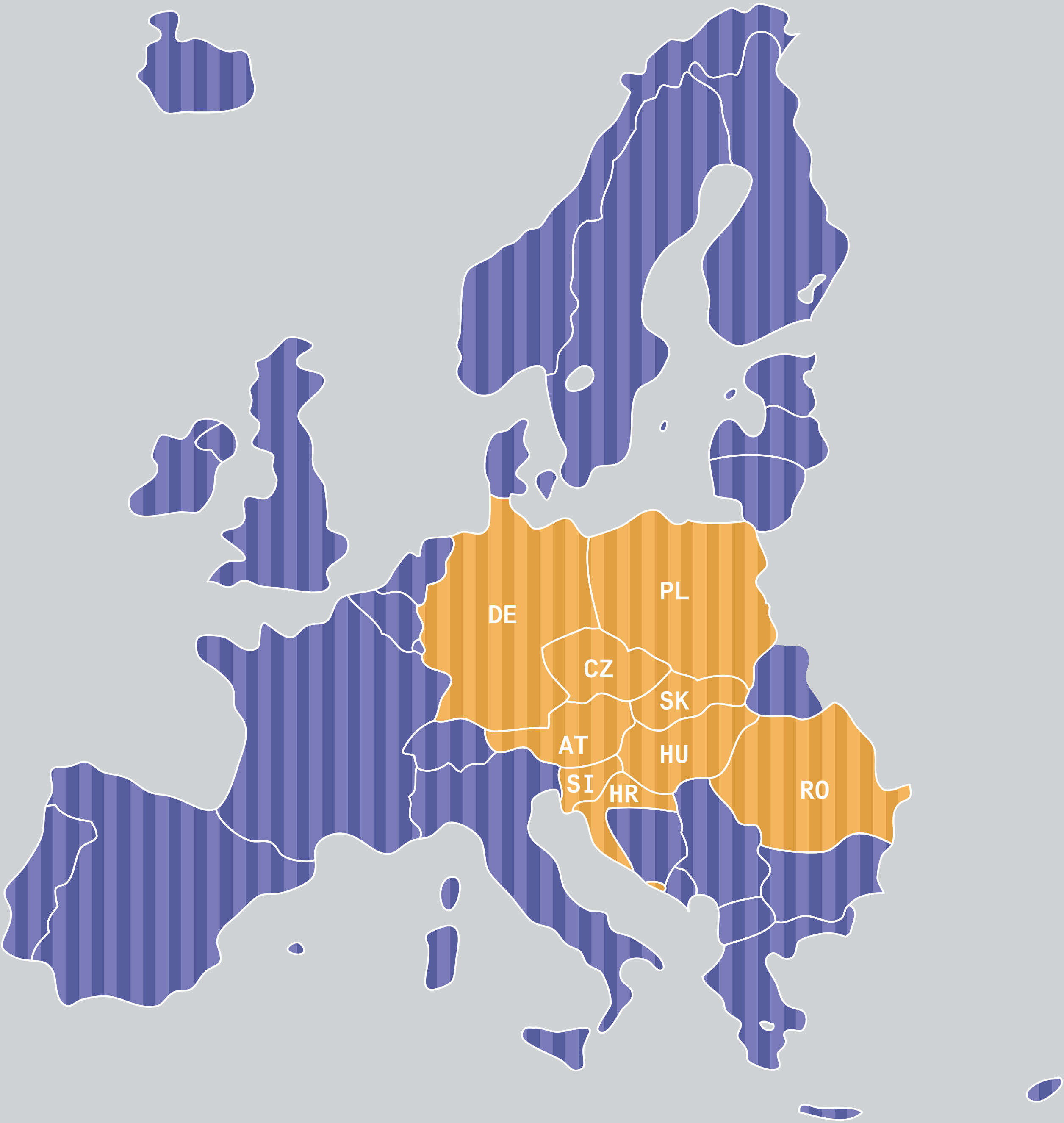
7.3.5.2 Investments of regional significance

Benefit in the area of SoS improvement result from 8 of the investments.

Benefits in the area of RES integration result from 1 of the investments.

Benefits in the area of market electricity result from 10 of the investments.

8 Transmission Adequacy



Are all investment needs identified in the coming decade appropriately solved by the proposed transmission projects?

This is most likely for every generation connection or security of supply issue: these are rather well limited and easier to address.

Projects also match the requirements of market integration in the foreseen scenarios, with the exception of rare situations which are still possible for these rather open and interacting concerns. Sizing investments to match these rare situations would not prove profitable for European countries.

There are many uncertainties linked to the transmission adequacy for North-South and West-East flows in Central and Central-East Europe. The German Nuclear Phase Out has created some uncertainty regarding the transmission adequacy of the proposed projects inside Germany. The latter as well as the uncertainty of the amount of installed capacity in conventional or RES generation could trigger additional investments in the CCE region.

With this in mind, the next TYNDP and RgIP edition could include, in addition to new boundaries which have arisen due to new investment needs, new investments in orange and red borders.

If everything goes as projected (e.g. in the frame of the scenarios presented above and with all the projects commissioned at the expected date) the planned projects should solve congestion in the CCE region.

After the realization of all these particular investments, the congestion will most likely be solved in the internal areas of Poland which are relevant for on-shore wind farms and connection of conventional power plants in Poland, as well as the connection of new pumped storage hydro plants in Romania. These hydro plants shall provide major support for balancing the system and particularly the intermittent generation of RES. After the realization of all boundary projects between Czech Republic and Germany, Slovakia and Hungary no significant congestion should be expected.

Residual congestion in some rare conditions or the need for further investigation remains in some areas. Additional projects may be needed in the German East and West corridors following the political decision to achieve nuclear phase-out by 2022 and the even more ambitious RES targets in Germany. New conventional generation will be integrated into western and central Czech Republic; as this facilitates the flows from West to East it will be necessary to strengthen the grid in this area. An additional reinforcement will also increase security of supply and the power exchange capacity from Germany to Poland and to Czech Republic/Slovakia whilst also supporting the RES and conventional generation integration in this area.

A number of additional projects may be needed in order to alleviate loop flows through South Eastern Europe and additional reinforcement will support the RES integration in this part of Europe (Romanian border with Moldova and Hungary and Croatian – Slovenian border with Hungary. Due to the age structure of existing 220-kV-lines in the concerned area and depending on the further development of RES, pump storages and other generation investments in Austria could be necessary.

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

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

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

The following map (see Figure 30) displays the overall picture:

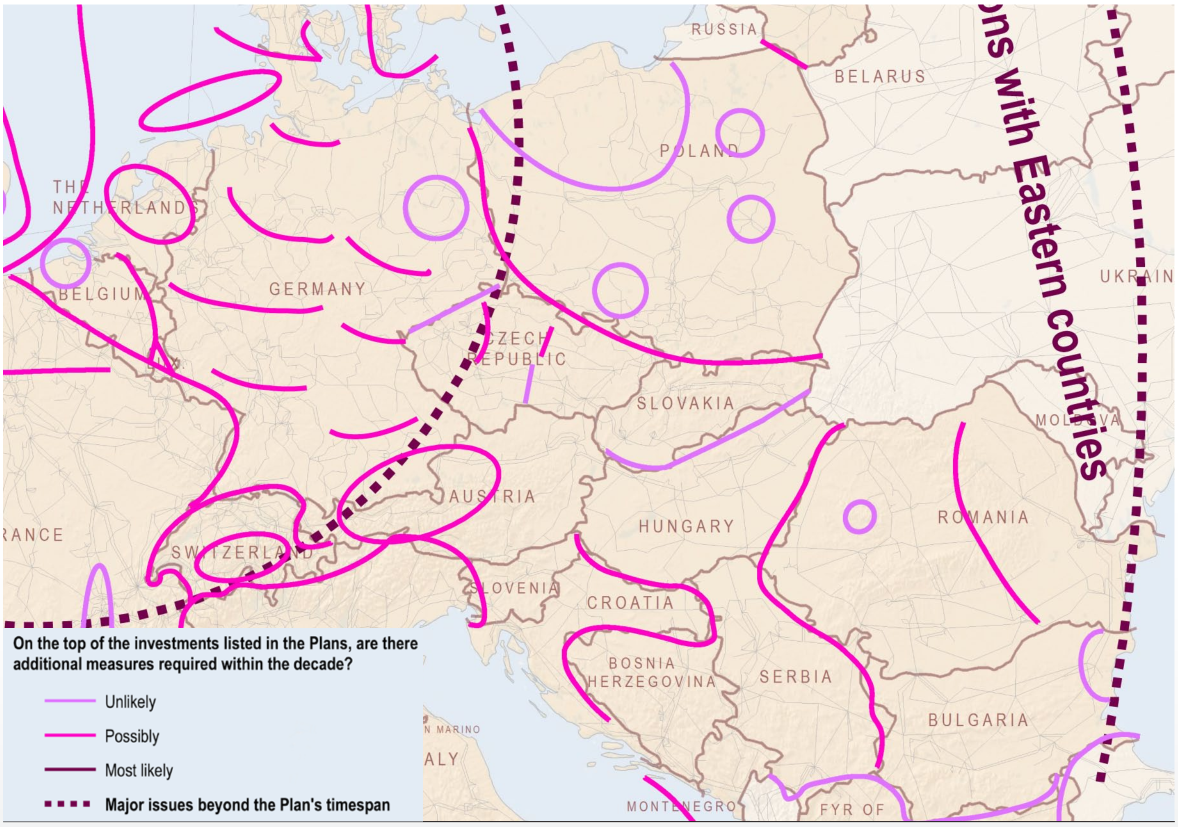


Figure 30:
Transmission adequacy in CCE region

9 Environmental Assessment

9.1 Overview

Environmental Impacts Assessment (EIA) is mandatory for each of the EU member states according to the EIA Directive (85/337/EEC). According to this Directive a range of public and private projects are subject to the EIA. These projects are defined in the separate Annexes I and II which define projects having significant effects on the environment and requiring an EIA (Annex I) as well as projects for which the national authorities must decide whether an EIA is needed (Annex II; the projects in Annex II are in general those not included in Annex I).

The Directive has been amended a few times (Directive 97/11/EC[1)], Directive 2003/35/EC[2)], and Directive 2009/31/EC[3)]). According to the http://ec.europa.eu/environment/eia/eia-legalcontext.htm the EIA procedure can be summarized as follows:

– the developer may request the competent authority to decide what should be covered by the EIA information to be provided by the developer (scoping stage);

– the developer must provide information on the environmental impact (EIA report – Annex IV);

– the environmental authorities as well as the public (and affected Member States) must be informed and consulted;

– the competent authority decides, taking into consideration the results of consultations;

– the public is informed of the decision afterwards and can challenge the decision before the courts.

The process outlined above is the general description of steps expected by the European Commission towards environmental assessment. In each individual EU country the authorities mentioned may differ (national and/or regional and/or local) whilst the process may also differ in length which may influence the preparatory and/or the realisation phase of the projects on the respective TSO side. With this in mind, each investment from TSOs requires careful planning and preparation.

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1) 1Council Directive 97/11/EC amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment

2) DIRECTIVE 2003/35/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC

3) 3DIRECTIVE 2009/31/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006

For non-EU countries the environmental assessment may differ significantly. Within the CCE region the only non EU member is Croatia which, however, signed the Accession Treaty to the European Union on 9th December 2011 and has fully transposed the EU legislation related to the environment into national legislation.

9.2 Environmental Indicator

9.2.1 Regional Investment Plan in Terms of kms of New Lines [1].

The next figure (Figure 32) shows the number of kilometres of new lines for AC and DC technology to be built up to 2020. It is evident that the major projects are to be realized using AC technology (almost 18000 km, around 76 %). Almost 70 % of each of the new projects belong to OHL and 30 % to cables (subsea or underground). There are also a number of projects which combine AC and DC technology.

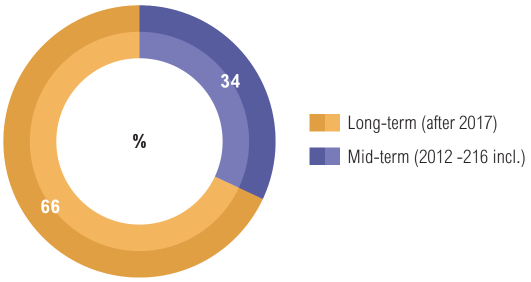

Figure 31:
Division of the RG CCE project between Mid and Long term period

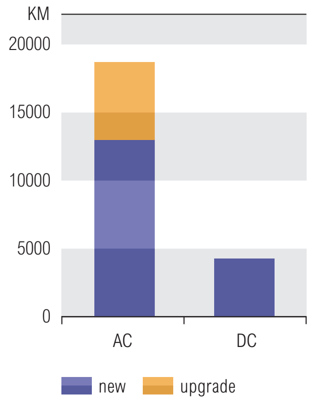

Figure 32:
Division of RG CCE project in kms

We can also say that in the CCE region approximately 80 % of all projects up to 2020 are the new lines/cables whilst around 20 % are supposed to be upgrades of existing lines (only AC), which is the more "environment friendly

[1] The figures displayed in this paragraph might be considered as not absolute as the length of the new lines has not been provided for each line/cable, in some cases a decision has not yet been made with regards to the kind of technology (AC/DC), the length, and so on.

approach" in transmission grid planning then erection of new lines. This is because they do not require the use of new land. In this respect it is necessary to mention that the category "Upgrade" may cover either change of the voltage level to a higher voltage or an increase of the capacity of the existing line. About 66% of all the projects are expected to reach completion in the long-term (LT) period, whereas around 44% should be completed in the mid-term (MT) period. Taking into account the public acceptance, TSOs would prefer to upgrade lines respectively in order to use existing corridors to build new lines, instead of using new corridors. Unfortunately in a number of cases this is not possible due to a lack of spatial planning and houses built underneath or near existing lines. Therefore some of the projects must be built on new corridors.

9.2.2 CO_2 Savings (for Scenario B and EU 2020)

If all the projects of pan-European significance are realized within the CCE region considering Scenario EU 2020 then approximately 60 Mto CO_2/year will be saved.

Figure 33 shows the difference of CO_2 emission production in RG CCE in 2020 compared to the year 2015 for both scenarios B & EU 2020 and also considering the Nuclear Phase Out (NPO) in Germany. It is clearly visible that the CO_2 emissions in Scenario B (with/without NPO) are higher in 2020, whereas in Scenario EU2020 (with/without NPO) it is lower. The results are rather expected. When looking at the difference between "with NPO" and "without NPO" variant, the "with NPO" shows higher CO_2 emissions production. This might be caused by the fact that the German nuclear power plants are replaced in the modeling tool by the fossil fuels' power plants over the entire region. When comparing Scenario B with Scenario EU 2020 it is visible that in B scenario no emission savings are expected in 2020.

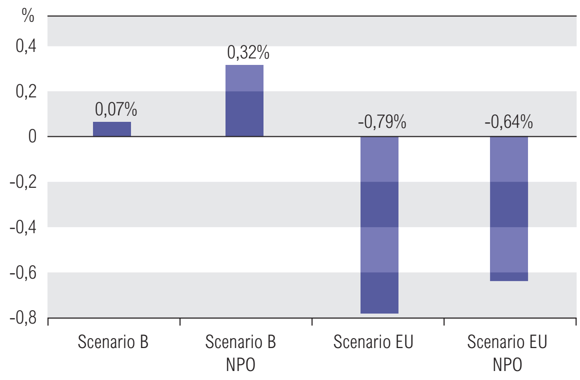

Figure 33:
CO_2 emission savings in 2020 comparing to 2015 in RG CCE

9.2.3 Load & RES Growth (MT & LT) versus km of New Lines

In the following figures (Figure 34 and Figure 35) the comparison between expected increase of load, net generating capacity of renewable energy sources (RES; including hydro power plants), and km of new lines between 2011 and 2016 (MT), and 2011 and 2020 (LT) is shown. As a source for the load, and RES data, Scenarios B and EU 2020 from the Scenario Outlook and Adequacy Forecast report for years 2011 to 2025 were used. Kilometres of new lines for the year 2011 were obtained from the ENTSO-E databases[1].

When looking at these two scenarios, the evolution of load and RES is rather expected taking into account the methodology used for the scenarios´ establishment. EU 2020 is based on the NREAPs which means higher RES integration and lower load evolution when compared to the Scenario B, which is supposed to be the "TSOs best estimate". This is obviously true even when taking into account the fact that for some TSOs the EU 2020 scenario is the same as Scenario B.

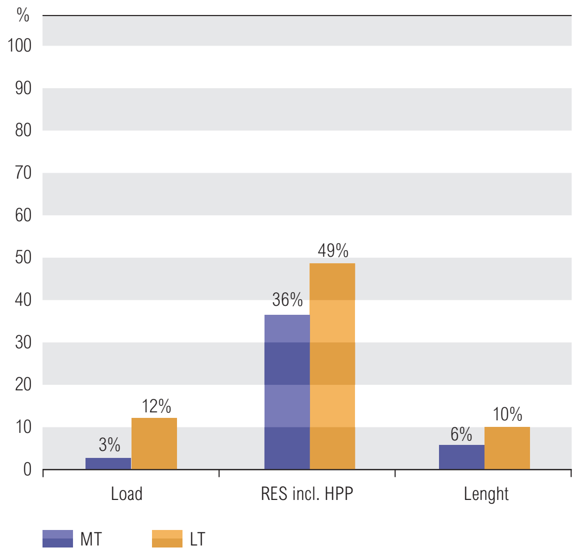

Figure 34:
Increase of load, RES (incl. hydro power plants), and km of new lines for Scenario B

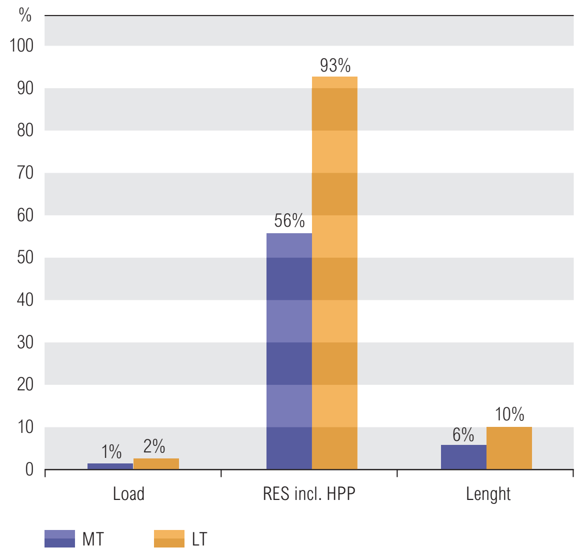

Figure 35:
Increase of load, RES (incl. hydro power plants), and km of new lines for Scenario EU2020

[1] https://www.entsoe.eu/resources/data-portal/miscellaneous/; this database refers to the "circuits length" from 2010; the difference between the length of the lines in 2010 and 2011 was neglected; the methodology for calculating the length for 2010 might be different from methodology for the length collected for TYNDP 2012; data for Austria used in the comparisons for the year 2011 refer to the year 2009

10 Assessment of Resilience

High voltage grid investments are expensive infrastructure projects, with a long lifetime (more than 40 years). They set precedence for coming projects and require years to be carried out. Both in order to avoid stranded costs and to meet grid users' expectations on time with appropriate solutions, TSOs assess the resilience of their investment projects. This assessment is performed in 4 major directions:

- Sustainable, 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 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 (defined in the scenario phase), 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 neighboring systems.

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.

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.

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 and PSTs;

PSTs 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. (Description of PST is included in Appendix 3)

The following are examples of novel technologies (FACTS components, special conductor, special tower design, high voltage cables, SF6 gas insulated switchgear, PST, and so on), or efficient conventional technologies to better utilize transmission equipment (upgrade to thicker conductor/bigger ampacity, upgrade to higher voltage, upgrade to more circuits, and so on) in countries of the CCE region:

Multiple Scenarios Considered for Identification/Justification of Projects

Based on the market flows results of market simulation, CCE TSOs calculated the approximate physical flows on cross-border interfaces by applying PTDF factors. Out of the 8736 hourly situations, each CCE TSO picked the one which seemed to be most stressful, relevant and representative for their grids, whilst being realistic at the same time. These selected points in time were subject to detailed network analysis (AC power flow and N-1 contingency analysis).

11 Conclusion

With approximately 340 GW expected installed capacity of generation from different technologies as indicated in Scenario EU 2020 (around 31 % of the total expected installed generation capacity in the ENTSO-E area), the CCE region shall continue to play a core role in the energy sector in Europe. This is supported by the fact that the region is strategically situated at the crossroads of the prevailing North-South and East-West power flow axes, in the very heart of the ENTSO-E, between the RES in the North and storage capacities in the Alps. This implies that the main drivers for grid development in the region continue to be connection of new generation (mainly RES), market integration and maintaining security of supply. The following summary of market study analysis gives a picture of how the CCE region could behave in the future:

For scenario EU 2020:

- The CCE region as group is expected to behave as a net importer of nearly 6 TWh. Main exchanges were investigated between market areas (Germany – Austria, Czech Republic – Slovakia, Slovakia – Hungary, Austria – Hungary and Austria – Slovenia). It is emphasized here that these are purely market exchanges and not physical grid flows/exchanges which revealed in most borders to be different when these market flows were applied in the network models.
- Importers of the region are Poland, Hungary Croatia and Germany. Exporters with more than 5 TWh are Austria and Czech Republic.
- Upon Nuclear Phase Out in Germany, sensitivity analysis of the CCE region revealed that it was a net importer of nearly 30 TWh. An unavailable production of nuclear units (about 60 TWh) was covered half by other technologies in Germany and half by import.

For scenario B:

- The CCE region emerged as a net exporter of nearly 13 TWh. Main exchanges were investigated between market areas (Germany – Austria, Czech Republic – Germany and Poland – Germany).
- Poland, Hungary and Croatia as was the case in the scenario EU, remain importers of the region, while exporters with more than 5 TWh are Czech Republic, Germany, Austria and Romania.
- On the other hand the region changes to an importer of nearly 12 TWh in cases of NPO in Germany. Around 60 TWh of unavailable production of nuclear units was covered half by other technologies in Germany and half by import.

Over 30 transmission projects of Pan-European significance (mid-term/long-term) have been identified in order to address and solve the concerns of the CCE region and Europe at large in the coming decade. A total of 89 investments are of national or regional relevance.

Approximately 75 % of the investment items of the TYNDP 2012 package were already present in the TYNDP 2010 and are hence confirmed. 25 % of new projects have evolved to tackle concerns of the CCE region. This percentage ratio shows the coherence between the two plans and its continuation as a living process (update) which will always react and address all varieties of regional challenges and changes that will be necessary over the long-term.

There is a total of approximately 23000 km of projects of pan-European and regional significance in the CCE region which should either be newly constructed or refurbished as Extra High Voltage routes (AC and DC).

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

Fulfillment of EU goals (Security of supply, RES integration and internal electricity market integration) must be reached without the operational security threat of the interconnected transmission system.

Transit flows which rank significantly among problems in the region have and will continue to trigger short- and medium-term measures besides grid extensions which are inevitable in order to ensure operational security of the transmission power system. Because of the above mentioned reasons installation of PST is considered as an inevitable measure with which to solve congestion in Poland, Czech Republic and possibly also for other countries (TSOs) in the CCE region (e.g. Slovakia).The next step, although more difficult and much more costly, shall be the new infrastructure erection mainly in the Germany North-South and Northeast/Southwest direction.

12 Appendices

Appendix 1: Table of Projects

In this section, detailed information regarding projects and particular investments in the CCE region is presented. It gives a synthetic description of each project with some factual information as well as the expected projects impacts and commissioning information.

Project & investment items

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

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

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

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

Labeling

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

Investment items which were present in the TYNDP 2010 have the same index in the TYNDP 2012 package. Indices of investments items which were not present in the TYNDP 2010 start with "Axxx".

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

Projects develop grid transfer capability across the boundaries as displayed on the following map (Figure 36). The numbers attached to every boundary on the following map correspond to the projects' indices relieving the constraints across that boundary:

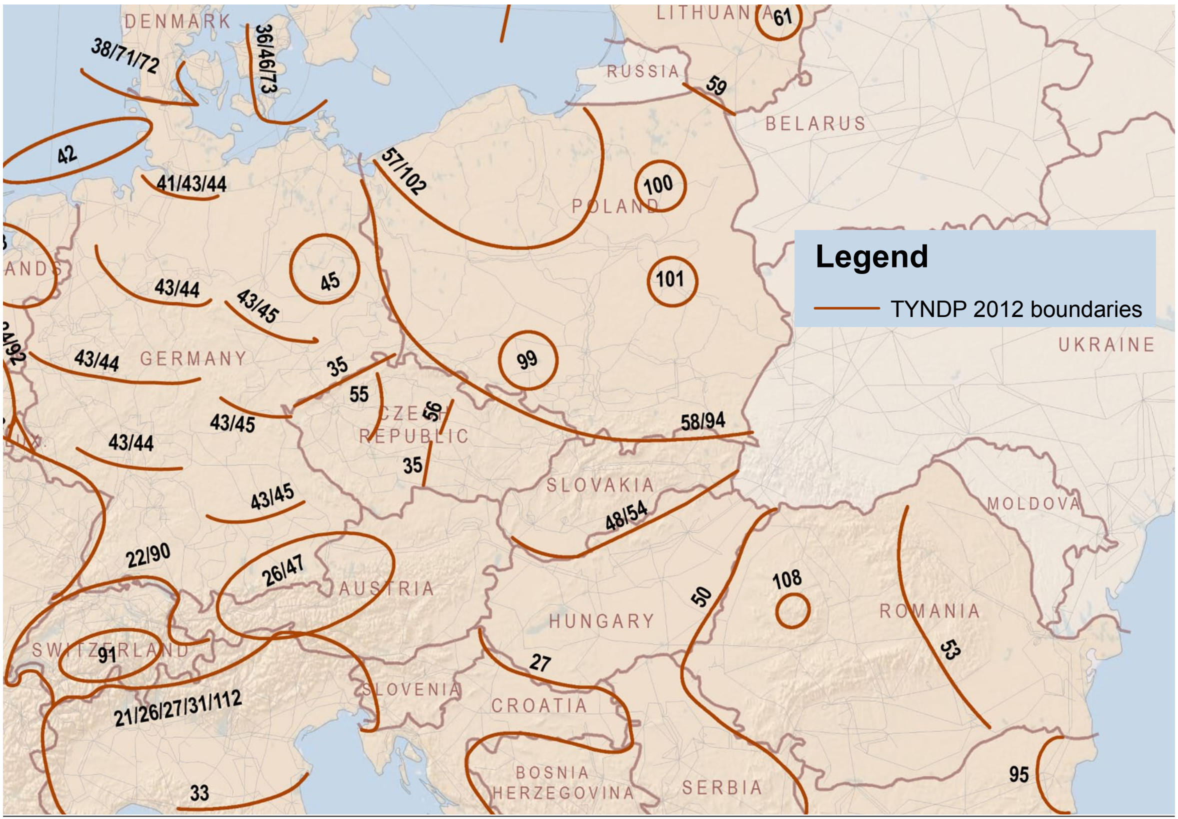

Figure 36:
Projects-Boundaries correspondence

For each project, the following information is displayed:

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

[1] Direct access can be also achieved incidentally.

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

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

[1] This date highly depends of the duration of the permitting process, which TSOs do not master. The date given here is the most likely one, according to present status and to TSO's experience in conducting projects. The date proposed for reinforcements at a very early stage, the consistency of which is still uncertain, is likely to be further refined by the next TYNDP.

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
26	26.63	Lienz (AT)	Veneto region (IT)	The project foresees the reconstruction of the existing 220 kV interconnection line as 380 kV line on an optimized route to minimize the environmental impact. Total length should be in the range of 100–150 km.	750 MW										planned	long term	Progresses as planned.		Reinforcement of the interconnection between Italy and Austria. Also the support the interaction between the RES in mainly Italy with the pump storage in the Austrian Alps.
	26.47.220	Lienz (AT)		Erection of a new 220/220 kV PST in the substation Lienz (AT).											under construction	2012	Project is in erection and expected to be commissioned 2012 according to the schedule.	The investment contributes also to project 47.	
	26.47.216																	The investment contributes both to project 26 and project 47. For the technical description see project 47.	
	26.64	Bressanone (IT)	new substation near Innsbruck (AT)	New double circuit 400 kV interconnection through the pilot tunnel of the planned Brenner Base Tunnel. Total line length: 65 km.											under consideration	>2022	Progresses as planned.		
	26.66	Prati di Vizze (IT)	Steinach (AT)	Upgrade of the existing 44 km Prati di Vizze (IT)–Steinach (AT) single circuit 110/132 kV OHL, currently operated at medium voltage and installing a 110/132 kV PST.											design & permitting	mid term	Investment delayed with 2 years due to the permitting process.		
	26.83	Volpago (IT)	North Venezia (IT)	Realization of a new 380 kV line between the existing substation of North Venezia and the future 380 kV substation of Volpago, connected in and out to the 380 kV "Sandrigo–Cordignano". Total line length: 31 km											design & permitting	2015	Delays due to authorization process.		
	26.93	Dolo (IT)	Camin (IT)	New 15 km double circuit 400 kV OHL between existing Dolo and Camin 400 kV substations, to be built in parallel with the existing line.											under construction	2014	Authorization process ended, construction phase ongoing.		
	26.97	Polpet (IT)		Voltage upgrade of the existing Polpet 150 kV/medium voltage substation up to 220 kV, complying with 400 kV standards. The substation will be connected by two shorts links to the existing Soverzene–Lienz 220 kV line.											design & permitting	2015	Authorization process started, project phase ongoing.		
	26.47.218	Obersielach (AT)	Lienz (AT)	New 190 km 380 kV OHL connecting the substations Lienz (AT) and Obersielach (AT) to close the Austrian 380 kV ring in the southern grid area. Line length: 190 km											under consideration	long term	Progresses as planned.	The investment contributes also to project 47.	
	26.A102	new interconnection between Italy and Austria		New possible interconnection line between Italy and Austria.											under consideration	long term	This investment replaces investment n° 65 mentioned on TYNDP 2010. The previous investment evolved so much that it is substituted by a new project. Feasibility studies ongoing including internal reinforcements.		
27	27.68	Okroglo (SI)	Udine (IT)	New 120 km double circuit 400 kV OHL with installation of a PST in Okroglo. The thermal rating will be 1,870 MVA per circuit.	>1,800 MW										planned	long term	Progresses as planned.		This project increases the capacity between Slovenia–Italy and Slovenia–Hungary. Project will remove congestion and strengthen connection on north-south and east-west axis.
	27.92	West Udine (IT)	Redipuglia (IT)	New 40 km double circuit 400 kV OHL between the existing substations of West Udine and Redipuglia, providing in and out connection to the future 400 kV substation of South Udine.											design & permitting	2015	The investment is delayed due to longer than expected authorization procedures.		
	27.A96	new interconnection between Italy and Slovenia		New interconnection between Italy and Slovenia.											under consideration	long term	Feasibility studies ongoing including the internal reinforcements.	Need for strengthening the connection between Slovenia and Italy and increasing of power exchange capability.	
	27.223	Cirkovce (SI)	Heviz (HU) Zerjavenec (HR)	The existing substation of Cirkovce (SI) will be connected to one circuit of the existing Heviz (HU)–Zerjavinec (HR) double circuit 400 kV OHL by erecting a new 80 km double circuit 400 kV OHL in Slovenia. The project will result in two new cross-border circuits: Heviz (HU)–Cirkovce (SI) and Cirkovce (SI)–Žerjavenec (HR).											design & permitting	2016	Presently in the authorization process. This investment was delayed due to permitting process.		

Table of projects – Regional Group Continental Central East

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	27.224	Krsko (SI)	Bericevo (SI)	New 400 kV double circuit OHL. This project will strengthen connection between East and Central part of Slovenia and connect an internal loop. Line length: 80 km	>1,800 MW										under construction	2015	Authorization process ended, construction phase is on going. This investment was delayed due to permitting process.		This project increases the capacity between Slovenia – Italy and Slovenia – Hungary. Project will remove congestion and strenghten connection on north-south and east-west axis.
	27.225	Divaca (SI)	Cirkovce (SI)	Upgrading 220 kV lines to 400 kV in corridor Divaca – Klece – Bericevo – Podlog – Cirkovce. Line length: 193 km											planned	long term	Progresses as planned.		
	27.A105	Lika(HR)	Brinje (HR)	New 55 km single circuit 400 kV OHL replacing aging 220 kV overhead line.											planned	2020	Strengthening of the 400 kV corridor across the Adriatic coast in Croatia in LT period and removal of regional congestion at north-south axis , also to accommodate power transfers from Croatia and Bosnia & Herzegovina to Italy through new IT – ME DC link (Investment 70).		
	27.A106	Lika (HR)	Velebit (HR)	New 60 km single circuit 400 kV OHL replacing aging 220 kV overhead line.											planned	2020			
	27.A107	Lika (HR)		New 400/110 kV substation, 2 × 300 MVA.											planned	2017			
	27.A108	Brinje (HR)		New 400/220 kV substation, 1 × 400 MVA.											planned	2020			
	27.229	Plomin (HR)	Melina (HR)	New 90 km double circuit OHL, with two connecting substations and transformer 400/220 kV, 400 MVA.											design & permitting	>2016	Project moved to long term, due to postponed commissioning date of thermal power plant Plomin.		
	27.227	Banja Luka (BA)	Lika (HR)	New 400 kV interconnection line between BA and HR.											under consideration	2020	End points of OHL and commissioning date defined after bilateral HR – BA agreement.		
28	28.70	Villanova (IT)	Lastva (ME)	New 1,000 MW HVDC interconnection line between Italy and Montenegro via 375 km 500 kV DC subsea cable and converter stations at both ending points.	1,000 MW										under construction	2015	Authorization process ended, construction phase ongoing. The substations on the ME side has been changed.		It contributes significantly to the increase of GTC between the West Balkans and IT such contributing to market integration; complements the ME – IT cable.
	28.86	Foggia (IT)	Villanova (IT)	New 178 km double circuit 400 kV OHL between existing Foggia and Villanova 400 kV substations, also connected in and out to the Larino and Gissi substations. A PST will be installed on the new 400 kV line.											design & permitting	2015	Progresses as planned.		
	28.89	Fano (IT)	Teramo (IT)	New 200 km single circuit 400 kV OHL between the existing 400 kV substations of Fano and Teramo, providing the connection in and out to the future substation to be built in Macerata area.											design & permitting	long term	The investment is delayed due to longer than expected authorization procedures.		
	28.232	Visegrad (BA)	Pljevlja (ME)	New 70 km single circuit 400 kV OHL between Visegrad and Pljevlja.											planned	2015	Feasibility study for 400 kV interconnections RS – ME – BA proposed under Infrastructure Projects Facility for western Balkans.		
	28.233a	Lastva (ME)		A new substation will be connected to the existing line 400 kV Podgorica 2 (ME) – Trebinje(BA), with two transformers 2 × 300 MVA 400/110 kV, and convertor station for the DC cable Lastva (Tivat) – Villanova (see 70).											design & permitting	2015	Feasibility study covering the aspects of route planning, substation location, environmental and social issues and equipment selection is due to end in second half of 2011.		
	28.233b	Lastva (ME)	Pljevlja (ME)	New 160 km double circuit 400 kV OHL existing substation Pljevlja and new substation Tivat.											design & permitting	2016	Feasibility study covering the aspects of route planning, substation location, environmental and social issues and equipment selection is due to end in second half of 2011.		
	28.A109	Bajina Basta (RS)	Visegrad (BA)	New 400 kV interconnection OHL between RS and BA, and reconstruction of existing two OHL 220 kV between BA and Serbia.											planned	>2016	New investment in TYNDP.	New 400 kV overhead line between RS and BA. It will eliminate constraints in the region for electric energy transits and exchange.	
	28.A110	Bajina Basta (RS)	TPP Obrenovac (RS)	New double circuit 400 kV OHL between new substation Bajina Basta (see infra), and substation Obrenovac.											design & permitting	>2016	New investment in TYNDP.	Obrenovac is the "strongest" 400 kV node in Serbia, thus providing significant upgrade for evacuation and energy transfer from north to south, and further down in Montenegro, through the new line between Bajina Basta and Pljevlja (ME).	
	28.A111	Bajina Basta (RS)	Pljevlja (ME)	New 86 km single circuit 400 kV OHL connecting existing substation Pljevlja (ME) and substation Bajina Basta (RS).											planned	>2016	New investment in TYNDP.		
	28.A112	Bajina Basta (RS)		New 400/110 kV substation in Bajina Basta, upgrading an existing 220/110 kV substation.											planned	>2016	New investment in TYNDP.		

Table of projects – Regional Group Continental Central East

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	28.A113	Bistrica (RS)		New 220/110 kV substation.	1,000 MW										design & permitting	2015	New investment in TYNDP.	After a topology change in the area, the investment will eliminate firm connection in "Vardiste" (secure and stable operation in Serbian network and systems of Bosnia & Herzegovina and Montenegro), to eliminate constraints in the region for electric energy transits and exchange.	It contributes significantly to the increase of GTC between the West Balkans and IT such contributing to market integration; complements the ME – IT cable.
	28.A114	Konjsko(HR)	Velebit (HR)	New 100 km single circuit 400 kV OHL replacing ageing 220 kV overhead line.											planned	2020	Strengthening of the 400 kV corridor across the Adriatic coast in Croatia in LT period and removal of regional congestion at north-south axis, also to accommodate power transfers from Croatia and Bosnia & Herzegovina to Italy through new IT – ME DC link (Investment 70).		
	28.231	Konjsko (HR)		Installation of a 150 MVAr reactive power device.											design & permitting	2014	Investment postponed 1 year due to permitting process.		
	28.A115	Plat (HR)		New 220/110 kV substation.											under construction	2013	New investment in TYNDP, contributing to mesh the network surrounding HVDC link IT – ME and to increase the reliability of the EHV system.		
	28.228	Trebinhe (BA)	Plat (HR)	Re-establishment of two previously existing 220 kV single circuit interconnection Trebinje (BA) – Plat (HR). Total length: 10 km											planned	2014	Progresses as planned.		
35	35.137	Vitkov (CZ)	Mechlenreuth (DE)	New 400 kV single circuit tie-line between new (CZ) substation and existing (DE) substation. Length: 70 km	500 MW										under consideration	long term	Progresses as planned.		This project is required to enable power flows between west and east, enhance the transfer capability between CZ and DE and supports the future generation evacuation.
	35.138	tbd (CZ)	tbd (DE) – southeastern part of 50Hertz Transmission control area (Röhrsdorf)	Possible increase of interconnection capacity between CEPS and 50Hertz Transmission is under consideration: – Either a new 400 kV tie-line (OHL on new route) or – a reinforcement of the existing 400 kV tie-line Hradec (CEPS) – Röhrsdorf (50Hertz Transmission).											under consideration	long term	Progresses as planned.		
	35.306	Vitkov (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA.											planned	2017 / 2018	It is closely dependent on construction of line investment n°308.		
	35.307	Vernerov (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA.											planned	2013 / 2016	Commissioning date has been divided into two phases: – 1st phase – temporary connection of wind plant 180 MW – 2nd phase – finalization of substation construction including connection to the distribution grid (consumption)		
	35.308	Vernerov (CZ)	Vitkov (CZ)	New 400 kV double circuit OHL, 1,385 MVA.											planned	long term	Permitting procedure complications are foreseen (line crosses protected area).		
	35.309	Vitkov (CZ)	Prestice (CZ)	New 400 kV double circuit OHL, 1,385 MVA.											under consideration	long term	Permitting procedure complications are foreseen (line crosses protected area).		
	35.311	Kocin (CZ)		Upgrade of the existing substation 400/110 kV; upgrade transformers 2 × 350 MVA.											design & permitting	long term	Schedule harmonization with market participants.		
	35.312	Mirovka (CZ)		Upgrade of the existing substation 400/110 kV with two transformers 2 × 350 MVA.											planned	long term	Schedule harmonization decided with market participants.		
	35.313	Kocin (CZ)	Mirovka (CZ)	Connection of 2 existing 400 kV substations with double circuit OHL having 120.5 km length and a capacity of 2 × 1,385 MVA.											planned	long term	Schedule harmonization decided with market participants.		
	35.314	Mirovka (CZ)	V413 (CZ)	New double circuit OHL with a capacity of 2 × 1,385 MVA and 26.5 km length.											planned	long term	Schedule harmonization decided with market participants.		

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	35.315	Kocin (CZ)	Prestice (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 115.8 km. Target capacity: 2 × 1,385 MVA	500 MW										planned	long term	Schedule harmonization decided with market participants.		This project is required to enable power flows between west and east, enhance the transfer capability between CZ and DE and supports the future generation evacuation.
	35.316	Mirovka (CZ)	Cebin (CZ)	Adding second circuit to existing single circuit line (88.5 km, 2 × 1,385 MVA).											under consideration	long term	Schedule harmonization decided with market participants.		
	35.317	Hradec (CZ)	Reporyje (CZ)	Upgrade of existing 400 kV single circuit OHL with length of 116.9 km. Target capacity: 1,385 MVA											commissioned	commissioned	Commissioned.		
36	36.141	Ishøj / Bjæverskov (DK)	Bentwisch / Güstrow (DE)	The Kriegers Flak Combined Grid Solution is the new offshore multiterminal connection between Denmark and Germany used for both grid connection of offshore wind farms Kriegers Flak and interconnection. Technical features still have to be determined.	600 MW										planned	long term	Permission for Danish wind farm KF 3 is in pending. Connection to Sweden is withdrawn at present, but can come on a later stage.		The Kriegers Flak Combined Grid Solution is the new offshore multiterminal connection be-tween Denmark and Germany used for both grid connection of offshore wind farms Kriegers Flak and interconnection.
37	37.142	Tonstad (NO)	Wilster (DE)	Nord.Link / NorGer: a new HVDC connection between southern Norway and northern Germany. Estimated subsea cable length: 520 – 600 km Capacity: 1,000 MW	up to 1,400 MW										design & permitting	2018/2021	Revised capacity and progress postponed, due to more demanding system operations and time needed to obtain necessary government permits for reinforcing the national grid.		The purpose is: Market integration with the continent and facilitating RES integration in southern and western Norway. Will also improve security of supply in southern Norway.
	37.408	Kristiansand, Feda (NO)		Reactive compensation due to HVDC links NorNed and Sk-agerak 4. Reactive power devices in 400 kV substations.											design & permitting	2012/2014	Feda is in the planning and permitting stage. Kristiansand is under construction(commis-sioned expected as planned 2012)		
	37.406	(southern part of Norway) (NO)		Voltage uprating of existing 300 kV line Sauda / Saurdal – Lyse – Tonstad – Feda – 1 & 2, Feda – Kristiansand; Sauda-Samnanger in long term. Voltage upgrading of existing single circuit 400 kV OHL Tonstad – Solhom – Arendal. Reactive power devices in 400 kV substations.											design & permitting	2016 (2013 – 2018)	Revised progress. Due to more demanding system operations and time needed to obtain necessary government permits for reinforcing the national grid. The investment now embed former TYNDP 2010's investments 407 and 409 and the technical description has been updated accordingly.		
39	39.428	Kassø (DK)	Tjele (DK)	Rebuilding of a 400 kV OHL of 173 km from a single circuit to a double circuit . This increases the transfer capacity with approx. 1,000 MW.	1,000 – 1,550 MW										design & permitting	2012/2014	Progresses as planned.		Step 3 in the Danish-German agreement to upgrade the Jutland – DE transfer capacity.
	39.144	Audorf (DE)	Kassö (DK)	Step 3 in the Danish-German agreement to upgrade the Jutland – DE transfer capacity. It consists of partially an upgrade of existing 400 kV line and partially a new 400 kV route in Denmark. In Germany new 400 kV line mainly in the trace of a existing 220 kV line. The total length of this OHL is 114 km.											under consideration	2017	Progresses as planned.		
40	40.446	Bascharage (LU)	Aubange (BE)	As a first step(2016) a PST could be placed in the existing 225 kV line between LU and BE. In a second stage, two solutions are currently investigated (4 TSOs – Elia, Amprion, CREOS, RTE are involved). Solutions 1 would be a new interconnection between CREOS grid in LU and ELIA grid in BE via a 16 km double circuit 225 kV underground cable with a capacity of 1,000 MVA. Solution 2 would be the interconnection between CREOS grid in LU and ELIA grid in BE via a new 380 kV double circuit. The current study will investigate the impact of this new interconnection on other boundaries (impact of loop flow) and on internal grids . The potential reinforcements of the other boundaries and the internal grids will also be taken into account in the evaluation.	380 – 900 MW			Luxemburg area							under consideration	2016 / 2020	The comissioning date and status changed as the study to determine the best investment is still ongoing.		Increase the transfer capability between LU,DE, BE and FR.

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		Project identification			**Project assessment**														
	40.A29	Bascharage (LU)	tbd (BE, DE and / or FR)	New interconnection with neighbor(s) either 220 kV or 400 kV	380 – 900 MW			Luxemburg area							under consideration	2020	New investment in TYNDP.	An ongoing network study (4 TSOs involved) investigates the robustness of the planned 220 kV connection between LU and BE and the potentially need for an upgrading to a 400 kV interconnector in the south.	Increase the transfer capability between LU,DE, BE and FR.
	40.447	Heisdorf (LU)	Berchem (LU)	New 20 km double circuit mixed (underground cable + OHL) 225 kV project with 1,000 MVA capacity including sub-stations for infeed in lower voltage levels.											design & permitting	2012 / 2017	Progresses as planned.		
	40.A30	Bascharage (LU)	Niederstedem (DE) or tbd (DE)	Upgrading and new construction of an interconnector to DE, in conjunction with the interconnector in the south of LU. Partial upgrading of existing 220 kV lines and partial new construction of lines. With power transformer station in LU.											under consideration	2020	New investment in TYNDP.		
41	41.149	Dollern (DE)	Stade (DE)	New 400 kV double circuit OHL Dollern – Stade including new 400 kV switchgear in Stade. Length: 14 km	>3,000 MW										design & permitting	mid term	This investment depends on the commissioning of a conventional power plant in the area. The additional reason for delay is the long permitting procedure associated with this investment.		Evacuation of the new conventional generation in the 50Hertz and TenneT area.
	41.150	Conneforde (DE)	Maade (DE)	New 400 kV double circuit (underground cable + OHL) Conneforde – Maade including new 400 kV switchgear Maade. Length: 37 km											design & permitting	long term	Progresses as planned.		
	41.A74	north of Control Area 50Hertz Transmission (DE)		Construction of new substations / lines for integration of newly build power plants in northern part of 50Hertz Transmission control area.											planned	long term	New investment in TYNDP, because of additionnal need for generation evacuation. Some of the investments are to be commissioned by the mid term and the some by long term.	Support of conventional generation integration in northeastern Germany, maintaining of security of supply and support of market development.	
42	42.152	Dörpen / West (DE)		New substation for connection of offshore wind farms.	>8,000 MW										under construction	mid term	Progresses as planned.	Commercially sensitive information about this new wind farm connection cannot be displayed in the TYNDP report.	Integration of the offshore wind parks and the onshore grid reinforcements in the northern DE.
	42.159	Cluster BorWin1 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 400 MW											under construction	mid term	The commission date of this wind farms connection should be in 2012. Energy transportation is however already enable.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.160	offshore wind park Nordergründe (DE)	Inhausen (DE)	New AC-cable connection with a total length of 35 km.											design & permitting	mid term	Progresses depend on development of the offshore wind farm.		
	42.161	offshore wind park GEOFreE (DE)	Göhl (DE)	New AC-cable connection with a total length of 32 km.											design & permitting	mid term	Progresses depend on development of the offshore wind farm.		
	42.163	Cluster HelWin1 (DE)	Büttel (DE)	New HVDC transmission systm consisting of offshore platform, cable and converters with a total length of 145 km. Line capacity: approx. 690 MW This Project includes also a new substation Büttel and connection of this new substation with the existing OHL Brünsbüttel – Wilster.											under construction	mid term	Progresses with delay.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.164	Cluster SylWin1 (DE)	Büttel (DE)	New line consisting of underground + subsea cable with a total length of 210 km. Line capacity: approx. 864 MW											under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.165	Cluster DolWin1 (DE)	Dörpen / West (DE)	New line consisting of underground + subsea cable with a total length of 155 km. Line capacity: 800 MW											under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.166	offshore wind park Riffgat (DE)	Emden / Borßum(DE)	New AC-cable connection with a total length of 80 km.											under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.167	Cluster BorWin2 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 800 MW											under construction	mid term	Progresses as planned.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.A82	Cluster DolWin2 (DE)	Dörpen / West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW											under construction	mid term	New investment in TYNDP, for connection of new offshore wind farms.	Due to nondisclosure agreements it is not possible to give further information about this wind farm connection in TYNDP.	
	42.A83	Cluster DolWin3 (DE)	Dörpen / West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW											design & permitting	mid term	New investment in TYNDP, for connection of new offshore wind farms.		

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	42.A84	Cluster BorWin3	Dörpen / West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 180 km. Line capacity: 900 MW	>8,000 MW										design & permitting	mid term	New investment in TYNDP for connection of new offshore wind farms.		Integration of the offshore wind parks and the onshore grid reinforcements in the northern DE.
	42.A85	Cluster HelWin2	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 145 km. Line capacity: 690 MW											under construction	mid term	New investment in TYNDP for connection of new offshore wind farms.	Due to nondisclosure aggreements it is not possible to give further information about this wind farm connection in TYNDP	
	42.A86	Cluster BorWin4 (DE)	Emden / Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 185 km. Line capacity: 900 MW											under consideration	long term	New investment in TYNDP for connection of new offshore wind farms.		
	42.A87	Cluster SylWin2 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 210 km. Line capacity: 800 MW											under consideration	long term	New investment in TYNDP for connection of new offshore wind farms.		
	42.211	further connections of more offshore wind farms (DE)		Further connections in the clusters BorWin, DolWin, SylWin and HelWin.											under consideration	long term	Progresses depend on development of the offshore wind farm.		
43	43.A81	Osterath (DE)	Philippsburg (DE)	New HVDC lines from Osterath to Philippsburg to integrate new wind generation especially from North / Baltic Sea towards Central-South Germany for consumption and storage.	10,000 MW			Bavaria and Baden-Württemberg area							under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		Combined DC and AC new infrastructure to accommodate the new RES generation, the associated flows from north to south and also to secure the security of supply in South Germany.
	43.A152	Emden (DE)	Osterath (DE)	New HVDC lines from Endem to Osterath to integrate new wind generation especially from North / Baltic Sea towards Central Germany for consumption and storage.											under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		
	43.A153	Wehrendorf (DE)	Urberach (DE)	New lines in HVDC technology from the region of Lower Saxony to North Baden-Württemberg to integrate new wind generation especially from North Sea towards Central-South Europe for consumption and storage. The investment is part of the transmission corridor Cloppenburg – North Baden-Württemberg.											under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		
	43.A154	Cloppenburg (DE)	Westerkappeln (DE)	New 400 kV double circuit OHL Cloppenburg – Westerkappel (75 km). The investment is part of the transmission corridor Cloppenburg – North Baden-Württemberg.											under consideration	long term	New investment in TYNDP due to increase of RES and changes in conventional power plants in Germany and increase transits.		
	43.A88	Brunsbüttel (DE), Wilster (DE), Kaltenkirchen (DE)	Großgartach (DE), Goldshöfe (DE), Grafenrheinfeld (DE)	New DC lines to integrate new wind generation from northern Germany towards southern Germany and southern Europe for consumption and storage.											under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.		
	43.A75	Lauchstadt (DE)	Meitingen (DE)	New DC lines to integrate new wind generation from Baltic Sea towards Central / Ssouth Europe for consumption and storage.											under consideration	long term	New investment in TYNDP due to long distance RES integration, voltage stability of the grid and security of supply in the south of Germany.	New Investment due to increase of RES and changes in conventionel power plants in Germany and increase transits.	
	43.A89	area of northern Lower Saxony (DE)		New lines for integration of on- and offshore wind generation incl. 380 kV lines Halbemond – Emden, Emden – Conneforde and Conneforde – Cloppenburg. Total length: 160 km											under consideration	long term	New investment in TYNDP due to new wind generation projects.		
	43.A90	area of Schleswig-Holstein (DE)		About 300 km new 380 kV lines and around 24 new transformers for integration of onshore wind in Schleswig-Holstein, incl. lines – Brunsbüttel – Barlt – Heide – Husum – Niebüll – border of Denmark, – Audorf – Kiel – Göhl – Siems – Lübeck – Kaltenkirchen and – Kaltenkirchen – Itzehoe – Brunsbüttel.											under consideration	long term	New investment in TYNDP due to new wind generation projects.	The German West-coast line (Brunsbuettel – Niebuel) is planned to be connected to the Danish grid in the 400 kV substation Endrup. The distance from the German/Danish border is approx. 80 km. Bilateral technical / economical investigations are ongoing. Reinforcements in the Danish 400 kV grid are foreseen in order to facilitate the increased power exchange capacity on the Danish-German border.	

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44	44.147	Dollern (DE)	Hamburg / Nord (DE)	New 400 kV double circuit OHL Dollern – Hamburg / Nord including one new 400/230 kV transformer in substation Hamburg / Nord and new 400 kV switchgear Kummerfeld. Length: 43 km	5,000 MW			Bavaria and Baden-Württemberg area							design & permitting	mid term	Delays due to authorization process.		This project helps accommodating the increasing flows, coming mainly form RES, from northwestern Germany to southwestern Germany and Switzerland.
	44.148	Audorf (DE)	Hamburg / Nord (DE)	New 400 kV double circuit OHL Audorf – Hamburg / Nord including two new 400/230 kV transformers in substation Audorf. Length: 65 km											design & permitting	mid term	This investment was scheduled for 2015. Presently it is foreseen a delay of around 1 year due to permitting process.		
	44.151	Wehrendorf (DE)	Ganderkesee (DE)	New line (length: approx. 95 km), extension of existing and erection of substations, erection of 380/110 kV transformers.											design & permitting	mid term	Delays due to authorization process.		
	44.156	Niederrhein (DE)	Dörpen / West (DE)	New 400 kV double circuit OHL Dörpen – Niederrhein including extension of existing substations. Length: 167 km											design & permitting	mid term	Delays due to authorization process.		
	44.157	Wahle (DE)	Mecklar (DE)	New 400 kV double circuit OHL Wahle – Mecklar including two new substations. Length: 210 km											design & permitting	mid term	Delays due to authorization process.		
	44.90.170	Großgartach (DE)	Hüffenhardt (DE)	New 380 kV OHL. Length: 23 km Included with the project: – 1 new 380 kV substation – 2 transformers											under construction	2012	Progresses as planned.	This investment contributes to both project 90 and 44.	
	44.171	Hüffenhardt (DE)	Neurott (DE)	Upgrade of the line from 220 kV to 380 kV. Length: 11 km Included with the project: 1 new 380 kV substation.											planned	2020	Progresses as planned.		
	44.90.172	Mühlhausen (DE)	Großgartach (DE)	Upgrading line from 220 kV to 380 kV. Length: 45 km											design & permitting	2014	Progresses as planned.	This investment contributes to both project 90 and 44.	
	44.90.173	Hoheneck (DE)	Endersbach (DE)	Upgrading line from 220 kV to 380 kV. Length: 20 km											design & permitting	2014	Progresses as planned.	This investment contributes to both project 90 and 44.	
	44.174	Bruchsal Kändelweg (DE)	Ubstadt (DE)	A new 380 kV OHL. Length: 6 km											design & permitting	2014	Postponed from one year due to permitting procedures.		
	44.90.176	Daxlanden (DE)	Eichstetten (DE)	Upgrade of transmission capacity of existing 380 kV line. Length: 120 km											under consideration	2020	Progresses as planned.	This investment contributes to both project 90 and 44.	
	44.178	Baden-Württemberg, Süden & Nordosten (DE)"		Installation of 2 × 250 MVAr 380 kV capacitance banks.											under construction	2014	One more bank in addition. Two have already been installed. Projects realized earlier because the need for reactive power compensation became urgent.		
	44.179	Rommerskirchen (DE)	Weißenthurm (DE)	New line, extension of existing and erection of substations, erection of 380/110 kV transformers. Total line length: 100 km.											under construction, design & permitting	mid term	Some parts are commissioned but the main elements of the investment are still in design and permitting due to delays in permitting process.		
	44.181	Dauersberg (DE)	Limburg (DE)	New 380 kV double circuit OHL, extension of existing of substations. Total line length: 20 km											under construction, design & permitting	mid term	Some parts are commissioned but the main elements of the investment are still in design and permitting due to delays in permitting process.		
	44.182	Kriftel (DE)	Obererlenbach (DE)	New 400 kV double circuit OHL Kriftel – Obererlebenbach in existing OHL corridor. Length: 11 km											planned	mid term	Some parts are commissioned but the main elements of the investment are still in design and permitting due to delays in permitting process.		
	44.A80	Area of West Germany (DE)		Installation of several 300 MVAr 380 kV capacitance banks, extension of existing substations.											under consideration	long term	New investment in TYNDP, because of additional needs for RES integration (combined with SoS).		
	44.183	Wehrendorf (DE)		Installation of 300 MVAr 380 kV capacitance banks, extension of existing substations.											design & permitting	mid term	Delays due to authorization process.		
	44.184	Bürstadt (DE)		Installation of 2 × 300 MVAr 380 kV capacitance banks, extension of existing substations.											design & permitting	mid term	Delays due to authorization process.		
	44.185	area of Muensterland and Westfalia (DE)		New lines and installation of additional circuits, extension of existing and erection of several 380/110 kV substations. Total length: approx. 110 km											design & permitting	long term	Delays due to authorization process.		
	44.186	Gütersloh (DE)	Bechterdissen (DE)	New lines and installation of additional circuits, extension of existing and erection of 380/110 kV substation. Total line length: 27 km											under construction	mid term	Delays due to authorization process.		
	44.187	area of West-Rhineland (DE)		New lines and installation of additional circuits, extension of existing and erection of several 380/110 kV substations.											under construction	2013	Progresses as planned.		

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	44.188	Kruckel (DE)	Dauersberg (DE)	New lines, extension of existing and erection of several 380/110 kV substations. Total line length: 130 km	5,000 MW			Bavaria and Baden-Württemberg area							planned	long term	Progresses as planned.		This project helps accommodating the increasing flows, coming mainly form RES, from northwestern Germany to southwestern Germany and Switzerland.
	44.A78	Pkt. Metternich (DE)	Niederstedem (DE)	Construction of new 380 kV double circuit OHLs, decommissioning of existing old 220 kV double circuit OHLs, extension of existing and erection of several 380/110 kV substations. Length: 108 km											planned	long term	New investment in TYNDP.	RES integration / Market integration especially east-west-direction.	
	44.A77	area of South Wuerttemberg (DE)		Construction of new 380 kV double circuit OHLs, decommissioning of existing double circuit OHLs, extension of existing 380 kV-substations. Length: approx. 60 km											planned	long term	New investment in TYNDP.	RES integration combined with pump storage in the alp region (market) / increasing of the NTC DE – CH / AT.	
	44.190	Saar-Pfalz-Region (DE)		New lines, extension of existing and erection of several 380/110 kV substations. Upgrade of an existing line from 220 to 380 kV											planned	long term	Delays due to authorization process.	Security of Supply (Neub. Frltg Fraulaut – Saarwellingen) combined with RES integration.	
	44.A155	Conneforde (DE)	Unterweser (DE)	Upgrade of 230 kV circuit Unterweser – Conneforde to 400 kV. Line length: 32 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A156	Dollern (DE)	Elsfleht / West (DE)	New 400 kV line in existing OHL corridor Dollern – Elsfleht / West. Length: 100 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A157	Dollern (DE)	Landesbergen (DE)	New 400 kV line in existing OHL corridor Dollern – Sottrum – Wechold – Landesbergen (130 km).											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A158	Hamm / Uentrop (DE)	Kruckel (DE)	Extension of existing line to a 400 kV single circuit OHL Hamm / Uentrop – Kruckel. Length: 60 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A159	Pkt. Blatzheim (DE)	Oberzier (DE)	New 400 kV double circuit OHL Pkt. Blatzheim – Oberzier including extension of existing substations. Length: 16 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A160	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 400 kV double circuit OHL Urberach – Pfungstadt – Weinheim – Daxlanden including extension of existing substations. Length: 219 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A161	Bürstadt (DE)	Daxlanden (DE)	New line and extension of existing line to 400 kV double circuit OHL Bürstadt – Lambshein – Daxlanden including extension of existing substations. Length: 134 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.A162	Großgartach (DE)	Endersbach (DE)	Extension of existing 400 kV line Großgartach – Endersbach. Lenght: 32 km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	44.175	Birkenfeld (DE)	Ötisheim (DE)	A new 380 kV OHL. Length: 11 km											planned	2020	New investment in TYNDP.		
	44.189	Niederrhein (DE)	Utfort (DE)	New 380 kV double circuit OHL Niederrhein – Utfort (24 km).											under consideration	long term	New investment in TYNDP.		
45	45.90.177				5,000 MW			Bavaria and Baden-Württemberg area										The investment contributes both to project 45 and project 90. For the technical description see project 90.	This project helps accomodating the increasing flows coming mainly form RES in NE DE to South DE and to the Alps.
	45.191	Neuenhagen (DE)	Vierraden (DE)	Project of new 380 kV double circuit OHL Neuenhagen – Vierraden – Bertikow with 125 km length as prerequisite for the planned upgrading of the existing 220 kV double circuit interconnection Krajnik (PL) – Vierraden (DE / 50Hertz Transmission).											design & permitting	2013 / 2015	Project in permitting phase, strong local resistance.		

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	45.193	Halle / Saale (DE)	Schweinfurt (DE)	New 380 kV double circuit OHL between the substations Vieselbach – Altenfeld – Redwitz with 215 km length combined with upgrade between Redwitz and Grafenrheinfeld (see project 153). The Section Lauchstedt – Vieselbach has already been commissioned. Support of RES integration in Germany, annual redispatching cost reduction, maintaining of security of supply and support of the market development. The line crosses the former border between East and West Germany and is right downstream in the main load flow direction. The project will help to avoid loop flows through neighboring grids.	5,000 MW			Bavaria and Baden-Württemberg area							design & permitting	mid term	Project partly completed, strong local public resistance. Delay due to permitting process.		This project helps accomodating the increasing flows coming mainly form RES in NE DE to South DE and to the Alps.
	45.197	Neuenhagen (DE)	Wustermark (DE)	Construction of new 380 kV double circuit OHL between the substations Wustermark – Neuenhagen with 75 km length. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.											under construction	mid term	Project partly under construction and partly in permitting phase. Expected date of commissioning was adjusted due to long permitting process and strong local public resistance.		
	45.199	Western Pomerania (DE)	Uckermark North (DE)	Construction of new 380 kV double circuit OHLs in northeastern part of 50Hertz Transmission control area and decommissioning of existing old 220 kV double circuit OHLs, incl. 380 kV line Bertikow – Pasewalk (30 km). Length: 135 km Support of RES and conventional generation integration in North Germany, maintaining of security of supply and support of market development.											planned	2015	Progresses as planned.		
	45.200	Lubmin (DE)	Erfurt area (DE)	380 kV grid enhancement and structural change area Lubmin / Stralsund and area Magdeburg / Wolmirstedt, incl. 380 kV line Güstrow – Wolmirsted (195 km).											planned	long term	Progresses as planned.		
	45.202	area upper Lausitz (DE)	area Gera(DE)	Upgrading existing double circuit 380 kV OHL Bärwalde – Schmölln in the southeastern part of the control area of 50Hertz Transmission. Length: approx. 50 km Support of RES and conventional generation integration in northeastern Germany, maintaining of security of supply and support of market development.											design & permitting	2017	Progresses as planned.		
	45.204	Calbe (DE)	Förderstedt (DE)	Construction of new 380 kV double circuit OHL between substation Calbe for double connection / loop into an existing line.											planned	mid term / long term	The evolution of this investment depends on the development of the power plant in the area. The date mentioned in the TYNDP 2010 was a typing mistake.		
	45.205	Fördertsedt	area Magdeburg (DE)	Construction of new 380 kV double circuit OHL from the substation Förderstedt with 20 km length for double connection / loop in for Förderstedt. Reinforcement of existing switchgear. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.											planned	2015 / 2020	Progresses as planned.		
	45.206	area Leipzig(DE)	area Chemnitz (DE)	Construction of new double circuit 380 kV OHL in existing corridor Röhrsdorf – Remptendorf (103 km).											under consideration	2020	Progresses as planned.		
	45.207	substations in southwestern part of 50Hertz Transmission control area (DE)		Construction of new 380 kV substation in southern Magdeburg area and restructuring of existing 220 kV equipment. Total length: approx. 50 km											planned	long term	Some of the investments are to be commissioned by the mid term and the some by long term.		
	45.208	lines and substations in southwestern part of 50Hertz Transmission control area (DE)		Construction of new 380 kV double circuit OHL in existing corridor Pulgar – Vieselbach (103 km). Support of RES and conventional generation integration, maintaining of security of supply and support of market development.											planned	2015 / 2020	Progresses as planned.		

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	45.209	substations in 50Hertz Transmission control area (DE)		Extension of existing and erection of new 380kV substations and several 380/110kV substations, incl. reactive power compensation devices.	5,000 MW			Bavaria and Baden-Württemberg area							design & permitting	mid term	This investment includes several substations in the 50Hertz Transmission control area. Present status varies form design & permitting, planning to under consideration and the date of commissioning varies from short/mid to long term.		This project helps accomodating the increasing flows coming mainly form RES in NE DE to South DE and to the Alps.
	45.A163	Wolmirstedt (DE)	Wahle (DE)	New double circuit OHL 380kV. Line length: 111km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.A164	Vieselbach (DE)	Mecklar (DE)	New double circuit OHL 400kV in existing OHL corridor (129km).											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.A165	Mecklar (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400kV (130km).											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.A166	Altenfeld (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400kV (130km).											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.A169	Grafenrheinfeld (DE)	Grossgartach (DE)	Additional 380kV circuit on an existing line. Length: 160km											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.A167	Redwitz (DE)	Schwandorf (DE)	New double circuit OHL 400kV in existing OHL corridor Redwitz – Mechlenreuth – Etzenricht – Schwandorf (185km).											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.A168	Raitersaich (DE)	Isar (DE)	New 400kV line in existing OHL corridor Raitersaich – Ludersheim – Sittling – Isar (160km).											under consideration	long term	New investment due to increase of RES, changes in conventional power plants in Germany and increase transits.		
	45.153	Redwitz (DE)	Grafenrheinfeld (DE)	Upgrade of 230kV connection Redwitz – Grafenrheinfeld to 400kV, including new 400kV switchgear Eltmann. Line length: 97km											design & permitting	mid term	Investment delay due to delay in the implementation or the line Halle – Schweinfurt (investment 45.193).		
	45.154	Redwitz (DE)		New 500 MVAr SVC in substation Redwitz.											planned	mid term	Progresses as planned.		
	45.155	Raitersaich (DE)		New 500 MVAr SVC in substation Raitersaich.											planned	mid term	Progresses as planned.		
	45.47.158																	The investment contributes both to project 45 and project 47. For the technical description see project 47.	
46	46.194	wind farm cluster Baltic Sea East (DE)	Lüdershagen/Lubmin (DE)*	Offshore wind farm connection project (by AC-cables on transmission voltage level or by clustering with DC connections) has to be constructed and afterwards also to be operated by the TSO (in this project: 50Hertz Transmission) according to German law.	>2,000 MW										design & permitting	2012-2020	This investment includes several connections of offshore wind farms in the eastern part of the Baltic Sea. The present expected date of commissioning varies from 2012 to 2020.		The integration of offshore wind generation in the Baltic Sea.
	46.195	wind farm cluster Baltic Sea West (DE)	Bentwisch (DE)	Offshore wind farm connection project (by AC-cables on transmission voltage level or by clustering with DC connections) has to be constructed and afterwards also to be operated by the TSO (in this project: 50Hertz Transmission) according to German law.											design & permitting	2013-2020	This investment includes several connections of offshore wind farms in the western part of the Baltic Sea. The present expected date of commissioning varies from 2013 to 2020.		

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47	47.A76	Vöhringen / Leupolz (DE)	Westtirol (AT)	Upgrade of an existing OHL to 380 kV, extension of existing and erection of new 380 kV substations including 380 / 110 kV transformers. Transmissions routs Vöhringen – Westtirol and Pkt. Woringen – Memmingen. Length: 114 km. This project will increase the current power exchange capacity between the DE, AT and CH.	>2,000 MW										planned	long term	New investment in TYNDP.		The reinforcement of the interconnection between Austria and Germany. Also the support the interaction between the RES in northern Europe(mainly DE) with the pump storage in the Austrian Alps. The project scheduling is not related only to the network needs, but even to the feasibility and to the authorization process (the possibility to anticipate specific projects could be evaluated in the future considering the three above mentioned elements).
	47.158	Irsching (DE)	Ottenhofen (DE)	Upgrade of 230 kV connection Irsching – Ottenhofen to 400 kV, including new 400 kV switchgear Zolling. Length: 76 km											planned	mid term	Progresses as planned.	The investment contributes also to project 45.	
	47.212	Isar / Ottenhofen (DE)	St. Peter (AT)	New 400 kV double circuit OHL Isar – St. Peter including new 400 kV switchgears Altheim, Simbach and St. Peter, and one new 400/230 kV transformer in substation Altheim and fourth circuit on line Isar – Ottenhofen. Line length: 90 km											design & permitting	2017	Progresses as planned.		
	47.26.216	St. Peter (AT)	Tauern (AT)	Completion of the 380 kV line St. Peter – Tauern. This contains an upgrade of the existing 380 kV line St. Peter – Salzburg from 220 kV operation to 380 kV operation and the erection of a new internal double circuit 380 kV line connecting the substations Salzburg and Tauern (replacement of existing 220 kV lines on optimized routes). Moreover the erection of the new substations Wagenham and Pongau and the integration of the substations Salzburg and Kaprun is planned. Line length: 130 km											design & permitting	2017 / 2019	Preparation for the permitting procedure is ongoing. APG is making efforts to set the 380 kV Salzburg-line 2017 into service. Depending on possible delays during the permitting procedure the commissioning is expected between 2017 and 2019	The investment contributes also to project 26.	
	47.26.218																	The investment contributes both to project 26 and project 47. For technical description please see project 26.	
	47.219	Westtirol (AT)	Zell-Ziller (AT)	Upgrade of the existing 220 kV line Westtirol – Zell-Ziller and erection of additional 220/380 kV transformers. Line length: 105 km											partly under construction	2013 – 2020	Project consists of several measures and is on schedule.		
	47.26.220																	The investment contributes both to project 26 and project 47. For technical description please see project 26.	
	47.221	St. Peter (AT)	Ernsthofen (AT)	Upgrade from 220 kV operation to 380 kV and erection of a 380 kV substation in Ernsthofen and St. Peter.											under construction	2013	The project is on schedule. Permissions are obtained. Commissioning is expected for 2013		
48	48.214	Gabcikovo (SK)	Gőnyü area (HU)	New interconnection (new 2 × 400 kV tie-line) between SK and HU starting from Gabčíkovo substation (SK) to the Gőnyü substation on Hungarian side (preliminary decision). Project also includes the erection of new switching station Gabčíkovo next to the existing one.	SK – HU 1,100 MW / HU – SK 400 MW			(North-West Hungary)							under consideration	2016	The commissioning date has been moved to earlier term due to earlier erection of new 400 kV line Veľký Ďur – Gabčíkovo that help to evacuate power from new NPP.	Negotiations still in progress. This project is closely connected with the project of erection of new line between Rimavska Sobota substation (SK) and Sajoivanka substation (HU) (see below).	This cluster will increase the transfer capacity between Slovak and Hungarian network systems and increase security of supply. The internal interconections in Slovakia are necessary for the same objective. Also this cluster is important for support of North – South flow from RES in North of EU.
	48.298	Veľký Ďur (SK)	Gabčíkovo (SK)	Erection of new 2 × 400 kV line between two important substations and extension of the substation Veľký Ďur (SK) Line length: 93 km											planned	2016	The commissioning date has been moved to earlier term due to ensure security of power evacuation from new NPP in Veľký Ďur area.		
	48.A125	Veľký Ďur (SK)	Levice (SK)	The erection of new 1 × 400 kV line between two important Veľký Ďur and Levice substations, including extension of the Veľký Ďur and Levice substation. The driver for this project is expected connection of to new generation units in Veľký Ďur area.											under consideration	2018	New investment in TYNDP, which will significantly increase of the security and reliability of the power evacuation from new NPP.		
	48.A126	Rimavská Sobota (SK)	Sajóivánka (HU)	Connection of the two existing substations (R.Sobota (SK) – Sajoóivánka (HU)) by the new 2 × 400 kV line (preliminary armed only with one circuit).											under consideration	2016	New investment in TYNDP.	Negotiations / bilateral studies in progress. This project is closely connected with the project 2 × 400 kV line Gabčíkovo (SK) – Hungary (see above).	
	48.A127	Sajóivánka (HU)	—	Second 400/120 kV transformer and 2 × 70 Mvar shunt reactors in station Sajóivánka.											under consideration	2016	New investment in TYNDP.		
	48.A128	Győr (HU)	—	Third 400/120 kV transformer and 70 Mvar shunt reactor in station Győr.											under consideration	2016	New investment in TYNDP.		

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50	50.238	Pancevo (RS)	Resita (RO)	New 131 km double circuit 400 kV OHL between existing substations in Romania and Serbia (63 km on Romanian side and 68 km on Serbian side).	1,000 MW			Area Belgrade and south Banat region							design & permitting	2015 (2019?)	Due to financing gap, the commissioning deadline was postponed to 2019. RO intends to apply for funding through the Operational Programme "Increase of Economic Competitiveness" – Priority Axis 4. This would ensure realization of the project and allow for faster finalization (2015 instead of estimated 2019). Constructive characteristics were updated as a result of progress of feasibility and design studies.		This project increases the transfer capability between Serbia, Romania and accommodates new RES generation on the west / east part of Romanian, respectively Serbia. It also increases the transfer capability on the interface between RO + BG / RS + BA + ME.
	50.269	Portile de Fier (RO)	Resita (RO)	New 400 kV OHL between existing substation 400 kV Portile de Fier and new 400 kV substation Resita. Line length: 116 km New 400 kV substation Resita, with 400/220 kV and 400/110 kV transformers, as development of the existing 220/110 kV substation.											design & permitting	2016	Constructive characteristics were updated as a result of progress of feasibility and design studies. Commissioning date has been slightly shifted.		
	50.A116	Beograd 20 (RS)		New 400/110 kV substation on the Belgrade territory.											under construction	2012	New investment in TYNDP.	By taking large amount of load from other Belgrade substations, the investment will both – improve the local SoS significantly and – relieve the constraints on the EHV local network and enable greater inter-area transits.	
	50.A117	Kraljevo 3 (RS)		Upgrade of the existing 220/110 kV substation Kraljevo 3 by constructing the 400 kV level.											design & permitting	2015	New investment in TYNDP.		
	50.A118	Kraljevo 3 (RS)	Bajina Basta (RS)	New 140 km double circuit 400 kV OHL between substation Kraljevo 3 and substation Bajina Basta. Kraljevo 3 (400 kV) will be connected to Kragujevac 2 (400 kV) substation, which is connected to Sofia (Bulgaria) through a 400 kV line.											planned	>2015	New investment in TYNDP.	New axis for transits from east to west, typically from Bulgaria to Bosnia & Herzegovina, Montenegro and further to the west.	
	50.270	Resita (RO)	Timisoara – Sacalaz – Arad (RO)	Upgrade of an existing 220 kV double circuit line to 400 kV double circuit line and replacement of 220 kV substations Timisoara and Sacalaz with 400 kV substations. Line length: 156 km											design & permitting	2022	Due to financing gap, the commissioning deadline was postponed to 2022. Constructive characteristics were updated as a result of progress of feasibility and design studies.		
53	53.276	Suceava (RO)	Gadalin (RO)	New 400 kV OHL between existing stations. Line length: 260 km	2,000 – 2,500 MW										planned	2021	Constructive design characteristics and time schedule were updated as a result of progress of feasibility and design studies.		The project will help evacuate important amount of new generation (wind + nuclear generation) in the eastern part of Romania.
	53.A131	Stejaru (RO)	Gheorghieni (RO)	Reconductoring (with HTLS) of existing simple circuit 220 kV line.											under consideration	2015	New investment in the TYNDP, required to integrate new RES generation and maintain the GTC for the entire project.		
	53.273	Cernavoda (RO)	Stalpu	New 400 kV double circuit OHL between existing stations. Line length: 145 km											planned	2017	Constructive characteristics were updated as a result of progress of feasibility and design studies.		
	53.274	Constanta (RO)	Medgidia (RO)	New 400 kV double circuit (one circuit wired) OHL between existing stations. Line length: 75 km											planned	2020	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.		
	53.275	Smardan (RO)	Gutinas (RO)	New 400 kV double circuit OHL between existing stations. Line length: 140 km											planned	2020	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.		

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				Project identification					**Project assessment**										
	53.271	connection in/out in Medgidia (RO) of actual 400 kV OHL Isaccea(RO) – Varna (BG)		The 400 kV Isaccea (RO) – Varna (BG) is passing near 400 kV substation Medgidia S. The line shall be connected in Medgidia S through a double circuit OHL. New wind farms shall be connected to the 400 kV OHL Isaccea – Medgidia S section. Substation Medgidia S, 400 kV, shall be refurbished with GIS technology in order to provide necessary space for new connections.	2,000–2,500 MW										design & permitting	2015	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.		The project will help evacuate important amount of new generation (wind + nuclear generation) in the eastern part of Romania.
	53.A132	Stalpu (RO)	Teleajen (RO) – Brazi (RO)	Upgrade of an existing 220 kV single circuit line to 400 kV. New 400 kV substations: – Stalpu (400/110 kV, 1 × 250 MVA), – Teleajen (400/110 kV, 1 × 400 MVA)											planned	2018	New investment in TYNDP.	This investment was merged with investment 273 in TYNDP 2010. They are now presented as separate investments in TYNDP 2012, according to internal project organization. The network development is still the same.	
	53.A133	Fantanele (RO)	Ungheni (RO)	Reconductoring (with HTLS) of existing simple circuit 220 kV line.											under consideration	long term	New investment in the TYNDP, required to accomodate new RES generation not foreseen in the TYNDP 2010, by increasing the GTC for the entire project.		
	53.272	connection in/out in Medgidia (RO) of actual 400 kV OHL Isaccea(RO) – Varna (BG)		Connection in/out in Medgidia (RO) of existing 400 kV OHL Isaccea (RO) – Dobrudja (BG), passing nearby. The line shall be connected in Medgidia S through a double circuit OHL. Substation Medgidia S, 400 kV, shall be refurbished with GIS technology in order to provide necessary space for new connections.											design & permitting	2015	As for other investments, the commissioning date was postponed due to financing gap. Constructive characteristics were updated as a result of progress of feasibility and design studies.	New wind farms shall be connected to the 400 kV OHL Isaccea – Medgidia S section.	
	53.A134	Gheorghieni (RO)	Fantanele (RO)	Reconductoring (with HTLS) of existing simple circuit 220 kV line.											under consideration	2015	New investment in the TYNDP, required to accomodate new RES generation not foreseen in the TYNDP 2010, by increasing the GTC for the entire project.		
54	54.293	Voľa (SK)	point of splitting (SK)	Splitting of the existing single 400 kV line between Lemešany and Veľké Kapušany substations to connect the new 400 kV substation Voľa with transformation 400/110 kV (replacing existing 220 kV substation). New 400 kV double circuit OHL. Length: 23 km	500 MW										design & permitting	2013	Progresses as planned.		This cluster will increase the transfer capacity between Slovak and Hungarian network systems and increase security of supply. The internal interconnections in Slovakia are necessary for the same objective. Also this cluster is important for support of north-south flow from RES in north of EU.
	54.294	Lemešany (SK)	Veľké Kapušany (SK)	Erection of new 400 kV line between Lemešany and Veľké Kapušany substations. The project includes the extension of the substations Lemešany and V.Kapušany. Line length: 100 km (including the loop erected under the investment 54.293)											planned	2018	Progresses as planned.		
	54.A127	Veľké Kapušany (SK)	tbd (HU)	Erection of new 2 × 400 line between SK and Hungary (substation on Hungarian side still to be defined).											under consideration	2021	New investment in TYNDP.		
55	55.302	Vyskov (CZ)	Cechy stred (CZ)	New second circuit 400 kV OHL, 1,385 MVA.	3,000 MW			Prague area							design & permitting	2015	Progresses as planned.		This project is required both to ease power flows west to east and to enhance security of supply of Prague.
	55.303	Babylon (CZ)	Bezdecin (CZ)	New second circuit 400 kV OHL, 1,385 MVA.											planned	2016	Progresses as planned.		
	55.304	Babylon (CZ)	Vyskov (CZ)	New second circuit 400 kV OHL, 1,385 MVA.											planned	2018	Progresses as planned.		
	55.A91	Praha Sever (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA.											planned	long term	New investment in TYNDP.		
	55.310	Vyskov (CZ)	Reporyje (CZ)	New connection between 2 existing substations line single circuit OHL 1,385 MVA.											under consideration	long term	Schedule harmonization with other priority investments: this investment has been delayed because of priority given to other investments.		

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56	56.A92	Chodov (CZ)	Cechy stred (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 35.1 km. Target capacity 2 × 1,385 MVA.	1,000 MW										planned	2021	New investment in TYNDP.		This project is required both to ease power flows west to east and for future generation evacuation.
	56.A93	Tynec (CZ)	Krasikov (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 103.8 km. Target capacity 2 × 1,385 MVA.											planned	2025	New investment in TYNDP.		
57	57.320	Dargoleza (PL)	—	A new AC 400/110 kV (450 MVA) substation between existing substations Słupsk and Żarnowiec in northern Poland. New substation Dargoleza is connected by splitting and extending of existing 400 kV line Słupsk – Dargoleza.	3,000 MW										planned	2020	The time horizon for commissioning of this investment has been changed due to change in wind farms connection schedule in the region.	The new substation Dargoleza is required for the connection new wind generation in northern Poland.	The infrastructure in this project assures reliable connection of 3,000 MW of wind generation in northern Poland. It also allows the evacuation of power in the southern direction.
	57.328	Piła Krzewina (PL)	Bydgoszcz Zachód (PL)	New 84 km 400 kV double circuit 2 × 1,870 MVA OHL interconnection line Piła Krzewina – Bydgoszcz Zachód temporarily on 220 kV.											design & permitting	2016	The time schedule of the project was shifted to meet the schedule of the RES (wind) generation connection. This one year delay in the plans appeared after updating of the NDP. The change in the NDP introduced a double circuit.		
	57.329	Żydowo (PL)	Słupsk (PL)	A new AC 400/110 kV substation next to existing 220/110 kV substation in northern Poland with transformation 400/110 kV 450 MVA. New substation Żydowo is connected by new 70 km 400 kV 2 × 1,870 MVA OHL double circuit lines Żydowo – Słupsk and Żydowo – Gdańsk Przyjaźń. Dismantling of existing 220/110 kV transformers + upgrade of substation SŁupsk.											planned	2020	The date of commissioning evolved due to regulatory, social and environmental issues. The investment also foresee upgrade works in substation Słupsk.		
	57.330	Żydowo (PL)	Gdańsk Przyjaźń (PL)	A new AC substation in Gdańsk Agglomeration Area. New substation Gdańsk Przyjaźń is connected by splitting and extending of one circuit of existing line Żarnowiec – Gdańsk Błonia and new 150 km 400 kV 2 × 1,870 MVA double circuit OHL line Żydowo – Gdańsk Przyjaźń with one circuit from Żydowo to Gdańsk temporarily on 220 kV after dismantling of 220 kV line Żydowo – Gdańsk.											planned	2020	The date of commissioning evolved due to regulatory, social and environmental issues.		
	57.352	Dunowo (PL)	Plewiska (PL)	Construction of a new double circuit 400 kV OHL Dunowo – Żydowo (2 × 1,870 MVA) partly using existing 220 kV line. Construction of a new 400 kV OHL Plewiska – Piła Krzewina – Żydowo (2x1870 MVA), single circuit temporarily working as a 220 kV. A new AC 400 kV switchgear in existing substation Pila Krzewina. Upgrade of substation Dunowo.											design & permitting	2020	Progressed as planned. The investment also foresee upgrade works in substation Dunowo.		
58	58.353	Krajnik (PL)	Baczyna (PL)	Construction of a new double circuit 400 kV OHL Krajnik – Baczyna (2 × 1,870 MVA, 91 km), single circuit temporarily working at 220 kV on Krajnik – Gorzów part. New substation 400 kV Baczyna will be connected by splitting and extending existing line Krajnik – Plewiska. Upgrading of limitations line Krajnik – Plewiska.	>1,000 MW										planned	2020	Progresses as planned.		Bridge Third interconnection between Poland and Germany.
	58.355	Mikułowa (PL)	Świebodzice (PL)	Double circuit line 220 kV Mikułowa – Świebodzice will be upgraded to 400 kV – single circuit temporarily working at 220 kV.											planned	2020	Progresses as planned.		
	58.A67	Gubin (PL)		New 400 kV substation planned near the PL – DE border. The substation will be connected to planned line Eisenhüttenstadt (DE) – Plewiska (PL) creating new lines Eisenhüttenstadt (DE) – Gubin (PL) and Gubin (PL) – Plewiska (PL).											planned	2020	New investment in TYNDP.	This new substation on the third DE – PL connection is necessary for future generation connection while ensuring interconnection capability.	
	58.140	Eisenhüttenstadt (DE)	Plewiska (PL)	New 400 kV double circuit OHL Eisenhüttenstadt (DE) – Plewiska (PL) including the construction of new substation Plewiska Bis (PL).											planned	2020	Progresses as planned.		

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59	59.368	Ełk (PL)	PL-LT border (LT)	Construction of a new 400 kV OHL Ełk to PL – LT border. (2 × 1,870 MVA, 108 km).	1,000 MW			South LT and NE/central PL							design & permitting	2015	Progresses as planned.		"LitPol Link" project. Interconnection of Lithuanian power system with Polish power system via Back to Back station. This project allows integration of Baltics to the internal European power market.
	59.369	Siedlce Ujrzanów (PL)	Miłosna (PL)	Construction of a new 400 kV OHL Siedlce Ujrzanów – Miłosna (1,870 MVA, 84 km). A new AC 400 kV switchgear in existing substation Siedlce Ujrzanow with transformation 400/110 kV 400 MVA.											design & permitting	2015	Progresses as planned.		
	59.370	Ełk (PL)	Łomża (PL)	Construction of a new 400 kV double circuit OHL Ełk – Łomża (2 × 1,870 MVA, 95 km). A new AC 400 kV switchgear in existing substation Ełk. A new 400 kV AC substation Łomża											design & permitting	2015	Łomża has been elected as end substation for the project and the technical description is adapted accordingly. Progresses as planned otherwise.		
	59.371	Ostrołęka (PL)	Narew (PL)	Construction of a new 400 kV OHL Ostrołęka – Łomża – Narew (1,870 MVA, 120 km). A new AC 400 kV switchgear in existing substation Ostroleka (in two stages) with transformation 400/220 kV 500 MVA and with transformation 400/110 kV 400 MVA. Extension of 400 switchgear in substation Narew.											design & permitting	2015	Progressed as planned. The investment also foresee extension works in substation Narew.		
	59.372	Oltarzew (PL)		A new AC substation with two transformers 400/220 kV 2 × 500 MVA and one 400/110 kV 330 MVA will be connected by splitting 400 kV line Rogowiec – Miłosna and Miłosna – Płock and 220 kV line Mory – Sochaczew and Mory – Janów.											under construction	2015	Progresses as planned.		
	59.373	Ostrołęka (PL)	Stanisławów (PL)	Single circuit line 220 kV Ostrołęka – Miłosna will be partly upgraded to double circuit line 400 kV (2 × 1,870 MVA, 106 km) with development of Ostrołęka 400 kV substation. New substation 400 kV Stanisławów will be connected by splitting and extending existing line Miłosna – Narew and Miłosna – Siedlce.											design & permitting	2020	Progresses as planned.		
	59.374	Kozienice (PL)	Siedlce Ujrzanów (PL)	Existing single circuit line will be upgraded to 400 kV line in the same direction (1,870 MVA, 90 km). Upgrade of Kozienice substation to connect the new line.											design & permitting	2020	Progressed as planned. The investment also foresee extension works in substation Kozienice.		
	59.375	Płock (PL)	Olsztyn Mątki (PL)	New single circuit line 400 kV (1,870 MVA, 180 km) with development of Olsztyn Mątki 400 kV substation.											design & permitting	2020	Progresses as planned.		
	59.376	Alytus (LT)	PL-LT border (PL)	Construction of Back-to-Back convertor station near Alytus 330 kV substation. Construction of double circuit 400 kV OHL between Alytus and PL – LT border (2 × 1,870 MVA, 51 km).											design & permitting	2015	Progresses as planned.		
	59.379	Kruonis (LT)	Alytus (LT)	New double circuit 330 kV OHL (2 × 1,870 MVA, 53 km).											planned	2015	Progresses faster than initially planned to support the LitPol project.		

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90	90.131	Bickigen (CH)		Addition of a second 400/220 kV transformer in an existing substation.	4,000 MW										design & permitting	2012	Progresses as planned.		This project increase the transfer capability between FR, DE, AT towards pump storage in CH.
	90.132	Mühleberg (CH)		Construction of a new 400/220 kV substation.											design & permitting	2015	Delays due to authorization process.		
	90.134	Bassecourt (CH)	Romanel (CH)	Construction of different new 400 kV line sections and voltage upgrade of existing 225 kV lines into 400 kV lines. Total length: 140 km											design & permitting	2015	Delays due to authorization process.		
	90.136	area of Bodensee (DE, AT, CH)		Construction of new lines, extension of existing ones and erection of 400/220/110 kV substation. This project will increase the current power exchange capacity between the DE, AT and CH. The project is expected to increase NTC and improve the security of supply.											planned	long term	Progress as planned.		
	90.129	Beznau (CH)	Mettlen (CH)	Upgrade of the existing 65 km double circuit 220 kV OHL to 400 kV.											design & permitting	2015	Progresses as planned.		
	90.130	La Punt (CH)	Pradella / Ova Spin (CH)	Installation of the second circuit on existing towers of a double circuit 400 kV OHL (50 km).											planned	2017	Delays due to authorization process.		
	90.133	Bonaduz (CH)	Mettlen (CH)	Upgrade of the existing 180 km double circuit 220 kV OHL into 400 kV.											under consideration	2020	Progresses as planned.		
	90.44.170																	The investment contributes both to project 44 and project 90. For the technical description see project 44.	
	90.44.172																	The investment contributes both to project 44 and project 90. For the technical description see project 44.	
	90.44.173																	The investment contributes both to project 44 and project 90. For the technical description see project 44.	
	90.44.176																	The investment contributes both to project 44 and project 90. For the technical description see project 44.	
	90.45.177	Goldshöfe (DE)	Bünzwangen (DE)	A new 380 kV OHL. Length: 45 km											under consideration	2020	Progresses as planned.	The investment contributes also to project 45.	
92	92.146	Aachen / Düren region (DE)	Lixhe (BE)	Connection between Germany and Belgium including new 100 km HVDC underground cable and extension of existing 380 kV substations. On Belgian side, new 380 kV circuit between Lixhe and Herderen and second 380 kV OHL in / out from Herderen to Lixhe. In Belgium, addition of 2 transformers 380/150 kV in Lixhe and in Limburg part.	1,000 MW			Northern Belgium							design & permitting	2017	Project entered design and permitting phase in 2011, technical description has been completed and expected date of commissioning is 2017.	Alegro Project	First Belgium – Germany interconnection. This project enhances security of supply of both BE and DE. This HVDC link in an AC grid brings flexibility and bidirectional power control allowing integration of RES in both countries. This project aims to be a demonstration for HVDC link integration in the AC meshed grid.
94	94.139	Vierraden (DE)	Krajnik (PL)	Upgrade of existing 220 kV line Vierraden – Krajnik to double circuit 400 kV OHL.	>1,000 MW										design & permitting	long term	Expected date of commissioning was adjusted due to long permitting process and strong local public resistance.		PSTs: Control of the transits of power on the polish synchronous profile (increase of import capacity, increase of grid operation safety).
	94.A68	Krajnik (PL)		Upgrade 400 kV.											design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
	94.A69	Mikułowa (PL)		Upgrade 400 kV.											design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
	94.A70	Krajnik (PL)		New PST.											design & permitting	2014	New investment in the TYNDP, split out from investment 139.		
	94.A71	Mikułowa (PL)		New PST.											design & permitting	2014	New investment in the TYNDP, split out from investment 139.		

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95	95.A119	Dobrudja(BG)	Burgas (BG)	New 140 km single circuit 400 kV OHL in parallel to the existing one.	1,500 MW										planned	2016	New investment in TYNDP, required to accommodate 2,000 MW RES in Dobrudja region.		It contributes to the accommodation of large amount of RES in Dobrudja region (2,000 MW). It also contributes to north-south transfers and increases the security of supply in Burgas region.
	95.265	Vidno (BG)	Svoboda (BG)	New 400 kV double circuit OHL to accommodate 2,000 MW RES generation in Northeast Bulgaria (Dobruja region). Line length: 2 × 70 km											planned	2015	Moved from LT (TYNDP 2010) to MT due to high interest for very fast implementation of about 2,000 MW RES generation in Dobrudja region.		
	95.263	SS 400/110 kV Svoboda (Krusari)		New 400/110 kV substation to accommodate the expected RES generation(2,000 MW) in Northeast Bulgaria (Dobruja region).											planned	2015			
	95.264	SS 400/110 kV Vidno		New 400/110 kV substation to accommodate the expected RES generation(2,000 MW) in Northeast Bulgaria (Dobruja region).											planned	2015			
	95.266	in / out in Svoboda on actual 400 kV OHL Isaccea (RO) – Varna (BG)		New 400 kV double circuit OHL to accommodate the expected RES generation(2,000 MW) in Northeast Bulgaria (Dobruja region). Line length: 2 × 10 km											planned	2015			
99	99.324	Dobrzeń (PL)	Wrocław / Pasikurowice (PL)	New 76 km 400 kV 2 × 1,870 MVA OHL double circuit line from Dobrzeń to splitted Pasikurowice – Wrocław line. Upgrade and extension of 400 kV switchgear in substation Dobrzeń.	1,800 MW			Warsaw and lower Silesia area							design & permitting	2017	Progresses globally as planned. Technical description and commissioning date have been updated so as to deliver full benefit as from 2017.		Dobrzeń: The project introduces new infrastructure (2 × 400 kV line) to allow power evacuation from two (2 × 9,000 MW) conventional units to be installed in existing power plant Opole. The new line provides power supply for agglomeration Wroclaw, it increases the security of supply for this area.
100	100.335	Ostrołęka (PL)	Olsztyn Mątki (PL)	New 138 km 400 kV 2 × 1,870 MVA double circuit OHL line Ostrołęka – Olsztyn Mątki after dismantling of 220 kV line Ostrołęka – Olsztyn with one circuit from Ostrołęka to Olsztyn temporarily on 220 kV.	1,000 MW										design & permitting	2017	The time schedule of the project was shifted to meet the schedule of the generation connection.		Ostrołęka: The new 400 kV line allows power evacuation from new 1,000 MW conventional unit to be installed in existing power plant Ostroleka.
101	101.327	Kozienice (PL)	Ołtarzew (PL)	New 130 km 400 kV 2 × 1,870 MVA OHL double circuit line Kozienice – Ołtarzew. Upgrade and extension of 400 kV switchgear in substation Kozienice for the connevtion of new line.	1,000 MW			Warsaw area							design & permitting	2017	The time schedule of the project was shifted to meet the schedule of the generation connection.		Kozienice: The new 2 × 400 kV line allows power evacuation from new 1,000 MW conventional unit to be installed in existing power plant Kozienice. The new unit is foreseen to supply Warsaw agglomeration area.
	101.338	Kozienice (PL)	Mory / Piaseczno (PL)	Replacement of conductors (high temperature conductors).											under construction	2014	Progresses as planned, with commissioning now expected in 2014.		The project also allows to close the 400 kV ring around Warsaw agglomeration are increasing the security of supply significantly.
102	102.A72	Gdańsk Błonia (PL)		Extension and upgrade of an existing 400/110 kV substation Gdańsk Błonia for connection of planned 900 MW power plant.	2,900 MW										planned	2020	New investment in TYNDP.	Power Evacuation North. The upgraded substation will connect a planned 900 MW CCPP.	North: The north-south corridor provides necessary capacity to evacuate the power from new 2,900 MW of conventional generation planned to be installed in northern Poland.
	102.334	Pątnów (PL)	Grudziądz (PL)	New 174 km 400 kV 2 × 1,870 MVA double circuit OHL line Pątnów – Grudziądz after dismantling of 220 kV line Pątnów – Jasiniec (two parallel lines) and Jasiniec – Grudziądz. One circuit from Pątnów to Grudziądz via Jasiniec temporarily on 220 kV.											design & permitting	2020	The time schedule of the project was shifted to meet the schedule of the generation connection.	Power Evacuation North.	
	102.326	Grudziądz (PL)	Gdańsk Przyjaźń (PL)	A new AC 400/110 kV substation between existing substation Grudziądz and planned substation Gdańsk Przyjaźń. New substation Pelplin is connected by new 110 km 400 kV 2 × 1,870 MVA OHL double circuit lines Grudziądz – Pelplin and Pelplin – Gdańsk Przyjaźń after dismantling of 220 kV line Jasiniec – Gdańsk.											planned	2020	The time schedule of the project was shifted to meet the schedule of the generation connection.	Power Evacuation North.	

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103	103.145	Niederrhein (DE)	Doetinchem (NL)	New 400 kV line double circuit DE-NL interconnection line. Length: 60 km	13,900 MW			NW part of Netherlands							design & permitting	>2013	Delays due to authorization process.		The project reinforces the Dutch grid to accommodate new conventional and renewable generation, to handle new flow patterns and to increase the interconnection capacity between DE and NL.
	103.438	Eemshaven (NL)	Diemen (NL)	New 175 – 200 km AC overhead line with capacity of 2 × 2,650 MVA of 380 kV.											design & permitting	2018	Delays due to authorization process.		
	103.439	Borssele (NL)	Geertruidenberg (NL)	New 100 – 130 km double circuit 380 kV OHL with 2 × 2,650 MVA capacity.											design & permitting	2016	Delays due to authorization process.		
	103.440	Maasvlakte (NL)	Beverwijk (NL)	New 380 kV double circuit mixed project (OHL + underground cable) including approximately 20 km of underground cable for 2,650 MVA. The cable sections are a pilot project. The total length of cable at 380 kV is frozen until more experience is gained.											under construction	2016	Delays due to authorization process.		
	103.441	Zwolle (NL)	Hengelo (NL)	Upgrade of the capacity of the existing 60 km double circuit 380 kV OHL to reach a capacity of 2 × 2,650 MVA.											under consideration	long term	Progresses as planned.		
	103.442	Krimpen aan de Ijssel (NL)	Maasbracht (NL)	Upgrade of the capacity of the existing 150 km double circuit 380 kV OHL to reach a capacity of 2 × 2,650 MVA.											under consideration	long term	Progresses as planned.		
108	108.A134	Tarnita (RO)	Mintia (RO)	New 145 km double circuit 400 kV OHL.	1,000 MW										planned	2018	New investment in TYNDP.	Connection of pumped storage hydro plant Tarnita Lapustesti to the grid. The plant has an installed capacity of 1,000 MW and will support system balancing, especially in order to face the intermittent RES output.	The project will connect to the grid 1,000 MW hydro pump storage.
	108.A135	Tarnita (RO)	Cluj E – Gadalin (RO)	New 40 km double circuit 400 kV OHL.											planned	2018	New investment in TYNDP.		
	108.A136	Tarnita (RO)		New 400 kV substation.											planned	2018	New investment in TYNDP.		

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	58	Ensdorf (DE)	St. Avold (FR)	Change of conductors on the German part of this single circuit 220 kV line (9 km) and installation of a phase-shifter in Ensdorf (DE) 220 kV substation.											commissioned	commissioned	Commissioned.		
	69	Candia (IT)	Konjsko (HR)	New 1,000 MW HVDC interconnection line between Italy and Croatia via 280 km 500 kV DC subsea cable and converters stations at both ending points.											under consideration	post 2022	These projects are very sensitive to the market and still under investigation.		
	168	Goldshöfe (DE)	Dellmensigen (DE)	Upgrade the line Goldshöfe – Dellmensigen from 220 kV to 380 kV. Line length: 114 km Included with the project : 3 × 380 kV substations, 2 transformers											under construction	2014	Investment 168 has been postponed to 2014 due to local resistance against the project in a specific area. The rest of the investment is ready.		
	168a	region South-West Bavaria (DE)		Upgrading the existing 220 kV OHL to 380 kV, length 100 km, and the extension of existing substations, erection of 380/110 kV-transformers.											cancelled	cancelled	The project was abandoned / was not seen necessary with the new set of projects in place. Note: in the previous TYNDP the status of the project was under consideration and not planned (printing mistake).		
	192	Hamburg / Krümmel (DE)	Schwerin (DE)	This 380 kV double circuit OHL project will close the missing gap in the northeastern German grid infrastructure. Only 65 km of new line must be constructed, 22 km already exist.											under construction	2012 / 2013	Commissioning delayed by complex permitting procedure. Line is partly constructed. Is expected to be commissioned in 2012 / 2013 short term.		
	198	Wuhlheide (DE)	Thyrow (DE)	Berlin South Ring: replacement of an existing old 220 kV double circuit OHL by a 380 kV double circuit OHL. Length: 50 km											cancelled	cancelled	Project was depending on the replacement of a CHP power plant based in Berlin. Due to a new general CHP concept the plant size could be adopted and the upgrade of the existing 220 kV connection to 380 kV was not necessary any longer. Project was given up with regard to the CHP plant investor.		
	222	Silz (AT)	Zell-Ziller (AT)	Upgrade of the existing 220 kV double circuit OHL Zell – Ziller – Silz. Line length: 42 km											under construction	2013 / 2014	Progress as planned.	This line, due to change in, switched from the TSO environment to the distribution area.	
	230	TPP Sisak (HR)	Mraclin(HR) / Prijedor (BA)	Connection of new generator on existing line 220 kV Mraclin (HR) – Prijedor (BA) via a new double circuit OHL. Line length: 12 km											design & permitting	2012 – 2013	The commissioning date is postponed due to the prolonged permitting procedures and due to the harmonization with installation of new generating unit in TPP Sisak.		
	279	Gyor (HU)	Martonvasar (HU)	Upgrade of an existing 220 kV single circuit line to 400 kV double circuit. Line length: 84 km											under construction	2012	It will be commissioned by the end of 2012.		
	282	Sajoszoged / God (HU)	Detk (HU)	New substation Detk with 2 × 250 MVA 400/120 kV transformation is connected by splitting and extending existing line Sajoszoged – God.											design & permitting	2017	The project was delayed due to a change in the generation (decommissioning of units connected to 120 kV deferred) which led to a delay in investment need.		
	284	Martonvasar / Paks (HU)	Dunaujvaros (HU)	New substation Dunaujvaros with 2 × 250 MVA 400/120 kV transformation is connected by splitting and extending existing line Martonvasar – Paks.											design & permitting	2015	2012 > 2015: Delayed due to delay in investment need, according to National Plan 2010 (load growth in the specific area will be lower than previously forecasted).		
	285	Debrecen (HU)		New substation Debrecen with 2 × 250 MVA 400/120 kV transformation is connected by changing the operating voltage of line Sajoszoged – Debrecen from 220 kV to 400 kV, this line being already designed for 400 kV.											design & permitting	2013	Progress as planned.		
	286	Martonvasar / Liter (HU)	Szekesfehervar (HU)	New substation Szekesfehervar with 2 × 250 MVA 400/120 kV transformation is connected by splitting and extending existing line Martonvasar – Liter.											planned	2016	2014 > 2016: Delayed due to delay in investment need, according to National Plan 2010 (load growth in the specific area will be lower than previously forecasted).		
	287	Albertirsa / God (HU)	Godollo (HU)	New substation Godollo with 2 × 250 MVA 400/120 kV transformation is connected by splitting and extending existing line Albertirsa – God.											planned	2015	Progress as planned.		

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	288	Albertirsa / Martonvasar (HU)	Szazhalombatta (HU)	New substation Szazhalombatta is connected by splitting and extending existing line Albertirsa – Martonvasar.											planned	2015	Progress as planned.		
	289	Felsozsolca (HU)	Sajoivanka (HU)	Reconstruction of line to double circuit, installation of the 2nd transformer in substation Sajoivanka. Line length: 29 km											cancelled	cancelled	Cancelled. New cluster #53 makes this investment unnecessary.		
	290	Oroszlany (HU)		New substation Oroszlany with 2 × 250 MVA 400/120 kV transformation is connected by splitting and extending the second circuit of line Martonvasar – Gyor.											under consideration	2016	2017 > 2016: Earlier completion is foreseen for financing and organization reasons.		
	291	Sajoszoged (HU)		New 400/120 kV 250 MVA transformer with PST.											cancelled	cancelled	Cancelled according to National Plan 2010. Generation pattern in the specific area will change significantly thus this investment is no longer necessary.		
	292	Debrecen (HU)		Reconstruction of 750 kV substation.											design & permitting	2013	Progress as planned.		
	296	Medzibrod (SK)	point of splitting (SK)	Connection of existing 220/110 kV Medzibrod substation to the 400 kV system by splitting the single 400 kV line Sučany – Liptovská Mara. Project includes also the reconstruction of Medzibrod substation from 220 kV level to 400 kV including transformation 400/110 kV. Line length: 36 km											under construction	2013	Substation Medzibrod has been reconstructed to the level of 400 kV (still operated on the level 220 kV till the new 400 kV lines will be completed).		
	297	Križovany (SK)	Horná Ždaňa (SK)	The new substation Bystričany with transformation 400/110 kV will be connected to the 400 kV system by two new 2 × 400 kV lines from Horná Ždaňa and Križovany substations and by splitting only one circuit in Bystričany substation. In the future the substation will be also equipped with a 220 kV switchgear. Line length: 112 km											planned	2019	Change of the date according to the changed investment plan schedule in the development plan of SEPS.		
	299	Krasikov (CZ)	Horni Zivotice (CZ)	New single circuit 400 kV OHL, 1,385 MVA.											design & permitting	2014	Progresses as planned.		
	322	Kromolice (PL)		A new AC substation between existing substations Plewiska and Ostrów and Pątnów in Poznań Agglomeration Area with transformation 400/110 kV 400 MVA. New substation Kromolice is connected by splitting and extending existing line Ostrów – Plewiska and Pątnów – Plewiska.											under construction	2012	The investment process ongoing according to plan. Faster commissioning date reported after update of NDP. The project will be commissioned by the end on 2012.		
	331	Gorzów (PL)	Leśniow (PL)	Upgrading of sag limitations (new capacity 461 MVA).											planned	2015	The investment process ongoing according to plan.		
	336	Warszawa Praga (PL)		A new AC substation with 2 × 275 MVA 220/110 kV transformation between existing substations Miłosna and Mory in Warszawa Agglomeration Area. New substation Warszawa Praga is connected by splitting and extending existing line Miłosna – Mory.											planned	>2015	The project appeared in the plans for generation connection purpose. Planned commissioning is dependant upon generation investment (the investor has withdrawn a new gen. unit from the plans). There is an existing combined heat power plant in this area; possible new generation in the future.		
	344	Lublin Systemowa (PL)	Abramowice (PL)	New 220 kV cable / OHL interconnection line Lublin Systemowa – Abramowice in Lublin agglomeration area (522 MVA, 18 km).											design & permitting	>2020	Investment postponed due to change in generation sector plans.		
	346	Halemba (PL)		Halemba substation is connected by splitting and extending of existing 220 kV lines Kopanina – Katowice.											cancelled	cancelled	Project withdrawn from TSO plans because of cancellation of construction of new generation unit.		
	348	several substations in PSE O control area		Installation additional and exchange existing transformers (400/110 kV and 220/110 kV), capacitors and SVC in substations. Upgrading of substations.											design & permitting	2015	The investment process ongoing according to plan.		

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Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	349	Puławy (PL)		A new AC 400 kV switchgear in existing substation Pulawy (with transformation 400/220 kV 500 MVA) will be connected by splitting and extending existing 400 kV lines: Kozienice – Lublin Systemowa and Kozienice – Ostrowiec.											planned	2020	The investment process ongoing according to plan. This investment is connected to the construction of a new power plant.		
	350	Chełm (PL)	Lublin Systemowa (PL)	Construction of a new 400 kV OHL Lublin Systemowa-Chełm with single circuit (1,870 MVA). A new AC 400 kV switchgear in existing substation Chelm with transformation 400/220 kV 500 MVA.											planned	2020	Upon withdrawal of new conventional power plant from the plans the content of the project in the area has changed. Initially the project was foreseen to accommodate a conventional generator.		
	351	Blachownia (PL)		A new AC 400 kV switchgear in existing substation Blachownia (with transformation 400/220 kV 500 MVA and 400/110 kV 400 MVA) will be connected by splitting and extending existing 400 kV line Joachimów – Wielopole and 220 kV line Kedzierzyn – Groszowice.											planned	2020	The project appeared in the plans for generation connection purpose. Planned commissioning is dependant upon generation investment (the investor has with-drawn a new gen. unit from the plans). There is an existing heat power plant in this area; possible new generation in the future.		
	354	Byczyna (PL)	Podborze (PL)	Double line 400 kV Byczyna – Czeczott – Podborze (2 × 1,870 MVA, 155 km) will be built in parallel with 220 kV line Byczyna – Bieruń – Poręba – Podborze in the same road. New substation 400 and 220 kV Podborze (with transforma-tion 400/220 kV 500 MVA) will be connected by splitting and extending existing lines Wielopole – Nosovice, Kopanina – Liskovec, Bujaków – Liskovec, Komorowice – Bieruń, Moszczenica – Poręba and new double circuit line 400 kV Podborze – Czeczott.											design & permitting	after 2020	The delay in the plans appeared after updating of the NDP. The time schedule of the project was shifted to meet the schedule of the generation connection.		
	356	Janów (PL)		New substation 400 kV Janów (with transformation 400/110 kV 400 MVA) will be connected by splitting and extending existing line Rogowiec – Płock.											planned	2020	The investment process is according to the plan.		
	357	Joachimów (PL)		Replacement of a transformer 400/220 kV (500 MVA).											planned	2020	The investment process ongoing according to plan.		
	359	Morzyczyn (PL)	Pomorzany / Glinki (PL)	New line 220 kV (522 MVA).											planned	>2020	Future realization of the investment dependant upon needs of increase of security of supply in the Szczecin agglomeration area.		
	360	Miłosna (PL)	Siekierki (PL)	New cable connection 220 kV Miłosna – Warszawa Siekierki (333 MVA, 10 km).											planned	>2020	Future realization of the investment dependant upon needs of increase of security of supply in the Warcowa agglomeration area.		
	361	Ołtarzew (PL)	Mory (PL)	Replacement of conductors (high temperature conductors). New capacity: 461 MVA											planned	2020	The investment process ongoing according to plan. The upgrade method not decided yet.		
	362	Wielopole (PL)	Moszczenica (PL)	Replacement of conductors (high temperature conductors). New capacity: 461 MVA											planned	2020	The investment process ongoing according to plan. The upgrade method not decided yet.		
	363	Byczyna (PL)	Siersza (PL)	Replacement of conductors (high temperature conductors). New capacity: 461 MVA											planned	2020	The investment process ongoing according to plan. The upgrade method not decided yet.		
	367	several substations in PSE O control area		Installation of an additional transformer and replacement of an existing one (400/110 kV and 220/110 kV). Shunt reactors in substations. Upgrading and decommissioning of substations.											planned	2020	The investment process ongoing according to plan.		
	319	Skawina (PL)		A new AC 400/110 kV substation next to existing 220/110 kV substation in Cracow Agglomeration Area with transformation 400/110 kV 2 × 400 MVA. New substation Skawina is connected by splitting and extending of existing 400 kV lines Tarnów – Tucznawa and Rzeszów – Tucznawa. Dismantling of existing 220/110 kV transformers.											design & permitting	2015	The investment process ongoing according to plan.		

Table of projects – Regional Group Continental Central East

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	321	Kromolice (PL)	Pątnów (PL)	New 79 km 400 kV 1,870 MVA OHL interconnection line Kromolice – Pątnów with one circuit from Plewiska to Koninn temporarily on 220 kV after dismantling of 220 kV line Plewiska – Konin.											under construction	end 2012	The investment process ongoing according to plan. Faster commissioning date reported after update of NDP. This project is due to be put in operation by the end of 2012.		
	323	Warszawa Siekierki (PL)	Piaseczno (PL)	A new AC 220/110 kV substation (with transformation 220/110 kV 2 × 275 MVA) in Warsaw Agglomeration Area connected by a new 20 km 220 kV 333 MVA cable/OHL line Warszawa Siekierki – Piaseczno.											design & permitting	2020	Investment postponed due to change in new generation unit connection schedule which was scheduled for 2015 but it was withdrawn from the medium term.		
	325	Krajnik (PL)	Pomorzany (PL)	A new AC substation in Szczecin Agglomeration Area. New substation Pomorzany is connected by new 24 km 220 kV 522 MVA line Krajnik – Pomorzany and 220/110 kV (275 MVA) transformer to existing 110 kV switchgear.											planned	2016	The delay in the plans appear after updating of the NDP. The time schedule of the project was shifted to meet the schedule of the generation connection (combined cycle power plant in Pomorzany).		
	332	Recław (PL)	Glinki (PL)	A new AC substation in Szczecin Agglomeration Area. New substation Recław is connected by new 52 km 220 kV 522 MVA line Recław – Glinki, existing 110 kV single circuit line Morzyczyn – Recław upgraded to 220 kV and two 220/110 kV (275 MVA) transformer to existing 110 kV switchgear. Splitting of existing 220 kV line Morzyczyn – Olice and expanding to Glinki substation.											design & permitting	2016	The delay in the plans appear after updating of the NDP. The time schedule of the project was shifted due to proper coordination with other investments in the area (325).		
	333	Pasikurowice (PL)	Świebodzice (PL)	A new AC substation in Wrocław Agglomeration Area. New substation Wrocław is connected to new 135 km (sum) 400 kV 1,870 MVA lines: Pasikurowice – Wrocław and Świebodzice – Wrocław. New 400 kV Wrocław substation with 2 × 400 MVA, 400/110 kV transformation. New 400 kV Świebodzice substation with 1 × 500 MVA, 400/220 kV transformation and 1 × 400 MVA, 400/110 kV transformation. New 400 kV OHL interconnection line Wrocław – Świebodzice after dismantling of 220 kV line Świebodzice – Biskupice and new 400 kV OHL interconnection line Pasi-kurowice – Wrocław, including new Wrocław substation.											under construction	2015	The investment process ongoing according to plan. The line Pasikurowice – Wrocławd and the substation Wrocław are already commissioned.		
	337	Radkowice (PL)	Kielce Piaski (PL)	New 26 km 220 kV 522 MVA OHL line Radkowice – Kielce Piaski, in Kielce agglomeration area.											design & permitting	2015	The investment process ongoing according to plan.		
	340	Lubocza (PL)		An existing substation in Kraków Agglomeration Area. Existing substation will be upgraded by splitting and ex-tending existing 220 kV line Siersza – Klikowa and installing second ATR 220/110 kV (160 MVA).											commissioned	commissioned	In the previous NDPs of PL the projects were structure in steps of 5 years. Therefore the date of commissioning mentioned in TYND 2010 is 2015. The project will be commissioned by the need of 2012.		
	341	Pątnów (PL)	Włocławek (PL)	Upgrading of sag limitations OHL 220 kV (389 MVA).											cancelled	cancelled	Investment suspended. After connection of planned generation unit in substation Włocławek Azoty the possibility of overload in the existing lines is eliminated.		
	342	Czarna (PL)	Polkowice (PL)	New 400 kV OHL interconnection line Czarna – Polkowice (1,870 MVA, 22 km), including new Polkowice 400 kV substation with 500 MVA, 400/220 kV transformation.											design & permitting	2016	The investment process ongoing according to plan. The delay in the commissioning of the project appeared after updating of the NDP.		

Table of projects – Regional Group Continental Central East

Project identification					Project assessment														
Project number	**Investment number**	**Substation 1**	**Substation 2**	**Brief technical description**	**Grid transfer capacity increase**	**Socio-economic welfare**	**RES integration**	**Improved security of supply**	**Losses variation**	**CO_2 mitigation**	**Technical resilience**	**Flexibility**	**Social and environmental impact**	**Project costs**	**Present status**	**Expected date of commissioning**	**Evolution compared to the TYNDP 2010 situation**	**Investment comment**	**Project comment**
	343	Byczyna (PL)		Upgrading of existing AC 220 kV substation Byczyna. A new 400 kV AC substation in Silesia Agglomeration Area with transformation 400/220 kV 2 × 500 MVA. New substation Byczyna is connected by splitting and extending existing line Tarnów – Tucznawa.											planned	2015	The investment process ongoing according to plan		
	358	Ostrów (PL)	Kromolice (PL)	Installation of a 2nd 400 kV circuit along an already existing line on the same voltage. (1,870 MVA, 212 km).											design & permitting	2020	The investment process ongoing according to plan		
	364	Czarna (PL)	Polkowice (PL)	New line will be second 400 kV circuit to existing line in the same direction. (1,870 MVA, 22 km).											planned	2020	The investment process ongoing according to plan. The first out of 2 circuits will be operational starting with 2015.		
	365	Wyszków (PL)		New substation 400 kV Wyszków (with transformation 400/110 kV 400 MVA) will be connected by splitting and extending line Ostrołęka – Stanisławów.											design & permitting	2025	The investment delayed because of spacial planing problems.		
	203	area Wolmirstedt (DE)	under consideration	Support of RES and conventional generation integration, maintaining of security of supply and support of market development.											under consideration	2020	Included in new investment H3 due to new wind BS generation.		
	180	Mengede (DE)	Kruckel (DE)	Installation of a second circuit 380 kV OHL and extension of existing substations. Line length: 16 km.											design & permitting	mid term	Project develops according ot the plan.		
	217	Dürnrohr (AT)	Sarasdorf (AT)	Installation of the 3rd and 4th circuit on the existing line Dürnrohr – Sarasdorf and restructuring in the area of the substation Bisamberg and the 220 kV Weinviertel line . Total length: 100 km											under construction	2014	The project is on schedule. Permissions are obtained. Commissioning is expected for 2014.		
	169	Großgartach (DE)		Upgrade the substation for a higher short circuit capacity. New installation includes 10 gas insulated bays, 63 kA, 3 busbars and 2 transformers.											commissioned	commissioned	Commissioned.		
	201	Bärwalde (DE)	Schmölln (DE)	New internal double circuit 380 kV line connecting the substations St. Peter and Salzach neu (replacement of the existing 220 kV line). Length: 46 km											design & permitting	2014	Delays due to authorization process.		
	196	wind farm Baltic 1 (DE)	Bentwisch (DE)	Connection of the offshore wind farm Baltic 1 (AC-cables on transmission voltage level).											commissioned	commissioned	Commissioned.		
	210	substations in 50Hertz Transmission control area		Construction of new 380/110 kV substations.											commissioned	commissioned	Freiberg and Stendal / West are commissioned. The remaining substations were transferred to the 44.209 investment.		
	213	Wien SO (AT)	Szombathely (HU)	Installation of the 2nd circuit on the existing interconnection from Wien SO (AT, APG) to the border (both circuits have already been installed on the Hungarian side, one is connected to Györ and the 2nd circuit to Szombathely). Line length: 63 km											commissioned	commissioned	2011 > 2010: Completed earlier. It was due to scheduling of the field work.		
	215	St. Peter (AT)	Salzach neu (AT)	New internal double circuit 380 kV line connecting the substations St. Peter and Salzach neu (replacement of the existing 220 kV line). Length: 46 km											commissioned	commissioned			
	226	Ernestinovo (HR)	Pecs (HU)	New 400 kV double circuit interconnection line between existing stations. Line length: 86 km											commissioned	commissioned	Commissioned.		
	277	Heviz (HU)	Szombathely (HU)	New 400 kV transmission line between existing stations. Line length: 78 km											commissioned	commissioned	Commissioned.		
	278	Gyor / Liter (HU)	Gonyu (HU)	New substation Gonyu (generator connection point) is connected by splitting and extending existing line Gyor – Liter.											commissioned	commissioned	Commissioned.		

Table of projects – Regional Group Continental Central East

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environ-mental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	295	Lemešany (SK)	Moldava (SK)	New 31 km double circuit 400 kV line, replacing a 220 kV one. The part of the line from Moldava substation up to switching substation Košice was put into operation in 10/2009.											commissioned	commissioned	Commissioned 2011.		
	300	Chotejovice (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA .											commissioned	commissioned	Commissioned.		
	301	Vyskov (CZ)	Chotejovice (CZ)	New single circuit 400 kV OHL, 1,385 MVA.											commissioned	commissioned	Commissioned.		
	305	Kletne (CZ)		New 400/110 kV substation equipped with transformers 2 × 350 MVA .											commissioned	commissioned	Commissioned.		
	280	Gyor / Martonvasar (HU)	Bicske (HU)	New substation Bicske with 2 × 250 MVA 400/120 kV transformation is connected by splitting and extending existing line Gyor – Martonvasar line.											commissioned	commissioned	2012 > 2010: Completed earlier. It was due to financing and field organization issues.		
	283	Albertirsa / Bekescsaba (HU)	Szolnok (HU)	New substation Szolnok with 2 × 250 MVA 400/120 kV transformers is connected by splitting and extending existing line Albertirsa – Bekescsaba.											commissioned	commissioned	2012 > 2011: Earlier completion due to scheduling of the field work.		
	281	Albertirsa (HU)	Martonvasar (HU)	Adding second circuit to existing 400 kV single circuit OHL. Line length: 45 km											commissioned	commissioned	Commissioned earlier due to scheduling of the field work.		
	339	Morzyczyn (PL)		A new AC substation in Szczecin Agglomeration Area with transformation 400/220 kV 330 MVA and 400/110 kV 330 MVA. New substation Morzyczyn is connected by splitting and extending existing 400 kV line Krajnik – Dunowo.											commissioned	commissioned	Commissioned. In the previous NDPs of PL the projects were structure in steps of 5 years. Therefore the date of commissioning mentioned in TYND 2010 is 2015. The project was commissioned in 2011.		
	345	Łagisza (PL)		A new AC 400 kV switchgear in existing substation Łagisza (with transformation 400/220 kV 500 MVA and 400/110 kV 330 MVA) is connected by splitting and extending of exist-ing 400 kV lines Rokitnica – Tucznawa.											commissioned	commissioned	Commissioned. In the previous NDPs of PL the projects were structure in steps of 5 years. Therefore the date of commissioning mentioned in TYND 2010 is 2015. The project was commissioned in 2011.		
	347	Gdańsk I (PL)		A new AC 400 kV switchgear in existing substation Gdańsk I is connected by splitting and extending of existing 400 kV lines Żarnowiec – Gdańsk Błonia.											commissioned	commissioned	Commissioned. In the previous NDPs of PL the projects were structure in steps of 5 years. Therefore the date of commissioning mentioned in TYND 2010 is 2015. The project was commissioned in 2011.		
	67	Divaca (SI)		Installation of a new 400 kV PST to assist control of power flows to Italy on secure level and secure the operation of Slovenian grid enabling full utilisation of regional market.											commissioned	commissioned	This is PST in SS Divaca and it has been in operation since 2011.		
	A130	Albertfalva (HU)		New 220/120 kV 160 MVA transformer.											planned	2020	Appeared in National Plan 2010. Transformer capacity extension on 220/120 kV is needed for maintaining security of supply.		
	A94	Prosenice (CZ)	Kletne (CZ)	New connection between existing substation a new substa-tion (see investment 299)											under consideration	long term	New project.		
	A95	Detmarovice (CZ)		New substation equipped with transformers 2 × 350 MVA											planned	long term	New project.		
	A73	Żarnowiec (PL)		Extension and upgrade of an existing 110 kV switchgear and installation of 400/110 kV transformer dedicated to wind farms planned to be connected to Żarnowiec substation. Upgrade of existing 400 kV switchgear for transformer installation.											planned	2020	The Żarnowiec substation is one of several substations in northern Poland incorporated in the project Wind Integration. The upgraded substation will serve as connection point for RES generation.		

Table of projects – Regional Group Continental Central East

Project identification					Project assessment														
Project number	Investment number	Substation 1	Substation 2	Brief technical description	Grid transfer capacity increase	Socio-economic welfare	RES integration	Improved security of supply	Losses variation	CO_2 mitigation	Technical resilience	Flexibility	Social and environmental impact	Project costs	Present status	Expected date of commissioning	Evolution compared to the TYNDP 2010 situation	Investment comment	Project comment
	A103	Weinviertel-line New investment for the integration of RES (mainly wind power) in the northeastern part of Austria ("Weinviertel")		To allow the grid integration of the planned renewable energy generation (mainly wind power) in the northeastern part of Austria ("Weinviertel"). To cover the foreseen load growth in that region the transmission grid infrastructure has to be enforced and new substations for the connection have to be erected.											planned	2016/2017	New project.		
	A145	Tynec (CZ)	Cechy stred (CZ)	New second circuit to existing single circuit OHL. Upgrade in length of 46.2 km. Target capacity: 2 × 1,730 MVA											planned	long term	New project.	This investment item is a complementary to the project 56. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	
	A146	Hradec (CZ)	Vyskov (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 45.3 km. Target capacity: 2 × 1,730 MVA											planned	long term	New project.	This investment item is a complementary to the project 35. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	
	A147	Phase Shifting Transformer Hradec (CZ)		Construction of new PST in substation Hradec with target capacity 2 × 1,700 MVA.											planned	mid term	New project.	This investment item is a complementary to the project 35. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	
	A148	Prosenice (CZ)	Krasikov (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 87.5 km. Target capacity: 2 × 1,730 MVA											planned	long term	New project.	This investment item is a part of the eastern area close to Poland and Slovakia which involves projects that address both interregional connection / transmission and international transmission needs. Investment will also strengthen the grid in developing area and ensure security of supply in this area. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	
	A149	Nosovice (CZ)	Prosenice (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 79.4 km. Target capacity: 2 × 1,730 MVA											planned	long term	New project.	This investment item is a part of the eastern area close to Poland and Slovakia which involves projects that address both interregional connection / transmission and international transmission needs. Investment will also strengthen the grid in developing area and ensure security of supply in this area. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	
	A150	Hradec (CZ)	Chrast (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 82.4 km. Target capacity: 2 × 1,730 MVA											planned	long term	New project.	This investment item is a complementary to the project 35. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	
	A151	Prestice (CZ)	Chrast (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 32.8 km. Target capacity: 2 × 1,730 MVA											planned	long term	New project.	This investment item is a complementary to the project 35. Complication during permit granting process is foreseen. It is intended also to ask for EU financial support.	

Table of projects – Regional Group Continental Central East

Appendix 2: Market Study

This part of the appendix is dedicated to the market study results obtained by RG CCE following an investigation into possible future market behavior. As previously mentioned in Chapter 5, 2 main scenarios were developed as well as a number of sensitivity studies. An overview of the main results of these simulations is presented here.

Scenario EU 2020

Base Case

Base Case – Balances

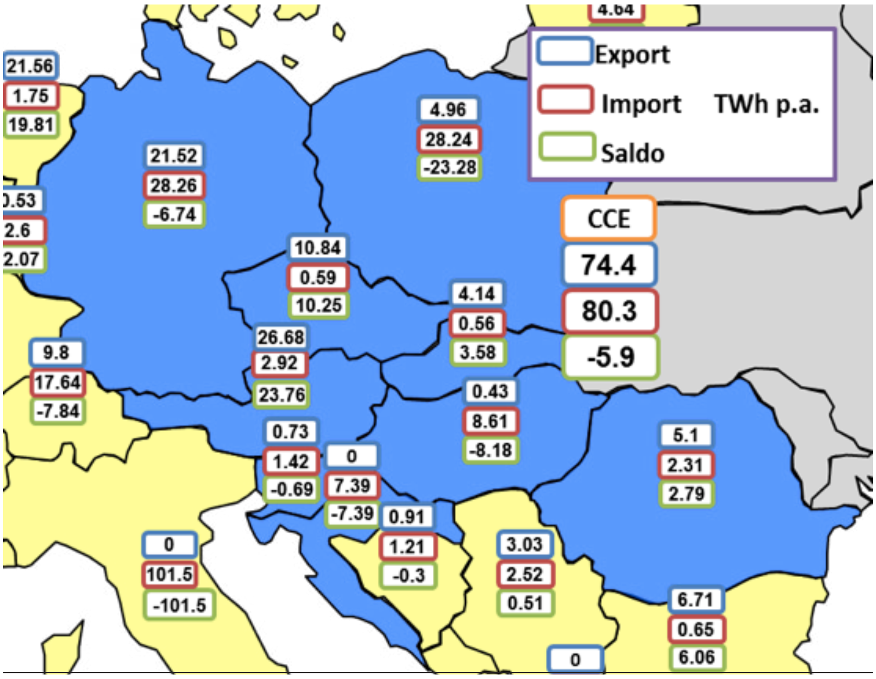


Figure 37:
Balances of RG CCE countries Scenario EU2020 – Base case

Base Case – Market flows

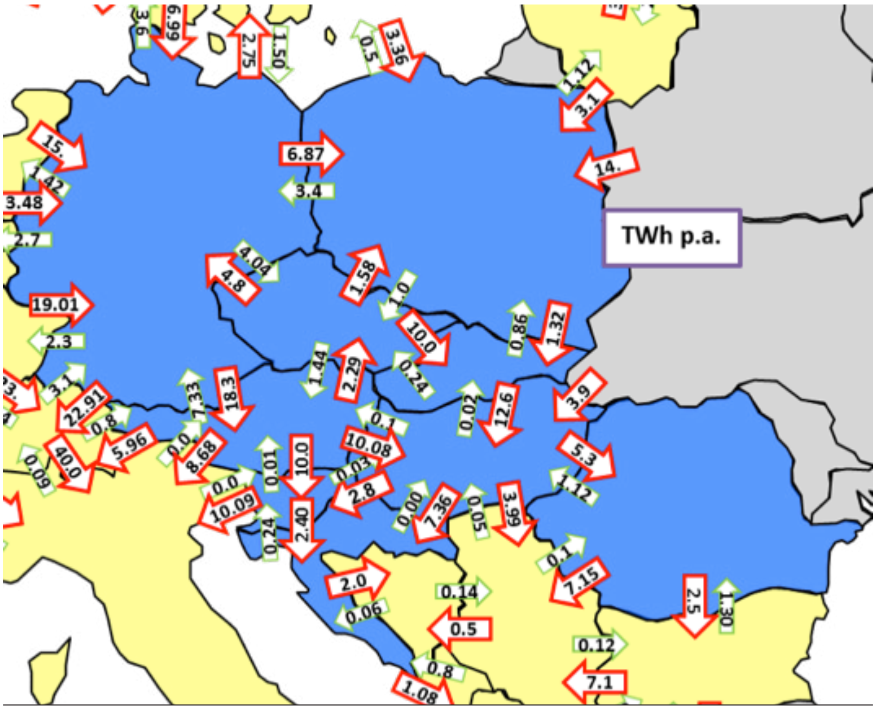


Figure 38:
Market Flows within RG CCE countries Scenario EU 2020 – Base case

Nuclear Phase Out

Nuclear Phase Out – Balances

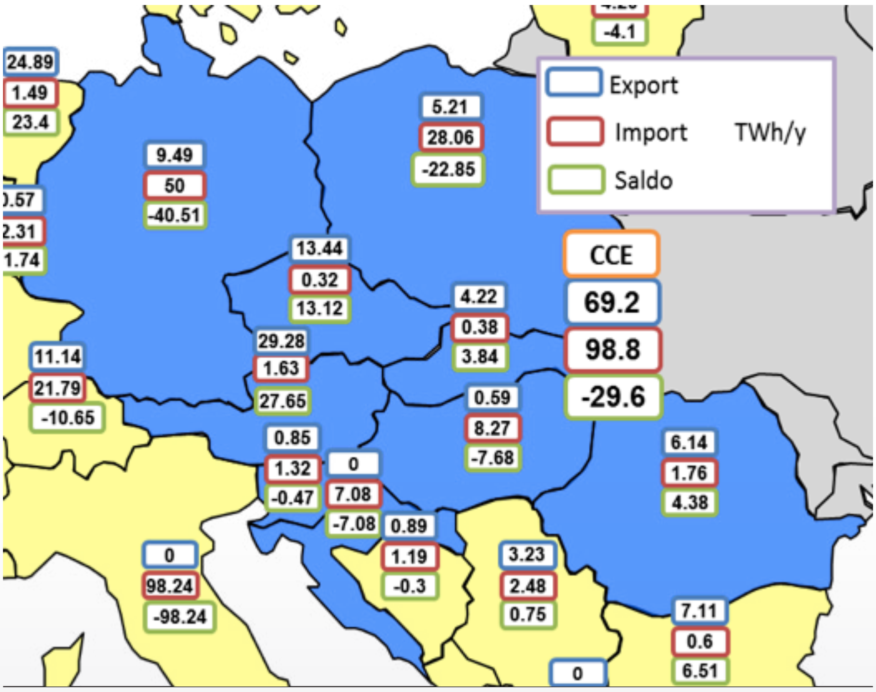


Figure 39:
Balances of RG CCE countries Scenario EU 2020 – Nuclear phase out

Nuclear Phase Out – Market flows

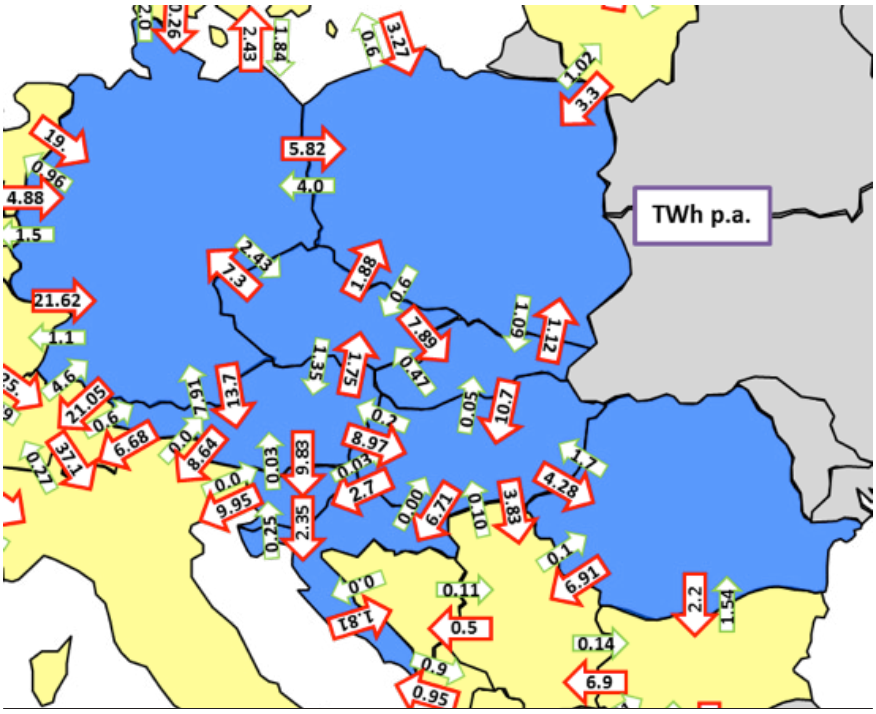


Figure 40:
Market Flows within RG CCE countries Scenario EU 2020 – Nuclear phase out

SCENARIO B

Base Case

Base Case – Balances

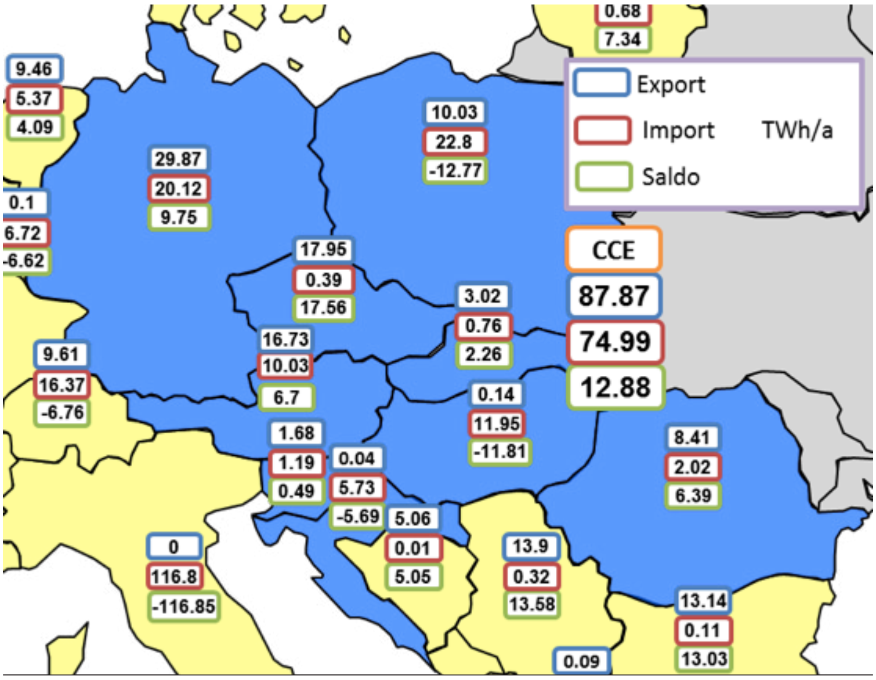


Figure 41:
Balances of RG CCE countries Scenario B – Base case

Base Case – Market flows

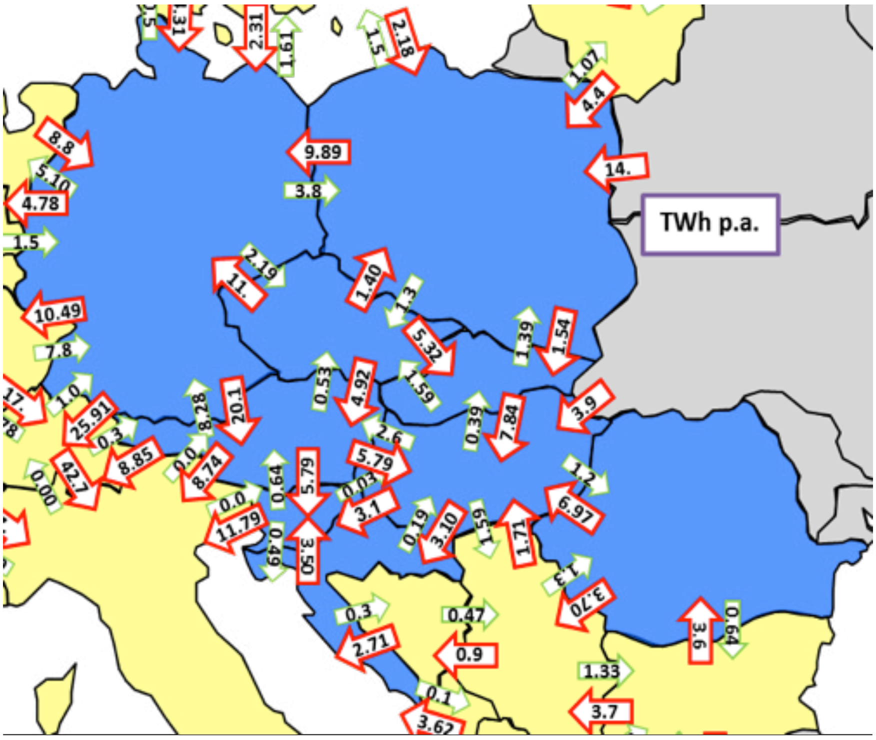


Figure 42:
Market Flows within RG CCE countries Scenario B – Base case

Nuclear Phase Out

Nuclear Phase Out – Balances

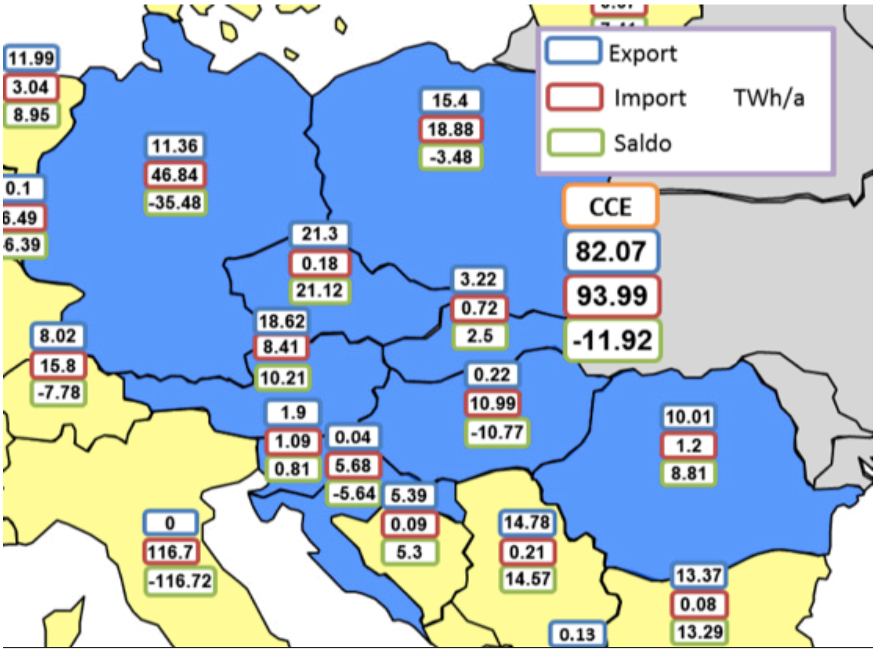


Figure 43:
Balances of RG CCE countries Scenario B – Nuclear phase out

Nuclear Phase Out – Market flows

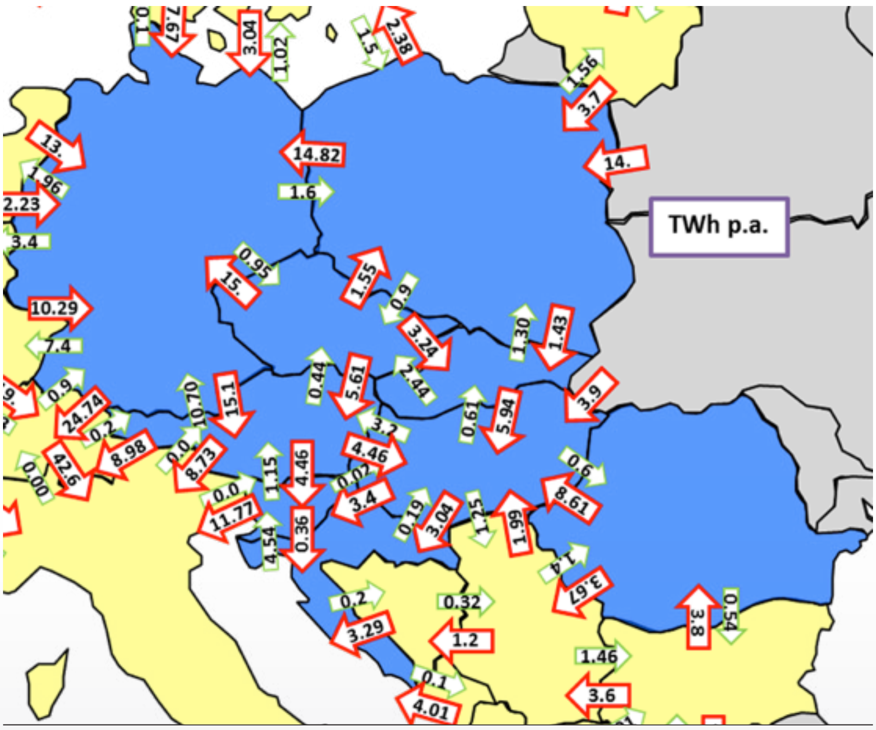


Figure 44:
Market Flows within RG CCE countries Scenario B – Nuclear phase out

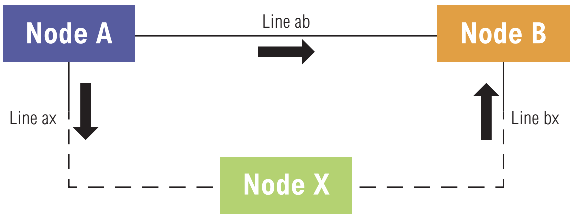
This overview of 4 simulated cases demonstrates that market flows are close depending on CO_2 price whilst Nuclear Phase Out also has a significant impact on market behavior in the CCE region. Market exchanges represent the trade, however real flows in the grid can be different and can also, in some cases, be in the opposite direction to market flows.

Appendix 3: PST

PST (phase shifting transformer)

PST does not create additional transmission capacities, but in some cases they help to use the existing capacities by optimizing the load flows.

Example:



In the figure above there is a simple grid with three nodes (A, B, X).

In this example there are high flows from A to B which cause overloads on this connection. On the other hand there are free capacities from A to X and X to B. By using a PST in the connection A to B the flows can partly shift to the connections A to X and X to B. In this example no additional lines are necessary due to the use of PST.

In the second example the same grid as before is used. However, in this grid there are overloads from A to B and from A to X. Here a PST in A to B can reduce the problems on the line, but doing this will increase the overloads on the connection A to X. In this example additional grid extensions are necessary.

12.1 Abbreviations

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

12.2 Imprint

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

Design & Layout: Oswald und Martin Werbeagentur, Berlin

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