European Network of
Transmission System Operators
for Electricity

Regional Investment Plan 2015 Continental Central East region

- Final version after public consultation

30 October 2015

Contents

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1 EXECUTIVE SUMMARY

1.1 Regional Investment Plans as foundation for the TYNDP 2016

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

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

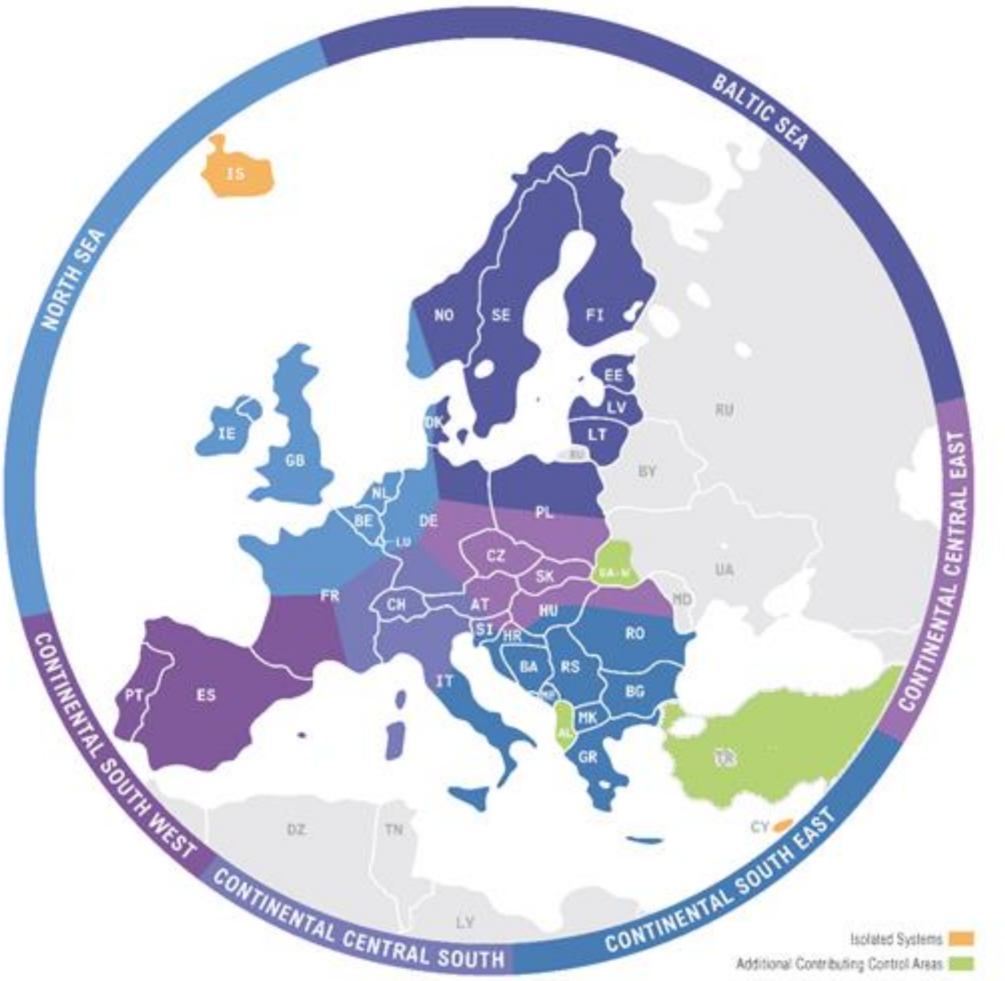

Figure 1-1 ENTSO-E System Development Regions

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

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

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

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

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

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

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

1.2 Key messages of the region

Continental Central East Regional Group (CCE RG) with almost one-third share (based on TYNDP2014 V4) of all installed generation capacity in the ENTSO-E area will continue to play a key role in the European internal energy market, its security, adequacy and sustainability. Adequate, well integrated and reliable grid networks are a crucial prerequisite for enhancement of security of supply and a bridge to facilitate Europe to meet its energy policy goals.

Connection of new generation capacities with a big share from renewable energy shall continue to be a major driver for grid development in the CCE region. While a political discussion continues in some countries in the region on how could the future generation mix evolve; on one hand, some countries like Germany have decided to phase-out nuclear power plants; on the hand, other countries in the region like

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Czech Republic, Poland, Slovakia, Hungary, Romania and Slovenia foresee significant increase share of power generation from nuclear energy under certain circumstances.

Further, grid infrastructure development in some countries (e.g. in Poland, Czech Republic) in the CCE region will be triggered by connection of generation from other technologies like gas turbines and traditional coal power plants even though European electricity market conditions in general are not in favour of power generation from gas-based turbines at the time being.

In line with the EC's communication on European Energy Security Strategy which addresses it's ambition to accelerate the construction of key interconnectors as well as the backbone transmission infrastructure within European regions (including CCE region), an exercise through Common Planning Studies (market and network based computations) that explore possible infrastructure development for 2030 has been performed and evaluated. Those studies have resulted into an identification (or at least confirmation) of those borders where increase of cross-border target transmission capacities that reflect future EU energy goals is beneficial and relevant and as a reflection to the European Commission proposal for Member States to ensure a minimum level of interconnection of 15% by 2030. The EU energy goals were taken into consideration in the choice of scenarios. As a result of market studies in the framework of Common Planning Studies in which the exercise of target capacities increase between borders and identification of bottlenecks was carried out, new candidate projects have been explored between Hungary – Romania and Poland – Germany. The project between Poland – Germany is foreseen to increase the import capacity of Poland from common profile Germany, Czech Republic and Slovakia.

Strong dependency and correlation between RES generation and direction of commercial power exchange is one of the phenomenon that has been also explored within common planning studies. While, during high RES generation in the northern-part of Europe, commercial power exchanges are in the north-south and west-east direction, during low RES generation in the northern part, the commercial power exchange are in the opposite direction. In some cases along the year, this changing behaviour has a quite short time lasting period. A grid development has therefore to take into account this power exchange volatility characteristic in order to properly optimize the grid structure.

As depicted in the TYNDP 2014 package and in particular in the CCE RgIP2014 a huge investment plan is also confirmed in this RgIP2015. Realization of this regional investment plan is a crucial prerequisite bridge towards the EU energy goals. About 35 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 131 investments are of national or regional relevance. Most of investment items of the RgIP2015 were already present in the RgIP2014 and are hence confirmed. This shows the coherence between the two consecutive plans (RgIP2014 and 2015) 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 mid- and long-term perspective.

With that ambitious investment plan however, it has to be noted down that Transmission System Operators have difficulties in implementing the required investments due to lengthy permit granting procedures, public opposition and unprecedented capital requirements. Therefore, a clear political willingness and commitment to build the required infrastructure, at EU, national and regional level, underpinned by more consistent regulatory frameworks, are needed to support the infrastructure implementation process.

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2 INTRODUCTION

2.1 General and legal requirements

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

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

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

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

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

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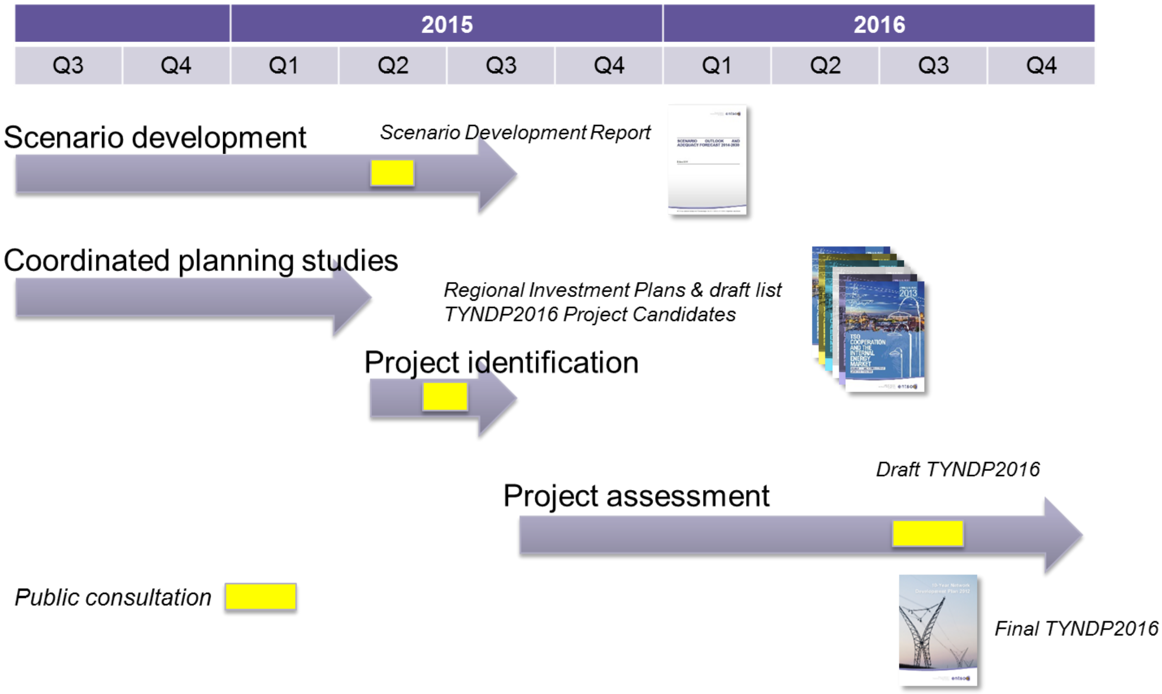

Figure 2-1 Overview of a two-year TYNDP process

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

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

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

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

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

2.2 The scope of the report

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

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

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

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

2.3 General methodology

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

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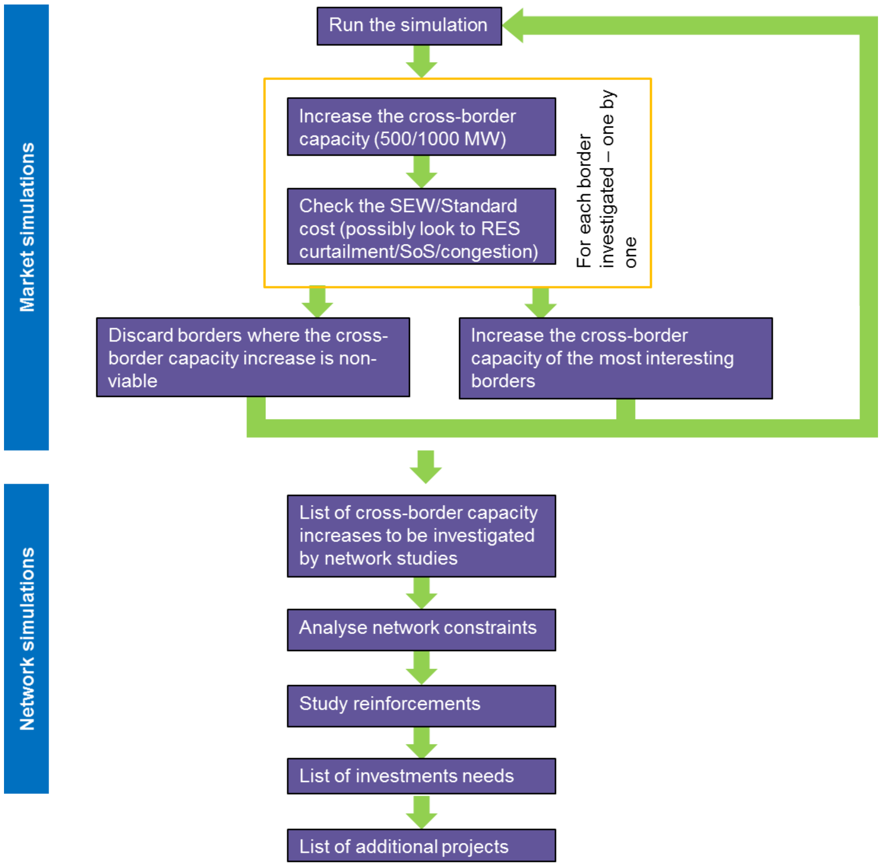

Figure 2-2 Common Planning Study workflow

Market Studies

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

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

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

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

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Network Studies

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

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

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

Regional knowledge

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

2.4 Report overview

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

Chapter 1 – Executive Summary

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

Chapter 2 - Introduction

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

Chapter 3 – Regional Context

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

Chapter 4 – Regional results

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

Chapter 5 – Project candidates

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

Chapter 6 – Next steps

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

Chapter 7 – Appendices

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

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3 REGIONAL CONTEXT

The Continental Central East Regional Group (CCE RG) under the scope of the ENTSO-E System Development Committee is among the 6 regional groups for grid planning and system development tasks. The Member States belonging to each group are shown in **figure 3-1** below. CCE RG itself consists of 9 countries: Austria, Croatia, Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and Slovenia; with the involvement of 10 companies/ TSOs: APG, HOPS, ČEPS, 50Hertz Transmission GmbH, TenneT TSO GmbH, MAVIR, PSE, Transelectrica, SEPS and ELES. The list of ENTSO-E countries and TSOs in the CCE RG outlined here is presented in **table 1.1** below:

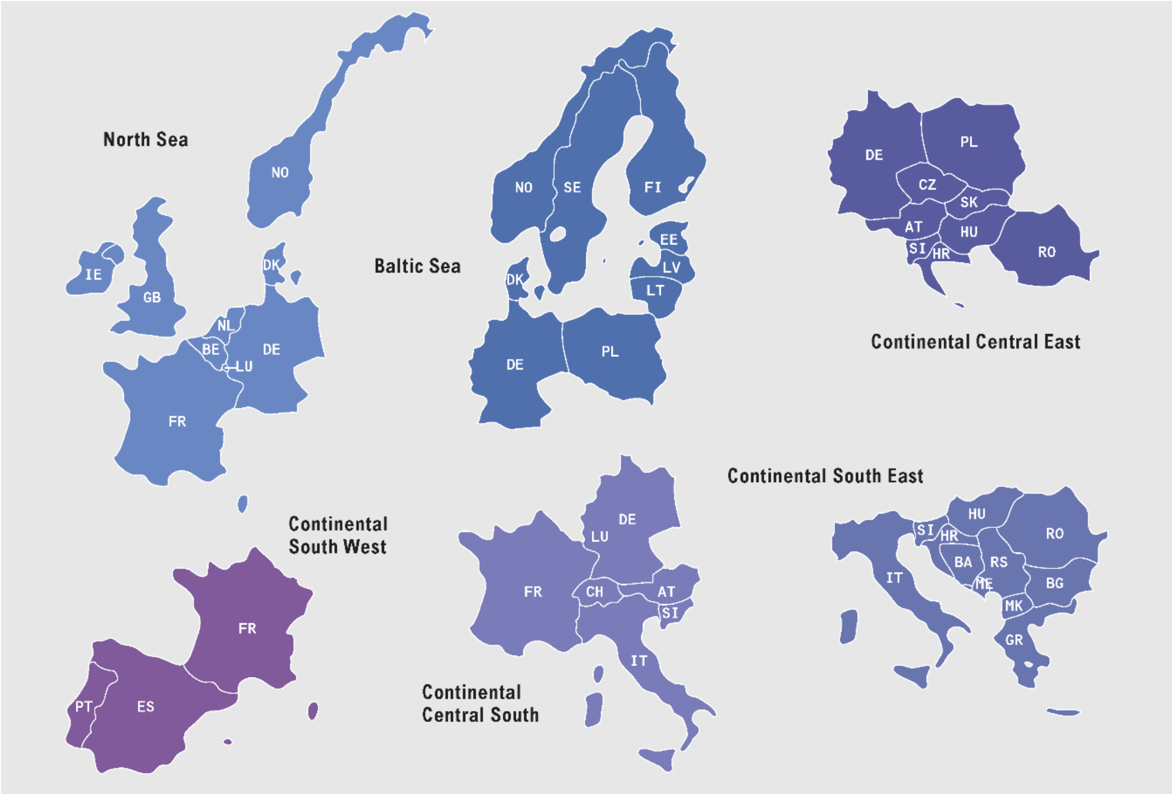

Figure 3-1 ENTSO-E regions (System Development Committee)

Country	Company/TSO
Austria	APG – Austrian Power Grid AG
Croatia	HOPS
Czech Republic	ČEPS, a.s.
Germany	50Hertz Transmission GmbH
	TenneT TSO GmbH
Hungary	MAVIR
Poland	PSE S.A.
Romania	C. N. Transelectrica S. A.
Slovak Republic	Slovenská elektrizačná prenosová sústava, a.s.
Slovenia	ELES, d.o.o.

Table 3-1 ENTSO-E Regional Group CCE membership

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3.1 Present situation

The Regional Group Continental Central East is characterized by the interconnected and highly meshed system, where all countries have at least 4 connections to adjacent TSOs (including DC connection). The majority of the TSOs control areas are inner AC systems, thus their systems and capacities are influenced by unscheduled flows. The main physical flows are in the north-south direction.

Due to this fact, NTC values on particular borders can vary hour by hour based on the availability of grid elements (by reason of reconstruction, revision or any other topological changes) and expected unplanned flows as it has been happening nowadays, however one can expect even higher variation in the future due to expected higher variability of electricity production. For illustration and better visualization of the present situation of interconnection capacities values in CCE region, the maximum 2014 NTC values for each border in both directions in CCE region are depicted in the **figure 3-2**.

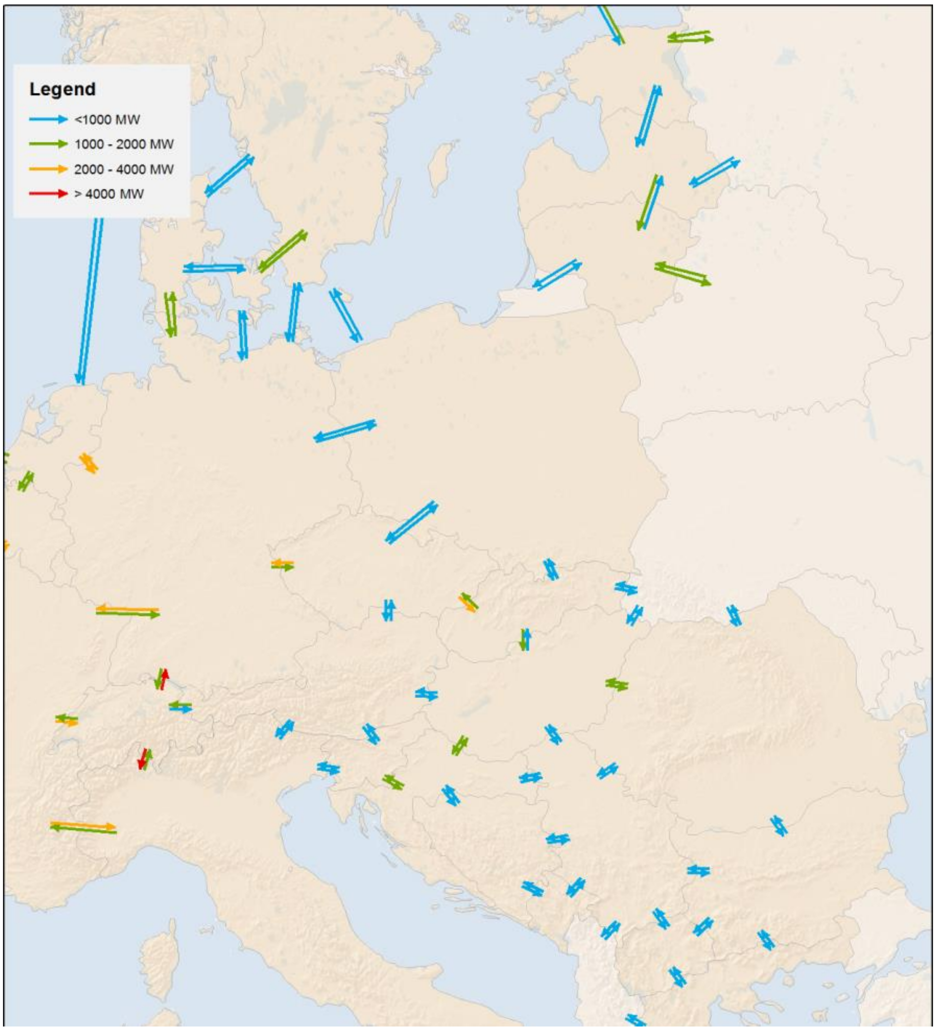

Figure 3-2 Illustration of the Net Transfer Capacities (NTC) in the CCE region (2014)

In the **figures 3-3** and **3-4** below, the net generation capacities and net generation in comparison with consumption in 2014 in the CCE region countries are depicted, in order to show CCE region generation mix. In order to see which of the CCE countries are exporting, importing or rather balanced, the balances of each CCE member state in 2014 are depicted in the next **figure 3-5**.

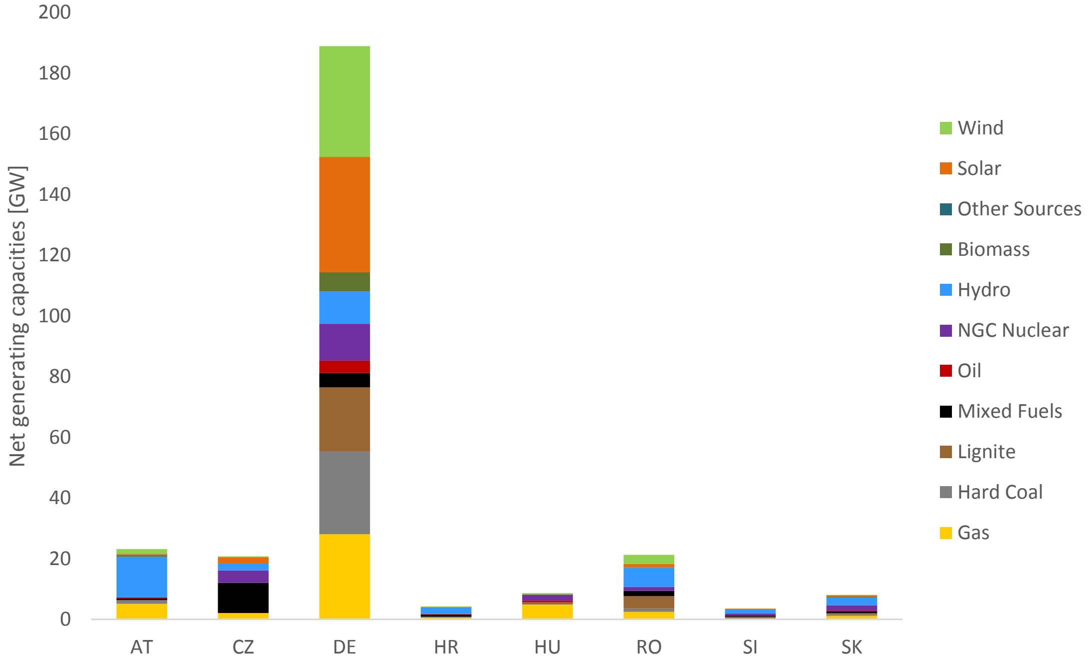

Figure 3-3 Net generating capacities of the CCE countries in the 2014

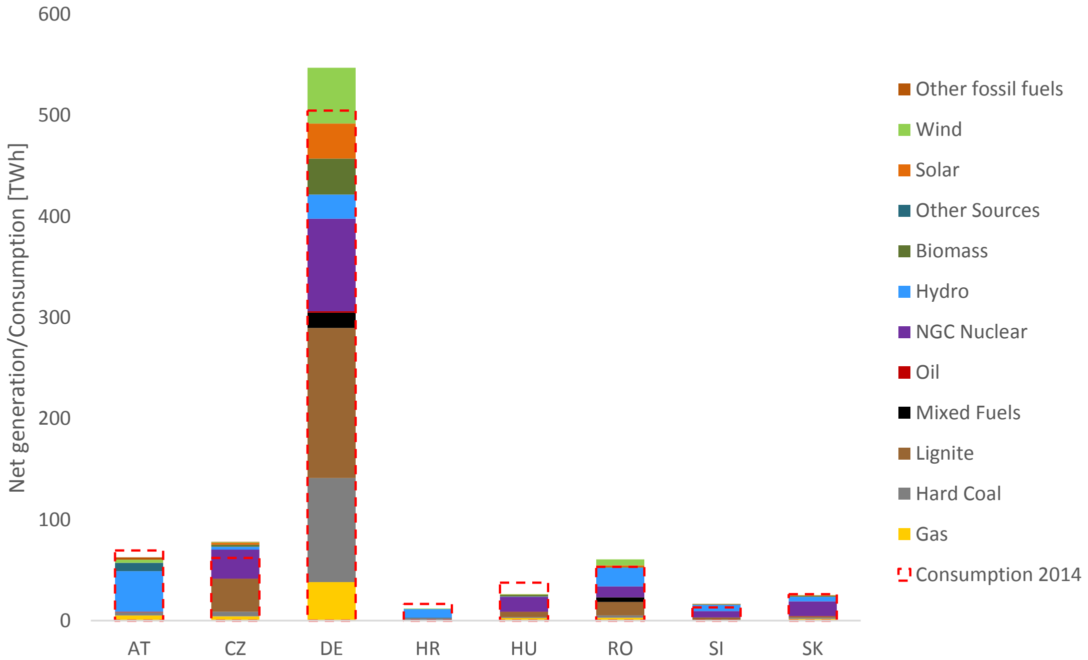

Figure 3-4 Net generation and consumption of the CCE countries in the 2014

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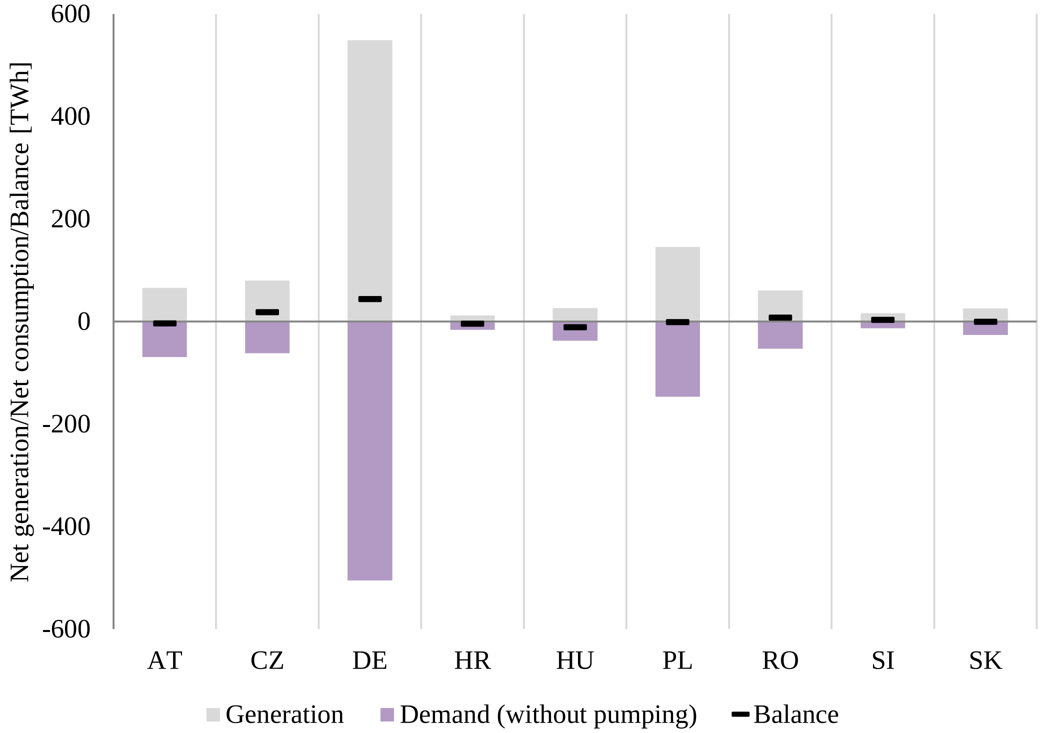


Figure 3-5 Balances, net generation and consumption values of the CCE countries in 2014

3.2 Main drivers of Grid Development

The energy sector is the one of the most dynamically developing sectors, and the transmission grid development needs to reflect these fast changes to ensure ongoing secure and reliable transmission system operation. The most influential drivers for grid development in the CCE region are listed below.

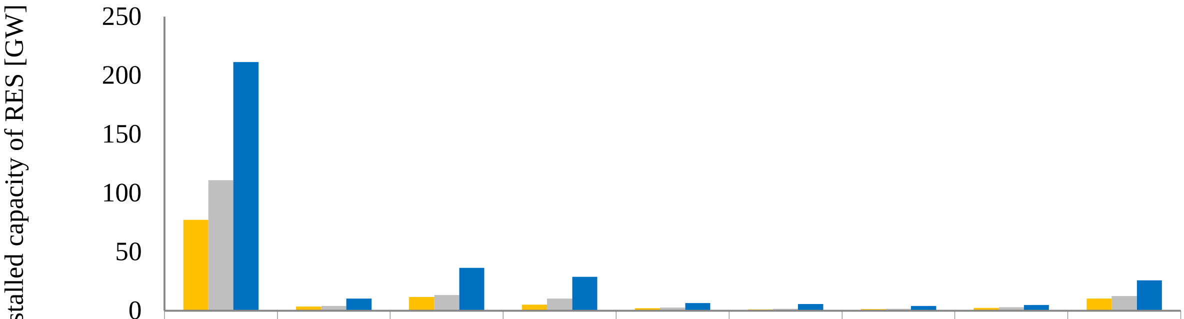
Generation evacuation

Generation connection is one of the main drivers for power system development across Europe. In future 2030 Visions, the merit order of the generation in comparison to the current situation will change considerably. This is based on input data, especially CO_2 emission and gas prices; and assumptions which differentiate the plausible future scenarios which can cause diverse load flow patterns through the particular visions. The CCE region transmission grid with all the reinforcements designed has to cope with such load flows, and at the same time ensure reliable and secure operation of the CCE region transmission grid.

In CCE region there is a large quantity of RES generation, with large fluctuations of generating power based on the actual weather (photovoltaic and wind power plants) that can cause uncertain situations in the CCE region transmission grid. When the RES generation is connected into the distribution grid as a distributed generation with small installed capacity, there is no need for huge reinforcements of the transmission grid because of the shorter distance between generation and consumption. But in the case of RES generation connected into the distribution or transmission grid as a large power park, or many small ones concentrated in one area, moreover with long distances between this generation and consumption areas, significant need of transmission grid reinforcement issues arise.

The CCE region has an ongoing increase of RES. The RES is often located far away from the load centers, for instance the area with most energy production from wind farms is Northern Germany. A lot of reinforcement projects are being designed to help the transmission grid in CCE region to cope with this kind of situation.

Based on National Renewable Energy Action Plans (NREAPs) data of CCE region members and the data used for Pan-European Market Studies (PEMS) in TYNDP 2014 process, evolvement of the RES installed capacity of each RG CCE member country from 2014 to 2030 in the high RES penetration scenario Vision 4 is depicted in the **figure 3-6** below.



	Germany	Czech republic	Austria	Poland	Slovak republic	Hungary	Slovenia	Croatia	Romania
2014	77.3	3.5	11.5	5.2	2.2	1.1	1.3	2.5	10.4
2020	110.9	4.0	13.2	10.3	2.7	1.5	1.7	3.0	12.6
2030_V4	211.4	10.3	36.4	28.9	6.5	5.7	4.2	4.9	25.8

Figure 3-6 RES installed capacities comparison in 2014, 2020 and 2030 Vision 4

Market integration – interconnection capacities reinforcement

The essence of the common market for Europe, which is one of the European Union goals, is to have sufficient interconnection capacities between regulation areas. Where there is congestion in the grid, the market splits. In CCE region there are a lot of projects designed to cope with insufficient interconnection transmission capacities on particular profiles, to fulfil the essential characteristics of the common European market.

Security of Supply improvement

Security of supply improvement of all areas in Europe is one of the most important goals to ensure an adequate number of transmission routes for safe and reliable energy supplies of electricity to load centers in Europe, both in normal operation of the grid, and during maintenance or congestions situations in the grid. It seems that security of supply is a concern for Cyprus, Iceland and the Baltic Sea Region which are isolated systems with a relatively low interconnection capacity with neighboring EU Member States. Nevertheless, in the CCE region which has a sufficiently interconnected transmission grid, security of supply issues arise. In Germany there are big changes in the productions structure due to German "Energiewende", therefore German TSOs plan new reinforcements to ensure security of supply in Southern Germany.

German nuclear power plants decommissioning

Nuclear power plants phase-out in Germany causes change of the merit order of the generation in the CCE region which leads to a change of the load flow pattern. Replacement of this type of power plant by RES, especially photovoltaic and wind power plants with large fluctuation of generating power based on the actual weather can be challenging because of:

- Fluctuating generation can cause higher need for ancillary services,
- Different location of the power plants. RES power parks are situated at the Northern part of the Germany and load centers at the Southern part which causes issues mentioned above in other drivers for power system development.

Climate change mitigation

Climate change mitigation and competition will require energy efficiency measures such as transfer from fossil-fuel based end-users to CO_2-free energy sources. Electricity peak demand is forecasted to grow moderately or rapidly by the year 2030, based on the future scenarios, where different assumptions and demand forecast factors are taken into consideration. On the main factor of future consumption, an increase is driven among other factors by growth in the use of electric vehicles and heat pumps. Based on the European goals, the share of the load covered by RES will grow in future scenarios. Example is given in the **figure 3-7**, where the yearly RES generation share on the yearly demand in the CCE region countries in year 2014 and 2030 Vision 4 in TYNDP2014 is depicted. Based on this you can see, that this grid development driver goes together with generation evacuation driver.

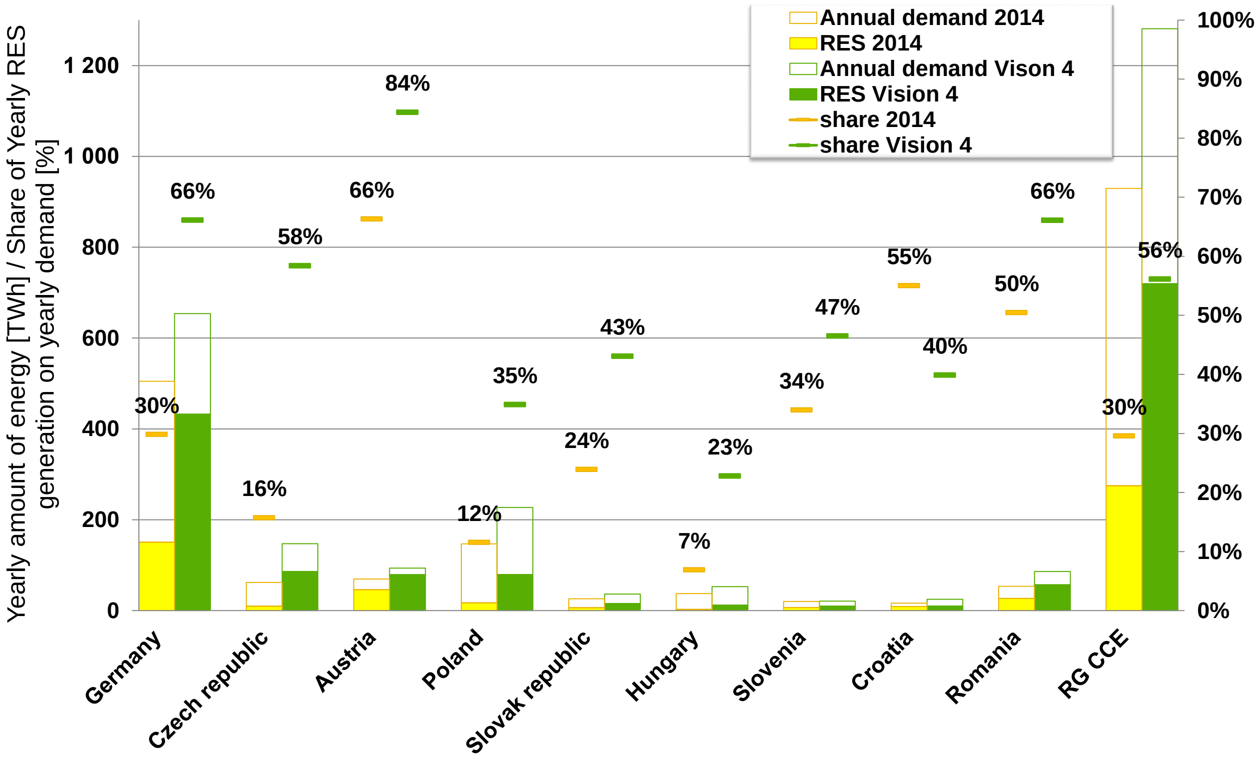


Figure 3-7 RES share on the demand for each CCE country in year 2014 and 2030 Vision 4 in TYNDP2014

All these drivers are interdependent and connected each to other therefore they cannot be treated separately. In the **figure 3-8** below, the main bottlenecks identified in CCE region are depicted, where every border is driven by the one of upper mentioned drivers for grid development.

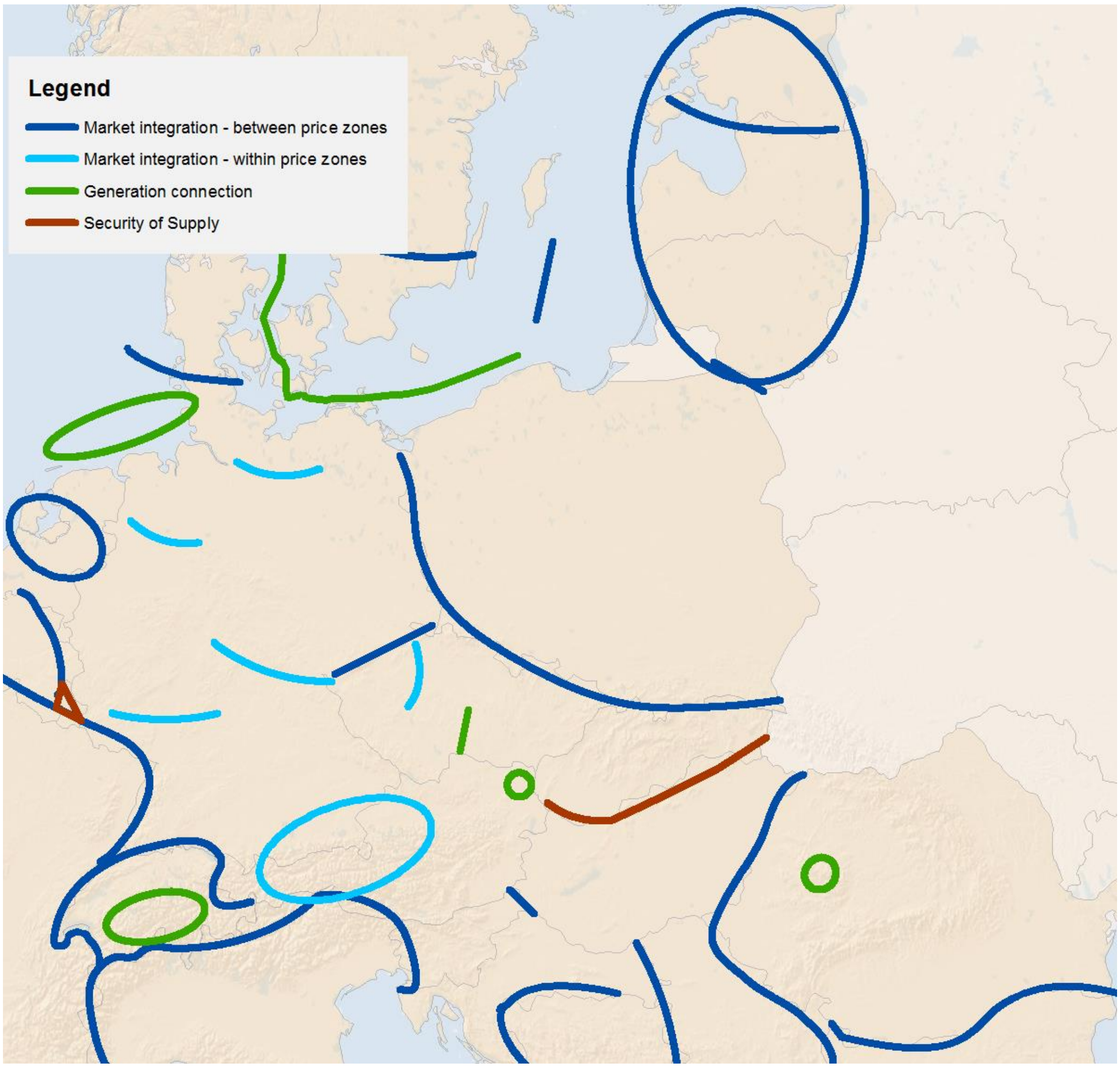


Figure 3-8 Map with main bottlenecks in CCE region bases on TYNDP2014

4 REGIONAL RESULTS

4.1 Description of the scenarios

The Common Planning Studies in the RG CCE were conducted based on the results of the high RES scenario TYNDP 2014 Visions 4 to identify future projects. In addition to the agreed cross-border capacity increase exercise during the Common Planning Studies an already considered polish import profile was further evaluated.
Besides above mentioned cross-border capacity increase exercise a sensitivity analysis was conducted based on the generation capacity reduction from selected generation technologies (nuclear and gas) in order to gain addition insight on the regional security of supply aspect (whether is fulfilled on not).

The following **figure 4-1** shows the annual generation and demand per country in the RG CCE from the TYNDP 2014 Vision 4 scenario before the Common Planning Studies.

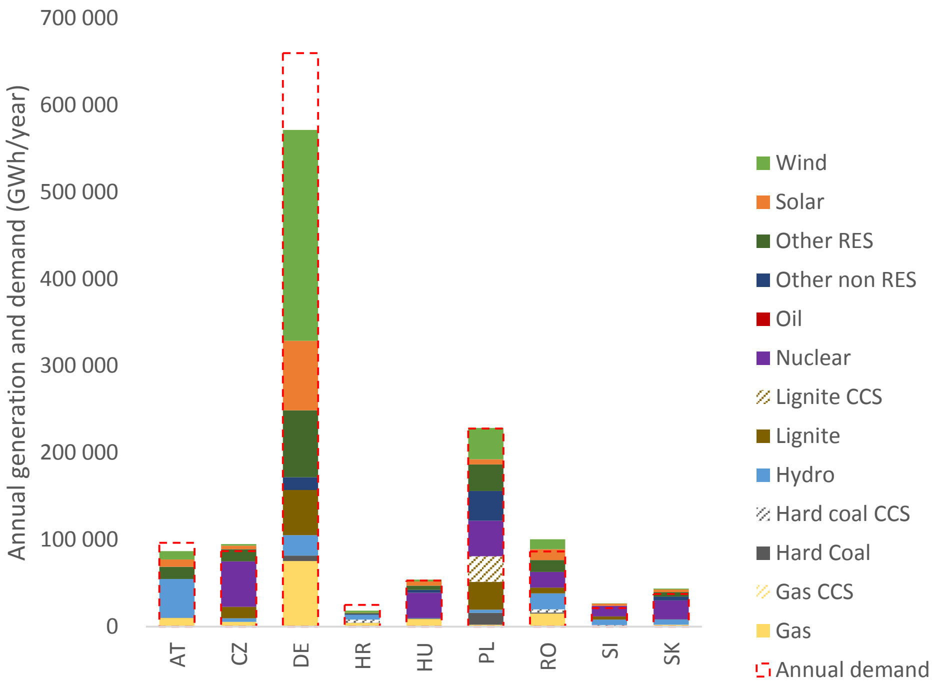


Figure 4-1 Annual generation and demand in CCE region in TYNDP 2014 Vision 4

The **figure 4-2** below shows the RG CCE installed generation capacity for the TYNDP 2014 Vision 4 scenario. This capacity is identical to the generation capacity even after the Common Planning Studies.

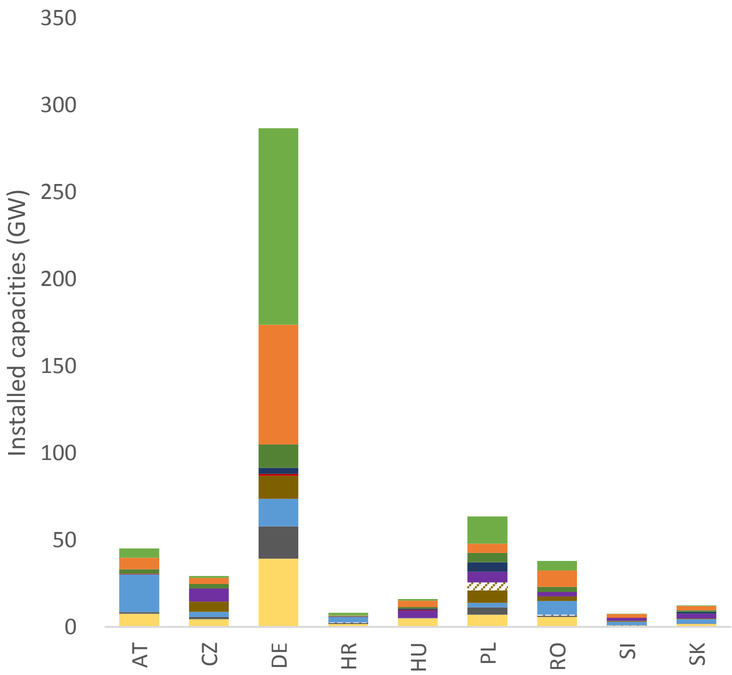


Figure 4-2 Installed capacities of CCE region countries in TYNDP 2014 Vision 4 and after Common Planning Studies

The following **table 4-1** shows the assumed fuel prices for the thermal power plants. The same fuel prices were used in the Common Planning Studies calculations.

		TYNDP 2014 V4/Common Planning Studies/sensitivity
Fuel prices [€/Net GJ]	Nuclear	0,377
	Lignite	0,44
	Hard Coal	2,21
	Gas	7,91
	Biofuel	same price as primary fuel type
	Light oil	16,73
	Heavy oil	9,88
	Oil shale	2,3
	CO_2 prices [€/ton]	93

Table 4-1 Fuel prices

In the **figure 4-3** below, the target capacities from the TYNDP 2014 Vision 4 are depicted in order to show capacities for the countries within ENTSO-E, used as a starting point for the Common Planning Studies calculations.

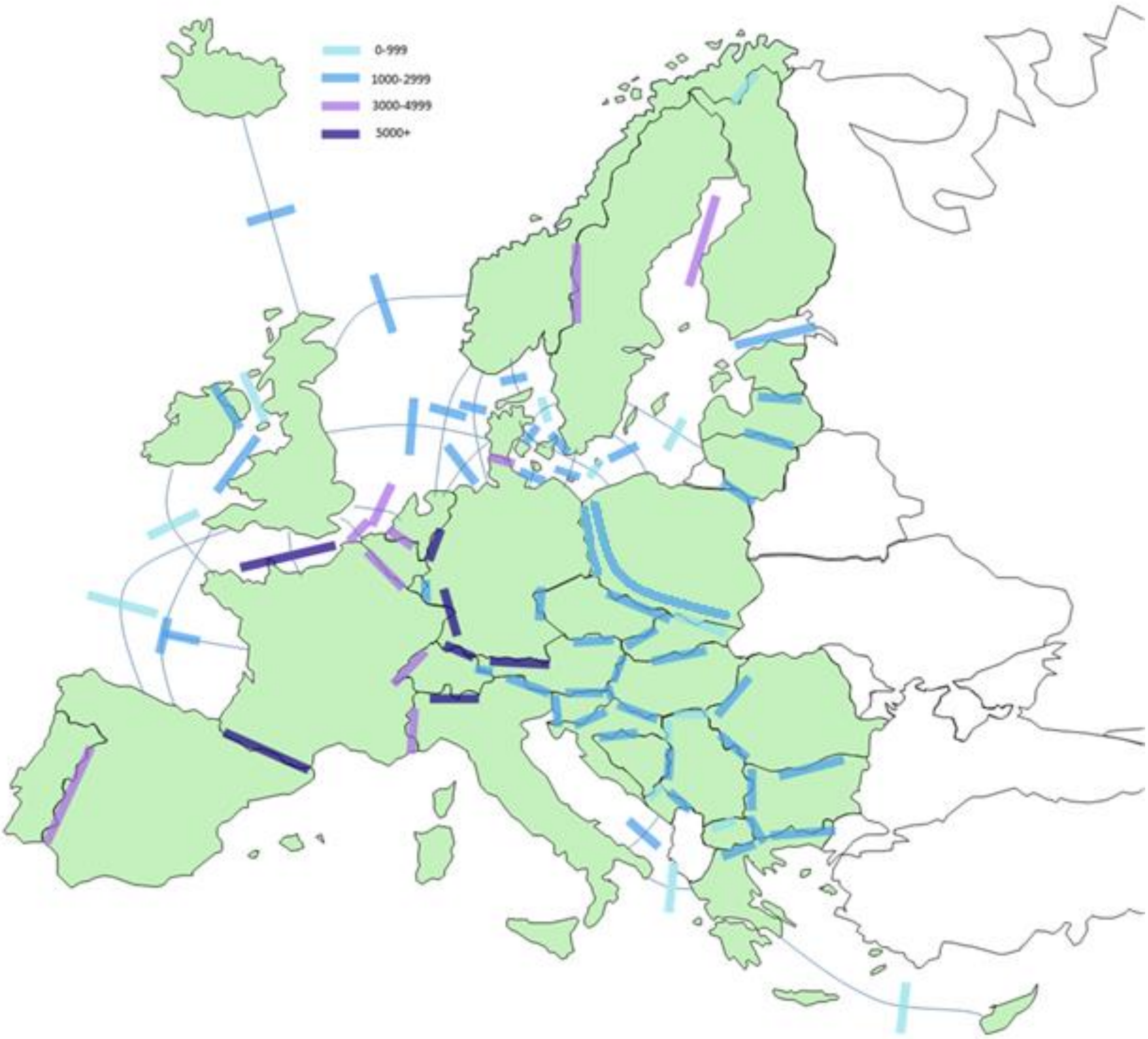


Figure 4-3 Target capacities of the countries within ENTSO-E in TYNDP 2014 Vision 4

4.2 Market results

4.2.1 Common Planning Study results

All 13 internal borders in the RG CCE were analyzed during the Common Planning Studies as can be depicted in **table 4-2** that shows the borders which were investigated and identified borders with beneficial cross-border capacity increase. Based on SEW/cost-ratio and Net Present Value (NPV) in each iteration step the borders with NPV were discarded and not considered in the next consecutive iteration. The number of borders in this way was reduced from one iteration to next iteration. The NPV is calculated with the supplied standard costs, the social economic welfare and an interest rate of 4% per year. For a more detailed description see appendix 7.2 "Detailed regional walkthrough of the process".

Moreover in the second iteration a Polish import scenario was evaluated. The evaluation is characterized as an increased import capacity to Poland from Germany, Czech and Slovakia (PL import increase is 1500 MW, divided between DE 900 MW, CZ 400 MW and SK 200 MW).

In the **figure 4.-4** as a comparison the annual demand and production per country after the Common Planning Studies is shown.

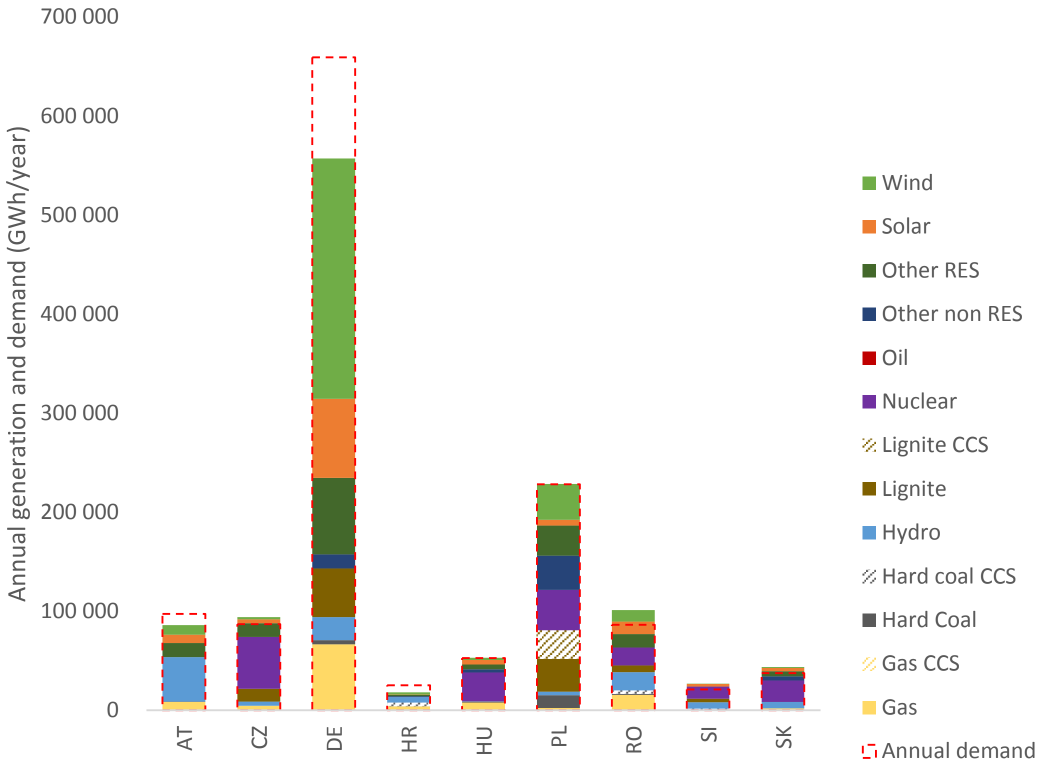


Figure 4.-4 Annual generation and demand of the CCE region countries after Common Planning Studies

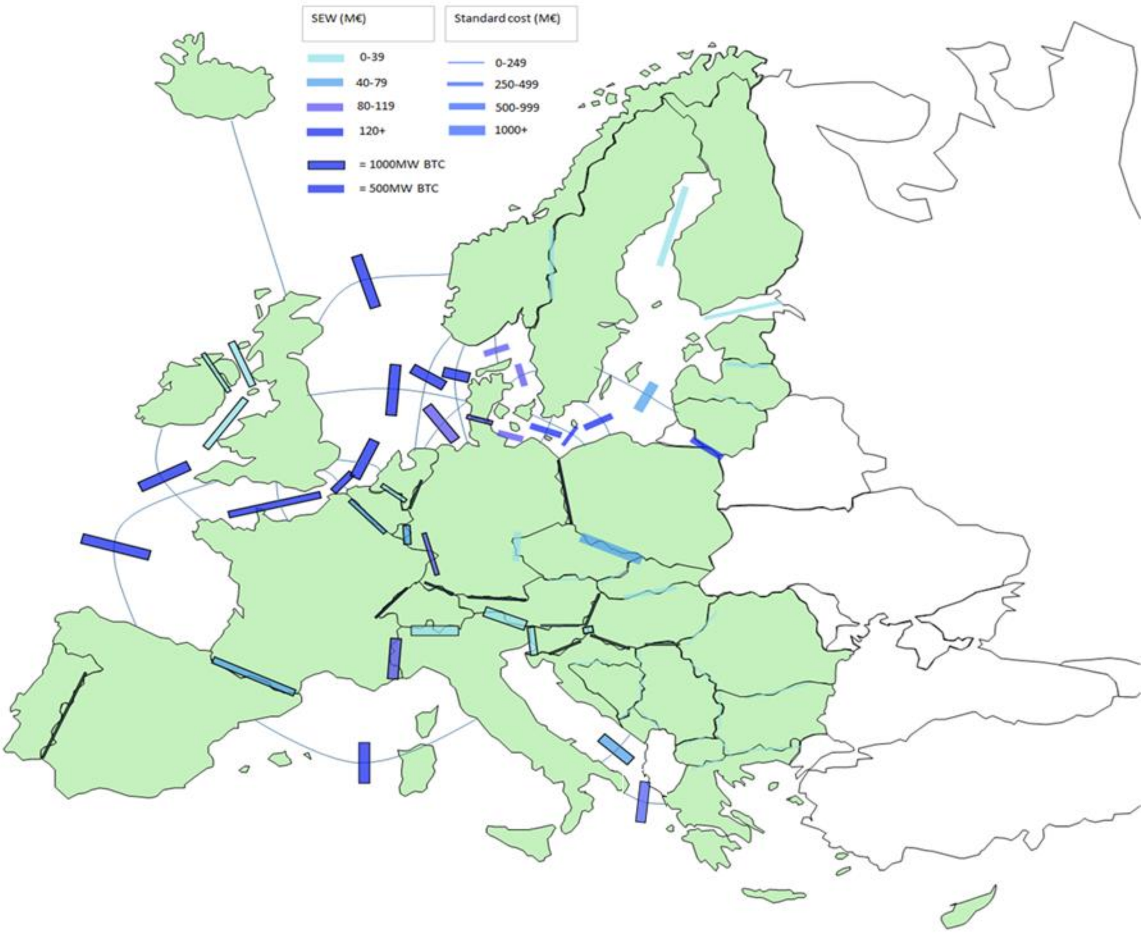


Figure 4-5 Borders with SEW and standard costs range in the 1st iteration of the screening process

In the **figure 4-5** SEW (colour representation in the figures) and standard costs (thickness representation in the figures) values, given in ranges are depicted for all borders after the first iteration of the market part Common Planning Studies. Detailed parameterization including standard costs and the SEW ranges of all performed iterations of the Common Planning Studies can be found in the appendix 7.2 “Detailed regional walkthrough of process” in Market Modelling of the Common Planning Studies.

Figure 4-6 shows the country power balance for the imported and exported energy in the RG CCE in comparison before and after the Common Planning Studies. In this figure all transfer capacity increases from the Common Planning Studies in the RG CCE and the other RGs were taken into account.

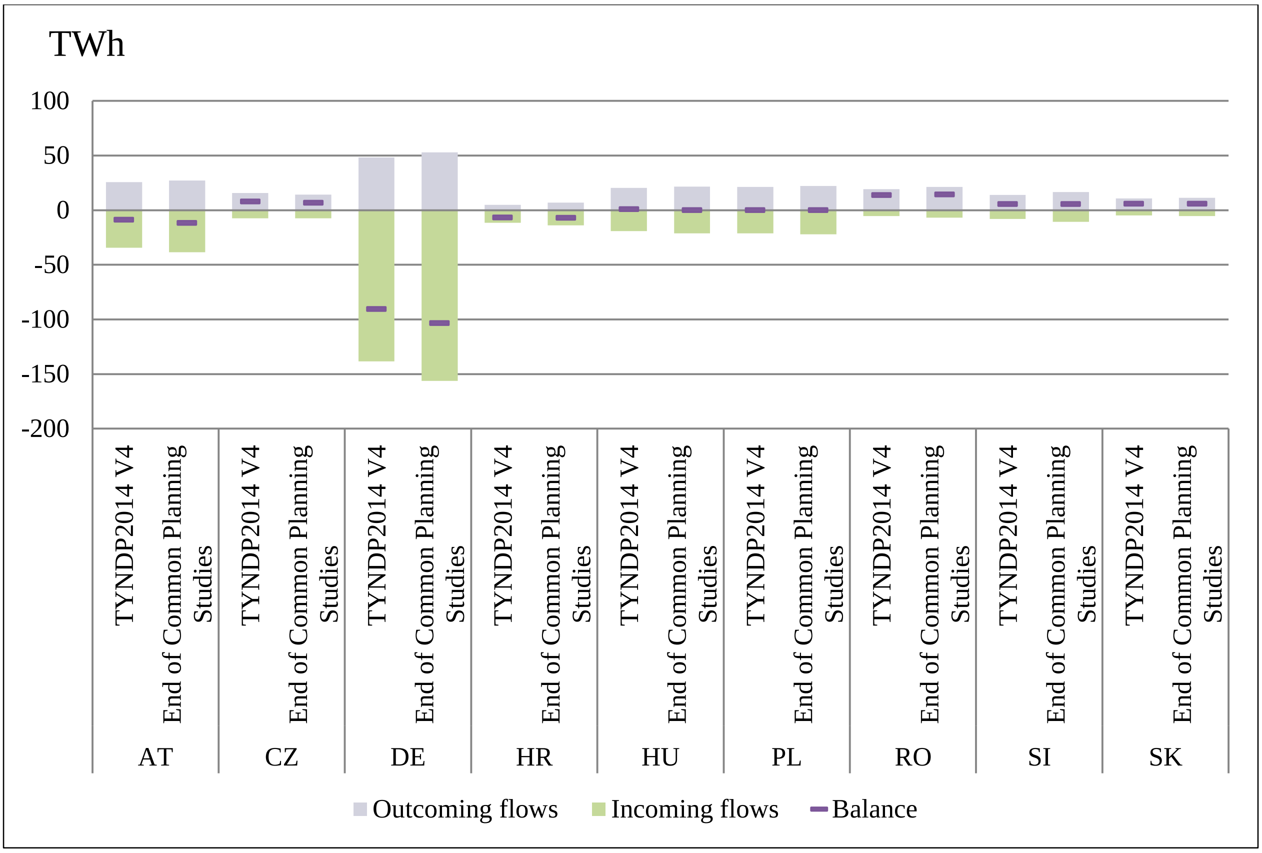


Figure 4-6 Country power balance TYNDP 2014 in comparison to the end of Common Planning Studies

It is noticeable that in each country in the RG CCE the amount of imported and exported energy was higher after the Common Planning Studies. That is due to the overall increased transfer capacity in the ENTSO-E region.

The results from the Common Planning Studies in the RG CCE explored two borders with beneficial cross-border capacity increase. The Polish transfer import capacity was totally increased by 1500 MW from Germany, Czech Republic and Slovakia in the following distribution (DE-PL 900 MW, CZ-PL 400 MW and SK-PL 200 MW). Then the Hungarian – Romanian border was also increased by 500 MW bi-directional.

Border	Additional bi-directional Market Capacity [MW]
AT-CZ	No additional capacity
AT-HU	No additional capacity
AT-SK	No additional capacity
CZ-DE	No additional capacity
CZ-PL	No additional capacity
CZ-SK	No additional capacity
DE-PL	No additional capacity
HR-HU	No additional capacity
HR-SI	No additional capacity
HU-RO	500
HU-SI	No additional capacity
HU-SK	No additional capacity

PL-SK	No additional capacity
Additional calculation focusing on Polish import capacity	
PLimport profile	1.500 (900 MW DE, 400 MW CZ, 200 MW SK)

Table 4-2 List of CCE region borders which has been studied in Common Planning Studies

For a more detailed approach see the appendix 7.2 "Detailed regional walkthrough" of the process in the appendix.

4.2.2 Sensitivity analysis description and results

A sensitivity analysis with reduced production capacity from gas and nuclear power plants (defined by each RG CCE member where it is relevant) was conducted based on the Common Planning Studies results with the increased transfer capacities. This sensitivity analysis aimed to verify whether the RG CCE can achieve and maintain its Security of Supply (SoS) based on the Common Planning Studies identified grid and a reduced production capacity of nuclear and gas power plants or not.

Figure 4-7 shows the annual generation and demand of the countries in the RG CCE. In the **figure 4-8** the reduced generation capacity for the sensitivity run is shown. For better visualization **figure 4-9** is given to show the reduction in the generating capacity for RG CCE during sensitivity study. Here it is noticeable that especially in the Czech Republic and Poland the generation capacity decreased significantly.

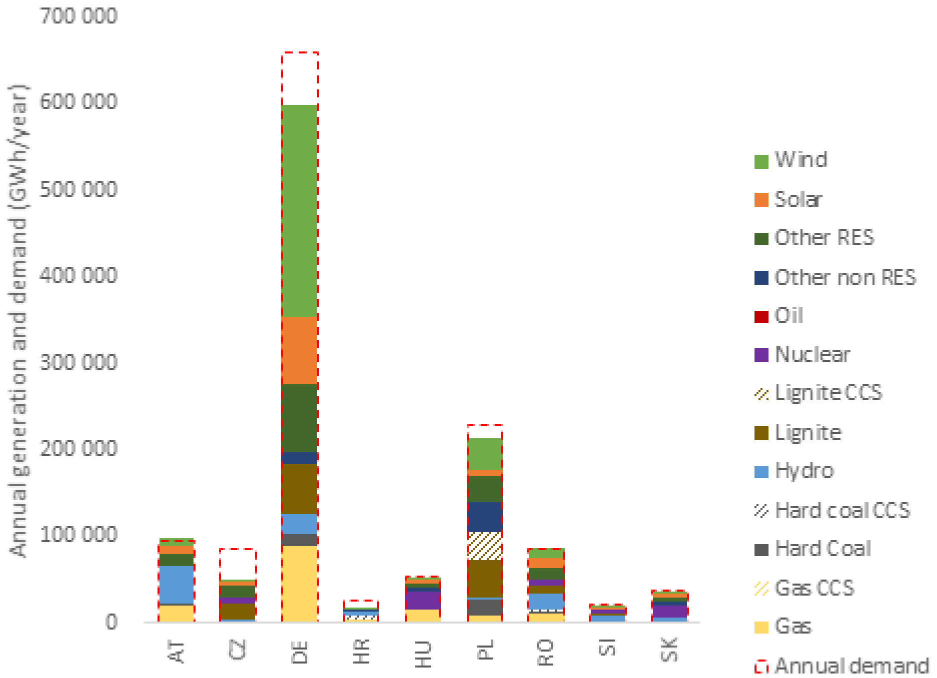


Figure 4-7 Annual generation and demand of the CCE region countries after sensitivity run with reduced gas and nuclear power plants

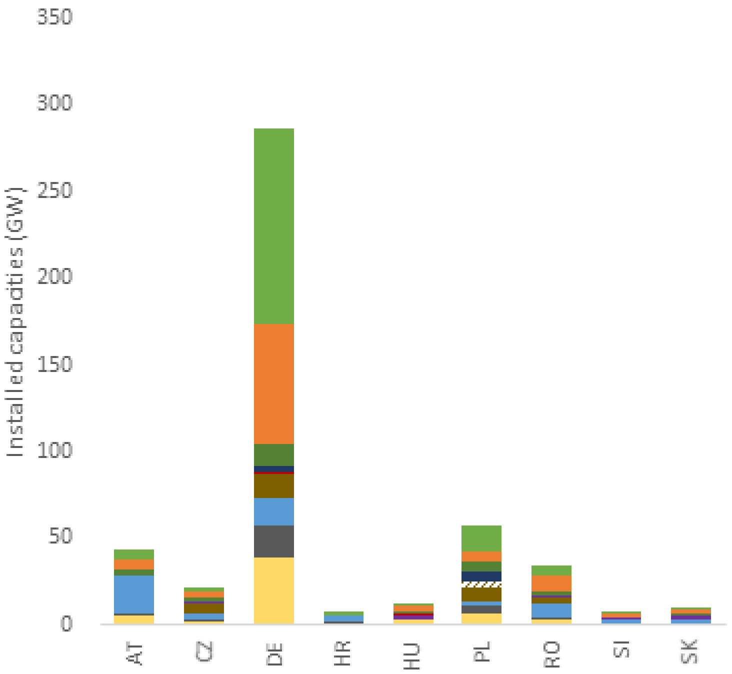


Figure 4-8 Installed capacities of CCE region countries in the sensitivity run with reduced gas and nuclear power plants

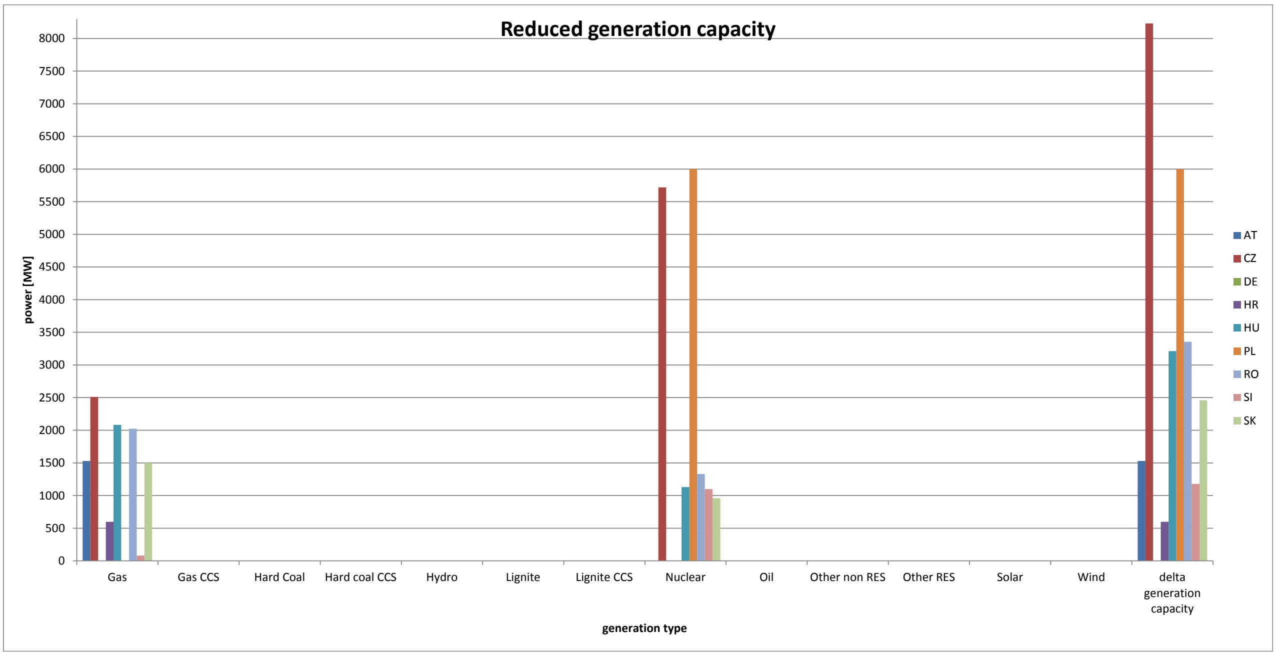


Figure 4-9 Reduced generating capacities of CCE region countries in the sensitivity run

The goal to check whether a SoS is maintained or not was achieved. Prior to reduced gas and nuclear generation capacity no energy not served (ENS) was identified in the RG CCE. In each hour considered the SoS for the whole region was maintained.

The following **figure 4-10** shows the imported and exported amount of energy per country in the RG CCE member states. In the table a comparison between the flows from the TYNDP 2014 Vision 4 and the results of the sensitivity run with the reduced generation capacity is shown.

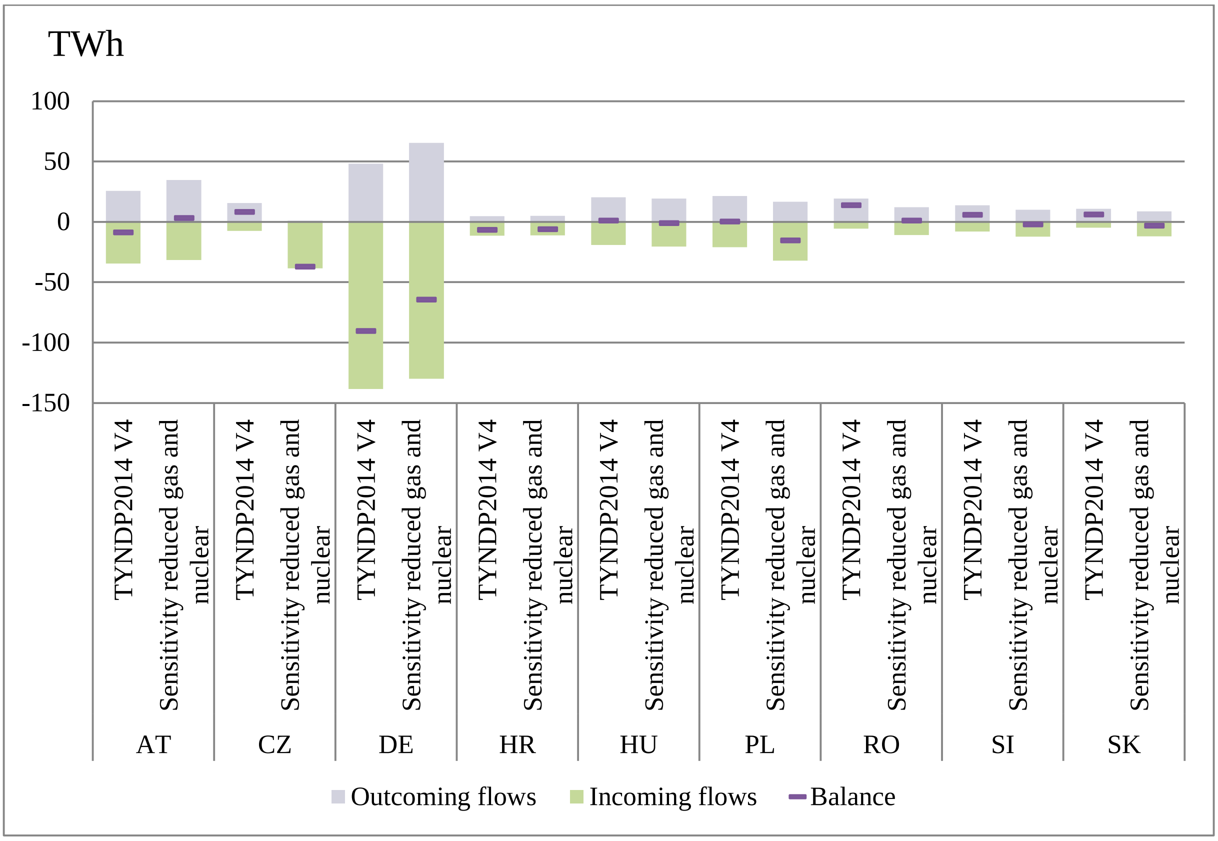


Figure 4-10 Country power balance TYNDP 2014 Vision 4 in comparison to the sensitivity scenario with reduced gas and nuclear power

In comparison to the Common Planning Studies the results from the sensitivity analysis regarding the exported and imported amount of energy per country differ. Countries which were former exporters changed to be importers (Czech Republic, Poland and Slovenia). It is also noticed that the Czech Republic became a significant importer. That is because of the reduced installed nuclear power plants in this sensitivity.

The sensitivity analysis show only a small value of ENS for Poland within the 2030 Vision 4 TYNDP2014 grid. By implementing the projects identified in the Common Planning Studies the value of ENS in Poland was 0 again, see the Table 4-2. This means, that no additional projects or investment needs compared to the results of the Common Planning Studies are necessary to implement. The increase of the Polish import profile, which was found in the Common Planning Studies, shows benefits for the SoS in Poland. Therefore the sensitivity analysis verify and confirm the results of the Common Planning Studies.

4.3 Network results

Based on the methodology for Network modelling part of Common Planning Phase the outcome of last Market simulation was implemented into the PTDF matrix to obtain simplified cross-border flows. In the **figure 4-11** the utilization of cross-border profiles is depicted using PTDF. This result supported the identification of point in time for detail load-flow calculation.

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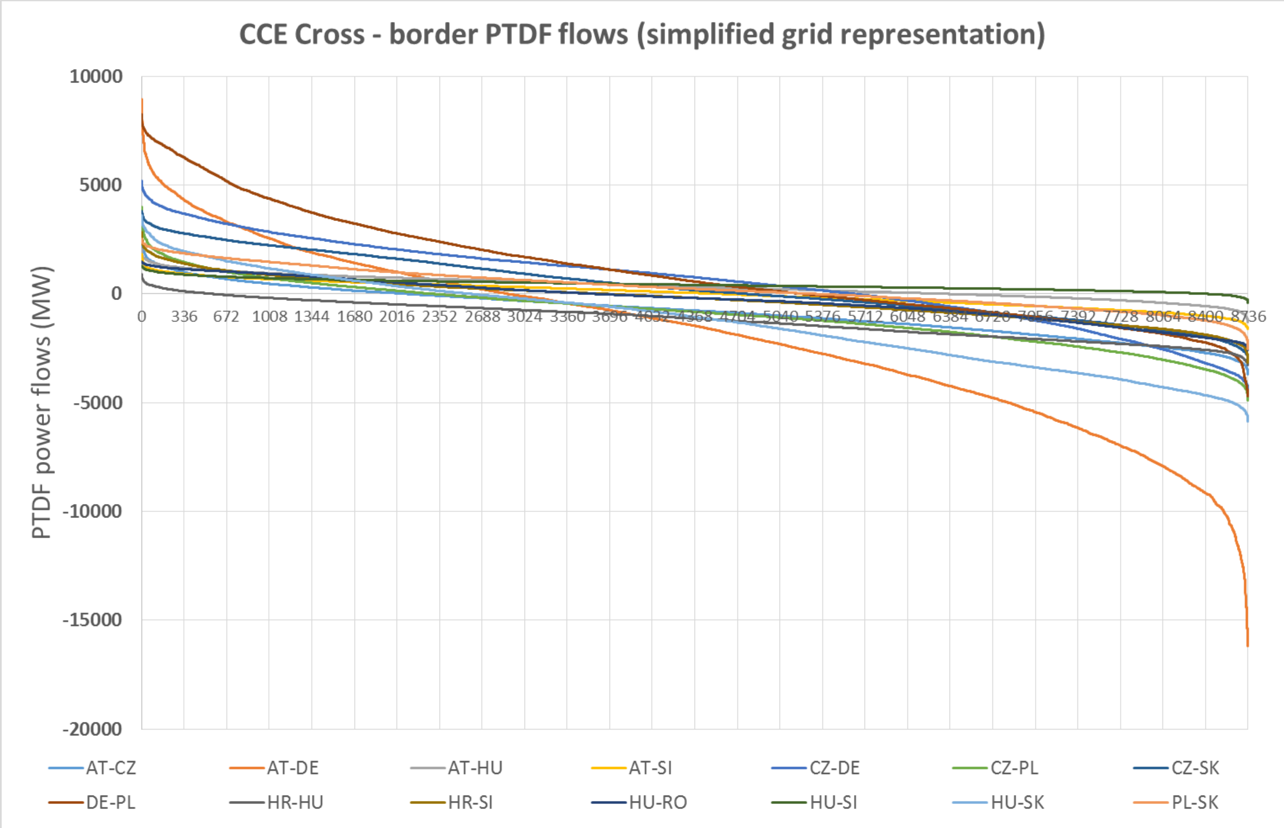

Figure 4-11 Cross-border PTDF flows (simplified grid representation) using final market run

Some of the most interesting information is depicted below.

As the main indicators to show main direction of the flows across the RG CCE were considered mean value to indicate which is the prevailed direction of flows. As the second indication 0,2 and 0,8 percentile to indicate flows with the high significance and also probability.

These statistic indicators are not synchronous, thus it does not reflect any load-flow case.

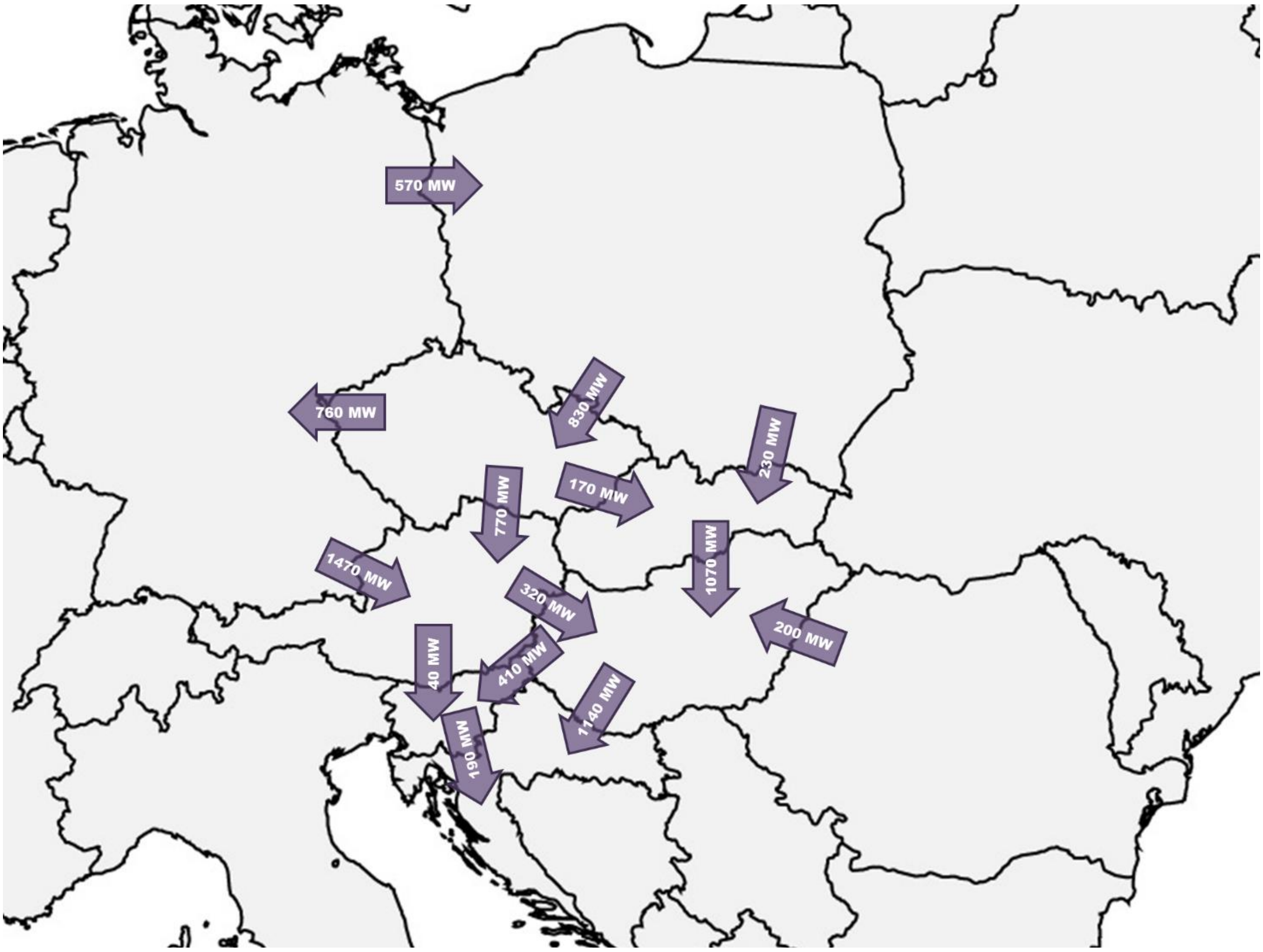

Figure 4-12 Prevailed direction of flows with mean value of PTDF flows

As indicated in the **figure 4-12**, the assumption for scenario used by common planning phase resulted in a central value of a set of hourly results. This value and the direction represents prevailed direction of flows. When considering also the volatility of flows and the volume percentile was used as seen on next **figure 4-13**.

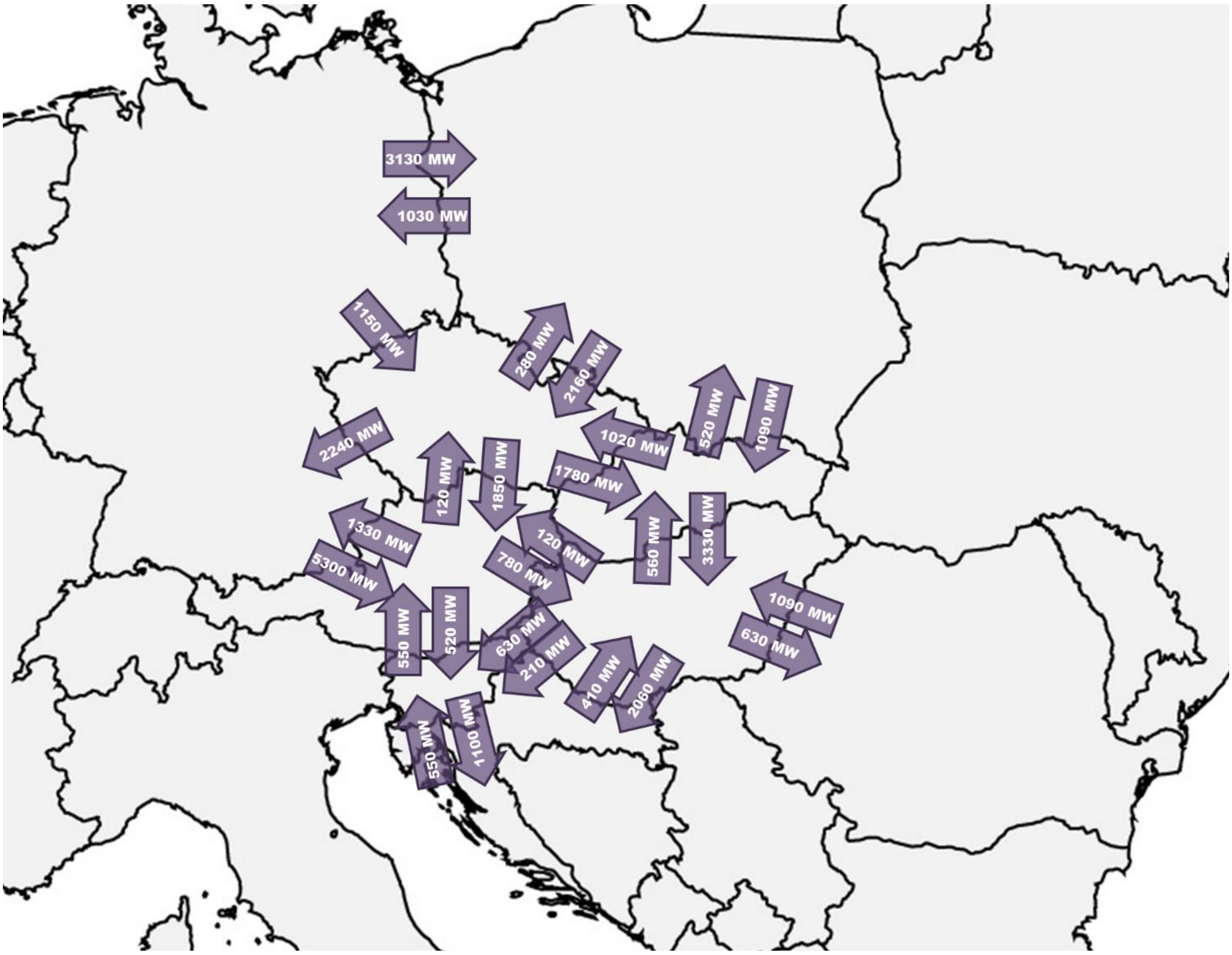

Figure 4-13 Percentile indicated the volatility and the volume of PTDF power exchanges

In the **figure 4-13** the 80% and 20% percentile is shown taken into consideration all 8736 hours simulated in Market Study part of the Common Planning Studies. These values represent the volume of the PTDF flows, which will be most probably reached in both directions considering assumptions of the scenario used.

As identified in the market study part of the Common Planning Studies one of the area to be reinforced to allow additional market exchanges is Polish synchronous connection, where import capability is limited.

According to the identified points in time, calculation showed some overloads in Polish system in the grid taking into consideration status of TYNDP 2014. The loaded lines can be seen on next **figure 4-14**.

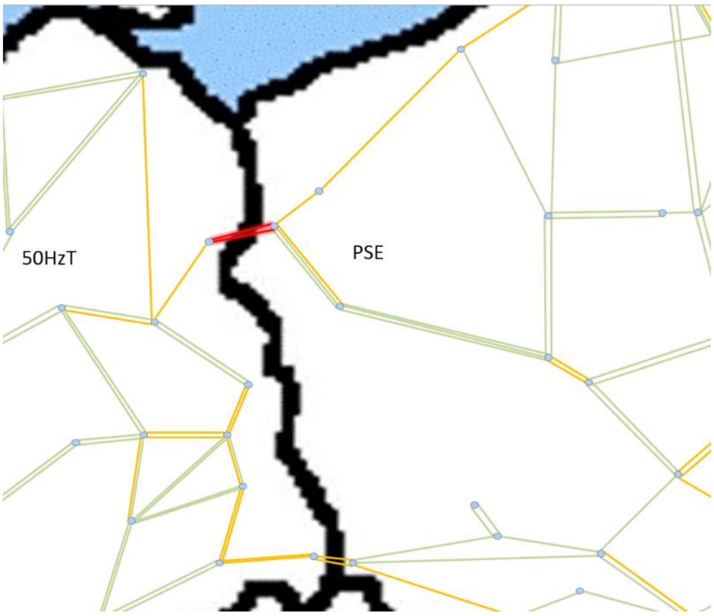

Figure 4-14 Identification of congested area on DE-PL profile limiting capacity on PL synchronous connection

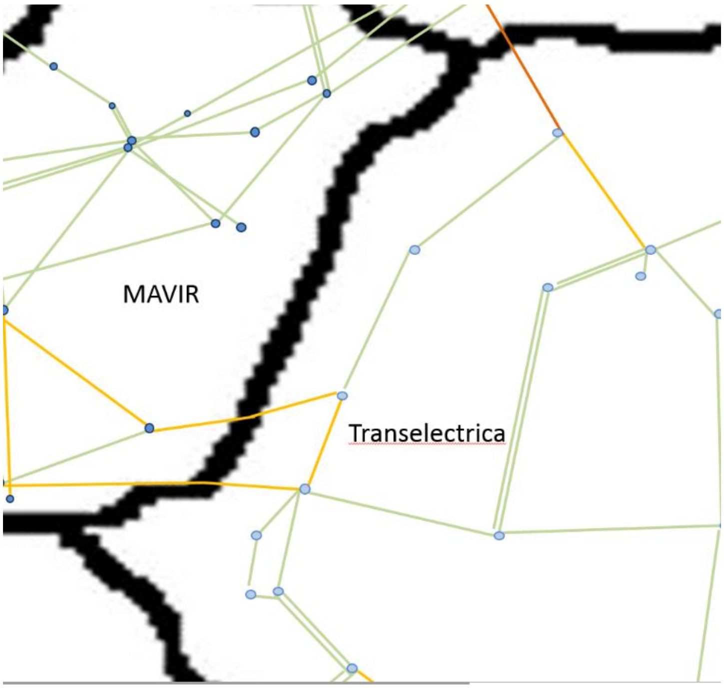

Figure 4-15 Identification of area on HU-RO profile having an impact on HU-RO market capacity

Due to technical reasons and security of the system operation, the preferable solution is to created new 3rd interconnector between Germany and Poland together with other internal investments to decrease flows in lines identified as heavy loaded.

Projects identified as possible measure for taken scenario in CCE region are:

- New interconnection between Poland and Germany together with needed internal reinforcements

As prerequisite for this 3rd interconnection between Germany and Poland is project called GerPol Power Bridge I. Without this project this 3rd interconnector identified during CPS does not provide significant system loading situation. Expected capacity increase can be achieved by construction mainly by projects:
400 kV line Baczyna – Plewiska, substations Zielona Góra and Gubin (with PST's on the 400 kV line Gubin – Eisenhuettenstad), new internal 400kV double circuit line Zielona Góra – Gubin and new double circuit tie-line 400 kV line Gubin – Eisenhuettenstadt. This choice of location make it possible for the new tie-line to contribute not only to market integration between member states - additional capacity of 1500 MW import on PL-DE/SK/CZ synchronous profile but also an improving network security - project contributes to increase of security of supply and flexibility of the transmission network in Zielona Góra area. Additional benefit represents integration of additional Renewable Energy Sources on the area of western and northwestern Poland as well as eastern part of Germany.

- New interconnection between Hungary and Romania together with required internal reinforcements

The benefits and the economic viability of a capacity increase on the Hungarian-Romanian border for high RES scenario was first demonstrated by the Common Planning Study of RgIP2015. Previously there had been no project considered on this border.
As a project candidate the two TSOs chose 400 kV tie-line between Debrecen-Jozsa (HU) and Oradea (RO), with double-circuit towers and single or double circuit conductors (to be further examined later by network analysis, in order to meet the expected 500 MW cross-border capacity increase bi-directionally).
This choice of route and terminal connections make it possible for the new tie-line to contribute not only to market integration but also the security of supply in both countries, having both of its terminals in substations serving populous cities.
This is a future project candidate, considered not earlier than 2030. The internal reinforcements that may be additionally necessary in either country can only be determined by detailed network analyses in extended time frame, closely coordinated with national development plans. Thus those are expected to appear only when the project will be carried over to TYNDP 2016.
More details, drivers and information about projects identified in the Common Planning Studies in the CCE region are described in the Chapter 5 “Project candidates” (subchapters 5.1 “Introduction” and 5.2 “List of candidate projects pr. Boundary”).

This chapter focused only on main steady state simulation and results, which are based on assumptions of the TYNDP 2014 Vision 4 taken for the Common Planning Studies.

4.4 E-Highway2050 scenarios perspective

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

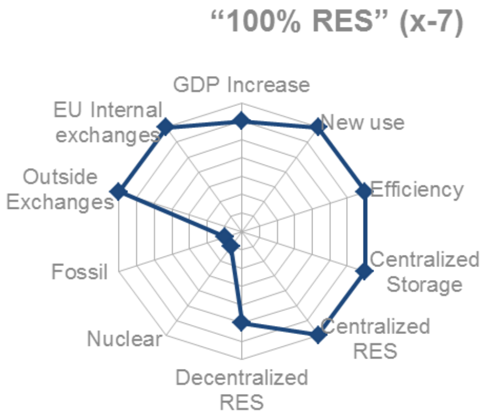

Figure 4-1 - Example of scenario characteristics

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

Figure 4-2 - Reduced European grid

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

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

In general, the reinforcements explored from the EH2050, which would be realised from 2030 to 2050 time horizon, go beyond the previous and current TYNDPs framework. From this perspective and given the fact that future generation mix expectations along with the potential for the further RES development in Europe, it is reasonable to develop high level long-term project concepts that may come into focus for future scenarios needs and therefore future TYNDP processes will have to take into consideration this issue. The realization of projects from both TYNDP and Regional Investment Plans is a crucial prerequisite bridge towards the future 2050 grid.

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5 PROJECTS

5.1 Introduction

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

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

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

TYNDP projects in this list are structured by

Boundary – which can be a specific border, a combination of borders, or an internal boundary;

Maturity – based on commissioning date and national approval projects are grouped as

Mid-term projects: Projects to be commissioned by 2022 will be assessed by TOOT method against the expected 2020 network if is acknowledged in the latest national plans or is having intergovernmental agreement;

Long-term projects: Projects to be commissioned by 2030 will be assessed by TOOT method against the expected 2030 network and PINT method against the expected 2020 network if the project is acknowledged in the latest national plans or is having intergovernmental agreement;

Future project candidates: All other projects which do not fall under the previous categories will be assessed with PINT method against the expected 2030 network.

The following map shows all cross-border projects to be assessed in TYNDP2016:

- Dark blue – new TYNDP projects (among which the ones identified during the Common Planning Studies)
- **Light** blue – re-confirmed TYNDP2014 projects

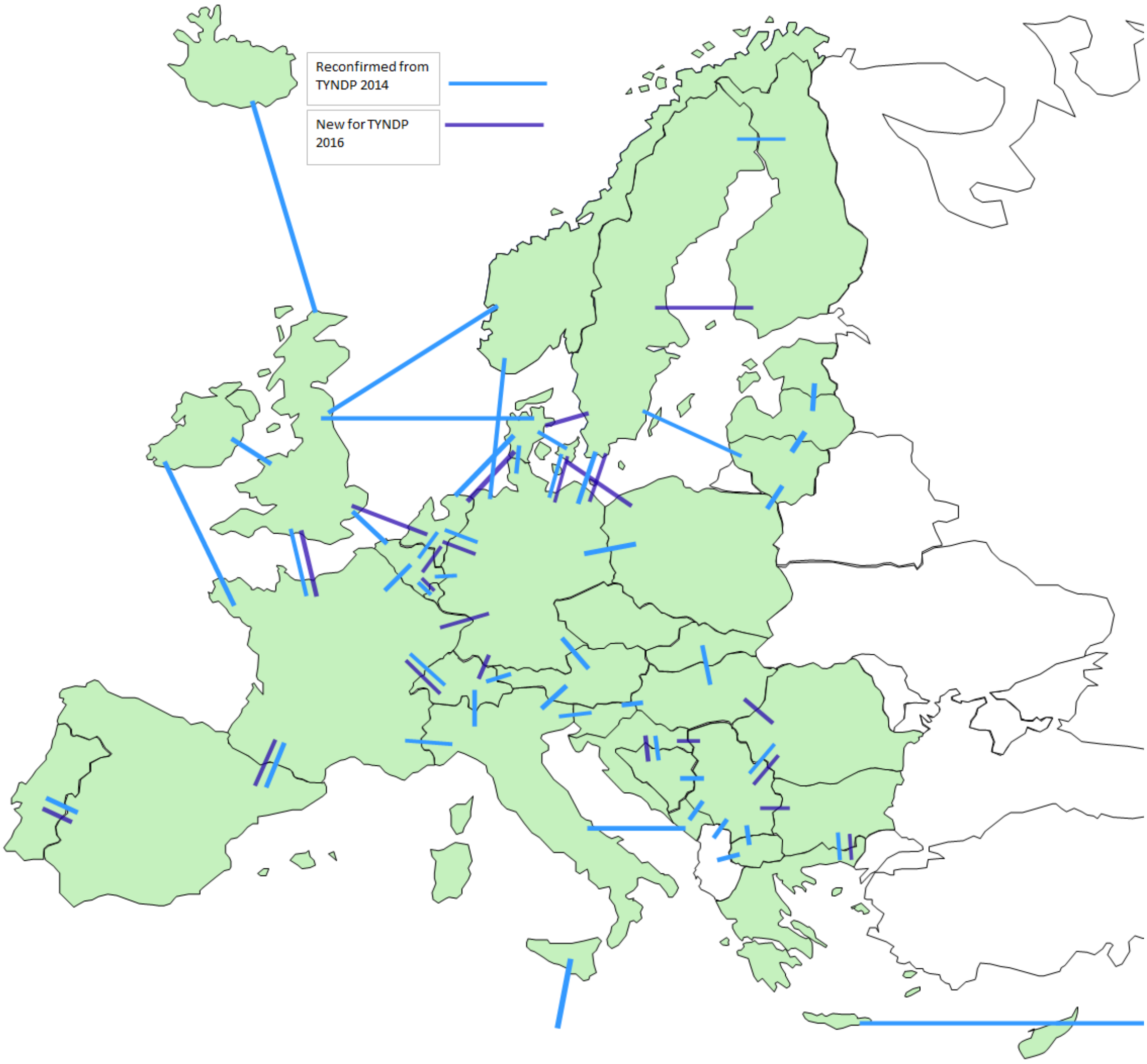

Figure 5-1 Borders with reconfirmed or new projects for TYNDP2016 assessment

5.2 List of projects for TYNDP 2016 assessment

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Czech - Germany	35	CZ Southwest-east corridor	A corridor of internal 400 kV overhead lines inside the Czech Republic connecting existing 420 kV substations between Prestice, Kocin, Mirovka and Cebin in the southwest-east direction. The project consists of buidling a new AC 400 kV overhead line which connects 420 kV substations Kocin and Mirovka with double circuit line of about 120.5 km lenght and a capacity of 2x1730 MVA, building of a 400 kV overhead lines that involves changing of a 400 kV existing single-ciruit line to double-circuit line with a capacity of 2x1730 MVA between Kocin-Prestice and Mirovka-Cebin. The upgrading of the existing 420 kV substation Kocin is also a part of the project.	0-500	35	Facilitation of the power flow in the north-south-west-east direction, reducing of infrastructure vulnerability in the southwest-east direction inside the Czech grid, insuring security of supply in the southern regions and provision of additional transmission capacity for connection of potential power generation capacities in the region is the main motivation of this project.	2028	Long-term Project	CEPS

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Czech - Germany	177	PST Hradec	Installation of 4 Phasing Shifting Transformers (PSTs) at the substation Hradec on the 400 kV interconnector (double-circuit line) between Hradec on the Czech Republic side and Rohrsdorf on the German side. The 4 PSTs in Hradec, each has rated throughput power of 850 MVA, 2 PSTs units installed in parallel for each tie-line of the double circle line and with a total rated throughput power of 1700 MVA per circuit, with a phase angle of up to 30° and 65 possible settings (-32,...0,...+32) for a rated voltage of 420 kV.	0-500	177	Installation of PSTs in Hradec at the cross-border interconnection CEPS-50Hertz will enable CEPS to deal effectively with the unplanned cross-border flows at the Rohrsdorf (Germany) - Hradec (Czech Republic) interconnector on both directions and therefore ensure the security of the Czech transmission grid including neighboring grids from a mid-term and a long-term perspective. PSTs will guarantee a very high degree of flexibility and ensure secure operation of the adjacent infrastructure, while keeping the cross-border flows within safe limits.	2016	Mid-term Project	CEPS
Czech - Germany	200	CZ Northwest-South corridor	A corridor of internal 400 kV overhead lines inside the Czech Republic connecting new 420 kV substations between Vernerov, Vitkov and existing substation Prestice in the northwest-south direction incuding looping of existing 400 kV overheadline (V413: Reporyje-Prosenice) into the existing substation 420 kV Mirovka. The project consists of building of two new 420 kV substations Vernerov and Vitkov, building of two 400 kV overhead lines involving changing a 220 kV double-circuit lines to 400 kV double-circuit lines with a capacity of 2x1730 MVA between Vernerov-Vitkov and Vitkov-Prestice and building a new double-circuit overhead line between Mirovka and V413.	0-500	200	The project will increase the transmission capacity in the western part of the Czech grid and therefore enabling the accomodation of the prevailing power flows in the north-west and west-east direction for the entire Central Eastern Europe. Further the project will enable connection of Renewable Energy Sources in the Karlovary region, reduce infrastructure vulnerability and ensure security of supply in the western region of the Czech Republic	2022	Mid-term Project	CEPS

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Hungary-Romania	259	HU-RO	400kV OHL between Hungary and Romania. In Romania a new transformer 400/220kV in Rosiori substation is necessary as internal investment associated to this project.	500	market integration under high RES conditions	Common Planning Studies 2015 performed based on TYNDP2014 Vision 4	>2030	Future Project	MAVIR ZRt;Transelectrica
Inside Germany	251	Audorf-Dollern	New 380-kV-line Audorf – Hamburg/Nord – Dollern" in existing 220-kV-corridor. Main focus of the project is the integration of onshore-RES – mainly wind – in Schleswig-Holstein. The project is labeled as PCI 1.4.2. and 1.4.2. It is the southbound connection of PCI 1.4.1. and is necessary to increase the GTC between Dänemark/West and Germany by 720/1000 MW.	3000			2017	Mid-term Project	Tennet-DE
Inside Germany	258	Westcoast line	New 380-kV-line Brunsbüttel – Niebül inside Schleswig – Holstein. Main focus of the project is the integration of onshore-RES – mainly wind – in Western Schleswig-Holstein. The project is labeled as PCI 1.3.2. It is the southbound connection of PCI 1.3.1. and is necessary to increase the GTC between Dänemark/West and Germany by 500 MW.	3000			2018	Mid-term Project	Tennet-DE
inside-DE	129	OWP Northsea TenneT Part 4	Connection of offshore wind parks in the North Sea to Germany. Mainly subsea DC cable. The OWP will help to reach the Eropean goal of CO2 reduction and RES integration	3600	129		2031	Future Project	TENNET-DE
inside-DE	191	OWP TenneT Northsea Part 2	Connection of offshore wind parks in the North Sea to Germany. Mainly subsea DC cable. The OWP will help to reach the Eropean goal of CO2 reduction and RES integration	5400	191		2022	Mid-term Project	TENNET-DE

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
inside-DE	192	OWP Northsea TenneT Part 3	Connection of offshore wind parks in the North Sea to Germany. Mainly subsea DC cable. The OWP will help to reach the Eropean goal of CO2 reduction and RES integration	4500	192		2027	Future Project	TENNET-DE
inside-inside	164	N-S Eastern DE_central section	North-South transmission in Germany. AC links from Northern Germany towards the load centers of Bavaria and Baden-Württemberg. Due to ongoing political discussions a change of the connection point Grafenrheinfeld is under consideration.	11800	164		2022	Mid-term Project	AMPRION;TENNET-DE
inside-inside	204	N-S transmission DE_par_line_2	new 380-kV-OHL between Thuringa and Bavaria due to increase of RES in Northen Germany	11800	204		2024	Long-term Project	50HERTZ;TENNET-DE
inside-inside	205	N-S transmission DE_par_line_1	new 380-kV-OHL between Thuringa and Bavaria due to increase of RES in Northern Germany	11800	205		2015	Mid-term Project	50HERTZ;TENNET-DE
inside-inside	206	Reinforcement Southern DE	"AC-busbar" in Southern Germany for energy dispatching within Bavaria and Baden-Württemberg and gathering solar energy.	11800	206		2024	Long-term Project	TENNET-DE;TRANSNET-BW
inside-inside	207	Reinforcement Northwestern DE	Integration of on- and offshore RES in Lower Saxony	5500	207		2024	Long-term Project	AMPRION;TENNET-DE
inside-inside	208	N-S Western DE_section North_1	Integration of on- and offshore RES in Lower Saxony	5500	208		2018	Mid-term Project	AMPRION;TENNET-DE
inside-inside	209	Reinforcement Northeastern DE	New 380-kV-lines in the area of Schleswig-Holstein mainly for integration of Onshore-Wind.	12000	209		2021	Mid-term Project	AMPRION;TENNET-DE
Internal boundary in Germany	235	HVDC Brunsbüttel/ Wilster to Großgartach/ Grafenrheinfeld	4 GW HVDC connection from Northern Germany (areas of Brunsbüttel/Wilster) to Bavaria / Baden-Württemberg (areas of Großgartach/Grafenrheinfeld)	4000	Integration of RES and security of supply of Southern Germany	NEP (German NDP)	2022	Mid-term Project	TenneT TSO;TransnetBW

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Internal Boundary in North-East Germany	240	380-kV-grid enhancement between Area Güstrow/Bentwisch and Wolmirstedt	380-kV-grid enhancement between the areas Güstrow/Bentwisch and Wolmirstedt.	1500	This Project will help to transport the expected amount of RES to the South of Germany. It will also help to increase the technical possibility in this area to integrate the expected new Interconnectors to Scandinavia (e.g. Hansa Power Bridge or Kontek 2).	NEP (German NDP)	2020	Mid-term Project	50Hertz Transmission
Internal Boundary in North-East Germany	242	Offshore Wind Baltic Sea (I)	AC grid connections connecting Offshore Wind Farms in Cluster 1 of the Baltic Sea (see German Offshore Grid Development Plan). Cluster 1 is located north east of Rügen in the German Exclusive Economic Zone.	750	RES connection	German Offshore Grid Development Plan	2018	Mid-term Project	50Hertz Transmission
Internal Boundary in North-East Germany	248	Offshore Wind Baltic Sea (II)	AC grid connections connecting Offshore Wind Farms in Cluster 1, 2 or 4 of the Baltic Sea (see German Offshore Grid Development Plan). Clusters are located north east of Rügen mainly in the German Exclusive Economic Zone.	500	RES connection	German Offshore Grid Development Plan	2026	Long-term Project	50Hertz Transmission
Internal Boundary in West-Germany	254	Ultranet	2 GW HVDC-connection from the Region of Osterath (Rhineland) to the Region of Philippsburg (Baden-Württemberg). New circuit on an existing route on the same pylons as AC lines.	2000	Integration of RES and security of supply of South-Germany.	NEP (German NDP)	2019	Mid-term Project	Amprion;TransnetBW
North-South	42	OWP TenneT Northsea part 1	Connection of offshore wind parks in the North Sea to Germany. Mainly subsea DC cable. The OWP will help to reach the Eropean goal of CO2 reduction and RES integration	5750	42		2017	Mid-term Project	TENNET-DE

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
North-South	130	HVDC Wolmirstedt to area Gundremmingen	2 GW HVDC-connection from Wolmirstedt to the area of Gundremmingen. Capacity extension to 4 GW is under investigation.	2000	130		2022	Mid-term Project	50HERTZ;AMPRION
North-South	132	N-S Western DE_section North_2	New 380-kV-OHL and one DC-Link in North-West Germany for integration of RES, mainly on- and offshore wind.	5500	132		2022	Mid-term Project	AMPRION;TENNET-DE
North-South	133	Longterm German RES	internal German DC-Link for RES integration	18000	133	This project becomes necessary in case of further long-term strong increase in RES generation like in Vision 3 and 4. The project is not in Vision 1 and 2. It connects areas with high installed capacities of RES and areas with high consumption and storage capabilities. For this reason the development of new North-South and Northeast- Southwest electricity transmission capacity in Germany is necessary. This project begins in the North and North-East of Germany, areas with high RES generation (planned and existing) and connections with Scandinavia (planed and existing).The project ends in the South of Germany, an area with high consumptions and connections to Austria and Switzerland (transit to Italy and pump storage in the Alps).	2034	Future Project	50HERTZ;AMPRION;TENNET-DE;TRANSNET-BW

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
North-South	134	N-S Western DE_section South	North-South transmission Western Germany - AC reinforcements and upgrades towards the load centers of Baden-Württemberg and Switzerland	5500	134	RES integration and system stability	2021	Mid-term Project	AMPRION;TRANSNET -BW
North-South	135	N-S Western DE_parallel lines	Grid reinforcement between North-West-Germany and South-West-Germany to integrate RES.	5500	135	RES integration and system stability.	2022	Mid-term Project	AMPRION
outside-inside	186	east of Austria	To allow the grid integration of the planned renewable energy generation (mainly wind power) in the north-eastern part of Austria ("Weinviertel") the transmission grid infrastructure (currently a rather weak 220kV line) has to be enforced and new substations for the connection need to be erected.	1500	186	To allow the grid integration of the planned renewable energy generation (mainly wind power) in the north-eastern part of Austria ("Weinviertel") and to cover the foreseen load growth in that region the transmission grid infrastructure has to be enforced and new substations for the connection need to be erected	2021	Mid-term Project	APG
Poland - Germany	94	GerPol Improvements	Upgrade of the existing 220 kV double interconnection line between Krajnik and Vierraden to 400 kV double line in the same direction together with installation of Phase Shifting Transformers on two existing interconnection lines (Krajnik-Vierraden by 50Hertz Transmission GmbH in Vierraden and Mikułowa-Hagenverder by PSE S.A. in Mikułowa) on the PL/DE border including an upgrade of substations Vierraden, Krajnik and Mikułowa	Direction A: 0-1500 - Direction B: 0-500	94	This Project contribute to the following: • decreasing of unscheduled flow from Germany to Poland, Poland to Czech Republic and Poland to Slovakia by increasing of controllability on entire synchronous profile; • enhancement of market capacity on Polish synchronous profile - PL/DE as well as PL-CZ/SK border in case of both import and export. The project provides additional capacity (NTC – Net TransferCapability) of 500 MW in terms of import and 1500 MW export; greater level of safety and reliability of operation of the transmission network in Poland due to enhanced control of power flow.	2017	Mid-term Project	50HERTZ;PSE

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Poland - Germany	229	GerPol Power Bridge II	Project consist from following investments: indentation to the 2x400 kV line Baczyna-Plewiska (new routes: Baczyna-Zielona Góra, Zielona Góra-Plewiska), 2x400 kV line Zielona Góra - Gubin, crossborder line 2x400 kV line Gubin (PL)-Eisenhuettenstadt (DE), new station Zielona Góra, new station Gubin (with Phase Shifting Transformers).	1500	The project contributes to the following:- increase of market integration between member states - additional NTC of 1500 MWimport on PL-DE/SK/CZ synchronous profile; -integration of additional Renewable Energy Sources on the area of western and north-western Poland as well as eastern part of Germany.	TYNDP 2014	2030	Future Project	50Hertz Transmission;PSE

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Poland - Germany	230	GerPol Power Bridge I	The reinforcements in the Polish transmission network in western part of the country near Polish/German border : construction new AC 2x400 kV lines Mikułowa - Świebodzice, Krajnik - Baczyna and Baczyna - Plewiska.	1500/500	Project contributes to the following:• increase of market integration between member states - additional NTC of 1500 import and 500 MW export on PL-DE/SK/CZ synchronous profile; • integration of additional Renewable Energy Sources on the area of western and north-western Poland as well as eastern part of Germany; • improving network security - project contributes to increase of security of supply and flexibility of the transmission network (security of supply of Poznań agglomeration area).	TYNDP 2014, Common Planning Studies	2022	Mid-term Project	50Hertz Transmission;PSE

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Slovakia - Hungary	48	New SK-HU intercon. - phase 1	This project will increase the transfer capacity between Slovak and Hungarian transmission systems, improve security and reliability of operation both transmission systems and support North - South RES power flows in CCE region. Main investments of this project are double circuit AC OHL 400 kV from new Gabcikovo (Slovakia) substation to Gönyű (Hungary) substation, with one circuit connected to the Veľký Ďur (Slovakia) substation and double circuit AC OHL (preliminary armed only with one circuit on Hungarian side) 400 kV from Rimavska Sobota (Slovakia) substation to Sajóivánka (Hungary) substation.	Direction A: 0-500 - Direction B: 0-425	48	This project will increase the transfer capacity between Slovak and Hungarian transmission systems, improve security and reliability of operation both transmission systems and support North - South RES power flows in CCE region. Main investments of this project are double circuit 400 kV line from new Gabcikovo (Slovakia) substation to Gönyű (Hungary) substation, with one circuit connected to the Veľký Ďur (Slovakia) substation and double circuit 400 kV line from Rimavska Sobota (Slovakia) substation to Sajóivánka (Hungary) substation. The project supports the North - South power flow from wind and photovoltaic power in Northern part of Continental Europe by increasing GTC of SK-HU profile and improves the possibilities of balancing the system. The project enhances system security of both Slovak and Hungarian system, especially during outages and maintenances on other interconnections between the countries.	2018	Mid-term Project	MAVIR;SEPS

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
Slovakia - Hungary	54	New SK-HU intercon. - phase 2	This project will increase the transfer capacity between Slovak and Hungarian transmission systems, improve security and reliability of operation both transmission systems and support North - South RES power flows in CCE region. Realization of this project is tightly connected to the negotiations between Slovak and Ukrainian TSOs regarding future operation of the existing Slovak interconnection with Ukraine. Main and only investment of this project is double circuit AC OHL 400 kV from Velke Kapusany (Slovakia) substation to Kisvárda region (Hungary).	0-500	54	This project will increase the transfer capacity between Slovak and Hungarian transmission systems, improve security and reliability of operation both transmission systems and support North - South RES power flows in CCE region. Realization of this projetct is tightly connected to the negotiations between Slovak and Ukrainian TSOs regarding future operation of the existing Slovak interconnection with Ukraine. Main and only investment of this project is double circuit AC OHL 400 kV from Velke Kapusany (Slovakia) substation to Kisvárda region (Hungary). The project supports the North - South power flow from wind and photovoltaic power in Northern part of Continental Europe by increasing GTC of SK-HU profile and improves the possibilities of balancing the system. The project enhances system security of both Slovak and Hungarian system, especially during outages and maintenances on other interconnections between the countries.	2029	Future Project	MAVIR;SEPS

Boundary	TYNDP 2016 Project Index	Project name	Description	Provisional GTC (MW)	TYNDP2014 reference (if applicable) or motivation for new projects	Detailed studies	Expected Commissioning Year	Classification	Project promoter(s)
West-East	55	CZ West-East corridor	The project consists of reinforcements of three 400 kV AC overhead internal lines located in the nothern-western part of the Czech Republic in the west-eastern direction of power flows between existing 400 kV substations Vyskov, Cechy Sterd, Babylon and Bezdecin. The individual reinforcement of the above lines will be achieved by changing the existing single-circuit line to double-circuit line with transmission capacity of 2x1730 MVA.	Direction A: 1250-1750 - Direction B: 1400-1600	55	The project will facilitate power evacuation from the existing and new generation capacities (CCGT and lignite) which are located in the high concentrated power generation capacities in the northern-western part of the Czech grid in the west-eastern direction of the power flow. Moreover the project will prevent the non-fulfilment of operational security criteria of the Czech power system; substantially increase the interoperability and flexibility of the system in the Czech Republic in the norther-western part of the CZ system and ensure the security of supply in all those regions whose supply depend on those lines including the central part where the Capital city is located. Enhancement of the market flows in the norther-western direction is another positive contribution of the project	2019	Mid-term Project	CEPS

In addition, the following storage projects will be assessed in TYNDP2016

Table 1 - Matching the EC's draft guidelines

Project name	Promoter(s)	Country	Type of storage	Maximum active power [MW]	Total storage capacity [GWh]	Expected commissioning year
Hydro Pump Storage Power Plant Pfaffenboden in Molln	Wien Energie GmbH	Austria	Hydro Pump Storage	300	1,8	2019
Kaunertal Extension Project	TIWAG	Austria	Pumped Hydro Storage	1076	152	2028

Table 2 - not matching the EC's draft guidelines

Project name	Promoter(s)	Country	Type of storage	Maximum active power [MW]	Total storage capacity [GWh]	Expected commissioning year
ANGS: Abengoa Northern Germany Storage	Abengoa	Germany	Molten salt	363	1059	2019

5.3 List of projects of regional significance

In this chapter you can find the projects of the regional significance which, have been explored during the Common Planning Studies in this Regional Investment Plan CCE 2015, and are new in comparison with the last Regional Investment Plan CCE 2014, are presented in the **table 5-1 below**. These projects of the regional significance are not in the Pan-European list of projects because they do not have impact on the cross-border capacities higher than 500 MW, but these national and regional projects are prerequisite for security and reliability of the regional grid considering the future scenarios and visions. Therefore not only new regional projects, but also the list of projects of regional significance from the Regional Investment Plan CCE 2014, with updated status and commissioning dates are given in the this report, in the **appendix 7.3 Projects of regional significance from the CCE Regional Investment Plan 2014**. Based on this, the evolvement of all regional projects in CCE region can be seen.

Name	Substation 1	Substation 2	Description	Current status of the investment	Expected commissioning date
	Gießen/Nord	Karben	New 380-kV-line Gießen/Nord - Karben in existing corridor for RES integration	Under consideration	2025
Substation Ravne	Ravne (SI)		Construction of the new substation 220/110 kV Ravne with new double 220-kV OHL Ravne-Zagrad (the length is approximately 4 km) and it will be included in existing interconnection 220-kV OHL 220 kV Podlog(SI)-Obersielach(AT)	Planning	2019

Table 5-1 Projects of the regional significance which are new in RgIP CCE 2015 compared to the previous RgIP CCE 2014.

5.4 Reference capacities

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

	Reference Capacities (including present situation, Mid-term and Long-Term projects but not including Future candidate projects) (MW)	
Border	2020 Expected Progress	2030 Visions
AT-CZ	1000	1000
AT-HU	1200	1200
CZ-AT	1200	1200
CZ-DE	2100	2600
CZ-PLE	0	0
CZ-PLI	500	500

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CZ-SK	2100	2100
DE-CZ	1500	2000
DE-PLE	0	0
DE-PLI	2000	2000
HR-HU	2000	2000
HR-SI	2000	2000
HU-AT	800	800
HU-HR	2000	2000
HU-RO	1300	1300
HU-SI	1700	1700
HU-SK	2000	2000
PLE-CZ	600	600
PLE-DE	3000	3000
PLE-PL	0	0
PLE-SK	990	990
PLI-CZ	0	0
PLI-DE	0	0
PLI-PL	2000	2000
PLI-SK	0	0
PL-PLE	3000	3000
PL-PLI	0	0
RO-HU	1400	1400
SI-HR	2000	2000
SI-HU	2000	2000
SK-CZ	1100	1100
SK-HU	2000	2000
SK-PLE	0	0
SK-PLI	990	990

Figure 5-2 Reference cross-border capacities for the Assessment phase, 2020 and 2030

5.5 Interconnection ratios

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

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

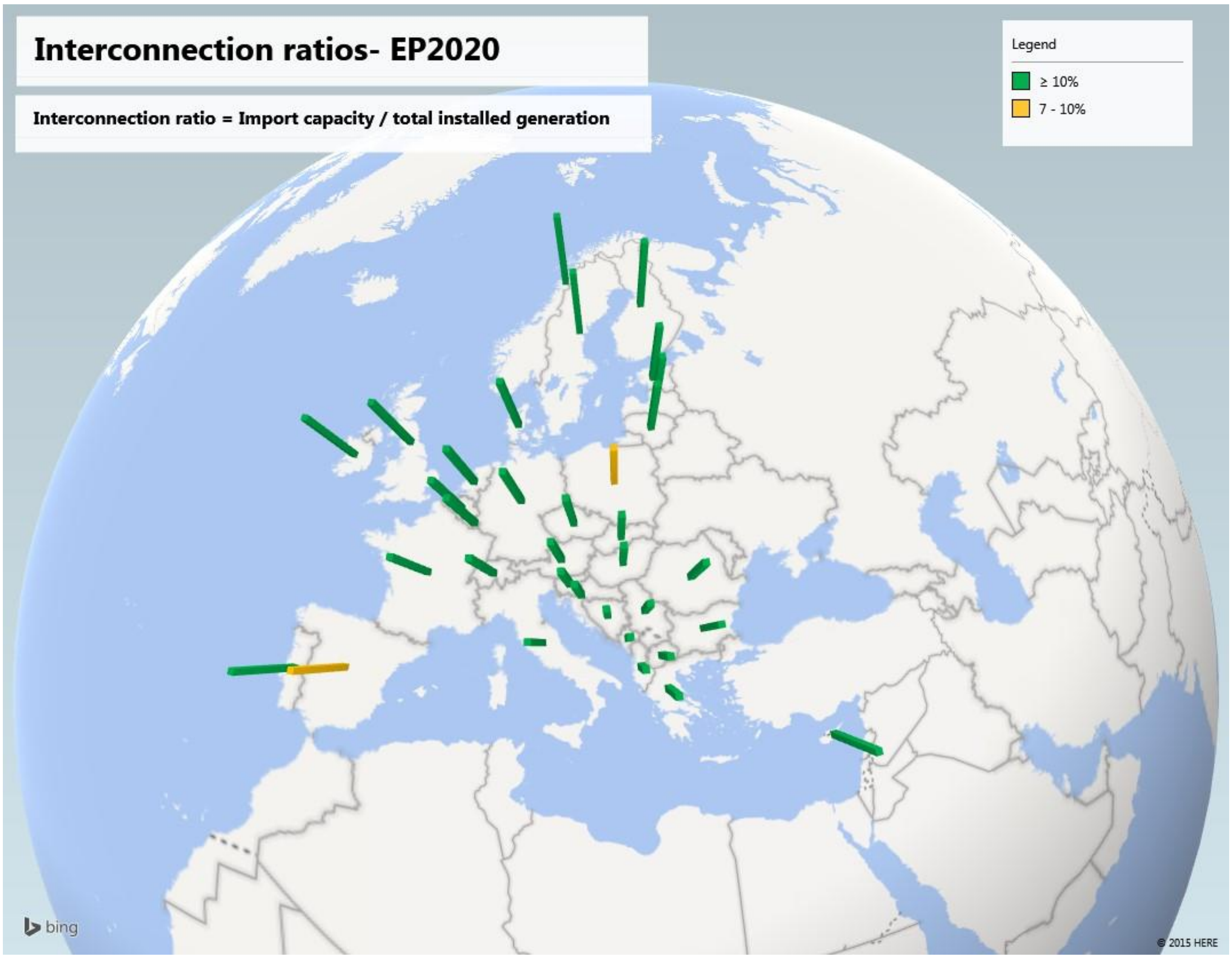

Figure 5-3 EP2020 Interconnection ratio

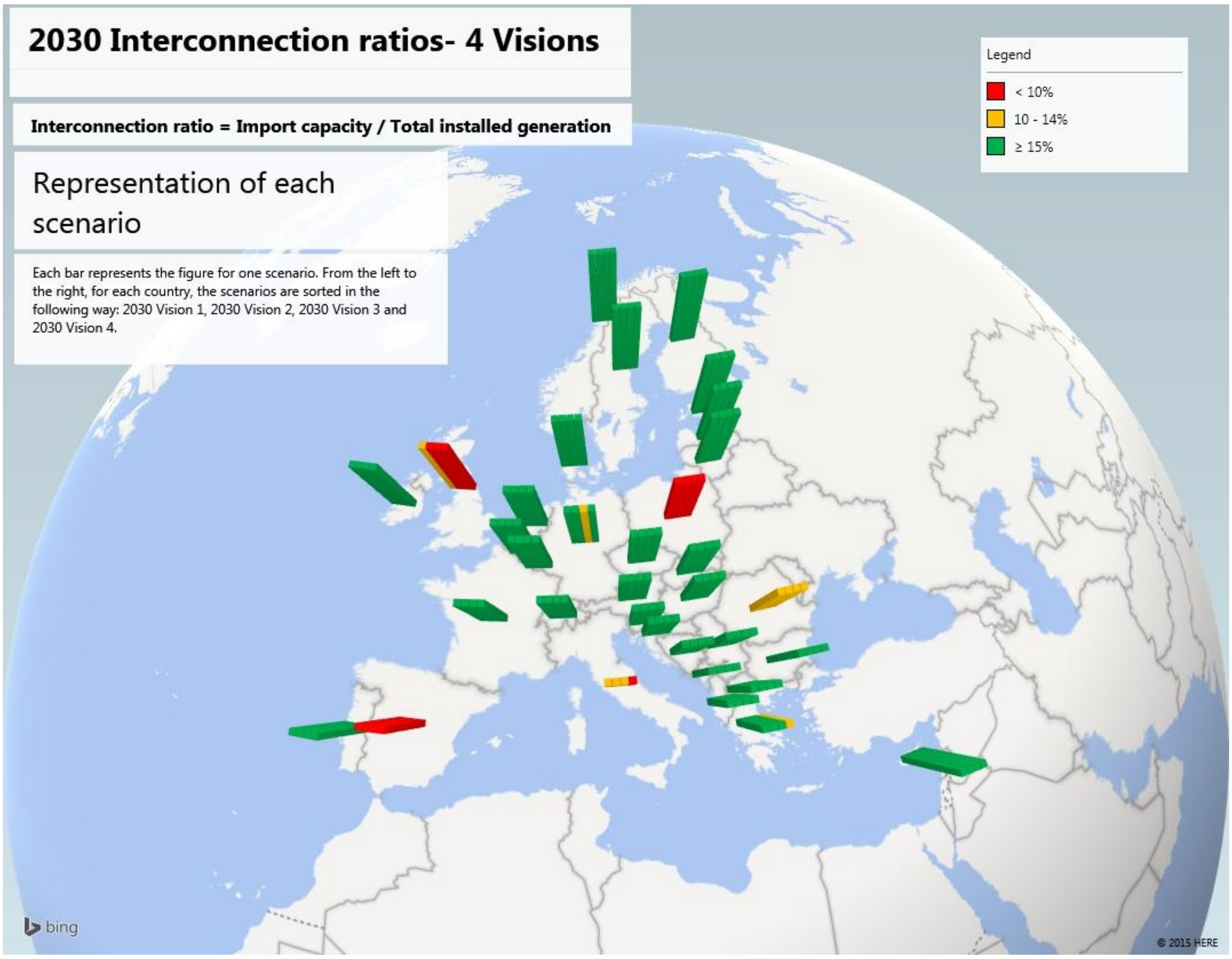

Figure 5-4 Interconnection ratio – 2030 Visions - import capacity divided by net generating capacity

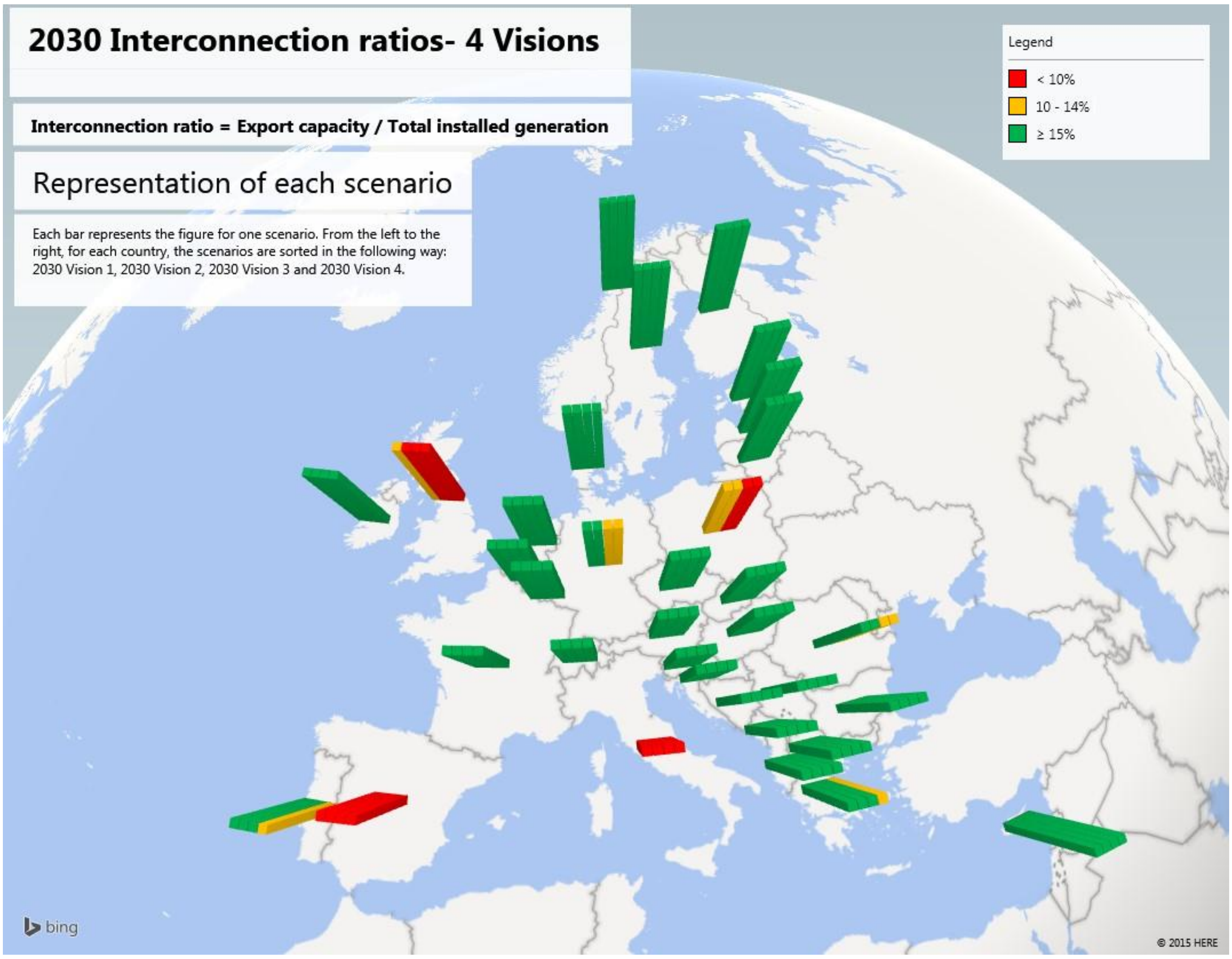

Figure 5-5 Interconnection ratio - 2030 Visions - export interconnection capacity divided by net generating capacity

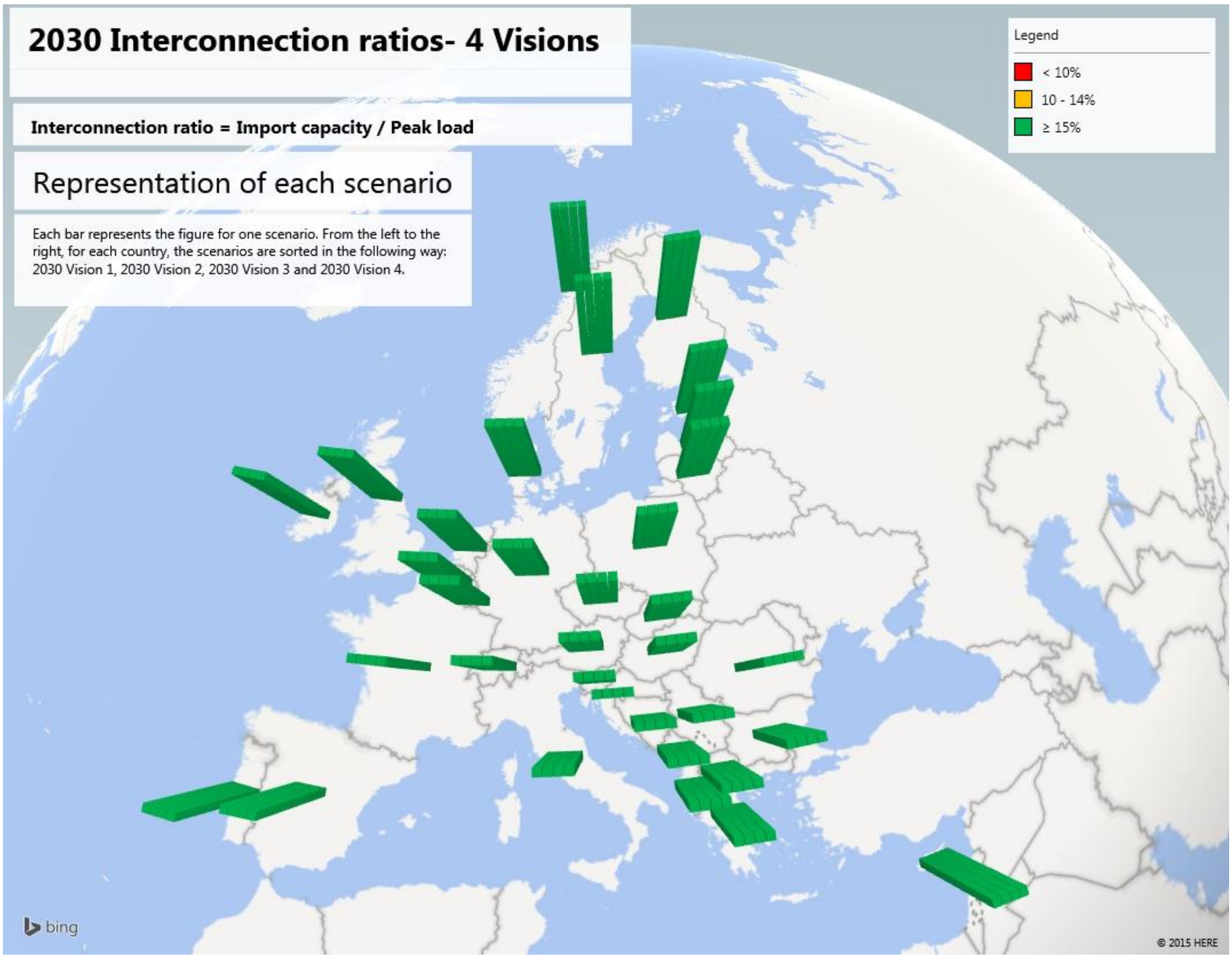

Figure 5-6 Interconnection ratio – 2030 Visions - import interconnection capacity divided by peak load

Three maps are presented for the 2030 interconnection ratios. These represent three different ways of defining the interconnection ratio for each country: the combined import capacity of its cross border interconnections divided by its total installed generation; the combined export capacity of its cross border connections divided by its total installed generation, and its import capacity divided by its peak load. The import and export capacities include planned mid and long term projects, but do not include future projects (those that would be commissioned beyond 2030).
Only one map is presented for the 2020 situation: this is as there is one accepted definition of interconnection ratio for the 2020 goal of 10% interconnection. This is import capacity divided by total installed generation.

The interconnection ratios values for each country are given as a division of interconnection capacities to net generating capacities or peak load of each country. As regards as the 2030 Visions of TYNDP 2016, it is thus obvious that the ratios can be different from the 2020 time horizon. It is because the fact that the interconnection capacity across the Visions are the mostly the same but the net generating capacities are higher (Visions´ dependent). The interconnection ratio for 2030 of each country therefore depends on the considered generation mix of each country and also on the Vision´s focus. The peak load increase between 2020 and 2030 is not as major as net generating capacities increase, therefore in **figure 5-6** where interconnection ratio is import capacity to peak load all RG CCE members fulfill interconnection criteria.

As the interconnection ratios of Poland and Romania is below 15 % level in 2030 Visions, the explanation for better clarification of the situation is provided below:

- By taking into account future project found during the Common Planning Studies (new project on Polish – German border: GERPOL Power Bridge II) which could bring 1500 MW increase of the Polish import transfer capacity from Germany, the Czech Republic and Slovakia and the level of interconnection ratios of Poland after the commissioning of these future project investments will be over 12 % in each Vision of the 2030 time horizon.
- In 2030 Visions there is a high increase of RES comparing to 2020 time horizon for Romania, which was not foreseen before and is not covered by interconnection capacity (Romanian national plan does not contain projects for interconnections). The new future candidate project found during the Common Planning Studies (new tie line between Romania and Hungary), could bring 500 MW increase of transfer capacity and the interconnection ratios of Romania will be in 2030 Visions over 15 %, excepting Vision 3, where the interconnection ratio will be approximately 14,4 %.

5.6 Long term perspective, remaining challenges and gaps

A continuing plan to connect and accommodate large-capacity of renewable source generation in the system will need large-scale transmission grid expansion and reinforcement in order to transmit the energy generated by these large-capacity renewable energy sources, which are generally located far from load centres and the existing grid. This “locational dependency” characteristic of these renewable sources, its partial unpredictability and uncertainties on the investor’s side which are normally driven by economic, political and regulatory factors will impose more difficulties in the system development planning processes. Through grid expansion, the geographic diversity of renewable source generation can be exploited to smooth out their aggregated variability and uncertainty and to reduce the renewable source power forecast error. Grid expansion and reinforcement can support interconnection between balancing areas, hence facilitating their cooperation or consolidation to share flexibility resources. However, to manage that kind of task, precise input information and assumptions must be at hand in order to properly design the grid architecture. As volume of RES increases the volatility in power flows phenomenon between areas will increase a need to better optimize the grid structure development to avoid stranded investments but to take into considerations all possible grid conditions which might occur. This will continue to be a challenging task for grid planners.

Europe has set-up the 2050 Energy road map which intends to continually increase the share of power generation from RES that is in line with the Energy policy targets towards a low carbon electricity sector, such a dramatic increase will require a huge volume of grid infrastructure investments. Given these expectations along with the potential for the further RES development in Europe, it is reasonable to develop high level long-term project concepts that may come into focus for future scenarios. These conceptual ideas are driven by objectives such as electricity market and RES integration. The current and previous TYNDPs looked to future scenarios 2020 and 2030. Scenarios beyond 2030 looking at a time horizon such as 2050 in compliance with the 2050 Energy road map will have to be considered in the future TYNDP processes.

The usage of existing corridors for reinforcement and expansion of the transmission network system aiming at not occupying new land is another challenge for grid planners. Operational security criteria and security of supply at large will have to be always insured while at the same time switching-off requirement of part of the existing grid will have to be fulfilled to enable the construction work of the new grid.

For increasing public-awareness, grid operators will have to continue to be in the front-seat to advertise and providing better information to public about the importance of the grid reinforcement and its expansion. Public awareness of the need for infrastructure reinforcement will help to ease the society negative attitude towards grid infrastructures and during permission granting procedures of grid investments.

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6 NEXT STEPS

6.1 A two-year cycle & CBA evolvement

Assessment methodology

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

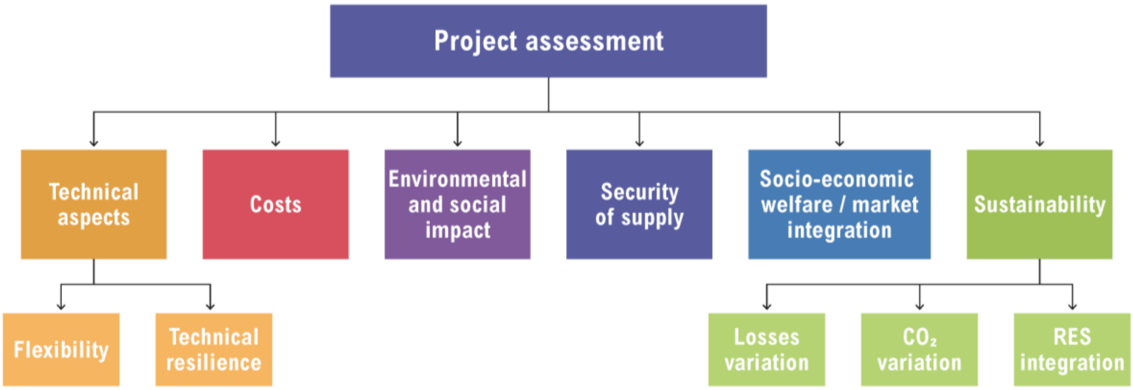


Figure 6-1 CBA Indicators

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

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

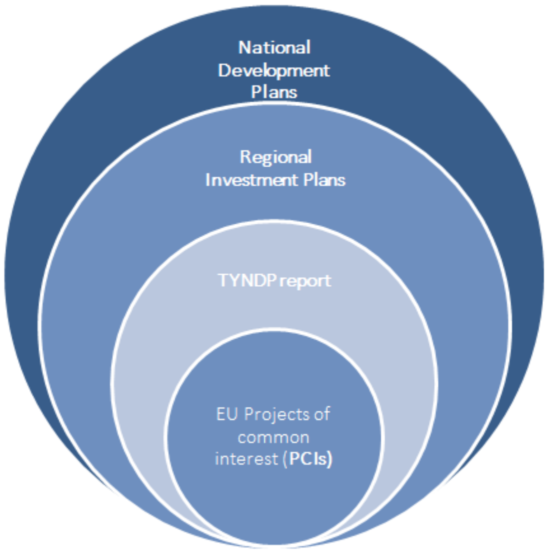
	CBA results non specific scenario		CBA results for each scenario							CBA results non specific scenario					
	GTC increase - direction 1 [MW]	GTC increase - direction 2 [MW]	TYNDP scenarios	Contribution to Intercon-nection rate [%]	B1 - SoS [MWh/y]	B2 - SEW [M€/y]	B3 - RES integration [MWh/y or MW/y]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

Scenarios

While this set of Regional Investment Plans is being published in summer 2015, ENTSO-E recently concluded a public consultation on a proposed Scenario Development Report in May-June 2015[1]. This report proposes a set of possible futures, describing storylines, methodologies, assumptions, and resulting load/generation mixes. One best estimate scenario for 2020 and four possible contrasting visions for 2030 have been proposed. These provide the mid- and long-term horizons as referred to in the CBA methodology against which all TYNDP2016 projects will be assessed.

Other infrastructure plans

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



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

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

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

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

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

7 APPENDICES

7.1 Detailed description of the methodology used

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

Market modelling description of the approach
The aim of the Common Planning Studies was to identify beneficial borders that will be increased in 500 or 1000 MW steps. Preliminary to the market studies members of the regional network-groups provided a list of costs for each possible increase and border. These costs included necessary internal reinforcements to make the additional cross-border capacity possible.
It was not necessary to specify costs for borders where new projects are not feasible. However – a good reason for why an increase of the cross-border capacity at this border is not feasible had be provided and agreed with the regional groups involved.
The following approach has been used.

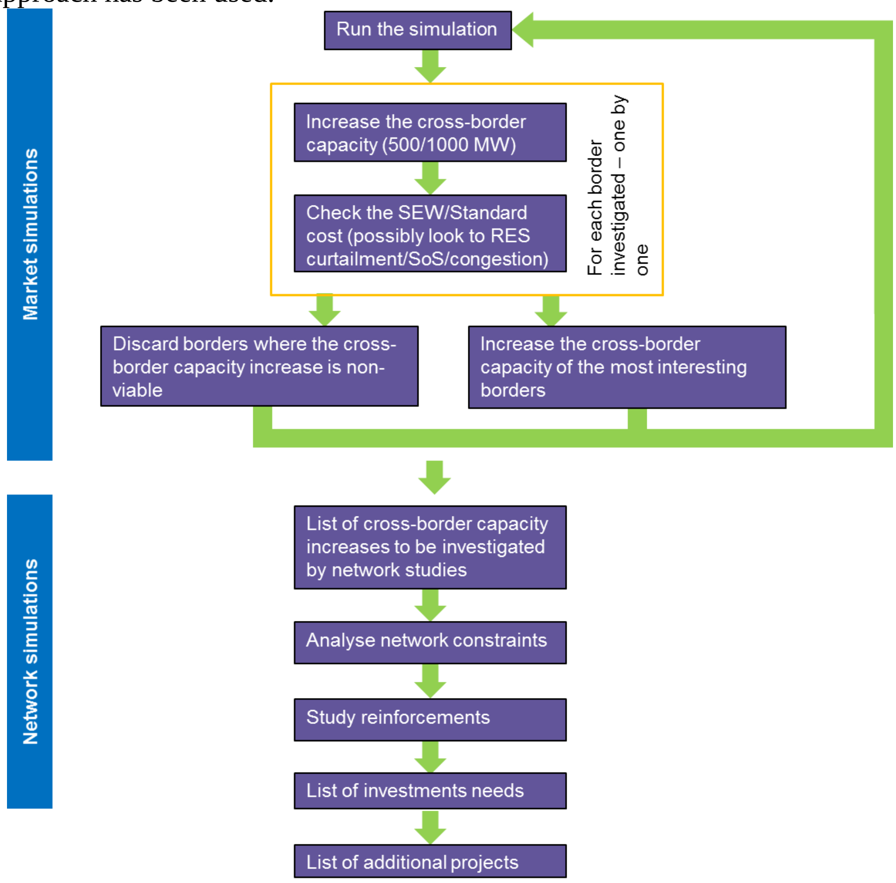


Figure 7-1 Overall overview of the Common Planning Studies process

1. The market simulation were run for the base case which was defined:

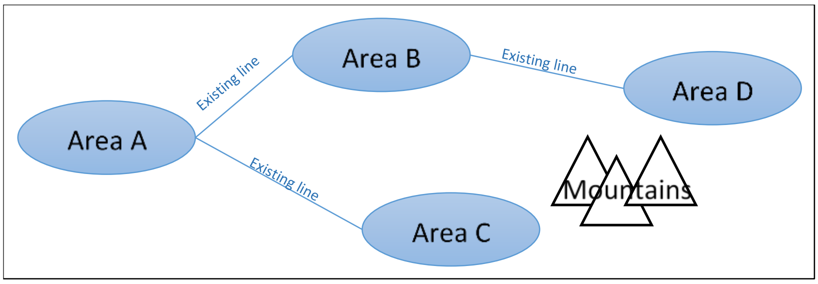
- on the base of data used TYNDP2014 V4 2030 Regional assessment (high RES conditions),
- on the base of an alignment performed by Project Group Market Modelling (PG MM) members respect the installed generation capacity and the generation profile (provided by PECD – Pan European Climate Database) for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

Additional details were permitted in the Regional area.

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

Practical example

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



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

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

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

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

Network modelling description of the approach

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

In the framework of the Common Planning Studies, the scope of Network Studies was to analyse, according to the market studies[3] findings, the most promising borders in terms of transfer capacity increase and identify the candidate projects which would achieve such potential transfer capacity increases in a feasible and cost efficient manner.

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

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

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

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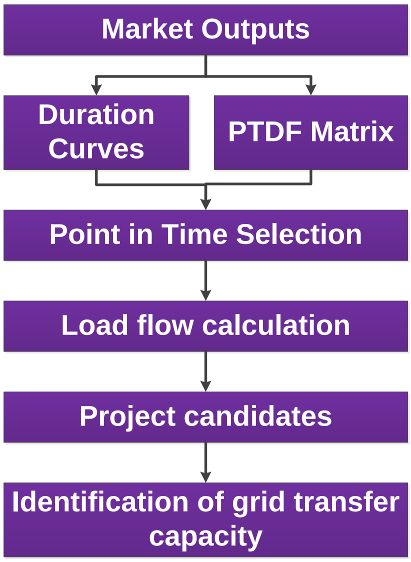

Figure 7-2 workflow of the Network Studies during Common Planning Studies

Network modelling

Network analyses were performed under the following framework:

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

Inputs from market results

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

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

Load flow simulations

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

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Bottleneck identification

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

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

Example of calculation of FS² in N conditions for a line (based on 5 PiT, with winter and summer limits):

PiT (N condition)	Weight (%)	F	P (MW)	Limit (MW) N condition	Overload (%)	S
WINTER 1	0,10	10	750	1000	-	0
WINTER 2	0,40	40	1100	1000	0,10	10
SUMMER 1	0,30	30	850	800	0,06	6
SUMMER 2	0,15	15	550	800	-	0
SUMMER 3	0,05	5	900	800	0,13	13
	FS²	5 925				

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

The reinforcement projects:

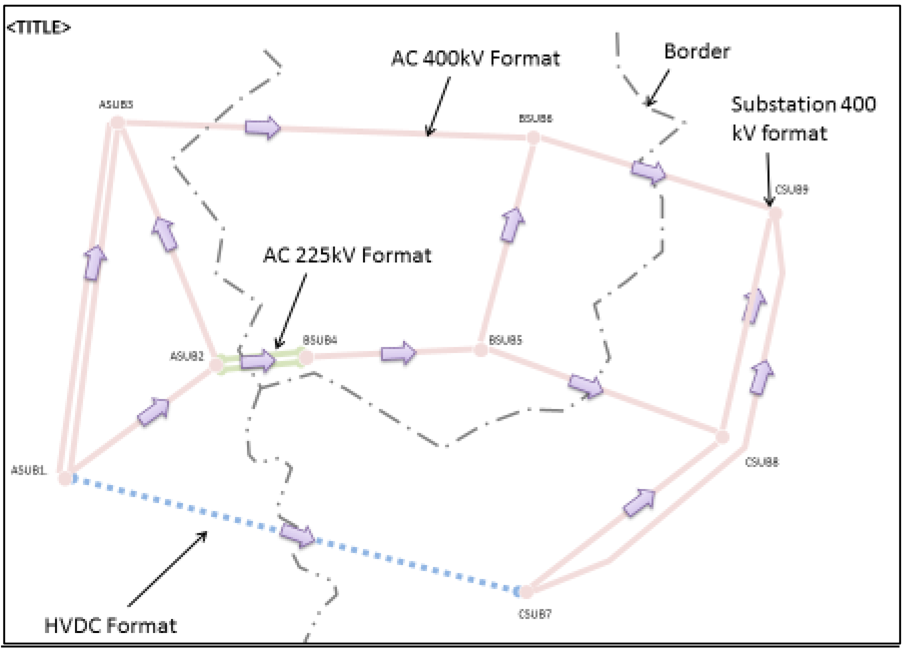
- were selected considering the severity and frequency of the bottlenecks
- considered first the border concerned by market increased target capacities

Map representation

<u>*Maps to illustrate physical flows:*</u>

Following types of map can were used:

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



Maps to illustrate bottlenecks:

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

7.2 Detailed regional walkthrough of process

Market Modelling of the Common Planning Studies

Additional to the general methodology described in chapter 2.3 “General Methodology” and chapter 7.1 “Detailed description of the methodology used”, this chapter will provide the detailed walkthrough on how the Common Planning Studies was conducted in the market modelling group of the RG CCE. The software used for the market simulation in the RG CCE was PowrSym. Based on the already described “General methodology” the Common Planning Studies was conducted as followed:

The RG CCE used the transfer capacity values and the market model from the TYNDP 2014 Vison 4 and then made a base run as a reference run (results from Vision 4 in TYNDP 2014). The increases were always compared to the base run from the specific iteration. For the Common Planning Studies each border between the countries in the RG was increased by the value according to the supplied standard costs.

With the supplied standard cost from the network modelling group the benefit for each boarder was calculated. The border with the highest benefit was chosen to be increased by the value with the highest benefit and was used as the new base scenario for comparison in the next iteration step. The borders

identified in the iterations in the other RGs were also increased and were adapted in the market model to be consistent with the results of the other RGs in the ENTSO-E.
After each of the iteration step borders with negative "Net Present Value" (NPV) were discarded and not considered in the next iteration. The NPV is calculated using the standard costs for the project, the SEW over a 25 year period of amortization and an interest rate of 4% per year. Therefore the NPV represents the current worth of the potential project.

This net present value per border mentioned above can be positive or negative and is used as an instrument to decide whether a potential project will be beneficial or not. If the net present value was negative for a border, this border was discarded and not further analyzed in the next iteration step. Each border with a positive NPV was investigated in the next iteration step. That was done to have new potential project candidates and to eliminate unbeneficial borders in the iteration steps.

Starting with the second iteration there was a special combination of Polish Import capacities from DE, CZ and SK. The following **table 7-1** shows all borders considered in the Common Planning Studies iterations. Detail results from each iteration can found below under sub-chapter "Detailed approach and results of the iteration steps". After three iterations there were no borders left with a positive NPV and the Common Planning Studies concluded for the RG CCE. With each iteration step the increases from the other RGs were taken into account too.

1. Iteration	2. Iteration	3. Iteration	4. Iteration	5. Iteration
AT-CZ	AT-CZ	AT-CZ	No borders with positive NPV left	No borders with positive NPV left
AT-HU	AT-SK	HU-RO		
AT-SK	CZ-PL	PL import (SK,CZ,DE)		
CZ-DE	CZ-PL			
DE-CZ	CZ-SK 500 MW			
CZ-PL	DE-PL			
CZ-SK 500 MW	HU-RO			
CZ-SK 1000 MW	HU-SK			
CZ-SK 1500 MW	PL import (SK,CZ,DE)			
DE-PL				
HR-HU				
HR-SI				
HU-RO				
HU-SI				
HU-SK				
PL-SK				

Table 7-1 Borders analyzed in the iterations of the Common Planning Studies

Remark: Some borders in the RG CCE belong to more than one ENTSO-E regional group. In these cases, there was an alignment between the regional groups, which made the analyzes for these borders. For example the borders AT-DE and AT-SI are internal borders for both CCE and CCS. It was decided, that these borders are calculated by CCS.

Summary

In the first iteration of the Common Planning Studies the border between Germany and Poland was identified as the most beneficial one and increased by 1000 MW. In the second iteration this border had again the highest benefit and should have been chosen again. However, during the harmonization and crosscheck process of standard costs input data after the two above simulations, the DE-PL standard costs had to be changed resulting that the DE-PL border not being chosen for capacity increase in the third iteration. For a more detailed description see the text below at the results of the iteration steps. This means that in the second iteration the border with the second highest benefit was chosen. Therefore the border between Hungary and Romania was increased by 500 MW.

In the third iteration the Polish import profile with an increased import capacity to Poland from Germany, Czech and Slovakia was chosen. Unfortunately at this point no other border with a positive NPV was left to be chosen. So the Common Planning Studies concluded in the RG CCE after three iteration steps with two identified possible projects.

In the fourth and fifth iteration only the increases from other RGs were taken into account to produce the same results in the final run as other RGs. After the conclusion of the Common Planning Studies the RG CCE identified two borders that indicated to have cross-border capacity beneficial increase. In the calculations results from all iterations of other RGs were taken into account too.

The range of the standard costs to increase the transfer capacity between the borders in the RG are given in the **table 7-2**. The costs are stated in M€ and are estimated for an increase of 1000 MW per border if not labeled otherwise.

Border	Standard Cost [M€]
AT-CZ	0-249
AT-HU	250-499
AT-SK	0-249
CZ-DE DE-CZ	500-999
CZ-PL	1000+ (500 MW & 1500 MW)
CZ-SK	0-249 (500MW), 250-499 (1000MW), 500-999 (1500 MW)
DE-PL	First iteration 0-249, after second iteration1000+
HR-HU	0-249
HR-SI	0-249
HU-RO	0-249 (500 MW)
HU-SI	250-999
HU-SK	250-999
Special case focusing on Polish import profile	
PL import profile	0-249

Table 7-2 Standard cost for reinforcement/construction of transfer capacity between countries

With these given ranges of standard costs and the results of the market simulation after each of the iteration steps the following tables and figures for the detailed approach were created.

Detailed approach and results of the iteration steps

The following combinations of three figures and three tables show the borders investigated together with initial transfer capacity and the increased capacity during that iteration. Figures are focused to depict the SEW and costs ratio, given in the ranges. More detailed information are given in the tables for each of iteration. The tables show the range of the standard costs and the results of the market simulation (SEW, avoided RES spillage, SoS improvement, CO_2 decrease). The last two columns give information about the benefit of the border. The border with the highest ratio between SEW and Cost was the most beneficial one and chosen to be increased in the next iteration step. The NPV gives additional information about the net present value of the border and is also given in the same range as the standard costs. Each border with a negative NPV is marked in red and was discarded in the next iteration step due to its indicative unprofitability.

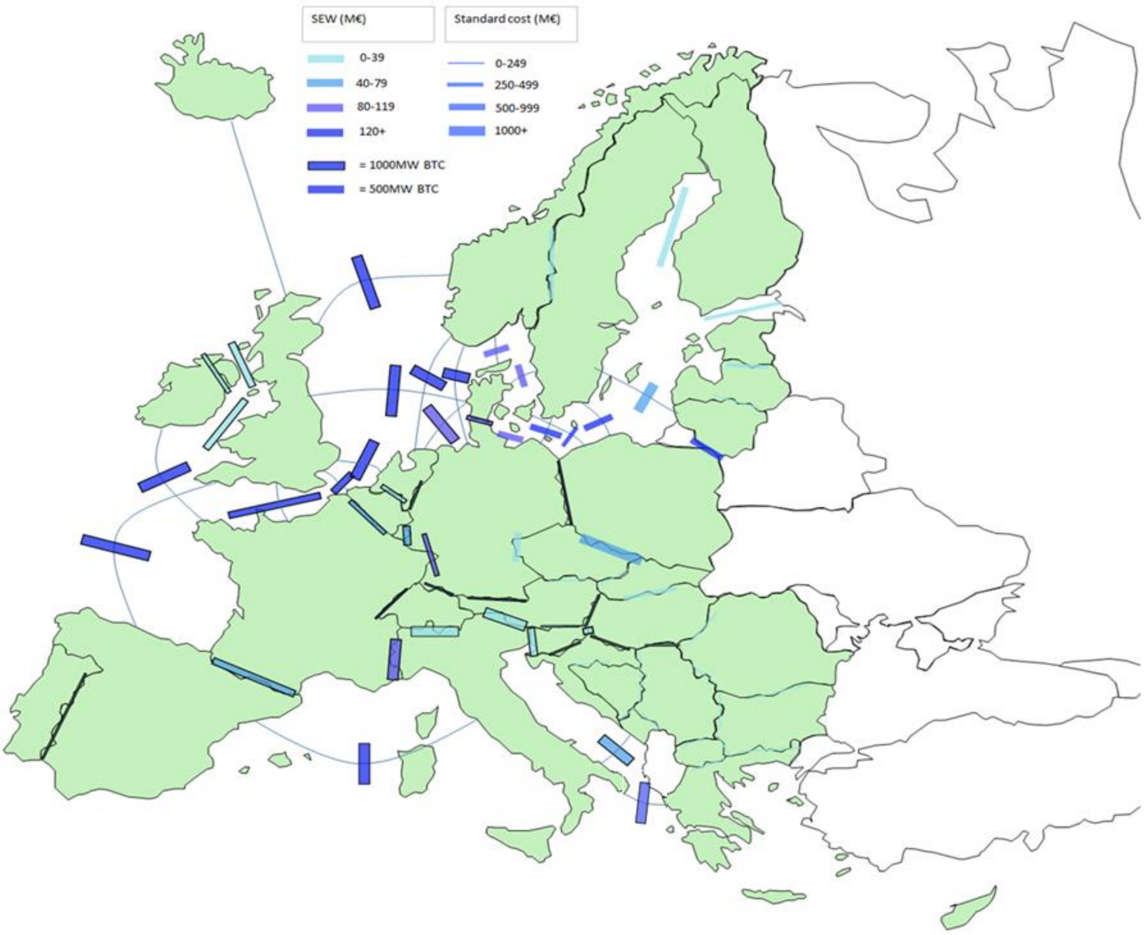


Figure 7-4 Borders with SEW and standard costs range in the 1st iteration of the market based Common Planning Studies iteration process

1. Iteration

Border	Initial transfer capacity Base case (Exp)	Initial transfer capacity Base case (Imp)	transfer capacity increase vs. Base case	Standard Cost [M€]	SEW increase [M€]	Avoided RES spillage [MWh]	SoS improv. [MWh]	CO_2 decrease [Mton]	RATIO SEW/Cost	NPV [M€]
AT-CZ	1000	1200	1000	0-249	0-39	103000	0	0,05	0,14	0-249
AT-HU	1200	800	1000	250-499	0-39	79000	0	-0,084	0,07	-(0-249)
AT-SK	0	0	1000	0-249	0-39	87000	0	-0,027	0,08	0-249

CZ-DE	2600	-	1000	500-999	0-39	0	0	0,034	0	-(500-999)
DE-CZ	2000	-	1000	500-999	0-39	283000	0	-0,094	0,03	-(250-499)
CZ-PL	1800	800	1500	1000+	80-119	166000	0	1,338	0,08	0-249
CZ-SK	2100	1100	500	0-249	0-39	0	0	-0,084	0,2	0-249
CZ-SK	2100	1100	1000	250-499	0-39	25000	0	-0,076	0,08	-(0-249)
CZ-SK	2100	1100	1500	500-999	0-39	35000	0	-0,079	0,05	-(0-249)
DE-PL	3000	2000	1000	0-249	80-119	238000	0	7,26	0,58	1000+
HR-HU	2000	2000	1000	0-249	0-39	24000	0	-0,023	0,03	-(0-249)
HR-SI	1500	1500	1000	0-249	0-39	0	0	0,003	0,02	-(0-249)
HU-RO	1300	1400	500	0-249	0-39	62000	0	0,062	0,2	0-249
HU-SI	1700	2000	1000	250-499	0-39	0	0	-0,004	0,01	-(250-499)
HU-SK	2000	2000	500	250-499	0-39	24000	0	-0,089	0,1	0-249
PL-SK	990	990	1000	-	40-79	86000	0	0,378	-	-

In the first iteration the border DE-PL had the highest ratio between SEW and standard costs thus making it the most profitable one and was chosen to be increased by 1000 MW in both directions. All borders with a negative NPV were discarded at this point as not further profitable and not considered in further iterations.

Figure 7-5 Borders with SEW and standard costs range in the 2nd iteration of the market based Common Planning Studies iteration process

2. Iteration

Border	Initial transfer capacity Base case (Exp)	Initial transfer capacity Base case (Imp)	transfer capacity increase vs. Base case	Standard Cost [M€]	SEW increase [M€]	Avoided RES spillage [MWh]	SoS improv. [MWh]	CO_2 decrease [Mton]	RATIO SEW/Cost	NPV [M€]
AT-CZ	1000	1200	1000	0-249	0-39	21000	0	0,03	0,13	0-249
AT-SK	0	0	1000	0-249	0-39	0	0	0	0	-(0-249)
CZ-PL	1800	800	1500	1000+	40-79	120000	0	-0,104	0,03	-(500-999)
CZ-PL	1800	800	PL-Ex-1500, PL-Im-500	1000+	40-79	161000	0	1,234	0,05	-(250-499)
CZ-SK	2100	1100	500	0-249	0-39	0	0	-0,011	0,01	-(0-249)
DE-PL	4000	3000	1000	0-249	40-79	210000	0	0,773	0,36	500-999
HU-RO	1800	1900	500	0-249	0-39	58000	0	0,101	0,13	0-249
HU-SK	2000	2000	500	250-499	0-39	0	0	0,017	0,05	-(0-249)
Special case focusing on Polish import profile										
PL import (SK,CZ, DE)	3000	2000	PL-1500-Im, DE-900-Ex, CZ-400-Ex, SK-200-Ex	0-249	0-39	150000	0	-0,134	0,11	0-249

After the second iteration the border DE-PL had again the highest ratio. However, during the harmonization and crosscheck process of standard costs input data after the two above simulations, the DE-PL standard costs had to be changed resulting that the DE-PL border not being chosen for capacity increase in the third iteration. A recalculation of the ratio and the NPV after the first iteration with the harmonized standard costs, which are considerably higher (see table 7-2 with provided range of standard costs), revealed that the border DE-PL had to have a negative NPV in the first iteration. Therefore it was agreed not to consider the increase on this border in the third iteration. The border with the second highest benefit in the second iteration was then chosen. The following is a detailed description focusing on the increased standard costs for the German Polish border and the impact on the surrounding grids as well.

Higher costs than standard appeared when potential increased power flows in direction from Poland to Germany exceed the level of 3000 MW. This additional expected flow creates additional needs for infrastructure and then higher costs than standard. Export from Poland to Germany in such quantity could be realized not only by Polish – Germany profile, but also by Polish – Czech border and it requires in consequence a lot of additional reinforcement necessary to integrate the additional power flows in the Polish grid especially in southern part of Poland (of course also in the Czech grid).
Polish experts find out, that to achieving this goal it is necessary to build in the Polish transmission system:

I. *New double circuit tie-line in the mountainous terrain (over standard cost of construction) with upgrading existing or building new substation.*
II. *New 400 kV lines in south - western part of Poland with new 400 kV substations.*
III. *New 400 kV lines in central - southern part of Poland with upgrading of existing stations.*

The cost on Polish side were evaluated on the level of 1 000 Mil. Euro.

The two borders with the second highest benefit were AT-CZ and HU-RO, both had the same beneficial ratio. Considering the higher RES integration impact of the HU-RO border, this border was chosen in the second iteration and increased by 500 MW. Again the borders with negative NPV were discarded and the ones with positive NPV were taken into account for the third iteration.

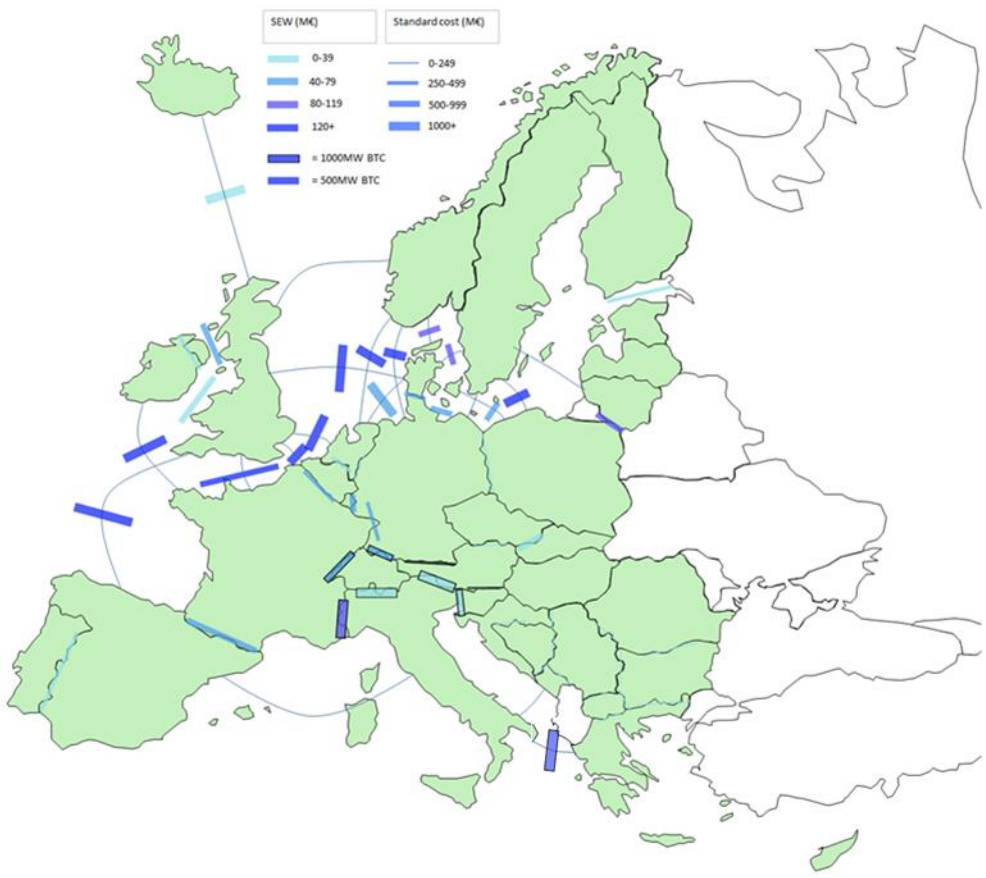


Figure 7-6 Borders with SEW and standard costs range in the 3rd iteration of the market based Common Planning Studies iteration process

3. Iteration

Border	Initial transfer capacity Base case (Exp)	Initial transfer capacity Base case (Imp)	transfer capacity increase vs. Base case	Standard Cost [M€]	SEW increase [M€]	Avoided RES spillage [MWh]	SoS improv. [MWh]	CO_2 decrease [Mton]	RATIO SEW/Cost	NPV [M€]
AT-CZ	1000	1200	1000	0-249	0-39	0	0	-0,035	0,06	-(0-249)
HU-RO	1800	1900	500	0-249	0-39	61000	0	-0,077	0,06	-(0-249)
Special case focusing on Polish import profile										
PL import (SK,CZ, DE)	3000	2000	PL-1500-Im, DE-900-Ex, CZ-400-Ex, SK-200-Ex	0-249	0-39	193000	0	-0,134	0,11	0-249

In the third iteration the Polish import profile where the import capacity to Poland was increased from three other countries (DE 900 MW, CZ 400 MW, SK 200 MW). The other borders hadn't had a positive NPV. According to the rule mentioned earlier that all borders with a negative NPV were to be discarded after an iteration step and therefore no other border could be chosen to be increased. With this fact taken into account this marks the end of the Common Planning Studies in the RG CCE.

Thus the Common Planning Studies in the RG CCE was after three iterations concluded due to no borders left with a positive NPV to be investigated. The final market results for the network modelling group and the sensitivity analyze with reduced gas and nuclear generation power, the fourth and fifth iteration were conducted as well, but only with the transfer capacity increases from the other RGs.

For comparison of the marginal cost per region are the next two figures. They show the average marginal costs per country and the differences per country. The first **figure 7-7** shows the average marginal costs for the Vision 4 2030 scenario in TYNDP 2014 and the second **figure 7-8** the average marginal costs at the end of market based part of Common Planning Studies that includes all market capacities increase. This helps to understand the power flows and transmission capacities between countries.

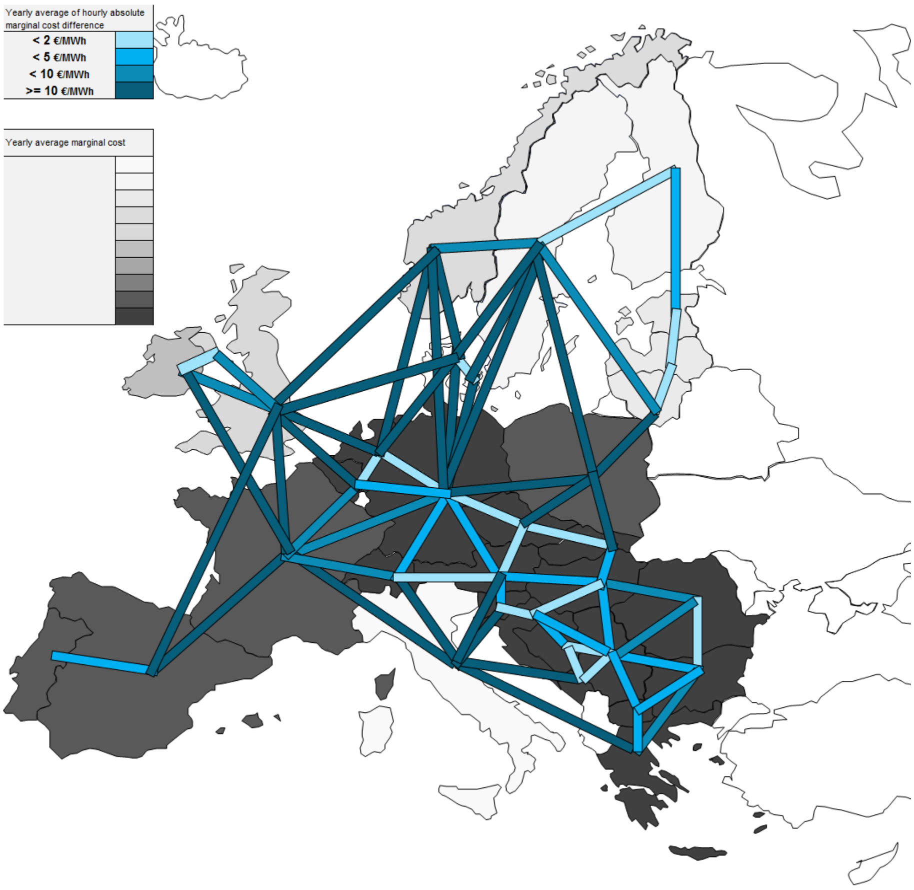


Figure 7-7 Average Marginal costs in the Vision 4 2030 scenario in TYNDP2014 for the entire ENTSO-E

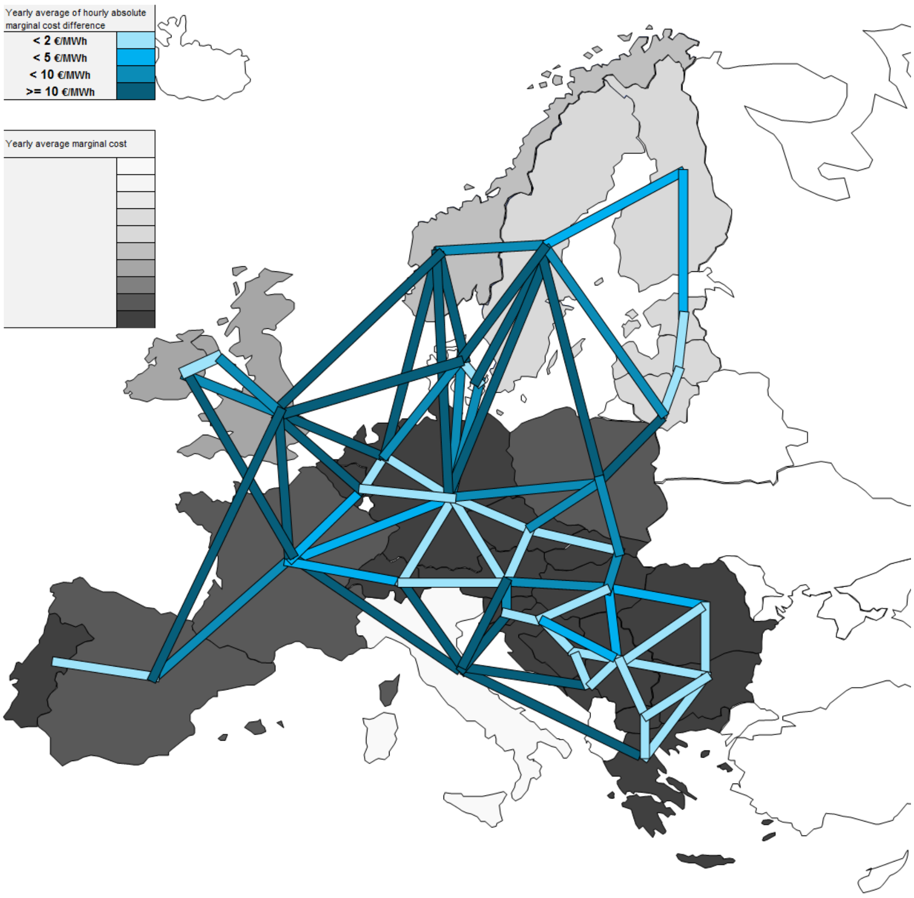


Figure 7-8 Average Marginal costs at the end of market based part of Common Planning Studies that includes all market capacities increase for the entire ENTSO-E

Sensitivity walkthrough

The sensitivity analysis that was conducted in the RG CCE based on the results from the Common Planning Studies to verify whether or not with a reduced generation capacity a security of supply can be achieved or not. This was to be done to test the robustness of the grid including the identified projects after the Common Planning Studies for the whole ENTSO-E region including all RGs.

Each TSO in the RG CCE was asked to provide a reduced generation capacity for gas and nuclear plants for the specific country. The market model was adapted to the new generation values and a new market simulation similar to the simulations of the iteration steps of the Common Planning Studies was carried out. The results were compared to the last iteration step of the Common Planning Studies and they revealed that no ENS was detected in the RG CCE. The results of the sensitivity are shown in chapter 4.2.2 “Sensitivity description and results”.

Network modellingof the Common Planning Studies

The work of the network studies in RG CCE following the common rules during this phase is described below:

- Common Planning Studies Network Studies were based on market outputs results in each Region (8736 hours simulations - it represents 52 weeks).

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

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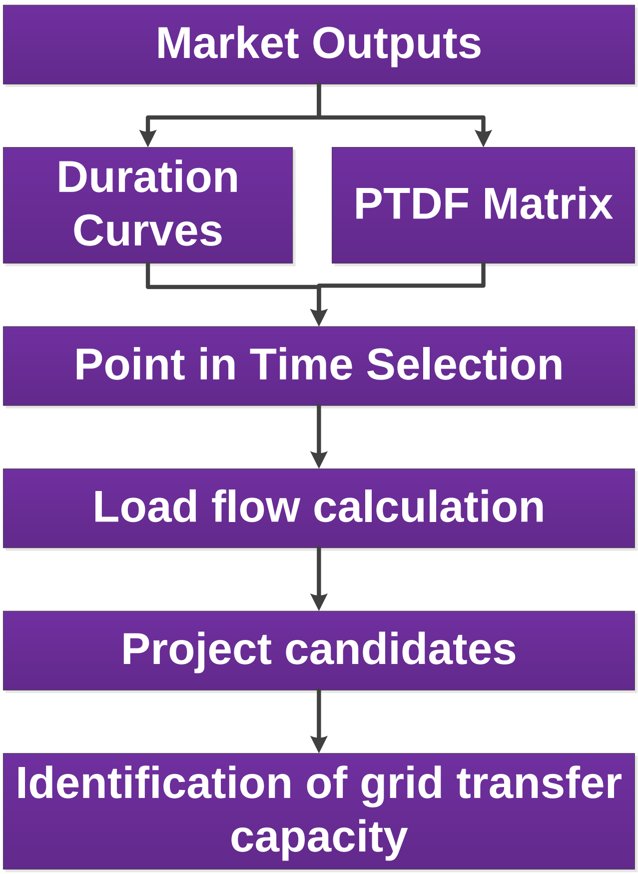

Figure 7-9 workflow of the Network Studies during CPS in RG CCE

Network modelling

Network analysis were performed under the following framework:

- Network datasets used to perform network simulations: the starting point for each region was the 2030 Vision 4 regional grid data set developed in TYNDP 2014 covering entire continental synchronous area.
- Models were updated according to the new projects listed in TYNDP 2014 and if relevant by other cross-border or national investment items.
- End of the Common Planning Studies process models for network modelling will be updated accordingly

Inputs from market results

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

- Thermal generation per fuel type and efficiency
- Renewable generation sources (wind, solar, …)
- Hydro generation (pumping, turbine):
- Dump energy per country
- Demand

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- Energy not supplied
- Balances
- Market exchanges on the border of the modelled perimeter (mostly HVDC connection to Northern countries or UK)

Load flow simulations

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

Based on the above description of the RG CCE general process implementation detail step by step process is descripted. Market exchanges and balances of particular zones or countries represents only the overall result of the most cost effective generation types under adopted assumptions in particular hour. These results provides very good indication in which direction one can expect transport of energy, however further detail analysis is required to get expected loadings of the lines and congested areas. The only one process, which can provide such information, is the investigation of real power flows by system with a representation of each individual line in investigated area.
RG CCE implemented continental Europe PTDF matrix as a first approximation of real flows to obtain information for all hours calculated by market simulation, how particular situation in market exchanges can be distributed to certain cross-border profile (all interconnectors are merged to one virtual connection, but with simplified grid impedance).

For further investigation the PTDF flows on the borders were investigated:

The exercise by using PTDF matrix allows evolving further identification of cases to be investigated in details. Set of criteria were discussed based on the studied scenario and PTDF flows and set up to further detailed analysis to cover all 8736 cases by 4 representative ones. The criteria followed the situation within the CCE region (e.g. German Export/Import, RES production, Demand, Market Exchanges over the particular borders, …) and its threshold for each criteria were defined (e.g. Export/Import has threshold 0). Further steps led to identification of 4 Points in Time to represent situations with e.g. high export other with import and so on according to the criteria defined among 8736 hours taking into the consideration defined thresholds. Those representative cases created group of representative cases with their representativeness to identify heavily loaded lines.
RG CCE modelled in detail continental Europe, because of meshed AC system, location of the region in continental Europe. HVDC connections to continental Europe has been modelled according to the market power exchanges, as they are equal.
According to the process mentioned above, 4 detail analysis has been carried out by network study tool using AC load – flow. This simulation provided not only information about heavy loaded lines and lines to be heavy loaded or overloaded under contingency conditions, but also voltage profiles across the system.

Methodology and Models

The network models used for AC load–flow calculation in the RG CCE Network modelling were built on model used for the assessment phase of TYNDP 2014, updated with the latest developments of the grid. They include detailed modelling of the transmission system with all busses, lines and transformers, and of the generation and demand of synchronous connection in continental Europe. In terms of complexity, a RG CCE model includes more than 18000 nodes, 10000 loads, about 15000 power plants, 18000 branches.

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7.3 Projects of regional significance from the CCE Regional Investment Plan 2014

ID	Name	Substation 1	Substation 2	Description	Current status of the investment	Expected commissioning date
326	Substation Pelplin	Pelplin (PL)		Construction of new 400/110kV substation Pelplin between existing substation Grudziądz and planned substation Gdańsk Przyjaźń.	Design & Permitting	2019
805	Grudziądz - Gdańsk	Grudziądz (PL)	Gdańsk Przyjaźń (PL)	Construction of new 400 kV line Grudziądz Węgrowo - Pelplin - Gdańsk Przyjaźń for planned generation connection.	Design & Permitting	2019
334	Pątnów - Grudziądz	Pątnów (PL)	Grudziądz (PL)	New 174 km 400 kV 2x1870 MVA double circuit OHL line Pątnów - Grudziądz after dismantling of 220kV line Pątnów - Jasiniec (two parallel lines) and Jasiniec - Grudziądz with extension of existing substations Patnów and Jasiniec. One circuit from Pątnów to Grudziądz via Jasiniec temporarily on 220kV.	Design & Permitting	2020
804	Gdańsk Błonia	Gdańsk Błonia (PL)		Extension and upgrade of an existing 400/110 kV substation Gdańsk Błonia for connection of planned 900 MW power plant.	Planning	2020
328	Piła - Bydgoszcz	Piła Krzewina (PL)	Bydgoszcz Zachód (PL)	New 400 kV double circuit line Piła Krzewina - Bydgoszcz Zachód temporarily on 220kV.	Design & Permitting	2019
329	Żydowo - Słupsk	Żydowo Kierzkowo (PL)	Słupsk (PL)	New 70km 400kV 2x1870 MVA OHL double circuit line Żydowo - Słupsk	Design & Permitting	2020
724	Żydowo Kierzkowo	Żydowo Kierzkowo (PL)		Construction of new AC 400/110kV substation Żydowo Kierzkowo next to existing 220/110kV substation in Northern Poland with transformation 400/110kV 450 MVA.	Design & Permitting	2019
330	Żydowo - Gdańsk Przyjaźń	Żydowo Kierzkowo(PL)	Gdańsk Przyjaźń (PL)	New 150 km 400 kV 2x1870 MVA double circuit OHL line Żydowo Kierzkowo - Gdańsk Przyjaźń with one circuit from Żydowo to Gdańsk temporarily on 220 kV.	Design & Permitting	2020
725	Gdańsk Przyjaźń	Gdańsk Przyjaźń		New substation Gdańsk Przyjaźń is connected by splitting and extending of one circuit of existing line Żarnowiec - Gdańsk Błonia and new OHL line Żydowo-Gdańsk Przyjaźń.	Planning	2020
352	Dunowo - Plewiska	Dunowo (PL)	Plewiska (PL)	Construction of a new double circuit 400kV OHL Dunowo - Żydowo (2x1870 MVA) partly using existing 220 kV line + Construction of a new 400kV OHL Plewiska - Piła Krzewina - Żydowo (2x1870 MVA); single circuit temporarily working as a 220kV + A new AC 400kV switchgear in existing substation Piła Krzewina + upgrade of substation Dunowo	Planning	2020

651	A30 LU-DE PLUS	Bascharage (LU)	Niederstedem (DE) or tbd (DE)	Upgrading and new construction of an interconnector to DE, in conjunction with the interconnector in the south of LU; Partial upgrading of existing 220kV lines and partial new construction of lines; With power transformer station in LU	Under Consideration	2032
447	447 LUXEMBOURG RING	Heisdorf (LU)	Berchem (LU)	Erection of a new 20km 225kV double-circuit mixed (cable+OHL)line with 1000 MVA capacity in order to create a loop around Luxembourg city including substations for in feed in lower voltage levels.	Under Construction	2017
446	446 BELUX INTERIM	Schifflange (LU)		As a first interim step a PST is commissioned in 2016 in Schifflange and connected to an existing OH-line with an additional 3.5km cable between Biff (CREOS-LU) and Substation Bascharage (CREOS-LU).	Under Construction	2016
138	138	tbd (CZ)	tbd (DE) - South-Eastern 50 Hertz	Possible increase of interconnection capacity between CEPS and 50Hertz Transmission is under consideration: either a new 400kV tie-line (OHL on new route) or a reinforcement of the existing 400kV tie-line Hradec (CEPS) – Röhrsdorf (50Hertz Transmission).	Under Consideration	2032
168	TNG-001	Goldshöfe (DE)	Dellmensigen (DE)	Upgrade the line Goldshöfe - Dellmensigen from 220kV to 380kV. Line length: 114km. Included in the investment: 3x 380kV substations, 2 transformers.	Under Construction	2015
170	TNG-004	Großgartach (DE)	Hüffenhardt (DE)	New 380kV OHL Großgartach Hüffenhardt. Length: 23km. Included in the project: 1 new 380kV substation, 2 transformers.	Commissioned	2014
172	TNG-005	Mühlhausen (DE)	Großgartach (DE)	Upgrade of the line Mühlhausen-Großgartach from 220kV to 380kV. Length: 45km.	Commissioned	2015
173	TNG-006	Hoheneck (DE)	Endersbach (DE)	Upgrade of the line Hoheneck-Endersbach from 220kV to 380kV. Length: 20km.	Under Construction	2015
174	TNG-007	Bruchsal Kändelweg (DE)	Ubstadt (DE)	A new 380kV OHL Bruchsal Kändelweg - Ubstadt. Length: 6km.	Commissioned	2014
175	NEP P70	Birkenfeld (DE)	Ötisheim (DE)	A new 380kV OHL Birkenfeld-Ötisheim (Mast 115A). Length: 11km.	Design & Permitting	2019
178	TNG 002 & 011	Goldshöffe and Engstlatt		Installation of 2x250 MVAr 380kV capacitance banks (1x250 MVar Goldshöfe and 1x250MVar Engstlatt).	Under Construction	2014
182	Kriftel-Obererlenbach	Kriftel (DE)	Obererlenbach (DE)	New 400 kV double circuit OHL Kriftel - Obererlebenbach in existing OHL corridor.	Under Construction	2016
185	Grid reinf. Münsterland /Westp.	Hanekenfähr (DE) and Ibbenbüren (DE)	Uentrop (DE)	In order to facilitate the integration of RES (especially wind) several grid reinforcements in the area of Münsterland/Westphalia are needed. This project will affect mainly the following substations: Hanekenfähr, Uentrop, Gütersloh, Wehrendorf, Lüstringen, Westerkappeln and Ibbenbüren. Within this area new lines and installation of additional circuits are planned. In addition the necessity for extension of existing and erection of several 380/110kV-substations is given.	Design & Permitting	2020

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186	Gütersloh-Bechterdissen	Gütersloh (DE)	Bechterdissen (DE)	New lines and installation of additional circuits, extension of existing and erection of 380/110kV-substation.	Commissioned	2014
187	Utfort-Rommerskirchen	Utfort (DE)	Rommerskirchen (DE)	New lines and installation of additional circuits, extension of existing and erection of several 380/110kV-substations.	Under Construction	2018
190	St. Barbara - Mittelbexbach	St. Barbara (DE)	Mittelbexbach (DE)	New lins, extension of existing and erection of several 380/110kV-substations	Commissioned	2016
191	Uckermarkleitung	Neuenhagen (DE)	Vierraden (DE)	Project of new 380kV double-circuit OHL Neuenhagen-Vierraden-Bertikow with 125km length as prerequisite for the planned upgrading of the existing 220kV double-circuit interconnection Krajnik (PL) – Vierraden (DE Hertz Transmission).	Design & Permitting	2017
197	Nordring Berlin	Neuenhagen (DE)	Wustermark (DE)	Construction of new 380kV double-circuit OHL between the substations Wustermark-Neuenhagen with 75km length. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	Under Construction	2018
199	Uckermark Nord	Pasewalk (DE)	Bertikow (DE)	Construction of new 380kV double-circuit OHLs in North-Eastern part of 50HzT control area and decommissioning of existing old 220kV double-circuit OHLs, incl. 380-kV-line Bertikow-Pasewalk (30 km).Support of RES and conventional generation integration in North Germany, maintaining of security of supply and support of market development.	Design & Permitting	2018
202	Bärwalde-Schmölln	Bärwalde (DE)	Schmölln (DE)	Upgrading existing double-circuit 380kV OHL in the South-Eastern part of the control area of 50Hertz Transmission. Bärwalde-Schmölln length approx. 50km. Support of RES and conventional generation integration in North-Eastern Germany, maintaining of security of supply and support of market development.	Commissioning	2014
206	Röhrsdorf - Remptendorf	Röhrsdorf (DE)	Remptendorf (DE)	Construction of new double-circuit 380-kV-overhead line in existing corridor Röhrsdorf-Remptendorf (103 km)	Planning	2021
208		Pulgar	Vieselbach	Construction of new 380kV double-circuit OHL in existing corridor Pulgar-Vieselbach (103 km) Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	Planning	2024
217	NA	Dürnrohr (AT)	Sarasdorf (AT)	Installation of the 3rd and 4th circuit on the existing line Dürnrohr - Sarasdorf. Total length: 100km.		
229	OHL 2 x 400 kV Plomin - Melina	Plomin (HR)	Melina(HR)	New 90 km double circuit OHL, with two connecting substations and transformer 400/220 kV, 400 MVA	Design & Permitting	2021
230	OHL Sisak - Mraclin/Prijedor	TPP Sisak (HR)	Mraclin(HR)/Prijedor(BA)	Connection of new generator on existing line 220kV Mraclin (HR) - Prijedor (BA) via a new double circuit OHL. Line length: 12km.	Under Construction	2017

231	150 MVAr reactive power device	Konjsko(HR)		Installation of a 150 MVAr reactive power device in substation Konjsko	Design & Permitting	2018
267	400kVOHL Suceava(RO)-Balti(MD)	Suceava (RO)	Balti (MD)	New 400 kV OHL (139 km) to increase capacity of transfer between Romania and Republic Moldova.	Design & Permitting	2022
268	RO-TR Subsea Cable	Constanta (RO)	Pasakoy (TR)	New DC link (subsea cable) between existing stations in RO and TR. Line length: 400km.	Under Consideration	2020
271	400 kV Medgidia S SS upgrade	Medgidia S (RO)		Substation Medgidia S 400 kV extended with new connections (400 kV OHL Rahmanu(RO)-Dobrudja(BG), 400 kV OHL Stupina(RO)-Varna(BG) and 300 MW windpark) and refurbished with GIS technology to provide the necessary space	Design & Permitting	2016
272	Stupina(RO)-Varna(BG) split	Medgidia S	400 kV OHL Stupina (RO)-Varna(BG) split	Connection in/out in 400 kV Medgidia S substation (RO) of existing 400kV OHL Stupina/ former Isaccea (RO)-Varna (BG), passing nearby. The line shall be connected in/out, through a double circuit OHL (1x2300 MVA in + 1x2300 MVA out).	Design & Permitting	2016
274	400 kVOHL Medgidia S-Constanta	Constanta (RO)	Medgidia(RO)	New 400kV double circuit (one circuit wired) OHL 1380 MVA between existing substations. Line length: 75km.	Planning	2020
284	NA	Perkáta (HU)		New substation Perkáta (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Martonvásár-Paks.	Under Construction	2015
286	NA	Székesfehérvár (HU)		New substation Székesfehérvár (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Martonvásár-Litér.	Planning	2024
287	NA	Kerepes (HU)		New substation Kerepes (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Albertirsa-Göd.	Under Construction	2016
290	NA	Oroszlány (HU)		New substation Oroszlány (HU) with 2*250 MVA 400/120 kV transformation is connected by splitting lines Gönyű-Bicske Dél and Győr-Martonvásár. 220 kV lines Oroszlány-Dunamenti and Oroszlány-Győr are uprated to 400 kV.	Planning	2017
292	NA	Kisvárda (HU)		Reconstruction of 750 kV substation by relocating to Kisvárda (HU). The substation is connected by splitting lines Sajószöged-Mukachevo and Albertirsa-Zakhidnoukrainska. The Albertirsa-Kisvárda section of the 750 kV line is utilized on 400 kV.	Planning	2018
293	Connection of subst. Voľa	Voľa (SK)	point of splitting (SK)	The Investment aims at connection of the new 400kV substation Voľa with transformation 400/110kV (replacing existing 220kV substation). This will be done by splitting of the existing single 400kV line between Lemešany and Veľké Kapušany substations. The new 400kV double circuit OHL will be of approximately 23km length.	Commissioned	2014

294	400kV line Lemesany-V.Kapusany	Lemešany (SK)	Veľké Kapušany (SK)	Reinforcement of the existing single 400 kV line between Lemešany and Veľké Kapušany substations. The project includes the extension both substations Lemešany and V.Kapušany. Line length: approximately 100 (including the loop erected under the Investment "Connection of substation Voľa").	Planning	2029
297	Substation Bystričany	Bystričany (SK)		Upgrade of the existing 220/110kV substation Bystričany. Upgrade of the existing 220/110kV substation Bystričany to 400/110 kV. The substation will be connected to the 400 kV system by the new 2x400kV line from substation Križovany with one circuit split and connected to substation Horná Ždaňa.	Design & Permitting	2021
298	SKnew2	Veľký Ďur (SK)	Gabčíkovo (SK)	Erection of new 2x400kV line between two important substations within Slovakia (Gabčíkovo and Veľký Ďur), including extension of the substation Veľký Ďur (SK). Line length:approx. 93km.	Cancelled	2016
299	Krasikov - H. Zivotice	Krasikov (CZ)	Horni Zivotice (CZ)	New single circuit 400kV OHL, 1385 MVA in North-western part Czech Republic	Under Construction	2016
324	DBN-PAS/WRC_RgIPCCE	Dobrzeń (PL)	Wrocław/Pasikurowice (PL)	New 76 km 400 kV 2x1870 MVA double circuit line from Dobrzeń to splitted Pasikurowice - Wrocław + upgrade and extension of 400 kV switchgear in substation Dobrzeń for purpose of generation connection.	Under Construction	2017
327	Kozienice-Ołtarzew_RgIPBS	Kozienice (PL)	Ołtarzew (PL)	New 130 km 400 kV 2x1870 MVA OHL double circuit line Kozienice - Ołtarzew + upgrade and extension of 400 kV switchgear in substation Kozienice for the connection of new line.	Design&Permitting	2019
375	Płock-Olsztyn Mątki	Płock (PL)	Olsztyn Mątki (PL)	New 400 kV line Płock-Olsztyn Mątki.	Cancelled	
613	66	Prati di Vizze (IT)	Steinach (AT)	Upgrade of the existing 44km Prati di Vizze (IT) – Steinach (AT) single circuit 110/132kV OHL, currently operated at medium voltage.	Design&Permitting	2016
672	Reactive power compensation	Area of West Germany (DE)		Installation of reactive power compensation (eg. MSCDN, SVC, phase shifter). Devices are planned in Kusenhorst, Büscherhof, Weißenthurm and Kriftel. Additional reactive power devices will be evaluated.	Planning	2018
673	Metternich-Niederstedem	Pkt. Metternich (DE)	Niederstedem (DE)	Construction of new 380kV double-circuit OHLs, decommissioning of existing old 220kV double-circuit OHLs, extension of existing and erection of several 380/110kV-substations. Length: 108km.	Planning	2021
678	Hamm-Kruckel	Hamm/Uentrop (DE)	Kruckel (DE)	Extension of existing line to a 400 kV single circuit OHL Hamm/Uentrop - Kruckel and extension of existing substations.	Planning	2018

681	Bürstadt - BASF	Bürstadt (DE)	BASF (DE)	New line and extension of existing line to 400 kV double circuit OHL Bürstadt - BASF including extension of existing substations.	Planning	2021
683	Wolmirstedt - Wahle	Wolmirstedt (DE)	Wahle (DE)	New double circuit OHL 380 kV; Line length 111 km	Planning	2022
684	Vieselbach - Mecklar	Vieselbach (DE)	Mecklar (DE)	New double circuit OHL 400 kV line in existing OHL corridor. (129 km)	Planning	2022
694	SKnew1	Veľký Ďur (SK)	Levice (SK)	The erection of new 1x400 kV line between two important Veľký Ďur and Levice substations, including extension of the V.Ďur and Levice substation.	Under Consideration	2026
698		Győr (HU)		70 Mvar shunt reactor in station Győr (HU)	Planning	2024
699		Győr (HU)		Third 400/120 kV transformer in station Győr (HU)	Planing	2024
706	400 kV Substation Sacalaz	Sacalaz (RO)		Replacement of 220 kV substation Sacalaz with 400 kV substation (1x 250 MVA, 400/110 kV).	Design&Permitting	2022
712	Upgrade OHLStejaru-Gheorghieni	Stejaru(RO)	Gheorghieni(RO)	Upgrade of the northern 220 kV corridor which is part of the cross-section between the wind generation hub in Eastern Romania and Bulgaria and the rest of the system. The axis Stejaru-Gheorghieni-Fantanele is upgraded, by replacing the existing conductors with high thermal capacity, low sag conductors; >460 MVA.	Planning	2020
713	Rahman(RO)-Dobrudja(BG) split	400 kV Medgidia S (RO)	Rahman(RO)-Dobrudja(BG) split	Connection in Medgidia (RO) of existing 400kV OHL Rahman (RO)-Dobrudja (BG), passing nearby. The line shall be connected in/out, through a double circuit OHL (1x1800 MVA in + 1x1800 MVA out).	Design&Permitting	2016
714	Upgrade OHL Brazi V - Stalpu	Stalpu (RO)	Teleajen (RO) - Brazi (RO)	Reinforcement of the cross-section between wind generation hub in Eastern Romania and Bulgaria and the rest of the system. A new 400kV OHL is built from Cernavoda (RO) to Stalpu (RO) and is continued by existing OHL Stalpu-Teleajen-Brazi V(RO), upgraded to operate at 400kV, from 220kV.	Planning	2018

716	220kVTeleajen upgrade to 400kV	Teleajen (RO)		The 220/110 kV ss Teleajen is upgraded to 400/110kV (1x400MVA). The new 400kVOHL Cernavoda-Stalpu is continued by the OHL Stalpu-Teleajen-Brazi V, upgraded to 400kV from 220kV, reinforcing the E-W cross-section. The 220 kV substations on the path are upgraded to 400kV. SoS in supplied area increases.	Planning	2019
717	Upgrade OHL Fantanele-Ungheni	Fantanele (RO)	Ungheni (RO)	Upgrade of the northern 220kV corridor which is part of the cross-section between the wind generation hub in Eastern Romania and Bulgaria and the rest of the system. The axis Stejaru-Ungheni is upgraded, by replacing the existing conductors with high thermal capacity, low sag conductors; >460MVA.	Under Consideration	2030
718	Upgrade Gheorghieni -Fantanele	Gheorghieni(RO)	Fantanele (RO)	Upgrade of the northern 220kV corridor which is part of the cross-section between the wind generation hub in Eastern Romania and Bulgaria and the rest of the system. The axis Stejaru-Ungheni is upgraded, by replacing the existing conductors with high thermal capacity, low sag conductors; >460MVA.	Planning	2020
719	400/110kV substation Voľa	Voľa (SK)		Upgrade of the existing 220/110kV substation Voľa with transformation 400/110kV (replacing existing 220kV substation).	Commissioned	2014
721	R Praha Sever	Praha Sever (CZ)		New 400/110kV substation equipped with transformers 2x350MVA.	Design & Permitting	2025
722	Chodov-Cechy Stred	Chodov (CZ)	Cechy stred (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 35.1km. Target capacity 2x1700 MVA.	Design & Permitting	2022
723	Tynec-Krasikov	Tynec (CZ)	Krasikov (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 103.8km. Target capacity 2x1385 MVA.	Design & Permitting	2025
732	Olsztyn Mątki	Olsztyn Mątki (PL)		Development 400 kV switchgear in Olsztyn Mątki substation.	Cancelled	
845	Line Križovany-Bystričany	Bystričany (SK)	Križovany (SK)	It is the Investment deeply connected to the investment Bystričany substation reconstruction. One circuit of the new 2x400kV line from 400 kV Križovany substation to the new 400 kV substation Bystričany will be connected to the 400kV Horná Ždaňa substation. Line length will be approximately 112 km.	Design & Permitting	2019
873	NA	Albertfalva (HU)		New 220/120 kV 160 MVA transformer at substation Albertfalva (HU).	Design & Permitting	2018
875	Prosenice-Nosovice	Prosenice (CZ)	Nosovice (CZ)	New connection between existing substation a new substation (see investment 299)	Design & Permitting	2022
876	R Detmarovice	Detmarovice (CZ)		New substation equipped with transformers 2x350MVA	Design & Permitting	2021
887	Tynec - Cechy Stred	Tynec (CZ)	Cechy stred (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 46.2km. Target capacity 2x1730MVA.	Design & Permitting	2040
888	Hradec-Vyskov	Hradec (CZ)	Vyskov (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 45.3km. Target capacity 2x1730MVA.	Design & Permitting	2024

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890	Prosenice-Krasikov	Prosenice (CZ)	Krasikov (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 87.5km. Target capacity 2x1730MVA.	Design & Permitting	2026
891	Nosovice-Kletne	Nosovice (CZ)	Kletne (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 79.4km. Target capacity 2x1730MVA.	Design & Permitting	2024
892	Hradec-Chrast	Hradec (CZ)	Chrast (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 82.4km. Target capacity 2x1730MVA.	Design & Permitting	2026
893	Prestice-Chrast	Prestice (CZ)	Chrast (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 32.8km. Target capacity 2x1730MVA.	Design & Permitting	2025
907	NA	Szigetcsép (HU)		New substation Szigetcsép (HU) with 2*250 MVA 400/120kV transformation is connected by splitting existing 400kV line Albertirsa-Martonvasar.	Design & Permitting	2017
908	NA	Ócsa (HU)		Installation of the 3rd 220/120 kV transformer in substation Ócsa (HU)	Planning	2020
909	NA	Detk (HU)		Installation of the 3rd 220/120 kV transformer in substation Detk (HU)	Planning	2017
913	400 kV OHL Stalpu Brasov	Stalpu 400 kV	Brasov 400 kV	New 400 kV OHL, AC,double circuit (initially 1 circuit wired), 170 km, between existing 400 kV substations Brasov(RO) and Stalpu (RO); extensions of the 400 kV end substations with the 400 kV bays.	Planning	2024
918	150MVAr reactive power device	Ernestinovo		Installation of a 150 MVAr reactive power device in substation Ernestinovo	Design & Permitting	2018
959	AC Enhanceme nt Lubmin-Güstrow	Lubmin (DE)	Güstrow (DE)	380-kV-grid enhancement and structural change Lubmin-Lüdershagen-Bentwisch-Güstrow	Under Consideration	2024
960	AC enhanceme nt Lubmin-Pasewalk	Lubmin (DE)	Pasewalk (DE)	380-kV-grid enhancement and structural change area Lubmin-Iven-Pasewalk.	Under Consideration	2024
965	AC Enhanceme nt Hamburg	Hamburg/Nord (DE)	Hamburg/Ost (DE)	AC Enhancement Hamburg	Under Consideration	2024
966	AC Enhanceme nt Krümmel	Krümmel (DE)	Hamburg/Nord (DE)	AC Enhancement Krümmel	Under Consideration	2024
967	Substations in 50Hertz	control area 50Hertz		Contructions of new substations, Var-compensation and extension of existing substations for integration of newly build power plants and RES in 50HzT control area	Planning	2024
974	Elsfleth - Ganderkesee	Elsfleht/West	Ganderkesee	new 380 kV OHL in existing corridor for RES integration between Elsfleth/West, Niedervieland and Ganderkesee	Planning	2021
975	Irsching - Ottenhofen	Irsching	Ottenhofen	new 380-kV-OHL in existing corridor between Irsching and Ottenhofen including new 380-kV-switchgear Zolling		2030
976	Dollern - Alfstedt	Dollern	Alfstedt	new 380-kV-OHL in existing corridor in Northern Lower Saxony for RES integration	Planning	2024
977	Unterweser - Elsfleth	Unterweser	Elsfleth/West	new 380-kV-OHL in existing corridor for RES integration in Lower Saxony	Planning	2024
978	Conneforde - Unterweser	Conneforde	Unterweser	new 380-kV-OHL in existing corridor for RES integration in Lower Saxony	Planning	2024

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993	PST Röhrsdorf	Röhrsdorf (DE)		Installation of new PSTs in Röhrsdorf	Planning	2023
1052	NA	Nyíregyháza (HU)		New substation Nyíregyháza (HU) with 2*250 MVA 400/120kV transformation is connected by splitting existing 400kV line Sajószöged-Mukachevo.	Planning	2020
1055	NA	Pomáz (HU)		New substation Pomáz (HU) with 2*250 MVA 400/120kV transformation.	Under Consideration	2025
1056	NA	Pomáz (HU)	Bicske Dél (HU)	New 400 kV double circuit transmission line between new substation Pomáz (HU) and existing substation Bicske Dél (HU).	Under Consideration	2025
1057	NA	Kerepes (HU)		Upgrade of substation Kerepes (HU) with 500 MVA 400/220kV transformation, connected by splitting existing line Ócsa-Zugló.	Planning	2023
1058	NA	Kerepes (HU)	Zugló (HU)	Reconstruction of 220kV line Kerepes-Zugló (HU) line to double circuit.	Planning	2023
1059	NA	Paks II (HU)		New 400 kV substation Paks II (HU) for the connection of the new units of Paks Nuclear Power Plant.	Planning	2023
1060	NA	Paks II (HU)	Albertirsa (HU)	New 400 kV double circuit transmission line between new substation Paks II (HU) and existing substation Albertirsa (HU).	Planning	2023
1061	NA	Paks II (HU)	Paks (HU)	New 400 kV double circuit transmission line between new substation Paks II (HU) and existing substation Paks (HU).	Planning	2023
1067	Klostermannsfeld-Lauchstädt	Klostermannsfeld (DE)	Lauchstädt (DE)	Upgrade of existing 380kV line	Planning	2024
1088	Mengede - Herne - Wanne	Mengede (DE)	Wanne (DE)	Reconductering of existing 380kV line Mengede - Herne - Wanne.	Design & Permitting	2016
1089	Ackerstraße - Mattlerbusch	Point Ackerstraße	Point Mattlerbusch	Reconductering of existing 380kV line between Point Ackerstraße-Mattlerbusch	Under Construction	2017
1090	Niederrhein - Utfort	Niederhein (DE)	Utfort (DE)	New lines and installation of additional circuits, extension of existing and erection of several 380/110kV-substations.	Design & Permitting	2018
1091	Günnigfeld - Wanne	Günnigfeld (DE)	Wanne (DE)	Reconductering of existing 380kV line	Design & Permitting	2018
1092	Landesbergen - Wehrendorf	Landesbergen (DE)	Wehrendorf (DE)	Installation of an additional 380-kV circuit between Landesbergen and Wehrendorf	Planning	2022
1093	Okriftel - FW Höchst-Süd	Point Okriftel	Farbwerke Höchst-Süd	The 220kV substation Farbwerke Höchst-Süd will be upgraded to 380kV and integrated into the existing grid.	Planning	2021
1094	380/220kV Transfomers	Several		This investment includes new 380/220kV transformes in Walsum, Sechtem, Siegburg, Mettmann and Brauweiler.	Planning	2019
1095	Lippe-Mengede	Lippe (DE)	Mengede (DE)	Reconductering of existing 380kV line between Lippe and Mengede.	Under Consideration	2025
1096	Lüstingen - Gütersloh	Lüstingen and Gütersloh	Gütersloh	The subsations Lüstingen to Güthersloh will be upgrade to use the line Lüstingen to Güthersloh with 380 kV.	Under Consideration	2020

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1097	Additional capacity to DSOs	Several		This investment includes several new 380/110kV transformers in order to integrate RES in Erbach, Gusenburg, Kottigerhook, Niederstedem, Öchtel, Prüm and Wadern. In addition a new 380kV substation and transformers in Krefeld Uerdingen are included.	Planning	2019
1100	Herbertingen - Neuravensburg	Herbertingen (DE)	point Neuravensburg (DE)	Between the 380-kv-station Herbertingen and point Neuravensburg a new line with a significantly higher transmission capacity will be constructed (Grid enhancement).	Under Consideration	2023
1101	Büttel - Wilster	Büttel	Wilster	new 380-kV-line in extisting corridor in Schleswig - Holstein for integration of RES especially wind on- and offshore	Planning	2021
1102	Mehrum	junction Mehrum	Mehrum	new 380-kV-line junction Mehrum (line Wahle - Grohnde) - Mehrum including a 380/220-kV-transformer in Mehrum	Planning	2019
1103	Borken - Mecklar	Borken	Mecklar	new 380-kV-line Borken - Mecklar in existing corridor for RES integration	Planning	2021
1104	Borken - Gießen	Borken	Gießen	new 380-kV-line Borken - Gießen in existing corridor for RES integration	Planning	2022
1105	Borken - Twistetal	Borken	Twistetal	new 380-kV-line Borken - Twistetal in existing corridor for RES integration	Planning	2021
1106	Wahle - Klein Ilsede	Wahle	Klein Ilsede	new 380-kV-line Wahle - Klein Ilsede in existing corridor for RES integration	Planning	2018
1108	Schwäbische Alb	Metzingen-Oberjettingen	Oberjettingen-Engstlatt	New 380kV OHL Metzingen-Oberjettingen (32 km) and new 380kV OHL Oberjettingen-Engstlatt (34 km)	Planning	2020
1109	Großgartach - Pulverdingen	Großgartach	Pulverdingen	New circuit 380kV OHL Großgartach-Pulverdingen (30 km) combined with reconductering existing circuit 380kV OHL Großgartach-Pulverdingen (30 km)	Design & Permitting	2024
1110	Eastern Baden-Württemberg	Dellmensingen	Rotensohl-Niederstotzingen	New circuit 380kV OHL Dellmensingen-Rothensohl (67 km) combined with reconductering existing circuit 380kV OHL Dellmensingen-Niederstotzingen (41 km)	Cancelled	2024

7.4 Guidelines for Project Promoters

In line with Regulation (EU) 347/2013, the EC provides a set of guidelines[4] for ENTSO-E to apply when handling all applications by project promoters for TYNDP inclusion. These guidelines ensure the same procedure, timeline and qualification criteria are used for all project promoters, and enshrine the rights and responsibilities of promoters, ACER, EC and ENTSO-E. It addresses Promoters of transmission infrastructure projects within a regulated environment, Promoters of transmission infrastructure projects within a non-regulated environment (i.e. exempted in accordance with Article 17 of Regulation (EC) No 714/2009, referred to as "merchant lines"), and Promoters of storage projects. All who aspire inclusion of their project in the PCI list in year X, need to be included in the latest available TYNDP of year X-1.
Based on the EC's draft guidelines, and building on the experience of past TYNDPs, all promoters of electricity transmission and storage projects were invited by ENTSO-E to submit between 1 April and 30 April 2015 their application for inclusion in the Ten-Year Network Development Plan 2016.

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

During May 2015 ENTSO-E reviewed the data submitted in order to verify its completeness and compliance with the guidelines. Throughout May any promoter had the opportunity to complete or update its project details, and ENTSO-E was in regular contact with all promoters to ensure a smooth process. All promoters were invited to provide information via a dedicated Sharepoint platform. Ultimately it is the applicant's responsibility to ensure the application was completed by end of May.
This procedure allowed ENTSO-E to compile a list of TYNDP project candidates which completes the picture of planning studies, regional context and investment needs sketched in the Regional Investment Plans[5]. This timely compilation of a list of TYNDP projects allows ENTSO-E to have a baseline reference architecture for CBA assessments starting in summer 2015. Any late request for TYNDP inclusion can be handled evidently in future TYNDP editions. Any request for significant change to TYNDP projects during the 2016 process will be assessed in line with ENTSO-E's governance rules, with oversight from EC and ACER, and taking on board the role of ENTSO-E's neutral Network Development Stakeholder Group.
The main drivers in this approach is to keep transparency over the development and updates of the TYNDP project list, and ensure clarity over the CBA assessment 'ingredients' (methodology, list of projects, scenarios, data).

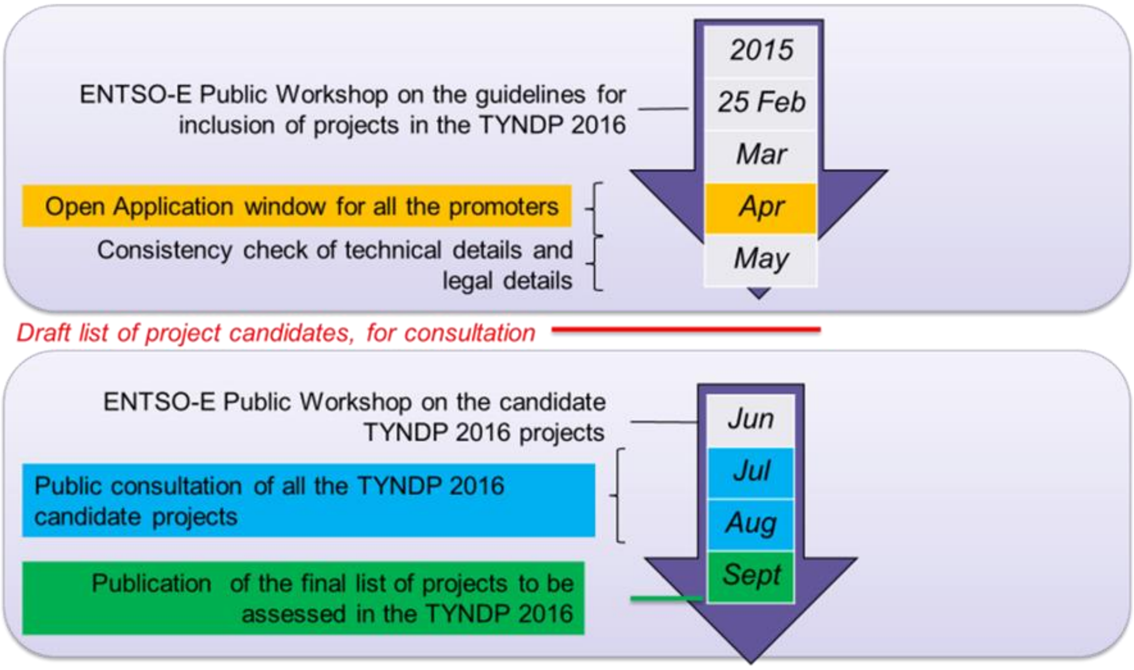

Figure 7-4 Workplan for project promotors

7.5 Abbreviations

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

- AC Alternating Current
- ACER Agency for the Cooperation of Energy Regulators

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

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

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

7.6 Terminology

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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