European Network of Transmission System Operators for Electricity

Regional Investment Plan 2015 Continental South East region

- Final version after public consultation

30 October 2015

Contents

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

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.

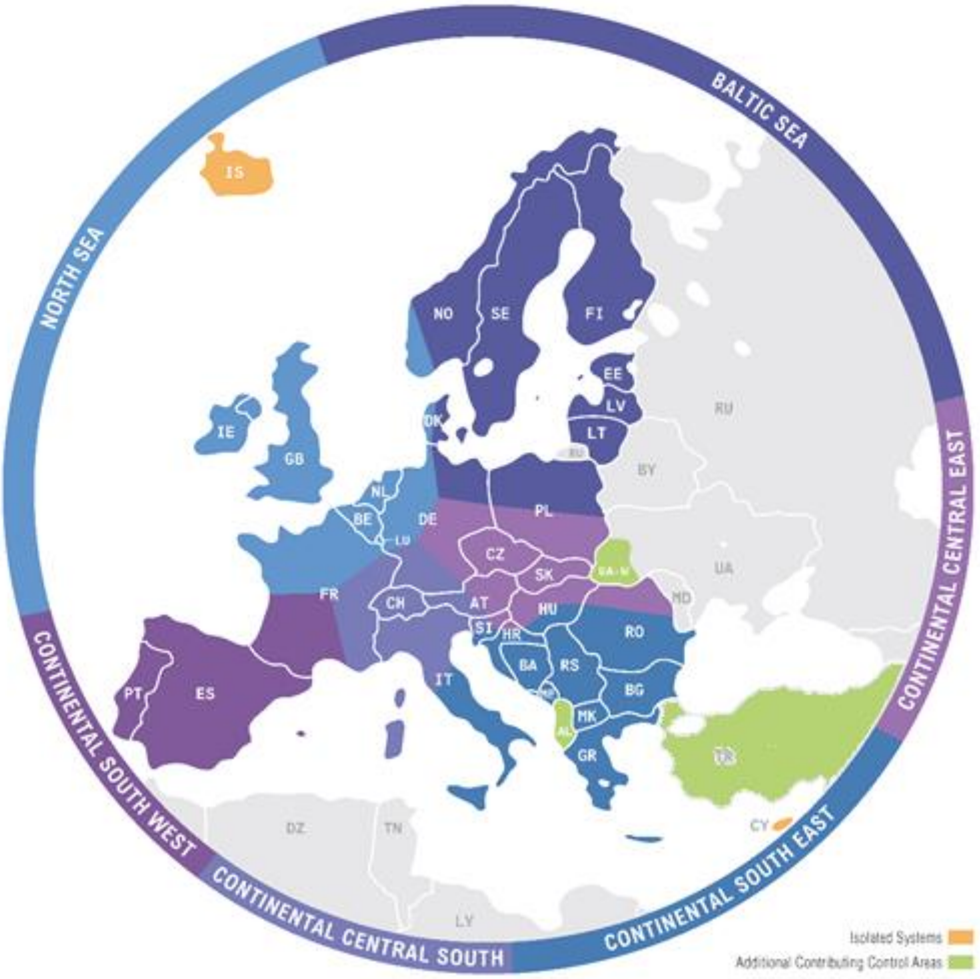


Figure 1-1 ENTSO-E System Development Regions

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

The Continental South East (CSE) region covers the Balkan area and Italy. The Regional Group CSE comprises the TSOs of Bosnia-Herzegovina (BA), Bulgaria (BG), Croatia (HR), Cyprus (CY), Greece (GR), Hungary (HU), FYR of Macedonia (MK), Montenegro (ME), Romania (RO), Serbia (RS) and Slovenia (SI).

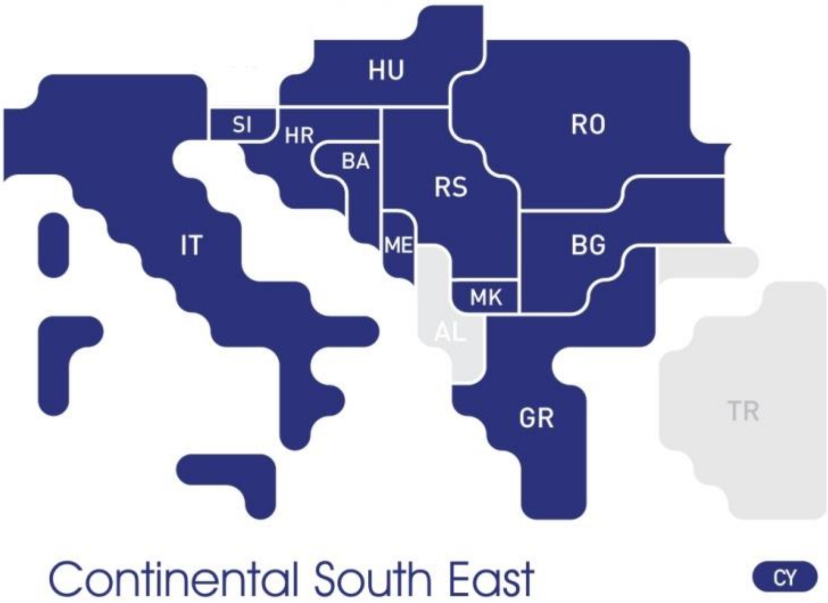


Figure 1-2 CSE region

Although Albania (AL) and Turkey (TR) are not ENTSO-E members these systems are connected to the Continental Europe Synchronous Area (CESA) system in parallel synchronous operation; As such, the systems of AL and TR are considered in the planning procedures of RG CSE: AL is fully modelled as well as the European part of the Turkish system.

In RG CSE participate a large number of non-EU countries; nevertheless, the vast majority of them follow the European legislation.

Although RG CSE covers a quite extended geographical area, it represents about 16% of the total electricity generation of ENTSOE area[1].

[1] http://ec.europa.eu/eurostat/tgm/download.do?tab=table&plugin=1&language=en&pcode=ten00087

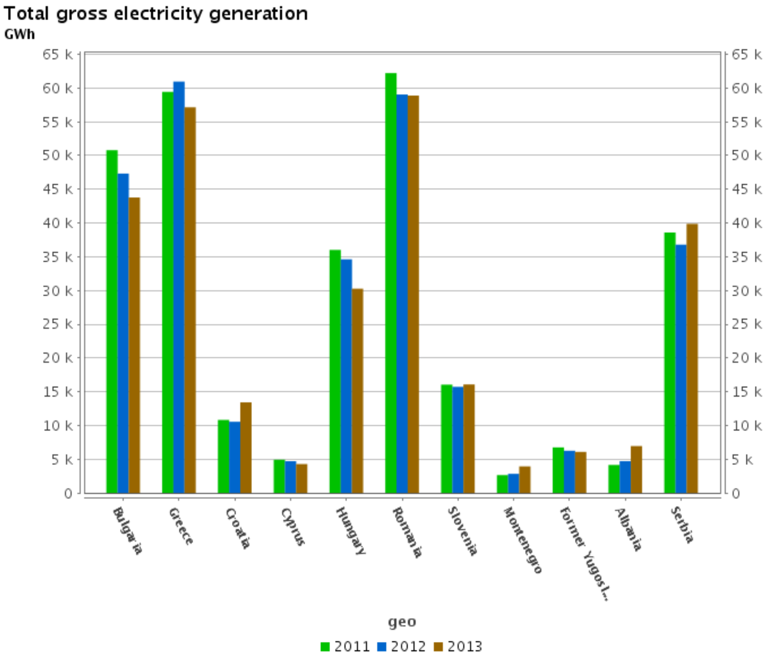


Figure 1-3 Gross electricity generation

Chart 1: Total gross electricity generation [GWh]

(Covers gross electricity generation in all types of power plants)

Source of Data: Eurostat

Considering joint operation of the Albanian and one part (European part) of the Turkish grid with the CSE grid, the CSE region considers including them in the regional model. Cyprus (CY) is an isolated system not currently electrically connected to the CESA (Continental Europe Synchronous Area) system.

The transmission system of the CSE Region of ENTSO-E (especially the Balkan Region) is a rather sparse network with predominant power flows from East to West (E->W) and North to South (N->S). Figure 1 shows the bulk power flows in Vision 4 where the arrows depict the predominant power flow directions and the relevant labels the maximum power/average power/hours.

Figure 1-4 Illustrative Bulk power flows in Vision 4 (ref. year 2030)

Due to the sparsity of the network, the transfer capacities among CSE countries are rather limited. Figure 2 illustrates the NTCs is the region.

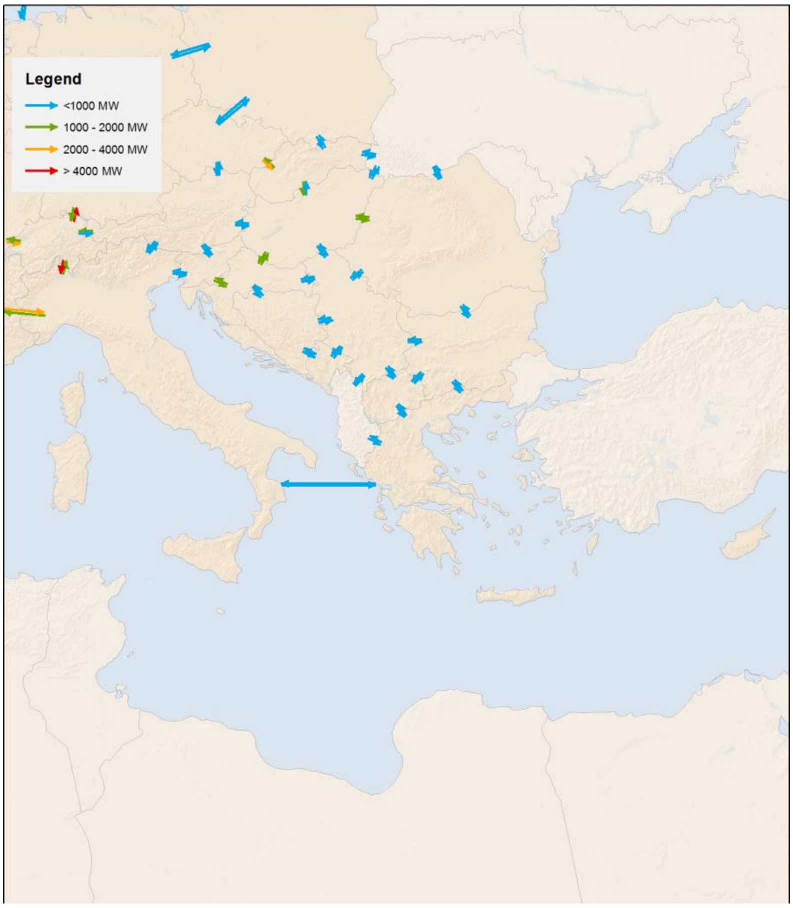


Figure 1-5 Illustration of Net Transfer Capacities in CSE region (2013)

The volume of electricity market exchanges during the last years is rather moderate compared to the rest of Europe. This is due to the small size of the power systems comprising the area and also its peripheral location within Europe.

Concerning the generation mix, thermal production has the largest share with a significant portion of lignite units as well as significant hydro capacity. Development of RES today is limited with the exception of Greece, Romania and Bulgaria.

The current RgIP for RG CSE comprises results and findings already reported in the TYNDP2014 and the relevant RgIP 2014 and the main findings of the Common Planning Study (CPS) for the region. The CPS was a necessary step for the efficient transmission planning of the region and important findings came out: compared to the projects included in the TYNDP2014, new needs were detected and some new candidate projects to further strengthen the major North to South and East to West corridors have been determined and proposed to be added to the RgIP and to be assessed in the view of the TYNDP2016.

The TYNDP 2014 projects have been explicitly reconfirmed by the relevant TSOs to be included in the TYNDP2016 as well.

On top of the projects included in TYNDP2014, the following new candidate transmission projects have been proposed to be assessed in the next TYNDP 2016, based on the results of common planning studies performed in the CSE Region:

- BG-GR border: a new 400 kV overhead line Maritsa East 1 (BG) – Nea Santa (GR)
- HR-RS border: a new 400 kV overhead line Sombor (RS) – Ernestinovo (HR)
- BG-RS border: a new double 400 kV overhead line
- RO-RS border: upgrading existing single to double 400 kV overhead line
- HR-BA border: upgrading of existing 220kV lines between substation Dakovo (HR) and substation Tuzla/Gradacac (BA) to 400kV lines
- 2 internal RS projects:
    - One project will close the 400 kV ring around region of Belgrade;
    - One project will upgrade network in Central Serbia from 220 kV to 400 kV voltage level.

As resulted by all studies performed so far, for the vast majority of the visions analysed, for the study horizon 2030 the predominant power flow directions from East to West (E->W) and North to South (N->S) still prevail.

Figure 1-6 Predominant power flow directions

As CSE region is located at the edge of the CESA system, it is significantly affected by the foreseen extensions of the Entso-e system to the east and south. Such extensions, already under consideration, include the connection of Ukrania (UA) and Moldova (MD) to the east but also Cyprus (CY) and further to Israel (IL) to the South. The recent connection of the Turkish system has also a significant influence to the SE Balkan system. Although these future connections have not been analysed in detail, it is obvious that the predominant flows (N->S and E->W) will still prevail and the need for further strengthening the East to West and North to South corridors within the region will be increased.

The drivers for transmission system development directly derive from the EU energy policy goals, i.e. the security of supply, the integration of the internal electricity market and the climate change mitigation through the wide exploitation of RES and the improvement of the efficiency in the electricity sector.

Under this framework, the main drivers of grid development in the CSE region can be briefly summarized to the following:

- Increase of Transfer Capacities and Market Integration facilitation: The grid in the CSE region is rather sparse compared to the rest of the continent. This leads to insufficient transfer capacities; the increase of existing transfer capacities (both cross-border and internal) is a prerequisite for the market integration in the region. Also, the price difference between the Balkan region and Italy comprises a major driver to increase the transfer capacities to Italy through undersea links across the Adriatic Sea and the SI-IT borders.

- Massive RES integration: The exploitation of RES in the Region is lacking (except GR, BG, RO). The anticipated largest RES integration (mainly wind, PV and hydro) in the region in order to achieve EU and National targets require extensive grid developments.

- Evacuation of future conventional generation mostly in the West part of the Region.

Table 1-1 Cross border capacities

Border	Initial cross border capacity	Cross border capacity increase
BG-GR	1400	1500
GR-MK	1400	500
HR-RS	450	500
BA-HR	500	500
GR-AL	250	500
RO-RS	1400	500
BG-MK	800	500
BG-RS	1100	500

The above table presents the required increase of target cross border capacities among the TSOs of the region according to the CPS results.

Although the NTCs among TSOs is limited, most of the countries already fulfill the Barcelona criteria.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

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 ENTSOE interconnected power system on mid- and long-term time horizons.
- The **Cost Benefit Analysis Methodology (CBA)** as developed by ENTSO-E and adopted by the EC, allows the assessment of infrastructure projects in an objective, transparent and economically sound manner against a series of indicators which range from market integration, security of supply, integration of renewable energy sources (RES-E) to environmental impact.

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

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

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

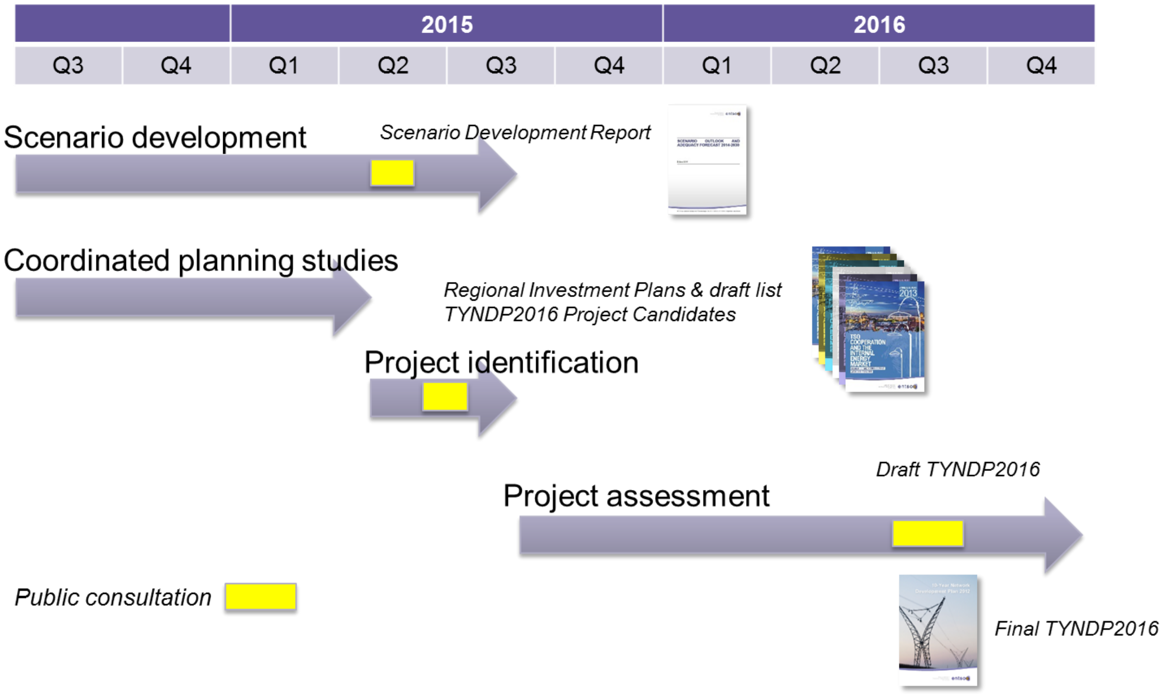


Figure 2-1 Overview of a two-year TYNDP process

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

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

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

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

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

2.2 The scope of the report

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

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

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

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

2.3 General methodology

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

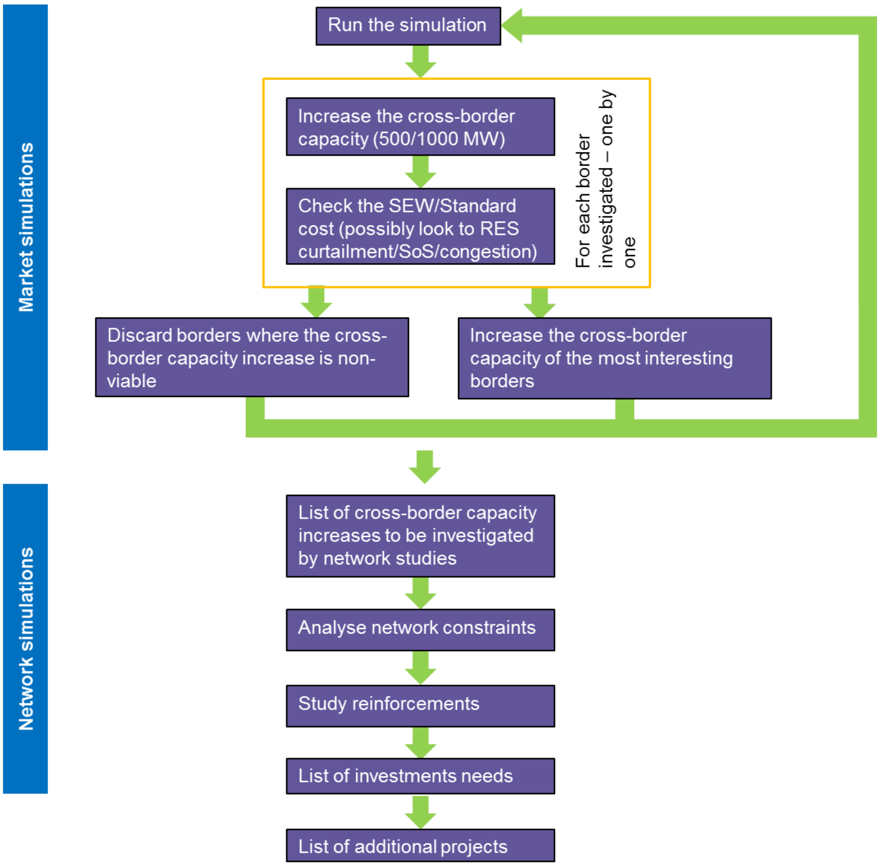


Figure 2-2 Common Planning Study workflow

Market Studies

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

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

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

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

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.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

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.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

3 REGIONAL CONTEXT

3.1 Present situation

The Continental South East Region (CSE) comprises the following countries: Bosnia-Herzegovina, Bulgaria, Croatia, Greece, Hungary, Italy, FYR of Macedonia, Montenegro, Romania, Serbia and Slovenia. In the following figures the current installed capacity, as well as the generation mix of the Region is shown:

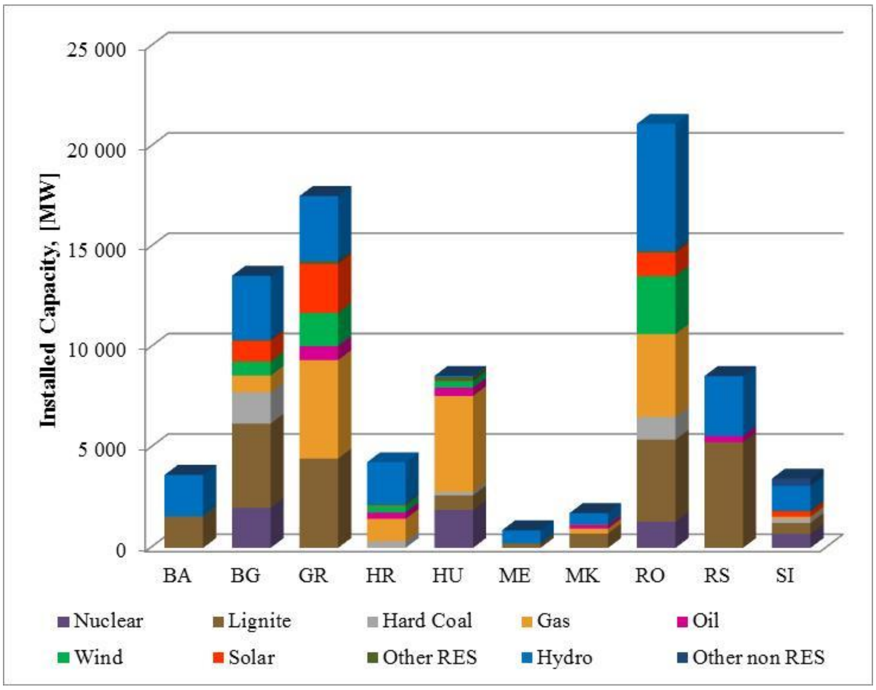


Figure 3-1 Installed Capacities, RG CSE - 2014

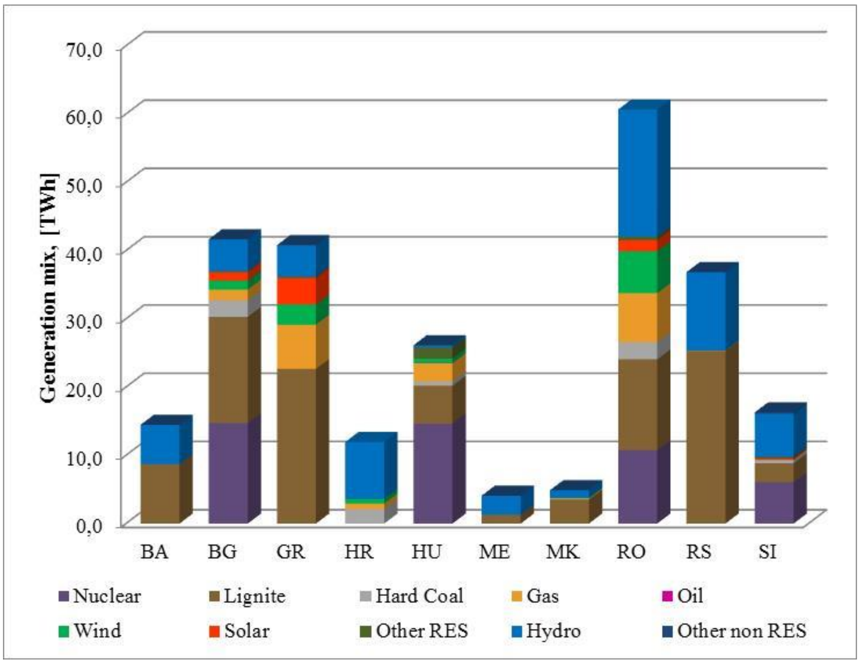


Figure 3-2 Generation Mix, RG CSE - 2014

The power system of the Region is dominated by coal (especially lignite), followed by hydropower. Most of the high lignite's share in the regional generation mix comes from RS, GR, BG, RO, BA, while the highest hydropower generation comes from RO, RS, HR and BA.
The nuclear power plants, with only 7 % share in the total installed capacity of the region, stands for about 18 % of the yearly generation. The nuclear power plants are located in BG, RO, HU and SI.
The power balance in the region was negative in 2014, while the main importers were HU, GR, HR and the exporters BG and RO, followed by BA and SI.
The current level of Net Transfer Capacities (NTC) in the region is illustrated in the Figure 3-3:

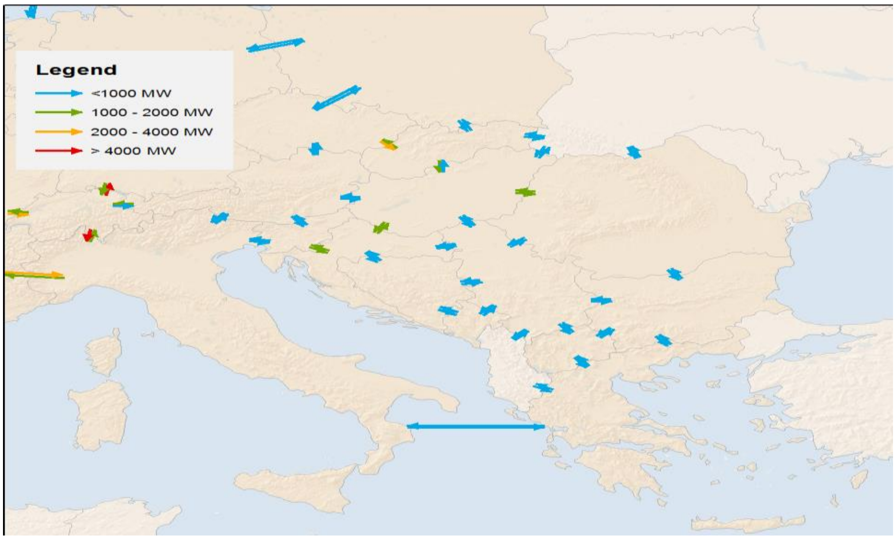


Figure 3-3 Illustration of Net Transfer Capacities in CSE region (2013)

The NTC is the maximum total exchange program between two adjacent control areas that is compatible with security standards and applicable in all control areas of the synchronous area, whilst taking into account the technical uncertainties on future network conditions.

It is to be mentioned that the NTC values for the same border and the same grid components change during the year, depending on the topology of the network, the generation and load pattern at a specific point in time.

3.2 Main drivers

The drivers for transmission system development directly derive from the EU energy policy goals, i.e. the security of supply, the integration of the internal electricity market and the climate change mitigation through the wide exploitation of RES and the improvement of the efficiency in the electricity sector.

Recent developments in the sector, such as implementation of market mechanisms and integration of renewable generation on a large scale, have already significantly changed system operation conditions in Europe.

Transmission system development is a major step towards the achievement of Pan-European and regional targets especially for the peripheral regions of Europe, particularly for those not sufficiently interconnected to the Central Europe, as is the case of the Balkan Peninsula, which has a rather spare network with limited cross-border and internal transfer capacities.

Under this framework, the main drivers of grid development in the Continental South East region can be briefly summarized to the following:

- Increase of Transfer Capacities: The grid in the CSE region is rather sparse compared to the rest of the continent. This leads to insufficient transfer capacities; the increase of existing transfer capacities (both cross-border and internal) is a prerequisite for the market integration in the region. Also, the price difference between the Balkan region and Italy comprises a major driver to increase the transfer capacities to Italy through undersea links across the Adriatic Sea and the SI-IT borders.

- Massive RES integration: The exploitation of RES in the Region is lacking (except GR, BG, RO). The anticipated largest RES integration (mainly wind, PV and hydro) in the region in order to achieve EU and National targets require extensive grid developments; a large amount of wind farms are expected in Greece and at the East coastal areas as well as at the West borders of Bulgaria and Romania leading to specific projects to evacuate future wind generation. Specific grid reinforcement have been also planned to evacuate hydro power from the West Balkan region (especially Serbia). Figure 3-4 presents the anticipated evolution in RES installed capacity in comparison with the situation at the end of 2012 (according to the Yearly Statistics and Adequacy Retrospect 2012); it is worth to notice the high gap between the current and the target values for each vision.

- Evacuation of future conventional generation mostly in the West part of the Region.

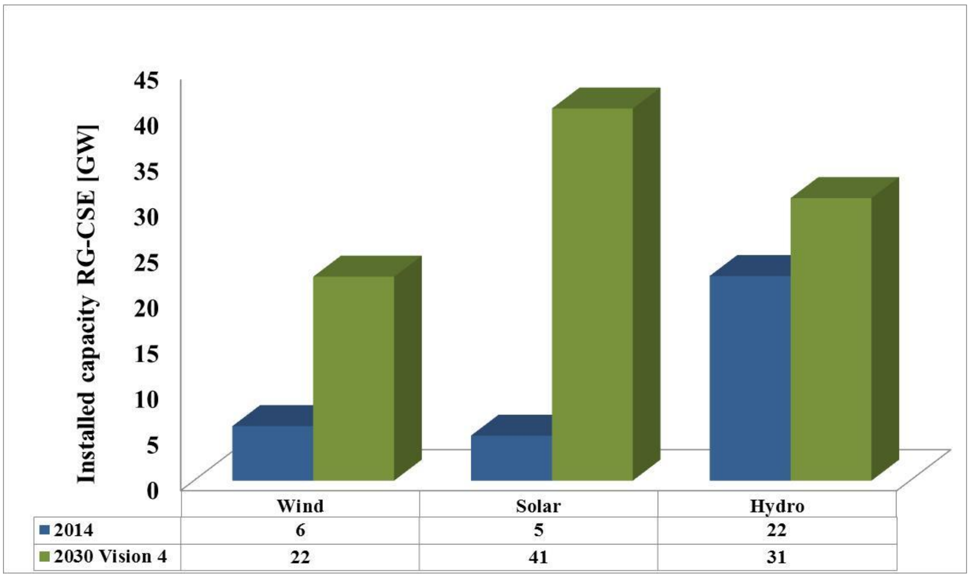


Figure 3-4 Expected evolution of RES penetration by 2030

3.3 Main Bottlenecks

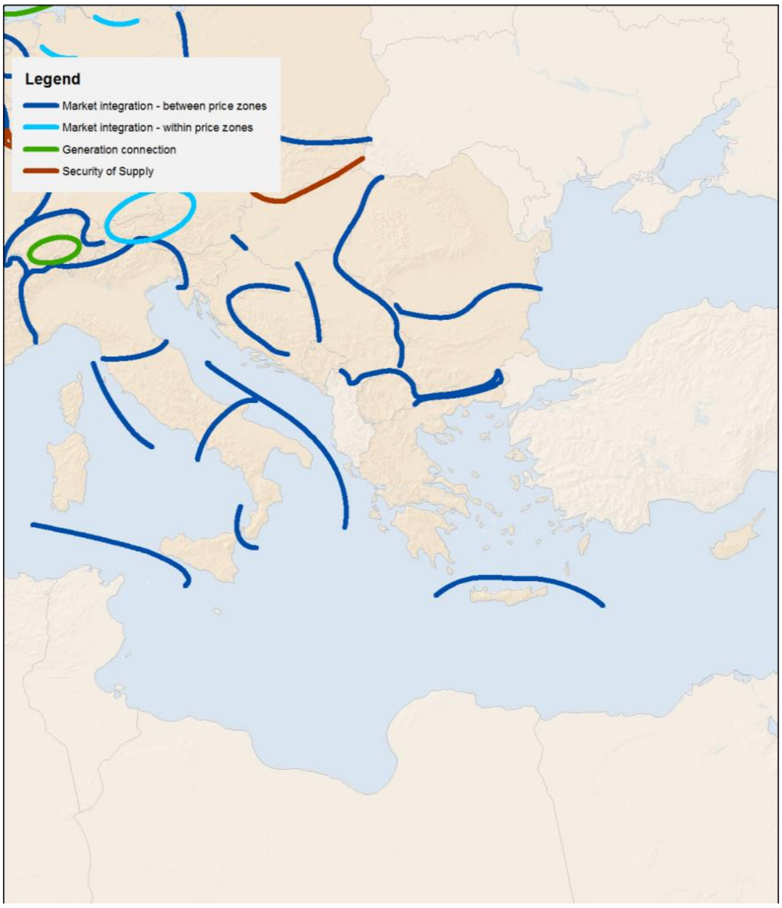


Figure 3-5 Map with remaining bottlenecks in the region

As a result of the market and network study process, several potential bottlenecks have been identified for the regional electricity system of the SE Europe in the coming decade (unless new transmission assets are developed). Figure 3-5 shows their location, i.e. the grid sections (the “boundaries”), the transfer capability of which may not be large enough to accommodate the likely power flows that will need to cross them unless new transmission assets are developed.

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

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

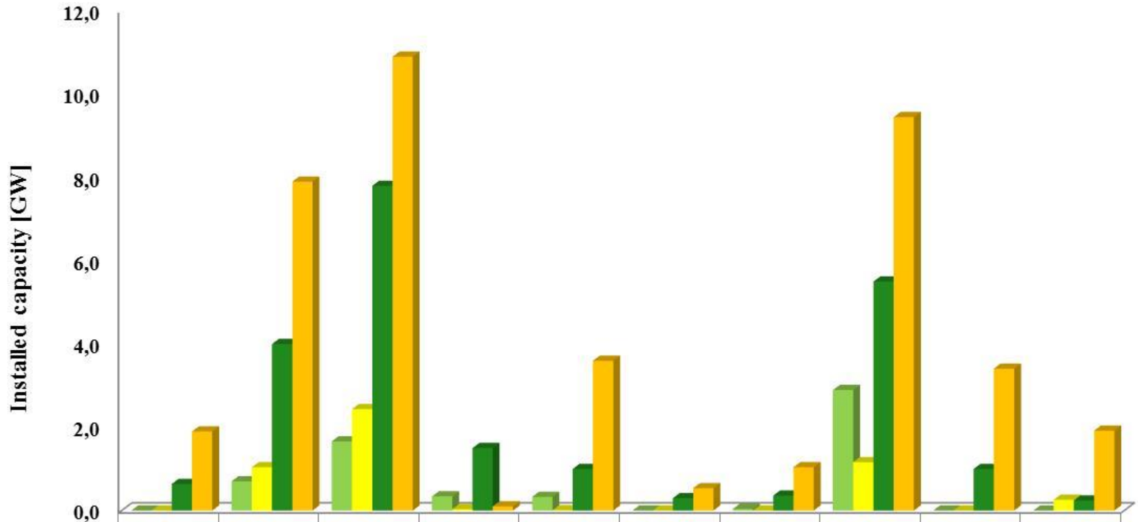
As can be seen in Figure 3-5 most of the boundaries identified in the CSE Region are marked as relevant to market integration issue. However, as will be explained later, there are cases where direct connection of generation is also a concern that may stimulate the need of increasing transmission capacity in the specific locations.

4 REGIONAL RESULTS

4.1 Description of the scenarios

The analysis was conducted for the pan-European top down Green Revolution scenario from TYNDP2014 (Vision 4) with very high renewable energy sources penetration, as *Reference* for the year 2030, in order to identify the optimal grid development to accommodate the high level of RES, in a reliable and cost-efficient way.

The huge increase of the solar and wind installed capacities in the region (especially in GR, RO and BG) foreseen in this scenario, compared to the current levels, is reflected in Figure 4-1.



	BA	BG	GR	HR	HU	ME	MK	RO	RS	SI
Wind, 2014	0,0	0,7	1,7	0,3	0,3	0,0	0,0	2,9	0,0	0,0
Solar, 2014	0,0	1,0	2,4	0,0	0,0	0,0	0,0	1,2	0,0	0,3
Wind, 2030	0,6	4,0	7,8	1,5	1,0	0,3	0,4	5,5	1,0	0,2
Solar, 2030	1,9	7,9	10,9	0,1	3,6	0,5	1,0	9,5	3,4	1,9

Figure 4-1 Installed capacity

RG CSE captured the entire Balkan region in the market study, including the Albanian power system, and analysed all the possible interconnections in the region, existing and potential ones.

Due to the massive RES development in this Vision and the correspondent high increase of the renewable electricity generation and the more volatile power flows in the region, new increases in cross-border transmission capacity, additional to those presented in RgIP2014, could be beneficial.

No other sensitivity analyses were conducted, assuming that the regional project portfolio resulted on the basis of this *Reference Scenario* is sufficient to accommodate any further grid development required for the 2030 horizon, as a step toward the 2050 horizon.

Figure 4-2 and Figure 4-3 depict the installed generation capacity per fuel type and, respectively, the annual demand and produced energy, for each country of the region, in the *Reference Scenario – Base Case* (before the iterations for border capacities increase).

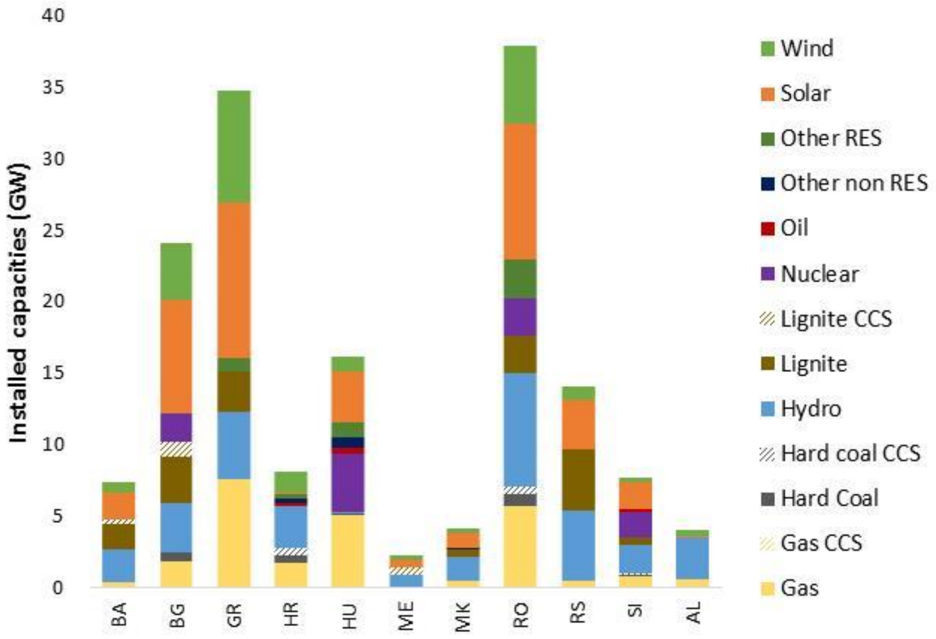


Figure 4-2 Installed capacity, RG CSE - in 2030 Vision 4 TYNDP2014

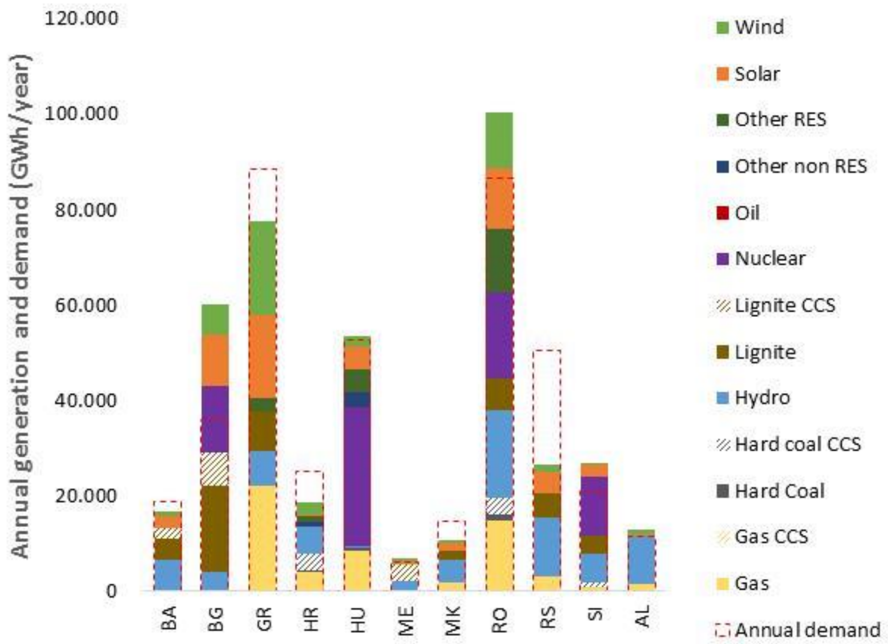


Figure 4-3 Demand and Generation per fuel type, RG CSE – in 2030 Vision 4 TYNDP2014 – base case

An important outcome of the market study for this Vision is that CSE Region is a net importer, with an annual energy balance of about -1.4 TWh in the *base case*. The main importers of the region are GR, RS, HR and MK, while the main exporters are BG, RO and SI.
The scenario is also characterized by the domination of the non CO_2 emitting generation in the region
Figure 4-4 depicts the yearly CO_2 emissions for the countries of the CSE Region as well as the annual average values of CO_2 emissions per GWh.

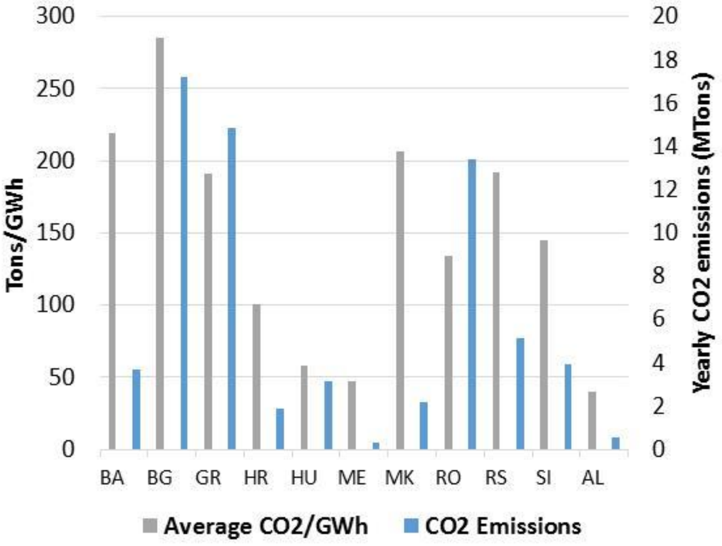


Figure 4-4 CO2 emissions

According to the common methodology developed, RG CSE analysed directly 19 borders between the countries in the region, the others being analysed jointly with other RGs: four with CCE (HR-HU, HR-SI, HU-RO, HU-SI) and three with CCS (ITS-ME, HR-ITS, ITN-SI).

Table 4-1 List of borders analysed within RG CSE in the iteration process

Border	Country A	code country A	Neighbours (land) or (sea)	code country B
BA-HR	Bosnia&Herzegovina	BA	Croatia	HR
BA-ME	Bosnia&Herzegovina	BA	Montenegro	ME
BA-RS	Bosnia&Herzegovina	BA	Serbia	RS
BG-GR	Bulgaria	BG	Greece	GR
BG-MK	Bulgaria	BG	FYR of Macedonia	MK
BG-RO	Bulgaria	BG	Romania	RO
BG-RS	Bulgaria	BG	Serbia	RS
GR-AL	Greece	GR	Albania	AL
GR-ITS	Greece	GR	Italy South	ITS
GR-MK	Greece	GR	FYR of Macedonia	MK
HR-ME	Croatia	HR	Montenegro	ME
HR-RS	Croatia	HR	Serbia	RS
HU-RS	Hungary	HU	Serbia	RS
ME-AL	Montenegro	ME	Albania	AL
ME-RS	Montenegro	ME	Serbia	RS
MK-AL	FYR of Macedonia	MK	Albania	AL
MK-RS	FYR of Macedonia	MK	Serbia	RS
RO-RS	Romania	RO	Serbia	RS
RS-AL	Serbia	RS	Albania	AL

4.2 Market results

On the basis of the four iterations performed under the framework of the Common Planning Studies for the *Reference scenario*, eight of the most beneficial borders within RG CSE have been identified, standing for a total of 5000 MW capacity increase in the region.

The main results are reported in the following Figure 4-5, while the detailed regional results of the four iteration loops are reported in section 7.2.

Border	Additional Interconnection Capacity [MW]
BA-HR	500
BA-ME	No additional capacity
BA-RS	No additional capacity
BG-GR	1500
BG-MK	500
BG-RO	No additional capacity
BG-RS	500
GR-AL	500
GR-ITS	No additional capacity
GR-MK	500
HR-ME	No additional capacity
HR-RS	500
HU-RS	No additional capacity
ME-AL	No additional capacity
ME-RS	No additional capacity
MK-AL	No additional capacity
MK-RS	No additional capacity
RO-RS	500
RS-AL	No additional capacity

Figure 4-5 CPS final market results: Optimal interconnection capacity increase for RG CSE selected borders

Due to these additional interconnection capacities, the annual inter-area market exchanges in RG CSE significantly change from the *base case* to the *final case* (after iterations) of the CPS *Reference scenario*, as presented below.

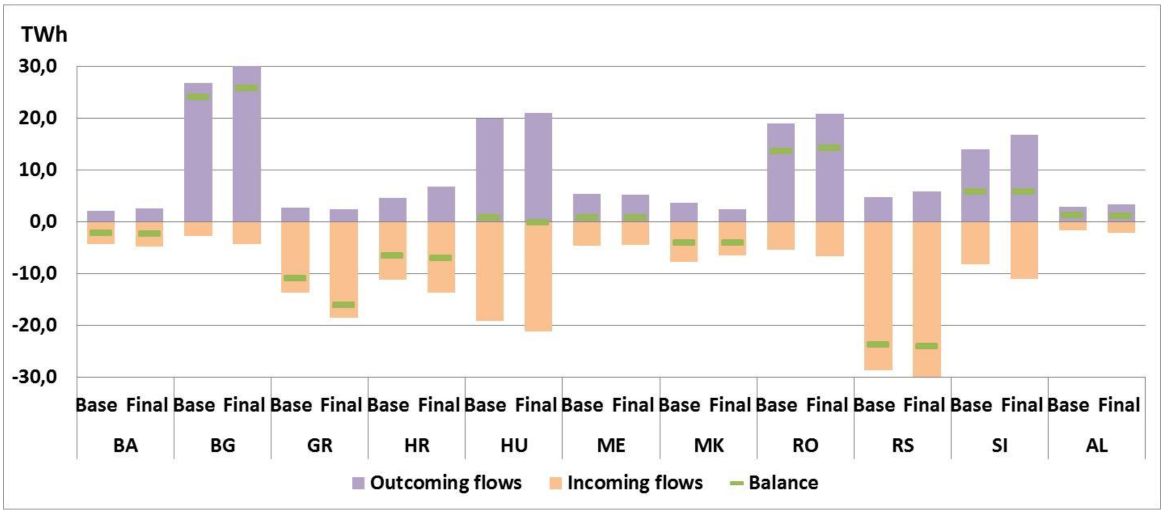


Figure 4-6 Annual inter-area flows in RG CSE

Positive value is corresponding to cumulated annual export and negative value to cumulated annual import. It is to be mentioned that about 2 TWh of the total net import of the Region represent the fixed net exchanges with non-ENTSO-E countries.

4.3 Network results

In the framework of the CPS in RG CSE in Vision 4 from TYNDP2014, and based on market simulations, screenshots were made for all hours in the year 2030 and load flow calculations were carried out on them (year round calculation). The results of power flow calculations on the Vision 4 of TYNDP2014, which can be defined as extreme vision for the CSE region, showed that the network in CSE is heavily loaded, even in base case. In base case overloads are seen 27% of the time. Furthermore, 70% of the time several lines are highly loaded in the CSE network. The reason for such a high loading of the transmission network in the CSE region is, as fore mentioned, the extreme scenario V4 TYNDP2014 used for the Common Planning Study simulations (high RES conditions top-down scenario)
In Figure 4-7, a map of bottlenecks in CSE in base cases in scenario V4 TYNDP2014 is shown. Lines with bottlenecks are marked with a red colour. Lines without overload are marked with a green colour.
Bearing in mind the extreme high installed capacity in the Power Systems (V4 TYNDP2014), only overloads of 400 kV transmission lines in base case were considered as triggers for investigation of potential new investment needs in the region. Overloads at 220 kV and possible overloads obtained through contingency analyses N-1 were interpreted as a local operational problems that could be solved by congestion management.
Histograms of most loaded interconnection (Table 4-2) and internal lines (Table 4-3) with the number of hours with overloading are available.

Table 4-2 shows that the most loaded interconnection line is between Serbia and Bulgaria. Next to this, significantly loaded lines are mainly located between Serbia and Romania, Bulgaria and Macedonia, Bulgaria and Greece. An explanation of these results lays in the fact that in V4 TYNDP2014 Bulgaria and Romania are significant exporters of electricity while Serbia, FYR of Macedonia and Greece are major importers. Serbia and FYR of Macedonia are importing in winter hours and in those hours specified overloads of lines appeared. Greece is a significant importer in the summer months and the problems of the interconnection line between Greece and Bulgaria could be expected in these hours.
Here it is necessary to underline that on the list of the most loaded borders in the region of CSE there are three borders which have only one interconnection line per border and that lines are overloaded in this scenario.

Table 4-3 shows the most loaded internal lines in CSE. It could be seen that problems in the base case could be expected on internal transmission lines in Romania, Serbia, Hungary, Greece and Slovenia.

Table 4-2 Histogram of the most loaded interconnection lines in CSE in V4 TYNDP2014

percent's range of loadings	OHL 400 kV Niš 2 (RS) - Sofia West (BG)	OHL 400 kV Djerdap 1 (RS) - Portile de Fier (RO)	OHL 400 kV Blagoevgrad (BG) - Thesalloniki (GR)	OHL 400 kV Melina (HR) - Divaca (SI)	OHL 400 kV Ceverna Mogila (BG) - Stip (MK)	OHL 400 kV Florina (GR) - Bitola 2 (MK)	OHL 400 kV Subotica 3 (RS) - Shandorfalva (HU)	OHL 400 kV Varna (BG) - Medigidia (RO)	OHL 400 kV Bekescsaba (HU) - Nadab (RO)
0 - 60	3252	6826	5301	7717	6342	7155	7002	8454	7594
60 - 80	1893	1163	1752	694	1897	1022	1402	248	730
80 - 100	1652	282	1242	265	469	543	317	30	407
100 - 120	1129	147	377	59	27	15	14	3	4
120 - 140	616	198	63	0	0	0	0	0	0
140 - 160	168	111	0	0	0	0	0	0	0
160 - 180	25	8	0	0	0	0	0	0	0
More	0	0	0	0	0	0	0	0	0

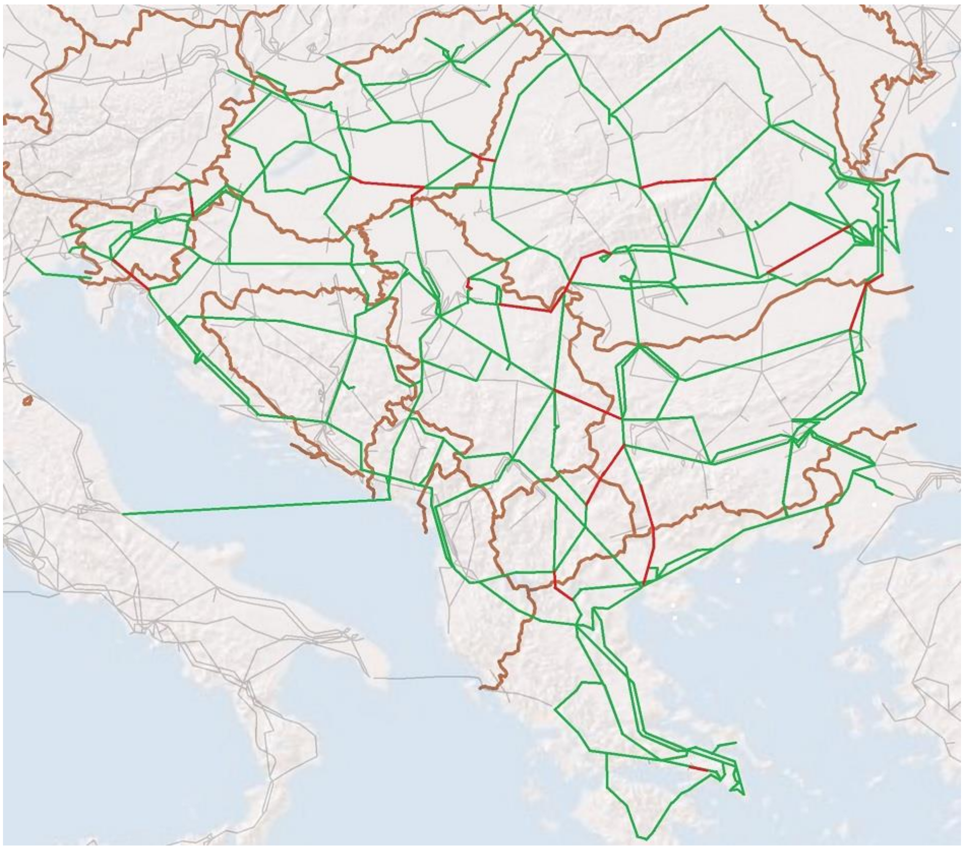


Figure 4-7 Map of bottlenecks in CSE in base cases for scenario V4 TYNDP2014

Table 4-3 Histogram of the most loaded internal lines in CSE in V4 TYNDP2014

percent's range of loadings	OHL 400 kV Paks (HU) - Sandorfalva (HU)	OHL 400 kV Djerdap 1 (RS) - RP Pozarevac (RS)	OHL 400 kV GKROUF11 (GR) -GKYTROUF12 (GR)	OHL 400 kV Maribor(SI) -Cirkovce (SI)	OHL 400 kV Urechesti (RO) -Portile de Fier (RO)	OHL 400 kV Bucuresti Sud (RO) -Gura Ialomitei (RO)	OHL 400 kV Braso (RO) -Sibiu (RO)	OHL 400 kV GKOUMO11 (GR) -GKYTROUF12 (GR)	OHL 400 kV Beograd 20 (RS) -Pancevo 2 (RS)
0 - 60	5626	5893	6628	5684	7194	7616	7935	7568	8212
60 - 80	1245	1808	1026	1995	1249	1028	656	892	473
80 - 100	965	815	956	1030	278	83	139	273	50
100 - 120	824	211	125	26	14	8	4	2	0
120 - 140	75	8	0	0	0	0	1	0	0
140 - 160	0	0	0	0	0	0	0	0	0
160 - 180	0	0	0	0	0	0	0	0	0
More	0	0	0	0	0	0	0	0	0

In order to answer the overloads occurring in analyzed scenario (V4 TYNDP2014) the representatives of CSE TSOs agreed on a list of new projects.

- Lines overload at the borders between Bulgaria and Serbia, Bulgaria and FYR of Macedonia, as well as Romania and Serbia will be solved with two new projects: double 400 kV OHL Sofia West (BG) - Nis 2 (RS) and the doubling of the existing 400 kV Djerdap 1 (RS) - Portile de Fier (RO).
- Constraints on the transmission line on the border between Bulgaria and Greece, which is observed on the future 400 kV Maritsa East (BG) - Nea Santa (GR) will be solved by doubling that transmission line.
- Overload at the border between Romania and Hungary will be solved by building a new 400 kV OHL Debrecen (HU) - Oradea (RO).
- Furthermore, market simulation results shown the need to increase the capacity on the borders between Serbia and Croatia as well as between Croatia and Bosnia-Herzegovina. Accordingly, the following projects were agreed:
    - New OHL 400 kV Ernestinovo (HR) - Sombor 3 (RS), which at the same time will resolve the overloads on the 400 kV Sandorfalva (HU) - Subotica 3 (RS) and on the internal 400 kV Paks (HU) - Sandorfalva (HU).
    - Upgrade of the existing 220kV lines between substation Dakovo (HR) and substation Tuzla/Gradacac (BA) to 400kV lines

In order to support increase of cross-border capacity, and at the same time, according to the national needs for upgrading the existing 220 kV network to 400 kV level, two internal projects were nominated in Serbia.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

- The first project consists in upgrading the existing 220 kV voltage network in central Serbia to 400 kV voltage level. This project is directly related to increasing the cross border capacity between Serbia and Bulgaria as well as increasing the cross border capacity between Serbia and Montenegro and Serbian and Bosnia-Herzegovina. The project thus built a totally new East to West corridor in CSE region, that will increase the potential of electricity transit on the corridor East-West from Bulgaria and Turkey towards Italy, Montenegro, Bosnia-Herzegovina.
- The second internal project in Serbia consists in closing the 400 kV ring around the city of Belgrade. This project resolves overloads that were noticed on the OHL 400 kV Pancevo 2 (RS) - Belgrade 20 (RS) in Common planning studies. Besides, it allows the transit of electricity from the exporter Romania towards importers Croatia and Italy, thus strengthening CSE corridors North to South as well as East to West (Serbia has eight borders and is located in the heart of CSE region).

The rest overloads in internal networks of Romania, Greece and Slovenia could be resolved by congestion management measures like changing topology, redispatch, etc.

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...).

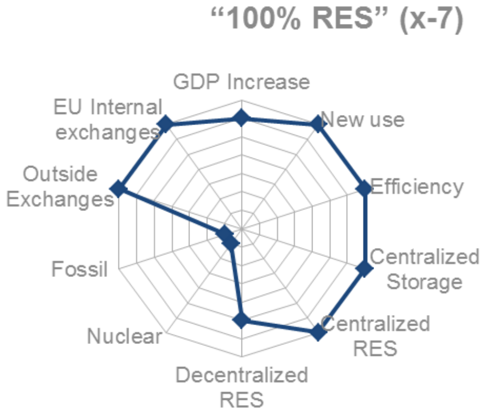


Figure 4-8 - Example of scenario characteristics

The methodology used in the e-Highway project, though different from the TYNDP planning, is still built around 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 4-9 - 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.

E-Highway2050 results show that North-South corridors play a major role in all scenarios.

Regarding CSE region, it is interesting to highlight the following results of EH2050 project:

- reinforcements of corridor from North to South of CSE region (**Large Scale RES**: Hungary/Croatia – Serbia – FYROM – Greece, **100% RES**: Bulgaria – Greece, **Small & Local**: Hungary/Croatia – Serbia and Bulgaria - Greece);
- reinforcements of corridor from East to West of CSE region (**Large Scale RES**: Greece - Italy, Montenegro – Italy and Romania – Hungary, **100% RES**: Greece - Italy, Montenegro – Italy and Romania – Hungary, **Big & Market**: Greece - Italy, **Fossil & Nuclear**: Greece - Italy, Bulgaria – Serbia and Romania – Hungary, **Small & Local**: Greece - Italy);

Concerning CSE RgIP2015 projects, the following reinforcement corridors are proposed, in line with E-Highway2050 finding (additional transmission capacity till 2030 on possible path to 2050):

- East to West and all along CSE region (Balkan area) ending in Italy;

- North to South – straightening of the existing congested corridors;

It can be underlined that CSE RG, in its investigations and sensitivity analysis, took into account existing AC connection of the Turkish power system with the rest of the Continental European power systems, what even more brought to attention the necessity of strengthening East to West corridor in this Region.

The modelization of the market and network for EH2050 project considered a quite simplified system for Turkey (one node for all Middle East area) as well as for Ukraine-West. Moldavia was not integrated in the model. ENTSOE Eastern neighbor countries as Turkey, Ukraine-West and Moldova have indeed a crucial and incresing importance for the Region CSE. It can be noted that Turkey is currently in the status of observer of ENTSO-E. Furthermore, ENTSO-E is involved in a Feasibility study regarding full AC interconnection of respectively Ukraine-West and Moldavia with the rest of the Continental European power system is under preparation, supported and financed by the European Commission.

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

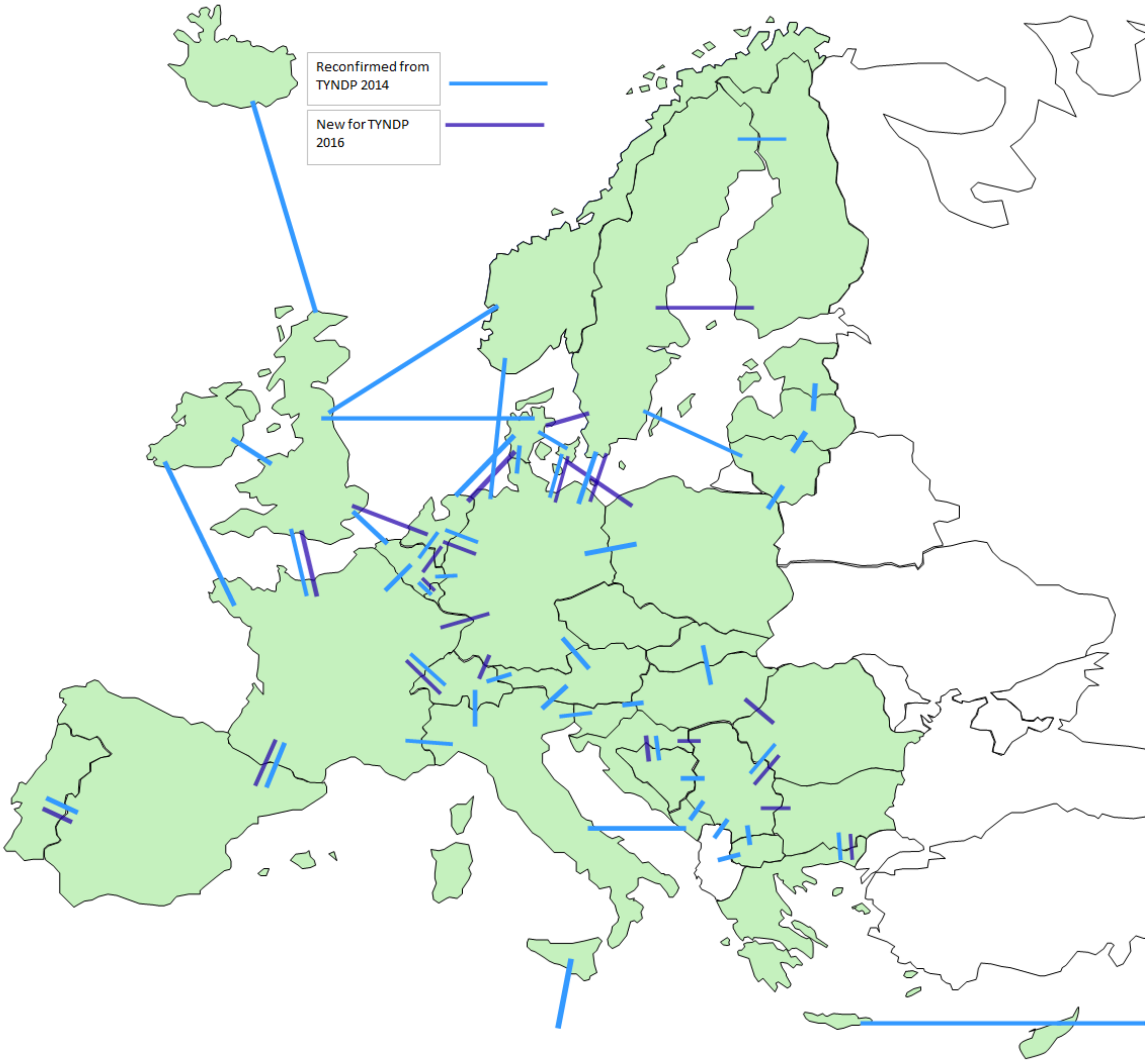


Figure 5-1 Borders with reconfirmed or new projects for TYNDP2016 assessment

5.2 List of projects for TYNDP2016 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)
Bulgaria - Greece	279	Third interconnector between Bulgaria and Greece	The new project concerns the construction of a new 400kV overhead line between the substations Nea Santa (GR)-Maritsa East 1 (BG).	500	The project necessity stems from the need to increase the transfer capacity between Greece and Bulgaria in order to accomodate connection of RES and improve market integration, according to the results by the Common Planning Studies based on TYNDP2014 Vision 4.		2030	Future Project	IPTO;ESO EAD
Bulgaria - Serbia	277	New double 400 kV interconnection line between Bulgaria and Serbia	New double 400 kV interconnection line between Bulgaria and Serbia	800	Market integration and RES connection	The project necessity stems for the need to increase the transfer capacity between RS and BG in order to accomodate connection of RES and market integration, according to the results by the Common Planning Studies based on TYNDP2014 Vision 4.	>2030	Future Project	ESO EAD;JP EMS

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)
Croatia - Bosnia Herzegovina	241	Upgrading of existing 220 kV lines between HR and BA to 400 kV lines	Upgrading of existing 220 kV lines between SS Đakovo (HR) and SS Tuzla/Gradačac (BA) to 400 kV lines.	500	The project necessity stems for the need to increase the target transfer capacity between HR and BA in order to accommodate exploitation of RES and market integration, according to the results by the Common Planning Studies based on TYNDP2014 Vision 4.	Common Planning Studies	2030	Long-term Project	HOPS;NOS BiH
Croatia - Serbia	243	New 400 kV interconnection line between Serbia and Croatia	Construction of new 400 kV interconnection line Sombor (RS) - Ernestinovo (HR)	500	Market integration and Security of supply	The project necessity stems for the need to increase the transfer capacity between RS and HR in order to accommodate connection of RES and improve market integration, according to the results by the Common Planning Studies based on TYNDP2014 Vision 4.	2030	Future Project	HOPS;JP EMS
Cyprus - Greece - Israel	219	EuroAsia Interconnector	The Euro Asia Interconnector consists of a 400 kV DC underwater electric cable and any essential equipment and/or installation for interconnecting the Cypriot, Israeli and the Greek transmission networks (offshore). The Interconnector will have a capacity of 2000 MW and a total length of around 820 nautical miles/around 1518 km (approx. 329 km between CY and IL, 879 km between CY and Crete and 310 km between Crete and Athens) and allow for reverse transmission of electricity	2000	219	(tbc)	PCI 3.10.1 12/2019, PCI 3.10.2 12/2022, PCI 3.10.3 12/2020	Mid-term project	EuroAsia Interconnector

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)
East-West	144	Mid Continental East corridor	The project consists of one double circuit 400 kV line between Serbia and Romania and reinforcement of the network along the western border in Romania: one new simple circuit 400 kV line from Portile de Fier to Resita and upgrade from 220 kV double circuit to 400 kV double circuit of the axis between Resita and Arad, including upgrade to 400 kV of three substations along this path. The project aims at enhancing the transmission capacity along the East-West corridor in south-eastern and central Europe. It will provide access to the market for more than 1000 MW installed new wind generation in Banat area (Serbia and Romania).	Direction A: 737 - Direction B: 453	144	The project enhances the transmission capacity along the East-West corridor in the South-Eastern and Central Europe.	2022	Mid-term Project	TRANSELECTRICA; EMS
East-West	146	CSE8 Transbalkan Corridor	The project aim is to increase transmission capacity and facilitate exchange of energy between north-east part of Europe and south-west of Europe.	1095	146		2018	Mid-term Project	CGES;EMS;NOS-BIH
Hungary - Slovenia	141	CSE3	The project consists of a new double circuit 400 kV line Cirkovce-Pince and a new 400 kV Cirkovce substation (Slovenia) by which a new connection to one circuit of the existing double circuit interconnection line between Hungary and Croatia will be made, thus creating two new cross border interconnection between Slovenia and Hungary and between Slovenia and Croatia. Existing 220 kV lines of the corridor Cirkovce-Divaca will be upgraded to 400 kV level.	HU->SI: 1700 - SI->HU: 2000	141		2021	Mid-term Project	ELES;MAVIR
inside-outside	227	CSE8 Transbalkan Corridor	The project aim is to increase transmission capacity within Serbia and facilitate exchange of energy between north-east part of Europe and south-west of Europe.	300	227		2022	Mid-term project	EMS

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)
Italy - Montenegro	28	Italy-Montenegro	The Italy-Montenegro interconnection project includes a new HVDC subsea cable between Villanova (Italy) and Lastva (Montenegro) and the DC converter stations.The HVDC link between Italy and Balkans is strictly correlated with the Transbalkan Corridor (projects 146 and 227) and the Mid Continental East Corridor (project 144).	1200	28	The project has a significant cross border impact, because it makes possible to increase the use of existing and future interconnections all along the corridor between Italy and Continental East Europe including the Member States Romania and Bulgaria; it helps to use most efficient generation capacity; enables possible mutual support of Italian and Balkan power systems; contributes to RES integration in the European interconnected system by improving cross border exchanges. Such benefits are ensured within different future scenarios.	2019	Mid-term Project	CGES;TERNA
Italy - Tunisia	29	Italy-Tunisia	The project consists in a new interconnection between Tunisia and Sicily to be realized through an HVDC submarine cable. The realization of the project is supported by the Italian and Tunisian Governments to increase the interconnection capacity of the Euro-Mediterranean system. Moreover, the project will contribute to reduce present and future limitations to the power exchanges on the northern Italian border under specific conditions, and therefore it will allow to significantly increase the transmission capacity and its exploitation by at least 500 MW on that boundary.	600	29	The project favours the use of the most efficient capacity in the PAN European interconnected system. The project also increases the system operational flexibility. Such benefits are ensured according to different future scenarios.	2021	Mid-term Project	TERNA

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	138	Black Sea Corridor	The project consists of one 400kV double circuit OHL Cernavoda-Stalpu and Gura Ialomitei, one 400 kV double circuit OHL Smardan-Gutinas and one 400 kV OHL single circuit Suceava – Gadalin, in Romania and also the new 400 kV OHL Dobrujda-Burgas in Bulgaria. This project allows transfer of generation from the Western cost of the Black Sea towards consumption and storage centers in Central Europe and South-Eastern Europe.	Direction A: 1260 - Direction B: 2196	138	The project reinforces the internal corridors in Romania and Bulgaria connecting the Black Sea Coast windy are to the rest of Europe, and also increases the cross-border tranfer capacity between Romania and Bulgaria.	2021	Mid-term Project	TRANSELECTRICA, ESO-EAD
North-South	142	CSE4	The project concerns the construction of new AC 400kV overhead lines at the south part of Bulgaria and a new AC 400kV interconnection between Bulgaria and Greece. This project will increase cross border transfer capacity between Bulgaria and Greece and contribute to the safe evacuation of renewable power in the area.	Direction A: 648 - Direction B: 82	142	This project will facilitate market integration by increasing the transfer capacity in the Bulgaria-Greece borders. It will also contribute to increase the volume of exchanges between the Continental Europe synchronous area and Turkey. Furthermore it will contribute to the safe evacuation of the power from the wind farms expected to be installed in the North-East part of Greece and the North-East of Bulgaria as well as photovoltaic power plants in the South part of Bulgaria. Mentioned project will be composed of a new 400kV AC interconnection between Bulgaria and Greece as well as two new 400kV OHL aiming at the strengthening of the transmission network at the South part of Bulgaria.	2021	Mid-term Project	ESO;IPTO-SA

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	147	CSE9	The project is comprised of investments in Serbia, FYR of Macedonia, Albania and Greece. These investments include new AC 400kV overhead lines and relevant substations. The project will increase transfer capacity in the predominant North-South direction of the CSE Region.	Direction A: 1157 - Direction B: 2709	147	The project aims to increase the transfer capacity in the predominant North-South direction that is from Romania, Serbia and Bulgaria towards Greece, FYR of Macedonia and Albania. In addition, a part of this project will increase the security of supply in the South-West part of the FYR of Macedonia. The investments forming the project are 400 kV lines and corresponding substations located in Greece, FYR of Macedonia, Serbia and Albania.	2020	Mid-term Project	EMS;IPTO-SA;MEPSO
Romania - Serbia	268	Upgrading existing single 400 kV interconnection line between Romania and Serbia to double 400 kV line	Upgrading existing single 400 kV interconnection line between Romania and Serbia to double 400 kV line	500	Market integration under high RES conditions	The project necessity stems for the need to increase the target transfer capacity between RS and RO in order to accommodate connection of RES and improve market integration, according to the results by the Common Planning Studies based on TYNDP2014 Vision 4.	>2030	Future Project	JP EMS;Transelectrica
Serbia internal	272	Network upgrade in Central Serbia from 220 kV to 400 kV voltage level	This project is linked with the new double 400 kV tie line between Bulgaria and Serbia project which is the outcome from Common Planning Studies during making RegIP2015. This project will increase transmission capacity in the East - West corridor (from Bulgaria and Turkey to West Balkan and Italy). With realization of this project an internal botlenecks in RS will be resolved which will have direct impact on increasing BTC values on the following borders: BG-RS, ME-RS and BA-RS.	500	Market integration		2030	Long-term Project	JP EMS

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)
Serbia internal	273	Closing of 400 kV ring around Belgrade region	This project will close the 400 kV ring around region of Belgrade. The project will increase transmission capability in the direction EAST - WEST and increase reliability of supply of Belgrade city. With realization of this project an internal bottlenecks in RS will be resolved which will have direct impact on increasing BTC values on the border RO-RS.	500	Market integration and Security of Supply	Common planning studies and internal network studies	2030	Long-term Project	JP EMS
West-East	136	CSE1	The project will contribute in strengthen Croatian transmission grid along its main north-south axis (in parallel with eastern Adriatic coast) allowing for additional long-distance power transfers (including cross border) from existing and new planned power plants (RES/wind/ and conventional/hydro and thermal/) in Croatia (coastal parts) and BiH to major consumption areas in Italy (through Slovenia) and north Croatia. The increased transfer capacity will support market integration (particularly between Croatia and Bosnia-Herzegovina) by improving security of supply (also for emergency situations), achieving higher diversity of supply&generation sources and routes, increasing resilience and flexibility of the transmission network.	Direction A: 612 - Direction B: 594	136		2022	Mid-term Project	HEP;NOS-BIH

In addition the following project(s), not matching the EC's draft guidelines, will be assessed in TYNDP2016:

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)
Greece	293	Southern Aegean Interconnector	The project refers to the construction of a submarine DC transmission link to connect the licensed RES plants (mentioned above) at the South Aegean Sea to mainland Greece and the islands of Crete, Kos and the Dodecanese. The capacity of the link will be 600-800MW both directions using HVDC (High Voltage Direct Current) technology. VSA conversion technology in conjunction with plastic (XLPE) cables will be used. The licensed RES projects consist of wind and solar power plants located on 23 small uninhabited islands. The link will be used for transmitting electricity from the RES plants mentioned above to the mainland and the island of Crete. More specifically, the power produced in each island will be transferred to the island of Levitha where the main conversion station will be built acting as a hub. These connections will be AC submarine cables (150 kV or 220 kV). The main link will be an HVDC link connecting the island of Levitha to both the metropolitan area of Athens and the island of Crete; the 400kV substation at Lavrion area will be the connection point in the Athens area and Korakia will be the connection point in Crete (located in the north coast). Both links will consist of two parallel cables in order to increase the reliability of each link; two converter stations are foreseen in Levitha and relevant converter stations in Lavrion and Korakia. Illustrative routing of the links is shown	600		(tbc)	2020	Future Project	Kykladika Meltemia SA

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)
			in the attached Entso-e map. The connection to Crete gives further possibilities for power transmission to Cyprus and further to Israel through the "EuroAsia Interconnector" (already accepted as a PCI by the E.C.). It is also possible to further extend this link to the main islands of the Dodecanese complex (namely Kos, Leros, Kalymnos, Nisyros, Tilos) in order to allow the supply of these islands and at the same time the supply of a complex of other smaller islands already connected to the main ones. This is a short link (10km to 15km long) and more likely it will be an AC one. All the installations on the islands (converter stations, substations etc) will be of closed type using GIS technology.						
Greece, Egypt, Libya	284	LEG1	LEG1 is a new project of VDC Interconnection Subsea 3000 MW connecting Egypt to Crete in Greece, via Tobruk in Libya. LEG1 project links European Network and South-East Medring. Following networks can then be linked to Europe: ELTAM, GCC power grid interconnection and EIJLLPST Eight Country interconnection projects. Renewable electricity produced in Libya, Egypt and Saudi-Arabia will be sent to Europe, whilst Europe will help southern countries to face high electricity demand. The HVDC submarine cable can find a path not deeper than 2500m. LEG1 will then challenge the European cable industries in their advanced technology capability.	3000		(tbc)	2021	Future Project	GreenPower 2020

In addition, the following storage projects will be assessed in the TYNDP2016, all 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
PCI hydro-pumped storage in Bulgaria - Yadenitsa	NATSIONALNA ELEKTRICHESKA KOMPANIA EAD	Bulgaria	Pumped Storage Hydro Power Plant	864	5,2	2021
Pumped Storage Complex with two independent upper reservoirs: Agios Georgios & Pyrgos	TERNA ENERGY S.A	Greece	Hydro (pumped storage)	594	3436	2021
Battery storage in South Italy	Terna	Italy	Battery Energy Storage System (BESS)	250	1,7	2022

5.3 List of projects of regional significance

The project 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 in the future scenarios and visions.

Investment ID	from substation name	to substation name	Description	Main driver	Expected commissioning date	Commissioning date in the TYNDP/RgIP 2014	Evolution driver description since TYNDP/RgIP 2014
474	Ravne (SI)		Construction 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)	SoS	2019		New Investment
267	Suceava (RO)	Balti (MD)	New 400 kV OHL (139 km) to increase capacity of transfer between Romania and Republic Moldova	Market integration	2022	2020	The project is associated to the connection of the Republic Moldova and Ukraine. Delay is associated to the procedure for the connection of UA+MD.
842	Balti (MD)	-	The project also implies new substation 400 kV in Moldova (extension of the substation Balti) with 400 kV level.	Market integration	2022	2020	The project is associated to the connection of the Republic Moldova and Ukraine. Delay is associated to the procedure for the connection of UA+MD.
268	Constanta (RO)	Pasakoy (TR)	New DC link (sbsea cable) between existing substaions in RO and TR. Line length:400 kV	Market integration	2020	2020	The decision process regarding financing scheme and project structure is not finalized. The project stays under consideration.
913	Salpu (RO)	Brasov (RO)	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.	RES integration	2024	2024	Investment on time
271	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	RES integration	2016	2016	Investment on time

Investment ID	from substation name	to substation name	Description	Main driver	Expected commissioning date	Commissioning date in the TYNDP/RgIP 2014	Evolution driver description since TYNDP/RgIP 2014
713	400 kV Medgidia (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).	RES integration	2016	2016	Investment on time
272	400 kV Medgidia (RO)	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).	RES integration	2016	2016	Investment on time
274	Constanta (RO)	Medgidia (RO	New 400kV double circuit (one circuit wired) OHL 1380 MVA between existing substations. Line length:75km.	RES integration	2020	2020	Investment on time
712	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.	RES integration	2021	2021	Investment on time
714	Stalpu (RO)	Teleajen - 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.	RES integration	2018	2018	Investment on time
716	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.	RES integration	2019	2019	Investment on time
717	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	RES integration	2030	2030	Investment under consideration. The final decision depends on the future level of East – West flows through the corridor. Investment on time

Investment ID	from substation name	to substation name	Description	Main driver	Expected commissioning date	Commissioning date in the TYNDP/RgIP 2014	Evolution driver description since TYNDP/RgIP 2014
			existing conductors with high thermal capacity, low sag conductors ; >460MVA.				
718	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.	RES integration	2021	2021	Investment on time

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.

Table 5-1 Reference cross-border capacities for the Assessment phase, 2020 and 2030

	Reference Capacities Reference Capacities (including present situation, Mid-term and Long-Term projects but not including future projects) (MW)	
Border	**2020 Expected Progress**	**2030 Visions**
AL-MK	200	200
AL-RS	760	760
BA-HR	1344	1844
BA-ME	500	500
BA-RS	1100	1100
BG-GR	1728	1728
BG-MK	530	530
BG-RO	1400	1400
BG-RS	600	600
CY-GR	2000	2000
GR-BG	1032	1032
GR-CY	2000	2000
GR-IT	500	500
GR-MK	350	350
HR-BA	1312	1812
HR-RS	600	600
HU-RS	600	600
IT-GR	500	500
ME-BA	400	400
ME-RS	1000	1000
MK-AL	200	200
MK-BG	150	150
MK-GR	400	400
MK-RS	1050	1050
RO-BG	1500	1500
RO-RS	1450	1450
RS-AL	330	330
RS-BA	1200	1200
RS-BG	350	350
RS-HR	600	600
RS-HU	600	600
RS-ME	1100	1100
RS-MK	950	950
RS-RO	1050	1050

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

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".

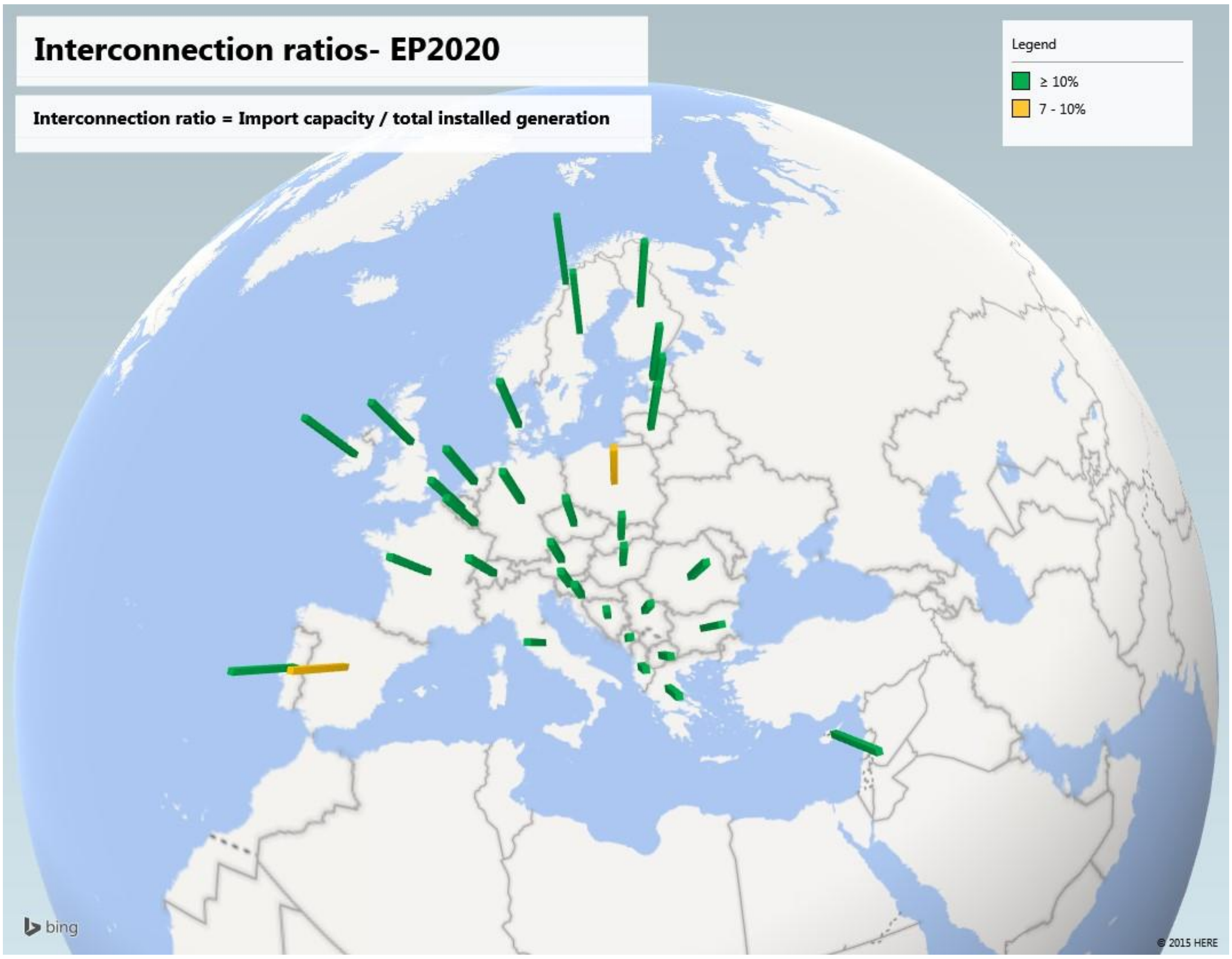


Figure 5-2 EP2020 Interconnection ratio

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

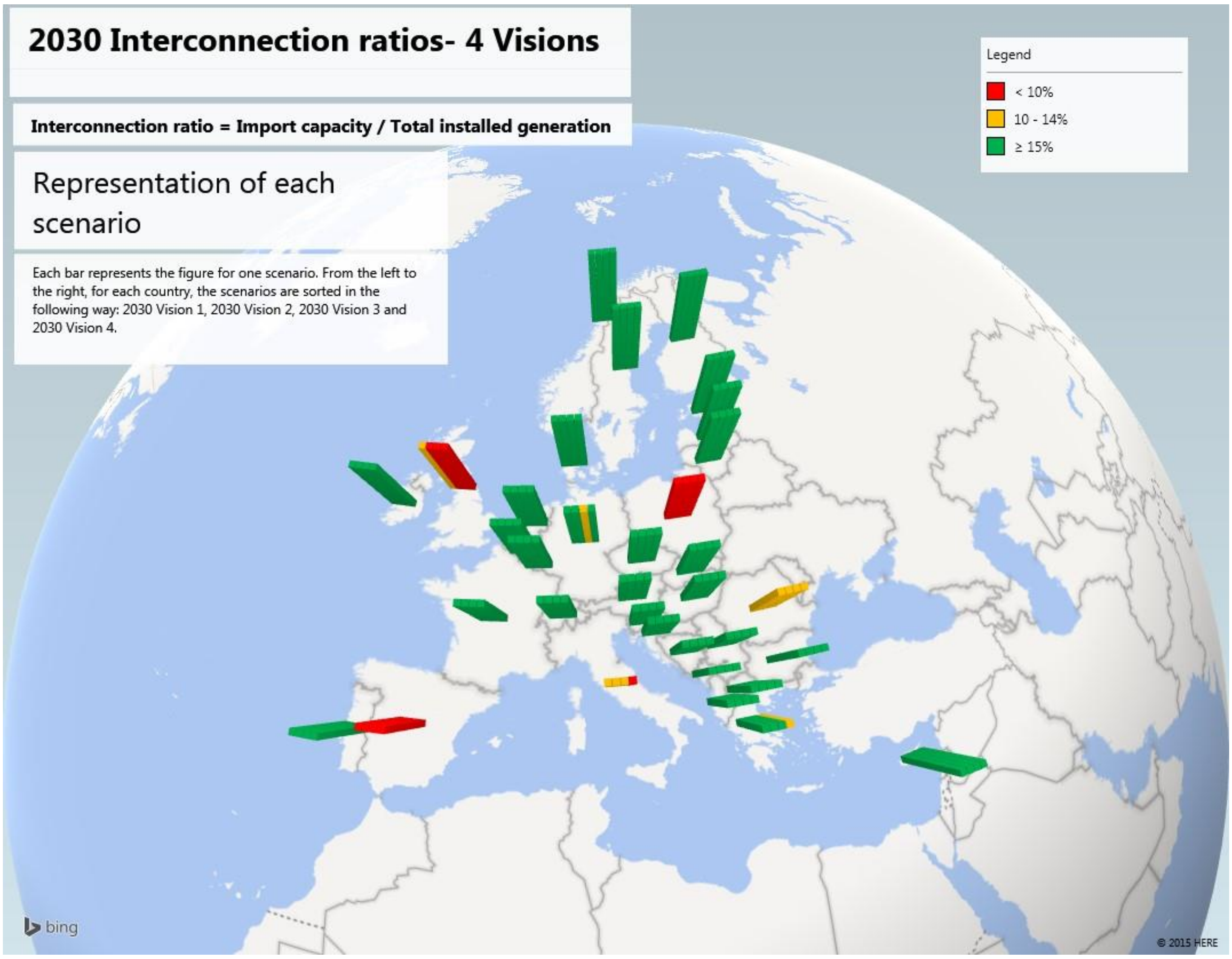


Figure 5-3 Interconnection ratio – 2030 Visions - import capacity divided by net generating capacity

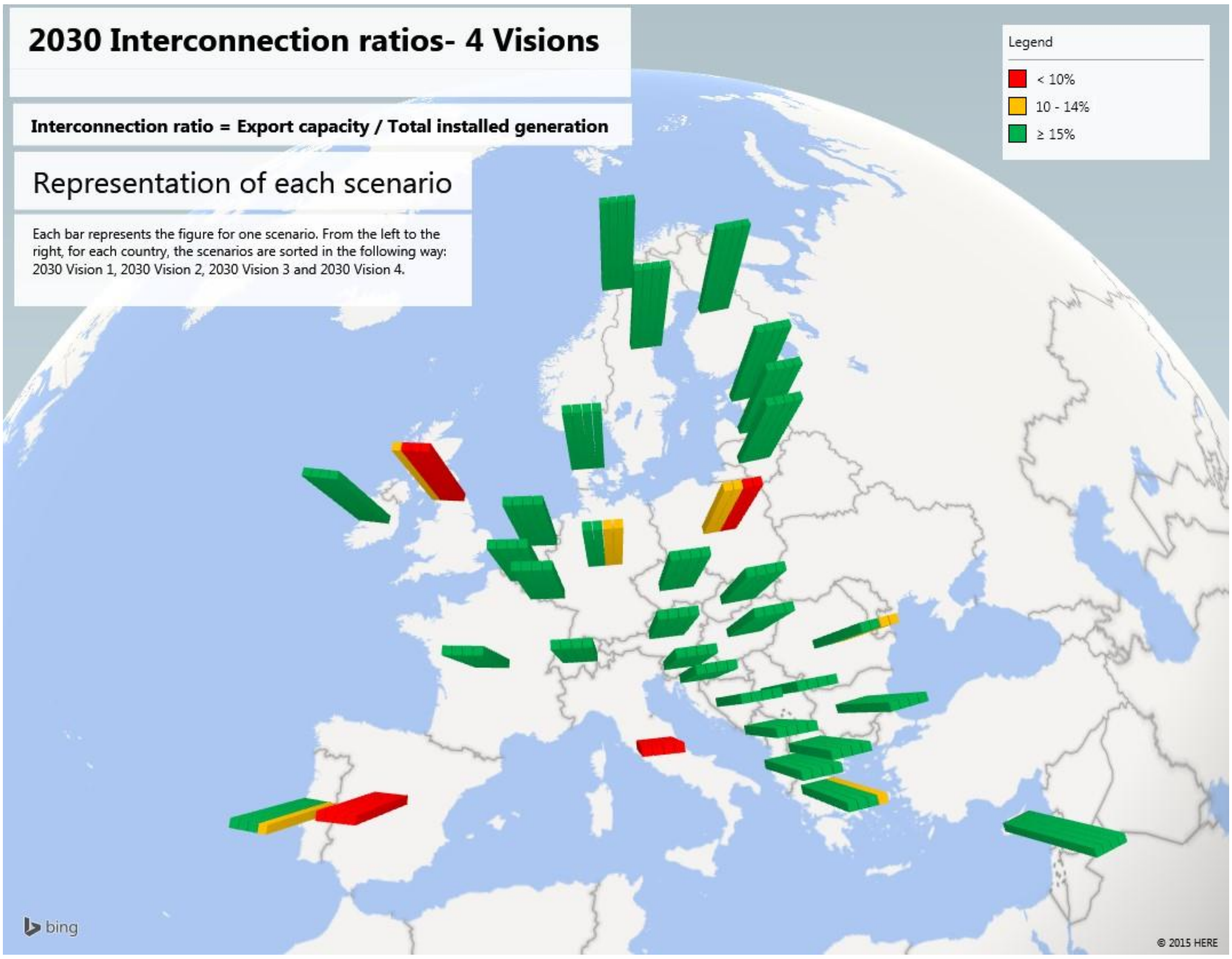


Figure 5-4 Interconnection ratio - 2030 Visions - export interconnection capacity divided by net generating capacity

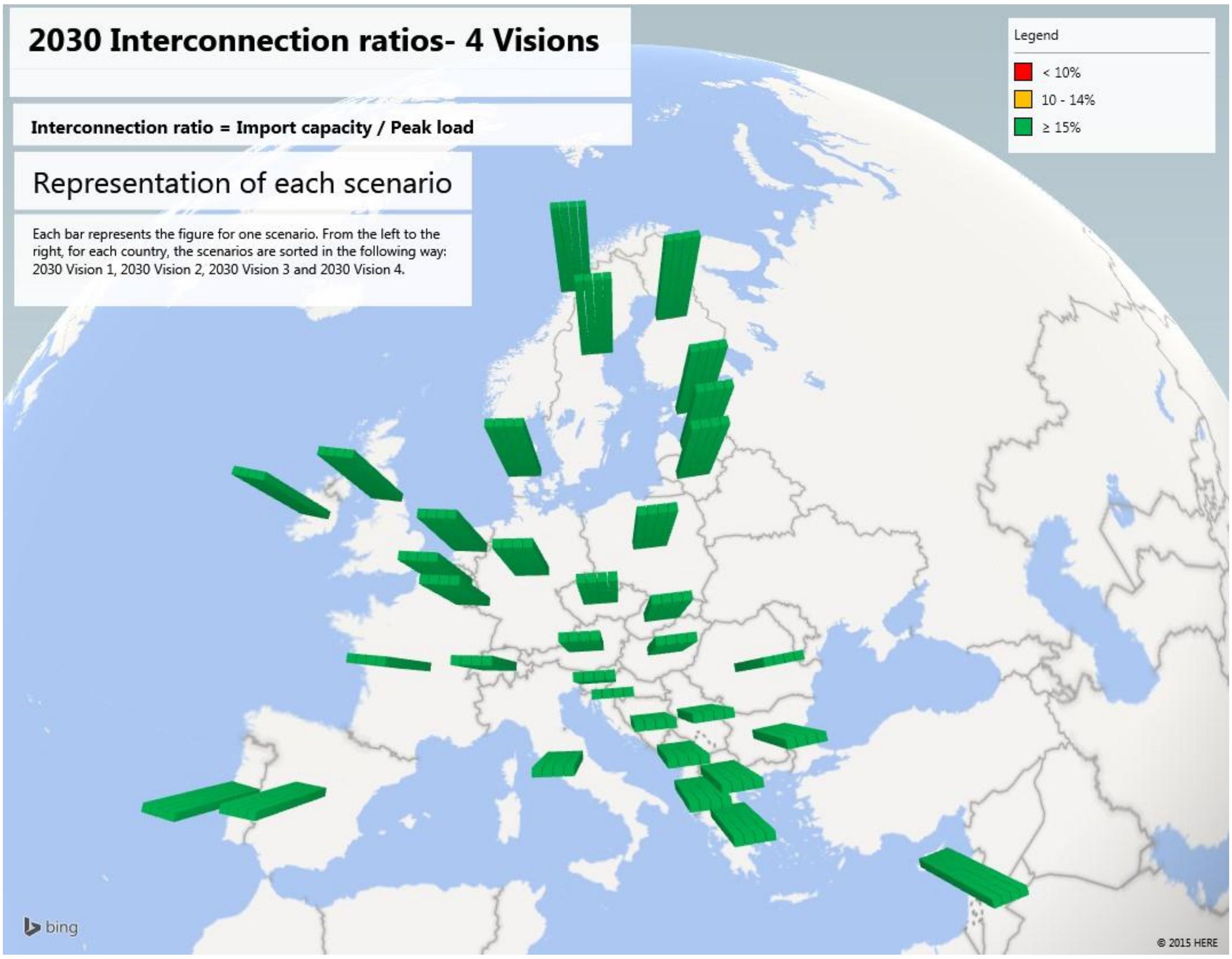


Figure 5-5 Interconnection ratio – 2030 Visions - import interconnection capacity divided by peak load

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.

5.6 Long term perspective, remaining challenges and gaps

Although any estimations for the far future (i.e. beyond 2030 looking at a time horizon such as 2050) are of high risk, taking into consideration the main policy lines towards a low carbon electricity sector, it is expected that the share of renewables on the electricity sector will dramatically increase and subsequently the conventional generation portfolio will be changed and adjusted to the new conditions. 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.

Under this framework, any estimations for the far future should be based on the most ambitious vision regarding RES exploitation, i.e. Vision 4 analysed in TYNDP 2014. It should be underlined that TYNDP 2014 Vision 4 is far beyond what the TSO transmission development plans usually considered up to now and will require important investments of national, regional and pan-European relevance on the network. As Vision 4 is a "top down" vision, a lot of the investments that will be possibly needed in the future (especially at the national level) have not been defined yet; this is due to the fact that the location of the new RES generation which is of major importance for planning the future network is still uncertain.

It should be also underlined that, especially at the National level, the level of dispersed RES generation and the energy efficiency measures are of high importance for transmission planning. More specifically, the portion of the RES generation connected to the low and medium voltage grids as dispersed generation is crucial; the larger the dispersed generation the less needs for transmission network development. Similar comments stand for the energy efficiency and demand side management measures.

Concerning the conventional generation, it is quite hard to estimate the future needs, but most likely increased flexibility will be needed. Also a number of technical challenges rise such as stability analysis, reconsideration of operational rules and regulation procedures, wide area network monitoring and on-line collaboration at the regional level (e.g. through Regional control centers) etc.

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

- Permitting procedures in order to clarify/harmonise projects approval decisions in the countries involved, given that the lack of harmonization increases social acceptance difficulties and costs of development;
- Regulatory issues related with interconnection projects cost acceptance by the different energy regulators involved allowing a fair but equivalent approach for investment recovery in the different national energy systems/
- The recognition of the setting of PCI priorities for the acceptance of these projects and the perspective of public financial support, if needed, taking into account the costs and benefits.
- Setting procedures and rules for the candidate new connected

Especially for the CSE region, the future connection of countries at the east (i.e. Ukraine and Moldova) and at the south (Cyprus or even Israel or future extension to the Middle East or North Africa) is of very high importance since it will affect dramatically the conditions in the transmission network of the region. In such cases significant reinforcements of the S→N and E→W corridors will be needed. Also, from the technical point of view such extensions will require the extensive use of HVDC technology which is another emerging technical challenge.

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 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.

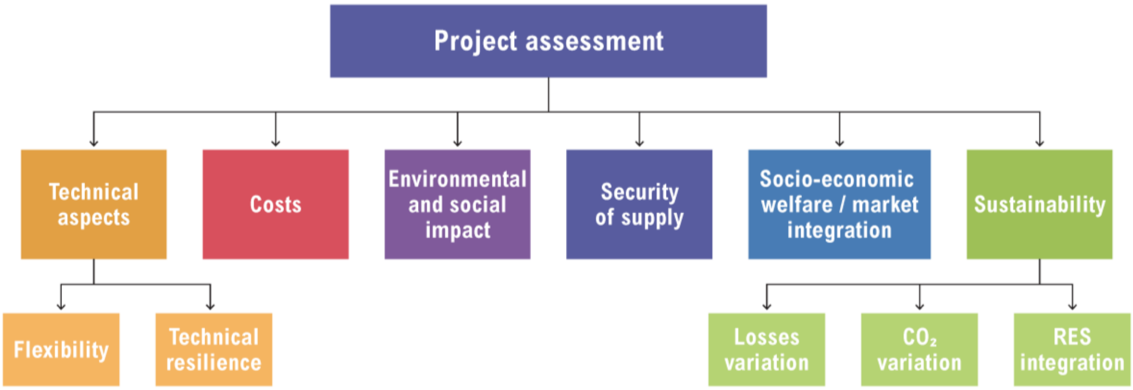


Figure 6-1 CBA Indicators

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:

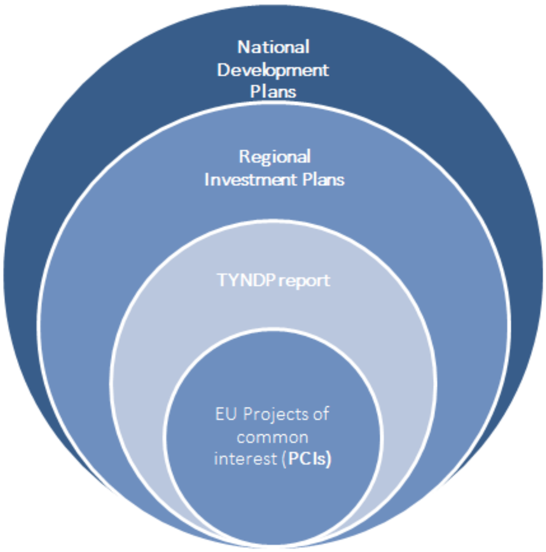
	CBA results non specific scenario		CBA results for each scenario								CBA results non specific scenario				
	GTC increase - direction 1 [MW]	GTC increase - direction 2 [MW]	TYNDP scenarios	Contribution to Intercon-nection rate [%]	B1 - SoS [MWh/y]	B2 - SEW [M€/y]	B3 - RES integration [MWh/y or MW/y]	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[2]. 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 TYNDP 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.

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

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

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.

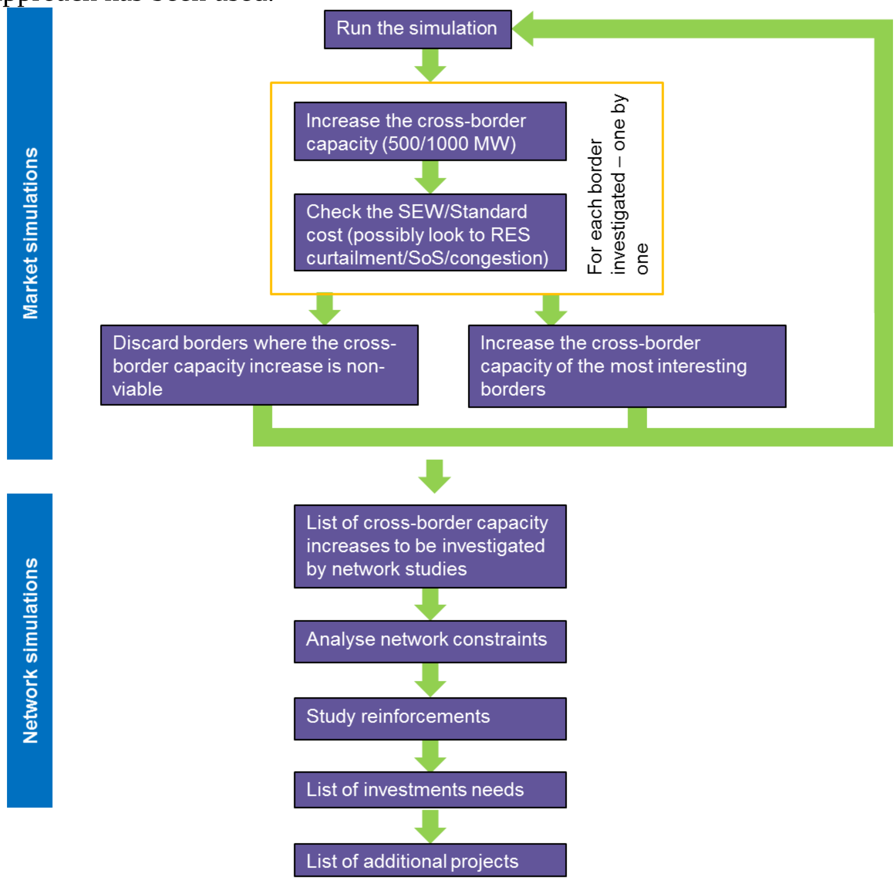


Figure 7-1 Overall overview of the Common Planning Studies process

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

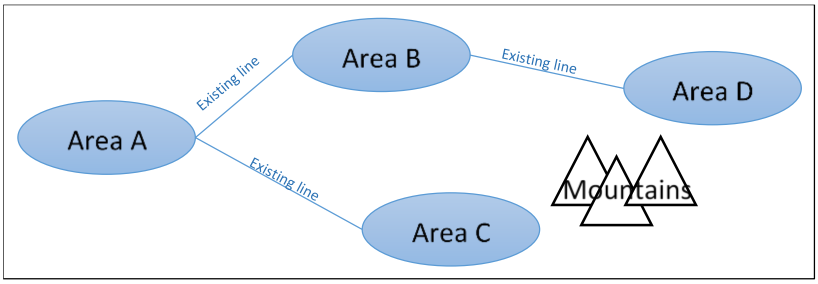
- on the base of data used TYNDP2014 V4 2030 Regional assessment (high RES conditions),
- on the base of an alignment performed by Project Group Market Modelling (PG MM) members respect the installed generation capacity and the generation profile (provided by PECD – Pan European Climate Database) for 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[3].
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.



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

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[4] 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.

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

- 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).

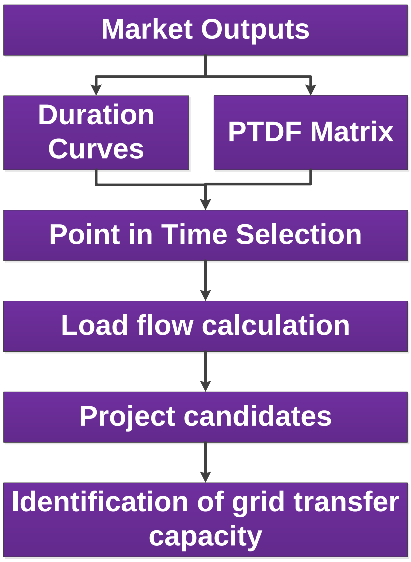


Figure 7-2 workflow of the Network Studies during Common Planning Studies

Network modelling

Network analyses were performed under the following framework:

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

Inputs from market results

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

- Thermal generation per fuel type and efficiency

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

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

Bottleneck identification

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

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

Example of calculation of 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				

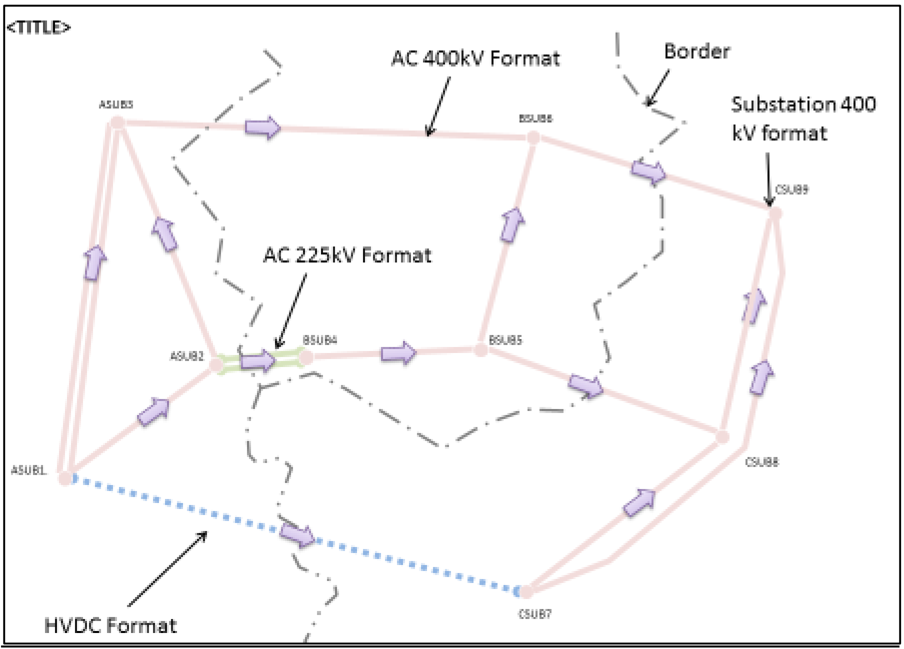
Figure 7-3 Workflow of the Network Studies during Common Planning Studies

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
Maps to illustrate physical flows:
Following types of map can were used:

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



Maps to illustrate bottlenecks:

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

7.2 Detailed regional walkthrough of process

The pan-European iterative market simulations were performed using the PowrSym4 market tool.

The screening process included all borders through all the four iterations, evaluated based on SEW/Cost indicator.

The standard costs related to the increase of the interconnection capacity have been roughly assessed by expert view in the region, taking into account the local specificity of the border, as presented in Table 7-1.

In the calculation of these preliminary figures, the TYNDP2014 and other on-going bilateral studies were considered to estimate the cost/ km of a HVAC of 500 MW and of a submarine cable of 1000 MW (for GR-IT, respectively), and the number of kilometres, for each possible project between the two countries.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

Table 7-1 Standard Cost

Border	Standard Cost [M€]
BA-HR	58
BA-ME	58
BA-RS	58
BG-GR	46
BG-MK	60
BG-RO	58
BG-RS	68
GR-AL	50
GR-ITS	2400
GR-MK(*)	24
HR-ME	58
HR-RS	58
HU-RS	-
ME-AL	58
ME-RS	58
MK-AL	58
MK-RS	58
RO-RS	66
RS-AL	58

(*) for the second 500 MW step of BTC increase for this border, the cost increases to 56M€

The main benefit indicators (SEW, RES, SoS) according to each iteration performed, are reported in the following tables.

Table 7-2 First iteration loop

Border	Initial BTC_ Base case (Exp)	Initial BTC_ Base case (Imp)	FIRST ITERATION LOOP BTC increase vs Base Case	Standard Cost [M€]	SEW increase [M€]	Avoided RES spillage [MWh]	SoS improvement [MWh]	CO_2 decrease [Mton]	RATIO SEW/Cost	
BG-GR	**1400**	**400**	**+500**	**46**	**31**	**77000**	**0**	**-0,172**	**0,674**	← Selected
BG-MK	800	800	+500	60	30	58000	560	-0,08	0,500	
RO-RS	1400	1300	+500	66	28	156000	0	-0,049	0,424	
BG-RS	1100	1000	+500	68	28	109000	40	-0,082	0,412	
GR-AL	250	250	+500	50	8	61000	0	-0,07	0,160	
HR-ME	0	0	+500	58	8	0	180	0,005	0,138	
MK-RS	640	800	+500	58	8	23000	270	0,047	0,138	
HR-RS	450	350	+500	58	4	0	0	-0,017	0,069	
BA-HR	900	700	+500	58	3	0	0	-0,007	0,052	
GR-MK	1400	700	+500	24	1	56000	0	-0,079	0,042	
GR-ITS	500	500	+1000	2400	83	849000	140	0,471	0,035	
BA-RS	1250	1200	+500	58	1	0	0	0,001	0,017	
BG-RO	1400	1500	+500	58	1	52000	0	0,001	0,017	
BA-ME	550	500	+500	58	0	24000	0	-0,013	0,000	
ME-AL	350	350	+500	58	0	26000	260	0	0,000	
ME-RS	1300	1300	+500	58	0	0	50	0	0,000	
MK-AL	250	200	+500	58	0	27000	0	-0,015	0,000	
RS-AL	700	700	+500	58	0	0	50	0,003	0,000	
HU-RS	600	700	+500	.....	11	0	420	-0,023	-	

Table 7-3 Second iteration loop

Border	Initial BTC_ Base case (Exp)	Initial BTC_ Base case (Imp)	SECOND ITERATION LOOP BTC increase vs Base Case	Standard Cost [M€]	SEW increase [M€]	Avoided RES spillage [MWh]	SoS improvement [MWh]	CO_2 decrease [Mton]	RATIO SEW/Cost	
GR-MK	**1400**	**700**	**500**	**24**	**8**	**0**	**180**	**-0,03**	**0,333**	} Selected
BG-GR	**1400**	**400**	**+1000**	**46**	**14**	**0**	**170**	**-0,165**	**0,304**	} Selected
GR-AL	250	250	+500	50	6	0	290	-0,067	0,120	
BG-RS	1100	1000	+500	68	7	0	130	-0,129	0,103	
RO-RS	1400	1300	+500	66	6	10000	250	-0,096	0,091	
MK-RS	640	800	+500	58	3	17000	0	0,036	0,052	
MK-AL	250	200	+500	58	2	15000	20	-0,003	0,034	
BG-MK	800	800	+500	60	2	27000	210	-0,15	0,033	
GR-ITS	500	500	+1000	2400	72	891000	0	0,416	0,030	
BA-HR	900	700	+500	58	0	36000	0	-0,123	0,000	
BA-ME	550	500	+500	58	0	13000	20	0,021	0,000	
BA-RS	1250	1200	+500	58	0	2000	0	0,002	0,000	
BG-RO	1400	1500	+500	58	0	18000	0	0,011	0,000	
HR-ME	0	0	+500	58	0	0	210	-0,106	0,000	
HR-RS	450	350	+500	58	0	32000	360	-0,117	0,000	
ME-AL	350	350	+500	58	0	0	0	0,016	0,000	
ME-RS	1300	1300	+500	58	0	0	10	-0,003	0,000	
RS-AL	700	700	+500	58	0	0	0	0,003	0,000	
HU-RS	600	700	500	.....	0	0	0	-0,135	-	

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

Table 7-4 Third iteration loop

			THIRD ITERATION LOOP							
Border	Initial BTC_ Base case (Exp)	Initial BTC_ Base case (Imp)	BTC increase vs Base Case	Standard Cost [M€]	SEW increase [M€]	Avoided RES spillage [MWh]	SoS improvement [MWh]	CO_2 decrease [Mton]	RATIO SEW/Cost	
HR-RS	**450**	**350**	**500**	**58**	**27**	**0**	**0**	**0,12**	**0,466**	Selected
BA-HR	**900**	**700**	**500**	**58**	**25**	**0**	**0**	**0,1**	**0,431**	Selected
GR-AL	**250**	**250**	**+500**	**50**	**21**	**29000**	**0**	**0,039**	**0,420**	Selected
RO-RS	1400	1300	+500	66	24	25000	0	0,061	0,364	
BG-MK	800	800	+500	60	21	8000	0	0,007	0,350	
MK-AL	250	200	+500	58	19	19000	0	0,06	0,328	
MK-RS	640	800	+500	58	19	23000	0	0,093	0,328	
BG-RS	1100	1000	+500	68	20	32000	0	0,006	0,294	
BA-ME	550	500	+500	58	17	2000	0	0,087	0,293	
HR-ME	0	0	+500	58	8	0	0	0,025	0,138	
BG-GR	1400	400	+1500	46	5	10000	0	-0,113	0,109	
BG-RO	1400	1500	+500	58	4	33000	0	0,027	0,069	
GR-ITS	500	500	+1000	2400	97	865000	0	0,508	0,040	
GR-MK	1400	700	+1000	56	1	10000	0	-0,016	0,018	
ME-AL	350	350	+500	58	1	6000	0	0,022	0,017	
BA-RS	1250	1200	+500	58	0	0	0	0,001	0,000	
ME-RS	1300	1300	+500	58	0	1000	0	-0,004	0,000	
RS-AL	700	700	+500	58	0	2000	0	0,014	0,000	
HU-RS	600	700	500	.....	27	0	0	0,098	-	

As described before, the starting point for each iteration was based on the jointly used dataset among Regional Groups, including the BTC increase of the borders selected in the previous iteration loop by all RGs. As a consequence, any update during the process of a RG, related to the estimated costs of the projects and, respectively, of the borders selected previously, affects the market results of all regions.

After the first and the second iterations the border capacities increased in all RGs, so, during the third iteration loop, the market results don't show a significant SOS improvement at the pan-European level, for any of the capacity increases with 500 MW steps of the investigated borders within RG CSE.

Nevertheless, in the fourth iteration, after removing some of the previously selected border increase in other Regions (as 1000 MW for DE-DKw, for example), due to the standard cost refining, the pan-European SOS level increases for some projects, as shown in the following, Table 7-5.

Table 7-5 Fourth iteration loop

			FOURTH ITERATION LOOP							
Border	**Initial BTC_ Base case (Exp)**	**Initial BTC_ Base case (Imp)**	**BTC increase vs Base Case**	**Standard Cost [M€]**	**SEW increase [M€]**	**Avoided RES spillage [MWh]**	**SoS improvement [MWh]**	**CO_2 decrease [Mton]**	**RATIO SEW/Cost**	
BG-GR	**1400**	**400**	**1500**	**46**	**6**	**22000**	**70**	**-0,105**	**0,130**	**Selected**
RO-RS	**1400**	**1300**	**+500**	**66**	**8**	**0**	**360**	**-0,062**	**0,121**	**Selected**
BG-MK	**800**	**800**	**+500**	**60**	**7**	**0**	**80**	**-0,089**	**0,117**	**Selected**
BG-RS	**1100**	**1000**	**+500**	**68**	**6**	**4000**	**0**	**-0,081**	**0,088**	**Selected**
BG-RO	1400	1500	+500	58	4	0	80	0,047	0,069	
GR-ITS	500	500	+1000	2400	74	863000	20	0,379	0,031	
BA-RS	1250	1200	+500	58	1	2000	290	0,009	0,017	
ME-AL	350	350	+500	58	1	24000	20	-0,004	0,017	
MK-AL	250	200	+500	58	1	12000	30	-0,02	0,017	
BA-HR	900	700	+1000	58	0	0	290	-0,039	0,000	
BA-ME	550	500	+500	58	0	0	370	-0,001	0,000	
GR-AL	250	250	+1000	50	0	30000	30	-0,061	0,000	
GR-MK	1400	700	+1000	56	0	4000	20	-0,027	0,000	
HR-ME	0	0	+500	58	0	0	0	-0,037	0,000	
HR-RS	450	350	+1000	58	0	0	110	-0,032	0,000	
ME-RS	1300	1300	+500	58	0	0	0	0,002	0,000	
MK-RS	640	800	+500	58	0	20000	60	-0,038	0,000	
RS-AL	700	700	+500	58	0	18000	0	-0,001	0,000	
HU-RS	600	700	+500	.....	1	0	70	-0,014	-	

The main results, showing the BTC increase in 2030 Vision 4 for the eight most beneficial borders in RG CSE, as the outcome of the four iterations performed, are presented in Table 7-6.

Table 7-6 Cross border capacity increase

Border	**Cross border capacity increase**
BG-GR	1500
GR-MK	500
HR-RS	500
BA-HR	500
GR-AL	500
RO-RS	500
BG-MK	500
BG-RS	500

For every boundary, the target capacities correspond in essence to the transmission capacity above which additional development would not be profitable. The additional interconnection capacity included in Table 7-6 were added to the initial value in order to have the new target capacity in high RES condition of this scenario.

7.3 Guidelines for Project Promoters

In line with Regulation (EU) 347/2013, the EC provides a set of guidelines[5] 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.

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[6]. 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).

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

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

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

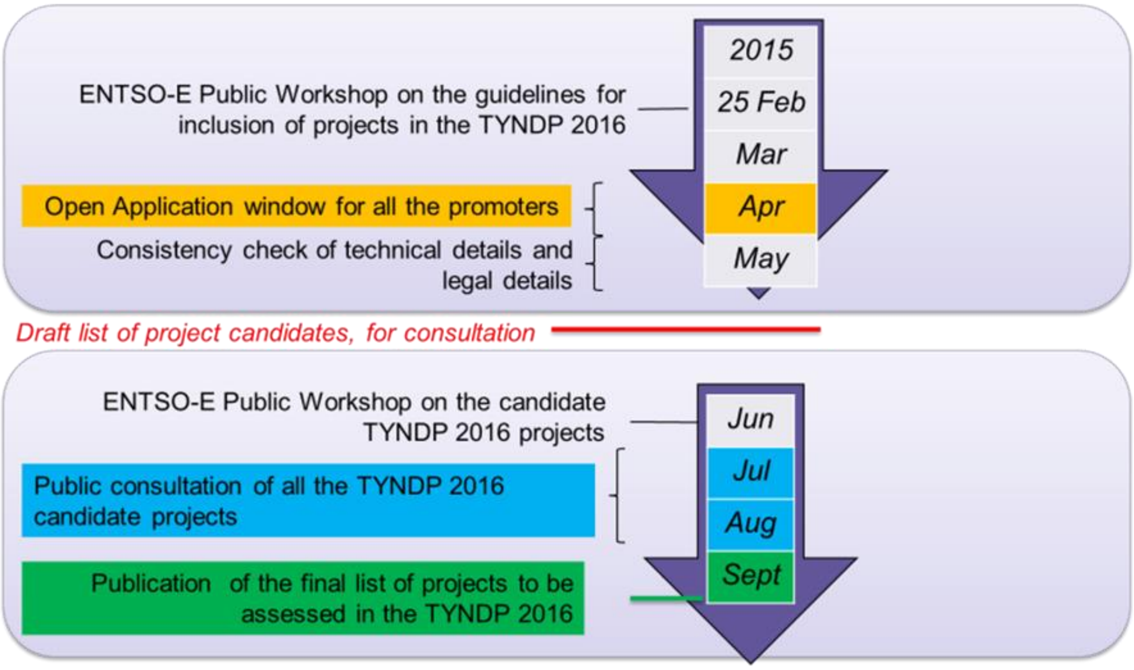


Figure 7-4 Workplan for project promotors

7.4 Abbreviations

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

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

- RG BS Regional Group Baltic Sea
- RG CCE Regional Group Continental Central East
- RG CCS Regional Group Continental Central South
- 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

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

7.5 Terminology

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

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

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

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

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

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

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

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

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.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu

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.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel + 32 2 741 09 50 • Fax + 32 2 741 09 51 • info@entsoe.eu • www. entsoe.eu