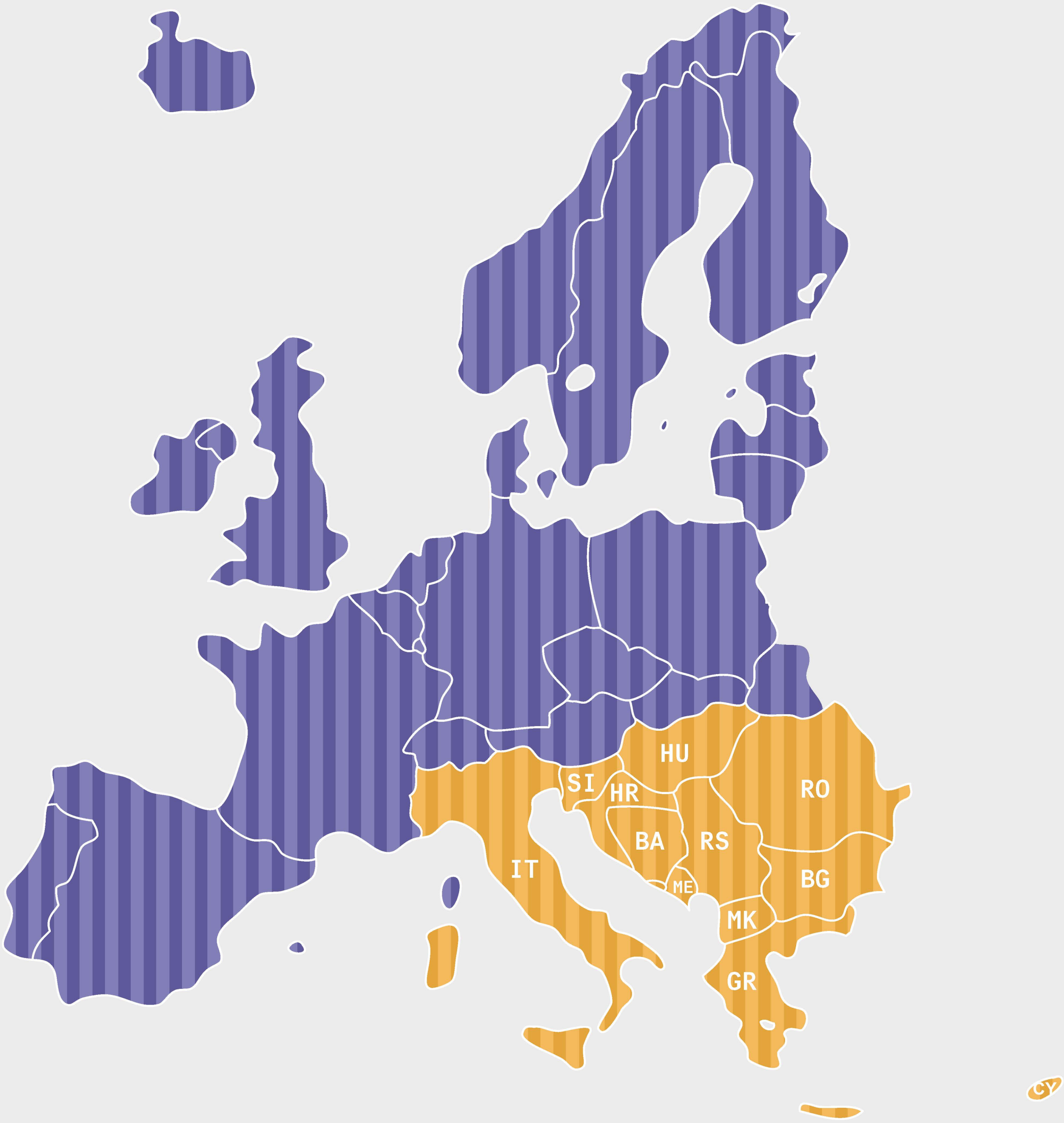
REGIONAL INVESTMENT PLAN 2014
CONTINENTAL SOUTH EAST Final



European Network of
Transmission System Operators
for Electricity

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

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0 Executive summary

0.1 RG CSE delivers the RgIP 2014 as a part of the ENTSO-E TYNDP 2014 package

The Continental South East Regional Group (RG CSE) under the scope of the European Network of Transmission System Operators for Electricity (ENTSO-E) provides herewith the 2014 release of the Continental South East Regional Investment Plan (CSE RgIP) 2014 as one of the packages of the community-wide Ten-Year Network Development Plan (TYNDP) 2014. The CSE RgIP 2014 is the proposed plan covering the coming ten years and beyond and supersedes the CSE RgIP 2012.

The present publication RgIP 2014 complies with the requirements of Regulation (EC) No 714/2009, in force since March 2010 whereby "ENTSO-E shall adopt a non-binding Community-wide 10 year network development plan, including a European generation adequacy outlook, every two years". The TYNDP 2014 is released as a package including this CSE RgIP 2014 with other 5 Regional Investment plans and Scenario Outlook and Generation Adequacy (SOAF).

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

The report is a result of tight and active two year period, during which extensive improvement was done on the scenario development, stakeholder involvement and cost and benefit assessment methodology.

Grid development is a vital instrument for achieving the European goals such as security of supply to European customers, sustainable development of the energy system (renewables) and affordable energy for European customers (market integration). TYNDP as a community wide report combines all these different goals and provides a reference for the European electricity grid development.

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

0.2 Regional Investment Plan CSE

The present report is part of an 8-document suite comprising a Scenario Outlook and Adequacy Forecast (SOAF), a Ten-Year Network Development Plan (TYNDP), and 6 Regional Investment Plans (RgIPs). The TYNDP 2014 and the 6 Regional Investment Plans associated are supported by regional and pan-European analyses, and take into account the feedback received from stakeholders during the public consultation of the TYNDP 2012, mainly related with the scenario building and CBA methodology application and improvements.

This Regional Investment Plan aims to describe the investment needs and access the associated planned projects for 2030 (time horizon agreed with stakeholders and that allows to anticipate the long term investments in the region) in the Continental South West (CSE) region, which covers Bosnia-Herzegovina, Bulgaria, Croatia, Greece, Hungary, FYR of Macedonia, Montenegro, Romania, Serbia and Slovenia. Albania is also taken into account. It assesses cross-border and internal projects of regional and/or European significance, which allow reaching the main European targets, with particular regard to the development of the Internal Electricity Market (IEM) and the integration of Renewable Energy Sources (RES). Also, it addresses some Security of Supply (SoS) issues at a more local level. Moreover, the RgIP provides information on monitoring the progress of TYNDP 2012 projects.

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0.3 How was the TYNDP 2014 package achieved and what improvement were made since 2012

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

- The exploration of a longer run horizon, namely 2030, beyond the 10-year horizon, along four contrasted "Visions", encompassing the futures that stakeholders required ENTSO-E to consider.

- New clustering rules to define projects of pan-European significance, focusing them on the few core investment items. The regionally significant supporting investments are presented in the Regional Investment Plans as the case may be.

- A numerical quantification of every project benefits assessment according to the consulted CBA methodology, with refined definitions for the security of supply, RES integration, socioeconomic welfare, resilience, flexibility and robustness, social and environmental indicators.

- A synthetic appraisal of the interconnection target capacities in the different scenarios.

- Easier and more frequent opportunities for stakeholders to take part, especially for transmission or storage project promoters that are not Members of ENTSO-E.

With the TYNDP 2014 package, RG CSE also improves its study tools and process compared to RgIP 2012, speeding up and strengthening data collection, model calibration, consistency checks and the merging of pan-European and regional results. The quality of the market and network modelling relies on the knowledge of all specific features of the local power system in the RG CSE, a detailed grid description; and the resulting ability to master and cut aptly through numerous parameters of high uncertainty. All in all, the TYNDP 2014 package presents a more holistic view of grid development, completing power transmission issues with environmental and resilience concerns.

0.4 Stakeholder involvement

ENTSO-E encourages stakeholders involvement in the TYNDP process. During the two-year TYNDP elaboration period ENTSO-E both provided information and asked for input from stakeholders during several phases of the process, via open workshops both European and regional, public web-consultations and bilateral meetings.
During preparation of the Scenarios several workshops and consultations were held where stakeholders input was used in improving the scenario content. Same process has followed the preparation of the CBA methodology. Also a dedicated Stakeholder group was created gathering European organisations to provide views on long term grid development related issues.

0.5 Scenarios

The TYNDP 2014 analysis is based on four Visions for 2030. The year 2030 is used as a bridge between the European energy targets for 2020 and 2050. The Visions are not forecasts of the future rather than selected

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as possible corners of the future so that the pathway realised in the future falls with a high level of certainty in the range described by the Visions.

The TYNDP 2014 uses 4 scenarios which differ on basis assumptions between Low and High degree of integration of the internal electricity market and are either on track for Energy Roadmap 2050 of being delayed. Differences in the high-level assumptions of the Visions are manifested among others in considerably higher CO2 prices but slightly lower fossil fuel prices in Visions 3 and 4, than in Visions 1 and 2.
There are two bottom-up scenarios (Vision 1 & 3) which were constructed with common guidelines and two top-down (Vision 2 & 4) which were developed at European level. All the scenarios built with stakeholders show reduction of the CO2 emissions and large increase of RES.

0.6 Results and main findings

Market and network studies in CSE Region focused in the assessment of new transmission projects in the area aiming at the increase of transmission capacities in the main corridors of the area as well as to support market integration with the rest of Europe, including Italy.
An important outcome from the regional Market studies was that CSE Region is a net exporter region, in all four Visions. Exported energy on an annual basis is higher in Visions 1 and 2 and the lowest appears in Vision 4. This can be justified by the very large RES penetration considered all over Europe at this Vision as well as the high CO2 values considered that make the generation portfolio of the area "less attractive.
Predominant power flow directions (E->W and N->S) continue to exist in 2030, concerning the Visions 1 and 2. In these two Visions exporting countries include Bulgaria, Romania, Serbia, Bosnia-Herzegovina, Montenegro, Slovenia and Albania. In Vision 3, predominant power flow directions continue to be as mentioned above but in some boundaries this trend appears for shorter periods, compared to the previous Visions.
In addition for almost 5000 hours power flow direction changes in the borders between Bulgaria and Romania. Due to the hypothesis of high CO2 price in this Vision, Bosnia-Herzegovina and Serbia are becoming importing countries, while Hungary is becoming an exporter. Greece (importer in Visions 1&2) is reducing imports and becomes almost balanced.
In Vision 4, power flow predominant direction changes in the west borders of Serbia and the borders between Croatia and Bosnia-Herzegovina. In addition the hours of power flow in the N->S direction are reduced (compared to Visions 1&2) at the borders between Bulgaria and Romania as well as at the South borders of Bulgaria and Serbia. Similar to Vision 3, exporting countries are Romania, Bulgaria, Hungary, Slovenia, Montenegro and Albania. However, due to the higher RES penetration and electricity demand level assumed in this scenario, volumes of energy exchanges are differentiated compared to Vision 3. As an example, due to the higher RES penetration in Romania, energy export is increased. On the other side, due to the higher energy consumption, imports in Greece are increased.
Integration of RES is one of the major drivers for the transmission system development in the area. Concerning wind farms, total installed capacity foreseen for 2030 in Visions 1 &2 is comparable to the level of EU2020 scenario in 2020 (about 18GW). For these two visions a higher penetration is considered for solar installations compared to the EU2020 scenario (8.1GW instead of 2.6GW). Highest RES penetration has been assumed in Vision 4 (22.7GW of wind and 39.3GW of solar installations).
In addition, market integration with Western Europe (especially Italy) is a key driver for the development of the transmission system in CSE Europe.
Regarding adequacy of the transmission network, regional studies depicted that under the precondition of implementing all planned investments, transmission capacity will be sufficient in most of the Visions in order to cope with expected power flows in both directions. Nevertheless, concerning the boundary at the West borders of Bulgaria and Romania some additional reinforcements may be needed in order to cope with the high RES penetration targets for 2030.

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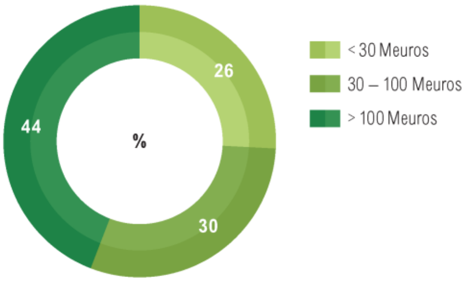
Another factor that may necessitate the need of increasing transfer capacity of the respective boundary is related to power flows due to exports of the Turkish power system as a dedicated sensitivity study depicted. The influence of the Turkish power system operation is an important source of uncertainty for transmission planning in the examined horizon, since exchanges with CESA will further increase bulk power transfers.
In the Continental South East Region 23 projects of European relevance have been identified. These projects are complemented from 118 transmission investments of Regional significance which are either necessary in order assist the 23 projects mentioned above or they contribute at a Regional level to achieve significant targets including security of supply and market integration.
Concerning the investments already included in TYNDP 2012, 45% of them are progressed as planned and 54% are delayed. However delays in most of the cases are less than five years.

The projects have been assessed with a multi-criteria assessment that evaluates their contribution to the Social Economic Welfare (SEW), CO2 emissions, RES integration, Security of Supply, variation of losses, resilience, flexibility and social and environmental impacts. The following figures present the main results for Vision 1 (more conservative scenario) and for Vision 4 (scenario which considers the higher amount of RES installed capacity).

Figures shown below depict statistics for the contribution of the CSE projects portfolio in the reduction of the total cost of electricity supply, in terms of the socio-economic welfare indicator (SEW). In Vision 1, 26% of the projects depict an increase of SEW which is less than 30MEuros per year, 30% an increase which is between 30MEuros and 100MEuros per year and 44% of the projects an increase which is higher than 100MEuros per year. Projects with highest SEW are located in the Balkan region and Italy. In Vision 4 the percentage or projects showing a SEW higher than 100MEuros increases to 65%. Projects belonging in this category are located in the Balkan region, Italy and at the north borders of the Region.



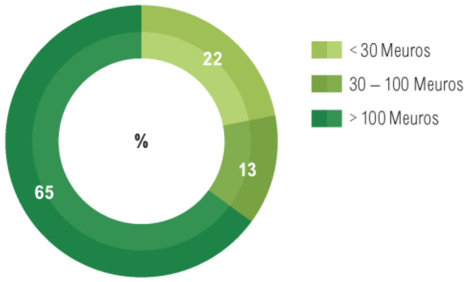


Figure 0-1 Projects contribution in the total cost of electricity supply in Vision 1	Figure 0-2 Projects contribution in the total cost of electricity supply in Vision 4

Regarding CO2 emissions, the statistics concerning the contribution of the CSE RG project portfolio on the CO2 emissions are depicted in the figures below. In Vision 1 a considerable percentage of the projects (44%) show a negative impact since it contributes towards an increase of CO2 emissions. This must be attributed to the percentage of RES penetration assumed in this scenario, as well as in the fact that the low CO2 price assumed results in an increased total annual generation of “more polluting” units like lignite ones. In Vision 4, the situation is reversed. 52% of the projects show a considerable contribution towards CO2 emissions reduction, which is higher than 500kT per year, 22% of the projects contribute to reduce CO2 emissions by less than 500kT per year and the rest of the projects have a negative impact on CO2 emissions. This change, compared to Vision 1 must be attributed to the considerably higher RES penetration considered in Vision 4 as well as to the higher CO2 price which resulted in a shift from coal and lignite to natural gas units.

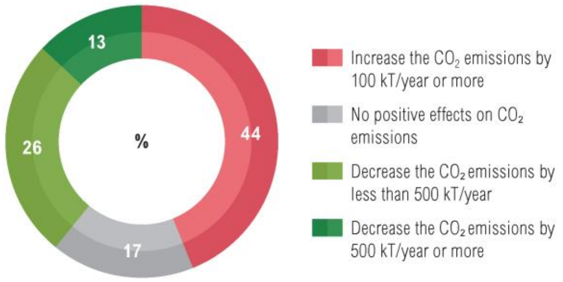


Figure 0-3 Projects contribution in the CO2 emissions reduction in Vision 1

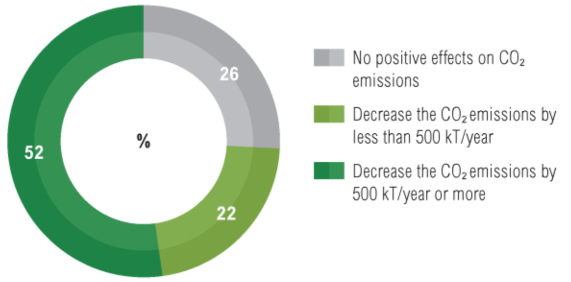


Figure 0-4 Projects contribution in the CO2 emissions reduction in Vision 4

The RES-indicator for the CSE region is shown in the diagrams below. In Vision 1 39% of the projects have a considerable impact on RES integration i.e. allow the direct connection of more than 500MW or the avoidance of curtailing of more than 300GWh of RES produced energy per year. On the other hand 52% of the projects have a neutral effect. In Vision 4, the percentage of projects with a positive impact on RES integration increases up to 48%. This increase must be attributed to the higher RES penetration considered in this vision. For the projects which assist to direct RES connection, the same value of RES indicator has been used in all visions (TSO estimation). Projects with a neutral impact on RES penetration (which in this vision are reduced to 43%) are mostly located to the North borders of the Region.

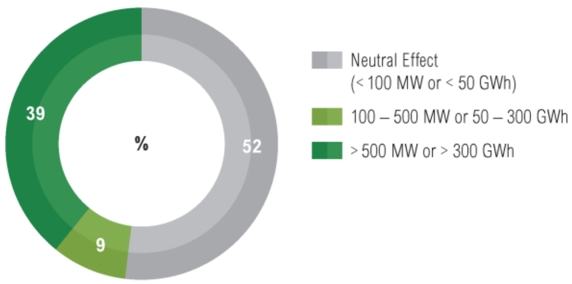


Figure 0-5 Projects contribution in RES integration in vision 1

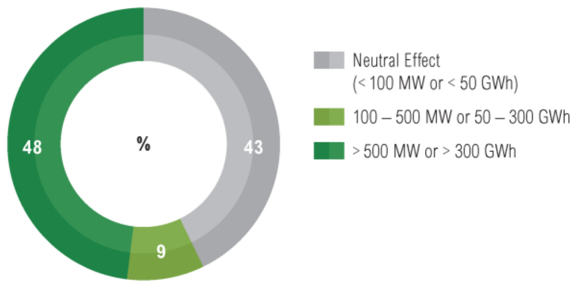
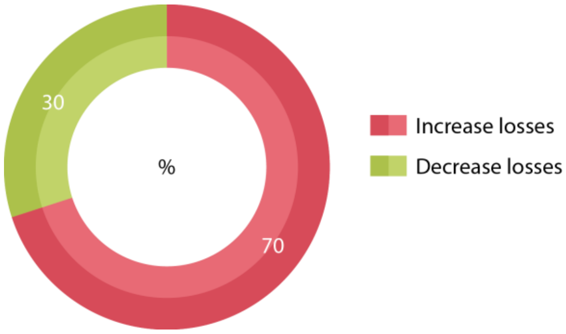


Figure 0-6 Projects contribution in RES integration in vision 4

Regarding the variation of losses, in Vision 1 70% of the projects assist in a reduction of losses, whereas this percentage is reduced to 61% in Vision 4. The percentage of projects with a negative contribution on losses is 30% in Vision 1 and increases to 35% in Vision 4. Projects increasing losses include in most of the cases HVDC radial interconnections. Observed reduction of projects contribution in energy efficiency in Vision 4 compared to Vision 1 can be explained due to the difference in flow patterns and the transmission of energy over longer distances from renewable generation installations towards the load centres.



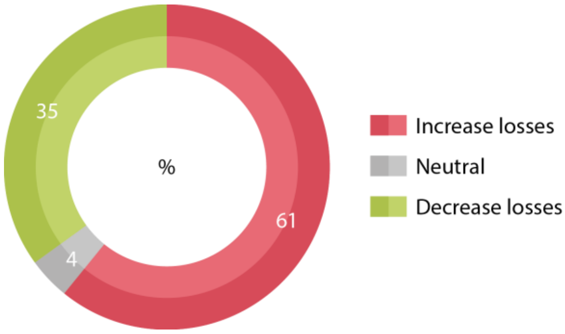


Figure 0-7 Impact of projects on losses in vision 1

Figure 0-8 Impact of projects on losses in vision 4

The diagram shown below depicts statistics of GTC increase that is expected to be achieved by 2030 in CSE Region. As can be seen the majority of the projects (57%) contributes to GTC increase that is less than 1000MW. The project with the highest GTC increase is a 3rd party project under the name "EuroAsia interconnector".

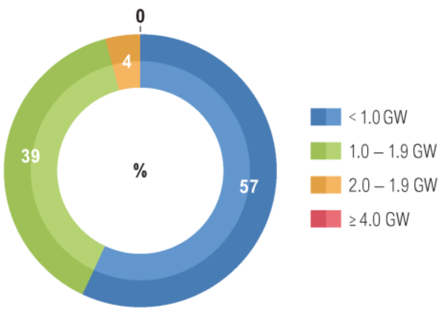
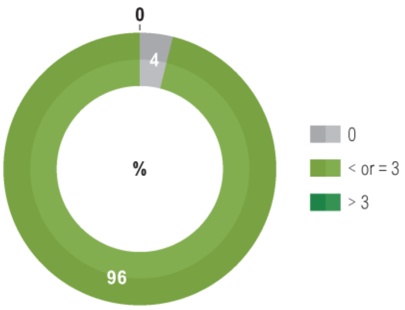


Figure 0-9 *Contribution of projects in transmission capacity increase (MW)*

As can be seen in the figure below, the majority of the projects in the CSE Region (about 96%) has an average contribution to the system technical resilience, quantified with a total score which is less or equal to 3.Only 5% of the projects has a 0 contribution to technical resilience. Similarly, more than half of the projects (61%) have a flexibility indicator ranking which is greater than 3.



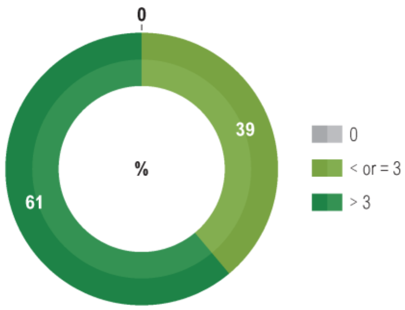


Figure 0-10 Impact of projects on system Resilience

Figure 0-11 Flexibility of projects

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Concerning CSE Region, most of the projects of Pan-European interest have a small environmental impact, since the estimate of the number of kilometers crossing sensitive areas is less than 15km in the majority of cases. The only exception to this conclusion is a Slovenian project part of which however concerns upgrade of existing 220kV lines. A similar conclusion exists for the social impact of mentioned projects.

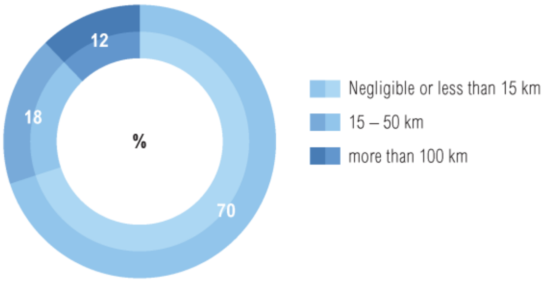

Figure 0-12 Social impact of projects

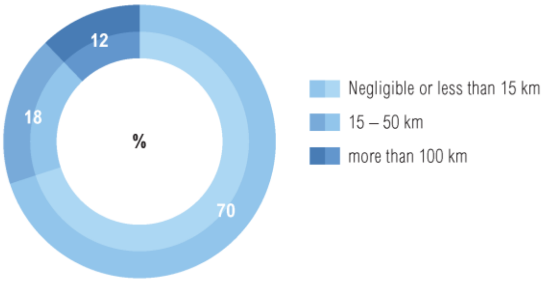

Figure 0-13 Environmental impact of projects

1 Introduction

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

The European Network of Transmission System Operators for Electricity (ENTSO-E) provides herewith the 2014 release of the Community-wide Ten-Year Network Development Plan (TYNDP).

The objectives of the TYNDP are to ensure transparency regarding the electricity transmission network and to support decision-making processes at regional and European level. This pan-European report and the appended Regional Investment Plans (RgIPs) are the most comprehensive and up-to-date European-wide reference for the transmission network. They point to significant investments in the European power grid in order to help achieve European energy policy goals.

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

- the Community-wide TYNDP report 2014
- the 6 Regional Investment Plans 2014; and
- the Scenario Outlook and Adequacy Forecast (SOAF) 2014.

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

ENTSO-E cannot be held liable for any inaccurate or incomplete information received from third parties or for any resulting misled assessment results based on such information.

The TYNDP 2014 package was consulted during Summer 2014 in order to be finalized in December 2014.

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

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

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

The present TYNDP package also anticipates on the implementation of Regulation EC 347/2013 (the **Energy Infrastructure Regulation**), in force since April 2013, and normally applying to the TYNDP 2016. **This regulation** organises a new framework to foster transmission grid development in Europe. Regulation EC 37/2013 defines the status of **Projects of Common Interest** (PCIs), foresees various supporting tools to support the realisation of PCIs, and makes the **TYNDP the sole basis for identifying and assessing the PCIs** according to a standard **Cost-Benefit-Analysis** (CBA) methodology.

The TYNDP is therefore not only a framework for planning the European grid, supplying a long term vision; it also now serves the assessment of every PCI candidate, whatever their commissioning time. The preparation of the TYNDP will be all the more demanding that the two roles complete each other more than they match and that additional resources are required.

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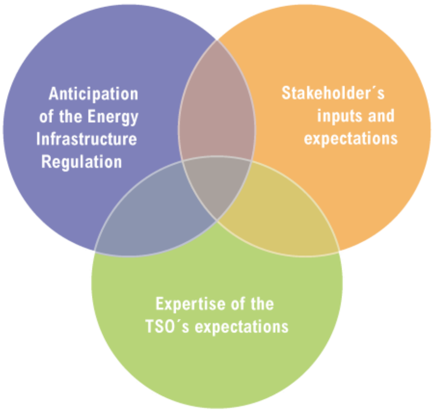
1.3 A top-down, open and constantly improving process



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

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

- Public workshops and consultations[1]: non-specific conferences and events, where ENTSO-E has been invited to, in total 17 dedicated workshops, in Brussels or regional, and six consultations paved the construction of the scenarios (the so-called "Visions"), the preparation of the CBA methodology and the production of first results and project assessments. The last consultation on scenarios was concluded in October 2013.
- A "Long Term Network Development Stakeholders Group[2]", gathering 15 members, aiming at debating and finalising the methodology (scenarios, CBA) improvements, regarding the TYNDP itself or grid development more generally. The group contributed in particular to refining the social and environmental indicator of the CBA and rethinking the basis for more transparent scenario development.
- A non-discriminatory framework enabling non-ENTSO-E Members to submit transmission and storage project candidates for assessment. Two submission windows were opened officially in February and in September 2013.
- Dedicated bilateral meetings, especially with DG Energy, ACER and market players also contributed to share concerns, jointly develop more and more harmonized methodologies and agree on the expected outcomes of the process.

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

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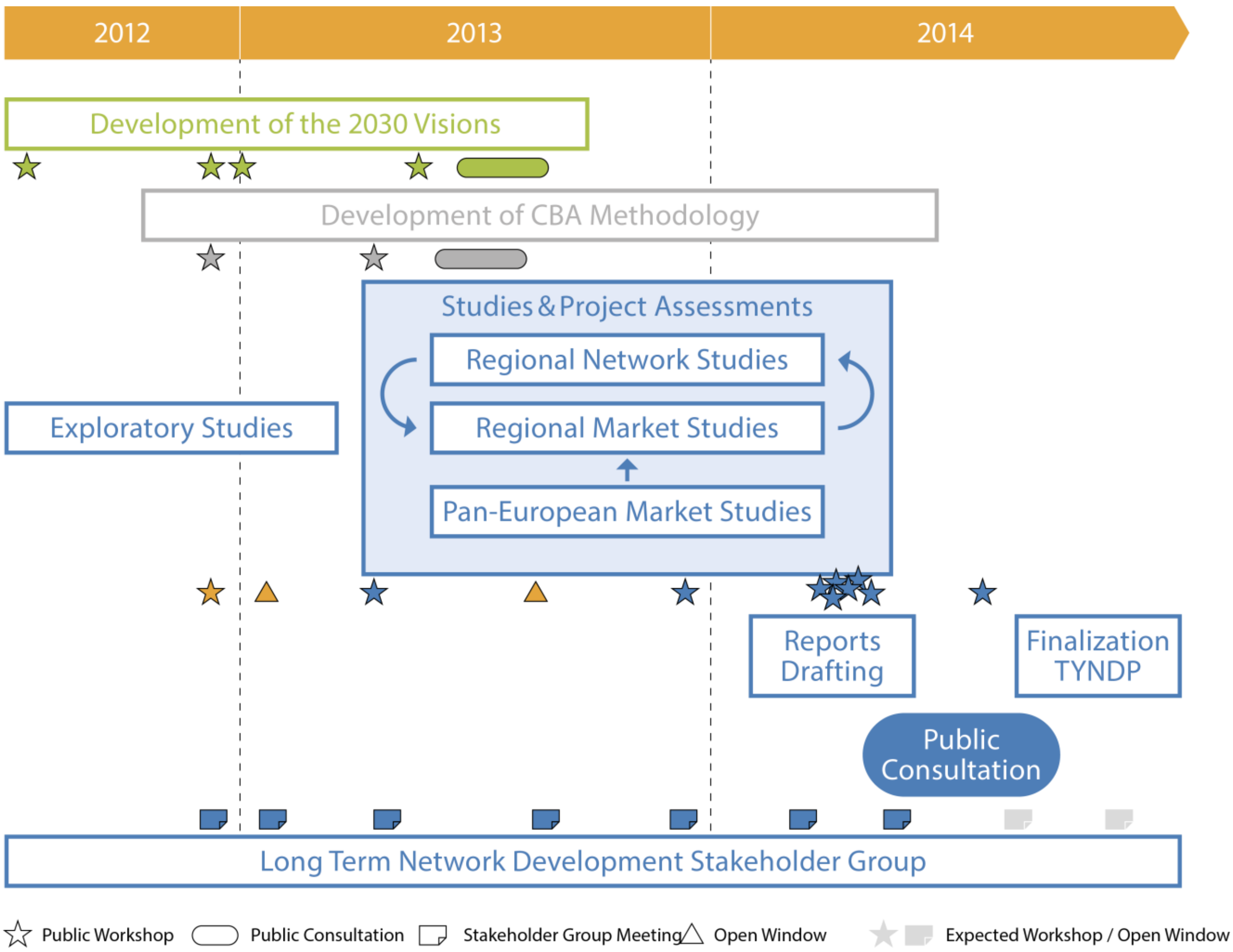

Figure 1-1 Overview of the TYNDP 2014 process

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

- ENTSO-E started drafting and consulting the CBA methodology in 2012 and has tested it over the whole TYNDP 2014 portfolio even before the validation of the CBA methodology in September 2014. The CBA is implemented in the TYNDP 2014 for four 2030-Visions. This choice has been made based on stakeholders' feedback, preferring a large scope of contrasted scenarios instead of a more limited number and an intermediate horizon 2020.
- ENTSOE invited non-ENTSO-E Members to submit transmission and storage project candidate for assessment, with the latest submission window, in September 2013.
- ENTSO-E included an assessment of storage projects in the TYNDP 2014 in addition to Transmission projects.

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

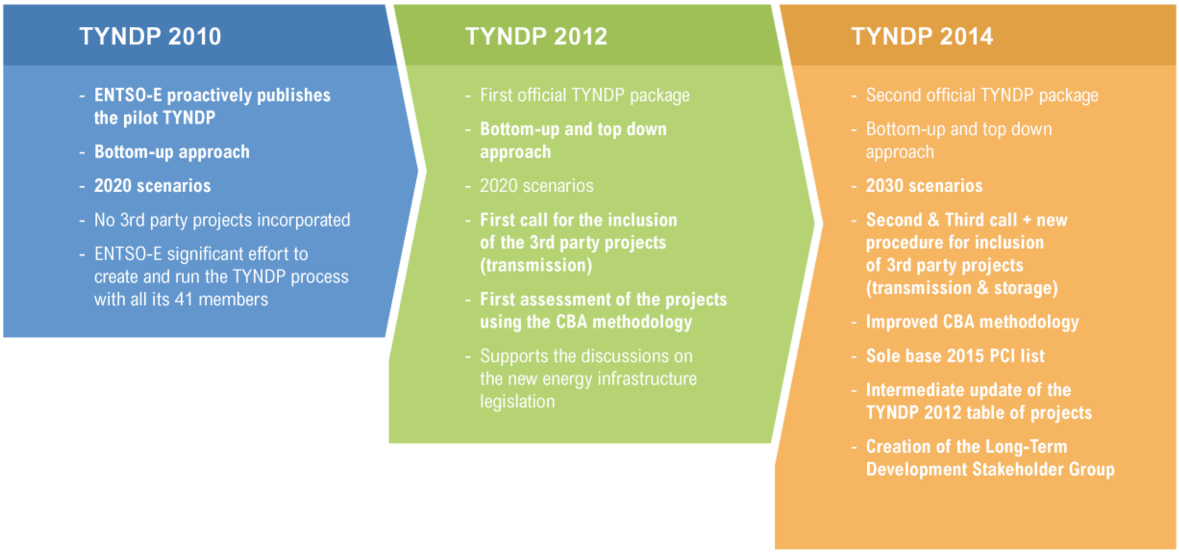

Figure 1-2 Overview of the TYNDP development over the versions

1.4 Regional Investment Plan of the Continental South East Regional Group

This report at hand is the 2014 release of the Regional Investment Plan of the Continental South East Regional Group. The Continental South East Regional Group (CSE RG) under the scope of the ENTSO-E System Development Committee is among the 6 regional groups for grid planning and system development tasks. The countries belonging to each group are shown in Figure 1.1-3 below. CSE RG itself consists of 11 countries: Bulgaria, Bosnia and Herzegovina, Croatia, FYR of Macedonia, Hungary, Greece, Italy, Montenegro, Serbia, Slovenia and Romania; with the involvement of 11 companies / TSOs : ESO, NOS BiH, HOPS, MEPSO, MAVIR ZRt, IPTO, TERNA, CGES, EMS, ELES and TRANSELECTRICA.

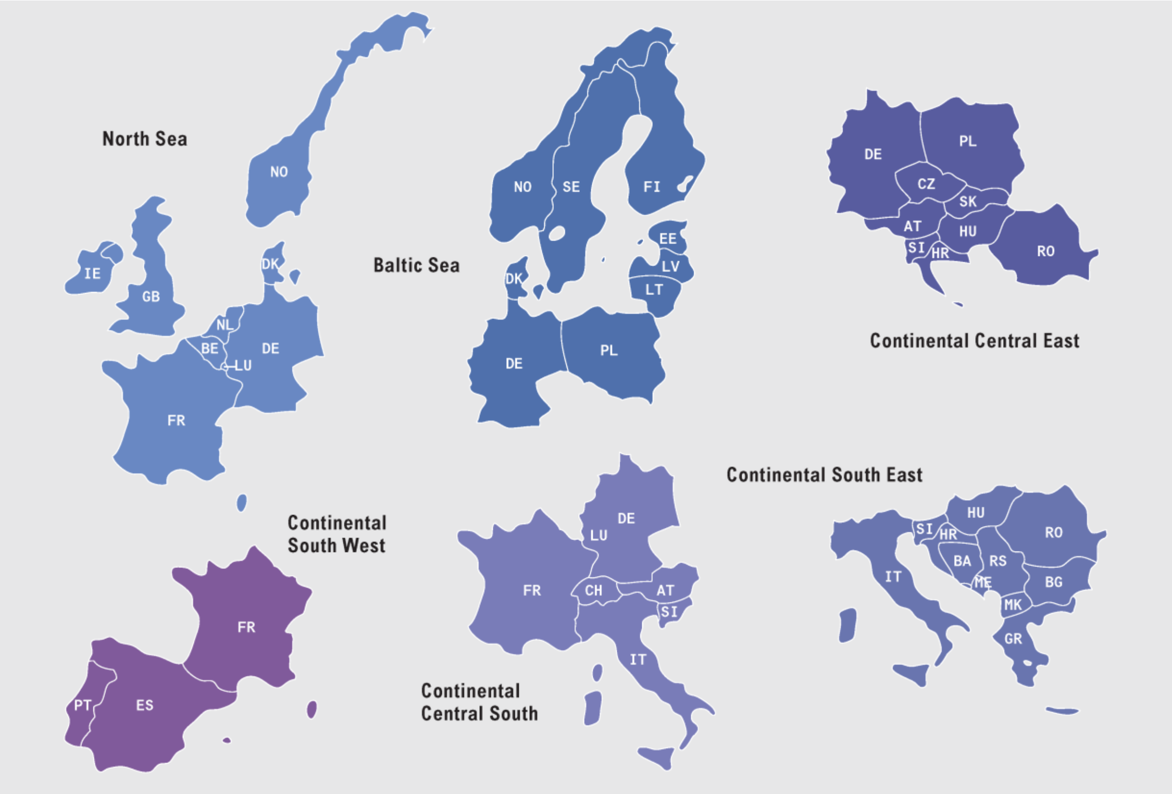

Figure 1.1-3 ENTSO-E regions (System Development Committee)

1.5 How to read the Regional Investment plan 2014

The document is structured in the following way:

- Chapter 0: Executive summary.
- Chapter 1: the present Introduction.
- Chapter 2: Methodology describes the overall process and specific methods used to elaborate the TYNDP 2014 package. (Regional parameters used to apply the methodology, as the case may be, or specific regional outlooks are presented in the Regional Investment Plans.)
- Chapter 3: Scenarios gives only a synthetic overview of the basic scenarios underlying the present TYNDP. (The detailed description of the scenarios and the generation adequacy forecast is in the SOAF 2014 report.)
- Chapter 4: Investment needs exposes the evolution of the European grid capacity from the present situation, highlighting the drivers of grid development, location of grid bottlenecks in ten-year time and bulk power flows across these bottlenecks.
- Chapter 5: Projects portfolio presents a synthetic overview of all planned projects of pan-European significance. (The technical details of the projects are in Appendix 1; see also the Regional Investment Plans.)
- Chapter 6: Transmission adequacy sums up the improved situation in ten-year time with all projects of pan-European significance implemented, provided target capacities for 2030 in every Vision.
- Chapter 7: Environmental concerns sums up the environmental impact of the planned projects.

- Chapter 8: Assessment of resilience resets the planned projects in larger and farther-looking perspective.
- Chapter 9: Assessment of TYNDP 2012 points out the main changes that have occurred with respect to the investments presented in the TYNDP 2012 submission.
- Chapter 10: Conclusion.
- Appendix 1: Sums up all the information regarding projects of Pan-European significance. ‘Transmission’ PCIs among them are specifically marked and can be easily located thanks to a specific correspondence table. ‘Storage’ PCIs are grouped in a separate list. ‘Smart grid’ PCIs are also reminded in a separate list (but are not subject to assessment in the TYNDP).
- Appendix 2: Provides a short description of the methodology applied for the Regional market and network studies
- Appendix 3: Includes results derived from the Regional network studies
- Appendix 4: Provides information for the distribution of bulk power flows in the 4 Visions
- Appendix 5: Includes a table of projects of National interest
- Appendix 6: Supplies the definition of key-concepts and a glossary.

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2 Methodology and Assumptions

2.1 General overview of the TYNDP 2014 process

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

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

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

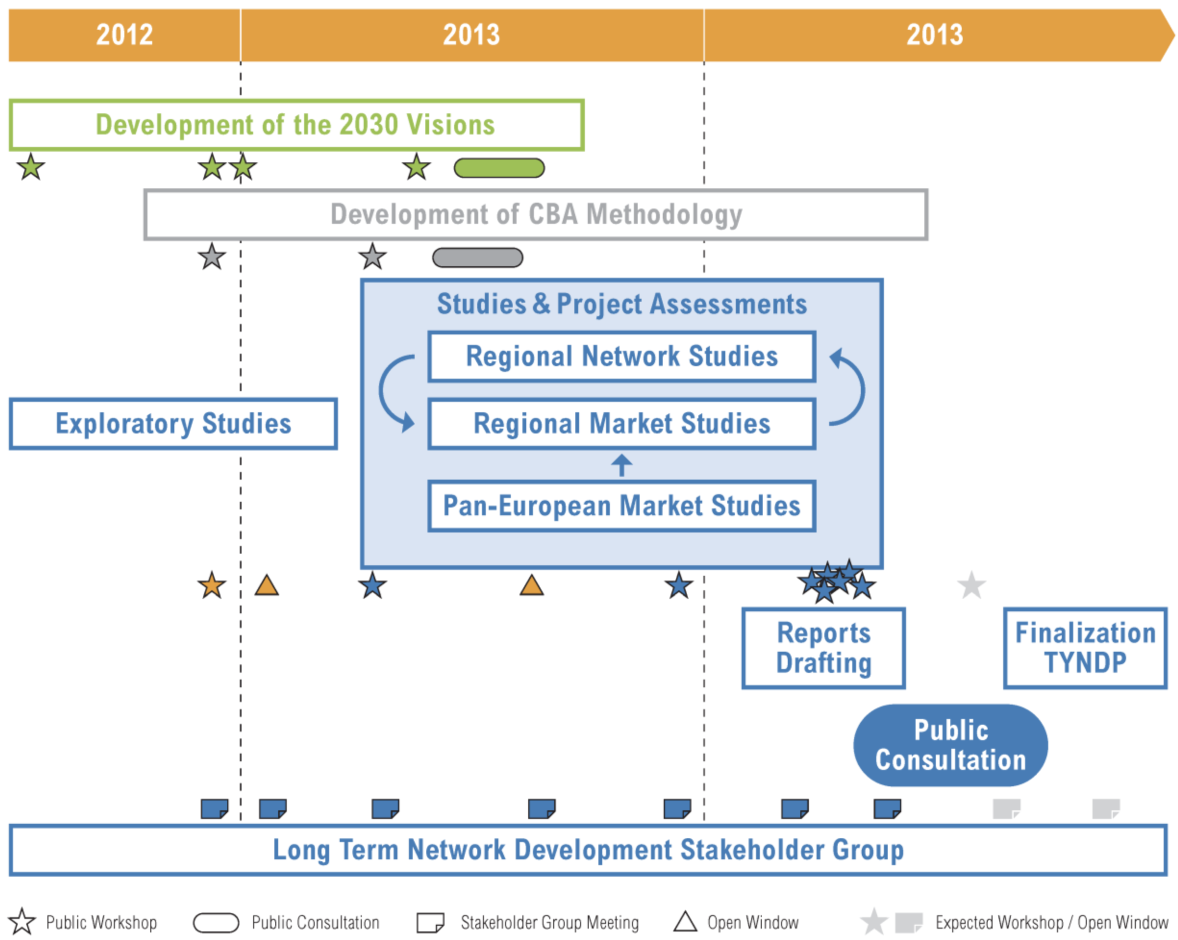

Figure 2-1 Overview of the TYNDP 2014 process

2.1.1 Scenarios to encompass all possible futures

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

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

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

- The trajectory toward the Energy roadmap 2050: Visions 3 and 4 maintain a regular pace from now until 2050, whereas Visions 1 and 2 assume a slower start before an acceleration after 2030. Fuel and CO2 price are in favour of coal in Visions 1 and 2 while gas is favoured in Visions 3 and 4.
- The consistency of the generation mix development strategy: Visions 1 and 3 build from the bottom-up for each country's energy policy with common guidelines; Visions 2 and 4 assume a top-down approach, with a more harmonised European integration.

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

2.1.2 A joint exploration of the future

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

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

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

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

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

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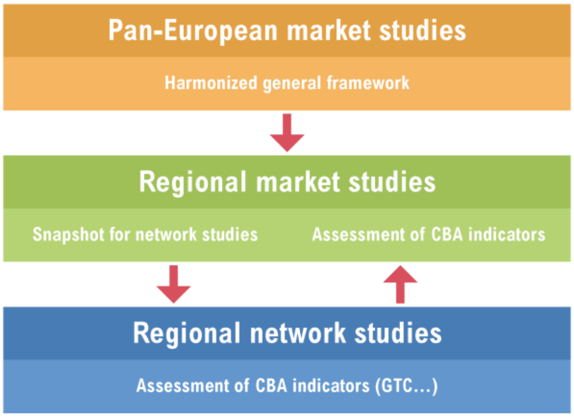

Figure 2-2 An iterative process towards the preparation of TYNDP 2014

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

- define parameters and datasets necessary to perform the market simulation based on the four 2030 Visions developed.
- provide the boundary conditions for the regional market studies necessary to ensure a consistent and harmonised framework for the regional assessment of the projects with the CBA methodology.

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

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

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

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

2.1.4 A TYNDP 2014 built with active involvement from stakeholders

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

Table 2-1 Example of stakeholder involvement

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

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

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

The LTND SG also organised a task force to provide recommendations on the involvement of stakeholders in the scenario building for future releases of the TYNDP. The report is published together with the TYNDP 2014 package[3].

2.2 Implementation of Cost Benefit Analysis (CBA)

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

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

[3] Link to the report.

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

ENTSO-E developed the Cost Benefits Methodology

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

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

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

2.2.1 Scope of Cost Benefit Analysis

Regulation (EU) No 347/2013, in force since 15 May 2013, aims to ensure strategic energy networks[4] by 2020. To this end, the Regulation proposes a regime of "common interest" for trans-European transmission grid projects contributing to implementing these priority projects (Projects of Common Interest; PCIs), and entrusts ENTSO-E with the responsibility of establishing a cost benefit methodology[5] with the following goals:

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

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

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

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

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

This set of common indicators forms a complete and solid basis both for project evaluation within the TYNDP and for the PCI selection process. With a multi-criteria approach, the projects can be ranked by the Member States in the groups foreseen by Regulation 347/2013. Art 4.2.4 states: « each Group shall determine its assessment method on the basis of the aggregated contribution to the criteria […] this assessment shall lead to a ranking of projects for internal use of the Group. Neither the regional list nor the Union list shall contain any ranking, nor shall the ranking be used for any subsequent purpose ».

The CBA assesses both electricity transmission and storage projects.

2.2.2 A multicriteria assessment

The cost benefit analysis framework is a multi-criteria assessment, complying with Article 11 and Annexes IV and V of Regulation (EU) 347/2013.

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

- To enable an appreciation of project benefits in terms of EU network objectives.
- To ensure the development of a single European grid to permit the EU climate policy and sustainability objectives (RES, energy efficiency, CO2).
- To guarantee security of supply.
- To complete the internal energy market, especially through a contribution to increased socio-economic welfare.
- To ensure the technical resilience of the system.
- To provide a measurement of project costs and feasibility (especially environmental and social viability).

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

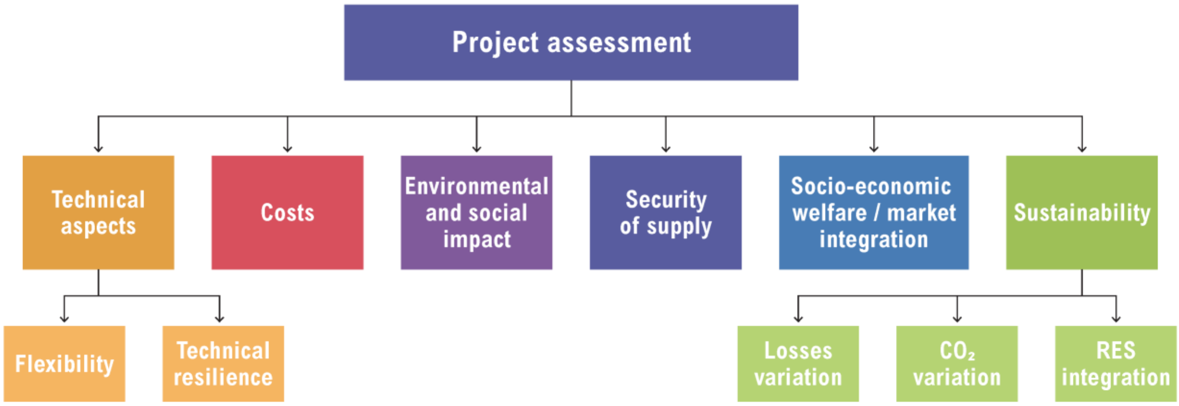

Figure 2-4 Main categories of the project assessment methodology

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

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

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

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

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

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

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

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

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

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

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

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

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

The **project impact on the surrounding areas** is defined as follows:

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

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

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

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

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

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

2.2.3 Implementation of CBA in the TYNDP 2014

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

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

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

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in an area, although no spillage is entailed resp. to solve local SoS issues. However, the pan-European modelling implied by the CBA is too broad to capture these effects and underestimates the benefits. This is commented in the projects assessments sheets, whenever appropriate.

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

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

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

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

The largest investment needs (e.g. offshore wind power to load centres in Germany, the Balkan corridor, etc.) may require some 30 investments items, scheduled over more than five years but addressing the same concern. In this case, for the sake of transparency, they are formally presented in a series of smaller projects, each matching the clustering rules, with related assessments; however, an introductory section explains the overall consistency of the bigger picture and how each project contributes to it.

2.3 Purpose of Market Studies

The purpose of Market Studies is to answer the question "which generation (location/type) is going to serve which demand (location) in any future instant?". In this sense the purpose of Market Studies is a twofold:

- To estimate future energy balances, reliability indices (such as LOLP, LOLE, etc), CO2 emissions, volumes of spilled RES energy etc.
- To provide the hourly distribution of required generation to meet the load among available generations, in order to produce "realistic" snapshots of system operation for every hour of the year.

The dispatch of available generation is performed in order to achieve a least cost dispatch; in this sense the RES plants are dispatched first (having priority in dispatch) while the thermal generation are scheduled according to their intrinsic merit order in each-hour.

All physical generation constraints such as flexibility and availability of thermal units, maintenance requirements, must-run units technical minimum as well as network constraints (transfer capacities) are taken into consideration.

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

Furthermore, the outcomes of the Market Studies are compared to investigate the impact of new projects in terms of economic efficiency as outlined in Chapter 5.

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2.3.1 System modelling

In the framework of the market studies conducted by the RG CSE, all the countries of the Balkan region, including Albania have been modeled in a high degree of detail; Italy has not been fully modeled due to its large size (compared to the rest of the RG CSE), also Italy has been studied by RG CCS.

Due to the modeling approach adopted, a simplified representation of all the other national systems (inside and outside the ENTSO-E perimeter) has been followed. In this respect the power systems at the boundary of the Region were represented with equivalent power flows on the interconnectors. In order to achieve consistency with the results of other regional groups (and mainly the neighboring ones) power flows mentioned previously have been provided by the RG CCS as an output of the corresponding market studies performed by RG CCS.

Concerning the modeling of third countries, Turkish power system has been represented in a simplified manner considering a constant level of power exchanges with the CSE Region. In the framework of 3rd party projects assessment the modeling perimeter has been extended in order also to include Cyprus and Israel. The map shown below depicts graphically these issues.

The estimated loads in the year 2030 have been projected to construct hourly time series for each system (8760 values). The RES plants contribution is also modeled through hourly time series as provided by local TSOS. The convention power plants (thermal, large hydro, pump-storage etc) have been modeled in detail.
The necessary data was obtained mainly by the ENTSO-E PEMDB while standard values, according to ENTSO-E guidelines, were used for thermal efficiency, availability and generation costs, as well as CO2 emission. Additional necessary data (such as technical minimums, must-run units, maintenance requirements etc.) have been provided directly from the TSOs of the CSE-RG, including among other things a detailed mapping of all generators in the network model in order to link each generator to a specific generation type.

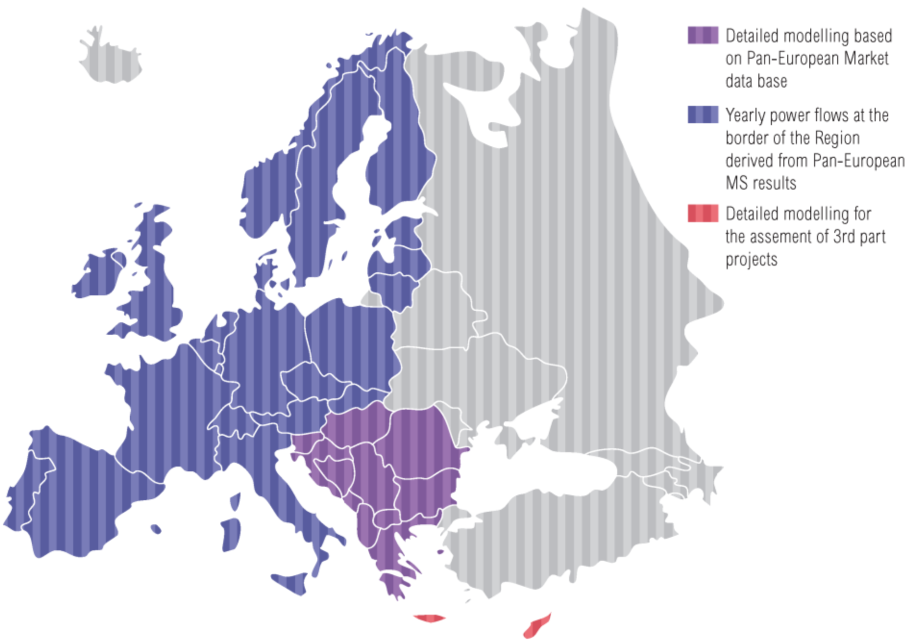

Figure 2-5. Power system modeling in market studies

2.3.2 Tools Used for Market Studies

The market studies were performed using the PROSIM tool which is a software application for the simulation of generation systems using either deterministic or probabilistic approach. The tool is an in-house software and has been developed by IPTO. PROSIM environment has been extended to take into account the transmission system and transmission constraints using a DG load flow module. Annual market simulations are performed on an hourly basis, leading to a least-cost economical dispatch of all available generation. Based on the hourly market simulation results, DC power flows are performed (using the full network model of the region), thus providing the loading duration curves of critical network elements. The probabilistic methodology applied, allows to take into account the forced outage rates of units as well as to determine the reliability of the system in terms of the Loss of Load Propability (LOLP) and Expected Unserved Energy (EUE). Network constraints are taken into account, in terms of thermal ratings of the interconnectors and GTC values computed over specific boundaries. In cases that during the optimal dispatching process, a grid constraint violation appears, a linear optimisation problem is solved in order to find the minimum cost deviation from the initial "optimal generation scheme that results in power flows respecting the grid constraints. A detailed description of both the methodology and algorithms used can be found in Appendix 2.

2.4 Network Studies Methodology

Network studies are extensively performed for all scenarios/visions in order to check the technical resilience of the transmission grid to cope with the needs; i.e network studies answer the question "will the dispatch of generation and load given in every case generated by the market study result in power flows that endanger the safe operation of the system? This process includes steady-state security assessment with respect to the well-known N-1 criterion.
More specifically, credible snapshots are selected and analyzed in order to calculate the power flows in all system elements based on the "optimum" generation dispatch as resulted by the market studies. The snapshots selected aim to analyze a variety of dispatch situations: frequent ones, or rare ones but resulting in particularly extreme flow patterns.

For each snapshot the smooth and secure system operation is checked in terms of thermal limits of transmission elements and voltage profiles by performing load flow calculations in N and N-1 system conditions.

2.4.1 Market Studies as an Input to the Network Studies

Input to common network studies is regional network topology. National transmission system models were merged into the regional network model which represents the basis for the network related analysis within the TYNDP 2014 process.

In order to achieve realistic representation of system conditions within one year and consequently to provide proper assessment of the projects, the hourly dispatch of generators has to be transferred to the grid models in order to achieve "realistic" load flow cases that should be checked in terms of system static security.

Under this approach, the results by the market simulations (i.e. the distribution of the necessary production to meet the loads among the available generators) are input to provide a load flow snapshot for each hour (8760 snapshots per year). For each hour/snapshot a DC load flow calculation is performed in order to estimate the physical flow across all transmission system elements.

Furthermore, the most interesting/credible snapshots/cases are selected for detailed static security assessment (respect to N-1 criterion) using AC load flow calculations.

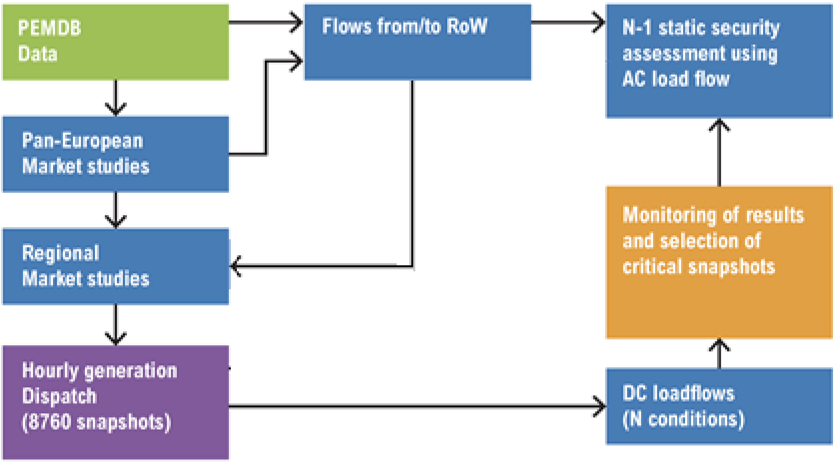

Figure 2-6. Overview of the process and link between Market Studies and Network Studies

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

Sensitivity of the regional network to the different exchange patterns with the power system outside the modelled area is also conducted using critical snapshots from market studies.

2.4.2 Network Studies Tools

In the framework of TYNDP 2014 Macro procedure, European TSOs have gathered network models in CIM exchange format for WP2030. Collecting the models has been done via centralized NMD database.

Software tools used by TSOs in CSE region are presented in following table.

Country	Software for CIM format	Software for grid analyses
Greece	ODMS	PSS/E
Bulgaria	PSLF	PSS/E
FYR Macedonia	ODMS	PSS/E
Serbia	TNA	PSS/E
Romania	ODMS	PSS/E
Hungary	ODMS	PSS/E
Bosnia and Herzegovina	TNA	PSS/E
Montenegro	TNA	PSS/E
Slovenia	NEPLAN	NEPLAN
Croatia	ODMS	PSS/E
Italy	SPIRA	

Although Albania and Turkey are not ENTSO-E members but considering joint operation of their power systems with the CSE Region, also the Albanian and one part of the Turkish model (European part of the grid) are included in regional model.

PSS/E load flow module was used for assessment of network related benefit indicators. Additionally, for assessment of Grid Transfer Capability, module “PSS/E Must” was used since it employs very fast incremental linear model with power transfer distribution factors around non-linear AC starting flows and results for each project can be produced very quickly.

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3 Scenarios

3.1 Description of the four 2030 visions

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

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

The Visions are not forecasts and there is no probability attached to them. In addition, these visions are not optimized scenario (e.g. no assessment was performed of where the solar development would be the most economically viable). These Visions also have no adequacy analysis associated with them and are based on previous ENTSO-E and regional market studies, public economic analyses and existing European documents.

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

The TYNDP 2014 uses 4 scenarios to assess the project portfolio on the Cost Benefit Analysis methodology:

– 2 bottom-up (vision 1 and 3): result from the input received from the national correspondents based on the common European guidelines.
– 2 top down (vision 2 and 4): are developed at the European level. These visions are based on data provided by the TSOs for the bottom-up visions which is further modified in order to reflect the assumptions[17] established for the studied visions.

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

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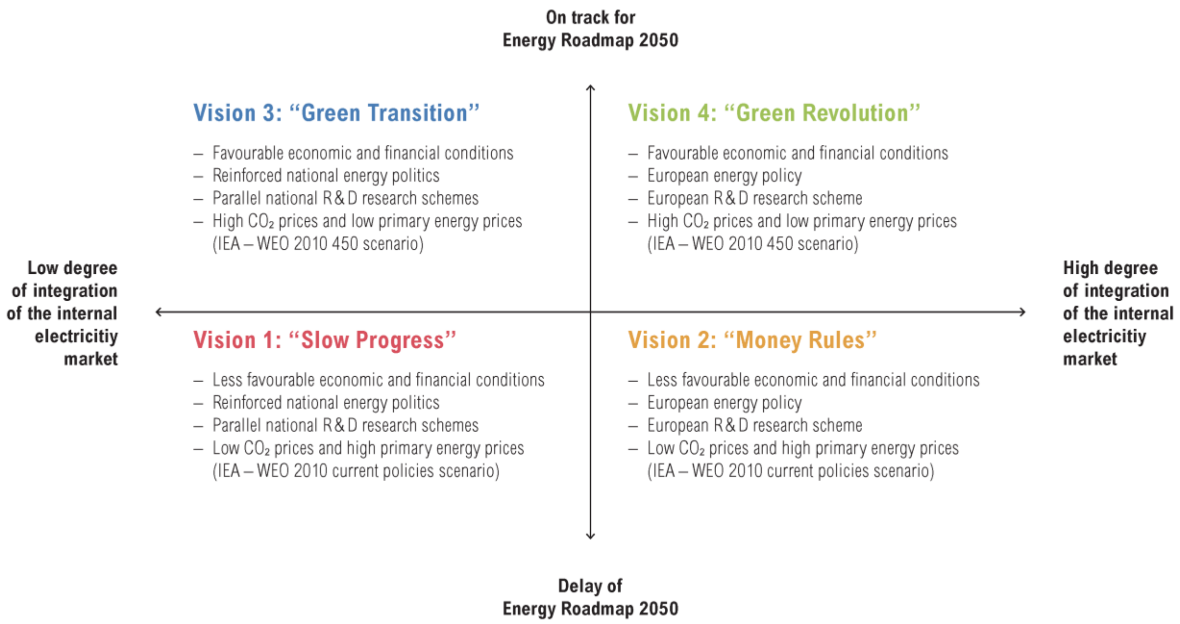

Figure 3-1 Overview of the political and economic frameworks of the four visions

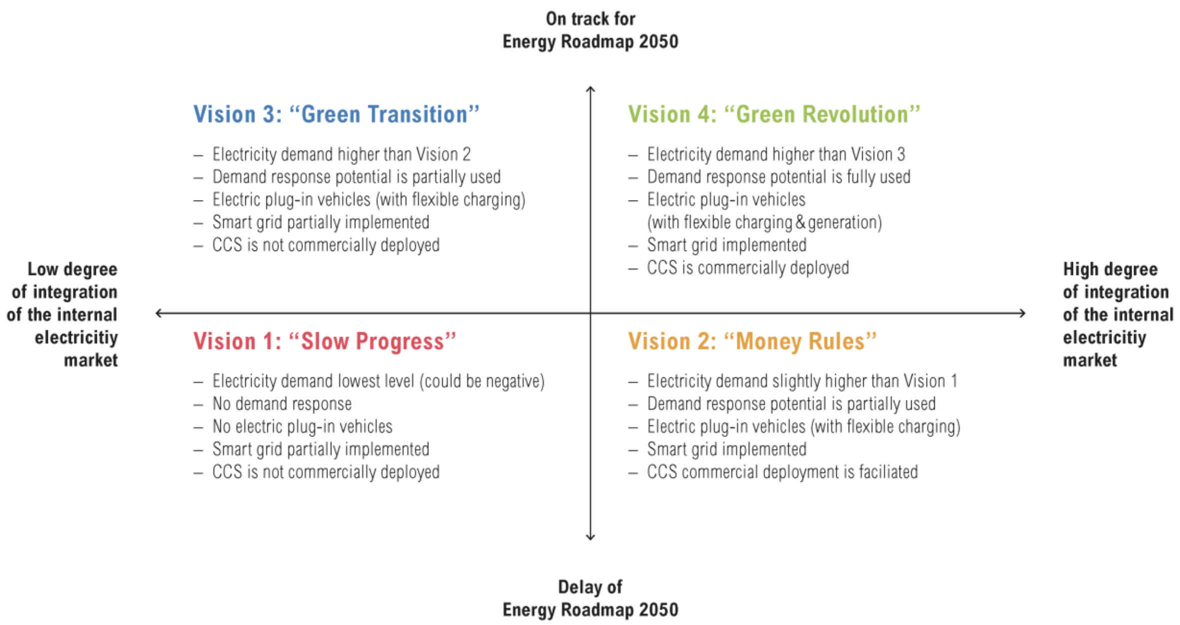

Figure 3-2 Overview of the generation and load frameworks of the four visions

Differences in the high-level assumptions of the Visions are manifested among others in quite different fuel and CO_2 prices sets, in Visions 3 and 4, compared to Visions 1 and 2, resulting in a reversed merit order of gas and coal units.

3.2 Vision 1

The first scenario analysed in the framework of TYNDP 2014 is the so called "Slow progress" scenario (following Vision 1). The vision 1 dataset is originally submitted to ENTSO-E by all national LACs (Long term Adequacy Correspondents) applying a set of guidelines developed by ENTSO-E. It reflects a slow progress in energy system development with less favourable economic and financial conditions. Vision 1 is also the Vision with the lowest increase of green energy.

In this paragraph will be reported the main data, with special regard about load, balance and generation for Continental South East countries as obtained in Vision 1 (details of tools used and system modelling reported in par.2.3 and par.2.4).

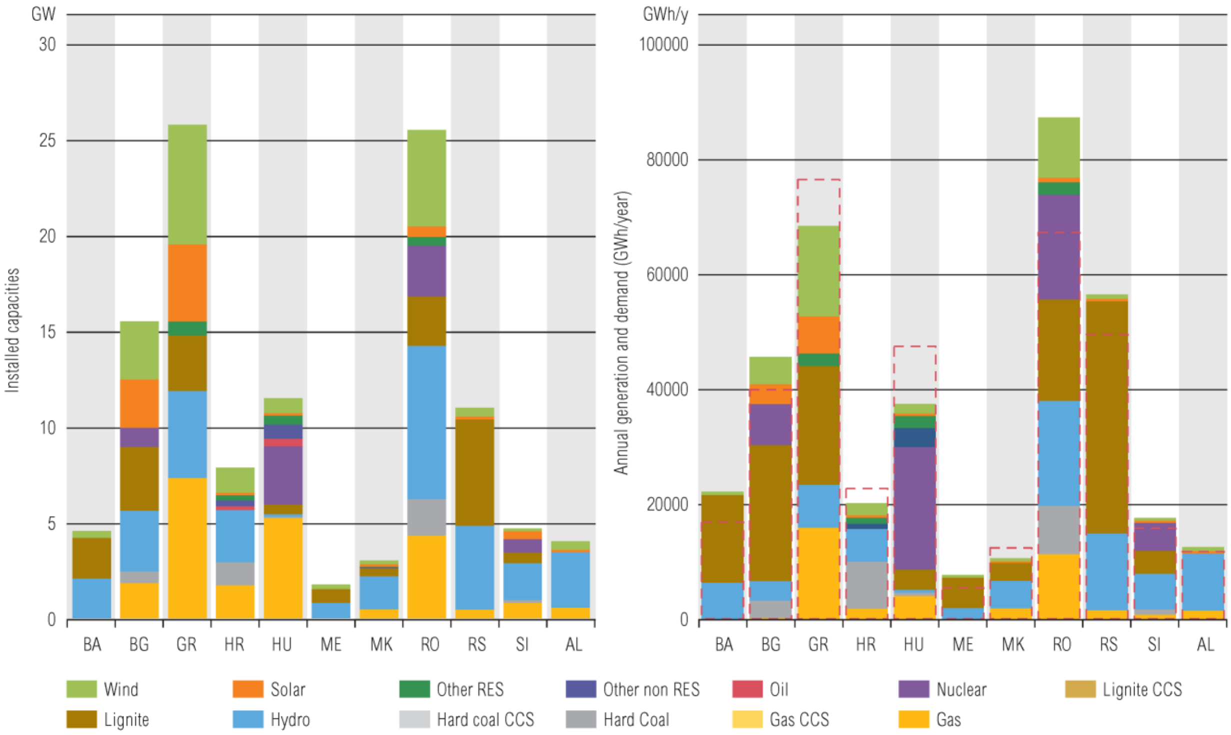

Figure 3-3 (left) Installed capacity in vision 1 in RG CSE - Figure 3-4 (right) Annual generation and demand in vision 1 in RG CSE

Figure 3-3 depicts installed generation capacity and Figure 3-4 (right) depicts annual produced energy per fuel type as well as demand for each country of the Region. Compared to the expected installed capacities reported in the TYNDP 2012 for 2020, in total no major increase is identified. This is because the CSE total for the scenario EU2020 was 113GW and for the scenario B was 110 GW while for Vision 1 is 114GW. However, moving from 2020 to 2030, with respect to Vision 1, a decrease is expected to the total installed capacity of lignite units together with an increase of the installed capacity of natural gas and solar units.

Concerning the annual energy balances, it is worth mentioning that exporters of the Region are RO, BG, RS BA, SI and AL in the order of their annual energy balance. This can be attributed to their "cheap" generation portfolio, that includes nuclear and lignite units. In Vision 1 the area is an exporter with an annual energy balance of 20.2TWh. A comparison in electricity demand figures for the CSE Region between 2020 and 2030 shows an 8% increase in annual energy consumption and a 6% increase in annual peak load.

Figure 3-5 shows yearly average figures regarding marginal cost per country and cost differences between the countries of the Region. This information aims at providing a general trend:

- RO, BG, RS, ME and BA are on average cheaper than the rest of the countries of the Region.
- As a result, price differences between this group of countries and the rest of the Region (including IT) is rather high since in many cases exceeds 5 Euros/MWh.

Figure 3-6 depicts yearly CO2 emissions for the countries of the CSE Region as well as annual average values of CO2 emissions per GWh. Higher average values appear in countries with a generator portfolio dominated by lignite units. Higher absolute values appear in exporting countries and in GR due to its large consumption. Compared to the level of 1990, CO2 emissions are reduced by 34% in the CSE Region.

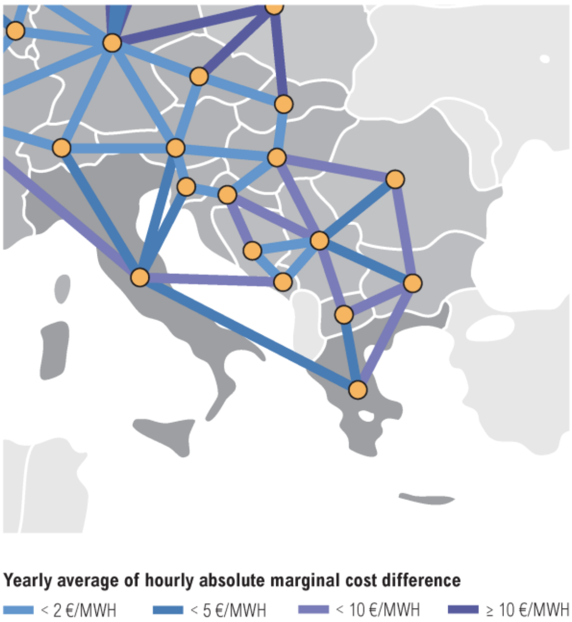

Figure 3-5 Yearly average marginal cost and marginal cost difference in Vision 1 in RG CSE

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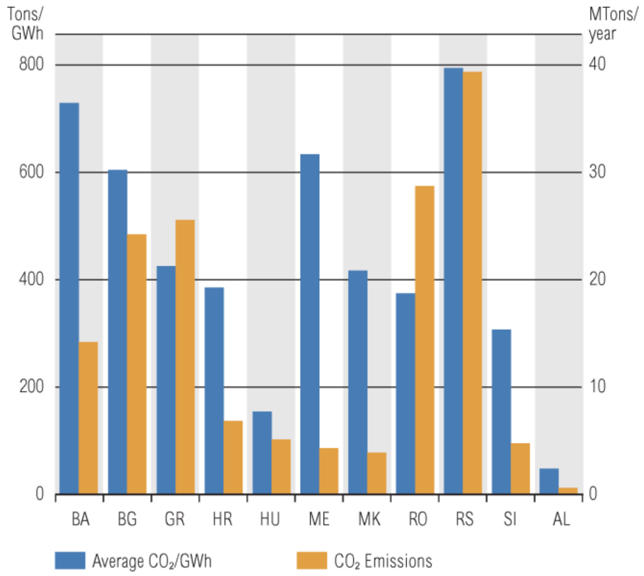

Figure 3-6 CO2 emissions in Vision 1 in RG CSE

3.3 Vision 2

The second scenario analysed is the "money rules" scenario (following Vision2). As mentioned above this is a top-down scenario derived from Vision1. Vision 2 has the same generation framework with Vision 1 and the same CO2 and primary energy prices are considered. However demand in Vision2 is higher than Vision1.

As can be seen in Figure 3-7 generation portfolio is the same with Vision1. As can be also seen below the share of each fuel is the same with Vision 1 for all countries. However generation is higher due to the higher demand. Exporting countries are also the same like in Vision 1. In Vision 2 the Region is an exporter with an annual energy balance of 26.4TWh.

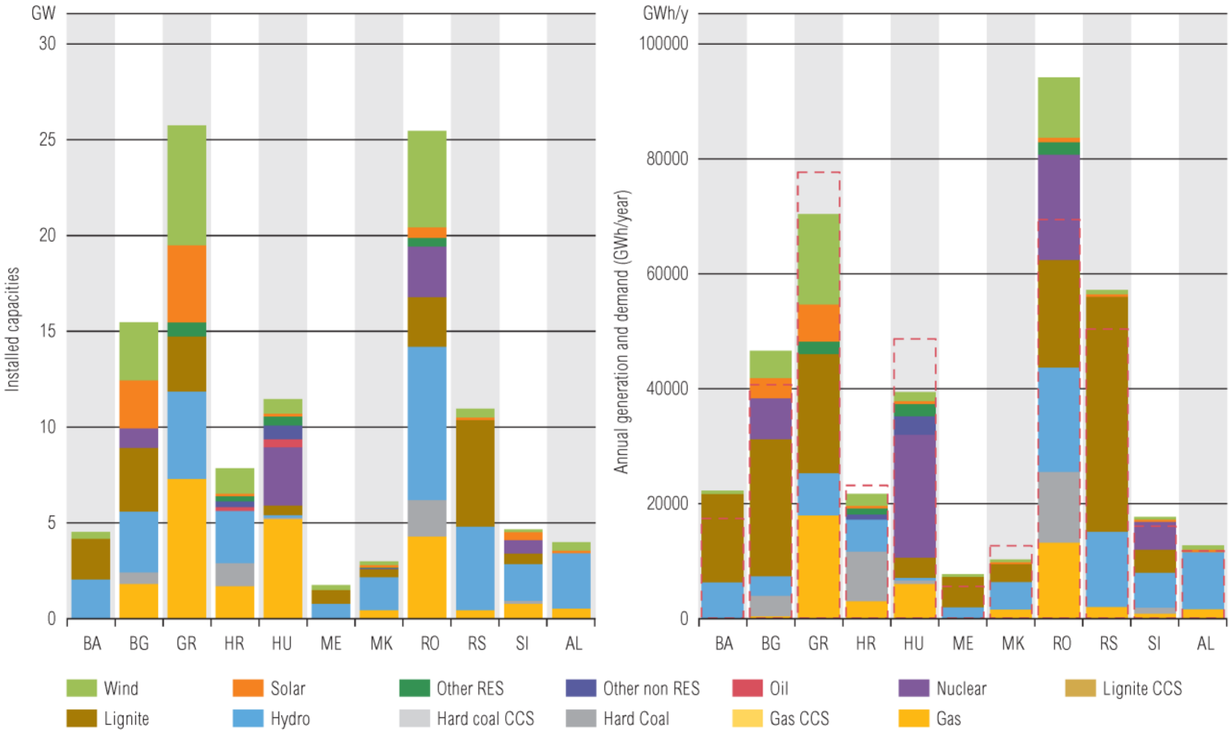

Figure 3-7 (left) Installed capacity in vision 2 in RG CSE Figure 3-8 (right) Annual generation and demand in vision 2 in RG CSE

Figure 3-9 depicts yearly average figures regarding marginal cost per country and cost differences between the countries of the Region. This information aims at providing a general trend:

- On average most of the countries in the Region, with the exception of GR, have the same yearly average marginal cost.
- As a result, price differences are smaller compared to Vision 1 and in most of the cases less than 2Euros/MWh.

Figure 3-10 depicts yearly CO2 emissions for the countries of the CSE Region as well as annual average values of CO2 emissions per GWh in Vision2. Compared to the level of 1990, CO2 emissions are reduced by 31% in the CSE Region.

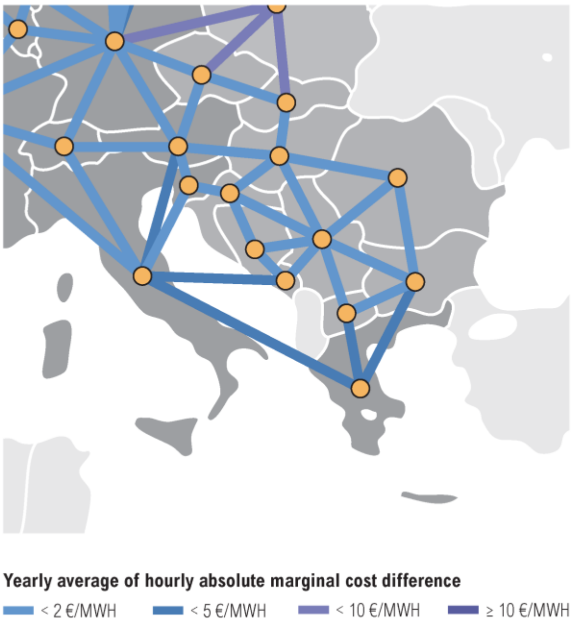

Figure 3-9 Yearly average marginal cost and marginal cost difference in Vision 2 in RG CSE

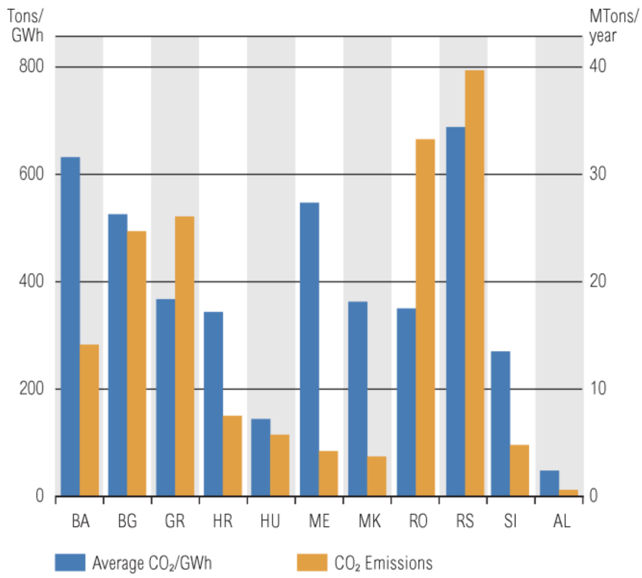

Figure 3-10 CO2 emissions in Vision 2 in RG CSE

3.4 Vision 3

The third scenario analysed is the "Green transition" scenario (following Vision3). It reflects a higher system development towards the 2050 roadmap with more favourable economic and financial conditions. In this context, it assumes a higher increase of green energy. Similar to Vision 1 it is a "bottom-up" scenario.

Figure 3-11 depicts installed generation per country. Compared to the figures reported in TYNDP 2012 for the year 2020, an increase of total installed capacity in the area is considered for Vision 3 up to 130GW. The generation portfolio is also differentiated due to a decrease in lignite units and an increase in gas units and renewable generation.

In Figure 3-12 showing annual generation and demand for the countries of the Region in Vision 3, can be seen that exporting units in the Region are RO, HU, BG, SI, AL and ME. It is also interesting to note that GR which is an importer in Visions 1 and 2 is almost balanced in this Vision. This can be explained by the fact that in Vision 3 high CO2 prices are assumed resulting in an increased production of gas units as well as by the increased renewable penetration. In Vision 3 the Region is an exporter with an annual energy balance of 8,6TWh.

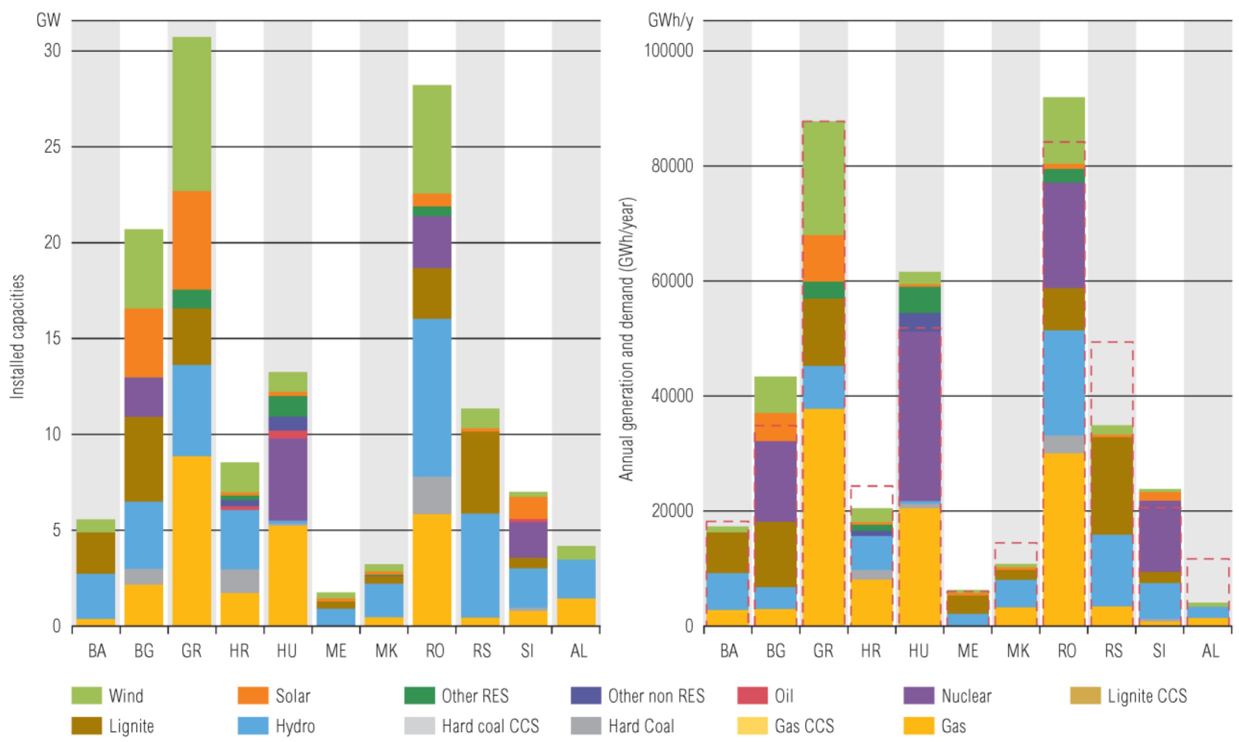

Figure 3-11 (left) Installed capacity in vision 3 in RG CSE - Figure 3-12 (right) Annual generation and demand in vision 3 in RG CSE

Figure 3-13 depicts yearly average figures regarding marginal cost per country and cost differences between the countries of the Region. This information aims at providing a general trend:

- On average the countries of the Region have a higher marginal price compared to Vision 1 and Vision 2 due to the high CO2 prices assumed in Vision 3.
- Highest price differentials appear between Bulgaria and neighboring countries.

Figure 3-14 depicts yearly CO2 emissions for the countries of the CSE Region as well as annual average values of CO2 emissions per GWh in Vision4. Compared to the level of 1990, CO2 emissions are reduced by 58% in the CSE Region

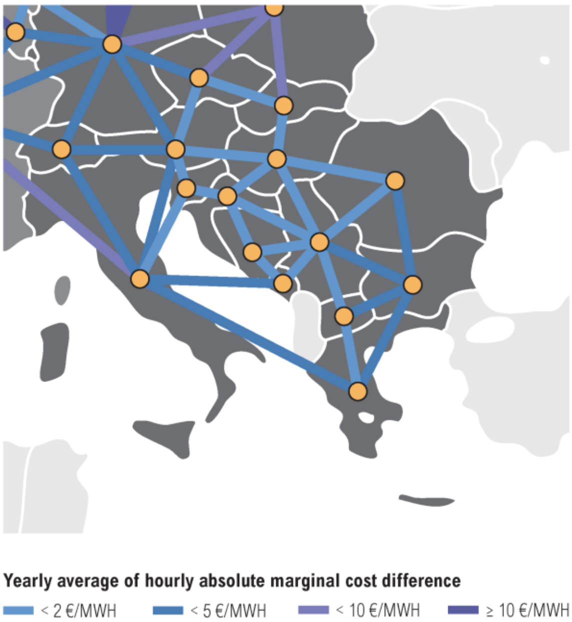

Figure 3-13 Yearly average marginal cost and marginal cost difference in vision 3 in RG CSE

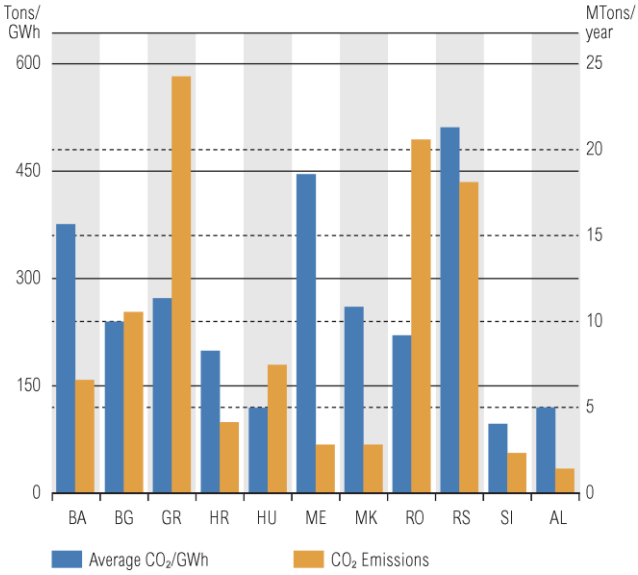

Figure 3-14 CO2 emissions in vision 3 in RG CSE

3.5 Vision 4

The third scenario analysed is the "Green revolution" scenario (following Vision4). As mentioned above, Vision 4 is a "top-down" scenario derived from Vision 3. As such it can be considered as a further evolution of Vision 3 in terms of higher degree of integration of the internal electricity market and a considerably higher RES penetration.

Figure 3-15 depicts installed generation capacity and Figure 3-16 depicts annual produced energy per fuel type as well as demand for each country of the Region. One of the important characteristics of this scenario is the hypothesis of considerable photovoltaic generation installed capacity especially in Greece, Romania and Bulgaria. This assumption constitutes also the major factor for the differentiation of the total installed generation capacity in the region (about 160GW) compared to what has been reported in TYNDP 2012 for the target year 2020.

In this scenario, major exporters of the Region are BG, RO. In Vision 4, CSE Region is an exporter with an annual energy balance of 4.3TWh.

Compared to the electricity demand of the region for 2020 reported in TYNDP 2012, an increase of about 22% is observed for annual energy consumption as well as an increase of about 17.5% in the annual peak load. This must be attributed mostly to the hypothesis in the framework of Vision 4.

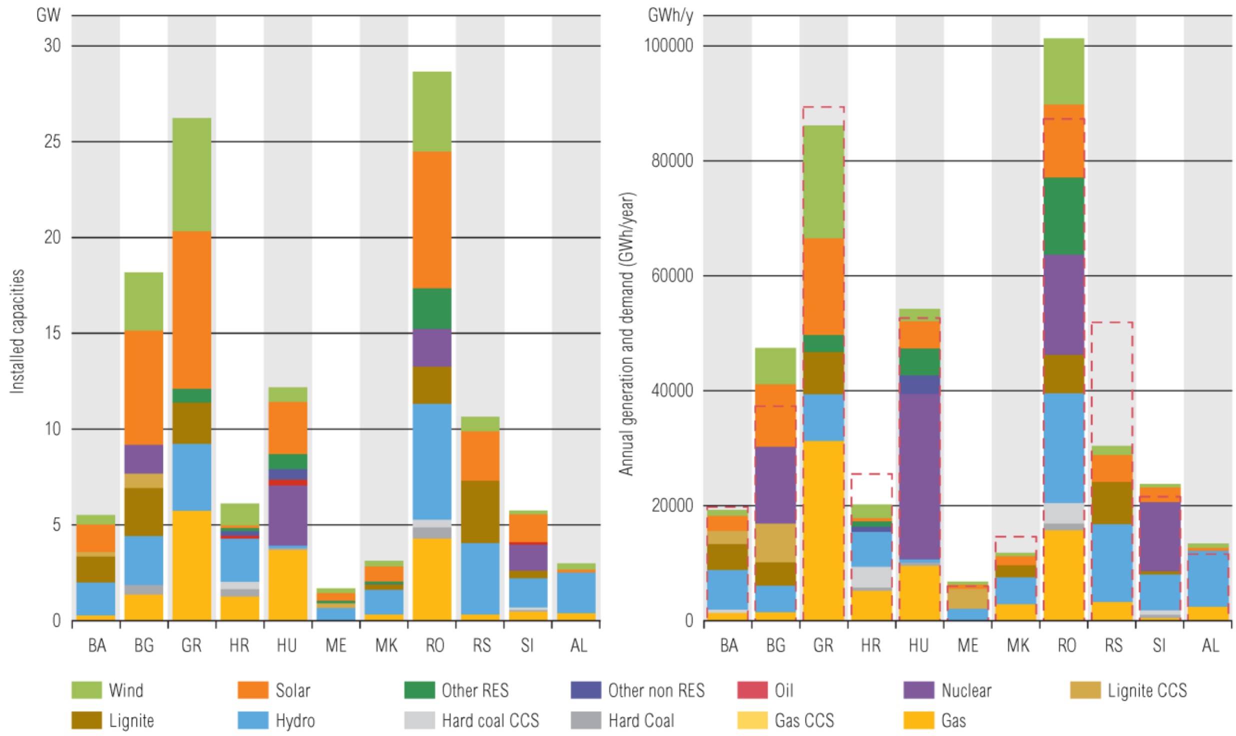

Figure 3-15 (left) Installed capacity in vision 4 in RG CSE - Figure 3-16 (right) Annual generation and demand in vision 4 in RG CSE

Figure 3-17 depicts yearly average figures regarding marginal cost per country and cost differences between the countries of the Region. This information aims at providing a general trend:

- On average the lowest marginal cost appears in BG and RO. This can be attributed to the fact the BG and RO are two of the countries in the Region with the largest RES increase.

- As a result, price differences between these countries and their neighbors are higher than 10Euro/MWh. These differences constitute an indication for the need of higher transfer capacities.

Figure 3-18 depicts yearly CO2 emissions for the countries of the CSE Region as well as annual average values of CO2 emissions per GWh in Vision4. Compared to the level of 1990, CO2 emissions are reduced by 75% in the CSE Region

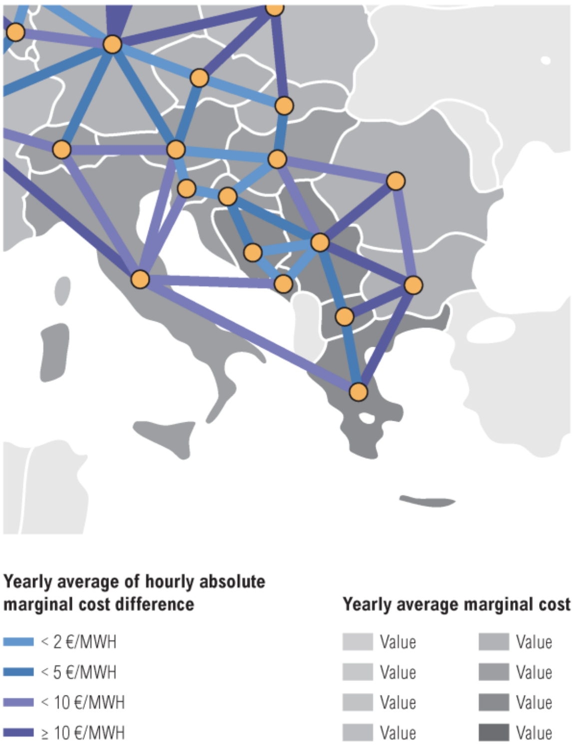

Figure 3-17 Yearly average marginal cost and marginal cost difference in vision 4 in RG CSE

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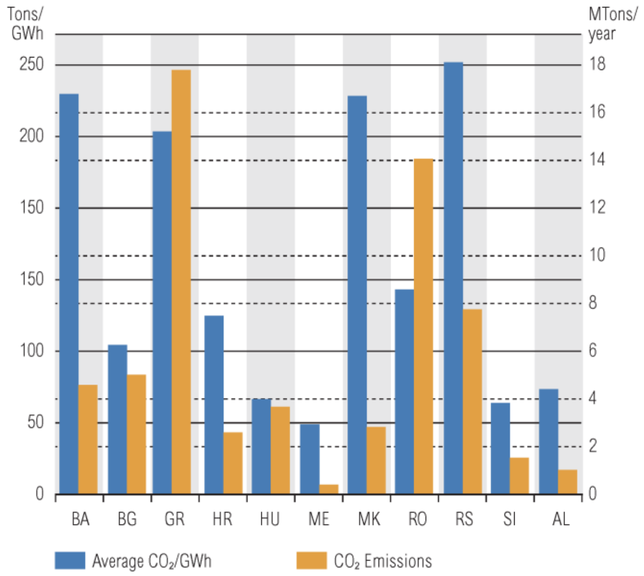

Figure 3-18 CO2 emissions in vision 4 in RG CSE

3.6 Network Studies Results

The main objective of the network studies is to assess the static system security and identify any transmission constraints. For each hour of the year one snapshot of network conditions is constructed based on system topology, expected load distribution among substations and the allocation of necessary production among generators according to the results by the market studies.

As already mentioned in ch. 3.4.1., all system snapshots (8760) are assessed for N conditions through DC load flow calculations.

Furthermore, some critical snapshots (Points in Time) that seem interesting are analysed in detail by applying N-1 static security criterion, utilizing AC load flow calculations. Results by the network studies are the main input for the computation of the following CBA indicators: losses, grid transfer capacities and resilience. Based on the specifics of each vision, results by network studies can identify different constraints and/or load flow patterns for each vision. Next sections analyze briefly the main findings per vision. Also the main conclusions derived from a sensitivity analysis of power flows in the main corridors; with respect to the conditions of the exchanges with the Turkish power system are also included.

3.6.1 Vision 1 Results

Vision 1 – "slow progress" – is mainly a bottom-up scenario characterized by a slow rate of electricity demand and a base load electricity based on lignite and hard coal. For Vision 1, the snapshots opted as "critical" and "most interesting" and were analysed in detail (N-1 static security assessment) seem to be the ones that fit to the following attributes:

- High level of load – high level of production from renewable sources
- High level of load – low level of production from renewable sources
- Low level of load – high level of production from renewable sources
- High level of import or export from the CSE region

As Vision 1 is a scenario with low rate of consumption growth and medium volume of RES penetration, no major differences are noticed compared to the TYNDP 2012 situation concerning the load flow patterns. Predominant load flow directions (N → S and E → W) still prevail while no major issues raised in terms of overloading and voltage profiles. Nevertheless, the proposed projects have definitely significant positive impact on transfer capacities and facilitate considerably both the market integration and RES penetration.

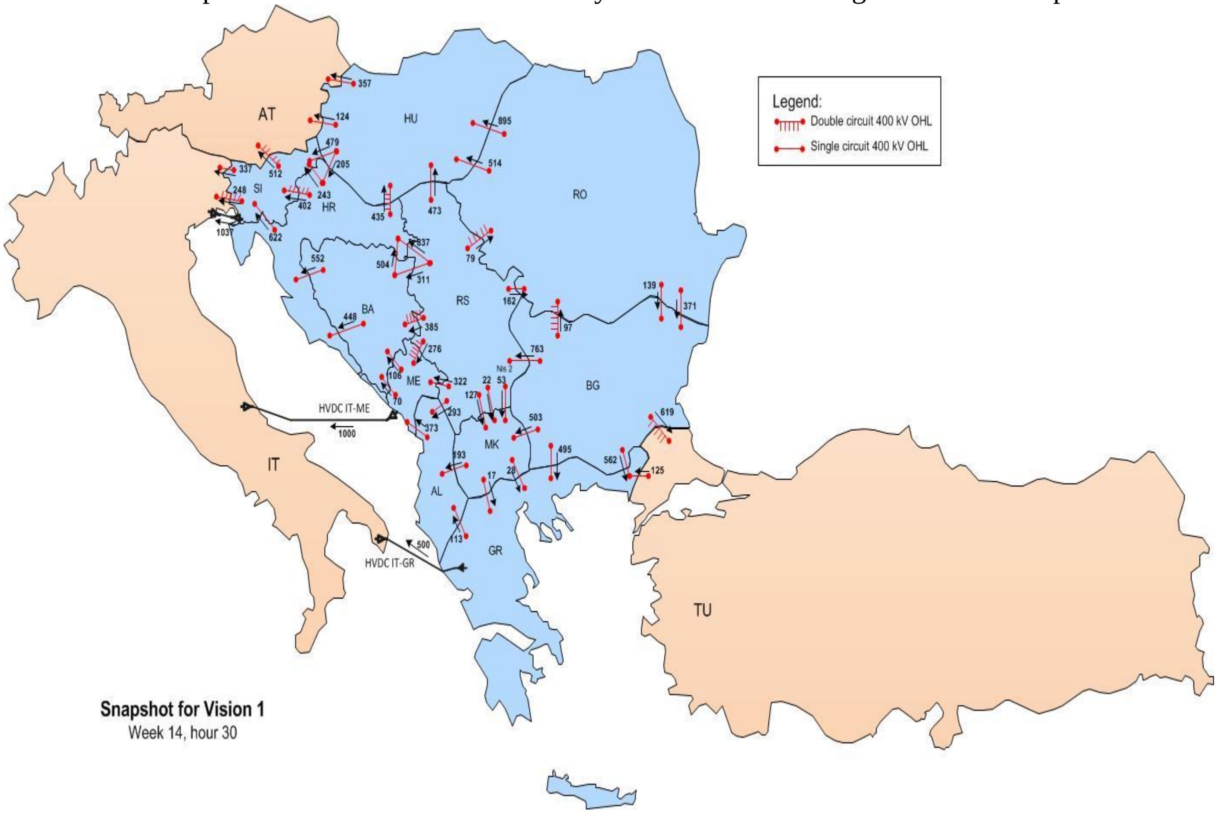

Figure 3-19 Selected snapshot in vision 1

Figure 3-19 presents graphically one of the selected snapshots mentioned above; Figure 3-19 shows the power flows and respective directions of power flow through 400 kV tie lines in the CSE region. This specific snapshot is characterized by high wind production and low load; under such conditions that may occur during off – peak hours the system of the CSE region faces the most critical cases.

In the selected snapshot, the network study results show that the project "Mid-Continental East Corridor" that is located in the borders of Romania - Serbia and Hungary has the most significant impact on the overloads. The high flows are due to the high export from Romania as there is high production from wind power plants.

Impact or Turkey - Sensitivity analysis

Since the CSE region is at the edge of the Continental Europe synchronous area, it is very sensitive to the exchanges with non-ENTSO-E TSOs. Special attention has been given to the sensitivity of the power flows in the region on the exchanges with Turkey.

As already mentioned, in all the performed network analyses, it has been considered that the Turkish system is constantly importing 500 MW (for every hour of the year). In order to assess the transmission adequacy in CSE region an extensive static security assessment applying the N-1 criterion was performed assuming various exchange patterns from high export to high import in several steps.

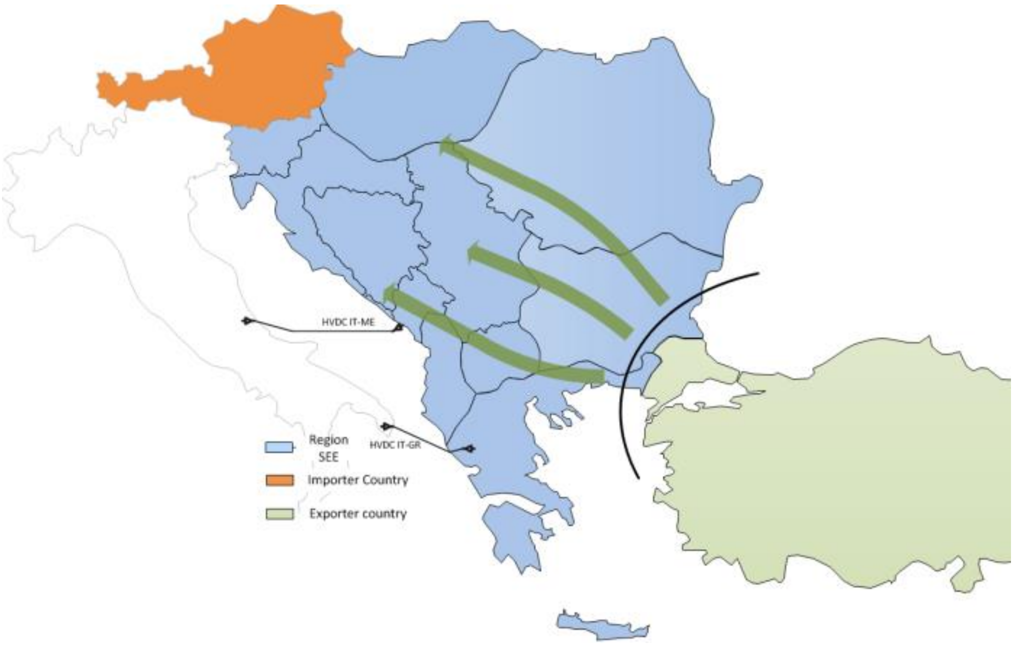

Figure 3-20 Sensitivity to exchange with power system of Turkey

Results of this sensitivity analysis show that the loading of specific overhead lines in the CSE region are significantly sensitive on the exchange pattern with Turkey. In case that Turkey is exporting, the exchanges have higher impact on CSE network than the cases that Turkey is importing energy. The border between Serbia and Bulgaria is the most sensitive to the exchanges with Turkey and the corresponding OHLs suffer most of the overloads.

An extensive description of the relevant studies performed is given in Appendix 3.

3.6.2 Vision 2 Results

Vision 2 – "Money Rules" is a top-down scenario similar to Vision 1 with higher load and higher exports to the rest of Europe; in terms of RES penetration, the scenario assumed is identical with the one used for Vision 1. Therefore, snapshots of interest are the same with Vision 1 and network study results are similar to the ones of Vision 1 in a macroscopic view. The predominant power flow directions (N → S and E → W) still prevail for the large portion of time within the year.

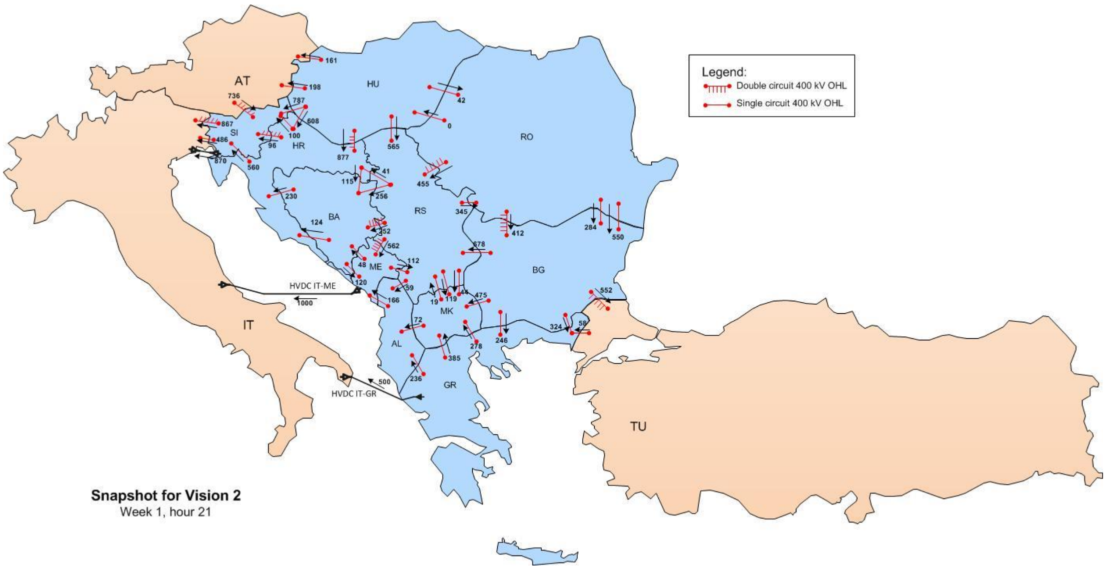

Figure 3-21 Selected snapshot in vision 2

Figure 3-21 presents graphically one studied case for Vision 2; Figure 3-21 illustrates the power flows on the 400kV tie-lines of the region. This specific snapshot refers to a situation with high load and low level of production from renewable sources. At this point of time, high power transfer to Italy is observed. (both DC links to Italy are fully loaded). Although there is a very high transfer to the west (Italy), to loading of the tie-lines is at a moderate level and no overloads occur.

3.6.3 Vision 3 Results

Vision 3 – "Green Transition" is a bottom-up scenario with rather high load, high RES penetration and high CO_2 prices. Analysis of power flows through yearly dc power flow simulations depicted that N→S and E→ W power flow directions continue to exist but in certain areas of the transmission system there is a considerable number of hours where the direction is reversed. Two such cases are presented below.

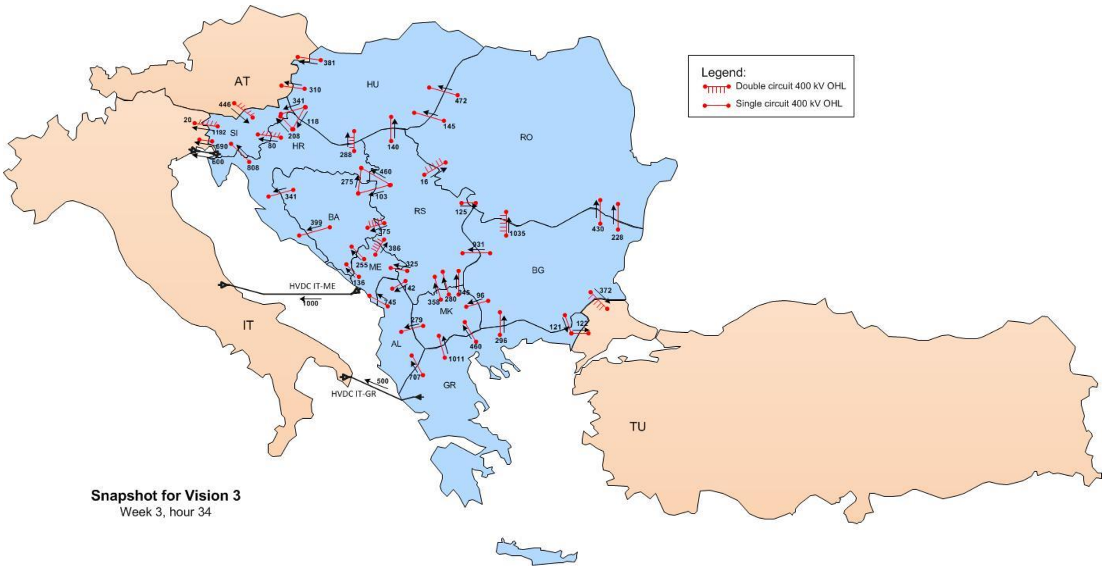

Figure 3-22 Selected snapshot in vision 3

In Visions 1&2 the block of countries including Greece, FYR of Macedonia and Albania is importing all over the year. In Vision 3 for about 1200hours this block is an exporter. Also in Visions 1&2 the power flow in the border between Romania and Bulgaria is in the N → S direction all over the year. In Vision 3 power flow changes direction for about 5000h.
Analysis of the operating conditions resulting in these changes compared to the Visions 1&2 show that in high load conditions Romania is importing energy from Bulgaria and Greece is exporting energy upstream in the S → N direction. Concerning Greece mentioned exports are higher in high wind conditions.
Taking into account the above issues, characteristic snapshots for Vision 3 are considered those corresponding to changes in the prevailing power flow directions. Such a snapshot is presented in Figure 3-22 that shows power flows in the major tie lines (400kV) for a peak hour with high wind conditions. At this point in time high power transfers to Italy (both DC links are loaded 100%) can be observed. Additionally, one can notice the reversing of power flow direction (S → N) in the GR – BU and BU – RO borders. In terms of network adequacy, most of the major tie-lines are loaded at a moderate level and no major findings were reported by the static security assessment.

3.6.4 Vision 4 Results

Vision 4 – "green revolution" – is a top-down scenario characterized by extremely high RES penetration and high load demand. The hypothesis of high RES exploitation includes a high amount of both WFs and PV plants in many countries of the region. Due to the very high uncertainties on the spatial distribution of RES plants (mainly for PVs), the network analysis has been focused mainly on the tie – lines.

The critical snapshots selected to be fully analyzed reflect the following conditions:

- High level of loading of the East-West corridor, from the West borders of Bulgaria and Romania to Italy
- High production from wind power plants and low demand and
- High production from PV power plants.

Figure 3-23 presents one of the analysed snapshots for vision 4. In this specific snapshot there is high production from PV power plants; hourly production from PV power plants in the Balkan region is 18929 MW while the total load of the region is 48416 MW (rather medium).

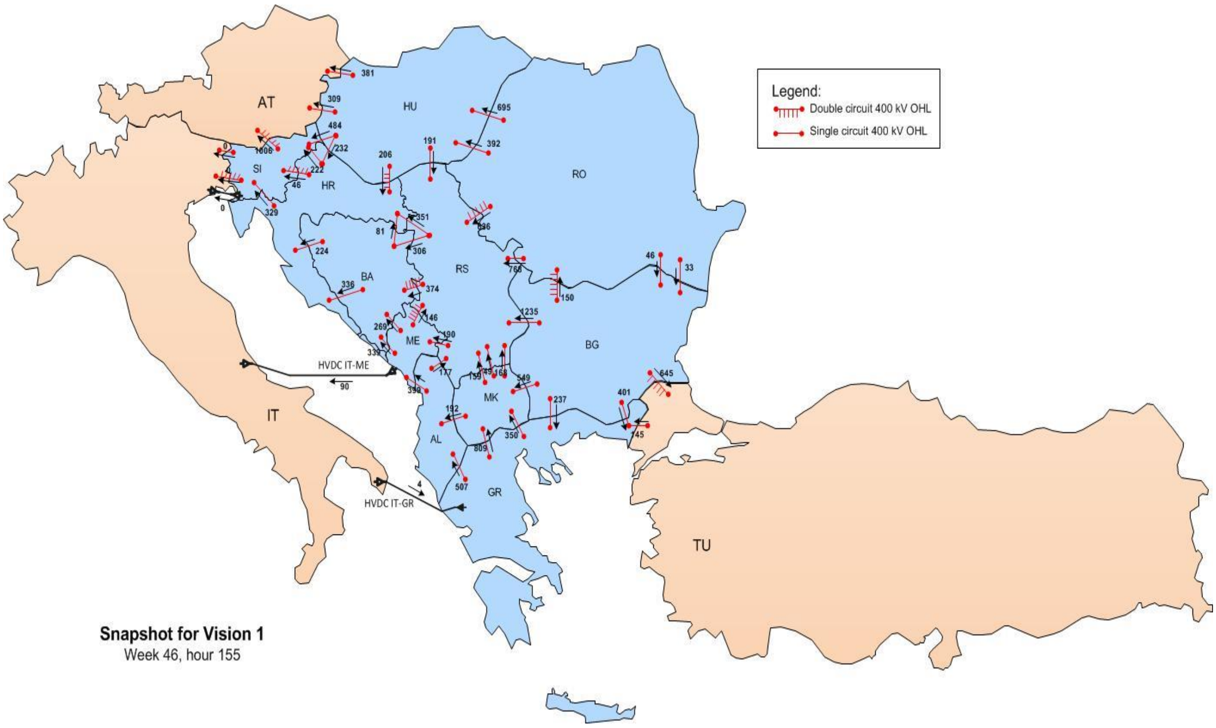

Figure 3-23 Selected snapshot in vision 4

As can be seen in Figure 3-23 , in this point of time, there are significant power flows in the west borders of Bulgaria and Romania; Greece (which is usually an importer) is exporting energy at the borders with Albania and FYR of Macedonia. This power flow trend is due to the fact that Bulgaria, Romania and Greece are the countries of CSE Region with the largest photovoltaic penetration in Vision 4.

The results of N-1 security analyses in Vision 4 show that there are since overload on several borders in the region: RS-BG, RO-HU, SL-HR and AL-ME.

Since Vision 4 is an extreme scenario in terms of RES penetration, there are conditions to which are considerably different from the ones usually considered in TSOs analysis. Taking into account also the uncertainties related to this scenario, further detailed analyses will be needed in the future, in order to reconfirm the validation of this scenario and re-examine the possible needs for new transmission investments.

A graphical representation of the power flow statistics within the study year for all visions is show in Appendix 4.

3.7 Comparison of the visions

As mentioned in chapter 3.1 the four Visions describe the range of a variety of possible future scenarios for the target year 2030. Visions 1 and 3 are "bottom-up" scenarios which were constructed based on relevant information by TSOs, while Visions 2 and 4 are "top-down" scenarios which were built with respect to specific assumptions so as to comply with the pan-European targets and relevant evolutions. The four visions investigated in the framework of TYNDP 2014 differ (sometimes significantly) from each other in terms of load evolution, RES penetration, CO2 prices, primary energy cost etc. Visions 1 and 4 comprise the two extremes; Vision 1 seems to be the most realistic scenario for CSE region. The following paragraphs present a comparison of the visions and report on the differences in the main hypothesis and the results achieved among visions.

3.7.1 Demand

In Vision 1, there are no major breakthroughs in energy efficiency developments and in the usage of electricity for transportation; as a consequence, electricity demand is expected to grow at a lower rate than in the other visions. In Vision 4, energy efficiency measures and the usage of electricity for transport and heating/cooling are intensified. Market designs are adapted in such a way that the highest energy savings are combined with the highest substitution to electricity. As a consequence, electricity demand is expected to grow at a higher rate than in any other vision, due to the fact that the introduction of these new uses of electricity more than compensates for the realized energy efficiency improvements.

Based on the above assumptions, the electricity demand in Vision 4 is almost 15% higher than in Vision 1.

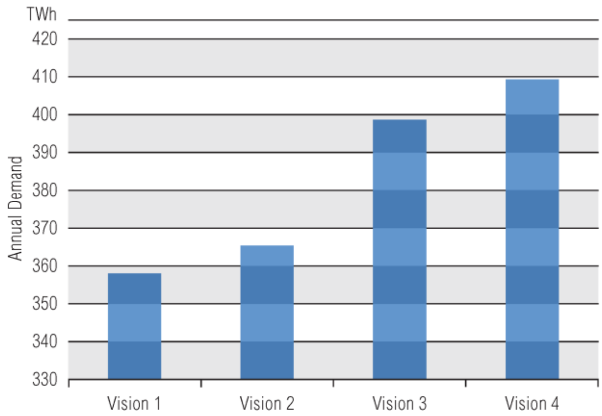

Figure 3-24 Annual demand in the 4 Visions in CSE Region

3.7.2 Installed capacity

The comparison of installed capacity between Vision 1 and Vision 4 highlights the significant differences considered in the electricity generation in each vision. The main differences can be summarized to the following:

- Substantial increase of wind and especially solar installed capacity in Vision 4 for all countries in the Region.
- The need for peak generators in Vision 4 in order to cope with expected volatility of the also increased RES generation in Vision 4.

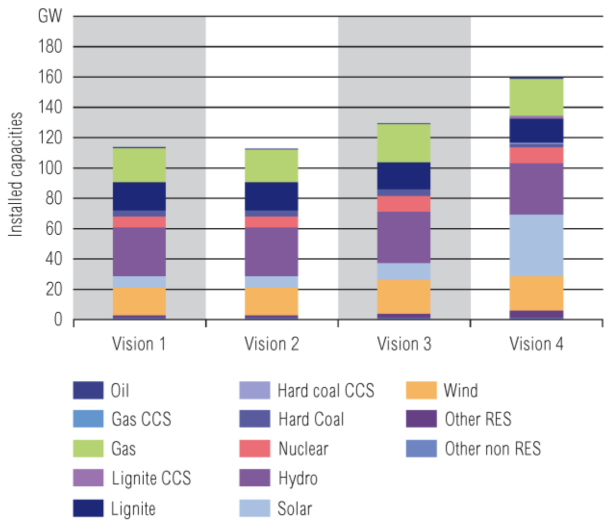

Figure 3-25 Installed capacities in the 4 Visions in CSE Region

3.7.3 Share of RES

The level of RES penetration (including hydro) rises from 38% close to 51% of the total electricity demand, when comparing Vision 1 and Vision 4, mostly due to the increased penetration of solar installations. In terms of annual energy production, the difference is quite large, with an increase of 56%.

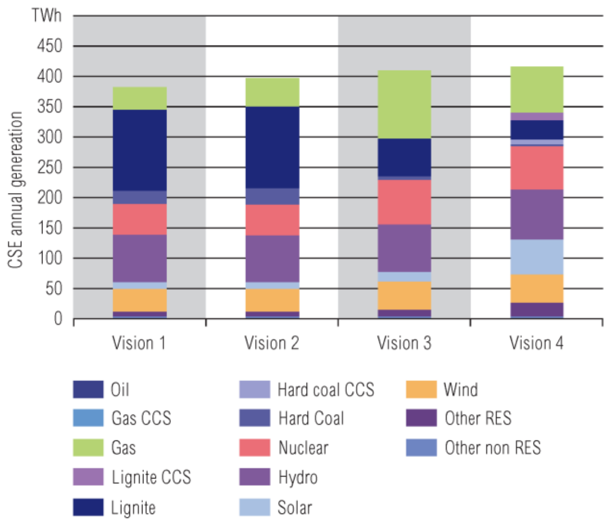

Figure 3-26 Production share by fuel in the 4 Visions in CSE Region

3.7.4 Balances

The Market study results show a decrease of the exporting balance of the region to the rest of Europe, from 20 TWh in Vision 1 to 4 TWh in Vision 4. Bulgaria and Romania are the main exporters of the CSE region and maintain their exporting status in all four visions. Among the countries in the region, Bulgaria and Slovenia appear to considerably increase their exporting energy, whereas Romania appears to become less exporting in Vision 4.

Serbia and Bosnia-Herzegovina are diverting from exporters (Vision 1 & 2) to importers (Vision 3 & 4) due to the different hypothesis of CO2 prices. In particular Serbia converts from an exporter in Vision 1, to an importer in Vision 4 with a significant increase in traded energy.

Figure 3-27 Annual national energy balances in the 4 Visions in CSE Region

3.7.5 CO2 emissions

Considering the high penetration of RES and the higher CO2 cost in the region in Visions 3 and 4, the Market study results show that the CO2 emissions in the region can be significantly reduced, when compared with the CO2 emissions expected for Vision 1 and Vision 2.

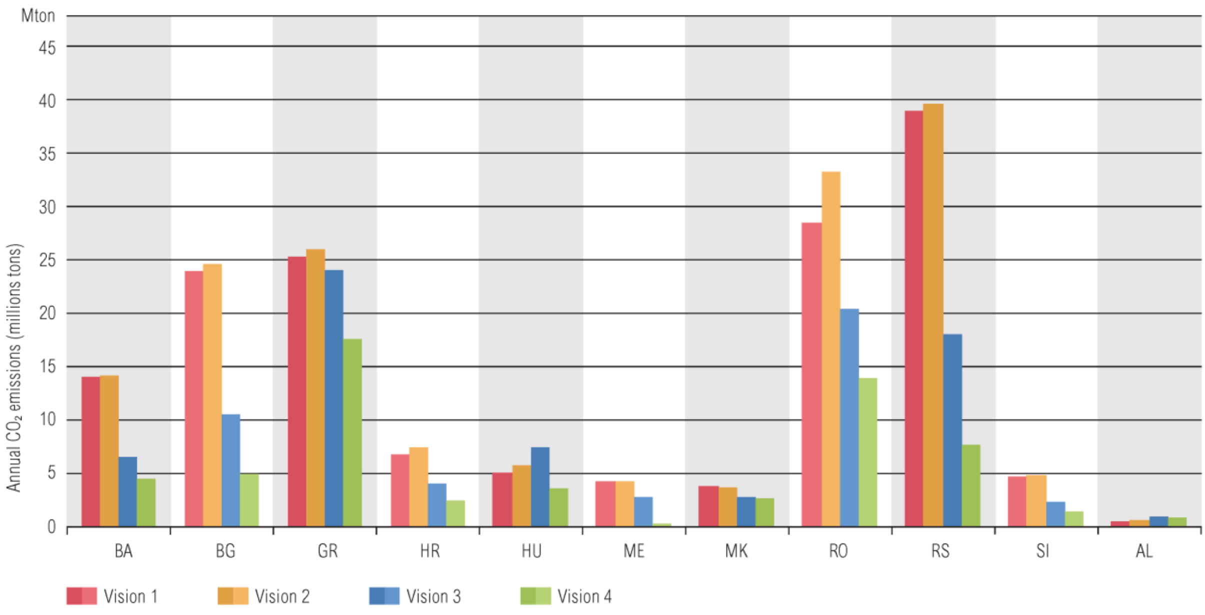

Figure 3-28 CO2 emissions in the 4 Visions in CSE Region

3.7.6 Bulk Power Flows

In Visions 1&2 there is always a predominant power transfer from the East to the West and from the North to the South of the region for almost all over the year. The pattern appears also in Visions 3&4. However for certain areas the number of hours of power flows in these directions is reduced. In addition, in Vision 3 power flow direction for most of the time changes in the Bulgaria-Romania borders. Also in Vision 4 power flow direction changes compared to Vision 1 in the border between Croatia and Bosnia-Herzegovina as well as at the West borders of Serbia.

4 Investment needs

4.1 Present Situation

The map shows diverse level of Net Transfer Capacities (NTC) in Europe. 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.

NTC values for the same equipment change under different conditions, for example the topology of the network or the load pattern at the given point in time that the study is conducted.

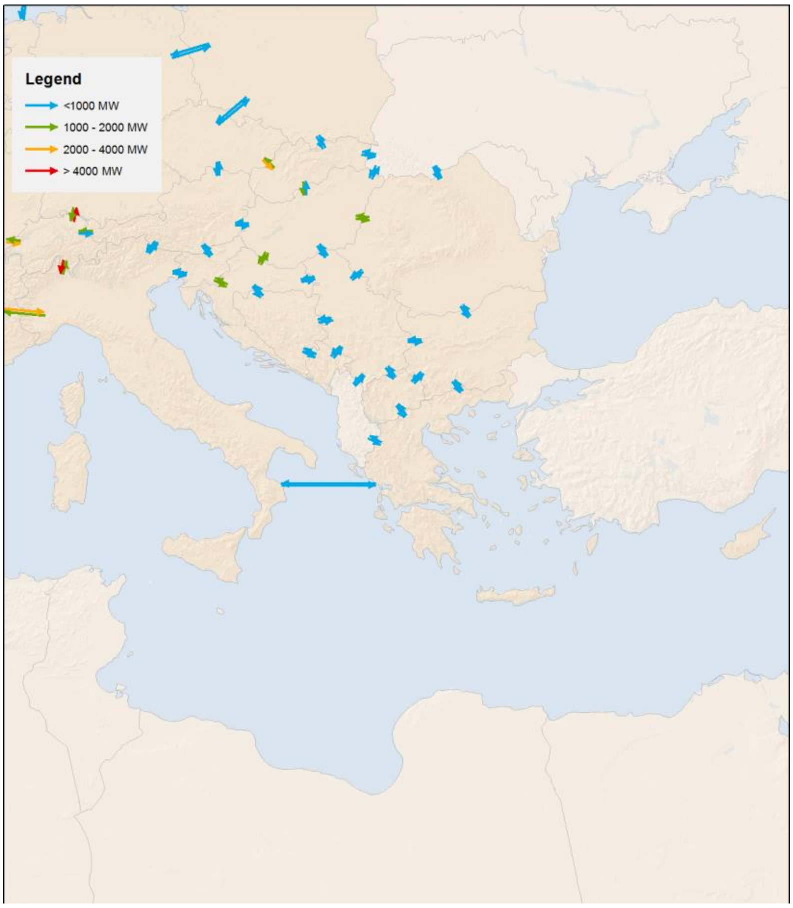

Figure 4-1 Illustration of Net Transfer Capacities in CSE region (2013)

Compared to the previous Regional Investment Plan, there is no change due to there being no new projects commissioned in the area with a contribution in the cross-border transfer capacity increase.

One of the main characteristics of the transmission network in the CSE region is interdependency, which means that cross-border exchanges between two power systems significantly influence power flows in the rest of the network, and particularly in the immediately neighbouring areas.

As a consequence, transit power flows are predominantly East-West and North-South directions, which creates congestion for countries close to the main exporters and importers of the area. For example, countries facing such issues include Slovenia, Serbia and FYR of Macedonia.

4.2 Drivers of Grid Development

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 is 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 4-2 present the anticipated evolution is 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.

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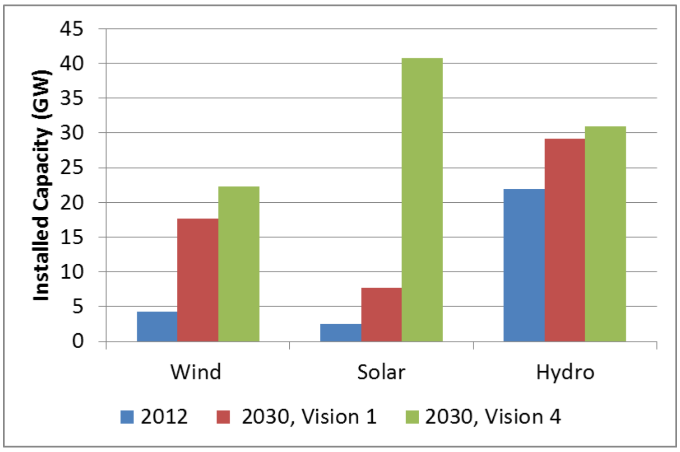

Figure 4-2 Expected evolution of RES penetration by 2030

4.3 Main Bottlenecks

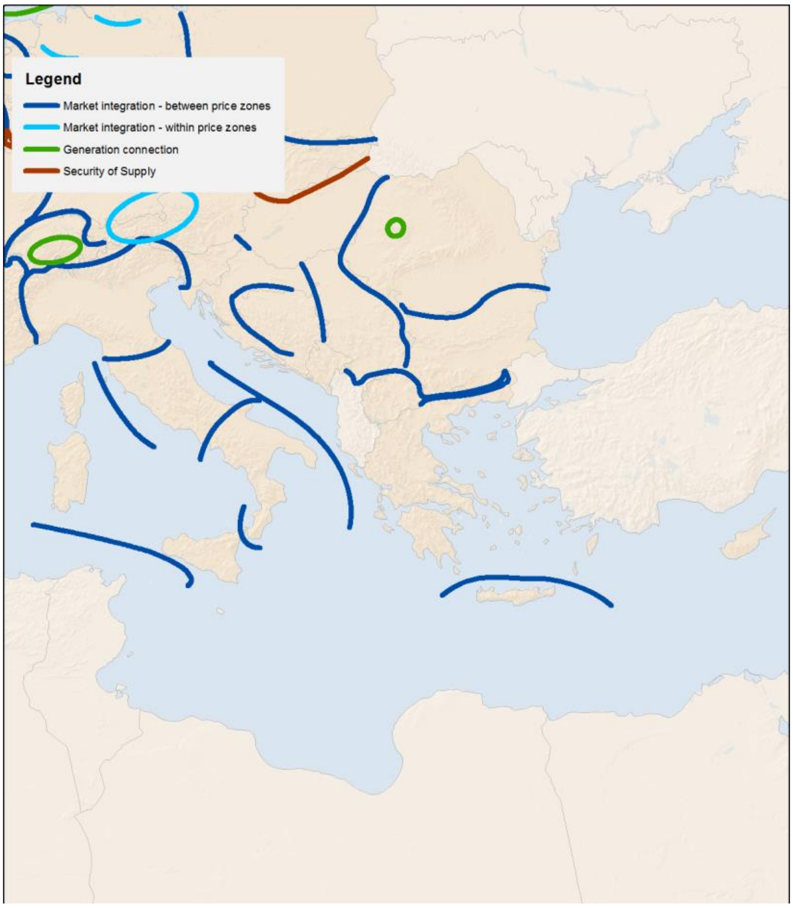

Figure 4-3 Map with remaining bottlenecks in the region

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As a result of the market and network study process, seven 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 4-3 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 4-3 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.

4.4 Bulk Power Flows in 2030

4.4.1 Generation Connections

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

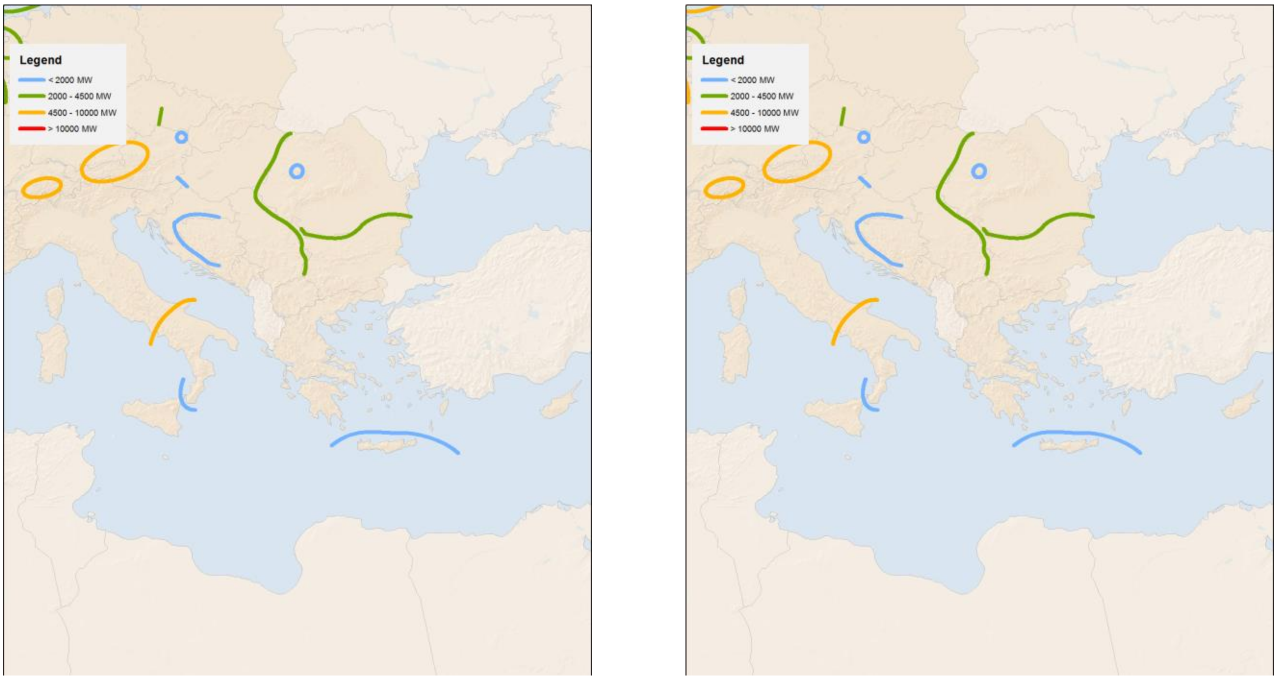


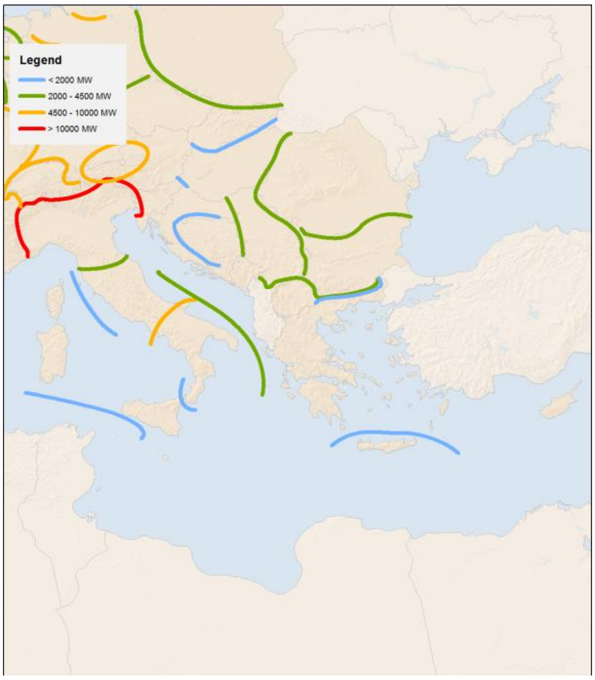
Figure 4-4 Map of bulk power flows related to generation connection (Vision 1 left and Vision 4 right)

Connection of renewable generation in specific areas of the Region is expected to result in considerable power flows necessitating grid reinforcements in the boundaries shown in Figure 4-4. Concerning the boundary at the west Romanian borders, considerable wind generation (more than 1000MW) is expected to be connected in the neighbouring area both in Romania and Serbia. Additionally, power flows through this boundary are expected to be influenced by the connection of the expected 1000MW hydro pump storage plant at the NW of Romania. For this plant a specific boundary is drawn in order to depict the necessity of specific transmission projects necessary for its connection.

Concerning the boundary at the borders between Bulgaria and Romania, the exploitation of the windy areas in both countries at the coast of Black sea is expected to trigger considerable power flows necessitating the increase of transfer capacity in the mentioned boundary. With the proper network development the capability to integrate about 5000MW will be realised.

The island of Crete in Greece has an enormous wind and solar potential that cannot be exploited due to the autonomous operation of its transmission system. Interconnection of the island of Crete will provide the means for transferring renewable energy produced in the island towards the load centre of Continental Greece.

4.4.2 Market Integration



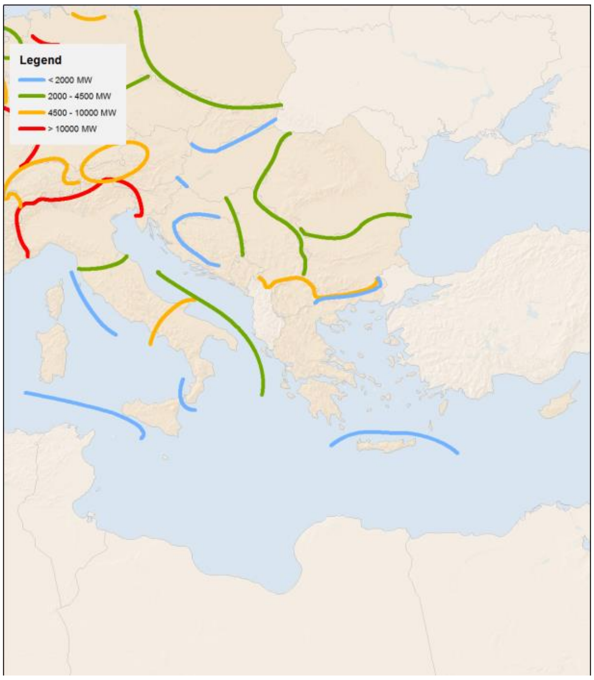


Figure 4-5 Map of bulk power flows related to market integration (Vision 1 left and Vision 4 right)

The map shows bulk power flow magnitudes in the previously mentioned boundaries that are expected to be triggered by market integration issues in the CSE Region. The orientation of these boundaries defines the main power flow directions in the Region that is North-South and East-West. Considerable power flows at the East of the Region in the East-West direction are related to the fact that Bulgaria and Romania are the main exporters of the Area. Considerable power flows at the same area but in the North-South direction are related to the fact that the block including GR, MK and AL is mainly importing. Finally large power flows at the Serbian west borders as well as at the west of the Region are related to the exports from the area towards Italy.

4.4.3 Security of Supply

Concerning SoS, in the CSE and especially in the Balkans peninsula the need of reinforcing the transmission capacity of specific boundaries for such a purpose does not exist in the context of SoS defined for the needs of this TYNDP.

5 Investments - Project Portfolio

5.1 Criteria for Project Inclusion

5.1.1 Transmission projects of pan-European significance

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

- The main equipment is at least 220 kV if it is an overhead AC line or at least 150 kV otherwise and is, at least partially, located in one of the 32 countries represented in TYNDP.
- Altogether, these assets contribute to a grid transfer capability increase across a network boundary within the ENTSO-E interconnected network (e.g. additional NTC between two market areas) or at its borders (i.e. increasing the import and/or export capability of ENTSO-E countries vis-à-vis others).
- An estimate of the above mentioned grid transfer capability increase is explicitly provided in MW in the application.
- The grid transfer capability increase meets at least one of the following minimums:

- At least 500 MW of additional NTC; or
- Connecting or securing an output of at least 1 GW / 1000 km² of generation; or
- Securing load growth for at least ten years for an area representing a level of consumption greater than 3 TWh / yr.

A refined project definition and a substantial evolution of the portfolio

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

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

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

5.1.2 ENTSO-E and Non ENTSO-E Member Projects

Most of the transmission projects are proposed by licensed TSOs, who are members of ENTSO-E. In the framework of transmission system development, it is possible however that some transmission projects are proposed by 'third party' promoters. In light of Regulation (EU) 347/2013, entered into force on 15 May

2013, which makes the ENTSO-E TYNDP the sole basis for the electricity Projects of Common Interest (PCI) selection, in 2013 ENTSO-E developed the "Procedure for inclusion of third party projects – transmission and storage – in the 2014 release of the TYNDP[18]", hereafter called the Third Party Procedure.

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

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

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

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

5.1.3 Regional investments

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

5.2 Projects portfolio

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

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

Figure 5-1 Midterm Map

Figure 5-2 Long Term Map

5.2.1 Projects of common interest

Projects of common interest (PCIs) in the CSE Region concern two categories. The first includes cross border transmission lines and relevant internal reinforcements aiming to increase cross border capacity in the following borders: France-Italy(1 project), Austria-Italy (3 projects), Italy-Montenegro (1 project), Italy-Switzerland (2 projects), Italy-Slovenia (2 projects), Romania-Serbia (1 project), Bulgaria-Greece (1 project), Romania-Bulgaria (1 project), project in Bulgaria aiming to increase the transfer capacity between Romania and Greece (1 project), Croatia-Hungary-Slovenia (1 project), Croatia-Bosnia and Herzegovina (1 project), Greece-Cyprus-Israel (1 project).

The second category includes storage projects. (see 5.2.5).

5.2.2 Projects of Pan-European Significance

Projects of Pan-European importance in the CSE Region include interconnection lines and internal reinforcements aiming at the increase of cross-border transfer capacities across the main corridors in the area in order to assist the integration of electricity market and the accommodation of new generation, which is mainly renewable.

The Investment plan proposed sums up about 6800km, with 82% of them overhead lines and the rest underground and subsea cables. It includes 10 cross-border projects within the region, 5 interconnection projects with the rest of pan European system (most of them under consideration), and 5 internal projects. There is also a project concerning the connection of the Italian power system with North Africa.

New HVDC projects concern subsea and underground cables. In addition 16% of the total length of new projects concerns upgrade of existing overhead AC lines aiming at the minimisation of grid extension and the creation of new routes.

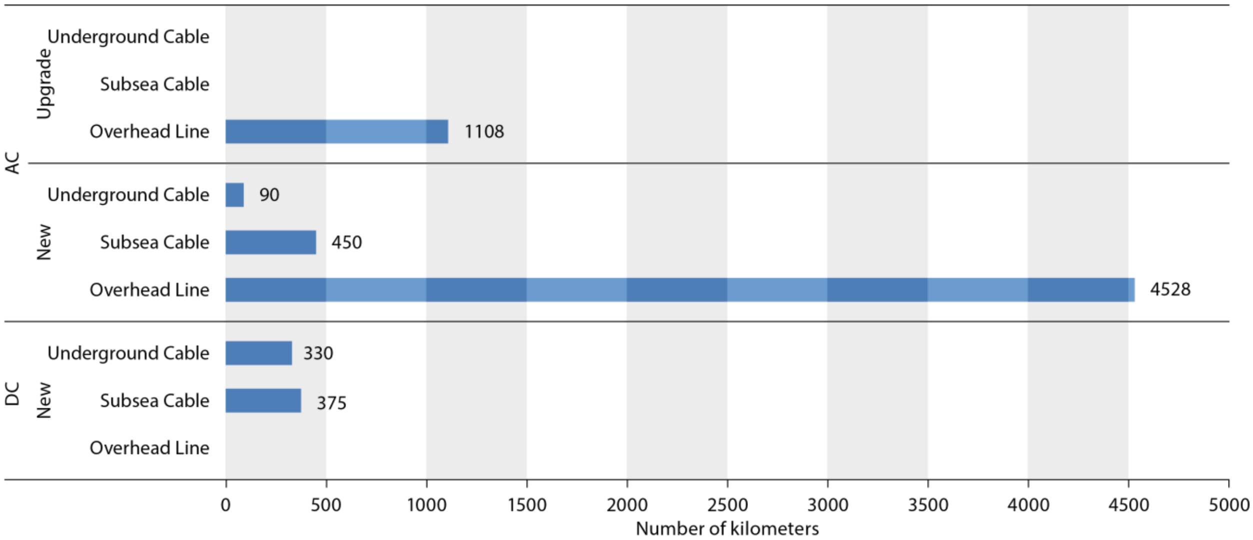


Figure 5-3 Projects of Pan-European significance in the CSE Region- breakdown per technology.

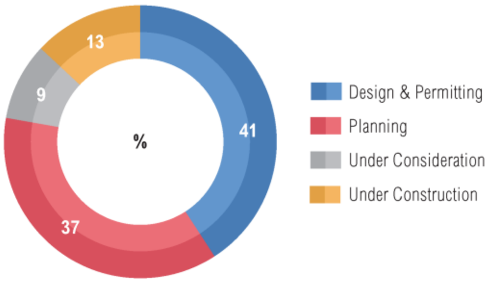


Figure 5-4 Statistics of the status of Pan-European projects in CSE Region

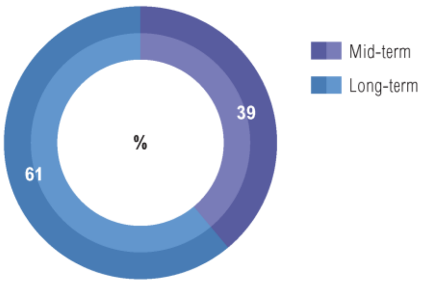


Figure 5-5 Statistics of the planned commissioning horizon for the Pan-European projects in CSE Region

As can be seen from the diagram in Figure 5-4 most of the projects in the Region are in the planning or in the design and permitting phase.

Concerning commissioning, 39% of the projects are planned for the mid-term and 61% of the projects for the long-term.

5.2.3 Investments of Regional Importance

Concerning the portfolio of Regional investments, it should be mentioned that although the "magnitude" of their expected benefits just not justify their inclusion in the TYNDP, their importance at a Regional level is quite important in terms of complementing projects of Pan-European significance, increasing security of supply is many areas of the Region or assisting the market integration of areas like the Greek islands. The total length of the transmission investments of Regional importance sums up about 7000km of which 55% concerns overhead lines.

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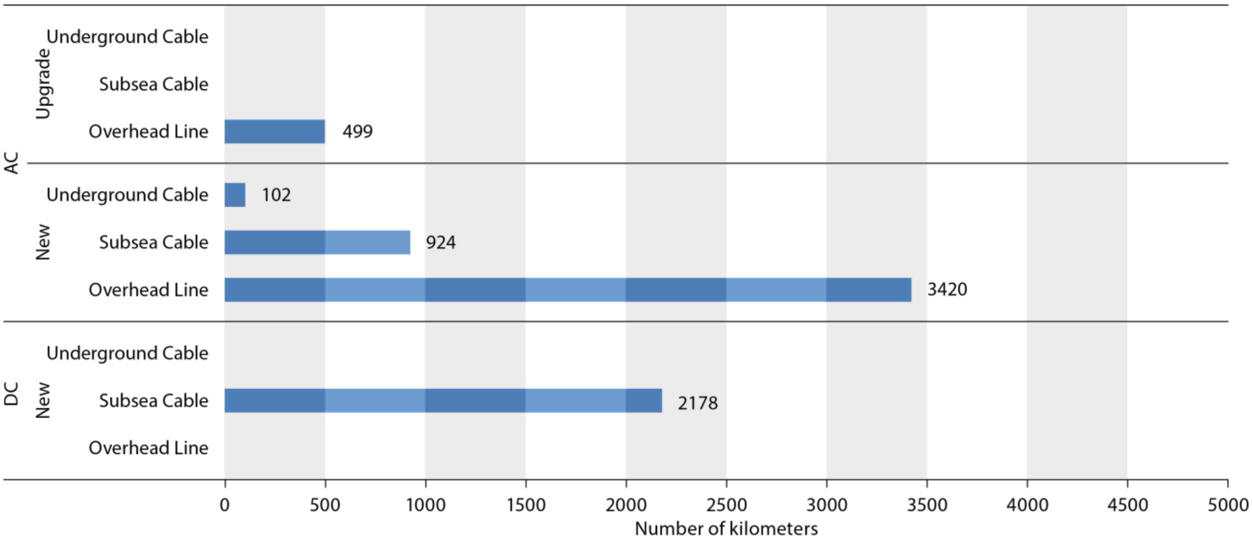

Figure 5- 5-6 Projects of Regional significance in the CSE Region- breakdown per technology

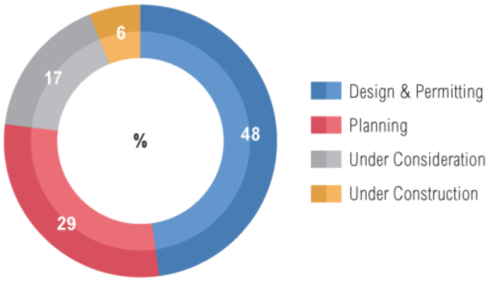

Figure 5- 5-7 Statistics of the status of the Regional significance projects in the CSE Region

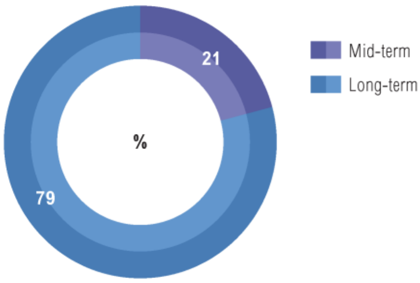

Figure 5- 5-8 Statistics of the planned commissioning horizon for the Regional significance projects in the CSE Region

As can be seen in the diagram of Figure 5- 5-7 most of the investments in this category are in the design& permitting phase. Concerning commissioning 79% of the investments are planned for the long-term and only 21% for the mid-term.

5.2.4 Investments of National Importance

There are in every country of the CSE region, a lot of further projects and investments that are needed at national level for a secure, sustainable and competitive market, but even so, they do not fulfil the criteria of regional or European significance. They are included in the National Development Plans.

5.2.5 Storage Projects

Three third party pump-storage projects are planned in Romania, Bulgaria and Greece. Detailed information about these projects can be found in the Appendix.

5.3 Assessment of the portfolio

5.3.1 Social and Economic Welfare

A project that increases GTC between two bidding areas allows generators in the low-priced area to export power to the higher-priced (import) area. The new transmission capacity reduces the total cost of electricity supply. Therefore, a transmission project can increase socio-economic welfare.

The socio-economic welfare indicator is calculated from the reduction of the total generation cost due to the new project (generation cost approach).

Figures shown below depict statistics for the contribution of the CSE projects portfolio in the reduction of the total cost of electricity supply, in terms of the socio-economic welfare indicator (SEW).

In Vision 1, 26% of the projects depict an increase of SEW which is less than 30MEuros per year, 30% an increase which is between 30MEuros and 100MEuros per year and 44% of the projects an increase which is higher than 100MEuros per year. Projects with highest SEW are located in the Balkan region and Italy.

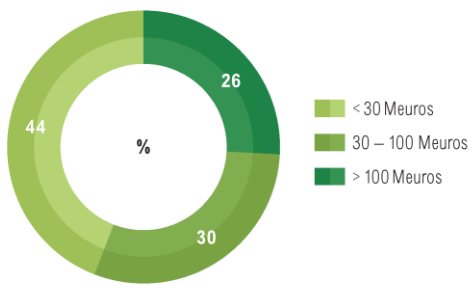

Figure 5- 5-9 Projects contribution in the total cost of electricity supply in Vision 1

In Vision 4, the percentage or projects showing a SEW higher than 100MEuros increases to 65%. Projects belonging in this category are located in the Balkan region, Italy and at the north borders of the Region.

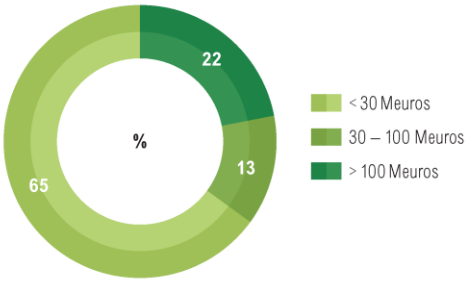

Figure 5- 5-10 Projects contribution in the total cost of electricity supply in Vision 4

5.3.2 CO2 emissions

By relieving congestion, reinforcements may enable low-carbon generation to generate more electricity, thus replacing conventional plans with higher carbon emissions. Considering the specific emissions of CO2 for each power plant and the total annual production of each plant the annual emissions at power plant level and perimeter level can be calculated. Generation dispatch and unit commitment used for the calculation of socio-economic welfare benefit with and without the project is used to calculate the CO2 impact, taking into account standard emission rates.

Figures below depict statistics concerning the contribution of the CSE RG project portfolio on the CO2 emissions. In Vision 1 a considerable percentage of the projects (44%) show a negative impact since it contributes towards an increase of CO2 emissions. This must be attributed to the percentage of RES penetration assumed in this scenario, as well as in the fact that the low CO2 price assumed results in an increased total annual generation of “more polluting” units like lignite ones.

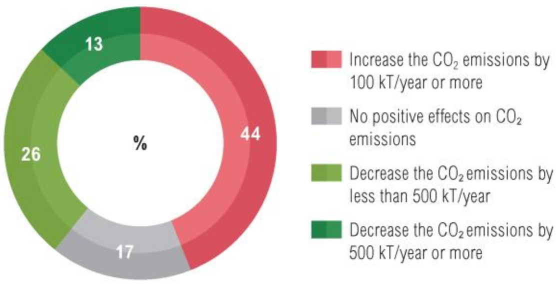

Figure 5- 5-11 Projects contribution in the CO2 emissions reduction in Vision 1

In Vision 4, the situation is reversed. 52% of the projects show a considerable contribution towards CO2 emissions reduction, which is higher than 500kT per year, 22% of the projects contribute to reduce CO2 emissions by less than 500kT per year and the rest of the projects have a negative impact on CO2 emissions. This change, compared to Vision 1 must be attributed to the considerably higher RES penetration considered in Vision 4 as well as to the higher CO2 price which resulted in a shift from coal and lignite to natural gas units.

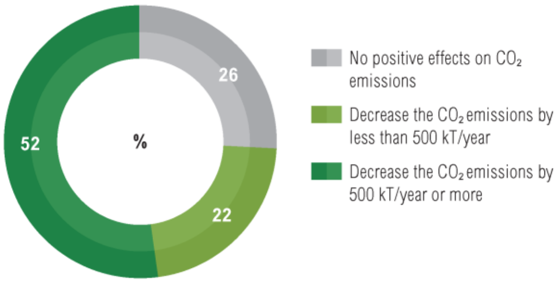

Figure 5- 5-12 Projects contribution in the CO2 emissions reduction in Vision 4

5.3.3 RES integration

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

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

The RES-indicator intends to provide a standalone value showing additional RES available for the system. The indicator measures the influence new grid-investments have on this RES-integration. The benefit indicator for RES-integration either has been calculated by using market models or has been based on TSOs internal studies especially in the cases of direct RES connection.

As can be seen in the diagram shown below, in Vision 1 39% of the projects have a considerable impact on RES integration i.e. allow the direct connection of more than 500MW or the avoidance of curtailing of more than 300GWh of RES produced energy per year. On the other hand 52% of the projects have a neutral effect.

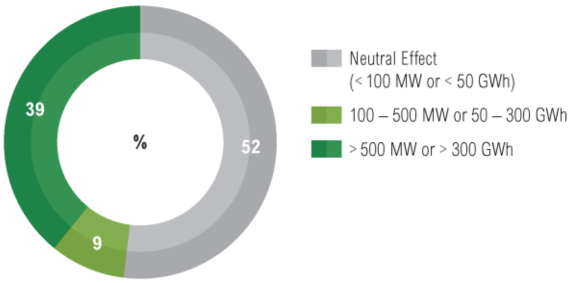

Figure 5- 5-13 Projects contribution in RES integration in Vision 1

In Vision 4, the percentage of projects with a positive impact on RES integration increases up to 48%. This increase must be attributed to the higher RES penetration considered in this vision. For the projects which assist to direct RES connection, the same value of RES indicator has been used in all visions (TSO estimation). Projects with a neutral impact on RES penetration (which in this vision are reduced to 43%) are mostly located to the North borders of the Region.

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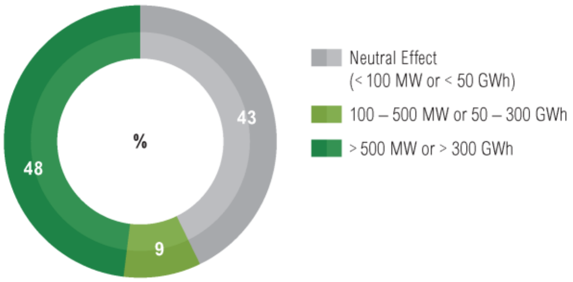

Figure 5- 5-14 Projects contribution in RES integration in Vision 4

5.3.4 Security of supply

Security of supply is the ability of a power system to provide an adequate and secure supply of electricity in ordinary conditions, in a specific area. In the framework of TYNDP and CBA methodology this area should be of a considerable size with an annual electricity demand of at least 3TWh. From the point of view of this rule, in CSE Region security of supply cannot be considered at stake. Clustering of transmission investments into projects does not aim to solve such issues.

However an exception can be considered for the Italian project number 30 that concerns the construction of a new transmission line between the island of Sicily and the mainland of Italy. Additionally there are specific cases where certain investments in a project are essential for resolving security of supply problems of smaller areas in the Region.

5.3.5 Losses

The impact of the projects portfolio on the energy efficiency is measured from its contribution to the thermal losses of the transmission system. In general, projects in CSE Region aims to make the transmission system more meshed, resulting in a reduction of electrical distance between production and consumption and as a result in a reduction in losses.

In Vision 1 70% of the projects assist in a reduction of losses. This percentage is reduced to 61% in Vision 4. The percentage of projects with a negative contribution on losses is 30% in Vision 1 and increases to 35% in Vision 4. Projects increasing losses include in most of the cases HVDC radial interconnections. Observed reduction of projects contribution in energy efficiency in Vision 4 compared to Vision 1 can be explained due to the difference in flow patterns and the transmission of energy over longer distances from renewable generation installations towards the load centres.

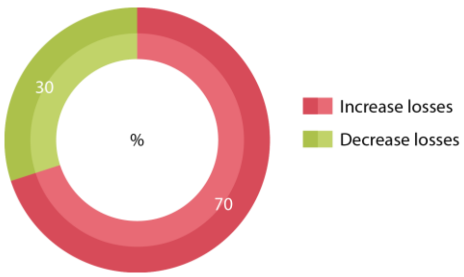

Figure 5- 5-15 Impact of projects on losses in Vision 1

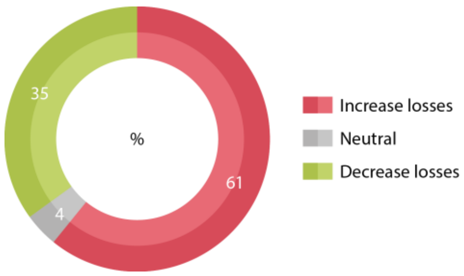

Figure 5- 5-16 Impact of projects on losses in Vision 4

5.3.6 GTC increases

Clustering of transmission investments into projects, aims at achieving a common measurable goal that is the increase of transmission capacity across a specific boundary between two areas. The diagram shown below depicts statistics of GTC increase that is expected to be achieved by 2030 in CSE Region. As can be seen the majority of the projects (57%) contributes to GTC increase that is less than 1000MW. The project with the highest GTC increase is a 3rd party project under the name "EuroAsia interconnector".

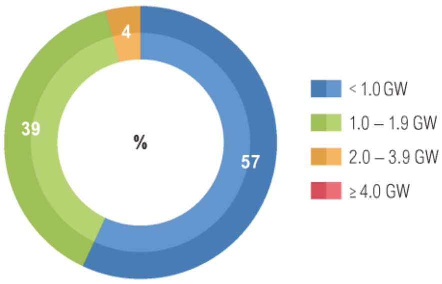

Figure 5- 5-17 Contribution of projects in transmission capacity increase (MW)

5.3.7 Resilience

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

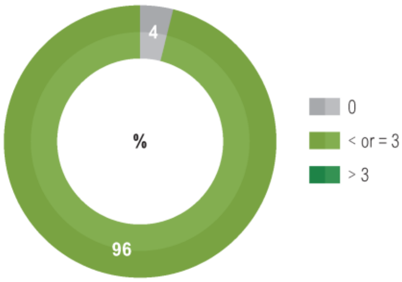

Figure 5- 5-18 Contribution of projects on system resilience

As can be seen in the above figure, majority of the projects in the CSE Region (about 96%) has an average contribution to the system technical resilience, quantified with a total score which is less or equal to 3.Only 4% of the projects has a 0 contribution to technical resilience. As an example, for the projects under the names "Mid Continental East Corridor" and "CSE8 Transbalkan Corridor" the outcome of detailed regional network studies (Appendix 3) show that they have the higher contribution in the system security during N-1 conditions combined with maintenance. At the same time, these two projects contribute to the decrease of the equivalent impedance of the corridor between the West borders of Romania and Bulgaria and the Montenegrin coast in which large bulk power flows are expected due to the power exchanges with the Italian power system via the new dc ME-IT interconnector. In this way improvement of the voltage stability in the Regional network is also expected. These facts result in a ranking equal to 3 for these two projects.

5.3.8 Flexibility

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

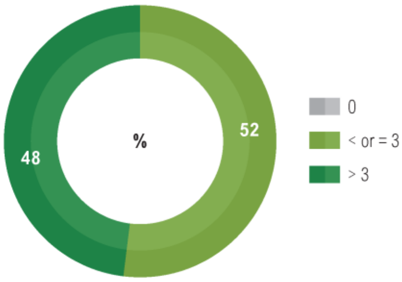

Figure 5- 5-19 Flexibility of projects

In CSE Region, more than half of the projects (52%) have a ranking which is greater than 3. This can be attributed to the fact that most projects are beneficial for more than one scenarios, their topology allow a certain degree of robustness against commissioning difficulties and also most of the projects include new interconnection lines that facilitate the sharing of balancing services. On the other hand, a number of projects include only internal lines dedicated to the connection of new generation and in this respect have a lower ranking.

5.3.9 S1-S2 indicators

The indicators 'social impact' and 'environmental impact' are used to:

- indicate where potential impacts have not yet been internalized i.e. where additional expenditures may be necessary to avoid, mitigate and/or compensate for impacts, but where these cannot yet be estimated with enough accuracy for the costs to be included in indicator C.1.

- indicate the *residual* social and environmental effects of projects, i.e. effects which may not be fully mitigated in final project design, and cannot be objectively monetised;

To provide a meaningful yet simple and quantifiable measure for these impacts, this indicator gives an estimate of the number of kilometres of a new line that might have to be located in an area that is sensitive for its nature or biodiversity (environmental impact), or its or social value (social impact).

It is often difficult in the early stages of a project to assess its social and environmental consequences, since precise routing decisions are taken later. The quantification on these indicators will thus be presented in the form of a range. For the same reason, projects under consideration are not assessed, they are to be scored only in a successive version of the TYNDP when further studies have been done.

The S1 and S2 indicators have been calculated based on TSO's input regarding the routing of projects and on data from the European Environment Agency (Common Database for Designated Areas and Corine Land Cover Urban Morphological Zones[19]).

Concerning CSE Region, most of the projects of Pan-European interest have a small environmental impact, since the estimate of the number of kilometers crossing sensitive areas is less than 15km in the majority of cases. The only exception to this conclusion is a Slovenian project part of which however concerns upgrade of existing 220kV lines. A similar conclusion exists for the social impact of mentioned projects.

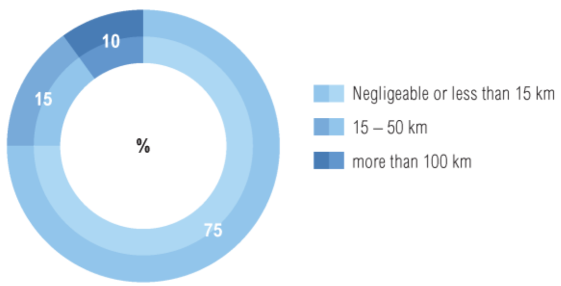

Figure 5- 5-20 Social impact of projects

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

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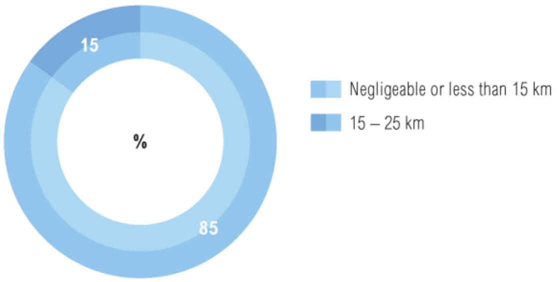

Figure 5- 5-21 Environmental impact of projects

5.4 Cost of the portfolio

The figure below depicts the cost distribution for the projects of Pan-European significance. The cost of almost half of the projects (about 44%) is below 300MEuros. Projects in the upper cost scale (>1000MEuros) concern HVDC interconnections. The total cost of the above mentioned projects is in the order of 16.8 billion Euros (Italian projects included).

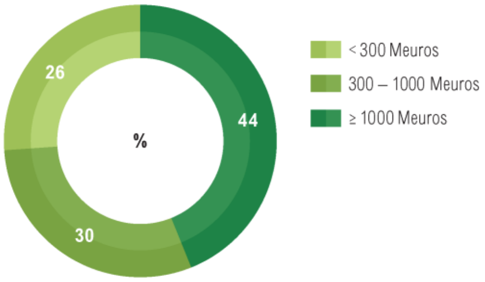

Figure 5- 5-22 Cost distribution for the projects of Pan-European significance in the CSE Region

5.4.1 Challenges of financing transmission grid development

The CSE region of ENTSO-E covers mainly the Balkan Peninsula (plus Italy). As one of the less developed regions in Europe, the transmission grid is rather sparse; therefore, the transmission investments needed to achieve the targets of 2030-2050 (for all visions) are very high compared to the "normal rate" of new transmission investments in the region. The volume of the transmission projects presented in the current RgIP for the next 15 years (up to 2030) is more than five times the volume of the transmission projects materialized in the corresponding previous 15 years (2000 – 2014). It is obvious that the financing of this ambitions plan faces difficulties in financing; these difficulties seem to be even higher in the current fiscal conditions (economic crisis). The materialization of TSOs projects requires higher charges for transmission system use

for the consumers; it is questionable if consumers and local economics in general can afford such increased charges.
Another specificity of the region is the fact that there are numerous non-EU countries in the region; this poses extra problems due to the differences in legislation and the available financing tools/sources.

Moreover, taking into account the continuous increasing public opposition to transmission projects, TSOs have to adopt expensive solutions in order to timely construct the required transmission projects; the usage of expensive underground cables and/or GIS substations especially in the periphery of densely populated urban areas requires considerably higher costs for transmission investments. Also, the targeted exploitation of RES (especially wind) in some countries (especially Greece) leads to the interconnection of some very windy islands to the mainland through very expensive undersea cables. Under the above mentioned conditions, it is obvious that the financing of the projects of TYNDP 2014 is not an easy task and TSOs have to deeply analyze the problems and opportunities and are called to find solutions in the years to come.

Some rough realistic that could potentially help in the financing of the projects and timely constructions are:

- To seek for subsidies or equivalent means (eg. cheap loans by developments banks) through the available mechanisms
- To make transmission projects attractive to private investors by using means such as project bonds increased (regulated) WAC, etc
- To propose regulations that accelerate the permitting phase
- To include the new transmission projects in the regulated asset basis prior to the commission of the projects, so as to be remunerated during the development/construction period, which is normally quite long and requires high capital costs.
- To have stable and investor friendly conditions for transmission projects as they have a long life-time and require long-term capital commitment.
- To offer a level of remuneration on capital investment comparable, if no higher, to comparable investments
- For the most crucial projects of European interest, one possible instrument is to offer extra rate of return to the capital invested in such projects (as a "premium" on top of the WAC) in order to make them more attractive to private investors.

The ENTSO-E public position paper "Incentivizing European Investments in Transmission network" offers a valuable reference on the possible solutions for financing transmission projects.

In any case, financing of the projects included in the TYNDP 2014 and the Regional Investment Plan for CSE region is not an easy task; it requires considerable continuous effort by TSOs and regulatory authorities (in many aspects) in order to facilitate the timely commission of the required new transmission infrastructure.

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6 2030 transmission capacities and adequacy

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

6.1 Target capacities by 2030

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

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

- In a meshed grid, parallel boundaries are interdependent and for a very similar optimum, different set of values can be envisaged although only one is displayed.
- The value of additional capacity derives directly by nature of the scenario. A very different perspective for the generation mix in one country compared to present 2030 Visions may give a very different result for target capacities beyond this country's borders.
- The computation is also undermined by the assumptions that must be made for the cost of an additional project on the boundary wherever no feasibility studies are available. Similar costs to former or similar projects must then be considered.

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

Additionally, ENTSO-E checked whether the interconnection capacity of every country meets the criterion set by the European Council[20] for interconnection development, asking from every Member States a minimum import capacity level equivalent to 10% of its installed production by 2005. Meeting this criterion led to lift up the target capacity between Spain on the one hand and France and UK on the other hand.

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

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

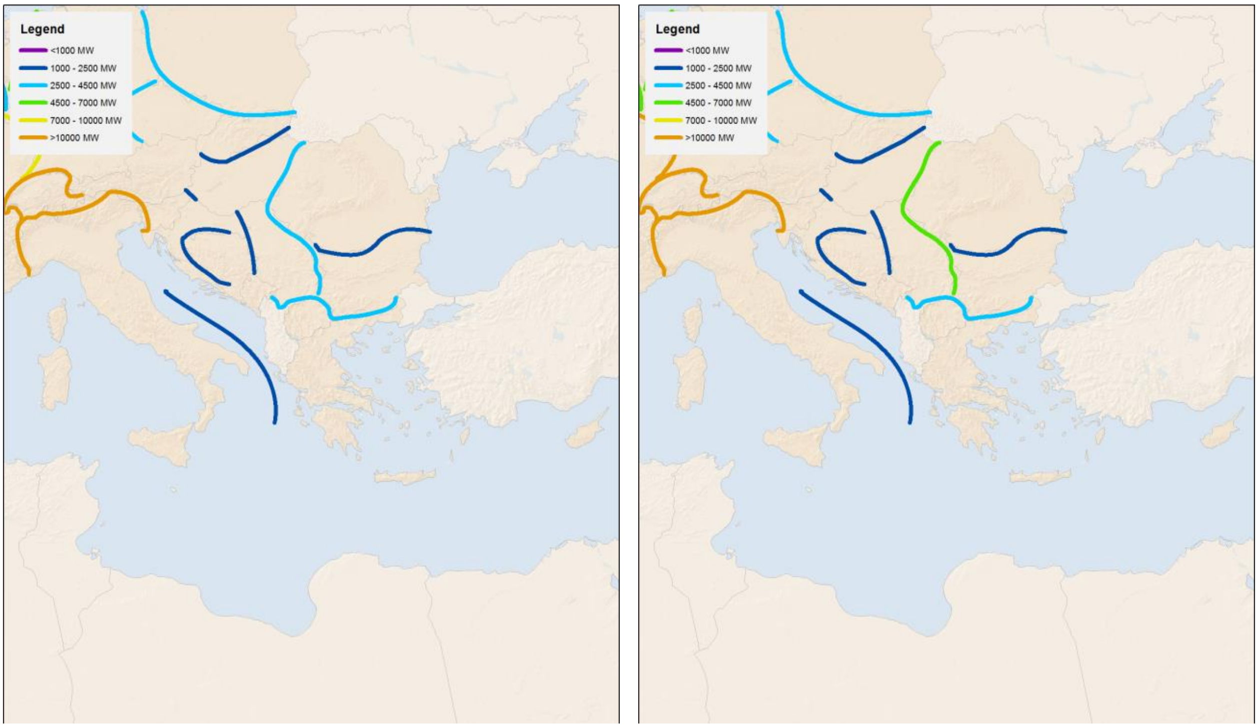


Figure 6-1 Target capacities by 2030 in Vision 1 (left) and in Vision 4 (right)

Figure 6-1 presents the target capacities by 2030 in Visions 1 and 4 respectively. Both maps show a similar picture. Highest transfer capacities are needed at the West borders of Bulgaria and Romania which are the main exporters of the Region, as well as at the North borders of Greece, FYR of Macedonia and Albania in order to cope with the high imports of this area, which is the main trend, but also to support exports of this area in Vision 4 due to the high RES penetration in Greece.

The only exception in target capacities between Vision 1 and Vision 4 concerns the boundary related to the West borders of Romania and Bulgaria and the borders of Hungary and Serbia. This is due to the fact that in Vision 4 higher RES penetration is considered for Bulgaria, Romania and Serbia.

6.2 Transmission adequacy by 2030

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

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

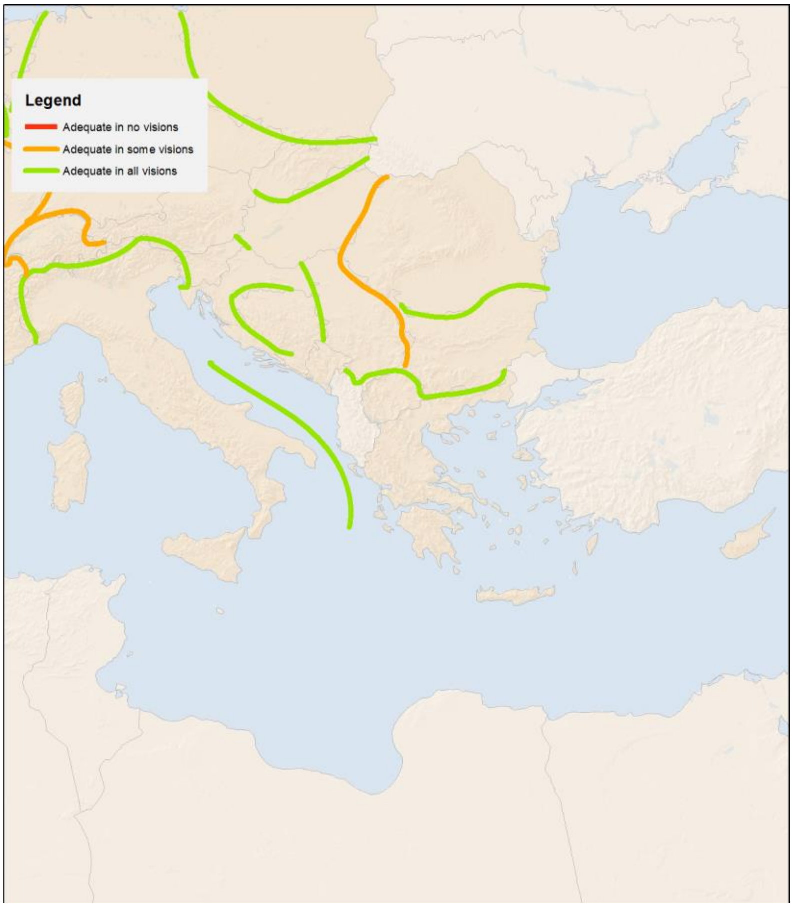


Figure 6-2 Transmission adequacy by 2030

Figure 6-2 shows that for most of the boundaries in the Region, the project portfolio provides the appropriate solutions to meet the target capacities. As such these boundaries have been coloured green. The only exception concerns the boundary at the West borders of Romania and Bulgaria, which is orange. In this case all the listed projects are prerequisite to meet target capacities goals, but some additional grid reinforcements might be required to cover investment needs specifically for the most ambitious scenarios of RES development by 2030 (especially Vision 4) but also to cope with uncertainties related to the impact of neighbouring non-ENTSO-E countries (especially Turkey which is already in parallel operation with Continental Europe Synchronous area, but also the possible connection of Ukraine and Moldova in the future).

7 Environmental assessment

This chapter supplies a synthetic overview of the environmental assessment of the grid development depicted in the CSE region. It is no need to do detailed environmental assessment of the pan-E projects because it runs for every project by their promoters in preparation phase of the project and more information are supplied in the National Development Plans of each TSO in CSE region.
Compared to the methodology used in TYNDP 2012 process for assessing the projects has been improved through a fruitful dialog with ENTSOE TYNDP's stakeholders, especially in the framework of the Long Term Network Development Stakeholders Group over the last two years. The outcome is a specific appraisal of the benefits of the projects with respect to potential spillage of RES generation and the replacement of the former social and environmental indicator by two more specific indicators with respect to crossing of urbanized and protected areas described in chapter 5.3.9.
This enhanced methodology enables to demonstrate strong conclusions: the projects of pan-European significance are key to make an energy transition in Europe – i.e. a significant increase of power generated from RES, CO2 emissions mitigation and a major shift in the generation pattern – possible, with optimised resorting to natural resources.

7.1 Development of RES as a main driver

As mentioned in the chapter dealing with investment needs, one of the main drivers for the development of the transmission system in the CSE Europe is the accommodation of a considerable amount of RES. About 60GW of RES are expected to be in operation in Vision 1 and 103GW in Vision 4. As a result RES penetration expressed as the percentage of annual demand covered by renewables will be about 38% in Vision 1 and will increase to 51% in Vision 4.

For the achievement of these targets development of the transmission system is necessary. In fact 48% of the European interest projects have a positive impact in this direction in Vision 1 and 57% of the projects in Vision 4.

7.2 CO2 mitigation

Mitigation of CO2 emissions is primarily related to the generation portfolio of each country. The diagram below depicts CO2 emissions decrease in the power sector of CSE Region, as a percentage of the 1990 levels, in the different Visions for 2030.

The average CO2 content of electricity is about 387kg/MWh in Visions 1 and 2, 249 kg/MWh in Vision 3 and 138 kg/MWh in Vision 4, compared to about 734 kg/MWh in 1990, before the crisis. In vision 1, Romania has decreased the CO2 content of generation by about 70 % with respect of 1990 values Bulgaria by around 35 % and Greece by around 26 %. In vision 4 this reduction is higher.

The grid has an indirect but essential positive effect on CO2 emissions as it is a prerequisite to implement clean generation technologies: the grid gives them the outlets possibly far from the load centres; the grid enable market mechanisms kick out of the merit order most expensive, fossil-fuel-fired high CO2 emitting power plants. However, either by directly connecting RES, avoiding spillage or enabling more climate friendly units to run. 39 % of the projects of pan-European significance in CSE region contributes to CO2 reduction in Vision 1 while this percentage increases to 74% in Vision 4.

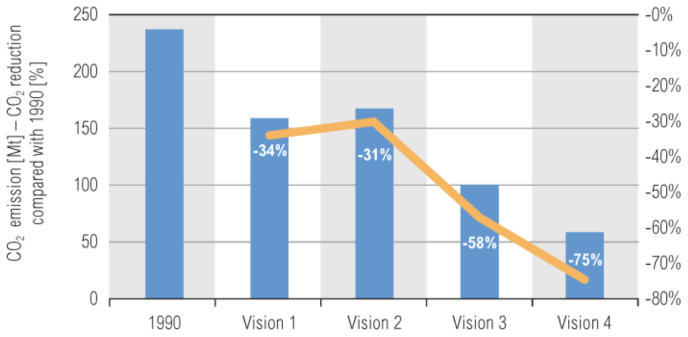
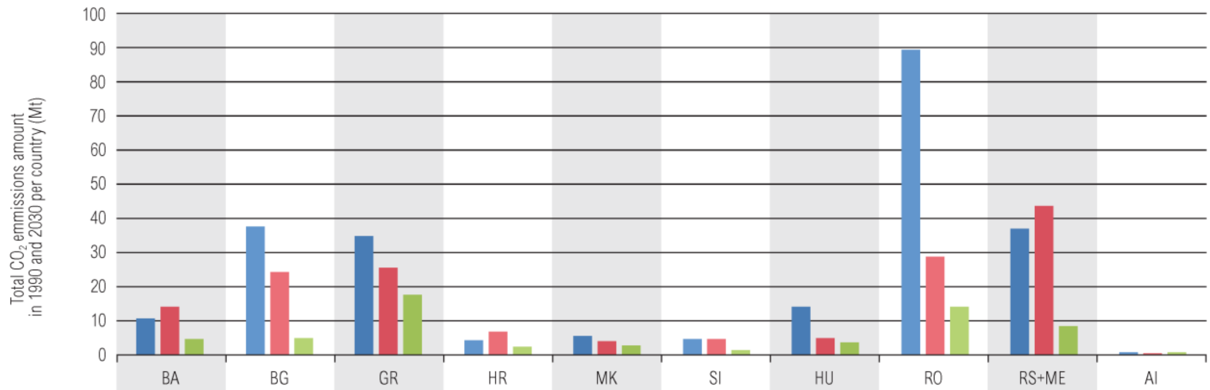


Figure 7-1 CO2 Emissions in each Vision



	BA	BG	GR	HR	MK	SI	HU	RO	RS+ME	AI
1990	10	37	34	4	5	4	14	88	36	1
Vision 1	14	24	25	7	4	5	5	28	43	1
Vision 4	4	5	18	3	3	1	4	14	9	1

Figure 7-2 CO2 Emissions per country in Visions 1 and 4.

7.3 A relatively limited network growth despite important shifts in the generation mix

By 2030, the generation fleet will experience an important shift. The net generating capacity is expected to grow from a bit more than 79 GW today up to 110 GW in Vision 1 and 156 GW in Vision 4. The construction effort will have to account not only for the net increase but also for the replacement of a large amount of the present units, which will come to the end of their life-time within the coming 15 years. This represents for the adaptation of the generation fleet a rate of 2.6 %/yr in Vision 1 and up to 6.5 %/yr in Vision 4.
On the other hand climate change mitigation and competition will require energy efficiency measures (including in the power sector) but also transfer from fossil-fuel based end-uses to CO2-free energy sources (i.e. more trains, electric vehicles and heat pumps for instance).The major driver for grid development is hence generation. New generating capacities are almost all located further away from load centres, RES especially (wind generation develops mostly as large wind farms, also offshore). The major shift in generation

mix will hence induce a massive relocation of generation means and, with large wind and solar capacities, more volatile flows, requiring the grid to adapt. Still, in comparison to the generation adaptation rate above, the grid's growth rate looks relatively modest, with about 1.2%/yr. This illustrates once more the "network effect", where the output developed by all elements together is greater than the summated output of every individual element.

7.4 Optimised routes

In the transmission grid of the CSE region there will be approximately 12397 km of the new transmission lines built and approximately 1617 km upgraded by 2030.
TSOs optimise the routes so as to avoid interferences with urbanised or protected areas as much as possible. In densely populated countries, or where a great share of the land is protected, it is very difficult to achieve the agreement of all aggrieved parties (inhabitants, protectionists, owners of the lands, etc.). The assessment of the urbanized and protected areas affected by the new lines is described in the section 8.3.9.

7.5 Mitigation measures taken

Project for new power transmission infrastructure are carefully designed so as to avoid, mitigate or compensate any undesirable impacts on the environment. TSOs work in this respect in close cooperation with Authorities and consult affected citizens in accordance with their national legislation about the proposed options as to find the best solutions.

Choosing the route and the technology (AC/ DC, cable/ overhead, etc.) are the two key decisions to avoid or mitigate any undesirable effect on the environment. It is needed to analyse the situation carefully case by case, e.g.:

- Building new power lines in the corridor of other existing infrastructures (other power lines, motorways, etc.) can minimise the affected areas.
- AC 220 kV or 400 kV cables can be appropriate in densely urbanised areas, where large amount of power must be supplied over a relatively short route crossing a very cramped area.

overhead technology may be more suitable than cabling when two 400 kV circuits must cross a forest, in case of overhead line there is need only to cut the trees for corridor and in case of cable lines there is need to dig a trench in addition.

In order to minimise environmental and social impact of transmission projects in CSE region, TSOs often examine the capability of using existing transmission corridors. Such projects in the area include upgrade of 220kV existing lines to 400kV in Serbia, Romania and Slovenia and the construction of new transmission lines parallel to existing ones in Bulgaria.

8 Assessment of the resilience

8.1 Assessment framework

The assessment of transmission projects is performed having in mind 4 major axes:

- **Sustainable and safe operation**: every investment should contribute to an improved quality of service and increased system reliability (at least not put the reliability of the system at risk),
- **Economic performance**: investments should prove useful and profitable in as many future situations as possible, bringing more benefits to the European population than they cost,

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- **Technical sustainability and flexibility**: as long lasting expensive infrastructure components, transmission investments should take advantage of the technological evolutions so as to optimize their performance and ensure that they do not become obsolete in the course of their expected lifetime; TSOs strive to make the best use of existing assets considering new technologies (such as HDVC, FACTS, PST, etc) in order to optimize grid development.

- **Compatibility** with longer run challenges looking ahead to 2050: present projects must be appropriate steps to meet future challenges and fit into wider and longer term perspectives.

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

8.2 Resilience to severe contingencies

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

- **Examination of rare, but severe failures**: In some cases, rare but severe failures, like those leading to the loss of a busbar or busbar section, or multiple independent failures, may be assessed in order to prevent serious interruption of supply within a wide-spread area. This kind of assessment is carried out for specific cases chosen by the TSO depending on probability of occurrence and consequences.

- **Examination of multiple failures due to common cause:** The so-called common-mode failures include the failure of several elements due to one single cause. The potential outage of lines with double or multiple circuits will most probably become increasingly relevant over the next years, as more and more power lines are set to be bundled onto already existent routes (several circuits on the same tower) and as conductors with higher thermal ratings will also be used, allowing for higher power flows.

- **Failures combined with maintenance:** Certain combinations of possible failures and non-availabilities of transmission elements are considered in some situations. Maintenance related non-availability of one element combined with the failure of another one are assessed. Such investigations are conducted by the TSO based on the probability of occurrence and/or based on the severity of the consequences. These investigations are of particular relevance for network equipment which may be unavailable for a considerable period of time due to a failure, maintenance or overhaul.

8.3 Mitigation measures

Grid planning mitigation measures, in essence, fall into one of the following three categories:
- System protection schemes,
- Upgrading of the existing components,
- Installing new grid components, and possibly creating new transmission routes.

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

9 Monitoring of the Regional Investment Plan 2012

This chapter aims to present a picture of the projects evolution compared to TYNDP 2012. In this respect, in the following paragraph statistics of the transmission investments evolution is presented, both of pan-European and Regional relevance. In addition the provision of the reasoning behind investments evolution is attempted based on the information provided by the TSOs of the Region.

9.1 Portfolio and monitoring statistics

In the RgIP 2014 156 investments already reported in the RgIP 2012 exist. 69 of them are clustered in projects with pan-European relevance, while 87 are of Regional importance. Figures below depict statistics of the investments evolution.

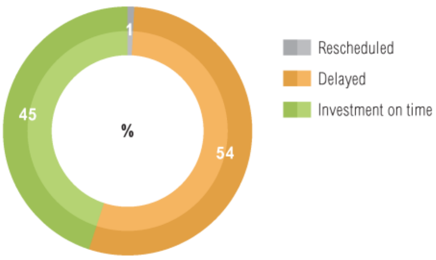

Figure 9-1 Evolution of the pan-EU significance investments in the CSE region

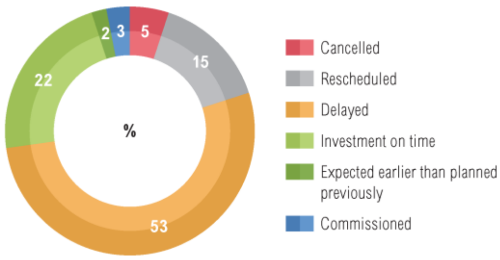

Figure 9-2 Evolution of the Regional significance investments in the CSE Region

Concerning the investments of pan-European relevance, 31 of them (45%) are on time, 37 of them (54%) are delayed and one of them (1%) is rescheduled. Concerning the investments of Regional significance, 19 of them (22%) are on time, 46 of them (53%) are delayed, 13 of them (15%) are rescheduled, 4 of them (5%) are cancelled, 2 of them (2%) are expected to be commissioned earlier than planned and 3 of them (3%) have been commissioned.

Concerning both categories of transmission investments the percentage of delayed projects, compared to the RgIP 2012 scheduling is higher than 50%. Major reasons for delays include:

- Difficulties in financing, which should be considered an outcome of the economic crisis
- Difficulties in the permitting processes

Rescheduling of investments is mainly a result of changes in planning data, like delays in the commissioning of new generation. Change in planning data is also the reason for cancelled investments. For example concerning the case of Greece, the reason of cancelling specific investments was the significant increase of distributed RES production as well as the spatial reallocation of thermal units that eliminated the need for the new transmission lines. It should be mentioned that the cases of rescheduling and cancelling of investments concern mostly projects in the long-term.

10 Conclusion

10.1 The TYNDP 2014 confirms the conclusion of the TYNDP 2012

Concerning the target year 2030, the TYNDP 2014 confirms the main conclusions of the TYNDP 2012. A major difference, concerns the higher RES penetration assumed (depending on the Visions) aiming at the alignment with the European energy policy goals for 2030 and 2050.

About 50% of the proposed projects with European significance address RES integration issues, either by directly connecting RES units, or indirectly by allowing the flow of RES between RES installations and load centres, and avoiding therefore the spillage of RES.

The project portfolio in this RgIP is a pre-requisite to ensure the energy transition and achieve electricity market integration. It covers all the pan-European and regional relevant infrastructure belonging to 11 European countries amounting to more than €17 billion investment portfolio for the next 15 years.

10.2 ENTSO-E supports the EIP implementation

All projects proposed by TSOs or other promoters have been assessed on the basis of a standard methodology: the Cost-benefit Analysis (CBA). The CBA has been prepared, shared and consulted on with all stakeholders during 2012 -2013. It is implemented in the TYNDP 2014 for all four 2030-Visions. This choice has been made based on stakeholder feedback, who preferred a large scope of contrasted scenarios compared to a more limited number and an intermediate horizon 2020. In this respect a systematic assessment is now available for all transmission and storage PCIs.

For the future TYNDPs and assessments, ENTSO-E and all interested stakeholders plan to evolve the CBA further to better match the decision makers' needs. Especially as it is already foreseen that the present methodology can be improved with respect to the so-called "capacity" value of assets (compared to the "energy" value). Storage projects in particular bring great capacity and flexibility to the power system that will be better reflected in their assessment in the future.

10.3 The European Internal Market and the energy transition requires grid

Challenges faced in CSE Region include:

- Completing market integration: in case of slow implementation of pan-European and regional relevant infrastructure the requested grid capacities in the main transmission corridors by 2030 may not be achieved.
- Reaching the 2030 RES targets: due to lack of timely necessary infrastructure the RES generation may not be fully accommodated.

Achieving the market, energy and climate objectives requires a smooth authorisation process, a proper regulation and economic framework.

Concerning permitting processes ENTSO-E and the RG CSE welcome the Regulation 347/2013 as there are many positive elements in the permitting legislation which will facilitate the fast tracking of transmission infrastructure projects including the proposal of one stop shop and defined timelines. However, from the financial supporting schemes point of view only the Projects of Common Interest are considered with a rather limited financial support, whereas there are many significant regional and national transmission projects that are crucial to the achievement of the European targets for climate change, renewable and market integration.

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10.4 General findings from the RG CSE studies

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).

The volume of electricity market exchanges 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. On the other hand, CSE Region will be influenced by the extension of CESA to the east by including the Turkish power system in the synchronous area with possible later inclusion of Ukraine and Moldova.

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.

Regional market and network studies performed in the framework of TYNDP 2014 showed that the Region is expected to be an exporter in all four Visions. The figure below depicts the Regional balances for each case. Higher exports appear in Vision 2, due to the low CO2 price assumed and the higher electricity demand in comparison to Vision 1. Lower exports appear in Vision 4 due to the high CO2 prices assumed and the very large RES penetration all over Europe.

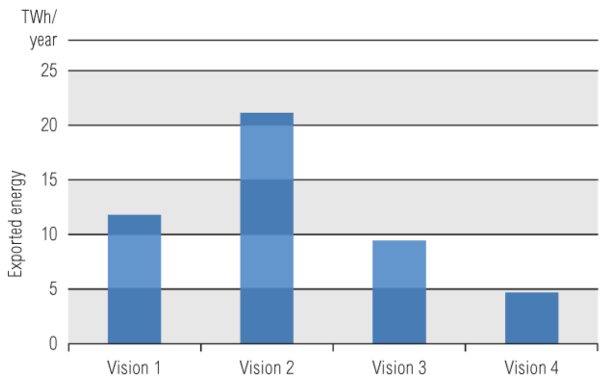

Figure 10-1 Regional energy balances in the 4 Visions.

Predominant power flow directions (E->W and N->S) continue to exist in 2030, concerning the Visions 1 and 2. In these two Visions exporting countries include Bulgaria, Romania, Serbia, Bosnia-Herzegovina, Montenegro, Slovenia and Albania. In Vision 3, predominant power flow directions continue to be as mentioned above but in some boundaries this trend appears for shorter periods, compared to previous Visions.

In addition for almost 5000 hours power flow direction changes in the borders between Bulgaria and Romania. Due to the hypothesis of high CO2 price in this Vision, Bosnia-Herzegovina and Serbia are becoming importing countries, while Hungary is becoming an exporter. Greece (importer in Visions 1 & 2) is reducing imports and becomes almost balanced.

In Vision 4 power flow predominant direction changes in the west borders of Serbia and the borders between Croatia and Bosnia-Herzegovina. In addition the hours of power flow in the N->S direction are reduced compared to in Visions 1 & 2, at the borders between Bulgaria and Romania as well as at the South borders of Bulgaria and Serbia. Similar to Vision 3, exporting countries are RO, BG, HU, SI, ME and AL. However,

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due to the higher RES penetration and electricity demand level assumed in this scenario, volumes of energy exchanges are differentiated compared to Vision 3. As an example, due to the higher RES penetration in Romania, energy export is increased. On the other hand, due to higher energy consumption imports in Greece are increased.

Integration of RES is one of the major drivers for the transmission system development in the area. Concerning wind farms, total installed capacity foreseen for 2030 in Visions 1 & 2 is comparable to the level of EU 2020 scenario in 2020, about 18GW. For these two visions a higher penetration is considered for solar installations compared to the EU 2020 scenario 8.1GW instead of 2.6GW. Highest RES penetration has been assumed in Vision 4 22.7GW of wind and 39.3GW of solar installations.

In addition, market integration with Western Europe especially in Italy is a key driver for the development of the transmission system in CSE Europe.

Regarding adequacy of the transmission network, regional studies depicted that under the precondition of implementing all planned investments, transmission capacity will be sufficient in most of the Visions in order to cope with expected power flows in both directions. Nevertheless, concerning the boundary at the West borders of Bulgaria and Romania some additional reinforcements may be needed in order to cope with the high RES penetration targets for 2030.

Another factor that may necessitate the need of increasing transfer capacity of the respective boundary is related to power flows due to exports of the Turkish power system as a dedicated sensitivity study depicted. The influence of the Turkish power system operation is an important source of uncertainty for transmission planning in the examined horizon, since exchanges with CESA will further increase bulk power transfers.

From a Regional point of view, foreseen installed generation up to year 2030 is sufficient to reliably meet the anticipated demand in all examined Visions.

11 Appendices

11.1 Appendix 1: technical description of projects

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

- Section 11.1.1 displays the detailed assessment of Projects of Pan-European significance within the CSE region, i.e. transmission projects stemming from ENTSO-E analyses or submitted by third parties, and matching the criteria of pan-European significance, be they eventually PCIs or not;
- Section 11.1.2 displays the list of all projects and investments within the CSE region, including latest information on the evolution of each investment since TYNDP and RgIPs 2012.
- Section 11.1.3 displays the list of all commissioned investments within the North Sea region.
- Section 11.1.4 displays the list of all cancelled investments within the North Sea region.
- Section 11.1.5 displays the assessment of storage projects within the North Sea region, complying with Reg 314/2013.

- Section 11.1.6 reminds the smart grid projects, complying with Reg 314/2013, but these are not to be assessed using the CBA methodology.

11.1.1 Transmission projects of pan-European significance

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

11.1.1.1 Transmission projects of pan-European significance

All projects (but one) presented in Section 11.1.1 are matching the criteria for projects of pan-European significance, set as of the TYNDP 2012.

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

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

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

11.1.1.2 Corridors, Projects, and investment items

Complying with the CBA methodology, a **project** in the TYNDP 2014 package can cluster several **investment items**, matching the CBA clustering rules. Essentially, a project clusters all investment items that have to be realised in total to achieve a desired effect.

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

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

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

11.1.1.3 Labelling

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

Since the TYNDP 2010, the TYNDP contains

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

Corridors have no reference number.

11.1.1.4 How to read every assessment sheet

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

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

Remarks

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

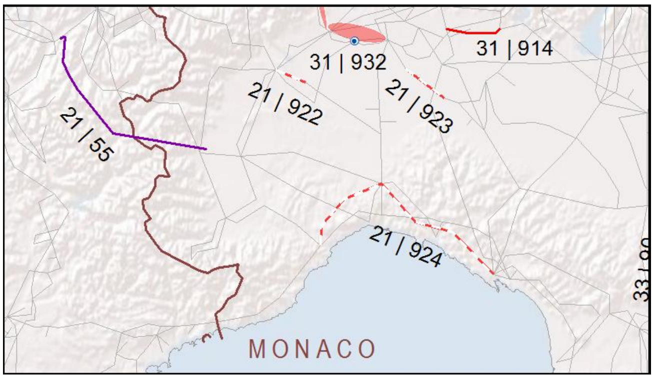
11.1.1.5 Assessment of projects of pan-European significance

Project 21: Italy-France

Description of the project

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

PCI 2.5.1



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

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

CBA results

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

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

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

Additional comments

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

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

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

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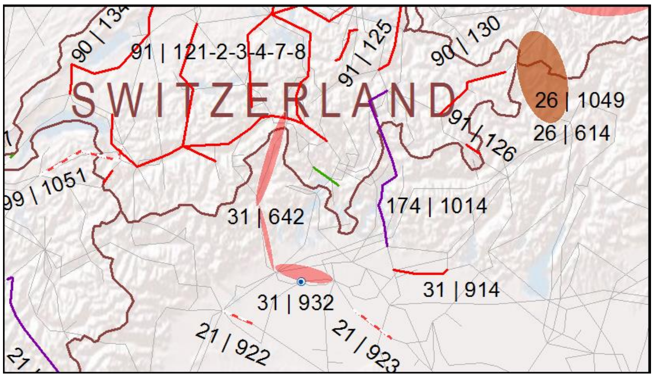
Project 31: Italy-Switzerland

Description of the project

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

PCI 2.15.1 and 2.15.2



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

								the 400 kV line Turbigo – Baggio

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
CH=>IT: 1000	IT=>CH: 950	1	4	Negligible or less than 15km	Negligible or less than 15km	1080

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[26;31]	0	[230000;290000]	[190;230]
Scenario Vision 2 - 2030	-	[32;39]	0	[230000;290000]	[-340;-280]
Scenario Vision 3 - 2030	-	[26;31]	0	[17000;21000]	0
Scenario Vision 4 - 2030	-	[54;66]	0	[50000;61000]	[-140;-120]

Additional comments

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

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

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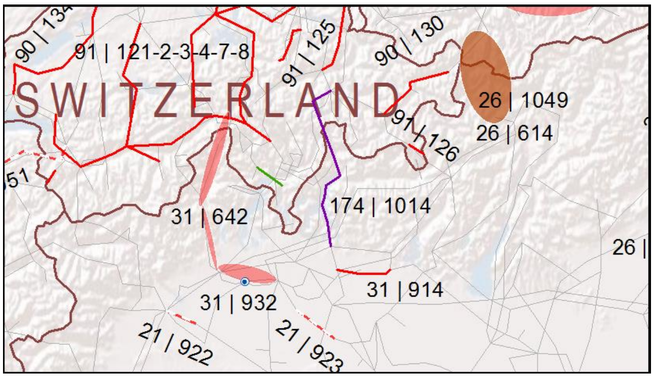
Project 174:

Description of the project

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

PCI 2.14



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1014	Verderio (I)	Sils (CH)	New +/- 400 kV DC cable and subsea link between Switzerland and Italy. Very short AC cable (380 kV) between the site of the converter station and the substation of Sils i.D.	-	Design & Permitting	2018	New Investment	Project application to TYNDP 2014.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
CH=>IT: 800	IT=>CH: 800	1	3	Negligible or less than 15km	Negligible or less than 15km	500*

CBA results	for each scenario				
Scenario	B1 SoS (MWh/year)	B2 SEW (MEuros/year)	B3 RES integration	B4 Losses (MWh)	B5 CO2 Emissions (kT/year)
Scenario Vision 1 - 2030	-	[19;24]	0	[-20000;-16000]	[170;210]
Scenario Vision 2 - 2030	-	[17;20]	0	[-24000;-20000]	[-500;-410]
Scenario Vision 3 - 2030	-	[18;23]	0	[1800;2200]	0

** the cost was updated after the submission of the report to ACER.*

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

Additional comments
Comment on the CBA assessment: costs figures have not been provided to ENTSO-E.

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

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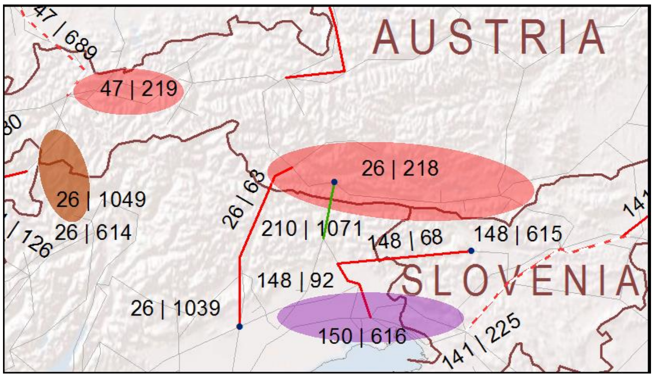
Project 26: Austria - Italy

Description of the project

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

PCI 3.3, 3.2.1 and 3.2.2



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
AT=>IT: 1450	IT=>AT: 1350	1	4	Negligible or less than 15km	Negligible or less than 15km	780-1180

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[57;70]	0	[-510000;-410000]	[520;640]
Scenario Vision 2 - 2030	-	[89;110]	[2700;3300] MWh	[-520000;-420000]	[-490;-400]
Scenario Vision 3 - 2030	-	[56;69]	[1100;1300] MWh	[-200000;-160000]	[-130;-100]
Scenario Vision 4 - 2030	-	[100;130]	[11000;14000] MWh	[-280000;-230000]	[-300;-240]

Additional comments

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

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

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

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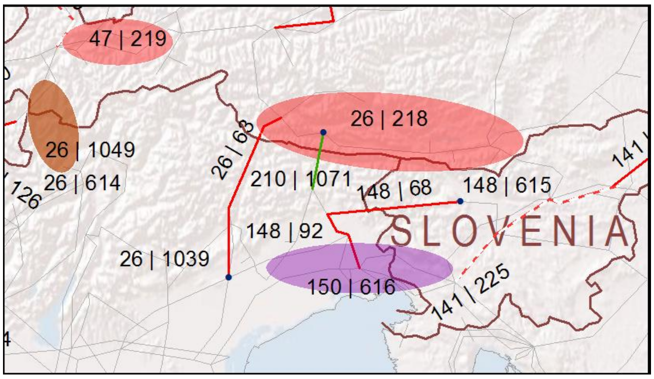
Project 210: E15

Description of the project

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

PCI 3.4



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
1071	Würmlach (AT)	Somplago (IT)	Würmlach - Somplago	-	Design & Permitting	2017	New Investment	Project application to TYNDP 2014.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
AT=>IT: 150	IT=>AT: 150	1	3	Negligible or less than 15km	Negligible or less than 15km	45-75

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[4;5]	0	[-13000;-11000]	0
Scenario Vision 2 - 2030	-	[9;11]	0	[-13000;-11000]	0
Scenario Vision 3 - 2030	-	[2;3]	0	[-2600;-2200]	0
Scenario Vision 4 - 2030	-	[5;6]	0	[-3600;-3000]	0

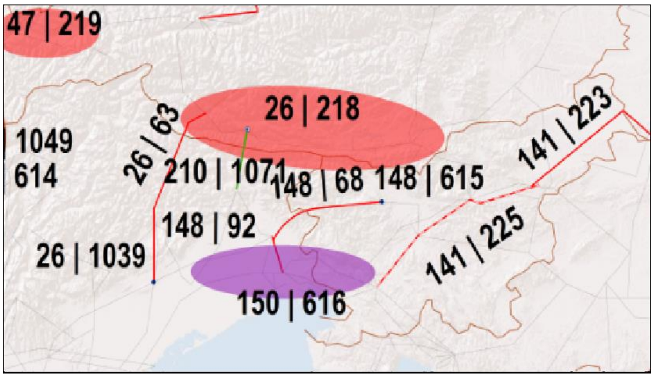
Additional comments

Project 148: CCS new

Description of the project

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

PCI 3.20



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
SI=>IT: 800	IT=>SI: 350	1	4	More than 100km	15-25km	420

CBA results	for each scenario				
Scenario	B1 SoS (MWh/year)	B2 SEW (MEuros/year)	B3 RES integration	B4 Losses (MWh)	B5 CO2 Emissions (kT/year)
Scenario Vision 1 - 2030	-	[23;28]	0	[-110000;-90000]	[220;270]
Scenario Vision 2 - 2030	-	[49;60]	0	[-140000;-120000]	[-260;-210]
Scenario Vision 3 - 2030	-	[15;18]	0	[-41000;-33000]	[0;1]
Scenario Vision 4 - 2030	-	[18;23]	0	[-260000;-220000]	0

Additional comments

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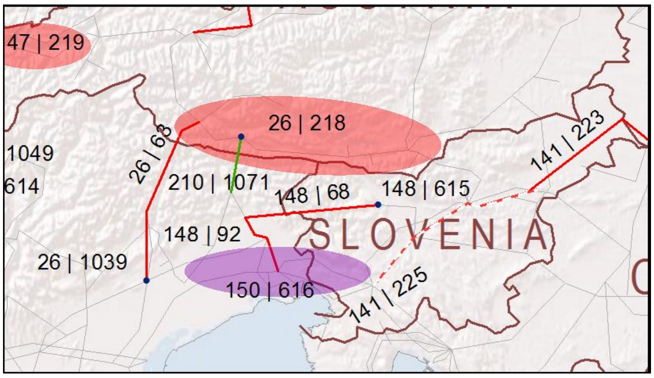
Project 150: CCS new 10

Description of the project

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



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

* The project is under permitting on the Italian side since 2012. The status under consideration refers only to the Slovenian side, where some project feasibility study is still in progress.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
SI=>IT: 800	IT=>SI: 700	1	3	NA	NA	870

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[22;27]	0	[1800;2200]	[220;270]
Scenario Vision 2 - 2030	-	[49;60]	0	[900;1100]	[-230;-190]
Scenario Vision 3 - 2030	-	[15;18]	0	[3600;4400]	[12;15]

Scenario Vision 4 - 2030	-	[19;24]	0	0	0

Additional comments

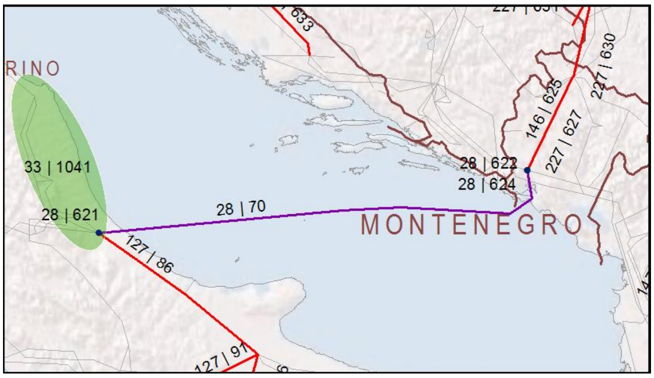
Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

Project 28: 28

Description of the project

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

PCI 3.19.1



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
IT=>ME: 1000	ME=>IT: 1000	1	3	Negligible or less than 15km	Negligible or less than 15km	1130

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[140;170]	[13000;15000] MWh	[-18000;-14000]	[1400;1700]
Scenario Vision 2 - 2030	-	[110;130]	0	[-18000;-14000]	[1100;1300]
Scenario Vision 3 - 2030	-	[290;360]	[330000;410000] MWh	[1800;2200]	[-650;-530]
Scenario Vision 4 - 2030	-	[290;350]	[990000;1200000] MWh	[3600;4400]	[-1700;-1400]

Additional comments

Comment on the RES integration: benefits in terms of RES integration are possible even in Vision 2 because the new interconnection improves the balance capacity of the system. This kind of benefits is not captured in all visions by market simulations because it is sometimes beyond the accuracy of the tool. Avoided spillage concerns mainly RES in the Italian and Balkan peninsulas.

Transbalkan Corridor

Description of the corridor

The "Transbalkan Corridor" is splitted into two projects (146, 227), representing its 2 phases spanning from 2015 to 2020.
Accompanying the new HVDC 400 kV cable between Montenegro and Italy (project 28), the reinforcement strategy along the corridor aims at supporting the increase of power transfers from north-west towards south-east part of this area and enabling further market integration. Investments which form this cluster are located on the territory of three countries: Serbia, Bosnia and Hertzegovina, Montenegro.
The two projects have been assessed as a whole and share the same common assessment.

Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
Project 146								
625	Lastva (ME)	Pljevlja (ME)	Reinforcement of the Montenegrin internal 400 kV transmission network with new 160 km double circuit 400kV AC OHL between existing substation Pljevlja and new substation Lastva. The investment will enable secure supply of Montenegrin power system and power transits directed to new HVDC link towards Italy. Also, this investment will enable connection of Renewable energy sources along its route.	1095	Design & Permitting	2016	Investment on time	Progress as planned.
1075	Kragujevac	Kraljevo	New internal 400 kV OHL will connect existing SS Kragujevac with SS Kraljevo which is planned for upgrade to 400 kV voltage level. This investment will enhance the possibility of energy transits in direction north-east to south-west and east to west.	1095	Design & Permitting	2018	Delayed	New axis for transits from East to the West, typically from Bulgaria to Bosnia and Montenegro, and further to the west.

1076	Kraljevo		Upgrade of the existing 220/110kV substation Kraljevo 3 by constructing the 400 kV level.	1095	Design & Permitting	2017	Delayed	This upgrade is required for the construction of new 400 kV OHL Kragujevac - Kraljevo which will increase local security of supply and power transfer from Eastern to Western part of region.
Project 227								
627	Bajina Basta (RS)	Visegrad (BA)	Description of broader context - New double circuit 400kV OHL connecting existing substation Pljevlja (ME) and substation Bajina Basta (RS) and new double circuit 400kV OHL connecting existing substation Visegrad (BA) and substation Bajina Basta (RS). In the first phase one 400 kV circuit would be equiped. In the second phase New SS Bistrica (RS) would be connected to the exisitng double circuit 400 kV OHL between SS Bajina Basta (RS), SS Visegrad (BA) and SS Pljevlja (ME). Part of regional transmission corridor northeast-southwest.	500	Planning	2020	Investment on time	Ongoing Regional trilateral feasibility study (financed by WBIF and supported by EC) between three TSOs (EMS, NOS BiH and CGES), including ESIA and preliminary design. Expected finalization time mid 2014.
628	SS Bajina Basta (RS)	SS Obrenovac (RS)	Double circuit 400 kV OHL between upgraded substation Bajina Basta and substation Obrenovac. Part of larger regional transmission corridor northeast-southwest.	500	Design & Permitting	2019	Delayed	Feasibility study, ESIA and preliminary design finalized (financed by WBIF and supported by EC). Ongoing process of adoption to local legislation needs.
630	Bajina Basta (RS)	Pljevlja (ME)	Description of broader context - New double circuit 400kV OHL (105km RS + 16km ME) connecting existing substation Pljevlja (ME) and substation Bajina Basta (RS) and new double circuit 400kV OHL connecting existing substation Visegrad (BA) and substation Bajina Basta (RS). In the first phase one 400 kV circuit would be equiped. In the second phase New SS Bistrica (RS) would be connected to the exisitng double circuit 400 kV OHL between SS Bajina Basta (RS), SS Visegrad (BA) and SS Pljevlja (ME). Part of regional transmission corridor northeast-southwest.	500	Planning	2020	Investment on time	Ongoing Regional trilateral feasibility study (financed by WBIF and supported by EC) between three TSOs (EMS, NOS BiH and CGES), including ESIA and preliminary design. Expected finalization time mid 2014.
631	Bajina Basta (RS)		Upgrade of existing 220/110 kV substation in Bajina Basta to 400/220/110 kV substation as part of overall western Serbia system upgrade to 400 kV voltage level. Part of larger regional transmission corridor northeast-southwest.	500	Design & Permitting	2019	Delayed	Feasibility study, ESIA and preliminary design finalized (financed by WBIF and supported by EC). Ongoing process of adoption to local legislation needs.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
East=>West: 1095	West=>East: 1095	1	4	Negligible or less than 15km	Negligible or less than 15km	85

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[330;410]	1000 MW	[-440000;-360000]	[500;620]
Scenario Vision 2 - 2030	-	[450;550]	1000 MW	[-740000;-610000]	[-3700;-3000]
Scenario Vision 3 - 2030	-	[280;340]	1000 MW	[-660000;-540000]	[-730;-590]
Scenario Vision 4 - 2030	-	[620;760]	1000 MW	[-390000;-320000]	[-4400;-3600]

Additional comments

Comment on the RES integration: the project helps connecting directly or indirectly about 1000 MW in the Balkan peninsula.

Project 136: CSE1

Description of the project

The project in Croatia include a new 400 kV OHL replacing the aging 220 kV OHL between existing substations Brinje and Konjsko, interdepending with the construction of two new 400/(220)/110 kV substations Brinje and Lika. The new 400 kV interconnection BanjaLuka (BA)-Lika (HR) will support market and RES integration in the area – South and Mid Croatia and North and Mid Bosnia and Herzegovina. The increased transfer capacity will enable higher diversity of supply&generation sources and routes, increasing resilience and flexibility of the transmission network.

PCI 3.5

Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
227	Banja Luka (BA)	Lika (HR)	New 400kV interconnection line between BA and HR	504	Under Consideration	2021	Rescheduled	Feasibility study is expected to be launched.
617	Lika(HR)	Brinje(HR)	New 55 km single circuit 400 kV OHL replacing aging 220 kV overhead line	215	Planning	2020	Investment on time	Feasibility study is expected to be launched.
618	Lika(HR)	Velebit(HR)	New 60 km single circuit 400 kV OHL replacing aging 220 kV overhead line	215	Planning	2020	Investment on time	Feasibility study is expected to be launched.
619	Lika (HR)		New 400/110 kV substation, 2x300 MVA	215	Planning	2018	Delayed	Feasibility study is expected to be launched.
620	Brinje (HR)		New 400/220 kV substation, 1x400 MVA	215	Planning	2020	Investment on time	Feasibility study is expected to be launched.
633	Konjsko(HR)	Velebit(HR)	New 100km single circuit 400 kV OHL replacing ageing 220 kV overhead line	215	Planning	2020	Investment on time	Feasibility study is expected to be launched.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
West=>East: 612	East=>West: 594	1	4	Negligible or less than 15km	15-25km	150

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[50;61]	830 MW	[9900;12000]	[-320;-260]
Scenario Vision 2 - 2030	-	[130;160]	830 MW	[-110000;-89000]	[-300;-240]
Scenario Vision 3 - 2030	-	[420;510]	900 MW	[-5300;-4300]	[-2700;-2200]
Scenario Vision 4 - 2030	-	[270;330]	900 MW	[8100;9900]	[-2300;-1900]

Additional comments

Comment on the RES integration: avoided spillage concerns RES in the Balkan peninsula.

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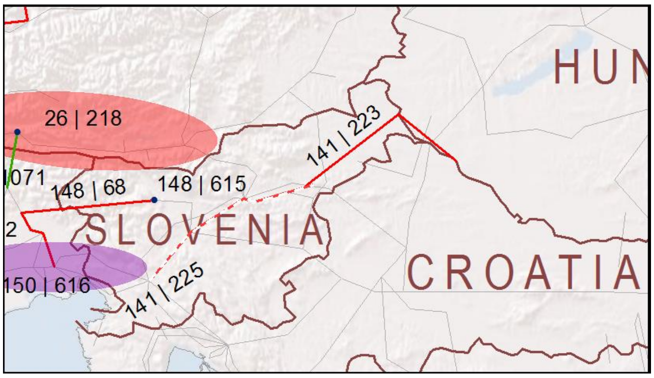
Project 141: CSE3

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
HU=>SI: 765	SI=>HU: 1085	0	4	More than 100km	15-25km	240-360

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[42;51]	0	[-120000;-95000]	[-200;-160]
Scenario Vision 2 - 2030	-	[40;49]	0	[-460000;-370000]	[-44;-36]
Scenario Vision 3 - 2030	-	[480;580]	0	[-240000;-190000]	[-3800;-3100]
Scenario Vision 4 - 2030	-	[300;370]	0	[-190000;-150000]	[-1700;-1400]

Additional comments

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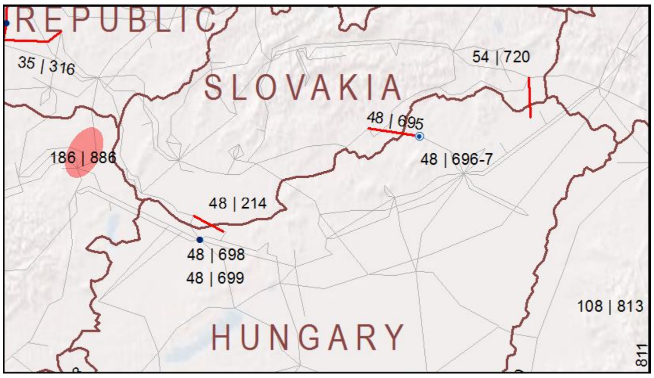
Project 48: New SK-HU intercon. - phase 1

Description of the project

This project will increase the transfer capacity between Slovak and Hungarian transmission systems, improve security and reliability of operation both transmission systems and support North - South RES power flows in CCE region. Main investments of this project are double circuit 400 kV line from new Gabcikovo (Slovakia) substation to Gönyű (Hungary) substation and double circuit 400 kV line from Rimavska Sobota (Slovakia) substation to Sajóivánka (Hungary) substation.

PCI 3.16 and 3.17



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
214	Gabcikovo (SK)	Gonyü area (HU)	New interconnection (new 2x400 kV tie-line) between SK and HU starting from Gabčíkovo substation (SK) to the Gőnyü substation on Hungarian side (preliminary decision). Project also includes the erection of new switching station Gabčíkovo next to the existing one.	1000	Planning	2018	Delayed	Expected commission date postponed on 2018 by reason of difficulties associated with finding the common national border crossing point.
695	Rimavská Sobota (SK)	Sajóivánka (HU)	Connection of the two existing substations (R.Sobota (SK) - Sajoóivánka (HU)) by the new 2x400 kV line (preliminary armed only with one circuit).	800	Planning	2018	Delayed	Expected commission date postponed on 2018 by reason of difficulties associated with finding the common national border crossing point.
696	Sajóivánka (HU)		2x70 Mvar shunt reactors in station Sajóivánka (HU)	800	Planning	2018	Delayed	Expected commission date postponed to 2018 as a result of negotiations between SEPS and MAVIR.
697	Sajóivánka (HU)		Second 400/120 kV transformer in station Sajóivánka (HU)	800	Planning	2018	Delayed	Expected commission date postponed to 2018 as a result of negotiations between SEPS and MAVIR.
698	Gyor (HU)		70 Mvar shunt reactor in station Győr (HU)	200	Planning	2018	Delayed	Investment rescheduled as a result of changes in planning input data (need delayed)

699	Gyor (HU)		Third 400/120 kV transformer in station Győr (HU)	200	Planning	2018	Delayed	Investment rescheduled as a result of changes in planning input data (need delayed)

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
SK=>HU: 0-500	HU=>SK: 0-425	1	3	Negligible or less than 15km	Negligible or less than 15km	97-98

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[27;34]	0	[-160000;-150000]	[410;500]
Scenario Vision 2 - 2030	-	[23;28]	0	[-220000;-180000]	[500;610]
Scenario Vision 3 - 2030	-	[31;38]	0	[2500;8300]	[65;80]
Scenario Vision 4 - 2030	-	[66;81]	0	[-12000;3600]	[-260;-220]

Additional comments

Comment on the security of supply: The project enhances system security of both Slovak and Hungarian system, especially during outages and maintenances on other interconnections between the countries

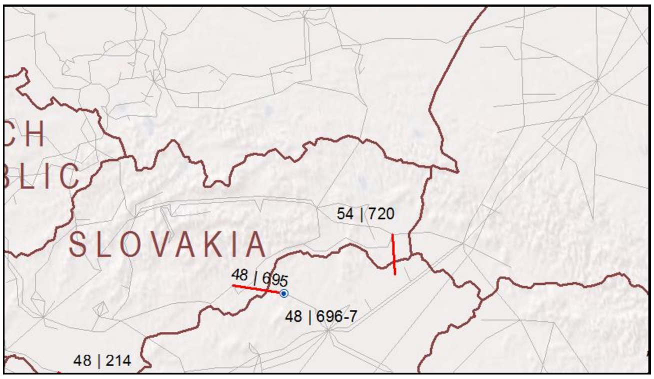
Comment on the RES integration: The project supports the North - South power flow from wind and photovoltaic power in Northern part of Continental Europe by increasing GTC of SK-HU profile and improves the possibilities of balancing the system.

Project 54: New SK-HU intercon. - phase 2

Description of the project

This project will increase the transfer capacity between Slovak and Hungarian transmission systems, improve security and reliability of operation both transmission systems and support North - South RES power flows in CCE region. Realization of this project is tightly connected to the negotiations between Slovak and Ukrainian TSOs regarding future operation of the existing Slovak interconnection with Ukraine. Main and only investment of this project is double circuit 400 kV line from Velke Kapusany (Slovakia) substation to Kisvárda region (Hungary).

PCI 3.18



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
720	Velké Kapušany (SK)	tbd (HU)	Erection of new 2x400 line between SK and Hungary (substation on Hungarian side still to be defined). The Investment is under consideration.	-	Under Consideration	2021	Investment on time	Progress as planned.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
SK=>HU: 0-500	HU=>SK: 0-500	1	3	Negligible or less than 15km	Negligible or less than 15km	21-22

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[2;3]	0	[-27000;-21000]	[-53;-44]
Scenario Vision 2 - 2030	-	[3;4]	0	[-37000;-45000]	[87;110]
Scenario Vision 3 - 2030	-	[12;15]	0	[-57000;-50000]	[-16;-13]
Scenario Vision 4 - 2030	-	[26;31]	0	[-27000;-19000]	[-92;-75]

Additional comments

Comment on the security of supply: The project enhances system security of both Slovak and Hungarian system, especially during outages and maintenances on other interconnections between the countries

Comment on the RES integration: The project supports the North - South power flow from wind and photovoltaic power in Northern part of Continental Europe by increasing GTC of SK-HU profile and improves the possibilities of balancing the system.

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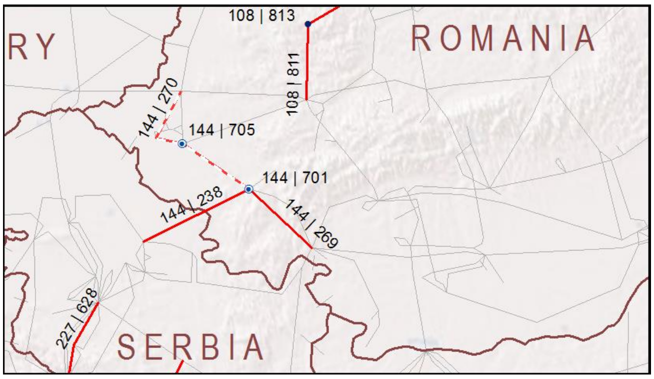
Project 144: Mid Continental East corridor

Description of the project

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) as well as to the pumped storage plant of more than 1000 MW in north-western Romania. The project improves operational regimes from the point of vue of stability and voltage collapse and facilitates maintenance of the network in the area.

PCI 3.22.1, 3.22.2 and 3.22.3.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
238	Pancevo (RS)	Resita (RO)	New 131 km double circuit 400kV OHL between existing substation in Romania and Serbia (63 km on Romanian side and 68 km on Serbian side) 2x1380 MVA.	350	Design & Permitting	2017	Investment on time	Activities are mostly synchronized on both sides. The main problem is right of land along the line path.
269	Portile de Fier (RO)	Resita (RO)	New 116 km 400kV OHL between existing substation 400 kV Portile de Fier and new 400 kV substation Resita; 1380 MVA.	287	Design & Permitting	2017	Delayed	The investment was coordinated with investment 50|238. The main problems are right of land along the line path and permitting.
270	Resita (RO)	Timisoara-Sacalaz-Arad (RO)	Upgrade of existing 220kV double circuit line Resita-Timisoara-Sacalaz-Arad to 400kV double circuit. Line length: aprox. 100 km d.c. + 74,6 km s.c.;2x1380 MVA; 1204 MVA the circuit between Sacalaz and C. Aradului	180	Design & Permitting	2022	Investment on time	Planned to start after investment 269 is finalized.
701	Resita (RO)		New 400 kV substation Resita (T400/220 kV 400 MVA + T 400/110 kV 250 MVA), as development of the existing 220/110 kV substation.	350	Design & Permitting	2017	Investment on time	Investment has been split. It is expected that the substation will be commissioned in two stages. In TYNDP 2012,

								timing referred only to the adjacent lines.
705	Timisoara (RO)		Replacement of 220 kV substation Timisoara with 400 kV substation (2x250 MVA 400/110 kV)	180	Design & Permitting	2022	Investment on time	Investments 269 and 701 have to be finalized first.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
East=>West: 737	West=>East: 453	3	4	15-50km	Negligible or less than 15km	130-220

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[170;210]	1000 MW	[-96000;-78000]	[1200;1500]
Scenario Vision 2 - 2030	-	[66;81]	1000 MW	[-160000;-130000]	[700;860]
Scenario Vision 3 - 2030	-	[18;22]	1000 MW	[-220000;-180000]	[-380;-310]
Scenario Vision 4 - 2030	-	[190;230]	1000 MW	[-340000;-280000]	[-330;-270]

Additional comments

Comment on the clustering: the project also takes advantage of investment items n°706, depicted in the Regional investment plan.

Comment on the RES integration: The projects directly connects 258 MW of RES in 400 kV substation Vrani (connected in-out to 400 kV line Resita-Pancevo, in Romania). The project helps integrate about 1000 MW of RES in the region of South-West Romania and North-East Serbia. It avoids 100-800 GWh of RES (spillage avoided, depending on Vision).

GTC is increased between (RO+BG) / (HU+RS).

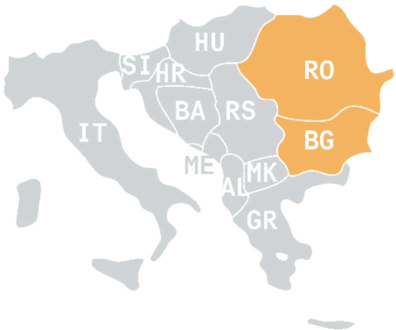
Project 138: Black Sea Corridor

Project 138: Black Sea Corridor

Description of the project

The project reinforces the corridor along the coast of the Black Sea (Romania-Bulgaria) and between this coast and the rest of Europe and Turkey.
Regional and European market integration will be enhanced, allowing for increased exchanges in the area.
Development of intermittent RES will be made possible by the capacity of the grid to transport their generation to consumption and storage centres and to accommodate balancing at regional/continental level.
The project improves operational regimes from the point of vue of stability and voltage collapse and facilitates maintenance of the network in the area.

PCI 3.8



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
265	Vidno (BG)	Svoboda (BG)	New 400kV double circuit OHL to accommodate 2000 MW RES generation in N-E Bulgaria (Dobruja region). Line length: 2x70km.	165	Planning	2019	Delayed	Delayed due to lack of funding.
273	Cernavoda (RO)	Stalpu (RO) and Gura Ialomitei (RO)	Reinforcement of the cross-section between the Western coast of the Black Sea (Eastern Romania) and the rest of the system. New 400kV double circuit OHL between existing substations Cernavoda and Stalpu, with 1 circuit derivation in/out in 400 kV substation Gura Ialomitei, situated in the vicinity of the new line. Line length:159km.2x1380 MVA	808	Design & Permitting	2019	Delayed	Longer than expected delay regarding clarification of legal framework for right of land acquirement and regarding environment permitting procedure.
275	Smardan(RO)	Gutinas(RO)	Reinforcement of the cross-section between the Western coast of the Black Sea (Dobrogea area) and the rest of the system. New 400kV double circuit OHL (one circuit wired) between existing substations. Line length:140km; 1380 MVA	560	Design & Permitting	2020	Investment on time	Rapid increase of wind generation connected in the area. Efforts to be made to speed construction.

276	Suceava(RO)	Gadalin(RO)	Reinforcement of the cross-section between developing wind generation hub in Eastern Romania and the rest of the system. New 400kV simple circuit OHL between existing substations. Line length: 260km. 1204 MVA	165	Design & Permitting	2021	Investment on time	No change of status.
715	Stalpu (RO)		To reinforce the cross-section between the Black Sea coast wind generation in Romania and Bulgaria and the consumption and storage centres to the West, the 220 kV OHL Stalpu-Teleajen-Brazi is upgraded to 400 kV, as a continuation of the 400 kV d.c. OHL Cernavoda-Stalpu. The 220/110 kV substation Stalpu is upgraded to 400/110kV (1x250MVA).	808	Planning	2019	Delayed	The investment was rescheduled in correlation with project 273.
800	Dobrudja(BG)	Burgas (BG)	New 140km single circuit 400kV OHL in parallel to the existing one.	165	Planning	2018	Delayed	Delayed due to lack of funding.
1112	Svoboda (BG)	splitting point	Construction of a new 400/110kV power line breaking up the existing 400kV Saedinenie OHL and connecting 400/110kV Svoboda substation.	165	Planning	2019	Delayed	Delayed due to lack of funding

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 1260	South=>North: 2196	3	3	Negligible or less than 15km	Negligible or less than 15km	173-403

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[110;130]	1330 MW	[-66000;-54000]	[-420;-340]
Scenario Vision 2 - 2030	-	[61;74]	1330 MW	[27000;33000]	[-780;-640]
Scenario Vision 3 - 2030	-	[410;500]	1330 MW	[-170000;-140000]	[-3400;-2700]
Scenario Vision 4 - 2030	-	[360;440]	1330 MW	[-25000;-20000]	[-2100;-1800]

Additional comments

Comment on the RES integration: The projects directly connects 1330 MW of RES in 400 kV substations Gheraseni (connected in-out to 400 kV line Gura Ialomitei – Stalpu), Independenta (connected in-out to 400 kV line Gutinas-Smardan), Vidno, Ustrem (Svoboda). The project helps integrating about 5000 MW of RES on the Black Sea coast more generally. It avoids about 9000 GWh spillage of RES in the region of the Black Sea Coast in Romania and Bulgaria. The assessment of spillage and indirect integration considers reinforcement of internal corridors in Romania and Bulgaria connecting the Black Sea Coast windy area to the rest of the system, not only cross-border transfer capacities.

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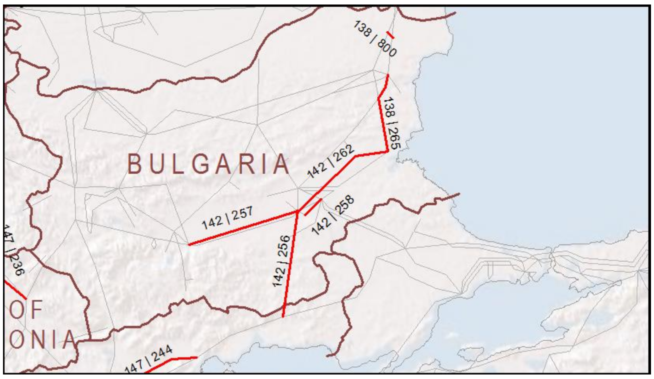
Project 142: CSE4

Description of the project

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.

PCI 3.7



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
256	Maritsa East 1 (BG)	N.Santa (GR)	New interconnection line BG-GR by a 130km single circuit 400kV OHL.	648	Design & Permitting	2021	Delayed	Delayed due to lack of funding.
257	Maritsa East 1 (BG)	Plovdiv (BG)	New 100km single circuit 400kV OHL in parallel to the existing one.	648	Design & Permitting	2016	Delayed	Delayed due to difficulties with the acquisition of the land
258	Maritsa East 1 (BG)	Maritsa East 3 (BG)	New 13km single circuit 400kV OHL in parallel to the existing one.	648	Design & Permitting	2016	Delayed	Delayed due to difficulties with the acquisition of the land
262	Maritsa East 1 (BG)	Burgas (BG)	New 400kV OHL. Line length: 150km.	648	Design & Permitting	2016	Delayed	Delayed due to difficulties with the acquisition of the land

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
North=>South: 648	South=>North: 82	2	4	15-50km	Negligible or less than 15km	100

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[54;67]	250 MW	[-110000;-88000]	[-22;-18]
Scenario Vision 2 - 2030	-	[200;250]	250 MW	[-140000;-110000]	[-150;-130]
Scenario Vision 3 - 2030	-	[100;120]	250 MW	[-170000;-140000]	[-510;-410]
Scenario Vision 4 - 2030	-	[150;180]	250 MW	[-130000;-110000]	[-970;-790]

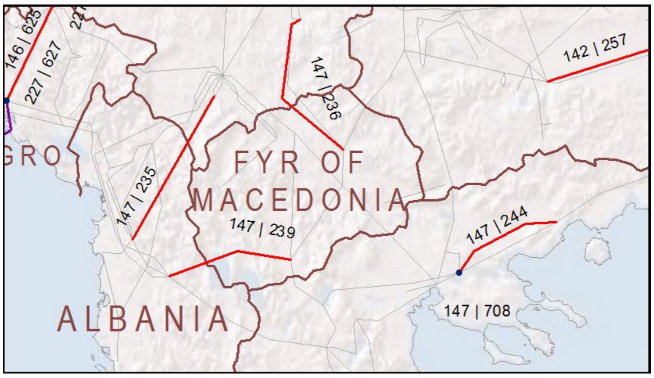
Additional comments

Comment on the RES integration: the project helps connecting directly or indirectly 250 MW in the Balkan peninsula.

Project 147: CSE9

Description of the project

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.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
235	Tirana(AL)	Pristina (RS)	New 238km 400kV OHL; on 78km the circuit will be installed on the same towers as the Tirana-Podgorica OHL currently in construction ; the rest will be built as single circuit line.	160	Under Construction	2016	Delayed	Slight delay, due to procedural reasons. In particular the previous tender has been cancelled and a new one was launched. Currently the project is under construction
236	Leskovac(RS)	Shtip (MK)	New 170km 400kV single circuit overhead interconnection between Serbia and FYR of Macedonia.	620	Under Construction	2014	Delayed	land acquisition
239	Bitola (MK)	Elbasan (AL)	New 150km cross-border single circuit 400kV OHL between existing substation Bitola and Elbasan	160	Design & Permitting	2017	Delayed	additional investigation of feasibility
244	Filippi(GR)	Lagadas (GR)	Connection of the new 400kV substation in Lagadas in Thessaloniki area to the existing substation of Filippi via a new 110km double circuit 400kV OHL.	301	Design & Permitting	2016	Delayed	Delays in the expropriation and permission process. These issues have been resolved.
708	Lagadas (GR)		New 400kV substation in Lagadas in Thessaloniki area.	301	Under Construction	2014	Delayed	Delays due to environmental licensing process

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 1157	South=>North: 2709	1	4	Negligible or less than 15km	Negligible or less than 15km	210

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[380;460]	300 MW	[-210000;-170000]	[-55;-45]
Scenario Vision 2 - 2030	-	[190;230]	300 MW	[-86000;-70000]	[120;140]
Scenario Vision 3 - 2030	-	[510;620]	300 MW	[-61000;-50000]	[-2200;-1800]
Scenario Vision 4 - 2030	-	[600;730]	300 MW	[-100000;-85000]	[-5300;-4400]

Additional comments

Comment on the RES integration: the project helps connecting directly or indirectly about 300 MW in the Balkan peninsula.

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Project 219: EUROASIA interconnector

Description of the project

Promoted by DEH Quantum Energy LTD

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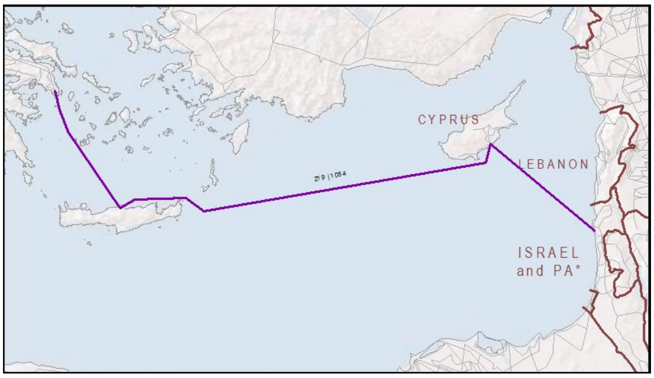
A 2000 MW link between Israel, Cyprus, and Greece (Creta and mainland).

PCI 3.10



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
949	Korakia site (CRETE)	Athens site (GREECE)	New HVDC interconnection between Crete and Athens	2000	Planning	2020	New Investment	Project application to TYNDP 2014.
971	Vasilikos site (CYPRUS)	Korakia site (CRETE)	New HVDC interconnection between Cyprus and Crete Islands	2000	Planning	2022	New Investment	Project application to TYNDP 2014.
1054	Hadera site (ISRAEL)	Vasilikos site (CYPRUS)	New HVDC interconnection between Israel and Cyprus	2000	Planning	2018	New Investment	Project application to TYNDP 2014.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
East=>West: 2000	West=>East: 2000	2	3	NA	NA	2300-5300

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[530;640]	[3400000;4100000] MWh	[1400000;1700000]	0
Scenario Vision 2 - 2030	-	[530;650]	[3600000;4400000] MWh	[1400000;1700000]	0
Scenario Vision 3 - 2030	-	[330;410]	[3500000;4200000] MWh	[1200000;1400000]	0
Scenario Vision 4 - 2030	-	[310;380]	[3500000;4300000] MWh	[1100000;1400000]	0

Additional comments

Comment on the RES integration: avoided spillage concerns mainly wind farms in Creta.

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

Comment on the S1 and S2 indicators: additional data are necessary to compute these indicators

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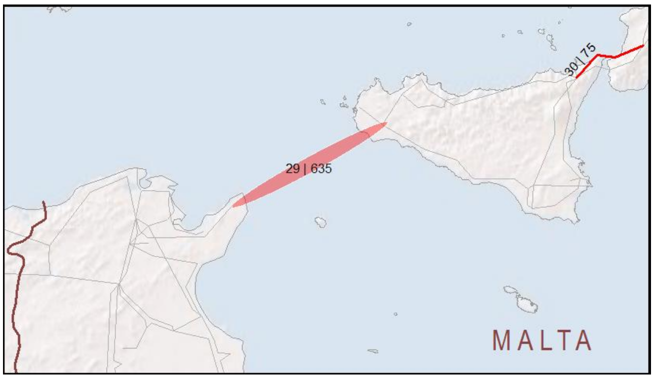
Project 29: Italy-North Africa

Description of the project

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



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
635	Sicily Area (IT)	North Africa node	New interconnection between Italy and North Africa-new DC submarine cable	-	Under Consideration	2030	Investment on time	Progress as planned.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
IT=>South: 600	South=>IT: 600	1	4	NA	NA	600

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[81;99]	0	[18000;22000]	0
Scenario Vision 2 - 2030	-	[81;99]	0	[18000;22000]	0
Scenario Vision 3 - 2030	-	[81;99]	0	[18000;22000]	0
Scenario Vision 4 - 2030	-	[81;99]	0	[18000;22000]	0

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Additional comments

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

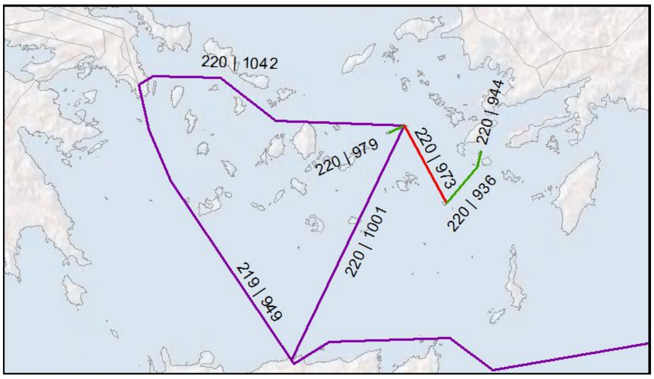
Comment on the Losses indicator: the load factor of the cable is steady in all Visions, leading to the same and high additional losses.

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

Project 220: Southern Aegean Interconnector

Description of the project

Promoted by Kykladika Meltemia S.A.
The project consists of collecting about 600 MW of RES in the Islands north-east to Crete via HVDC cables.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
936	Kandeliousa	Syrna	AC Subm. Cable to connect Kandeliousa offshore WF HV substation (18MW) to Syrna SS	200	Design & Permitting	2020	New Investment	Project application to TYNDP 2014. Commissioning date: 2018-2020
944	Kandeliousa	Pergousa	AC Subm. Cable to connect Pergousa offshore WF HV substation (42MW) to the Kandeliousa SS	200	Design & Permitting	2020	Investment on time	Project application to TYNDP 2014.Commissioning date: 2018-2020
973	Syrna	Levitha	AC Subm. Cable to connect Syrna offshore WF HV substation (156MW) to the AC part of the Levitha Converter SS	400	Design & Permitting	2020	New Investment	Project application to TYNDP 2014. commissioning date: 2018-2020
979	Kinaros	Levitha	AC Subm. Cable to connect Kinaros offshore WF HV substation (111MW) to the AC side of the Levitha Converter SS	200	Design & Permitting	2020	New Investment	Project application to TYNDP 2014. commissioning date: 2018=2020
1001	Levitha island	Korakia (new s/s in Crete)	New DC link (2 converter SS + 250 km DC subm. cable) to Crete	600	Design & Permitting	2020	New Investment	Project application to TYNDP 2014. commissioning date: 2018-2020
1042	Lavrion 400kv S/S	Levitha island	New DC link (2 converter SS + 270 km DC subm. cable) to connect 537MW of offshore WF generation to the mainland	600	Design & Permitting	2020	New Investment	Project application to TYNDP 2014. commissioning date expected: 2018-2020

			(Area of Athens)					

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 650	South=>North: 650	2	2	Negligible or less than 15km	Negligible or less than 15km	1400-3200

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[150;180]	[2000000;2400000] MWh	[120000;150000]	0
Scenario Vision 2 - 2030	-	[140;170]	[2000000;2400000] MWh	[130000;160000]	0
Scenario Vision 3 - 2030	-	[160;200]	[2000000;2400000] MWh	[110000;130000]	0
Scenario Vision 4 - 2030	-	[150;190]	[2000000;2400000] MWh	[100000;130000]	0

Additional comments

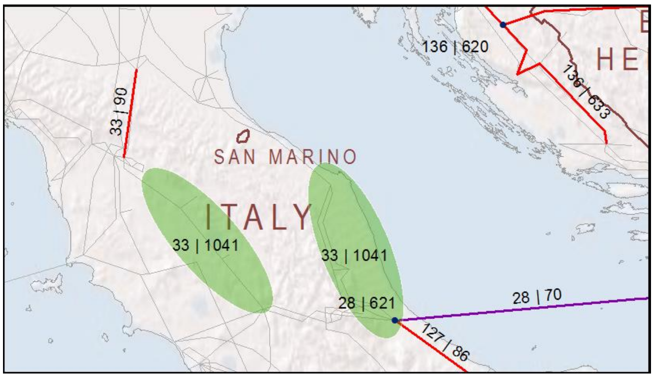
Comment on the RES integration: the project helps connecting directly or indirectly about 600 MW of RES in the Greek Islands that will be almost entirely spilled without the project.

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

Project 33: 33

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 600	South=>North: 600	1	3	15-50km	Negligible or less than 15km	280

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[110;130]	[1100000;1400000] MWh	[-340000;-280000]	[-680;-550]
Scenario Vision 2 - 2030	-	[100;130]	[1100000;1300000] MWh	[-340000;-280000]	[-640;-520]
Scenario Vision 3 - 2030	-	[170;200]	[1300000;1500000] MWh	[-310000;-260000]	[-940;-770]
Scenario Vision 4 - 2030	-	[180;220]	[1500000;1800000] MWh	[-350000;-290000]	[-1100;-900]

Additional comments

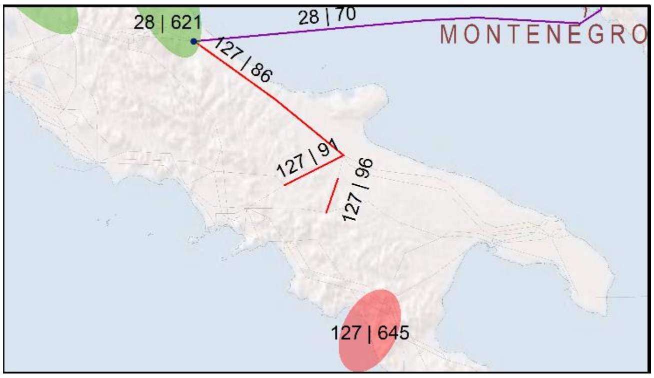
Comment on the RES integration: the project allows to overcome the limitations to RES power plants installed in central part of Italy where in Vision 1 are expected about 9 GW of wind and solar power plants

Project 127: 127

Description of the project

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

PCI 3.19.3



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)

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

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[370;450]	[4600000;5600000] MWh	[-170000;-140000]	[-3100;-2600]
Scenario Vision 2 - 2030	-	[350;420]	[4300000;5300000] MWh	[-170000;-140000]	[-3000;-2400]
Scenario Vision 3 - 2030	-	[460;560]	[5100000;6200000] MWh	[-130000;-110000]	[-3500;-2900]
Scenario Vision 4 - 2030	-	[460;560]	[5100000;6300000] MWh	[-280000;-230000]	[-3500;-2900]

Additional comments

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

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

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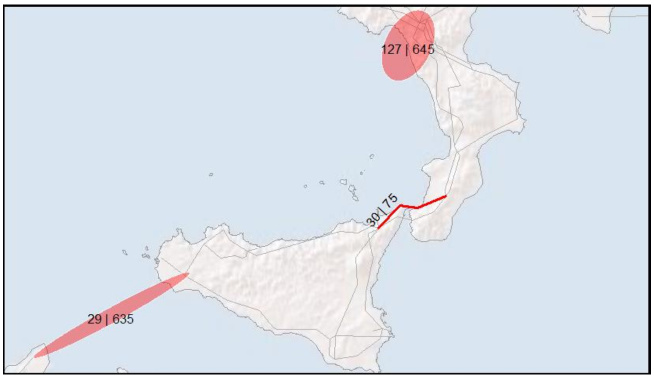
Project 30: 30

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
South=>IT: 1000	IT=>South: 1000	1	2	Negligible or less than 15km	Negligible or less than 15km	780

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	[18000;22000]	[320;390]	[1500000;1900000] MWh	[-39000;-32000]	[-1400;-1200]
Scenario Vision 2 - 2030	[19000;23000]	[300;370]	[1500000;1800000] MWh	[-39000;-32000]	[-1300;-1100]
Scenario Vision 3 - 2030	[23000;28000]	[490;590]	[2000000;2400000] MWh	[-55000;-45000]	[-2000;-1700]
Scenario Vision 4 - 2030	[37000;45000]	[410;510]	[2000000;2400000] MWh	[-61000;-50000]	[-2000;-1600]

Additional comments

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

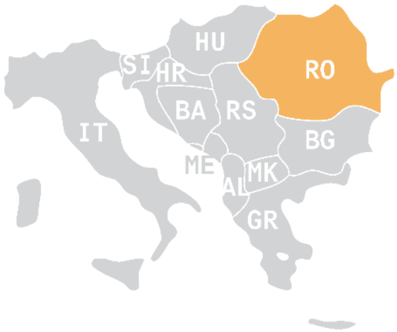
Comment on the RES integration:
The considered project allows to overcome the limitations to RES power plants installed in Sicily island where in Vision 1 are expected about 4GW of Wind and Solar power plants

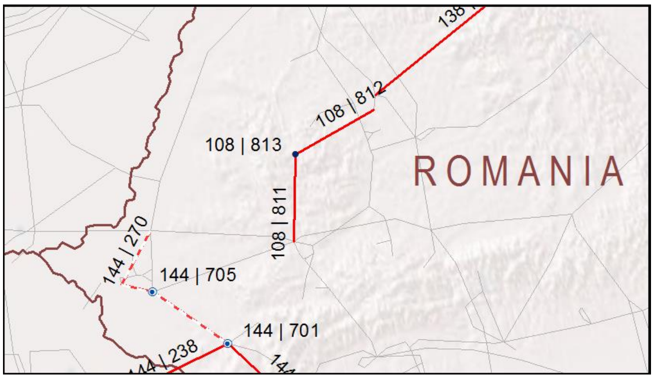
Comment on the CO2 indicator: the very high scores reflect that the project enables a better use of RES from Sicily

Project 108: 1000MW HPS Tarnita connection

Description of the project

The project consists of two double circuit 400-kV lines that are needed to connect to the grid the future 1000MW Hydro Pumped Storage Tarnita-Lapustesti, situated in the North-West of Romania. The project will supply reserve/balancing services for Romania and possibly for neighboring countries (Hungary, Serbia, Bulgaria, other). It will support integration of intermittent RES generation.





Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
811	Tarnita (RO)	Mintia (RO)	New double circuit 400kV OHL Tarnita(RO)-Mintia(RO) 2x1380 MVA.	1000	Planning	2018	Investment on time	The project shall be built only if the Hydro Pumped Storage plant shall be built. Final investment decision is pending.
812	Tarnita (RO)	Cluj E - Gadalin (RO)	New double circuit 400kV OHL Tarnita(RO)- Cluj E-Gadalin (RO) 2x1380 MVA.	1000	Planning	2018	Investment on time	The project shall be built only if the Hydro Pumped Storage plant shall be built. Final investment decision is pending.
813	Tarnita (RO)		New 400kV substation connecting 1000 MW Hydro Pumped Storage Tarnita Lapustesti to the grid.	1000	Planning	2018	Investment on time	The project shall be built only if the Hydro Pumped Storage plant shall be built. Final investment decision is pending.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>outside: 1000	outside=>inside: 1000	3	3	Negligible or less than 15km	Negligible or less than 15km	100-170

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[9;12]	[35000;43000] MWh	[-47000;-39000]	[400;490]
Scenario Vision 2 - 2030	-	[4;5]	[9900;12000] MWh	[-21000;-17000]	[250;310]
Scenario Vision 3 - 2030	-	[3;4]	[19000;23000] MWh	[-200000;-170000]	[-46;-37]
Scenario Vision 4 - 2030	-	[94;120]	[660000;800000] MWh	[51000;62000]	[-550;-450]

Additional comments

11.1.2 List of projects and investments within the region

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

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
21	**Italy-France**								
		922	Rondissone (IT)	Trino (IT)	Removing limitations on the existing 380 kV Rondissone-Trino	2019	Planning	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the italian National Development Plan 2013
		923	Lacchiarella(IT)	Chignolo Po(IT)	Removing limitations on the existing 380 kV Lacchiarella-Chignolo Po	2019	Planning	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the italian National Development Plan 2013
		924	Vado (IT)	Vignole (IT)	Removing limitations on the existing 380 kV Vado-Vignole and Vignole-Spezia	2019	Planning	New Investment	The item contributes to get the full advantage of the new HVDC cables was planned for the first time in the italian National Development Plan 2013
		55	Grande Ile (FR)	Piossasco (IT)	"Savoie - Piémont" Project : New 190km HVDC (VSC) interconnection FR-IT via underground cable and converter stations at both ends (two poles, each of them with 600MW capacity). The cables will be laid in the security gallery of the Frejus motorway tunnel and also along the existing motorways' right-of-way.	2019	Under Construction	Delayed	After some delay in the works of the Frejus service gallery of the motorway, in which the cables will be installed, the project timeline has been updated. Works are already in progress.
26	**Austria - Italy**								

		1039	Volpago (IT)		New 380/220/132 kV substation with related connections to 380 kV Sandrigo Cordignano and 220 KV Soverzene Scorzè where removing limitations are planned	2020	Planning	Delayed	The Volpago Substation was included in the TYNDP 2012 as part of the item 26.83 which had as commissioning date 2015. Permitting process delayed due to territorial constraint
		1049	tbd (IT)	tbd (AT)	interconnector IT-AT (phase 2)	2023	Under Consideration	New Investment	project progress
		218	Obersielach (AT)	Lienz (AT)	New 380kV OHL connecting the substations Lienz (AT) and Obersielach (AT) to close the Austrian 380kV-Security Ring in the southern grid area. Line length: 190km.	2023	Under Consideration	Investment on time	Progress as planned.
		63	Lienz (AT)	Veneto region (IT)	The project foresees the reconstruction of the existing 220kV-interconnection line as 380kV-line on an optimized route to minimize the environmental impact. Total length should be in the range of approx. 140km.	2023	Planning	Investment on time	Planning in progress coordinatedly between TERNA and APG
		614	Nauders (AT)	Glorenza (IT)	interconnector IT-AT (phase 1)	2018	Design & Permitting	Investment on time	-
28	**28**								
		624	Lastva (ME)		New 400 kV substation Lastva in Montenegro will be connected to the existing line 400kV Podgorica 2(ME)-Trebinje(BA), with two transformers 2X300MVA 400/110kV. This substation will enable secure supply of the Montenegrin coastal network, and connection of the convertor station for the HVDC cable between Montenegro and Italy.	2015	Design & Permitting	Investment on time	on time
		70	Villanova (IT)	Lastva (ME)	New 1000MW HVDC interconnection line between Italy and Montenegro via 375km 500kV DC subsea cable and converter stations at both ending points.	2017	Under Construction	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase

		621	Villanova (IT)		Converter station of the new 1000MW HVDC interconnection line between Italy and Montenegro via 375km 500kV DC subsea cable.	2017	Under Construction	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
		622	Lastva (ME)		Converter station in Montenegro of the new 1000MW HVDC sub-sea 500 kV cable between Italy and Montenegro.	2017	Under Construction	Delayed	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
29	**Italy-North Africa**								
		635	Sicily Area (IT)	North Africa node	New interconnection between Italy and North Africa-new DC submarine cable	2030	Under Consideration	Investment on time	-
30	**30**								
		75	Sorgente (IT)	Rizziconi (IT)	New 90km double circuit 400kV line, partly via subsea cable and partly via OHL. This line is part of a larger project that foresees the creation of the future 400kV grid of Sicily.	2015	Under Construction	Delayed	rescheduling of 6 months work due to technical issues during construction phase
31	**Italy-Switzerland**								
		914	Cassano (IT)	Chiari (IT)	Upgrade to 380 kV of part of existing 220 kV Cassano Ric.Ovest	2022	Design & Permitting	New Investment	The interconnection scheme envisaged in TYNDP 2012 is now defined. The upgrade of Chiari-Cassano is identified as critical to get full advantage of the Giacomo project.
		932	Magenta(IT)		new 400 kV section in Magenta substation	2020	Design & Permitting	Investment on time	HVDC link between Pallanzeno and Baggio will be realized using existing 220 kV line connecting the Magenta 220/132 kV substation. Consequently, a new 400 kV section will be needed to reconnect the Magenta substation to the 400 kV line Turbigo – Baggio

		124	Mettlen (CH)	Airolo (CH)	Upgrade of existing 225kV OHL into 400kV. Line length: 90km.	2020	Under Consideration	Investment on time	-
		642	Airolo (CH)	Pallanzeno(IT)-Baggio(IT)	New interconnection project beetween Italy and Switzerland;	2022	Design & Permitting	Investment on time	permitting process started on the Italian side since September 2012
33	**33**								
		1041	Villanova (IT)	S. Barbara (IT)	Removing limitations on existing 220 kV grid between Villanova e S.Barbara	2020	Planning	New Investment	The item 1041 has a significant effect on the grid transfer capacity
		90	Calenzano (IT)	Colunga (IT)	Voltage upgrade of the existing 80km Calenzano-Colunga 220kV OHL to 400kV, providing in and out connection to the existing 220/150kV substation of S. Benedetto del Querceto (which already complies with 400kV standards).	2018	Design & Permitting	Delayed	delay in the permitting process (EIA)
48	**New SK-HU intercon. - phase 1**								
		214	Gabcikovo (SK)	Gonyü area (HU)	New interconnection (new 2x400 kV tie-line) between SK and HU starting from Gabčíkovo substation (SK) to the Gőnyü substation on Hungarian side (preliminary decision). Project also includes the erection of new switching station Gabčíkovo next to the existing one.	2018	Planning	Delayed	Expected commission date postponed on 2018 by reason of difficulties associated with finding the common national border crossing point.
		695	Rimavská Sobota (SK)	Sajóivánka (HU)	Connection of the two existing substations (R.Sobota (SK) - Sajoóivánka (HU)) by the new 2x400 kV line (preliminary armed only with one circuit).	2018	Planning	Delayed	Expected commission date postponed on 2018 by reason of difficulties associated with finding the common national border crossing point.
		696	Sajóivánka (HU)		2x70 Mvar shunt reactors in station Sajóivánka (HU)	2018	Planning	Delayed	Expected commission date postponed to 2018 as a result of negotiations between SEPS and MAVIR.
		697	Sajóivánka (HU)		Second 400/120 kV transformer in station Sajóivánka (HU)	2018	Planning	Delayed	Expected commission date postponed to 2018 as a result of negotiations between SEPS and MAVIR.

		698	Gyor (HU)		70 Mvar shunt reactor in station Győr (HU)	2018	Planning	Delayed	Investment rescheduled as a result of changes in planning input data (need delayed)
		699	Gyor (HU)		Third 400/120 kV transformer in station Győr (HU)	2018	Planning	Delayed	Investment rescheduled as a result of changes in planning input data (need delayed)
54	**New SK-HU intercon. - phase 2**								
		720	Velké Kapušany (SK)	tbd (HU)	Erection of new 2x400 line between SK and Hungary (substation on Hungarian side still to be defined). The Investment is under consideration.	2021	Under Consideration	Investment on time	No change.
108	**1000MW HPS Tarnita connection**								
		811	Tarnita (RO)	Mintia (RO)	New double circuit 400kV OHL Tarnita(RO)-Mintia(RO) 2x1380 MVA.	2018	Planning	Investment on time	The project shall be built only if the Hydro Pumped Storage plant shall be built. Final investment decision is pending.
		812	Tarnita (RO)	Cluj E - Gadalin (RO)	New double circuit 400kV OHL Tarnita(RO)- Cluj E-Gadalin (RO) 2x1380 MVA.	2018	Planning	Investment on time	The project shall be built only if the Hydro Pumped Storage plant shall be built. Final investment decision is pending.
		813	Tarnita (RO)		New 400kV substation connecting 1000 MW Hydro Pumped Storage Tarnita Lapustesti to the grid.	2018	Planning	Investment on time	The project shall be built only if the Hydro Pumped Storage plant shall be built. Final investment decision is pending.
127	**127**								
		86	Foggia (IT)	Villanova (IT)	New 178km double circuit 400kV OHL between existing Foggia and Villanova 400kV substations, also connected in and out to the Larino and Gissi substations.	2019	Design & Permitting	Delayed	delay in the permetting process (EIA) concerning the part Foggia-Gissi still under authorization; the part Villanova Gissi is already authorized
		91	Foggia (IT)	Benevento II (IT)	Upgrade of the existing 85km Foggia-Benevento II 400kV OHL.	2014	Under Construction	Investment on time	No changes

		96	Deliceto (IT)	Bisaccia (IT)	New 30km single circuit 400kV OHL between the future substations of Deliceto and Bisaccia, in the Candela area.	2017	Design & Permitting	Delayed	delay in the permitting process (EIA)
		645	Laino (IT)	Altomonte (IT)	New 400kV OHL between the existing substations of Laino and Altomonte in Calabria.	2017	Design & Permitting	Delayed	delay in the permitting process (EIA)
136	**CSE1**								
		227	Banja Luka (BA)	Lika (HR)	New 400kV interconnection line between BA and HR	2021	Under Consideration	Rescheduled	Feasibility study is expected to be launched.
		617	Lika(HR)	Brinje(HR)	New 55 km single circuit 400 kV OHL replacing aging 220 kV overhead line	2020	Planning	Investment on time	Feasibility study is expected to be launched.
		618	Lika(HR)	Velebit(HR)	New 60 km single circuit 400 kV OHL replacing aging 220 kV overhead line	2020	Planning	Investment on time	Feasibility study is expected to be launched.
		619	Lika (HR)		New 400/110 kV substation, 2x300 MVA	2018	Planning	Delayed	Feasibility study is expected to be launched.
		620	Brinje (HR)		New 400/220 kV substation, 1x400 MVA	2020	Planning	Investment on time	Feasibility study is expected to be launched.
		633	Konjsko(HR)	Velebit(HR)	New 100km single circuit 400 kV OHL replacing ageing 220 kV overhead line	2020	Planning	Investment on time	Feasibility study is expected to be launched.
138	**Black Sea Corridor**								
		1112	Svoboda (BG)	splitting point	Construction of a new 400/110kV power line breaking up the existing 400kV Saedinenie OHL and connecting 400/110kV Svoboda substation.	2019	Planning	Delayed	Delayed due to lack of funding
		273	Cernavoda (RO)	Stalpu (RO) and Gura Ialomitei (RO)	Reinforcement of the cross-section between the Western coast of the Black Sea (Eastern Romania) and the rest of the system. New 400kV double circuit OHL between existing substations Cernavoda and Stalpu, with 1 circuit derivation in/out in 400 kV substation Gura Ialomitei,situated in the vicinity of the new line. Line length:159km.2x1380 MVA	2019	Design & Permitting	Delayed	Longer than expected delay regarding clarification of legal framework for right of land acquirement and regarding environment permitting procedure.

		275	Smardan(RO)	Gutinas(RO)	Reinforcement of the cross-section between the Western coast of the Black Sea (Dobrogea area) and the rest of the system. New 400kV double circuit OHL (one circuit wired)between existing substations. Line length:140km; 1380 MVA	2020	Design & Permitting	Investment on time	Rapid increase of wind generation connected in the area. Efforts to be made to speed construction.
		276	Suceava(RO)	Gadalin(RO)	Reinforcement of the cross-section between developing wind generation hub in Eastern Romania and the rest of the system. New 400kV simple circuit OHL between existing substations. Line length: 260km. 1204 MVA	2021	Design & Permitting	Investment on time	No change of status.
		715	Stalpu (RO)		To reinforce the cross-section between the Black Sea coast wind generation in Romania and Bulgaria and the consumption and storage centers to the West, the 220 kV OHL Stalpu-Teleajen-Brazi is upgraded to 400 kV, as a continuation of the 400 kV d.c. OHL Cernavoda-Stalpu. The 220/110 kV substation Stalpu is upgraded to 400/110kV (1x250MVA).	2019	Planning	Delayed	The investment was rescheduled in correlation with project 273.
		265	Vidno (BG)	Svoboda (BG)	New 400kV double circuit OHL to accommodate 2000 MW RES generation in N-E Bulgaria (Dobruja region). Line length: 2x70km.	2019	Planning	Delayed	Delayed due to lack of funding.
		800	Dobrudja(BG)	Burgas (BG)	New 140km single circuit 400kV OHL in parallel to the existing one.	2018	Planning	Delayed	Delayed due to lack of funding.
141	**CSE3**								
		223	Cirkovce (SI)	Heviz (HU) Zerjavenec (HR)	The existing substation of Cirkovce(SI) will be connected to one circuit of the existing Heviz(HU) -Zerjavinec(HR) double circuit 400kV OHL by erecting a new 80km double circuit 400kV OHL in Slovenia. The project will result in two new cross-border circuits: Heviz(HU)-Cirkovce(SI) and Cirkovce (SI)-Žerjavenec (HR).	2016	Design & Permitting	Investment on time	Progresses as planned.

		225	Divaca (SI)	Cirkovce (SI)	Upgrading 220kV lines to 400kV in corridor Divaca-Klece-Bericevo-Podlog-Cirkovce.	2020	Design & Permitting	Investment on time	Progresses as planed.
142	**CSE4**								
		256	Maritsa East 1 (BG)	N.Santa (GR)	New interconnection line BG-GR by a 130km single circuit 400kV OHL.	2021	Design & Permitting	Delayed	Delayed due to lack of funding.
		257	Maritsa East 1 (BG)	Plovdiv (BG)	New 100km single circuit 400kV OHL in parallel to the existing one.	2016	Design & Permitting	Delayed	Delayed due to difficulties with the acquisition of the land
		258	Maritsa East 1 (BG)	Maritsa East 3 (BG)	New 13km single circuit 400kV OHL in parallel to the existing one.	2016	Design & Permitting	Delayed	Delayed due to difficulties with the acquisition of the land
		262	Maritsa East 1 (BG)	Burgas (BG)	New 400kV OHL. Line length: 150km.	2016	Design & Permitting	Delayed	Delayed due to difficulties with the acquisition of the land
143	**CSE5 - RgIP**								
		1022	Vetren	Blagoevgrad	The construction of this line will significantly increase interoperability and secure operation of Bulgarian 400kV network under normal and repair conditions. Security of supply in the South-West part of Bulgaria will be enhanced and dynamic sustainability of PSHPP Chaira (largest in Southeast Europe) will be increased.	2023	Under Consideration	New Investment	New investment
		1023	Plovdiv	Tsarevets	New transverse connection in North-South direction.	2023	Under Consideration	New Investment	New investment
144	**Mid Continental East corridor**								
		238	Pancevo (RS)	Resita (RO)	New 131 km double circuit 400kV OHL between existing substation in Romania and Serbia (63 km on Romanian side and 68 km on Serbian side)2x1380 MVA.	2017	Design & Permitting	Investment on time	Activities are mostly synchronized on both sides.The main problem is right of land along the line path.
		269	Portile de Fier (RO)	Resita (RO)	New 116 km 400kV OHL between existing substation 400 kV Portile de Fier and new 400 kV substation Resita; 1380 MVA.	2017	Design & Permitting	Delayed	The investment was coordinated with investmment 50.238. The main problems are right of land along the line path and permitting.

		701	Resita (RO)		New 400 kV substation Resita (T400/220 kV 400 MVA + T 400/110 kV 250 MVA), as development of the existing 220/110 kV substation.	2017	Design & Permitting	Investment on time	Investment has been split. It is expected that the substation will be commissioned in two stages.In TYNDP 2012, timing reffered only to the adjacent lines.
		270	Resita (RO)	Timisoara-Sacalaz-Arad (RO)	Upgrade of existing 220kV double circuit line Resita-Timisoara-Sacalaz-Arad to 400kV double circuit. Line length: aprox. 100 km d.c. + 74,6 km s.c.;2x1380 MVA; 1204 MVA the circuit between Sacalaz and C. Aradului	2022	Design & Permitting	Investment on time	Planned to start after investment 269 is finalized.
		705	Timisoara (RO)		Replacement of 220 kV substation Timisoara with 400 kV substation (2x250 MVA 400/110 kV)	2022	Design & Permitting	Investment on time	Investments 269 and 701 have to be finalized first.
146	**CSE8 Transbalkan Corridor**								
		1075	Kragujevac	Kraljevo	New internal 400 kV OHL will connect existing SS Kragujevac with SS Kraljevo which is planned for upgrade to 400 kV voltage level. This investment will enhance the possibility of energy transits in direction north-east to south-west and east to west.	2018	Design & Permitting	Delayed	New axis for transits from East to the West, typically from Bulgaria to Bosnia and Montenegro, and further to the west.
		1076	Kraljevo		Upgrade of the existing 220/110kV substation Kraljevo 3 by constructing the 400 kV level.	2017	Design & Permitting	Delayed	This upgrade is required for the construction of new 400 kV OHL Kragujevac - Kraljevo which will increase local security of supply and power transfer from Eastern to Western part of region.
		625	Lastva (ME)	Pljevlja (ME)	Reinforcement of the Montenegrin internal 400 kV transmission network with new 160 km double circuit 400kV AC OHL between existing substation Pljevlja and new substation Lastva. The investment will enable secure supply of Montenegrin power system and power transits directed to new HVDC link towards Italy.	2016	Design & Permitting	Investment on time	on time

					Also, this investment will enable connection of Renewable energy sources along its route.				
147	**CSE9**								
		235	Tirana(AL)	Pristina (RS)	New 238km 400kV OHL; on 78km the circuit will be installed on the same towers as the Tirana-Podgorica OHL currently in construction ; the rest will be built as single circuit line.	2016	Under Construction	Delayed	slight delay, due to procedural reasons. In particular the previous tender has been canceled and a new one was launched. Currently the project is under construction
		236	Leskovac(RS)	Shtip (MK)	New 170km 400kV single circuit overhead interconnection between Serbia and FYR of Macedonia.	2014	Under Construction	Delayed	land acquisition
		239	Bitola (MK)	Elbasan (AL)	New 150km cross-border single circuit 400kV OHL between existing substation Bitola and Elbasan	2017	Design & Permitting	Delayed	additional investigation of feasibility
		244	Filippi(GR)	Lagadas (GR)	Connection of the new 400kV substation in Lagadas in Thessaloniki area to the existing substation of Filippi via a new 110km double circuit 400kV OHL.	2016	Design & Permitting	Delayed	Delays in the expropriation and permission process. These issues have been resolved.
		708	Lagadas (GR)		New 400kV substation in Lagadas in Thessaloniki area.	2014	Under Construction	Delayed	Delays due to environmental licensing process
148	**CCS new**								
		68	Okroglo (SI)	South Udine (IT)	New 120km double circuit 400kV OHL between Okroglo(SI) and future substation of South Udine (IT) with PST in Okroglo	2021	Planning	Investment on time	There are some issues with social acceptance and teritorial constraints. End of construction works are planned by the end of 2021.Full operation is expected by end of 2021(beginning of 2022).

		615	Okroglo (SI)		Installation of a new 400kV PST in Okroglo which is a part of a double 400 kV OHL Okroglo(SI)-Udine(IT).	2021	Planning	Investment on time	End of construction works are planned by the end of 2021. Full operation is expected by end of 2021 (beginning of 2022).
		92	West Udine (IT)	Redipuglia (IT)	New 40km double circuit 400kV OHL between the existing substations of West Udine and Redipuglia, providing in and out connection to the future 400kV substation of South Udine.	2016	Under Construction	Delayed	permitting only recently completed (March 2013) and construction work had to be rescheduled accordingly. Note that the expected commissioning date for the project is december 2016
150	**CCS new 10**								
		616	Slovenia (SI)	Salgareda (IT)	New HVDC link between Italy and Slovenia.	2022	Under Consideration	Investment on time	Project is under feasibility study.
171	**CSE9a**								
		912	Kumanovo		New 400/110 kV substation in North East part of FYRO Macedonia area connected in/out to the new 400 kV line Leskovac-Shtip.	2030	Under Consideration	New Investment	it is a new investment
		1002	SS Skavica	SS Prizren	New approximately 45 km (30 km Albanian Part) 400 kV OHL between Albania and Serbia, according to construction of 300 MW HPP Skavica.	2028	Planning	New Investment	New investment
		1003	SS Skavica	SS Tirana	New 400kV approximately 100 km OHL according to construction of 300 MW HPP Skavica.	2028	Planning	New Investment	new investment
		237	TPP Kosovo (RS)	Skopje (MK)	A new 400kV OHL relevant to planning investment of 2000MW of TPP in the area of Kosovo and Metohija. Line length: 85km.	2025	Under Consideration	Rescheduled	uncertainties in new investments TPP in Kosovo area
174	**Greenconnector**								
		1014	Verderio (I)	Sils (CH)	New +/- 400 kV DC cable and subsea link between Switzerland and Italy. Very short AC cable (380 kV) between the site of the converter station and the substation of Sils i.D.	2018	Design & Permitting	New Investment	Project application to TYNDP 2014.

210	**E15**								
		1071	Würmlach (AT)	Somplago (IT)	Würmlach - Somplago	2017	Design & Permitting	New Investment	Project application to TYNDP 2014.
219	**EUROASIA interconnector**								
		949	Korakia site (CRETE)	Athens site (GREECE)	New HVDC interconnection between Crete and Athens	2020	Planning	New Investment	Project application to TYNDP 2014.
		971	Vasilikos site (CYPRUS)	Korakia site (CRETE)	New HVDC interconnection between Cyprus and Crete Islands	2022	Planning	New Investment	Project application to TYNDP 2014.
		1054	Hadera site (ISRAEL)	Vasilikos site (CYPRUS)	New HVDC interconnection between Israel and Cyprus	2018	Planning	New Investment	Project application to TYNDP 2014.
220	**Southern Aegean Interconnector**								
		936	KANDELIOUSA	SYRNA	AC Subm. Cable to connect Kandeliousa offshore WF HV substation (18MW) to Syrna SS	2020	Design & Permitting	New Investment	Project application to TYNDP 2014. Commissioning date: 2018-2020
		944	KANDELIOUSA	PERGOUSA	AC Subm. Cable to connect Pergousa offshore WF HV substation (42MW) to the Kandeliousa SS	2020	Design & Permitting	Investment on time	Project application to TYNDP 2014.Commissioning date: 2018-2020
		973	SYRNA	LEVITHA	AC Subm. Cable to connect Syrna offshore WF HV substation (156MW) to the AC part of the Levitha Converter SS	2020	Design & Permitting	New Investment	Project application to TYNDP 2014. commissioning date: 2018-2020
		979	KINAROS	LEVITHA	AC Subm. Cable to connect Kinaros offshore WF HV substation (111MW) to the AC side of the Levitha Converter SS	2020	Design & Permitting	New Investment	Project application to TYNDP 2014. commissioning date: 2018=2020
		1001	LEVITHA island	KORAKIA (new s/s in Crete)	New DC link (2 converter SS + 250 km DC subm. cable) to Crete	2020	Design & Permitting	New Investment	Project application to TYNDP 2014. commissioning date: 2018-2020
		1042	LAVRION 400kV S/S	LEVITHA island	New DC link (2 converter SS + 270 km DC subm. cable) to connect 537MW of offshore WF generation to the mainland (Area of Athens)	2020	Design & Permitting	New Investment	Project application to TYNDP 2014. commissioning date expected: 2018-2020
227	**CSE8 Transbalkan Corridor**								

		627	Bajina Basta (RS)	Visegrad (BA)	Description of broader context - New double circuit 400kV OHL connecting existing substation Pljevlja (ME) and substation Bajina Basta (RS) and new double circuit 400kV OHL connecting existing substation Visegrad (BA) and substation Bajina Basta (RS). In the first phase one 400 kV circuit would be equiped. In the second phase New SS Bistrica (RS) would be connected to the exisitng double circuit 400 kV OHL between SS Bajina Basta (RS), SS Visegrad (BA) and SS Pljevlja (ME). Part of regional transmission corridor northeast-southwest.	2020	Planning	Investment on time	Ongoing Regional trilateral feasibility study (financed by WBIF and supported by EC) between three TSOs (EMS, NOS BiH and CGES), including ESIA and preliminary design. Expected finalization time mid 2014.
		628	SS Bajina Basta (RS)	SS Obrenovac (RS)	Double circuit 400 kV OHL between upgraded substation Bajina Basta and substation Obrenovac. Part of larger regional transmission corridor northeast-southwest.	2019	Design & Permitting	Delayed	Feasibility study, ESIA and preliminary design finalized (financed by WBIF and supported by EC). Ongoing process of adoption to local legislation needs.
		630	Bajina Basta (RS)	Pljevlja (ME)	Description of broader context - New double circuit 400kV OHL (105km RS + 16km ME) connecting existing substation Pljevlja (ME) and substation Bajina Basta (RS) and new double circuit 400kV OHL connecting existing substation Visegrad (BA) and substation Bajina Basta (RS). In the first phase one 400 kV circuit would be equiped. In the second phase New SS Bistrica (RS) would be connected to the exisitng double circuit 400 kV OHL between SS Bajina Basta (RS), SS Visegrad (BA) and SS Pljevlja (ME). Part of regional transmission corridor northeast-southwest.	2020	Planning	Investment on time	Ongoing Regional trilateral feasibility study (financed by WBIF and supported by EC) between three TSOs (EMS, NOS BiH and CGES), including ESIA and preliminary design. Expected finalization time mid 2014.

		631	Bajina Basta (RS)		Upgrade of existing 220/110 kV substation in Bajina Basta to 400/220/110 kV substation as part of overall western Serbia system upgrade to 400 kV voltage level. Part of larger regional transmission corridor northeast-southwest.	2019	Design & Permitting	Delayed	Feasibility study, ESIA and preliminary design finalized (financed by WBIF and supported by EC). Ongoing process of adoption to local legislation needs.
		907	Szigetcsép (HU)		New substation Szigetcsép (HU) with 2*250 MVA 400/120kV transformation is connected by splitting existing 400kV line Albertirsa-Martonvasar.	2016	Planning	New Investment	New project to secure the supply in the Southern Budapest area from 400kV
		908	Ócsa (HU)		Installation of the 3rd 220/120 kV transformer in substation Ócsa (HU)	2020	Planning	New Investment	New project to increase security of supply in the Southern Budapest area
		909	Detk (HU)		Installation of the 3rd 220/120 kV transformer in substation Detk (HU)	2017	Planning	New Investment	New project to secure the supply in the Northeast Hungary area
		913	Stalpu 400 kV	Brasov 400 kV	New 400 kV OHL, AC,double circuit (initially 1 circuit wired), 170 km, between existing 400 kV substations Brasov(RO) and Stalpu (RO); extensions of the 400 kV end substations with the 400 kV bays.	2024	Planning	New Investment	The investment will be realized after the investment 400 kV OHL Cernavoda-Stalpu is built.
		918	Ernestinovo		Installation of a 150 MVAr reactive power device in substation Ernestinovo	2016	Design & Permitting	New Investment	The installation of the reactive power device in substation Ernestinovo with the purpose of voltage regulation in the northern part of the Croatian network and of the interconnections.
		919	Jagodina	Pozarevac	400 kV OHL between SS Jagodina and SS Pozarevac.	2023	Under Consideration	New Investment	Part of National TYNDP2012.
		920	Kragujevac	Kraljevo	400kV OHL Kragujevac-Kraljevo	2016	Design & Permitting	Investment on time	Part of National TYNDP
		921	Kraljevo	Nis	400kV OHL Kraljevo-Nis	2028	Under Consideration	New Investment	Part of National TYNDP2012.

		1052	Nyíregyháza (HU)		New substation Nyíregyháza (HU) with 2*250 MVA 400/120kV transformation is connected by splitting existing 400kV line Sajószöged-Mukachevo.	2020	Planning	New Investment	New project to secure the supply in Eastern Hungary from 400 kV
		1055	Pomáz (HU)		New substation Pomáz (HU) with 2*250 MVA 400/120kV transformation	2025	Under Consideration	New Investment	New project to secure the supply in the Northern Budapest area from 400 kV.
		1056	Pomáz (HU)	Bicske Dél (HU)	New 400 kV double circuit transmission line between new substation Pomáz (HU) and existing substation Bicske Dél (HU)	2025	Under Consideration	New Investment	New project to secure the supply in the Northern Budapest area from 400 kV.
		1057	Kerepes (HU)		Upgrade of substation Kerepes (HU) with 500 MVA 400/220kV transformation, connected by splitting existing line Ócsa-Zugló	2025	Planning	New Investment	New project to secure the supply in the Eastern Budapest area from 400 kV.
		1058	Kerepes (HU)	Zugló (HU)	Reconstruction of 220kV line Kerepes-Zugló (HU) line to double circuit	2025	Planning	New Investment	New project to secure the supply in the Eastern Budapest area from 400 kV.
		1059	Paks II (HU)		New 400kV substation Paks II (HU) for the connection of the new units of Paks Nuclear Power Plant	2024	Planning	New Investment	New project for the connection of the new units of Paks Nuclear Power Plant.
		1060	Paks II (HU)	Albertirsa (HU)	New 400 kV double circuit transmission line between new substation Paks II (HU) and existing substation Albertirsa (HU)	2024	Planning	New Investment	New project for the connection of the new units of Paks Nuclear Power Plant.
		1061	Paks II (HU)	Paks (HU)	New 400 kV double circuit transmission line between new substation Paks II (HU) and existing substation Paks (HU)	2024	Planning	New Investment	New project for the connection of the new units of Paks Nuclear Power Plant.
		1072	SS Beograd 20		New 400/110 kV substation on the Belgrade territory	2015	Under Construction	Delayed	By taking large amount of load from other Belgrade substations, the investment will both in/ improve the local SoS significantly, and ii/ relieve the constraints on the EHV local network and enable greater inter-area transits.

		1073	SS Bistrica		After a topology change in the area, the investment will eliminate firm connection in "Vardiste" (secure and stable operation in Serbian network and systems of Bosnia and Herzegovina and Montenegro), to eliminate constraints in the region for electric energy transits and exchange.	2017	Design & Permitting	Delayed	It contributes significantly to the increase of GTC between the West Balkans and IT such contributing to market integration; complements the ME - IT cable
		1074	Bajina Basta	Obrenovac	New double circuit 400 kV OHL between new substation Bajina Basta and substation Obrenovac	2019	Design & Permitting	Delayed	Obrenovac is the "strongest" 400 kV node in Serbia, thus providing significant upgrade for evacuation and energy transfer from north to south, and further down in Montenegro, through the new line between Bajina Basta and Pljevlja (ME)
		1077	Bajina Basta	Kraljevo	New 115 km double circuit 400kV OHL between substation Kraljevo and substation Bajina Basta. Kraljevo (400kV) will be connected to Kragujevac (400 kV) substation.	2023	Planning	Investment on time	New axis for transits from East to the West, typically from Bulgaria to Bosnia and Montenegro, and further to the west.
		1083	S.Teresa (IT)	Budduso (IT)	New 150 kV line connecting the substation of S.Teresa, Tempio and Buddusò, allowing the realization of a new 150 kV backbone in Sardinia	2018	Design & Permitting	New Investment	-
		1084	Cagliari Sud (IT)	Rumianca (IT)	New 150 kV cable connecting the substation of Cagliari Sud and Rumianca	2015	Under Construction	New Investment	-
		1085	Andros	Livadi	New 150kV subsea cable interconnection between the island of Andros and South Evia.	2017	Design & Permitting	New Investment	
		1086	Andros	Tinos	New 150kV subsea cable between the islands of Andros and Tinos	2017	Design & Permitting	New Investment	
		1087	Naxos		New 150kV substation in Naxos	2017	Design & Permitting	New Investment	

		1044	Vetren	Blagoevgrad	The construction of this line will significantly increase interoperability and secure operation of Bulgarian 400kV network under normal and repair conditions. Security of supply in the South-West part of Bulgaria will be enhanced and dynamic sustainability of PSHPP Chaira (largest in Southeast Europe) will be increased.	2023	Under Consideration	New Investment	New investment
		110	Restructuring of Sorrento Peninsula netw		It is planned a new 380/220/150kV substation in East Vesuvius area (near Naples) connected in and out to the existing 380 and 220kV lines “Montecorvino-S. Sofia” and "Nola-S. Valentino". Related to this project, it has been programmed also some reinforcements and restructuring of the existing 220kV and 150 kV network in the area of Sorrento Peninsula.	2020	Design & Permitting	Delayed	Delay to the authorization process
		105	Treviso (IT)		New 380/132kV substation in Treviso area, connected in and out to the existing 380kV line “Sandrigo - Cordignano".	2022	Design & Permitting	Delayed	Long permitting process(request for building and operation)
		118	Porto Ferraio (Elba Island)(IT)	Colmata (IT)	New 40km 132kV connection via subsea cable between the existing substation of Porto Ferraio and Colmata.	2020	Design & Permitting	Delayed	Delays due to authorization process
		119	Capri, Ischia, Procida (IT)	Missing data	New 150kV subsea connection between the Capri, Ischia and Procida islands to the existing substations of Cuma and Torre Annunziata (mainland Italy). New 150 kV substation in Capri island.	2020	Design & Permitting	Delayed	Delay due to authorization process. At present only one connection from Capri to mainland is permitted (commissioning date 2016)
		101	Turin (IT)		Restructuring of the 220kV network in the urban area of Turin. Some new 220kV cables, some new 220/132kV substations and some reinforcements of existing assets are planned.	2019	Under Construction	Investment on time	-

		84	Casanova (IT)	Vignole (IT)	Voltage upgrade of the existing 100km Casanova-Vignole 220kV OHL to 400kV.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		601	Asti area (IT)		New 400/220/150kV substation in Asti area.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		230	TPP Sisak (HR)	Mraclin(HR)/Prijedor(BA)	Connection of new generator on existing line 220kV Mraclin (HR) - Prijedor (BA) via a new double circuit OHL. Line length: 12km.	2016	Design & Permitting	Delayed	The commissioning date is postponed due to the prolonged permitting procedures and due to the delayed installation of new generating unit in TPP Sisak.
		248	Polypotamo (GR)	N. Makri (GR)	New 150kV double circuit subsea cable. Line length:33km.	2014	Under Construction	Delayed	Delays due to public opposition.
		250	Lavrion (GR)	Syros (GR)	New 150kV subsea cable AC connection between Lavrio and the island of Syros	2016	Design & Permitting	Delayed	Project redesign to adapt in the current situation. Currently a tender is on-going. In addition, by 2018 a 2nd cable between Lavrio and Syros and a new 400kV/150kV autotransformer in Lavrio S/S will be installed.
		251	Syros (GR)	Tinos (GR)	New 150kV subsea cable between the islands of Syros and Tinos	2016	Design & Permitting	Delayed	Project redesign to adapt in the current situation. Currently a tender is ongoing.
		835	Syros (GR)	Paros (GR)	New 150kV subsea cable between the islands of Syros and Paros	2016	Design & Permitting	Delayed	Project redesign to adapt in current conditions. Currently a tender is ongoing.
		836	Syros (GR)	Mikonos (GR)	New 150kV subsea cable between the islands of Syros and Mikonos	2016	Design & Permitting	Delayed	Project redesign to adapt in the current situation. Tender is ongoing.

		837	Syros (GR)		New 150kV Substation in Syros	2016	Design & Permitting	Delayed	Project redesign to adapt in the current situation. A tender is ongoing
		838	Paros(GR)		New 150kV S/S in Paros	2016	Design & Permitting	Delayed	Project redesign to adapt in the current situation. A tender is ongoing
		839	Mikonos (GR)		New 150kV S/S in Mikonos	2016	Design & Permitting	Delayed	Project redesign to adapt in the current situation. A tender is ongoing.
		840	Paros (GR)	Naxos (GR)	New 150kV subsea cable between the islands of Paros and Naxos	2017	Design & Permitting	Delayed	Project redesign to adapt in the current situation.
		841	Naxos (GR)	Mikonos(GR)	New 150kV subsea cable between the islands of Naxos and Mikonos	2017	Design & Permitting	Delayed	Project redesign in order to adapt in the current conditions
		66	Brennero (IT)		New 132 kV substation with a 110/132kV PST.	2016	Design & Permitting	Delayed	Investment scheme reviewed (former Prati di Vizze)
		613	Prati di Vizze (IT)	Steinach (AT)	Upgrade of the existing 44km Prati di Vizze (IT) – Steinach (AT) single circuit 110/132kV OHL, currently operated at medium voltage.	2016	Design & Permitting	Investment on time	-
		83	Volpago (IT)	North Venezia (IT)	Realization of a new 380kV line between the existing substation of North Venezia and the future 380kV substation of Volpago, connected in and out to the 380kV "Sandrigo - Cordignano" .	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		93	Dolo (IT)	Camin (IT)	New 15km double circuit 400kV OHL between existing Dolo and Camin 400kV substations, to be built in parallel with the existing line.	2025	Design & Permitting	Delayed	The authorization granted in 2013 was canceled by a State Council Resolution
		97	Polpet (IT)		Restructuring of the existing 220 and 132 kV network in the Media Valle del Piave with the realization of a new 220/132 kV substation. The substation will be connected by two shorts links to the existing Soverzene-Lienz 220kV line.	2017	Design & Permitting	Delayed	delay in the permetting process due to the request of several integrations, during EIA, by the Authorities involved

		267	Suceava (RO)	Balti (MD)	New 400 kV OHL (139 km) to increase capacity of transfer between Romania and Republic Moldova.	2020	Design & Permitting	Investment on time	Building schedule on both sides of the border has to be agreed. The investment commitment implies new substation 400 kV in Rep. Moldova (extension of the substation Balti (MD) with 400 kV level, as extension of the existing 330/35 kV substation).
		842	Balti (MD)		The project also implies new substation 400 kV in Moldova (extension of the substation Balti (MD) with 400 kV level).	2020	Design & Permitting	Investment on time	-
		268	Constanta (RO)	Pasakoy (TR)	New DC link (subsea cable) between existing stations in RO and TR. Line length: 400km.	2020	Under Consideration	Investment on time	The decision process regarding financing scheme and project structure is not finalized. The project stays under consideration.
		229	Plomin (HR)	Melina(HR)	New 90 km double circuit OHL, with two connecting substations and transformer 400/220 kV, 400 MVA	2018	Design & Permitting	Investment on time	Investment commissioning date depends on the constructing and commissioning of the new generating unit in thermal power plant Plomina.
		231	Konjsko(HR)		Installation of a 150 MVAr reactive power device in substation Konjsko	2016	Design & Permitting	Delayed	Because of the longer time needed to design the expected commissioning is delayed for two years.
		232	Buk Bijela (BA)	Brezna (ME)	Reinforcement of the West-East transmission corridor with new single circuit 400kV OHL between Bosnia and Herzegovina and Montenegro. This investment will increase transmission capacities between these two countries and enable larger power transits in both directions especially when HVDC link between Montenegro and Italy is comissioned.	2020	Planning	Delayed	Regional feasibility study for 400kV OHL between RS, ME and BA under Infrastructure Projects Facility for Western Balkans is in progress in which the details for this project will be defined by mid-2014.

		89	Fano (IT)	Teramo (IT)	New 200km single circuit 400kV OHL between the existing 400kV substations of Fano and Teramo, providing the connection in and out to the future substation to be built in Macerata area.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		632	Bistrica (RS)		New 220/110 kV substation Bistrica	2016	Design & Permitting	Delayed	location permit and environmental study are adopted
		284	Perkáta (HU)		New substation Perkáta (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Martonvásár-Paks.	2015	Design & Permitting	Investment on time	-
		286	Székesfehérvár (HU)		New substation Székesfehérvár (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Martonvásár-Litér.	2023	Planning	Rescheduled	Investment rescheduled as a result of changes in planning input data (need delayed)
		287	Kerepes (HU)		New substation Kerepes (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Albertirsa-Göd.	2016	Planning	Delayed	Small delay due to difficulties with substation siting.
		76	Partanna (IT)	Ciminna (IT)	New 65km single circuit 400kV OHL in Sicily between existing Partanna and Ciminna substations.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		290	Oroszlány (HU)		New substation Oroszlány (HU) with 2*250 MVA 400/120kV transformation is connected by splitting and extending the second circuit of line Martonvásár-Győr.	2017	Planning	Delayed	Generator connection request delayed.
		292	Debrecen (HU)		Reconstruction of 750kV substation, by relocating to Debrecen (HU).	2017	Under Consideration	Delayed	Alternative technical solutions are being studied.
		74	Ciminna area (IT)		For the realization of 400kV grid reinforcement, it will be realized the voltage upgrade of the existing Ciminna substation up to 400kV.	2019	Design & Permitting	Investment on time	-

		636	Assoro (IT)		For the realization of 400kV grid reinforcement, it will be realized a new 400/150kV substation Assoro.	2019	Planning	Investment on time	-
		637	Chiaramonte Gulfi (IT)	Ciminna (IT)	Realization of new 400 kV line: "Chiaramonte Gulfi -new station of Assoro- Ciminna"	2019	Design & Permitting	Investment on time	-
		638	Sorgente 2 (IT)		New 400/150 kV substation in Sorgente area will be temporally connected in and out to the existing 400 line kV "Paterno - Sorgente" and to the local 220 kV and 150 kV network.	2019	Planning	Investment on time	-
		916	Assoro (IT)	Villafranca (IT)	Realization of new 400 kV line "Assoro-Sorgente2-Villafranca"	2019	Planning	New Investment	-
		917	Paternò (IT)	Priolo (IT)	Realization of new 400 kV line: "Paternò-Pantano-Priolo"	2017	Design & Permitting	Investment on time	-
		77	Partinico (IT)	Fulgatore (IT)	New 45km single circuit 400kV OHL between Partinico and Fulgatore in Western Sicily.	2020	Planning	Delayed	rescheduling of permitting process: discussion of preliminary localization with local Authorities
		100	Milan (IT)	-	Restructuring of the 220kV network in the urban area of Milan. Some new 220kV cables (33km), a new 220kV substation (Musocco) and some reinforcements of existing assets (35km) are planned.	2019	Design & Permitting	Delayed	Rescheduling of work to guarantee, during construction phase, the continuity of service in metropolitan area of Milan
		112	Tirano (IT)	Verderio(IT)	New 140km single circuit 400kV OHL between Tirano and Verderio substations connecting also the new 400kV substation Grosio/Piateda.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		85	Pavia area (IT)	Piacenza area (IT)	New 45km double circuit 400kV OHL between 2 substations in the Pavia area and Piacenza.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios

		102	Naples (IT)	-	Restructuring of the 220kV network in the urban area of Naples. Some new 220kV cables and some reinforcements of existing assets are planned. Total length: 36km.	2018	Design & Permitting	Investment on time	-
		644	Aliano (IT)	Montecorvino (IT)	New connection OHL 400 kV between north Basilicata and Campania region.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		88	Montecorvino (IT)	Benevento (IT)	New 70km double circuit 400kV OHL between the existing 400kV substations of Montecorvino and Benevento II, providing in and out connection to the future substation to be build in Avellino North area, which will be also connected to the existing "Matera-S. Sofia" 400kV line.	2021	Design & Permitting	Delayed	delay in the permitting process (EIA) related to part Montecorvino Avellino Nord; discussion of preliminary localization with local Authorities for Avellino Nord Benevento
		94	Mantova area (IT)	Modena area (IT)	New 35km 400kV OHL between the 2 substations in Modena and Mantova area.	2030	Under Consideration	Investment on time	-
		648	Codrongianos (IT)	Suvereto (IT)	Repowering of existing HVDC interconnection between Sardinia, Corse and mainland Italy via 220kV DC subsea cable (358km). The first connection is in operation since 1970.	2030	Under Consideration	Rescheduled	The investment was put under consideration in the National Development Plan due to changes in feasibility conditions and planning scenarios
		700	Leskovac(RS)		New 400/110 substation will be built in Serbia between connection nodes.	2013	Under Construction	Investment on time	Investment on time
		706	Sacalaz (RO)		Replacement of 220 kV substation Sacalaz with 400 kV substation (1x 250 MVA, 400/110 kV).	2022	Design & Permitting	Investment on time	Correlated with investments 270 and 701.
		702	Beograd 20 (RS)		New 400/110 kV substation on the Belgrade territory.	2014	Under Construction	Delayed	delay in permitting procedure
		703	Kraljevo 3 (RS)		Upgrade of the existing 220/110kV substation Kraljevo 3 by constructing the 400 kV level.	2016	Design & Permitting	Delayed	slightly delayed

		704	Kraljevo 3 (RS)	Bajina Basta (RS)	New 400kV OHL between substation Kraljevo 3 and substation Bajina Basta. Part of regional transmission corridor east-west.	2020	Planning	New Investment	Applied for Feasibility study, ESIA and preliminary design development by WBIF (supported by EC).
		707	Ohrid area (MK)		New 400/110 kV substation in Ohrid area connected in/out to the new 400 kV line Bitola-Elbasan.	2017	Design & Permitting	Delayed	additional investigation of feasibility
		240	Patras (GR)	400 kV Continental System (GR)	In&out connection of the New 400kV substation in Patras to the existing Axeloos - Distomo 400kV OHL via a new 15km double circuit line, part of which will consist of subsea cable. The project shall constitute the first 400kV corridor to Peloponnese.	2015	Design & Permitting	Delayed	Local opposition and delay in permitting procedures
		709	Patras (GR)		New 400kV substation in Patras (GIS Technology).	2020	Design & Permitting	Delayed	Delays due to public opposition and licensing procedures. The foreseen development of local consumption allows the displacement of the investment implementation.
		241	Patras (GR)	Megalopolis (GR)	Connection of the new 400kV substation in Megalopolis to Patras 400kV substation via a 110km double circuit OHL. 2nd corridor to Peloponnese.	2016	Design & Permitting	Delayed	Delays due to public opposition and permitting procedures
		710	Megalopolis (GR)		New 400kV substation in Megalopolis.	2013	Under Construction	Investment on time	The evolution of the construction of the EHV S/S in Megalopoli is on time.
		242	Megalopolis (GR)	Korinthos (GR)	Connection of the new 400kV substation in Korinthos (GIS Technology) to the Megalopolis substation via a 110km double circuit 400kV OHL.	2018	Design & Permitting	Delayed	Delays due to public opposition and permitting procedures
		711	Korinthos (GR)		Construction of a new 400kV substation in Korinthos (GIS Technology).	2018	Design & Permitting	Delayed	Delays due to strong public opposition
		243	Korinthos (GR)	Koymoyndoyros (GR)	Replacement of the existing 150kV double circuit line by a 87km double circuit 400kV OHL.	2018	Design & Permitting	Delayed	Delays due to public opposition and licensing procedures.

		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	2016	Design & Permitting	Delayed	Timing was correlated with investments 272 and 713.
		713	400 kV Medgidia S (RO)	Rahman(RO)-Dobrudja(BG) split	Connection in Medgidia (RO) of existing 400kV OHL Rahman (RO)-Dobrudja (BG), passing nearby. The line shall be connected in/out, through a double circuit OHL (1x1800 MVA in + 1x1800 MVA out).	2016	Design & Permitting	Delayed	Longer than expected delay regarding clarification of legal framework for right of land acquirement and regarding environment permitting procedure.
		272	Medgidia S	400 kV OHL Stupina (RO)-Varna(BG) split	Connection in/out in 400 kV Medgidia S substation (RO) of existing 400kV OHL Stupina/ former Isaccea (RO)-Varna (BG), passing nearby. The line shall be connected in/out, through a double circuit OHL (1x2300 MVA in + 1x2300 MVA out).	2016	Design & Permitting	Delayed	Longer than expected delay regarding clarification of legal framework for right of land acquirement and regarding environment permitting procedure.
		274	Constanta (RO)	Medgidia(RO)	New 400kV double circuit (one circuit wired) OHL 1380 MVA between existing substations. Line length:75km.	2020	Planning	Investment on time	Comissioning estimated 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.	2021	Planning	Rescheduled	The rescheduling takes into account slower than expected increase of the generation park in the area, which was the main driver for the investment and the difficulty to finance the unprecedented volume of simultaneous investment needs.
		714	Stalpu (RO)	Teleajen (RO) - Brazi (RO)	Reinforcement of the cross-section between wind generation hub in Eastern Romania and Bulgaria and the rest of the system. A new 400kV OHL is built from Cernavoda(RO) to Stalpu(RO) and is continued by existing OHL	2018	Planning	Investment on time	Investments 714 and 716 are complementary with investments 273 and 715.

					Stalpu-Teleajen-Brazi V(RO), upgraded to operate at 400kV, from 220kV.				
		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.	2019	Planning	Delayed	The investment was rescheduled in correlation with project 273.
		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 existing conductors with high thermal capacity, low sag conductors ; >460MVA.	2030	Under Consideration	Investment on time	The final decision depends on the future level of East – West flows through the corridor.
		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.	2021	Planning	Rescheduled	The rescheduling takes into account slower than expected increase of the generation park in the area, which was the main driver for the investment and the difficulty to finance the unprecedented volume of simultaneous investment needs.

		78	Palermo area (IT)		Restructuring of the network in the Palermo area. The work consists of a new 220/150kV substation, complying with 400kV standards, connected to the Ciminna substation with a new 400kV line and in & out the existing Bellolampo-Caracoli 400kV line, and also the connection of 15 kV lines "Casuzze - Monreale" and "Casuzze - Guadalami" and a repowering of the existing Casuzze 150/MV substation. It is foreseen also large a restructuring of the 150kV network in the palermo area in order to increase the security and the quality of supply.	2016	Design & Permitting	Delayed	Delay in the permitting procedure
		263	SS 4 /11 kV Svoboda(Krusari)		New 400/110kV substation to accommodate the expected RES generation(2000MW) in N-E Bulgaria (Dobruja region)	2019	Planning	Delayed	Delayed due to lack of funding.
		264	SS 4 /11 kV Vidno		New 400/110kV substation to accommodate the expected RES generation(2000MW) in N-E Bulgaria (Dobruja region)	2019	Planning	Delayed	Delayed due to lack of funding.
		266	IN-OUT in Svoboda on actual 4 kV OHL Is	Dobrudja	New 400kV double circuit OHL to accommodate the expected RES generation(2000MW) in N-E Bulgaria (Dobruja region). Line length: 2x10km.	2019	Planning	Delayed	Delayed due to lack of funding.
		870	Brezna (ME)		A new substation will be connected to the planned line 400kV Lastva-Pljevlja(ME), with two transformers 2X300MVA 400/110kV				
		871	Maoce (ME)		A new TPP substation will be connected to the existing line 400kV Ribarevine-Pljevlja(ME)				
		872	Andrijevo (ME)		A new HPP substation will be connected to the existing line 400kV Ribarevine-Pljevlja(ME)				
		873	Albertfalva (HU)		New 220/120kV 160MVA transformer at substation Albertfalva (HU).	2018	Design & Permitting	Expected earlier than planned previously	-

		882	Attiki (GR)	Crete (GR)	Project concerns the interconnection of the island of Crete with the mainland. Interconnection line from Crete will be possible connected to an existing 400kV S/S in the Attica region. The alternative is the line to arrive at an existing or new S/S in Peloponnese peninsula. Final decision will be taken according to detailed techno-economical and oceanographic studies.	2021	Planning	Expected earlier than planned previously	Project extremely important due to the high energy cost in the autonomous power system of Crete and the high RES potential.

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

Investment ID	TYNDP 2012 index	from substation name	to substation name	short description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
931		Foggia (IT)		PST installed on the new 400kV line Foggia-Benevento (splitted from 32.91)	2012	Commissioned	Commissioned	the previous date was referred to the completion of all work included in the item 32.91; the commissioning of PST is on time with the previous forecast
54	21. 54	Cornier (FR)	Piossasco (IT)	Replacement of conductors (by ACCS) on existing grid	2013	Commissioned	Commissioned	Investment commissioned on time.
81	21. 81	Trino (IT)	Lacchiarella (IT)	A new 380kV double circuit OHL between the existing 380kV substations of Trino and Lacchiarella in North West Italy area. Total line length: 95km	2014	Commissioned	Commissioned	rescheduling of work due to further secondary permitting during land rights acquisition and construction phase
246	246	Aliveri(GR)	System (GR)	New 400kV double circuit line Aliveri-System. Line length: 70km.	2013	Commissioned	Commissioned	
865	246	Aliveri(GR)		Construction of the new 400kV S/S Aliveri in Eviai area.	2013	Commissioned	Commissioned	
249	249	Polypotamo (GR)	N. Evia (GR)	New 150kV double circuit OHL. Line length: 40km. Along the new transmission line, 4 new 150/20kV substation shall be build for the interconnection of new wind farms in Evia island.	2013	Commissioned	Commissioned	
224	27. 224	Krsko (SI)	Bericevo (SI)	New 400kV double circuit OHL between Krsko and Bericevo.	2014	Commissioned	Commissioned	Progresses as planned.
279	279	Gyor (HU)	Martonvasar (HU)	Upgrade of an existing 220kV single circuit line to 400kV double circuit. Line length:84km.	2012	Commissioned	Commissioned	-
228	28. 228	Trebinhe(BA)	Plat(HR)	Re-establishment of two previously existing 220kV single circuit interconnection Trebinje(BA)-Plat(HR); Total length 10km.	2014	Commissioned	Commissioned	

623	28. 86	Villanova (IT)		A PST will be installed on the new 400kV line Foggia-Villanova	2012	Commissioned	Commissioned	the previous date was referred to the completion of all work included in the item 28.86 of TYNDP 2012; the commissioning of PST is on time with the previous forecast
634	28. A115	Plat (HR)		substation 220/110 kV Plat	2013	Commissioned	Commissioned	commisioned
843	285	Józsa (HU)	Sajószöged (HU)	Upgrade of operating voltage of line Sajoszoged-Debrecen from 220kV to 400kV to connect the new substation Jozsa.	2013	Commissioned	Commissioned	-
285	285	Józsa (HU)		New substation Józsa with 2*250 MVA 400/120kV transformation.	2013	Commissioned	Commissioned	-
87	30. 87	Feroleto (IT)	Maida (IT)	New 400kV OHL across Calabria between the substation of Feroleto and the substation of Maida	2013	Commissioned	Commissioned	-
646	32. A99	Aliano (IT)		New 400/150 kV substation in Aliano connected in and out to the existing 400 line kV "Matera - Laino" and to the local HV network.	2012	Commissioned	Commissioned	-
56	56	Camporosso (IT)		New 450 MVA PST in Camporosso (IT) 220kV substation on Camporosso (IT) - Menton (FR) - Trinité-Victor (FR) OHL.	2012	Commissioned	Commissioned	-

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

Investment ID	TYNDP 2012 index	from substation name	to substation name	short description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
834	247	Aliveri(GR)	Larimna (GR)	New 400kV double circuit line Aliveri-System. Line length: 128km.	-	Cancelled	Cancelled	The project has been cancelled due to changes in system planning
255	255	Lamia (GR)		Construction of a new 400kV EHV SS in Lamia and connection to the two circuits of the existing 400kV lines Trikala-Distomo and Larisa-Larymna.	-	Cancelled	Cancelled	Due to the significant increase of distributed RES energy production and the spatial relocation of new thermal power plants the need for this line does not exist any more.
64	26. 64	Bressanone (IT)	New substation near Innsbruck (AT)	New double circuit 400kV interconnection through the pilot tunnel of the planned Brenner Base Tunnel.	-	Cancelled	Cancelled	Further studies led to abandone the scheme from Bressanone to Innsbruck via the Brenner tunnel (previous investment 26.64 in TYNDP 2012)
282	282	Detk (HU)		New substation Detk with 2*250 MVA 400/120kV transformation is connected by splitting and extending existing line Sajoszoged-God.	-	Cancelled	Cancelled	Investment cancelled as a result of changes in planning input data (need gone)
288	288	Százhalombatta (HU)		New substation Szazhalombatta is connected by splitting and extending existing line Albertirsa-Martonvasar.	-	Cancelled	Cancelled	Generator connection request cancelled
844	289	Sajóivánka (HU)		Installation of the 2nd transformer in substation Sajoivanka.	-	Cancelled	Cancelled	-
289	289	Felsozsolca (HU)	Sajóivánka (HU)	Reconstruction of line to double circuit. Line length: 29km.	-	Cancelled	Cancelled	-
73	29. 73	El Aouaria (TU)	Partanna (IT)	New 350km 1000 MW HVDC line between Tunisia and Italy via Sicily with 400kV DC subsea cable and converters stations at both ends.	-	Cancelled	Cancelled	The previous items 29.A97 and 29.73 of TYNDP 2012 have been merged in 29.635
291	291	Sajószöged (HU)		New 400/120kV 250MVA transformer with PST.	-	Cancelled	Cancelled	-

252	49. 252	Melliti (GR)	Kardia (GR)	New 400kV double circuit OHL. Length:40km.	-	Cancelled	Cancelled	Due to the significant increase of distributed RES energy production and the spatial relocation of new thermal power plants the need for this line does not exist any more.
253	49. 253	Kardia (GR)	Trikala (GR)	New 400kV double circuit OHL. Length:80km.	-	Cancelled	Cancelled	Due to the significant increase of distributed RES energy production and the spatial relocation of new thermal power plants the need for this line does not exist any more.
254	49. 254	Larissa(GR)	Trikala (GR)	New 400kV double circuit OHL. Length:57km.	-	Cancelled	Cancelled	Due to the significant increase of distributed RES energy production and the spatial relocation of new thermal power plants the need for this line does not exist any more.

11.1.5 Storage projects

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

Caveats

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

Project index	Project description	GTC (MW)	S1	S2	b6 technical resilience	b7 flexibility	scenario	SoS (MWh/yr)	SEW (Meuros/yr)	RES avoided spillage (MWh/yr)	Losses variation (MWh/yr)	CO2 emissions variation (kT/yr)
108	Grid integration of 1000MW Hydro Pumped Storage Tarnita.	1000	NA	NA	3	3	Scenario Vision 1 - 2030	-	[9;12]	[35000;43000]	[-47000;-39000]	[400;490]
							Scenario Vision 2 - 2030	-	[4;5]	[9900;12000]	[-21000;-17000]	[250;310]
							Scenario Vision 3 - 2030	-	[3;4]	[19000;23000]	[-200000;-170000]	[-46;-37]
							Scenario Vision 4 - 2030	-	[94;120]	[660000;800000]	[51000;62000]	[-550;-450]
217	Pumped Storage Complex with two independent upper reservoirs: Agios Georgios & Pyrgos	590	NA	NA	2	3	Scenario Vision 1 - 2030	-	[1;2]	[34;41]	0	[49;60]
							Scenario Vision 2 - 2030	-	[3;4]	[6200;7600]	0	[62;75]
							Scenario Vision 3 - 2030	-	[3;4]	[1600;1900]	0	[17;20]
							Scenario Vision 4 - 2030	-	[10;13]	[21000;26000]	0	[-36;-29]
218	Hydro-pumped storage in Bulgaria - Yadenitsa	860	NA	NA	1	2	Scenario Vision 1 - 2030	-	[3;4]	[49;60]	0	[72;89]
							Scenario Vision 2 - 2030	-	[4;5]	[9000;11000]	0	[90;110]
							Scenario Vision 3 - 2030	-	[5;6]	[2300;2800]	0	[24;29]
							Scenario Vision 4 - 2030	-	[15;18]	[31000;38000]	0	[-52;-43]

11.1.6 Smart Grid PCIs

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

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

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11.2 Appendix 2 - Short description of methodology

The methodology is based on the assumption that integration of internal markets and proper enhancement of networks should lead to 'least cost' generation. Uncertainties concerning the evolution of future generation capacity (location, type and capacity) are treated with a scenario-based approach. For each determined scenario, annual market simulation is performed, on an hourly basis, leading to 'least cost' economic dispatch of all available generation. Based on the hourly market simulation results, DC power flows are performed, providing thus the loading duration curves of critical network elements. Grid Transfer Capability (GTC) is calculated for every critical corridor/boundary of the transmission system and compared to hourly power flows, in order to check whether networks can support the 'least cost' generation schedule found. Finally, proposed transmission projects are evaluated through the calculation of numerous indicators.

The methodology comprises market studies (generation simulation) taking into account transmission constraints approach and network studies. The main steps of the methodology are the following:

1. Market studies: Joint simulation of all multi-area generation systems under consideration is performed in order to determine the 'least cost' economic dispatch of available generation, considering fuel costs, variable O&M costs and CO2 costs. Simulation takes into account the flexibility of the units and must-run constraints, ignoring network system constraints. More specifically, annual probabilistic simulation is initially performed, in order to account for the forced outage rates (FOR) of the units, resulting in the expected annual energy balance, generation cost and emissions, as well as typical reliability indices (LOLP and Expected Unserved Energy). Based on the merit order obtained from the annual simulation process, deterministic hourly simulation is then performed by neglecting the FOR of generating units and considering that all units that are not out of service for maintenance are available for dispatch. Snapshots for each hour of the year are created.
2. Clustering of proposed transmission projects: Network corridors that appear systematically congested or are of particular commercial interest are chosen as Critical Corridors of the system to be studied. Proposed projects are clustered based on their anticipated contribution and linked to one of the selected critical corridors.
3. Calculation of Bulk Power Flows: Hourly snapshots obtained in Step 1 are used as input for performing hourly DC load flows, thus resulting in the loading of every transmission device (lines and transformers) of the network and in particular of every critical corridor of the network for the entire year under consideration.
4. The most critical snapshots are further analyzed in terms of static security (N and N-1) to assess the technical resilience of the proposed solutions.
5. Calculation of Grid Transfer Capability: the increase of Grid Transfer Capability (GTC) on each critical corridor of the network, achieved by the completion of the corresponding cluster of projects, is calculated.
6. Evaluation of proposed transmission projects: Indicators reflecting the impact of the proposed transmission projects on set EU targets (among others security of supply, RES penetration, network losses and CO2 emissions) are calculated.

Figure 1 presents the main procedures used in the methodology.

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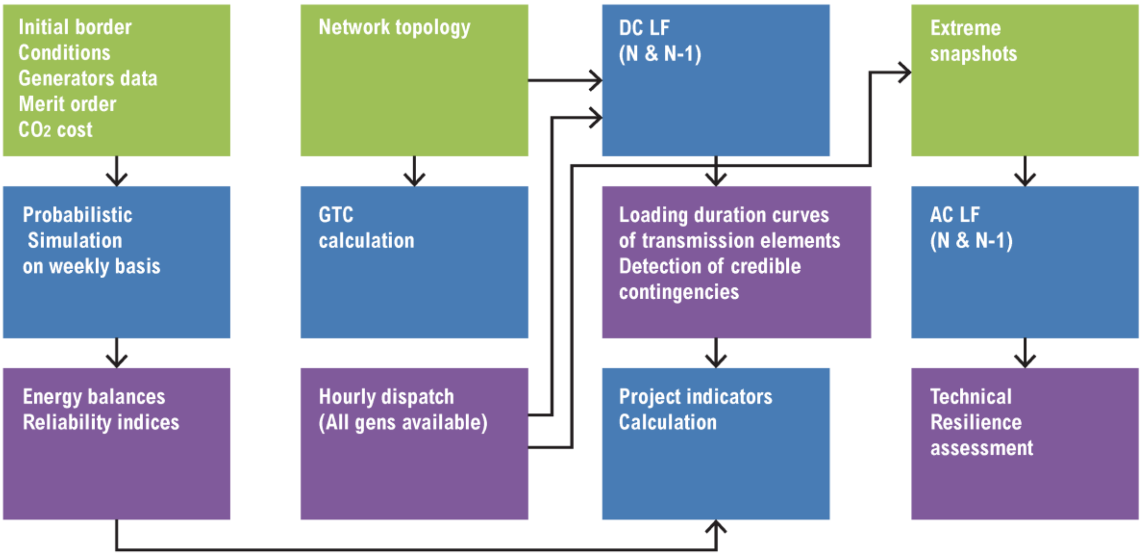

Fig. 1: Main procedures of the proposed methodology

2.1 Market Studies

Market studies are performed using a probabilistic production costing model, which simulates the joint operation of multi-area generation systems for a given time horizon, using a weekly time step. The model computes the energy balance, the cost of operation, the polluting emissions and finally generation reliability indices. During each week, the generation mix and the loading order of the generating units are assumed to be fixed. The hourly loads of the period under consideration are assumed known and deterministic.

Initially, the model simulates the impact of interconnections with neighboring countries, outside the region under consideration, and then the operation of non-dispatchable renewable energy sources (wind, run of river hydros, solar and other). Following that, storage and pump storage hydro plants are simulated. The resulting load has to be served by the thermal units of the system. More specifically, simulation of the generation system is performed through the following steps:

On annual basis and for each area of the region separately the model:

- Modifies the chronological load series to account for imports and exports with countries outside the region, the operation of non-dispatchable units, storage hydro units and pump storage units.
- Determines the annual maintenance scheduling based on the levelized criterion, taking into consideration maintenance requirements of generating units.

The timeseries data of each area are aggregated into single regional timeseries. From this point on, the entire region is considered as a single control area.

The operation of the thermal units is simulated; for each week the model performs the following tasks:

- Determines the dispatch order of the blocks of the thermal units. Blocks are placed in a priority list in ascending order of their incremental cost taking into account adopted practices of the system.
- Dispatches the blocks of the thermal units according to the priority list. Probabilistic techniques are utilized in order to account for the forced outage rates of the units. Hours of operation, required fuel and emissions for each thermal unit are determined.
- Determines the reliability of the system in terms of the Loss-of-Load Probability (LOLP) and Expected Unserved Energy (EUE), the expected cost and expected CO2 emissions.

After the annual probabilistic simulation has been completed, deterministic hourly simulation is performed for the same set of input data:

- Based on the weekly merit order obtained previously, thermal units are dispatched again, this time not taking into account their forced outage rate (FOR). Hourly generation for every thermal unit is determined.

2.2 Clustering of proposed projects

In the framework of the proposed methodology, several corridors of the network are chosen as Critical Corridors and their behaviour is studied in depth. Critical Corridors include corridors with known predominant power flows (e.g. bulk power flows from east to west), corridors with systematic congestion issues and corridors that present a particular commercial interest. In order to study each critical corridor, a specific node is chosen (usually national borders between neighbouring countries are selected), on which power flows are calculated and is defined as a 'system Boundary'. Proposed transmission projects (new projects as well as reinforcements of existing networks) are grouped into clusters and linked to one of the selected critical corridors, based on their expected impact.

2.3 Calculation of Bulk Power Flows

In order to calculate the bulk power flows on the critical corridors of the transmission system the DC Load Flow model (a simplified linear approach to solving the power flow problem) is applied. This approach is commonly used in market related issues, such as NTC calculations, congestion management etc, due to its simplicity and the transparency that it provides. The use of the DC load flow (DC-LF) method decouples the problem of active power flows from reactive power and voltages which are in any case local issues. The DC-LF solution assumes that all voltages are equal to nominal values and therefore there is only one feasible solution, as opposed to the full AC load flow where various solutions can be achieved, depending on assumptions regarding compensating devices, transformer tap positions, reactive power provided by generating units and other parameters. Furthermore, the DC-LF solution can easily be reproduced by third parties, thus guarantying transparency.

Based on the hourly results obtained from the market simulation, snapshots for every hour of the year are created. The DC-LF problem is solved for every hour of the year, resulting in the loading of every transmission device (lines and transformers) of the network for the entire year under consideration. Hourly power flows on all tie-lines that cross a boundary are appropriately summed, providing thus the desired Bulk Power Flows on the corridor under consideration.

2.4 Calculation of Grid Transfer Capability (GTC)

Grid Transfer Capability (GTC) is the ability of the grid to transport electricity across a boundary, that is, from one area (TSO, area within a country or price zone) to another, compatible with security standards applicable in the concerned areas .It depends on the considered state of consumption, generation and exchange, as well as the topology and availability of the grid.

GTC is calculated by simulating extra power transfer (ΔE) in addition to the base case exchange (BCE):

$$GTC = BCE + \Delta E$$

In fact, extra power transfer, or maximal increase in power transfer, is simulated by appropriate changes in generation pattern in respective areas (generation shift, ΔE): by increasing the generation in source area, and in contrast, by appropriately decreasing the generation in sink area.
The Grid Transfer Capability is oriented, which means that across a boundary, there may be two different values .For the calculation of GTC a composite approach for definition of source/sink area is used (area may be single national TSO, area within a country or price zone, otherwise a set of TSOs, countries or price zones) .A boundary may be fixed or may vary from one horizon or scenario to another.

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GTC value from the source area to the sink area (see figure for illustration) is calculated by proportionally increasing the generation in the source area and proportionally decreasing the generation in the sink area .The shift of the generation is noted as ΔE^{+} for the generation increase in the source area and ΔE^{-} for generation decrease in the sink area .If surplus of power is exhausted in the source area, additional artificial generation reserve is considered (generation shift is achieved proportional to engagement, while ignoring generation technical limits) .

GTC is assumed to be equal to TTF (Total Transfer Flow) or TBC (Total Border Capacity), that is, sum of the physical active power flows in the base case (Flowref) and the flow from maximal generation shift (PTDF x ΔE), on all tie-lines which form the boundary .

GTC = (TTF, TBC) = Flowref + PTDF x ΔE .

Although GTC is defined as an exchange program, the value of GTC is identical to the real physical flows between systems while maximal possible exchange is obtained and N-1 criterion is satisfied.

For N-1 security check (contingency and monitoring) the following are taken into account:
− all 400 kV & 220 kV internal elements,
− all 400 kV & 220 kV tie-lines in the SEE .

When selecting the critical contingency which determines transfer capability limit, only the network in the vicinity of the boundary is considered.
The methodology is applied, considering as a starting point the WP 2030 regional model with all new investments (grouped in clusters) of the investment plan IN operation. The contribution of each cluster is assessed by setting the respective clusters OUT of operation and assessing the ΔGTC variation on the respective boundary:

$\Delta GTC_{ClusterX} = GTC_{all\ Clusters,IN} - GTC_{ClusterX,OUT}$

Calculations follow this order:

- For every source>sink pair, a list of the most restrictive contingencies is generated, with ΔE (maximal generation shift) for every contingency.
- One contingency is selected as the most relevant for transfer capability assessment.
- Using distribution factors (PTDF), selected ΔE (maximal generation shift) is distributed on all interconnections in the Continental South East.
- The load flows originating from this ΔE (maximal generation shift) which are added on base case flows (Flowref), are summed as GTC values.
- For each studied project, it is assumed that the GTC on the respective border/s is given by:

$$GTC = Flow_{ref} + PTDF \times \Delta E$$

- The contribution of each project on grid transfer capability on respective boundary, ΔGTC, is assessed by calculating the difference between
- GTC value calculated for the base case network topology with all projects are IN operation, and GTC values calculated for specific network topology while the respective project is OUT of operation:

$$\Delta GTC_{ClusterX} = GTC_{all\ Clusters,IN} - GTC_{ClusterX,OUT}$$

11.3 Appendix 3 - Network studies results

11.3.1 Appendix 3.1 Exploratory Phase

As part of TYNDP 2014 Macro-procedure, multilateral exploration studies for the 2030 vision 1 should be performed. Beside market simulations, CSE RG decided to perform preliminary network studies, during this phase of TYNDP 2014 preparation, as well.

The plan was to perform preliminary network assessments using snapshots corresponding to extreme cases, the most stressed cases, as defined by market studies (selected snapshots) in order to identify potential congested corridors as well as the need for new investment projects for observed scenario V1.

The following analysis were performed on the regional network model of South-East Europe with implemented production for WP2030 (Vision 1) and with network topology defined for the year 2020. Two cases were analysed:

A) Importing (regional) case;
B) Exporting (regional) case;

For each of the above mentioned cases, specific snapshots were selected for which, plan was to perform load flow, N-1, G-1 and N-1-1 contingency analysis.

The following snapshots were selected:

A) Importing (regional) case
   - 23rd week, 149 h – Sunday the 9th of June, at 5 h (CET),
   - 49th week, 44 h – Tuesday the 4th of December at 20 h (CET),
   - 51st week, 43 h – Tuesday the 18th of December at 19 h (CET),

B) Exporting (regional) case
   - 9th week, 148h – Sunday the 3rd of March at 4 h (CET),
   - 24th week, 62h – Wednesday the 13th of June at 14 h (CET),
   - 37th week, 156h – Sunday the 16th of September at 12 h (CET),

N-1 contingency analysis were conducted in a way which assumed outage of 400 kV and 220 kV lines as well as 400/220 kV transformers. Same elements were observed in the monitoring list.

Conclusions

The results of the preliminary network studies show, that there are possible congestion points in the CSE regional network which can be candidates for the new infrastructure elements and reinforcements especially if sensitivity to the exchanges with countries at the East of the Region (e.g. Turkey) is taken into account.

Different critical points were registered depending on the exchange of the CSE region – Importing or the Exporting.

In the Importing cases in which these is a high import of Greece critical elements are in the direction from the North-west towards the South – internal lines in Serbia and interconnection between Bosnia and Herzegovina and Montenegro and between FYR of Macedonia and Greece. Additional analysis showed that this case is sensitive to the exchange level of Turkey i.e. higher import and more critical elements appear.

In the Exporting cases Romania and Bulgaria have the highest export and most of the critical elements are on the so called east - west corridor: especially 400 kV interconnection between Serbia and Bulgaria (400 kV

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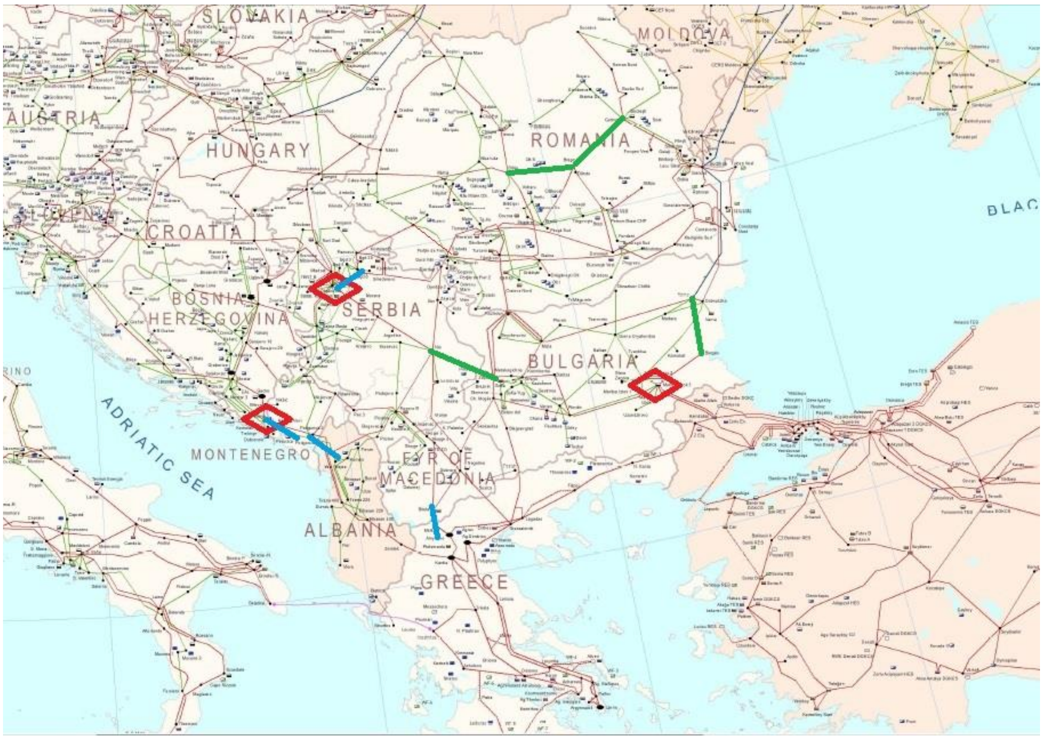
OHL Nis - Sofia, which is highly loaded even in base case), 400 kV line Varan – Burgas in Bulgaria and 400 kV lines between Gutinas, Brasov and Sibiu.

In all cases 220 kV part of the network between Martonvasar and Dunamenti in Hungary appeared to be critical but since its neighbouring systems are modelled as fixed injections this result should be taken with some reserve.

Based on the load duration curves, six of the mostly loaded interconnection lines in the region were identified. It must be noticed that this loads were registered with TR import of around 500 MW, in the case of TR export majority of this loads would be much higher.

If we take into consideration that in selected snapshots for the Exporting case, there are significant load flows through interconnection lines and that in these periods planned maintenance of OHLs are usually performed, it can be concluded that these regimes (in Exporting case) are the critical one. Even more critical values of load flows on interconnecting OHLs are possible when Turkey is looked upon as possible exporting country.

Next picture show identified bottlenecks in the network planned for 2020 and production planned for 2030 in Vision 1 for importing and exporting cases.



***Picture 1**:* CSE RG Map with the identified bottlenecks in 2030 (importing and exporting cases)

11.3.2 Appendix 3.2 Report on Technical Resilience in Vision 1

According to the CBA methodology, the assesment of benefit named “technical resilience” was conducted for all clusters of investments in the region of CSE. The assesment was done by conducting N-1 contingency analysis on the snapshots models for 2030 generated by market simulations for Vision 1 2030. As most suitable snapshots, chosen were the ones which would represent in best way four critical regimes:

- High level of load – high level of production from renewable sources

- High level of load – low level of production from renewable sources
- Low level of load – high level of production from renewable sources
- High level of import or export from the CSE region

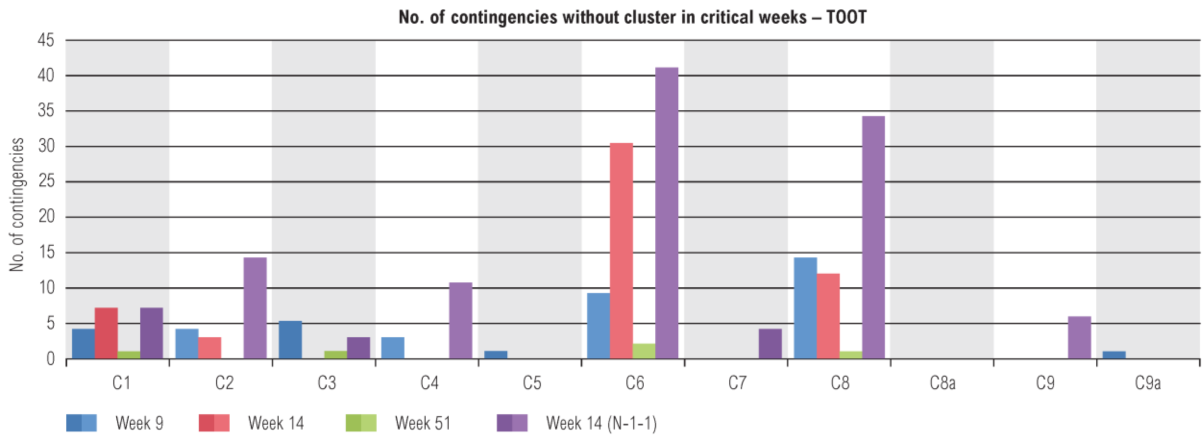
After reviewing the results of market simulations it was found that the most critical regimes are in following hours:

- 9th week 5h
- 14th week 30h
- 50th week 91h
- 51st week, 20h

In addition to N-1 contingency analysis, N-1-1 contingency analysis was checked on the snapshot model for 14th week 30h. This was done because the 14th week is in April, in the month when disconnection of lines usualy takes place because of regular yearly maintenance. For this purpose, one possible set of lines which was additionally disconnected was defined and it consisted of following lines:

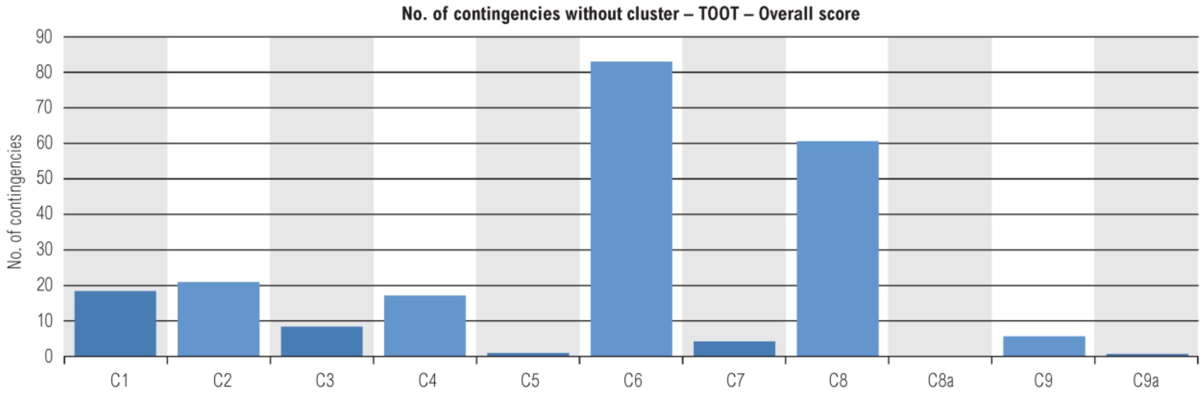
- OHL 400 kV Blagoevgrad (BG) - Thessaloniki(GR)
- OHL 400 kV Zerjavinec (HR) - Hevic (HU) 1
- OHL 400 kV Drmno (RS) - Smederevo 3 (RS)
- OHL 400 kV Ribarevina (ME) - Maoce (ME)
- OHL 400 kV Kozloduy (BG) - Mizia (BG)
- OHL 400 kV Konjsko (HR) - RHE Velebit (HR)
- OHL 400 kV Bucuresti Sud (RO) - Gura Ialomitei (RO)
- OHL 220 kV Vau Dejes (AL) - Komani (AL)

The assessment of technical resiliance was conducted by applying TOOT metodology on all analysed clusters in the region of CSE. The summary results of technical resilience assesment are shown on the Picture 1 and Picture 2. On the Picture 1 the number of overloadings per selected snapshots and clusters which were detected after applying TOOT metodology is shown. In this way showing of results, the bars show the number of overloadings which could be resolved by constructing all projects in analysed cluster in given time periods (snapshots). For example, for the 14th week and cluster 6 when TOOT metodology is applyed (i.e. when cluster c6 is removed), 31 cases of overloadings are detected in the network.



Picture 1: Number of overloads per weeks and clusters obtained applying TOOT metodology

In the purpose of comparing clusters, on the Picture 2 the total number of cases in which overloadings are detected is shown. As it can be seen from Picture 2, the clusters 6 and 8 have higher impact on technical resiliance when comparing with clusters 5, 7, 8a and 9a which impact on technical resilience is smaller.



Picture 2: Number of overloads per clusters obtained applying TOOT metodology

11.3.3 Appendix 3.3 "N-1" analysis for Vision 4

Network adequacy of CSE region in Vision 4 was checked on three snapshots obtained from market simulation. The snapshots were chosen according to following criteria:

1. Hour which represents one of the critical situations on the interconnections lines of the CSE region.
2. Hour in which there is high production from wind power plants in our region and low demand at the same time.
3. Hour in which there is high production from solar power plants in our region.

After analyzing market results it was concluded that appropriate snapshots should represent following timestamps:

1. The most loaded interconnection line in Vision 4 is OHL 400 kV Nis (RS) – Sofia West (BG). Because of that the snapshot was chosen according to active power flow on it, i.e. 46th week 67h,
2. 26th week 26h, low demand 38588 MW, high wind conditions (12979 MW) and
3. 46th week 155h, medium demand 48416 MW, PV production 18929 MW.

Base case and “N-1” security analyses were conducted by monitoring only power flows on interconnection lines in CSE region.

For snapshot representing 46th week 67h, system summary values are shown in the table 1.1.

Table 1.1: System summary values for week 46, hour 67

Country	Generation (MW)	Load (MW)	Losses (MW)	Total (MW)
Albania	2156	1860	69	220
Bosnia	1978	2458	120	-601
Bulgaria	8836	5752	214	2847
Croatia	3697	3613	210	-128
Greece	13990	12381	295	1315
Hungary	8608	7448	205	952
F.Y.R. of Macedonia	1408	2183	42	-817
Montenegro	1484	946	45	488
Romania	16827	13057	486	3197
Serbia	6646	7799	260	-1425
Slovenia	2837	3009	85	-280
Turkey	211	700	5.5	-494

Based on results obtained from N-1 contingency analysis, most of the overloadings were located in the east and northeast part of the CSE region. Romania, Bulgaria and Hungary are exporters in this snapshot with the total export of 7000 MW. Energy flows are predominantly in the direction East – West and Northeast – Southwest. Critical element is OHL 400 kV Nis (RS) – Sofia West (BG), which is overloaded for several outages in the region. This OHL is loaded at 93% in base case.

Tie lines between Romania and Hungary are also overloaded in some cases (400 kV OHLs Sandorfalva (HU) – Arad (RO) and Bekescsaba (HU) – Nadab (RO)). There is one overloading on the Hungary – Slovenia border e.g. tie line 400 kV Heviz (HU) – Cirkovce (SI) which is overloaded for the outage of OHL 400 kV Heviz (HU) – Zerjavinec (HR). There are two overloadings in the 220 kV network: 220 kV OHL Podgorica (ME) – Koplik (AL) and Divaca (SI) – Pehlin (HR).

In snapshot for 26th week 26h, system summary values per country are given in table 1.2.

Table 1.2: System summary values for week 26, hour 26

Country	Generation (MW)	Load (MW)	Losses (MW)	Total (MW)
Albania	1027	706	18	296
Bosnia	1574	1327	79	168
Bulgaria	4198	3303	176	695
Croatia	1773	1926	123	-275
Greece	11361	11752	232	-623
Hungary	7145	5216	145	1784
F.Y.R. of Macedonia	853	1021	13	-181
Montenegro	931	439	27	460
Romania	10519	7491	360	2582
Serbia	3860	3596	93	159
Slovenia	1901	1811	47	32
Turkey	205	700	4.9	-500

Based on results obtained from N-1 contingency analysis, no overloading is detected in this regime.

In snapshot for 46th week 155h, system summary values per country are given in table 1.3.

Table 1.3: System summary values for week 46, hour 155

Country	Generation (MW)	Load (MW)	Losses (MW)	Total (MW)
Albania	1642	1491	44	100
Bosnia	1482	2081	63	-662
Bulgaria	7877	4583	23	3138
Croatia	2049	2935	61	-947
Greece	10242	9185	179	878
Hungary	6565	5955	76	533

F.Y.R. of Macedonia	915	2020	35	-1140
Montenegro	1251	929	17.3	300
Romania	11924	9244	88	2320
Serbia	5574	7666	12	-2333
Slovenia	2393	2328	51	8
Turkey	206	700	5.7	-500

In this snapshot Romania, Bulgaria and Hungary export about 6000 MW and power flows are in the East – West direction. In this case Serbia and FYR of Macedonia are huge importers of electricity as can be seen from the table 1.3.

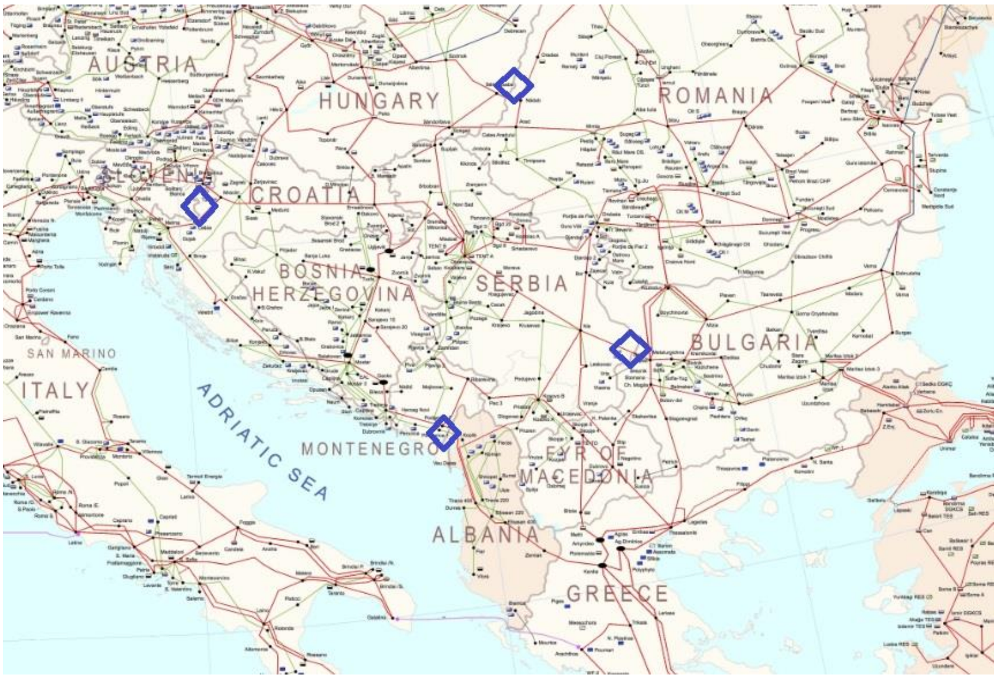
When N-1 security criteria is analysed it was determined that only tie-line which is overloaded is 400 kV OHL Nis 2 (RS) – Sofia West (BG) for several outages.

Conclusions

By conducting "N-1" security analyses for Vision 4 for CSE region the overload issues on tie lines were noticed on the following borders:

- Bulgaria – Serbia
- Rumania – Hungary
- Slovenia – Croatia
- Albania – Montenegro

On the Picture 1 borders with overloading issues are marked.



Picture 1: Borders in the region of CSE with detected overloadings on interconnection lines

Vision 4 is extreme scenario in the sense of the high penetration of RES. This is top-down vision which means that the sum of installed capacities for PV per TSOs was obtained by ENTSO-e. Such approach led to scenarios which are considerably different from the ones usually considered in TSOs analysis. Taking into account also the uncertainties related to this scenario, further detailed analyses will be needed in the future, in order to reconfirm the validation of this scenario and re-examine the possible needs for new transmission investments.

11.3.4 Appendix 3.4 Sensitivity analysis of CSE on Turkey’s balance

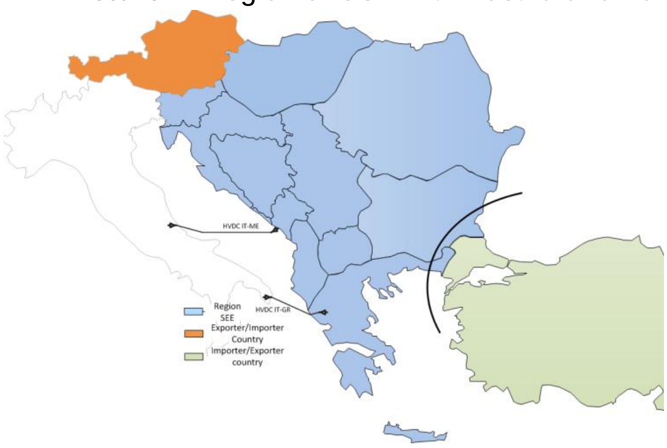
During the work on TYNDP 2014, one of the assumptions was that the totals of all countries that are not members of ENTSO-E are constant at all hours in 2030 and with these constant values of totals market and network calculations were conducted. Value of Turkey’s total in each hour which was taken into consideration was the import of 494 MW. Because of this, there was a need to verify transmission adequacy of the CSE region in the form of satisfying N-1 criteria for different values of Turkey’s totals.

Sensitivity of CSE region on Turkey’s totals was investigated by using two different snapshot models generated by market simulations, for:

- 1st week, 36 h and
- 30th week, 14 h.

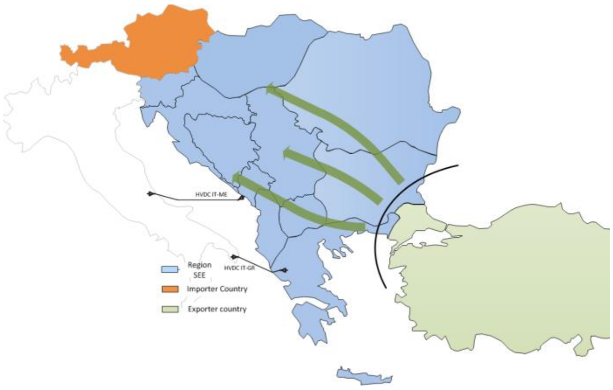
These snapshots were selected so that the most critical initial conditions for sensitivity determination are obtained.

Picture 1: Region of CSE with Austria and Turkey



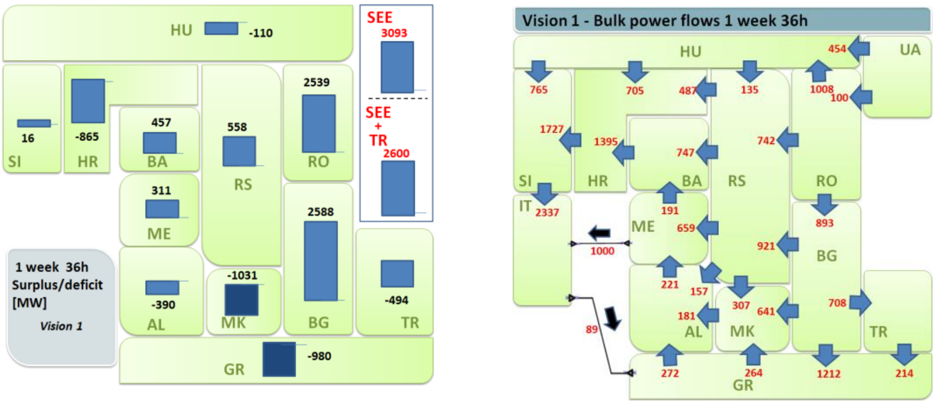
Sensitivity is analysed by monitoring overloads in the region of CSE (Picture 1) on all 400 kV and 220 kV OHLs and 400/220 kV transformers. In all cases of Turkey’s totals it was assumed that Austria, i.e. borders AT-DE and AT-CZ cover the debalans.

Sensitivity of CSE region on Turkey's export – 1st week, 36h



Picture 2: Export of Turkey

Sensitivity of CSE region on Turkey's export is analysed by using snapshot of 1st week and 36th hour. This snapshot was chosen for analysing sensitivity on Turkey's export because in this particular hour exports of Bulgaria and Romania are on high level. Totals of countries and bulk power flows in the region of CSE which are present in this snapshot are shown on the Picture 3.



Picture 3: Totals of countries and bulk power flows in Base case for the region of CSE

Respecting the number of interconnection lines per one border, from Picture 3 it can be seen that border between Serbia and Bulgaria is the most loaded border (921 MW) in the region CSE. In other word, the OHL 400 kV Nis 2 (RS) – Sofia West (BG) is the most loaded interconnection line in this snapshot in the CSE.

Analysis is conducted for four different levels of Turkey's export:

- Base case, where the import of Turkey is 494 MW,
- Total of Turkey is 0 MW,
- Export of Turkey is 500 MW and
- Export of Turkey is 1000 MW.

On all four analysed cases load flow and N-1 security analysis were conducted.

For cases of Turkey's export of 500 MW and 1000 MW as highly loaded elements 400 kV OHLs in Serbia and Croatia are detected. In Serbia, highly loaded OHLs are 400 kV OHL S. Mitrovica 2 – Mladost who's loading in base case reach the level of 92.3 % and 400 kV OHL Nis 2 (RS) – Sofia West (BG) with loading in base case of 95.9 %. It is determined that 400 kV OHL S. Mitrovica 2 – Mladost is load sensitive on Turkey's export – loading is increased for about 7 % for every 500 MW of Turkey's export increase, while loading of OHL 400 kV Nis 2 (RS) – Sofia West (BG) is increased for about 9 % for every 500 MW of Turkey's export increase. In Croatia, it is detected that highly loaded is OHL 400 kV Melina – Brinje with loading in base case of 96.2 %. It is detected that this OHL is load sensitive on Turkey's export – loading is increased for about 9 % for every 500 MW of Turkey's export increase.

When N-1 security analysis was conducted, it was noticed that significant number of overloadings were detected for values of Turkey's totals rangeing from -494 (Turkey's import) MW to 1000 MW (Turkey's export). Three directions with congestion were detected, as shown Picture 2. First congested direction is detected in transmission network along Adriatic sea in Croatia. In this direction, as most critical OHL 400 kV Melina – Brinje is recognized, while in 220 kV network most critical are OHL 220 kV Brinje – HPP Senj, OHL 220 kV Melina – HPP Senj and OHL 220 kV Pehlin (HR) – Divaca 2 (SL). Second congested direction was detected in transmission network in Serbia where overloading problem is detected on two OHLs: OHL 400 kV Nis 2 (RS) – Sofia West (BG) and OHL 400 kV S. Mitrovica 2 (RS) – Mladost (RS). Overloading on OHL 400 kV Nis 2 (RS) – Sofia West (BG) was detected for four potential outages with Turkey's export of 500 MW, while for Turkey's export of 1000 MW overloading of this line is detected for 14 different outages of which most critical is outage of OHL 400 kV Stip (MK) – Ceverna Mogila (BG) (for this outage mentioned critical OHL is overloaded at 116.5 %). Third direction on which congestions are detected is the direction over Bulgaria, Romania and Hungary. On this direction, overloading problems occur at interconnection lines between Romania and Hungary. Overloads are detected at the level of Turkey's export of 1000 MW on OHL 400 kV Arad (RO) – Shandorfalva (HU) and on OHL 400 kV Paks (RO) – Shandorfalva (HU).

Sensitivity of the CSE region on Turkey's import – 30th week 14h

Picture 4: Import of Turkey

Sensitivity of the CSE region to the Turkish import was analyzed on a snapshot for 30th week and 14h. This snapshot was chosen for assessment of sensitivity because the total of Greece is maximal i.e. Greece imports about 4,500 MW, and also the totals of Romania and Bulgaria are at a lower level. The totals of CSE countries and bulk power flows present in a given snapshot are shown in Picture 5.

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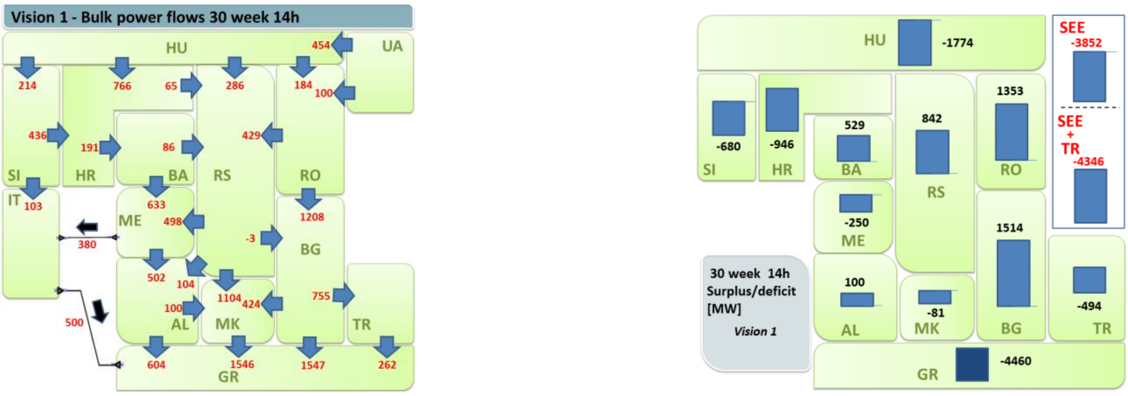


Picture 5: Totals of countries and bulk power flows in Base case on borders for case of Turkish import

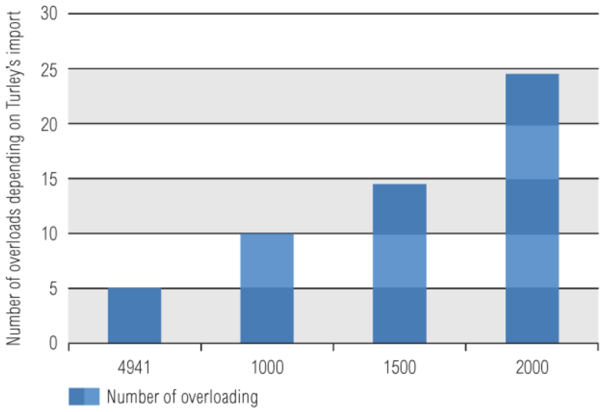
The sensitivity analysis for the region was performed for four different totals of Turkey:

- base case, where Turkey imports 494 MW,
- import of 1000 MW,
- import of 1500 MW, and
- import of 2000 MW,

On all four analysed cases load flow and N-1 security analysis were conducted. Given that snapshot is for week 30, which is in the summer, all four cases of Turkish imports were checked in the situation with maintenance on OHLs in the region, i.e. N-1-1 was checked on two contingency lists.

When analyzing load flow in base case for this snapshot, it was noticed that only one element is loaded above 80% in all four cases: OHL 400 kV interconnection Florina (GR) - Bitola (MK). On 400 kV OHL Florina (GR) - Bitola (MK) calculated limit is 1218 MVA, as a consequence of restrictions on Bitola side. In the case of Turkey's import of 494 MW, base case loading of the OHL is 82.6%, while in the case of 2000 MW import, loading reaches 97.6% i.e. almost overloaded. It could be seen that increasing of Turkey's imports by 500 MW increase loading of this OHL by 5%.

Picture 6 shows the total number of overloaded elements for the worst case contingency. For example OHL 400 kV Florina (GR) - Bitola (MK) is overloaded with 110.8% for tripping of OHL 400 kV Kardia (GR) - Zemblak (AL). However, this transmission line is overloaded for five different events among which the worst case is OHL 400 kV Kardia (GR) - Zemblak (AL). It was detected that the critical line in terms of overloading is OHL 400 kV Florina (GR) - Bitola (MK) which is overloaded in range between 110.8% and 133% for the analyzed totals. In addition to this, the total number of cases in which there are contingencies with overloads is increasing. Sensitivity of this OHL is such that for every Turkey’s import increase of 500 MW, for the disconnection of OHL 400 kV Kardia (GR) - Zemblak (AL), overloading increases by 7%. The number of tripping OHLs which result in overloading of the OHL 400 kV Florina (GR) - Bitola (MK) also increases (for about 3).



Picture 6: Number of overloads depending on Turkey's import

In addition to this OHL, other critical elements are two 220 kV interconnection OHLs between Montenegro and Albania and Bosnia and Herzegovina. Overloading of these two lines is understandable if one bears in mind that both lines are parallel with 400 kV OHLs. Outage of the 400 kV OHLs results in increasing power flows in 220 kV network, causing the overloading of above mentioned interconnection OHLs. Picture 6 shows the number of overloads which occur in the CSE region for the N-1 security analysis performed depending of the Turkey's import.

In operational terms, it is necessary to perform regular annual maintenance of OHLs which necessitates the need of disconnection transmission lines. In practice maintenance works are performed on several OHLs in the CSE region simultaneously.

For this reason, N-1 security analysis is performed on two different maintenance lists. First maintenance list includes following OHLs:

- OHL 400 kV Blagoevgrad (BG) - Thessaloniki(GR)
- OHL 400 kV Zerjavinec (HR) – Hevitz (HU) 1
- OHL 400 kV Pozarevac (RS) - Smederevo 3 (RS)
- OHL 400 kV Ribarevina (ME) - Maoce (ME)
- OHL 400 kV Kozloduy (BG) - Mizia (BG)
- OHL 400 kV Konjsko (HR) - RHPP Velebit (HR)
- OHL 400 kV Bucuresti Sud (RO) - Gura Ialomitei (RO)

Due to the disconnected OHL 400 kV Blagoevgrad (BG) - Thessaloniki (GR), base case loading of the OHL 400 kV Florina (GR) - Bitola (MK) is in the range from 96.7% to 112.2% for Turkey's imports from 494 MW to 2000 MW. Such a high percentage of loading suggests that this OHL is critical in terms of overloading. Besides mentioned OHL, high percentage of overloading was recorded on OHLs 220 kV in Montenegro. Loadings of OHLs 220 kV in the base case are in range from 80 % to 90 %. High loading percentage on this OHLs 220 kV was caused by disconnection of OHL 400 kV Ribarevina (ME) - Maoce (ME). Besides overloadings analyzed in base case, when conducting N-1 contingency analysis additional overloadings emerge. Overloading of OHL 400 kV Thesaloniki (GR) – Dubrovo (MK) is in range from 102.6 % to 123 % for the outage of OHL 400 kV Florina (GR)– Bitola (MK). Besides this, significant overloadings are detected in 220 kV transmission network in Montenegro.

In other set of OHLs which are switched off in the model (assuming that they are switched of for the purpose of maintenance) the following OHLs are included:

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- OHL 400 kV Pljevlja 2 (ME) - B. Basta (RS)
- OHL 400 kV TPP Kolubara (RS) - SS Kolubara (RS)
- OHL 400 kV Filipi (GR) - Lagadas (GR)
- OHL 400 kV Bitola (MK) - Skopje 4 (MK)
- OHL 400 kV Rahman (RO) - Isaccea (RO)
- OHL 220 kV Medjuric (HR) - Prijedor (BA)
- OHL 400 kV Zemblak (AL) - Kardia (GR)

Switching off OHL 400 kV Zemblak (AL) - Kardia (GR) has as consequence overloading of OHL 400 kV Florina (GR)– Bitola (MK) in all analyzed cases of Turkey's import.

As for maintenance list 2, in this case a problem with overloading of OHL 400 kV Thesaloniki (GR) – Dubrovo (MK) for the outage of OHL 400 kV Florina (GR) – Bitola (MK) also emerges. Significant overloading of internal OHL 400 kV Mladost (RS) – Obrenovac (RS) in the range from 108.5 % to 135.4 % is also detected.

Conclusions

Based on previously conducted analysis, the following conclusinos can be made:

- Some of the overloading OHLs in the region of CSE are significantly sensitive on the Turkey's total.
- Turkey's export has higher impact on overloading then Turkey's import in the region.
- Respecting the number of interconnection lines per one border and states with high export Bulgaria and Romania, the border between Serbia and Bulgaria is one of the most loaded border in Vision 1, in the region CSE.
- With existing totals of Romania and Bulgaria in the snapshot, sensitivity analysis has shown that for Turkey's export (Austria's import) there are lines which shown significantly sensitivity:
  - OHL 400 kV Nis 2 (RS) – Sofia West (BG)
  - OHL 400 kV Mladost (RS) – S. Mitrovica 2 (RS)
  - OHL 400 kV Melina (HR) - Brinje (HR) which contingency leads to overloading in the 220 kV voltage network in Croatia in the significant amount.
- Analysis has shown that two transmission elements stand out who's amount of overloading has shown significant sensitivity:
  - OHL 400 kV Bitola 2 (MK) – Florina (GR)
- For given conditions in the snapshot, analysis N-1-1 with Maintenance list 1 has shown that for all four studied scenarios of Turkey's import, outage of OHL 400 kV Blagoevgrad (BG) – Thessaloniki (GR) due to maintenance, is not possible because of high level of loading of the OHL 400 kV Bitola 2 (MK) – Florina (GR).
- For given conditions in the snapshot, analysis N-1-1 with Maintenance list 2 has shown that for all four studied scenarios of Turkey's import, outage of OHL 400 kV Blagoevgrad (BG) - Thessaloniki (GR) due to maintenance is not possible because of high level of loading of the OHL 400 kV Bitola 2 (MK) – Florina (GR) and OHL 400 kV Dubrovo (MK) – Thessaloniki (GR).

11.4 Appendix 4 - Distribution of bulk power flows

In the maps shown below, bulk power flows in the boundaries studied by the CSE Region are depicted. The arrows show the prevailing direction of power flow. The first number (red color) corresponds to the maximum power flow, the second number to the average power flow and the third number denotes the number of hours the power flows in the direction of the arrow. This information is an outcome of yearly DC power flows.

Figure 1. Bulk power flows in Vision 1

Figure 1. Bulk power flows in Vision 2

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Figure 3. Bulk power flows in Vision 3

Figure 4. Bulk power flows in Vision 4

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11.5 Appendix 5 - Table of projects of national interest

Country code	Substation 1	Substation 2	Code of item in national plan	Investment item description	Status	Expected commissioning date in national plan	Expected cost (Meuro)	Additional information
HR	Drava		HR15TS400	New 400/110 kV	Planned	2023	30	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand
HR	Vrboran		HR16TS220	Upgrade of 110/x kV substation with 220 kV switchyard	Planned	2023	15	This project is optional depending on commissioning of new production facilities (primarily wind power plants) and increase of demand
HR	Đakovo		HR17TS400	Upgrade of 220 kV substation with 4000 kV switchyard	Planned	2023	30	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand
HR	Vodnjan		HR18TS220	Upgrade of 110 kV substation with 220 kV switchyard	Planned	2023	15	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand

Country code	Substation 1	Substation 2	Code of item in national plan	Investment item description	Status	Expected commissioning date in national plan	Expected cost (Meuro)	Additional information
HR	Gračac		HR19TS400	New 400/110 kV substation	Planned	2023	30	This project is optional depending on commissioning of new production facilities (primarily wind power plants) and increase of demand
HR	Knin-Pađene		HR20TS400	New 400/110 kV substation	Planned	2023	30	This project is optional depending on commissioning of new production facilities (primarily wind power plants) and increase of demand
HR	Nova Sela		HR21TS400	New 400/220/110 kV substation	Planned	2023	35	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand
HR	Tumbri	Veleševac	HR22DV400	New 31,7 km double circuit 400 kV OHL	Planned	2023	14,2	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand

HR	Nova Sela	Plat	HR23DV220	New 145 km double circuit 220 kV OHL	Planned	2023	34	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand

Country code	Substation 1	Substation 2	Code of item in national plan	Investment item description	Status	Expected commissioning date in national plan	Expected cost (Meuro)	Additional information
HR	TPP Osijek	Ernestinovo	HR24DV400	New 10 km double circuit 400 kV OHL	Planned	2023	4,5	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand
HR	TPP Slavonski Brod	Razbojište	HR25DV400	New 60 km double circuit 400 kV OHL	Planned	2023	27	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand
HR	Lika	Melina	HR26DV400	New 68 km single circuit 400 kV OHL	Planned	2023	18,7	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand

HR	RHPP Korita	Konjsko	HR27DV400	New 26,1 km double circuit 400 kV OHL	Planned	2023	11,8	This project is optional depending on commissioning of new production facilities (power plants) and increase of demand

11.6 Abbreviations

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

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11.7 Imprint

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