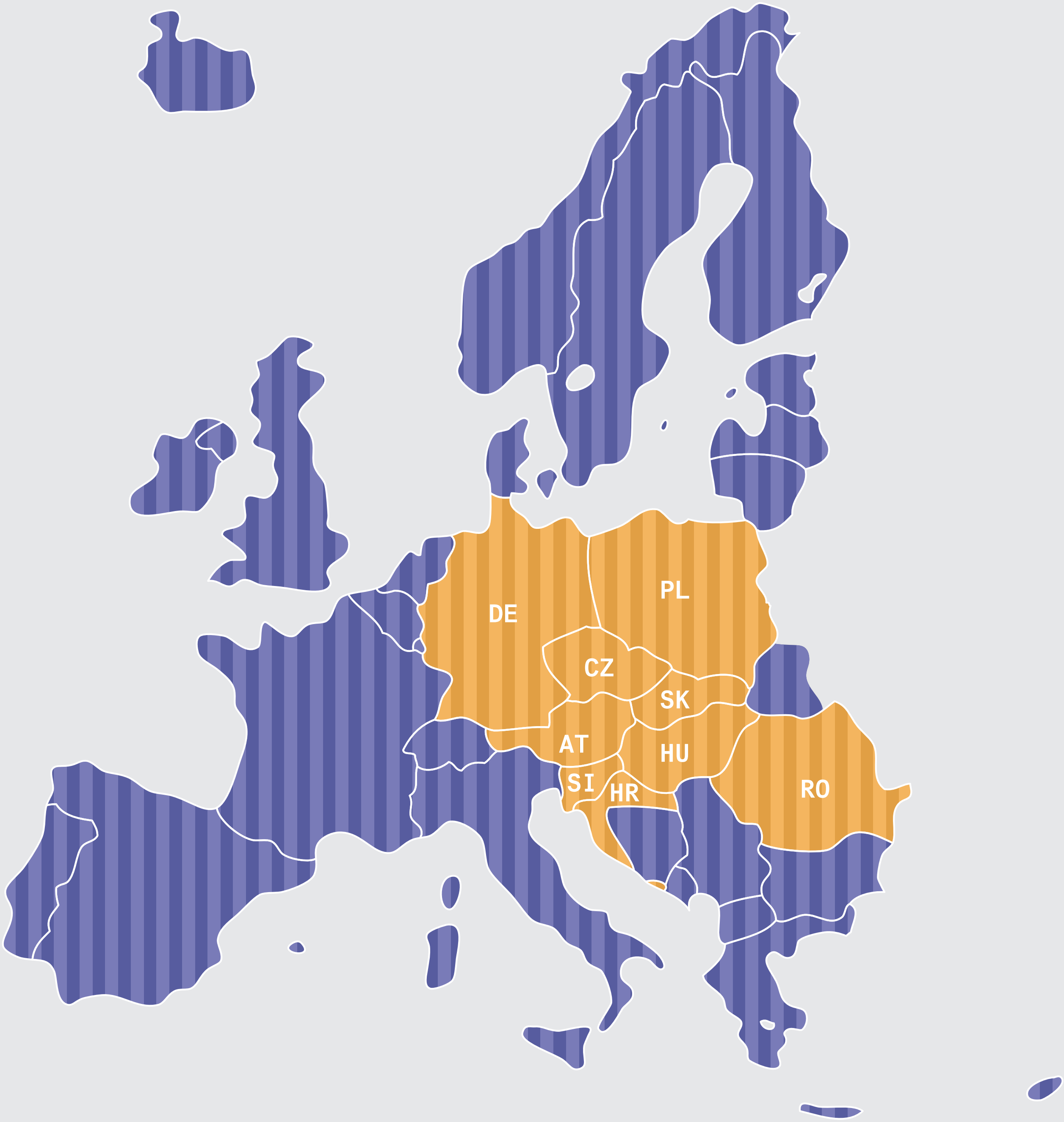
REGIONAL INVESTMENT PLAN 2014
CONTINENTAL CENTRAL EAST Final



European Network of
Transmission System Operators
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Table of content

Table of content 2
0 Executive Summary 5
0.1 RG CCE delivers the RgIP 2014 as part of the ENTSO-E TYNDP 2014 Package 5
0.2 Achievement of TYNDP 2014 package and improvements since 2012 5
0.3 Stakeholder involvement 6
0.4 Scenarios 6
0.5 Results 6
1 Introduction 10
1.1 ENTSO-E compiles a vision for grid development: the TYNDP package 2014 10
1.2 Regulation EC 347/2013 sets a new role for the TYNDP 11
1.3 A top-down, open and constantly improving process 11
1.4 Continental Central East Regional Group 12
1.5 How to read the Continental Central East Regional Investment Plan 2014 Report 13
2 Methodology and Assumptions 15
2.1 General overview of the TYNDP 2014 process 15
2.1.1 Scenarios to encompass all possible futures 15
2.1.2 A joint exploration of the future 16
2.1.3 A complex process articulating several studies in a two-year timeframe 16
2.1.4 A TYNDP 2014 built with active involvement from stakeholders 17
2.2 Implementation of Cost Benefit Analysis (CBA) 18
2.2.1 Scope of Cost Benefit Analysis 19
2.2.2 A multicriteria assessment 20
2.2.3 Implementation of CBA in the TYNDP 2014 22
2.3 Market and Network Studies 24
2.3.1 System Modelling 24
2.3.2 Tools Used for Market and Adequacy Studies 25
2.4 Network Studies Methodology 25
2.4.1 Market Studies as an Input to the Network Studies 25
2.4.2 Network Studies Tools 26
3 Scenarios 27
3.1 Description of the four 2030 visions 27
3.1.1 Vision 1 29
3.1.2 Vision 2 30
3.1.3 Vision 3 32
3.1.4 Vision 4 33

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3.1.5 Network Studies Results 35
3.2 Comparison of the visions 37
4 Investment needs 39
4.1 Present situation 39
4.2 Drivers of Grid Development 40
4.3 Main Bottlenecks 42
4.4 Bulk Power Flows in 2030 43
4.4.1 Generation Connections 43
4.4.2 Market Integration 46
4.4.3 Security of Supply 49
5 Assessment of the regional Investment Plan 2012 52
5.1 Portfolio and monitoring statistics 52
5.1.1 Specific focus on delayed projects 53
6 Investments - Project Portfolio 55
6.1 Criteria for Projects Inclusion 55
6.1.1 Transmission projects of pan-European significance 55
6.1.2 ENTSO-E and Non ENTSO-E Member Projects 56
6.1.3 Regional investments 56
6.2 Description of portfolio 57
6.3 Assessment of the portfolio 63
6.3.1 SEW 63
6.3.2 CO2 63
6.3.3 RES 64
6.3.4 SoS 65
6.3.5 Losses 65
6.3.6 GTC 66
6.3.7 Technical resilience 67
6.3.8 Flexibility 68
6.3.9 S1-S2 indicators 68
6.4 About €50 billion by 2030 in CCE region: a financial challenge 70
7 2030 transmission capacities and adequacy 74
7.1 Target capacities by 2030 74
7.2 Transmission adequacy by 2030 75
8 Environmental assessment 78
8.1 Grid development is key for RES development in CCE region (Europe) 78
8.2 The Plan make ambitious CO2 emissions mitigation targets possible 79
8.3 A relatively limited network growth despite major shifts in the generation mix 80

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8.4 New transmission capacities with optimised routes 81
8.5 Mitigation measures 82
9 Assessment of resilience 83
9.1 The general framework 83
9.2 Visions studied in CCE region 84
10 Conclusion 86
Appendices 88
11 Appendix 1: technical description of projects 89
11.1 Transmission projects of pan-European significance 89
11.1.1 Transmission projects of pan-European significance 89
11.1.2 Corridors, Projects, and investment items 90
11.1.3 Labelling 90
11.1.4 How to read every assessment sheet 90
11.1.5 Assessment of projects of pan-European significance 92
11.2 List of projects and investments within the region 188
11.3 List of commissioned investments from TYNDP and RgIPs 2012 within the region 238
11.4 List of cancelled investments from TYNDP and RgIPs 2012 within the region 241
11.5 Storage projects 243
12 Abbreviations 246

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0 Executive Summary

0.1 RG CCE delivers the RgIP 2014 as part of the ENTSO-E TYNDP 2014 Package

The Continental Central East Regional Group (RG CCE) under the scope of the European Network of Transmission System Operators for Electricity (ENTSO-E) provides herewith the 2014 release of the Continental Central East Regional Investment Plan (RgIP) 2014 as one of the package of the community-wide Ten-Year Network Development Plan (TYNDP) 2014. The CCE RgIP 2014 is the proposed plan covering the coming ten years and beyond and supersedes the CCE RgIP 2012. This 10-year plan and beyond presents the components of the overall short-, mid-term and long-term development of the CCE regional transmission system with some level of certainty which may need some adaptations in the coming update foreseen after two years upon its release. All information in this development plan including project details is correct with reference to the end of the year 2012.

This 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 CCE 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 CCE RgIP and TYNDP 2014 at large 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 with its 6 RgIPs 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 Achievement of TYNDP 2014 package and improvements 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.

New features in TYNDP 2014

- Scenarios as four visions for 2030
- 3rd party projects, improved process for transmission projects and storage
- Stakeholder group was formed
- Improved Cost benefit methodology

The process for TYNDP 2014 includes several phases; exploratory phase where new proposals were sought, technical assessment where proposed projects were assessed according the CBA methodology (a version which was submitted to ACER in November 2013 for opinion) in the four visions and finally drafting phase, where the results were transformed into communicative results.

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Parallel to this main process ENTSO-E prepared 4 visions for 2030 and Cost Benefit Assessment methodology defined in the EIP package during the two year period.

0.3 Stakeholder involvement

ENTSO-E encourages stakeholder involvement in the TYNDP process. During the two-year 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 stakeholder-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 organizations to provide views on long term grid development related issues.

0.4 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 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 basic 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 CO_2 prices, but slightly lower fossil fuel prices in Visions 3 and 4 than in Visions 1 and 2.

There are two bottom-up scenarios which were constructed with common guidelines and two top down which were developed at European level. All the scenarios built with stakeholders show reduction of the CO_2 emissions and large increase of RES.

0.5 Results

This CCE RgIP 2014 explores with a longer time horizons, 2030, the evolution of the electricity system and the flows patterns across vary between the 4 predefined 2030 visions, the goal is to recognize potential system development issues in time to be able to properly answer to them.

The analyses, including both market and network studies identified about 13 boundaries for the CCE region electricity system. These boundaries might see bottlenecks in future in case new transmission assets are not developed. Market studies and network studies have been performed at the pan-European and CCE regional level while taking into consideration Europe in its entirety.

Following the substantial increase of RES deployment which is foreseen for the year 2030, notably in the Vision 4 the so called "Green Revolution" compared to the forecasted RES increase for the year 2020 which was outlined in the TYNDP 2012 release it is revealed that for the time period up to 2030 the connection of new generation, mainly from RES shall continue to be for the CCE region among the main drivers for grid development, complemented by the need to ensure market integration and maintaining security of supply. The CCE RgIP and the TYNDP 2014 at large confirms the conclusions of the CCE RgIP and TYNDP 2012. In the 2030 Vision 4 a total installed capacity of generation from RES is expected to reach an amount of approximately 275 GW (52% of wind, 37% Solar and 11% from other RES) compared to 158 GW which was forecasted in the TYNDP 2012 based on Scenario EU2020. RES generation contributes 54% share of the total installed capacity in the CCE region. A total installed capacity of generation from all technologies is foreseen for the year 2030 (Vision 4) to reach 507 GW compared to 340 GW for the year 2020. For the year 2030 CCE region has around 30% share of the total expected installed generation capacity in the entire ENTSO-E area; indicating that the CCE region shall continue to play in Europe a core role in the system adequacy and energy sector at large. While economic activities have declined over the last years, it is expected that for the coming years a return to demand growth, albeit at more modest levels than those experienced

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over the previous decade. Electricity peak demand is forecasted to be stable by the year 2030 reaching a total amount of 169 GW peak demand in the region when considering Vision 1 (moderate European growth). On the other hand, the consumption increase is driven among other factors by growth in the use of electric vehicles and heat pumps, while reaching 2% annual demand growth (peak load 207 GW) in Vision 4. The share of the load covered by RES in CCE region varies from 34 % in Vision 1 to 56 % in Vision 4.
From the market and grid studies results the following further conclusions can be drawn:
For the year 2030 Vision 1 (referred as "Slow Progress"):

- The CCE region based on this Vision is expected to behave as a net exporter of nearly 32 TWh/year. Annual generation for the region reached a total amount of 1111 TWh/year while the demand reached at an amount of 1065 TWh/year. 34% of the total regional annual generation is from RES where out of this 50% is contributed by German wind and solar generation together. Noticeable increase in RES is also foreseen in Poland, Romania and Austria.

- Main exchanges above 10 TWh/year at least in one direction between market areas in the region were investigated between Germany – Austria, Czech Republic – Germany, Slovakia – Hungary, Czech Republic – Austria, Croatia – Slovenia and between Poland – Czech Republic. It is emphasized here that these are purely market exchanges and not physical grid flows/exchanges which revealed in most borders to be different when these market flows were applied in the network models.

- Main exporting countries in CCE region are revealed to be the Czech Republic (25TWh/year), Romania (20TWh/year) and Poland (15TWh/year). Importing countries with more than 5TWh are Germany (19TWh/year) and Hungary (10TWh/year).

- The countries of the CCE region have different e nuclear policy. While Germany foresees nuclear power plants shut-down, countries like the Czech Republic, Hungary, Romania, Slovakia and Poland foresees still a substantial share and increase in their generation portfolio from nuclear generation for the year 2030.

For the year 2030 Vision 4 (referred as "Green Revolution"):

- In this vision there is a shift from net exporting to net importing characteristic of the region. CCE region behaves like a net importer of nearly 104 TWh/year. Annual generation in the region reached a total amount of 1194 TWh/year while demand at an amount of 1281 TWh/year. 56% of the total regional annual generation is from RES where out of this 49% is contributed by German wind and solar generation together. Noticeable increase in RES is also foreseen in Poland, Romania and Austria.

- Main exchanges above 10 TWh/year at least in one direction between market areas in the region were revealed between Germany – Austria, Poland – Germany, Czech Republic – Germany, Croatia – Slovenia and between Slovakia - Hungary. These are purely market exchanges.

- Main exporting countries in CCE region are revealed to be Romania (13TWh/year), the Czech Republic (11 TWh/year), and Slovenia (10 TWh/year). Importing countries with more than or equal to 5TWh are Germany (112 TWh/year), Poland (13 TWh/year) and Croatia (5TWh/year).

- In this vision a substantial increase for year 2030 from nuclear power generation is foreseen from countries like the Czech Republic, Hungary, Romania, Slovakia and Poland.

In addition to the CCE regional investments which were elaborated in the TYNDP 2012 there are 69 new investments items included in the Regional Investment Plan 2014 (RgIP 2014). These new investments are evolved to deal with the main drivers for grid development in the region but also to ensure the objectives of the European energy policy goals and power networks, notably ensuring the development of a single European grid to permit the 20-20-20 objectives, guaranteeing security of supply and completing the internal energy market. 142 investments have a status of Regional significance. 174 investments are clustered into 34 projects and classified as of pan-European significance. Roughly 60 % of the all projects of Pan-European significance in CCE region help integrate RES. Moreover, in most severe cases, projects of pan-European in significance avoid RES spillage. The German corridors show the largest benefit with respect to avoiding RES spillage (from 10 TWh/year in Vision 1 up to 30 TWh/year in Vision 4).

The evolution of regional CCE investment portfolio leads to conclusion that 28% of all its investments (including both of those of pan-European and regional significance) are delayed or rescheduled. If only projects of pan-European are considered the delay and rescheduling is on the 35% of the projects. 48% of the delayed projects are mid-term projects. Taking into consideration the fact that the reasons behind of the most of the delayed projects are related to permit grant procedures and public negative attitude towards construction of lines (notably overhead lines) the following tasks will remain to be the main challenges for TSOs in the region and for the entire ENTSO-E: minimization of the length of the infrastructure routing, optimization to decrease the number of lines to be build or the corridors to be occupied and divergence of those corridors from sensitive and environmentally protected biodiversity and urban areas. About half of the projects are expected to be commissioned on time or expected ahead of time; mid-term and long-term projects foreseen on time are divided nearly in the same ratio (76% of projects with status on time are long-term projects).

There is a total of approximately 28000 km of projects of Pan-European significance in the CCE region for the year 2030 compared to 23000 km explored in the TYNDP 2012 which should either be newly constructed or refurbished as Extra High Voltage routes (AC and DC).

From the medium-term market integration perspective more capacity is needed between Germany and Poland. Following future possible power flows with more emphasis on the exploration and enhancement of the market opportunities between borders, border like Slovakia-Hungary is among those border candidates which are necessary for additional interconnection capacity.

Regional Group Continental Central East system is characterized by its interconnected systems, where all countries have at least 4 interconnections to adjacent TSO (including DC connection). Majority of these TSOs inner systems are AC systems; thus their systems and capacities are influenced by unscheduled power flows. Looking to the development of market capacities; increase of peak values is revealed in the TYNDP 2014 in comparison to the TYNDP 2012. Particularly this increase of peak NTCs applies to Hungarian-Romanian border, where the NTC went above 1GW in both directions. Related to the Hungarian-Croatian border there was also an increase over 1GW in import direction from Croatia to Hungary. NTC peak increase was also reached on the Czech-German border in the German export direction and on the Czech-Austrian border in the Czech export direction also over 1GW for both borders. Target capacities are therefore proposed as requested by EU. The unplanned loop-flows will continue to be an issue which TSOs in the region will have to tackle in a coordinated manner.

From Security of Supply perspective for a control area like Germany, the issue of the ongoing change of generation pattern (shut down of conventional power plants near areas with high demand and increase of RES in areas with low demand especially wind in Northern Germany) is a trigger for grid investments which will facilitate the expected flows from North to South to ensure Security of Supply.

Further, upon fulfilment of general criteria which are outlined in the Regulation (EU) 347/2013, third party projects with pan-European significance based on non-discriminatory procedures are assessed like other ENTSO-E projects and presented in the TYNDP 2014. 3 storage projects from the third party project promoters submitted their requests to the CCE RG for the inclusion of their projects in the TYNDP 2014 process. The projects are from Hungary, Poland and Romania. Since the Polish project withdrew its request for assessment, the remaining 2 projects have undergone the required assessment.

Generally, a major regional concern is that the full needed grid development may not be in time if the RES targets are met as planned by 2020 and 2030. Permit grant procedures are lengthy, and often cause commissioning delays. If energy and climate objectives are to be achieved, it is of upmost importance to smooth the authorization processes. The adoption of Regulation (EU) No 347/2013 is seen as the facilitator for this requirement. The adoption of the regulation is welcomed by TSOs, however its added-value and positive effect to grid development process will only depend on how the implementation is done and the needed follow-up of the regulation itself by the Member States. Moreover, one must also notice that the supporting schemes outlined in the regulation are limited to the Project of Common Interest whereas there are many significant national transmission projects which are crucial to the achievement of Europe's targets for climate change, renewable and market integration.

Fulfilment of EU goals (Security of supply, RES integration and internal electricity market integration) must be reached without the operational security threat of the interconnected transmission system.
Transit flows which rank significantly among problems in the region have and will continue to trigger short- and medium-term measures besides grid extensions which are inevitable in order to ensure operational security of the transmission power system. Because of the above mentioned reasons installation of PSTs (Phase Shifting Transformers) is considered as an inevitable measure with which to solve congestion in Poland, Czech Republic and on their heavily loaded connections to Germany (50Hertz) and possibly also in other countries (TSOs) in the CCE region. The next step, although more difficult and much more costly, shall be the new infrastructure erection mainly in the Germany North-South and Northeast/Southwest direction.

To conclude, large scale penetration of renewable energies in the CCE region can only be realized along with the extension of transmission networks' infrastructure.

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1 Introduction

Adequate, integrated and reliable energy networks are a crucial prerequisite not only for Union energy policy goals, but also for the Union's economic strategy. Developing our energy infrastructure will allow the Union to deliver a properly functioning internal energy market, enhance security of supply, enable the integration of renewable energy sources, increase energy efficiency and allow consumers to benefit from new technologies and intelligent energy use. Energy infrastructures are also indispensable to make the transition into a competitive low-carbon economy happen.

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

The key requirement of the 3rd Package which formed the legislative driver for the "2012 Ten Year Network Development Plan" and this present report "2014 Ten Year Network Development Plan" suite of documents is Article 8.3(b) of The Regulation, whereby "The ENTSO for Electricity shall adopt: (b) a non-binding Community-wide network development plan,… including a European generation adequacy outlook, every two years".

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

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

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 together with RgIP 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 suite of documents consisting of

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

All these documents present information of European importance. They complement each other, with limited repetition of information from one document to another only 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; the present Community-wide TYNDP report hence only sums up synthetic information for concerns and projects of pan-European significance. ENTSO-E hopes thus to meet the various expectations of their stakeholders, requiring for grid development synthetic and detailed perspectives at the same time.

The TYNDP 2014 package together with this CCE RgIP is consulted during the Summer 2014 in order to be finalized in December 2014.

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

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

The present publication complies with the requirements of Regulation EC No 714/2009, 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 the **Energy Infrastructure Regulation** (EU) No 347/2013, in force since April 2013. **This regulation** organises a new framework to foster transmission grid development in Europe. Regulation (EU) No 347/2013 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 hence 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 even more demanding, the two roles must complement each other and additional resource as required.

1.3 A top-down, open and constantly improving process

The CCE RgIP at large 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. Many stakeholders' consultations and workshops have been organized, also EU and ACER consultations on their particular opinions and positions were taken into consideration together in accordance of TYNDP 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 (EC) No 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; 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]: notwithstanding non-specific conferences and events, where ENTSO-E has been invited to, in total 14 dedicated workshops, in Brussels or regional and 6 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 methodology (scenarios, CBA) improvements, regarding the TYNDP itself or grid development more generally. The group contributed in particular to refining the social and

[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/

environmental indicator of the CBA and rethinking the basis for more transparent scenario development.

- 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.

The preparation of the TYNDP 2014 was an even 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 test 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.

1.4 Continental Central East Regional Group

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

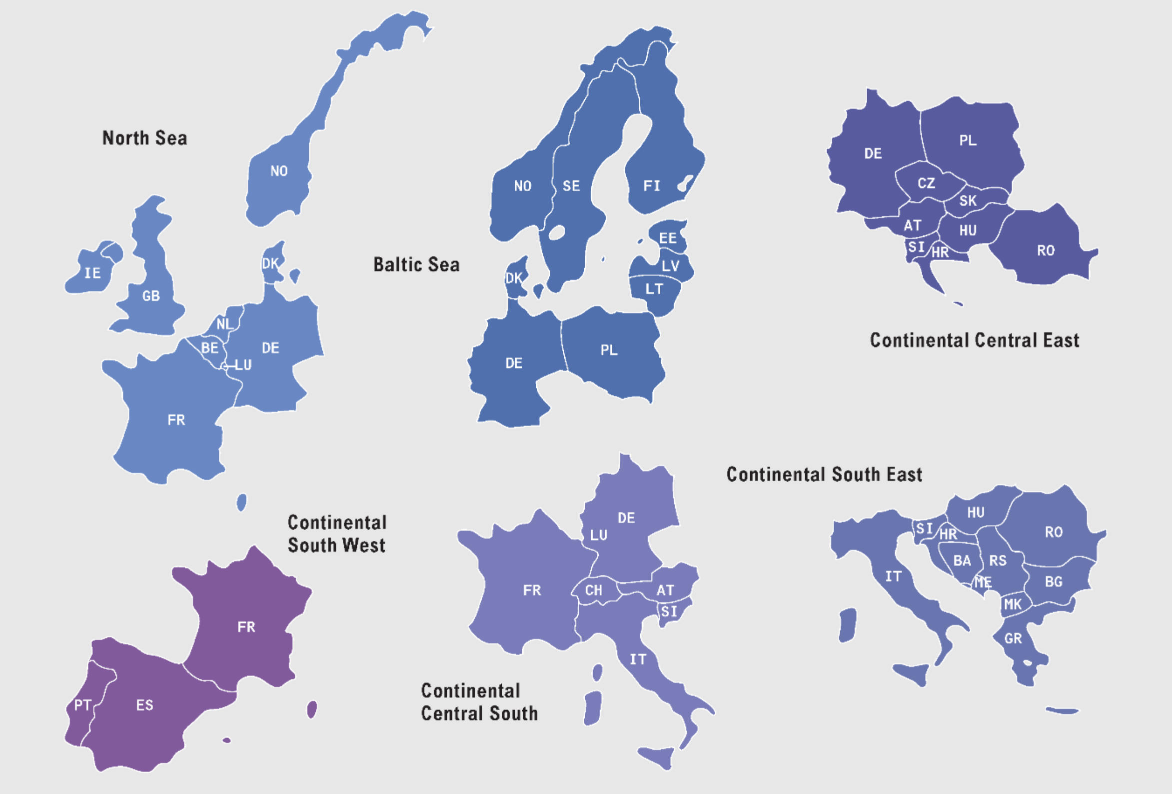

Figure 1-1 ENTSO-E regions (System Development Committee)

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

Table 1.1 ENTSO-E Regional Group CCE membership

1.5 How to read the Continental Central East Regional Investment Plan 2014 Report

The document is structured in the following way:

- Chapter 0: Executive summary.
- Chapter 1: the present Introduction.

- Chapter 2, Assessment of TYNDP 2012 points out the main changes that have occurred with respect to the investments presented in the TYNDP 2012 submission.
- Chapter 3, 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 4, 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 5, 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 6, 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 7, 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 8, Environmental concerns sums up the environmental impact of the planned projects.
- Chapter 9, Assessment of resilience resets the planned projects in larger and farther-looking perspective.
- Chapter 10, Conclusion.

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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.

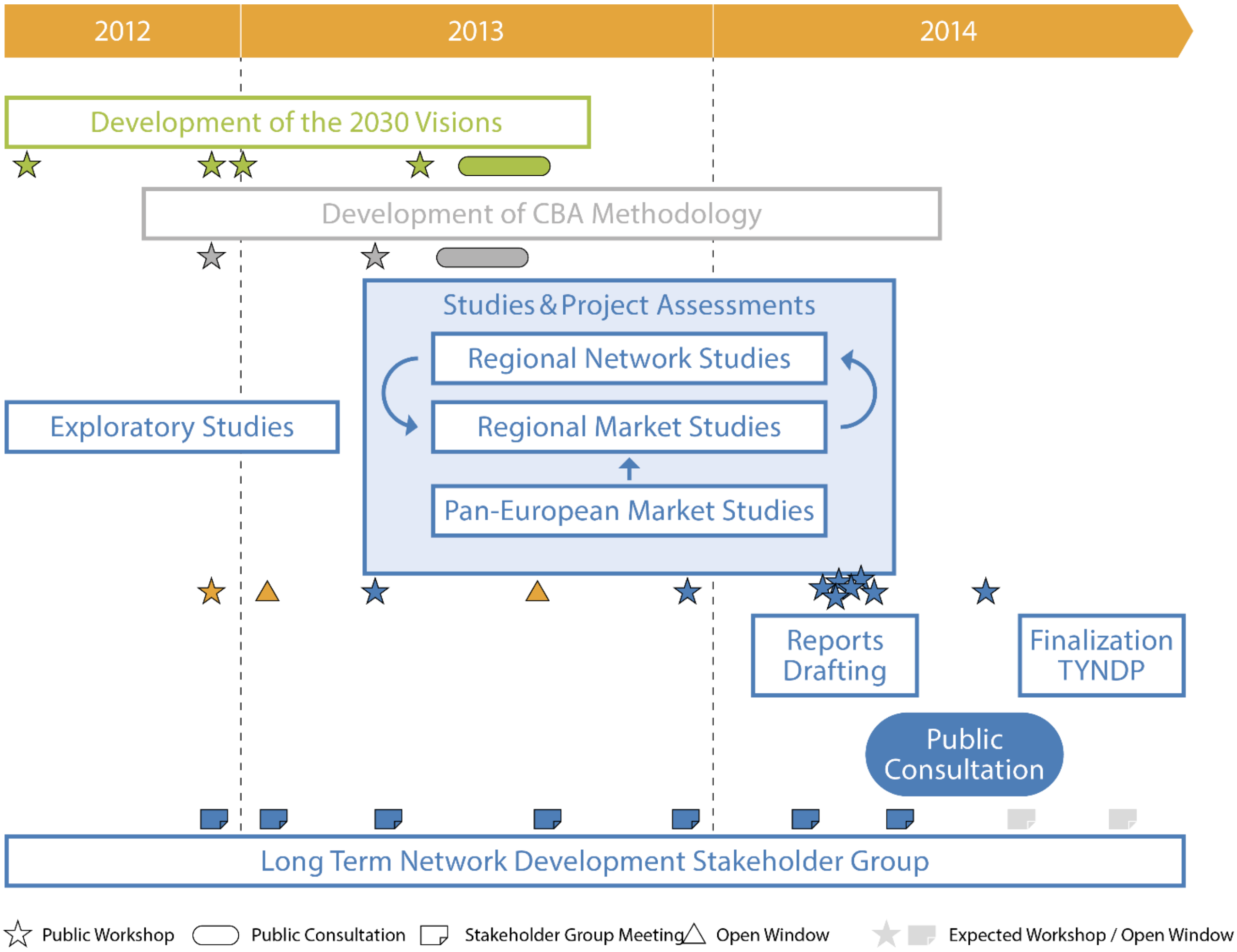

Figure 2-1 Overview of the TYNDP 2014 process

2.1.1 Scenarios to encompass all possible futures

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

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

The 2030 visions are further developed in the SOAF report and chapter 3 of this present RgIP 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 were to establish what the main flow patterns are 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 is described in the following section.

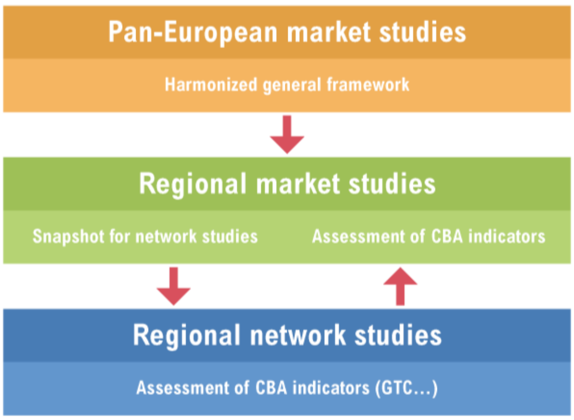

Figure 2-2 An iterative process towards the preparation of TYNDP 2014

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 each Regional Investment Plan.

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 led to a major shift in the generation mix and means that the energy sector in Europe is undergoing major changes. All these evolutions trigger grid development and the growing investment needs are currently reflected both in European TSOs' investment plans and in the ENTSO-E TYNDP.

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

[3] Link to the report.

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) No 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.

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

[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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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 (EU) No 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) No 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

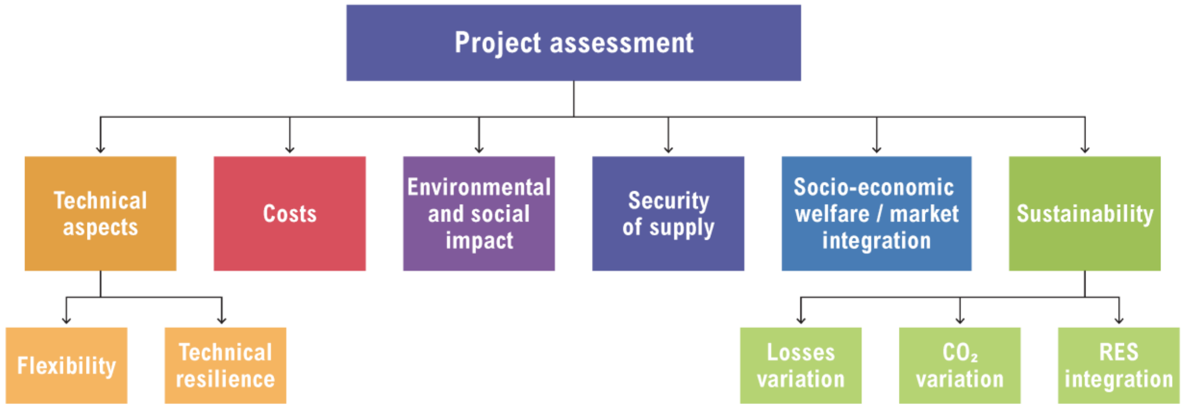

Figure 2-4 Main categories of the project assessment methodology

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 grid transfer capability (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.

[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 Regulation (EU) No 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".

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B5. Variation in CO_2 emissions is the characterisation of the evolution of CO_2 emissions in the power system. It is a consequence of B3 (unlock of generation with lower carbon content)[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 ACER in September 2014. ENTSO-E has used the TYNDP 2014 as an opportunity to conduct a real-life test of the methodology in order to be able to tune it if necessary. The implementation of the CBA in this trial phase hence focuses on checking the feasibility of its implementation while also answering actual stakeholder concerns.

Every single indicator has been computed for a large selection of project cases. In this respect, the RES – avoided RES spillage – indicator (resp. the SoS – loss of load expectation – indicator) must be completed 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.

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2.3 Market and Network Studies

The purpose of the market studies together with network studies is to identify congested areas and to investigate the impact of the new interconnection projects by comparing two different grid situations in terms of economic efficiency; the ability of the system to schedule plants accordingly to their intrinsic merit-order, the overall resulting variable generation costs as well as the overall amount of CO2 emission, and volumes of spilled energy. Through market simulation an economic optimisation is conducted for [every hour of the year] taking into account several constraints; such as flexibility and availability of thermal units, wind and solar profiles, load profile and uncertainties, and transmission capacity between countries. Through network studies a system adequacy is evaluated and a number of relevant cases is tested in regards to N-1 security criteria, voltage stability and others based on particular case.

2.3.1 System Modelling

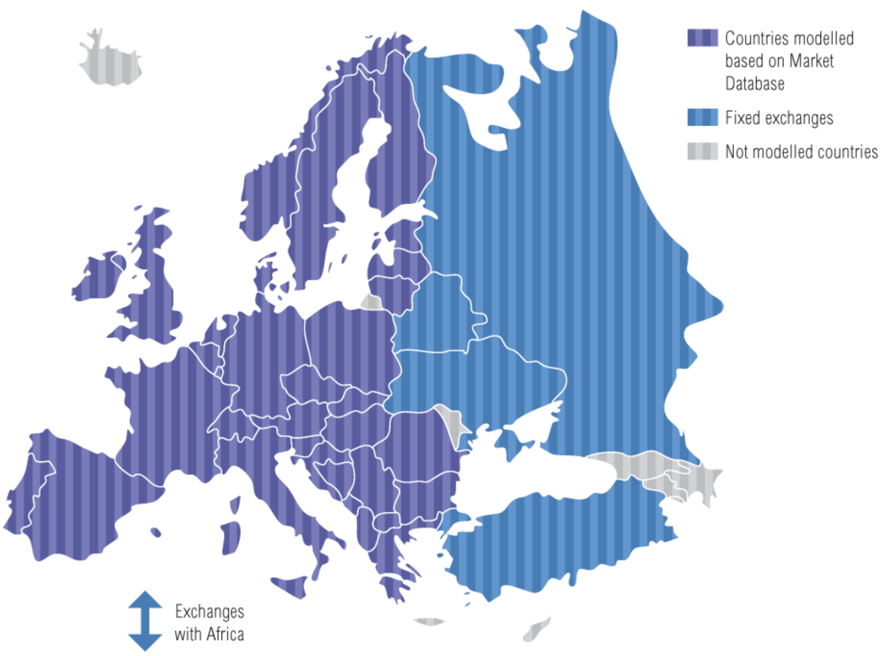

Figure 2-5 Perimeter of RG CCE market studies

RG CCE was on modelling the entire ENTSO-E area. Therefore the data from common PEMMDB were used for every country.

Each country for market study purpose is modelled as one single node (all generation and load data being aggregated to this single node), assuming that there is no internal constraint within the country, and expected transmission capacity between countries.

Expected market capacity is a value between two countries. In the case of Poland there are additional restrictions, which are driven by the structure of Polish internal system and the aim to provide maximum capacity for market study. The maximum import and export possibilities are much lower than the sum of all capacities on the Polish borders. Due to this, the import and export capacities were also limited in the market simulations.

The future explored market exchange capacity between countries is drawn from the present network transfer capacity plus capacity which shall be added from new planned investments to be commissioned before 2030.

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Load:

For the load, hourly time series out of the PEMMDB were used. Those time series were derived based on the assumptions of common ENTSO-E 2030 visions.

Generation:

Thermal units were modelled with their main relevant characteristics: installed capacity, fuel type (incl. fuel and CO2 price), start-up costs, efficiency, must-run obligations, minimum up and down times, availabilities and so on.

The **hydraulic system** was divided into three kinds of power plant: run of river, storage and pump storage. The behaviour of pump hydro power plants (pump and turbine operating modes) was internally implemented into the software tool depending on its internal structure and data format.

Non-dispatchable generation (wind, solar, etc.) are being considered by scaling time-series normalized to installed capacities. The normalized time-series are based on common ENTSO-E climate database.

Some countries have connections with Non-ENTSO-E countries. Hungary, Romania and Slovakia are connected to the so called Burshtyn island of West Ukraine. The exchange between these countries is considered by an hourly time series in the same way as for countries from the RG CCE region (e.g. connection of Spain to Morocco etc.).

2.3.2 Tools Used for Market and Adequacy Studies

Regional Group CCE has used the software PowrSym4 for the market simulations. PowrSym4 is a software tool licensed by OSA (Operation Simulation Associates, Inc., USA). This simulation tool optimizes generation costs based on chronological simulation, implicitly modelling energy storages. Unavailability and outages of generation capacity are solved by Monte Carlo simulation. Forced generation as wind or solar can be simulated by fix inputs (creation of time series in advance).

Currently in this software tool the interpretation of the used net transfer capacity doesn’t take into consideration the exact impedances of the system.

2.4 Network Studies Methodology

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 (accounting especially for the well-known N-1 rule)?” If yes, then transmission projects are designed, tested and evaluated for all relevant cases. Studied cases explore a variety of dispatch situations: frequent ones, or rare ones but resulting in particular extreme flow patterns.

2.4.1 Market Studies as an Input to the Network Studies

The market simulations were calculated for every vision and for every hour of the selected time horizon 2030. That resulted into 8736 grid situations (points in time). For these cases the generation dispatch, load and market flows between market areas are known. However it should be noted that market flows and physical flows can be very different. This is due to the fact that network studies must follow the market simulation to assess whether the grid is able to handle the simulated dispatch.

In terms of time and also of no appropriate tool for such whole year grid analysis the network studies were analysed based on the methodology for points-in-time (PiT) selection described in the “Guidelines grid studies for project assessment” prepared by WG TYNDP. Every TSO of RG CCE chose important parameters for its network (e.g. high RES infeed vs. cross-border capacity or gas production vs. wind production, etc.) and based on these parameters the most representative PiTs were selected. The common agreement of all members in RG CCE was to investigate 4 PiTs as an adequate amount of cases for network studies analysis. From each of these chosen PiTs the generation pattern was taken from the market study results and based on that the network models were built up. In case of network studies the security and reliability of the system was assessed through the specific indicators defined in CBA methodology for project assessment (e.g. technical resilience, flexibility, losses, etc.) as illustrated in the Figure 2-6 below.

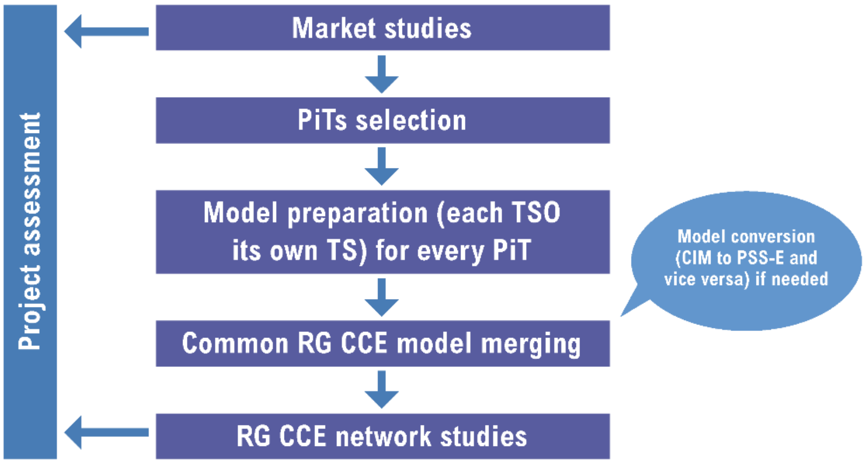

Figure 2-6 Illustration of the assessment of projects process

2.4.2 Network Studies Tools

For network studies different software tools were used across regional group depending on the concrete TSO and its experience (PSLF, PSS-E, Integral, ODMS and NEPLAN). Each of these software tools used different formats of the models. The mostly used was PSSE (.raw, .sav) but "CIM" format was used as well. Each of them is purely network calculation tool. The list of software tools is given below in Table 2.2.

RG CCE member	Network calculation tool
APG	Integral
CEPS	PSS/E
ELES	NEPLAN
TenneT DE	Integral
50Hertz	Integral
HOPS	PSS/E
MAVIR	PSS/E
Transelectrica	PSS/E
SEPS	PSLF
PSE	PSS/E, PSLF

Table 2.2 A list of grid software tools used by TSOs in CCE Regional Group

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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 scenarios is 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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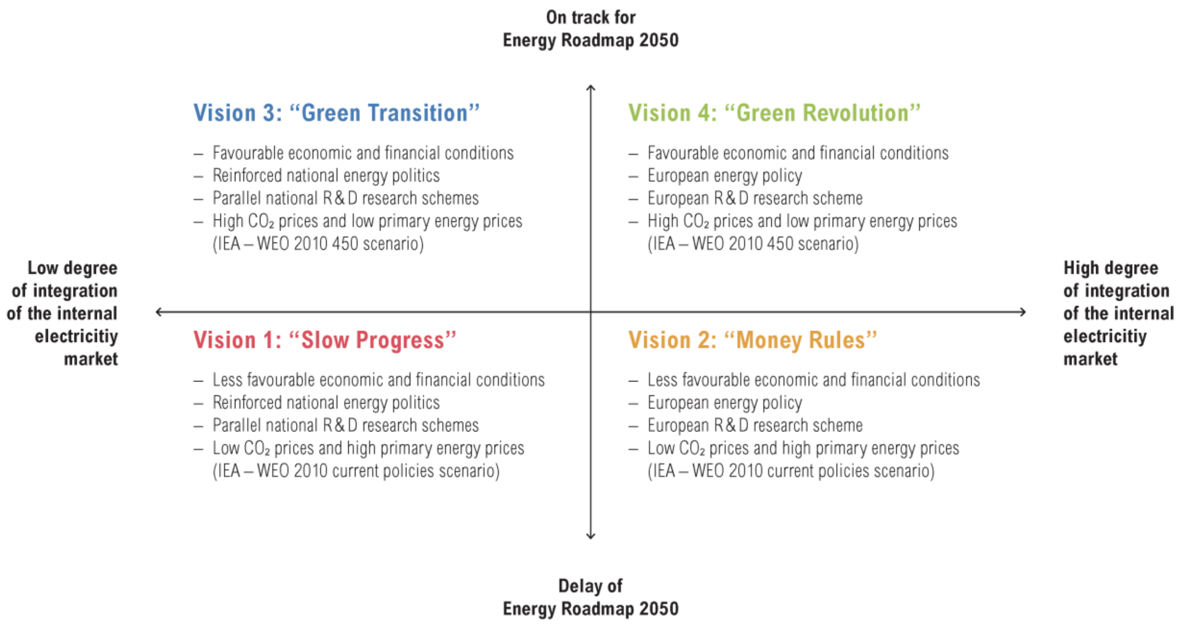

Figure 3-1 Overview of the political and economic frameworks of the four visions

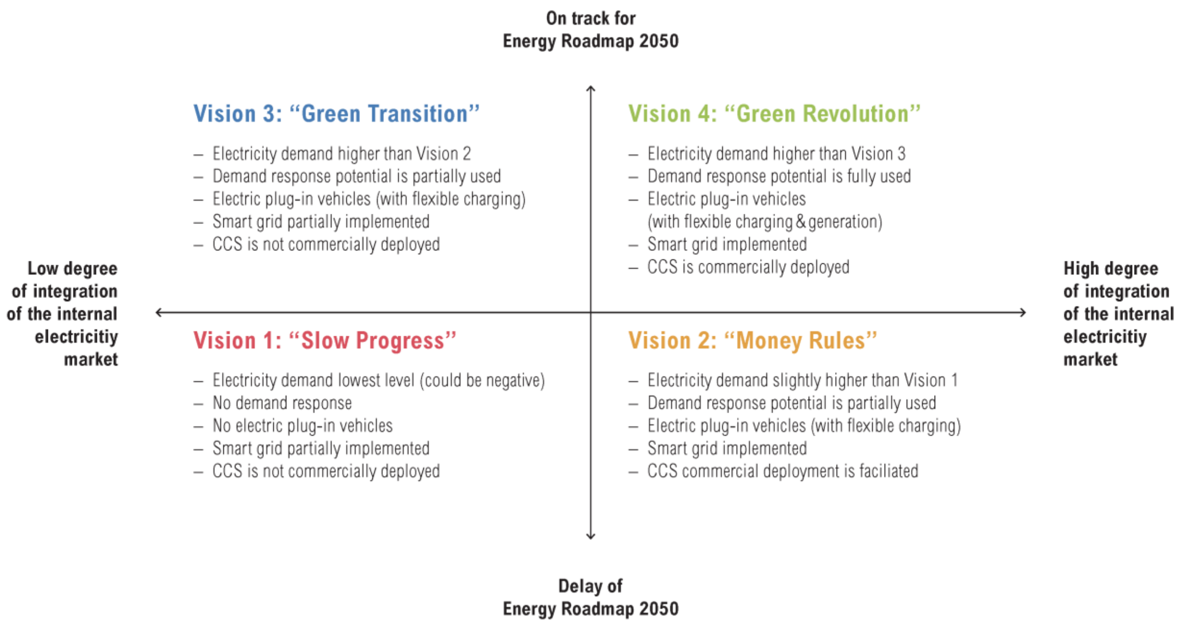

Figure 3-2 Overview of the generation and load frameworks of the four visions

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.

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3.1.1 Vision 1

As introduced in previous paragraphs projects have been evaluated based on four different ENTSO-E 2030 Visions. The first of these is the “Slow progress” scenario (following Vision 1). The vision 1 dataset is originally submitted to ENTSO-E by particular TSOs 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 and overall consumption in accordance with the guidelines of the ENTSO-E 2030 Visions scenario building.

In this paragraph the main data will be explored with a special focus to load, balance and generation for Continental Central East countries as outlined in Vision 1.

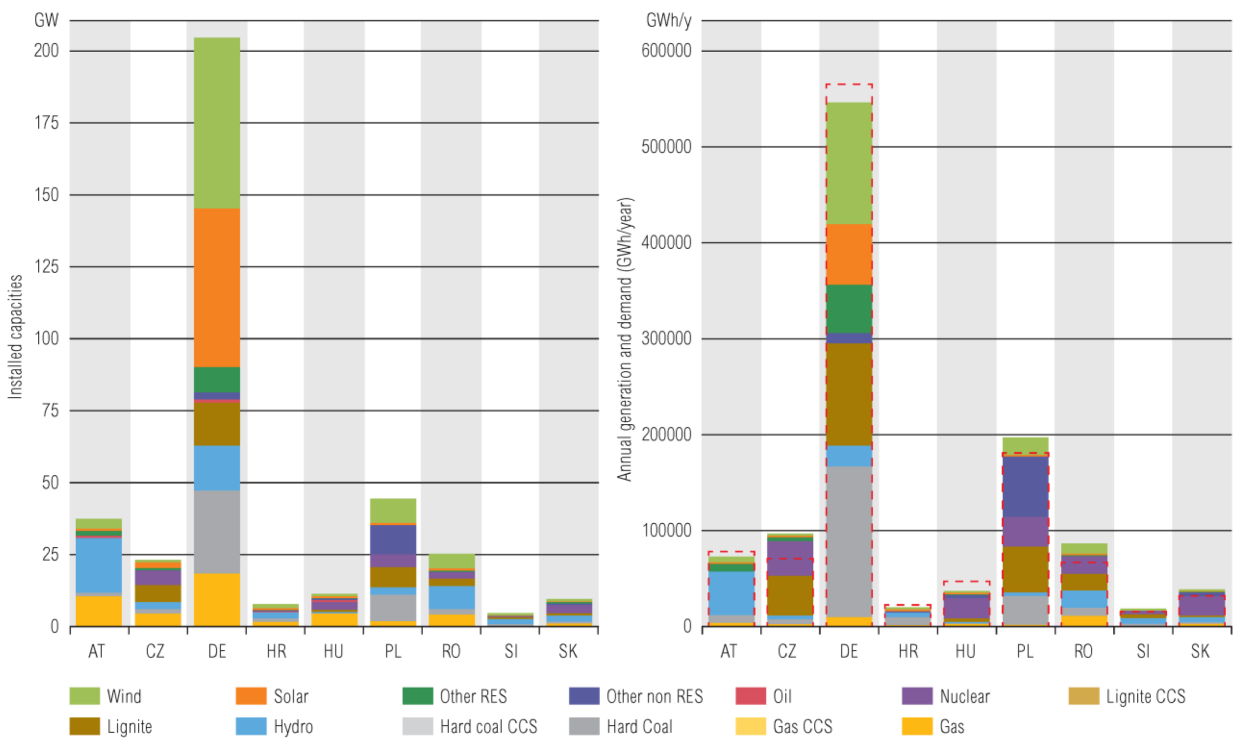

Figure 3-3 Installed capacity in vision 1 in RG CCE (GW)

Figure 3-4 Annual generation and demand in vision 1 in RG CCE (GWh/year)

Figure 3-3 shows the CCE countries installed generation capacities in Vision 1. The increase of RES compare to current situation is obvious for the long time period till 2030 with a particular attention to Germany which contributes the biggest share of RES generation in the CCE region and for the entire ENTSO-E system. Noticeable increase of RES is also foreseen in Poland, Austria and Romania. The main change in installed capacity in CCE is the increase from wind and solar. In the whole CCE region, there is only a slight decrease of nuclear power plants. To cope with CO2 emissions decrease the Czech Republic, Hungary, Romania and Slovakia increase their nuclear capacities as well as Poland.

Figure 3-4 shows the annual generation and demand in vision 1 for RG CCE. 34% of the production in CCE region comes from RES. CCE behaves as a net exporter in Vision 1, its exporting capacity reaches a total of 32 TWh for the year 2030 based on Vision 1. Main exporting countries are Czech Republic (25 TWh), Romania (20 TWh) and Poland (15 TWh). Importers are Germany (19 TWh), Hungary (10 TWh) and Croatia (3 TWh).

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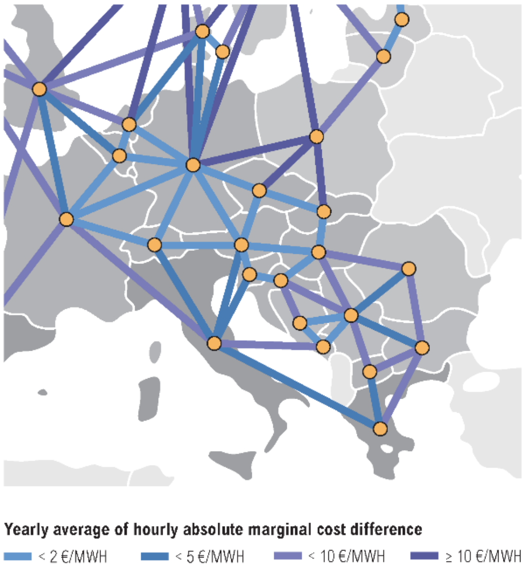


Figure 3-5 Yearly average marginal cost difference in RG CCE

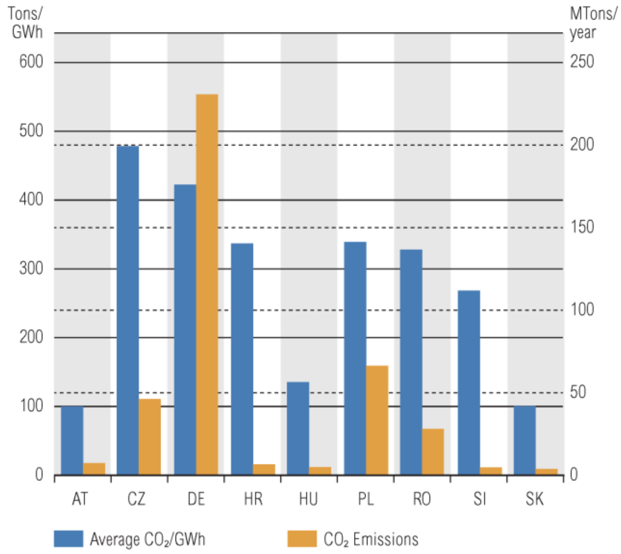


Figure 3-6 CO2 emissions in vision 1 in RG CCE (MT/year)

Figure 3-5 shows the average generation marginal cost differences in RG CCE. The average generation marginal cost differences inside CCE are not very high for most borders. The average marginal cost differs only between Poland and its neighbours. At least the average marginal cost is not a sufficient indicator for necessary grid extensions, the benefits of gird extension depends on the hourly prices spread.

Figure 3-6 shows the amount of CO2 emission per country in CCE. As it can be seen from the figure, Germany contributes a big share of CO2 emission followed by Poland and then the Czech Republic. Fuel and CO2 are in favour of this Vision 1, causing high utilization of traditional power plants in these countries and hence the high CO2 emission. Noticeable CO2 emission is also seen from Romania.

Due to the low progress in RES only the very small amount of 20.5 GWh Dump Energy was calculated.

3.1.2 Vision 2

Assessment of projects has been performed also based on Vision 2, the so called “Money rules” scenario. Taking into account that some conventional power plants will run out of money, Vision 2 have less conventional power plants than Vision 1, due to this fact for some borders higher trading exchanges are expected than in Vision 1.

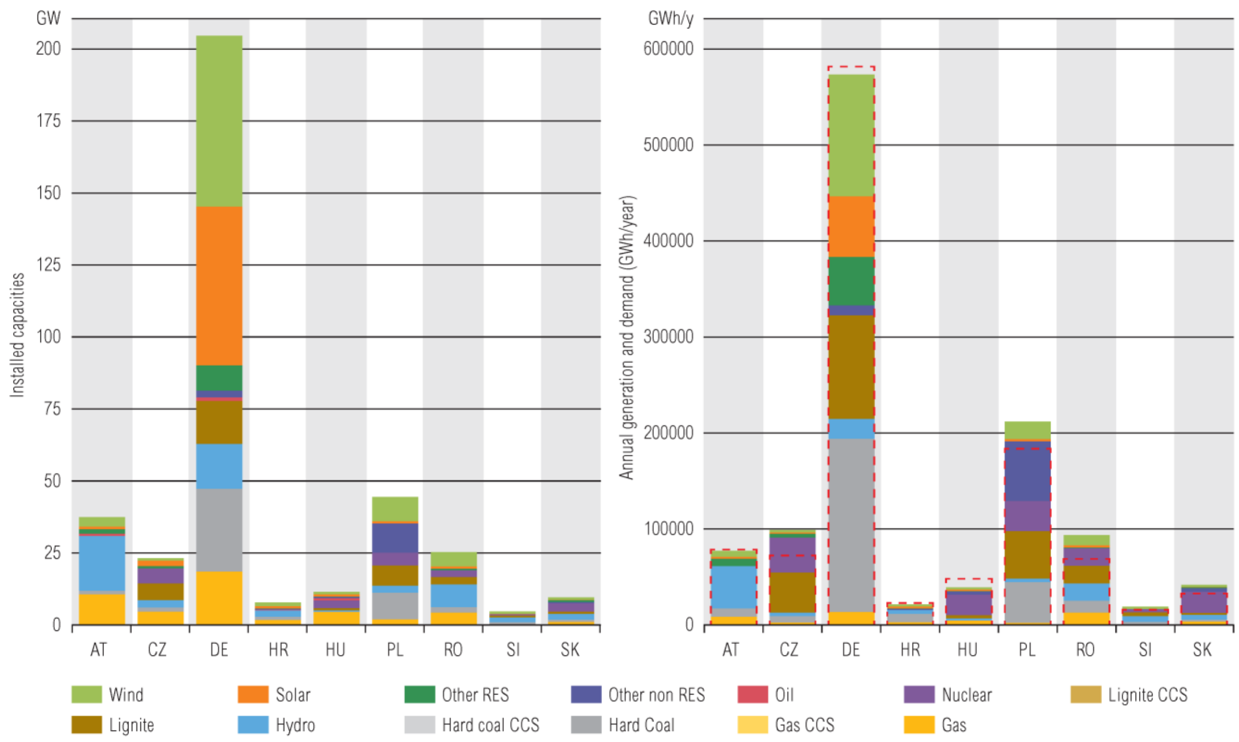


Figure 3-7 Installed capacity in vision 2 in RG CCE (GW)

Figure 3-8 Annual generation and demand in vision 2 in RG CCE (GWh/year)

Figure 3-7 shows the CCE countries installed generation capacities in Vision 2. The increase of RES is similar to Vision 1. The main change in installed capacity in CCE is the increase from wind and solar. In the whole CCE region, there is only a slight decrease of nuclear power plants. To cope with CO2 emissions decrease the Czech Republic, Hungary, Romania and Slovakia increase their nuclear capacities as well as Poland.

Figure 3-8 shows the annual generation and demand in vision 2 for RG CCE. 32% of the production in CCE region comes from RES, this decrease compare to Vision 1 was caused by assumptions of Vision 2 – e.g. increased demand due to more favourable economic conditions. CCE behaves as a net exporter in Vision 2, its exporting capacity reaches a total of 69 TWh for the year 2030 based on Vision 2. Main exporting countries are Poland (28 TWh), Czech Republic (26 TWh) and Romania (25 TWh). Importers are Germany (8 TWh), Hungary (9 TWh) and Austria with Croatia (1.5 TWh each).

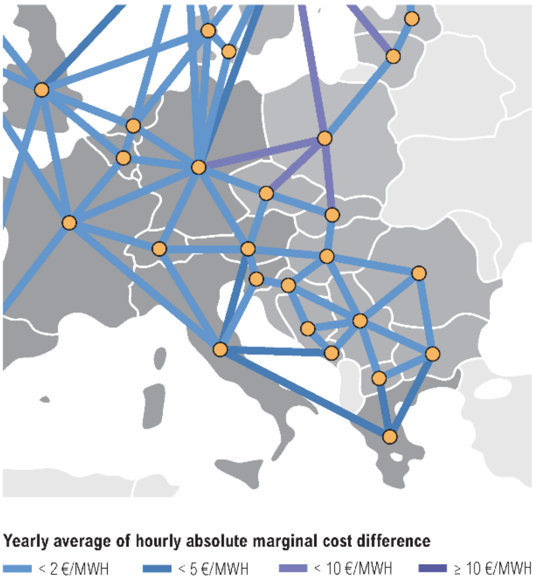


Figure 3-9 Yearly average marginal cost difference in RG CCE

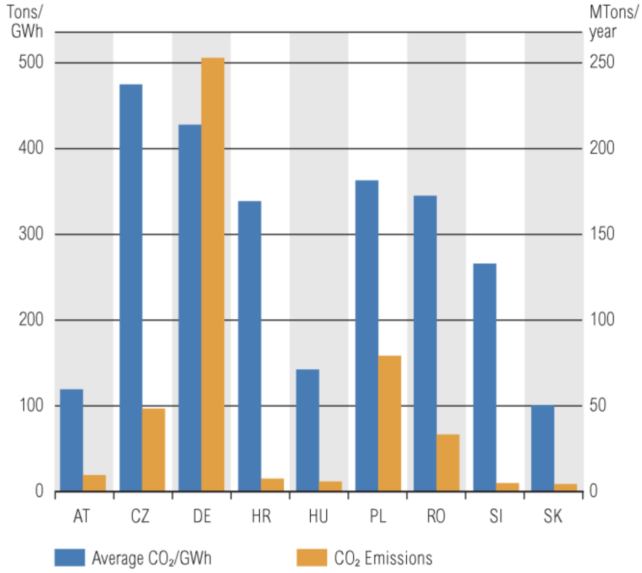
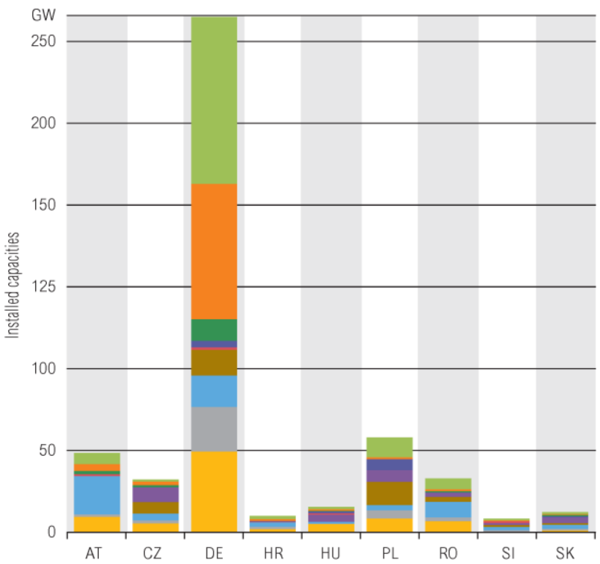
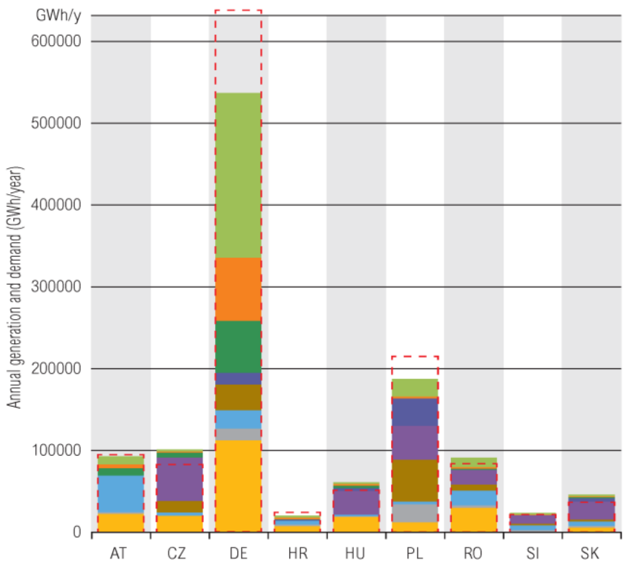


Figure 3-10 CO2 emissions in vision 2 in RG CCE (MT/year)

3.1.3 Vision 3

Assessment of projects has been performed also based on Vision 3, known as “Green transition” scenario. This scenario has an ambitious increase of RES. Due to high CO2 prices the productions costs of the power plants highly depending on the CO2 emissions.





Fire 3-11 Installed capacity in vision 3 in RG CCE (GW)

Figure 3-12 Annual generation and demand in vision 3 in RG CCE (GWh/year)

Fire 3-11 shows the CCE countries installed generation capacities in Vision 3. The installed capacity of RES is higher compare to Vision 1, where the RES installed capacity is about 35% more than in Vision 1. The main change in installed capacity in CCE is the increase from wind and solar and also slight increase nuclear installed capacity in Vision 3 compare to Vision 1.

Figure 3-12 shows the annual generation and demand in vision 3 for RG CCE. 44% of the production in CCE region comes from RES, this increase compare to Vision 1 was caused by assumptions of Vision 3 – e.g. due to favourable economic conditions and reconsidered European RES goals. CCE behaves as a net importer in Vision 3, its importing capacity reaches a total of 86 TWh for the year 2030 based on Vision 3. Main exporting countries are Czech Republic (26 TWh), Slovakia (9 TWh) and Hungary (9 TWh). Main importers are Germany (101 TWh) and Poland (27 TWh).

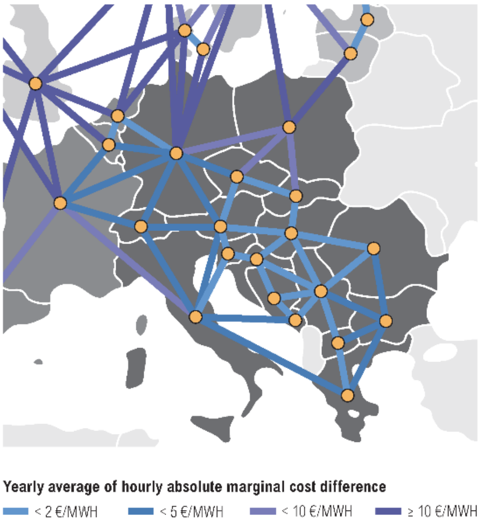


Figure 3-13 Yearly average marginal cost difference in RG CCE

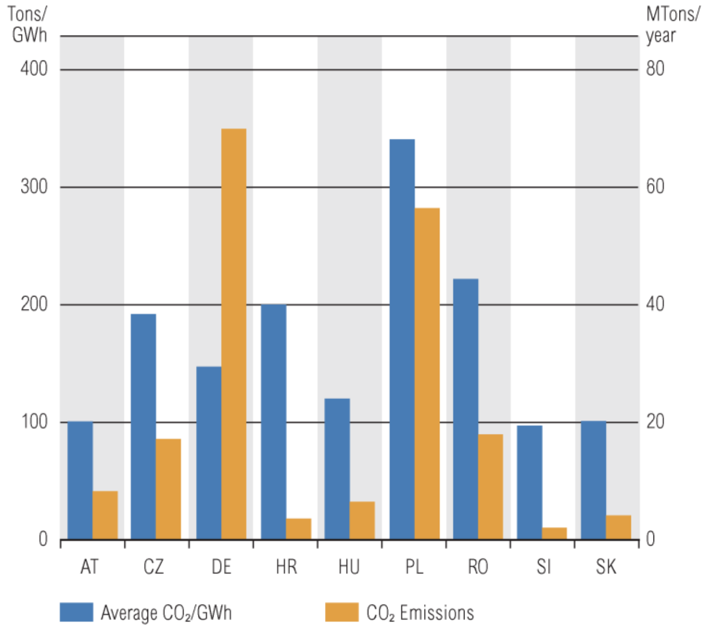


Figure 3-14 CO2 emissions in vision 3 in RG CCE (MT/year)

3.1.4 Vision 4

Moreover, projects are evaluated based on Vision 4, the Green Revolution scenario. Main data particularly focusing on load, balance and generation for the RG CCE are elaborated in this chapter.

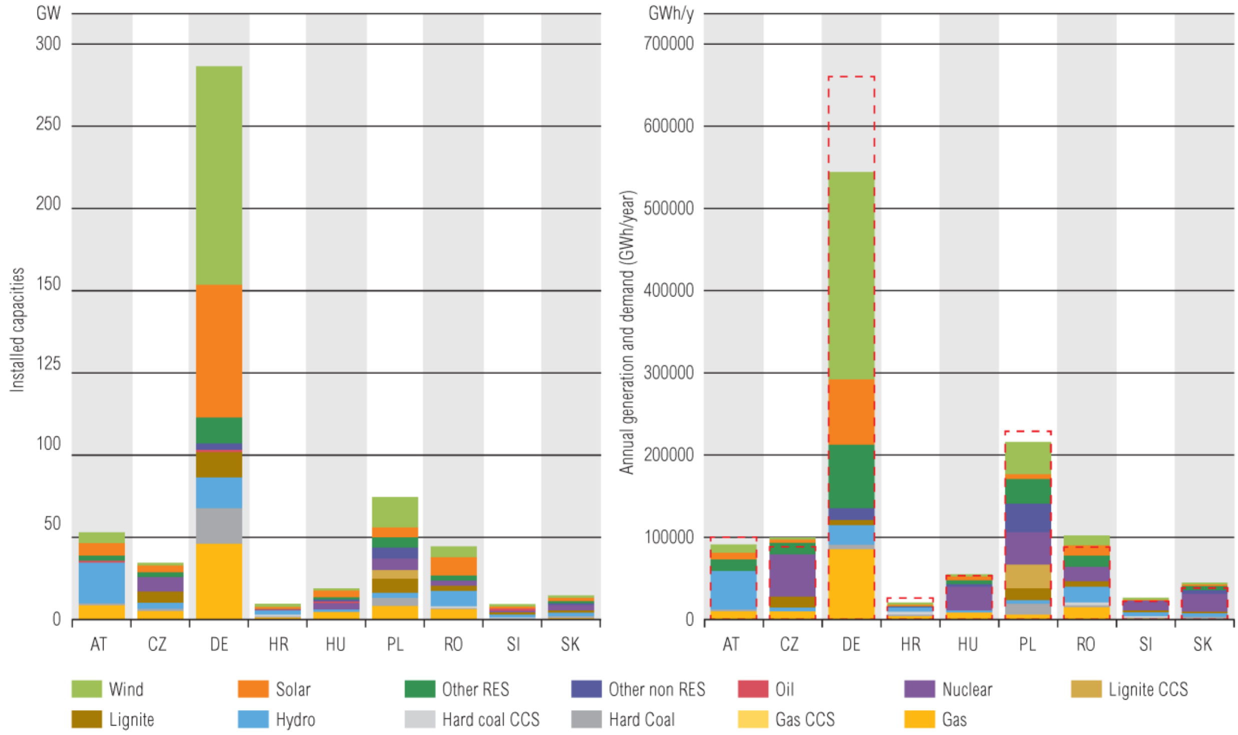


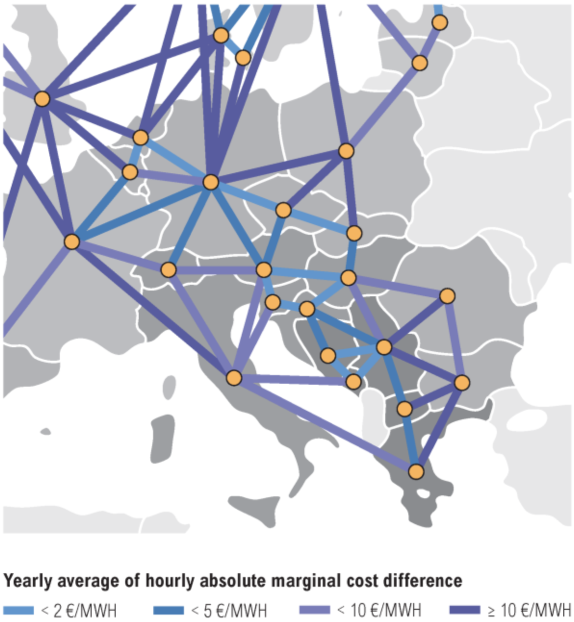
Figure 3-15 Installed capacity in vision 4 in RG CCE (GW)

Figure 3-16 Annual generation and demand in vision 4 in RG CCE (GWh/year)

Figure 3-15 shows the installed generation capacities based on Vision 4 for the countries in CCE RG. The obvious increase of RES is seen from the picture, which is the highest compared to the other three Visions. The additional increase in installed capacity in CCE is introduced in wind and solar compare to Vision 4. The development in other installed capacities is driven by less favourable conditions for fossil fuels based generation, an installed capacity in nuclear is the same as in Vision 3.

Figure 3-16 shows the annual generation and demand in vision 4 for RG CCE. 56% of the production is from RES. CCE behaves like a net importer in Vision 4 with total importing energy of 104 TWh. Main exporters are Romania (13 TWh), Czech Republic (11 TWh), Slovenia (10 TWh). Importers are Germany (112 TWh), Poland (13 TWh) and Austria (9 TWh).

The countries of CCE have different energy strategies. Czech Republic, Slovakia, Hungary and Poland will build additional nuclear power plants, which will decrease CO2 emissions. On the other hand, Germany will shut down his nuclear power plants. To decrease CO2 emissions Germany strongly increase RES.



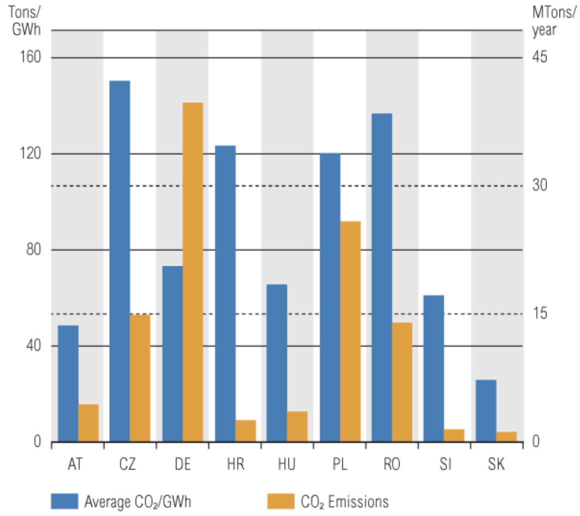


Figure 3-18 CO2 emissions in vision 4 in RG CCE

Figure 3-17 Yearly average marginal cost difference in RG CCE in Vision 4

Figure 3-17 shows the average generation marginal cost differences in RG CCE. The average marginal cost differences inside CCE are not very high for most borders. The average generation marginal cost differs only between Poland and his neighbours. However the average marginal cost is not an indicator for necessary grid extensions. The benefits of grid extension depend on the hourly prices spread.
Figure 3-18 shows the amount of CO2 emission per country in CCE.

Due to the strong increase in RES especially in Germany an increase in Dump energy up to 5313.1 GWh Dump Energy was observed.

3.1.5 Network Studies Results

Network studies results are based on the load flow and N-1 criteria analysis of each selected PiT (Point in Time) from each of the 4 Visions. These results have to meet the main technical indicators of secure and reliable network operation. Among these indicators one can count mainly the loading of the grid, network losses, voltage issues, load flow patterns, etc. Network results are correct if all these indicators are in a range of given limits of the grid.

Every PiT in all visions describes different network operation situations depending on a different generation dispatch, its location and type. Based on this it is very difficult to choose one representative case or PiT which really characterizes typical situation in network operation within the region.

In the tables below (in particular chapter of each Vision) a description of the chosen PiTs for all visions network studies calculations is given together with their representativeness. Based on this one can see which PiT represents the longest part of the investigated time horizon taking into consideration the distinct representatives for particular geographic area in the region.

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1. *Network Studies Results Vision 1*

Based on the assumptions of Vision 1 the studied cases show quite good coherence of input assumptions and the planned grid structure, where even under the less challenging RES development the importance of German North-South corridors is significant. When considering the given assumptions it can be seen that the prevailed directions of flows across areas follow the already planned TYNDP and regional projects. Main directions are from North to South (From Germany, Czech Republic and Poland to Austria, Slovakia and then to Italy) and from East to West (From Romania across Hungary, Croatia and Slovenia to Italy).

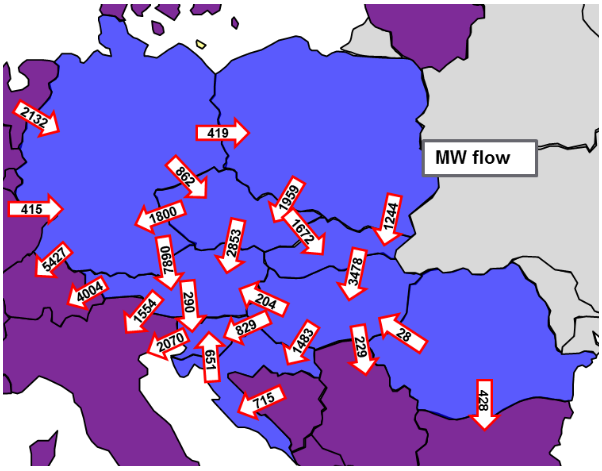

Figure 3-19 One of the 8760 cases of network flows results from Vision 1

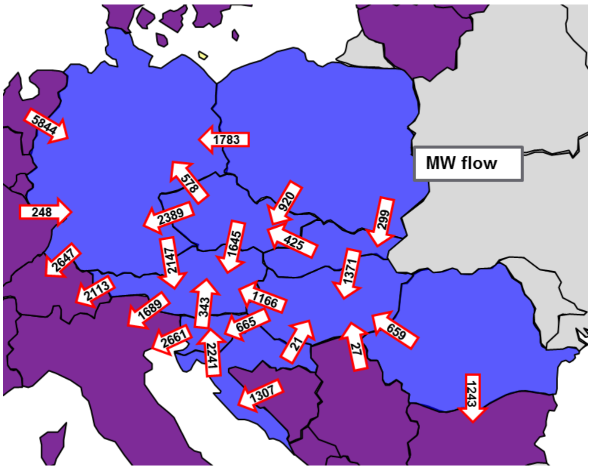

Figure 3-20 One of the 8760 cases of network flows results from Vision 1

The figures show different flows on the borders case by case and high differences are mainly caused by intermittent sources production changes. Particular representativeness of the case is taken into account to assess CBA indicators and system adequacy. All figures are before any countermeasure by PST or changing grid configuration to investigate system adequacy. CBA indicators which were assessed from the network studies perspective are GTC contribution, losses variation in CCE region, technical resilience and flexibility. Project 48 and 54 the two interconnection projects between Hungary and Slovakia are interdependent on each other, where Project 54 follows the Project 48. It means that construction of Project 54 is dependent on the realization of Project 48. For the network assessment of the projects by means of TOOT (Take Out One at a Time) method, it means that at first Project 54 was taken out from the model the entire network system was assessed, and after that, from the model with Project 54 already withdrawn, Project 48 was taken out and again the entire network system was assessed.

For Vision 1, the GTC contribution values reach 1880 MW (SK-HU direction) and 500 MW (HU-SK direction), which indicates significant contribution of the Project 48 on GTC values on the SK-HU profile in both directions. Based on the calculations, Project 48 reduces losses by more than 154.7 GWh in the CCE region per year.
Project 54 has also positive contributions on GTC values on the SK-HU profile in both directions – up to 740 MW. The estimated losses reduction in the CCE region is about 24.3 GWh per year due to this project. It also has positive effect during maintenance and failure. This positive aspect from the project is explored in all visions. Project 54 also improves the ability of the grid to endure outage contingencies during maintenance.

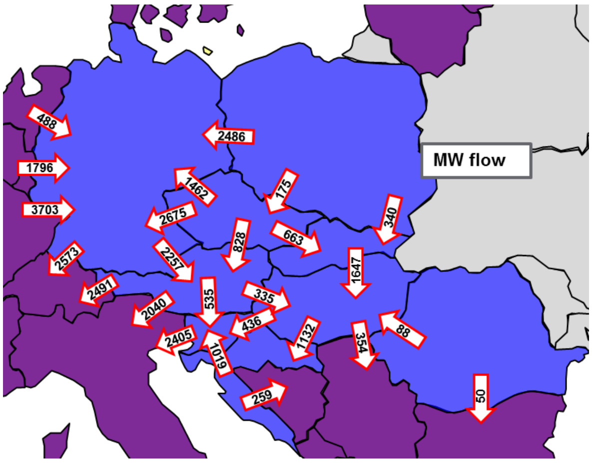

Figure 3-21 One of the 8760 cases of network flows results from Vision 4

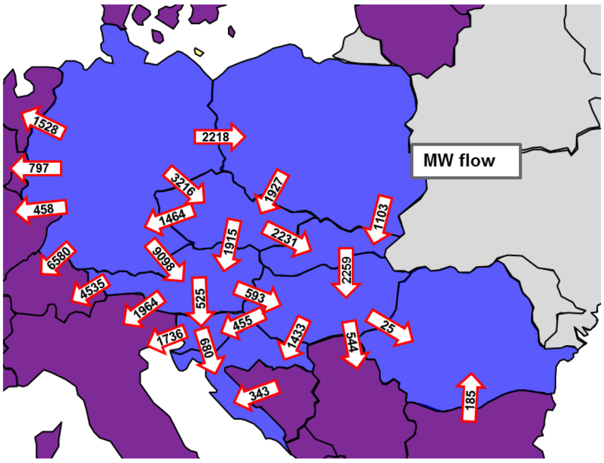

Figure 3-22 One of the 8760 cases of network flows results from Vision 4

As mentioned in previous chapters the most RES challenging vision is Vision 4 with its generation portfolio on the path towards 2050 goals with respect to CO2 emission reduction. The results of Network studies show the significant change in variability of the flows compare to the Vision 1. The analysis of the flows does not bring any identification of the prevailed flows. There are prevailed energy exchanges in the direction from United Kingdom to northern part of Continental Europe and then to the southern direction especially to Italy. The changes in flows are driven by available production in RES (Wind and Solar). When there is enough production in RES the areas with high penetration of this type of energy sources export energy to the rest of the system replacing the conventional power plants. These changes brings additional needs for grid infrastructure, on one hand covering those cases when energy should be evacuated from area with high production of RES and on the other hand ensuring energy is imported to those areas during situations when no wind and solar energy is available. The result of forcing conventional power plants out of the system is the decrease of reactive power from those major traditional sources. This phenomena brings additional need of compensating reactive power not only for transmission lines but also for reactive power sources to overcome high loaded system, but also the periods with low loaded system with the need to decrease high voltages. All figures are before any countermeasure by PST or changing grid configuration to investigate system adequacy.

In Vision 4, Project 48 increases GTC values on the SK-HU profile by up to 500 MW in both directions. Only minor loss reduction is expected (~4.2 GWh per year) with a relatively wide confidence level caused by the same reason as in Vision 3. The project increases the ability to endure outage contingencies during maintenance regarding cross-border overhead lines for this vision too, and seems to be needed in all visions.

Project 54 has minor GTC increase values on the SK-HU profile (~100 MW) in both directions. The losses decrease has an estimated value of 22.7 GWh per year. The project has positive effect during maintenance and failure. This positive effect is explored in all visions. The project increases the ability to endure outage contingencies during maintenance regarding cross-border overhead lines.

3.2 Comparison of the visions

The aim of this section is to provide the reader with a synthetic view of the four Visions by comparing their main characteristics.

The most important monitored characteristic parameters, which differ through the visions, are total yearly consumption, generation mix and RES share in the total supply, CO2 emissions, and average energy price.

Differences in the high-level assumptions of the Visions are manifested among others in markedly different fuel and CO2 prices sets in Visions 3 and 4 compared to Visions 1 and 2, resulting in a reversed merit order for gas and coal units.

In the figure below, the evolution of the total yearly consumption through the Visions is depicted in CCE region.

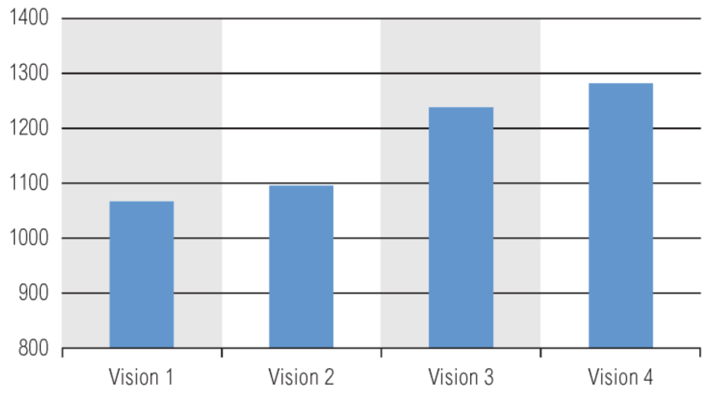

Figure 3-23 Comparison of the total yearly consumption in all the 2030 Visions (CCE region)

As a consequence of the chosen mix, the average CO2 content of electricity is about 220 kg/MWh in Visions 1 and 2, 120 kg/MWh in Vision 3 and 70 kg/MWh in Vision 4, compared to about 350 kg/MWh in 2007, before the crisis. Globally CO2 emissions of the power sector are divided by two to three from Vision 1 to Vision 4 as depicted on the chart below, achieving CO2 emission levels 40% to 80% lower compared to 1990.

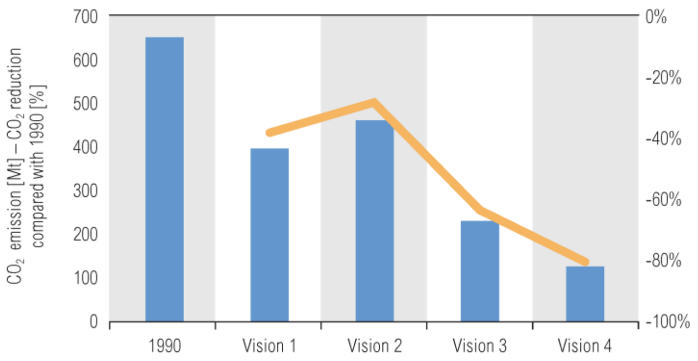

Figure 3-24 Comparison of the yearly amount of CO2 emissions produced and the CO2 reductions comparing 1990 in all the 2030 Visions

With a marginal cost of 0 €/MWh, the increased share of RES in the mix from Vision 1 to Vision 4 also makes the average MWh cost in Europe close to 30-40 €/MWh in all Visions, however for slightly different reasons: a lower (resp. higher) set of fuel and CO2 prices combined with a 40% (resp. 60%) of RES penetration in Vision 1 (resp. Vision 4). This cost price per kWh is similar to the present wholesale market costs. However, the two figures are not exactly comparable, as a "capacity" component, per MW, must be added in a context of higher RES penetration where specific incentives for back up steerable generation capacities are required.

4 Investment needs

4.1 Present situation

The map below in Figure 4-1 shows diverse level of Net Transfer Capacities (NTC) in the Continental Central East region. The NTC is the maximum total exchange program between two adjacent control areas that is compatible with security standards and applicable in all control areas of the synchronous area, whilst taking into account the technical uncertainties on future network conditions.

The situation in the Regional Group Continental Central East is characterized by the interconnected system, where all countries have at least 4 connections to adjacent TSO (including DC connection). The majority of the TSOs control areas are inner AC systems, thus their systems and capacities are influenced by unscheduled flows. Looking to the development of market capacities; increase of peak values can be seen compared to situation presented in the last TYNDP 2012 document. Particularly this increase of peak NTCs applies to Hungarian-Romanian border, where the NTC went above 1GW in both directions. Related to the Hungarian-Croatian border there was an increase over 1GW in the import direction from Croatia to Hungary. NTC peak increase was also reached on the Czech-German border in the German export direction to the Czech Republic and on the Czech-Austrian border in the Czech export direction to Austria also over 1GW for both borders. Here maximum values are presented to provide consistent picture in comparison with expected values in other chapters of this document. Values can vary hour by hour based on the availability of grid elements (reconstruction, revision…) and expected unplanned flows as it has been happening nowadays, however one can expect even higher variation in the future due to expected higher variability of electricity production.

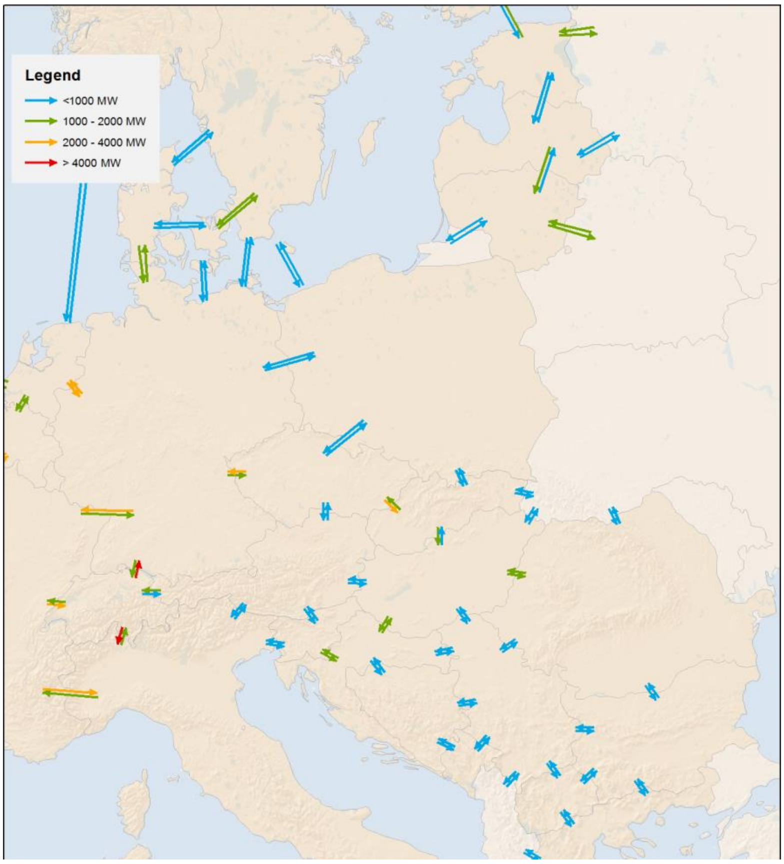

Figure 4-1 Illustration of Net Transfer Capacities in CCE region (2013)

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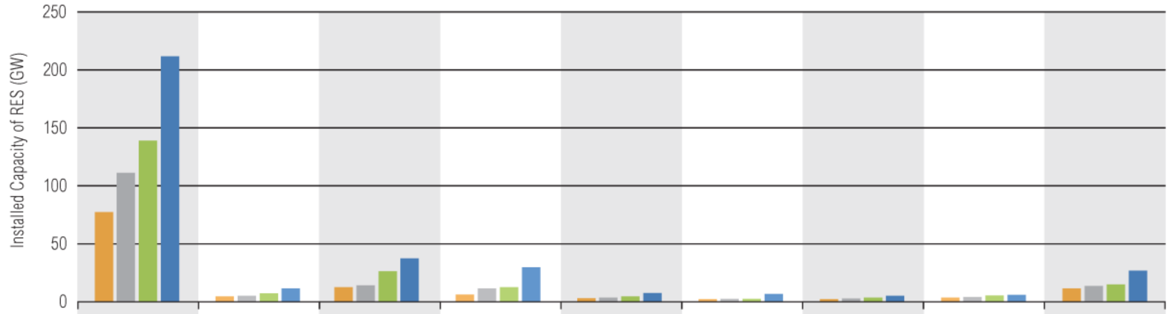
4.2 Drivers of Grid Development

Generation connection is one of the main drivers for the power system development in common. In vision 2030 visions the merit order of the generation is changing based on the input data, especially CO2 emission and gas prices, and assumptions of different visions, what cause diverse load flow patterns through the particular visions, which the CCE region transmission grid with all the reinforcements designed has to cope with and at the same time ensure reliable and secure operation of the CCE region transmission grid.

Especially RES generation, in CCE region there is major amount of the RES generation with high fluctuation of generating power based on the actual weather (photovoltaic and wind power plants) that can cause uncertain situations in the CCE region transmission grid. When the RES generation is connected into the distribution grids as a distributed generation with small installed capacity, there is no need of huge reinforcement of the transmission grid because of the closer distance between generation and consumption. But in case of the RES generation connection into the distributing or transmission grid as a large power parks or many small ones concentrated in one area and in addition with long distance between this generation areas and consumption areas serious need of transmission grid reinforcement issues arise.

The CCE region has an ongoing increase of RES. The RES is often located far away from the load centres, e.g. the area with most energy production from wind farms is Northern Germany. Due to this fact a lot of reinforcement projects are designed to help transmission grid in CCE region to cope with this kind of situation.

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



	Germany	Czech republic	Austria	Poland	Slovak republic	Hungary	Slovenia	Croatia	Romania
2014	77,3	3,5	11,5	5,2	2,2	1,1	1,3	2,5	10,4
2020	110,9	4,0	13,2	10,3	2,7	1,5	1,7	3,0	12,6
2030_V1	138,9	6,1	25,2	11,4	3,7	1,4	2,5	4,4	13,9
2030_V4	211,4	10,3	36,4	28,9	6,5	5,7	4,2	4,9	25,8

Figure 4-2 Evolvement of the RES installed capacity of each RG CCE member country from2014 to 2030.

Market integration – interconnection capacities reinforcement

The essence of the common market functioning in whole Europe, what is also one of the European Union goals, is to have sufficient interconnection capacities between regulation areas. In the moment when there is congestion in the grid, the market splits. In CCE region there are a lot of project designed to cope with insufficient interconnection transmission capacities on particular profiles. For example there are two projects on Slovak - Hungarian profile in order to improve interconnection transmission capacity between these two regulation areas.

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Security of Supply improvement

The security of supply improvement of all areas in Europe has to be one of the most important goals to ensure adequate amount of transmission routes for safe and reliable energy supplies of electricity to load centres in Europe in normal operation of the grid and during maintenance or congestions situations in the grid. It seems that security of supply is a concern for Cyprus, Iceland and the Baltic Sea Region which are isolated systems with a relatively low interconnection capacity with neighbouring EU Member States. Nevertheless also in the CCE region with sufficiently meshed transmission grid Security of supply issues arise. In CCE region there are areas with lack of security of supply, especially in Southern Germany. Due to that fact German TSOs designed new reinforcements to cope with this security of supply issues.

Not only German projects, but also other CCE member TSOs projects contribute to security of supply improvement even though any project did not prove it in the assessment of the security of supply indicator, but the explanation of this fact can be found in project description and also additional comments of the pan-European projects in CCE region in Annex 1 of the TYNDP 2014 report.

Improvement of electricity efficiency

Improvement of electricity efficiency analyze was done through the variation of losses indicator assessment where variation of losses in whole CCE region with and without particular projects were observed. For the assessment results of this indicator refer to the chapter 6.3.6. The whole region as the scope of the variation of the losses assessment seems to be too large. This indicator should be assessed on the smaller area and the improvement of the electricity efficiency should be task and commitment for each particular TSO coordinated from the region or EU.

German Nuclear power plants decommissioning

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

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

Climate change mitigation

Climate change mitigation and competition will require energy efficiency measures such as transfer from fossil-fuel based end-users to CO2-free energy sources. Electricity peak demand is forecasted to be stable by the year 2030 reaching a total amount of 169 GW peak demand in the region when considering Vision 1 (moderate European growth). On the other hand, the consumption increase is driven among other factors by growth in the use of electric vehicles and heat pumps, while reaching 2% annual demand growth (peak load 207 GW) in Vision 4. The share of the load covered by RES in CCE region varies from 34 % in Vision 1 to 56 % in Vision 4.

All these drivers are interdependent and connected each to other therefore they cannot be treated separately.

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4.3 Main Bottlenecks

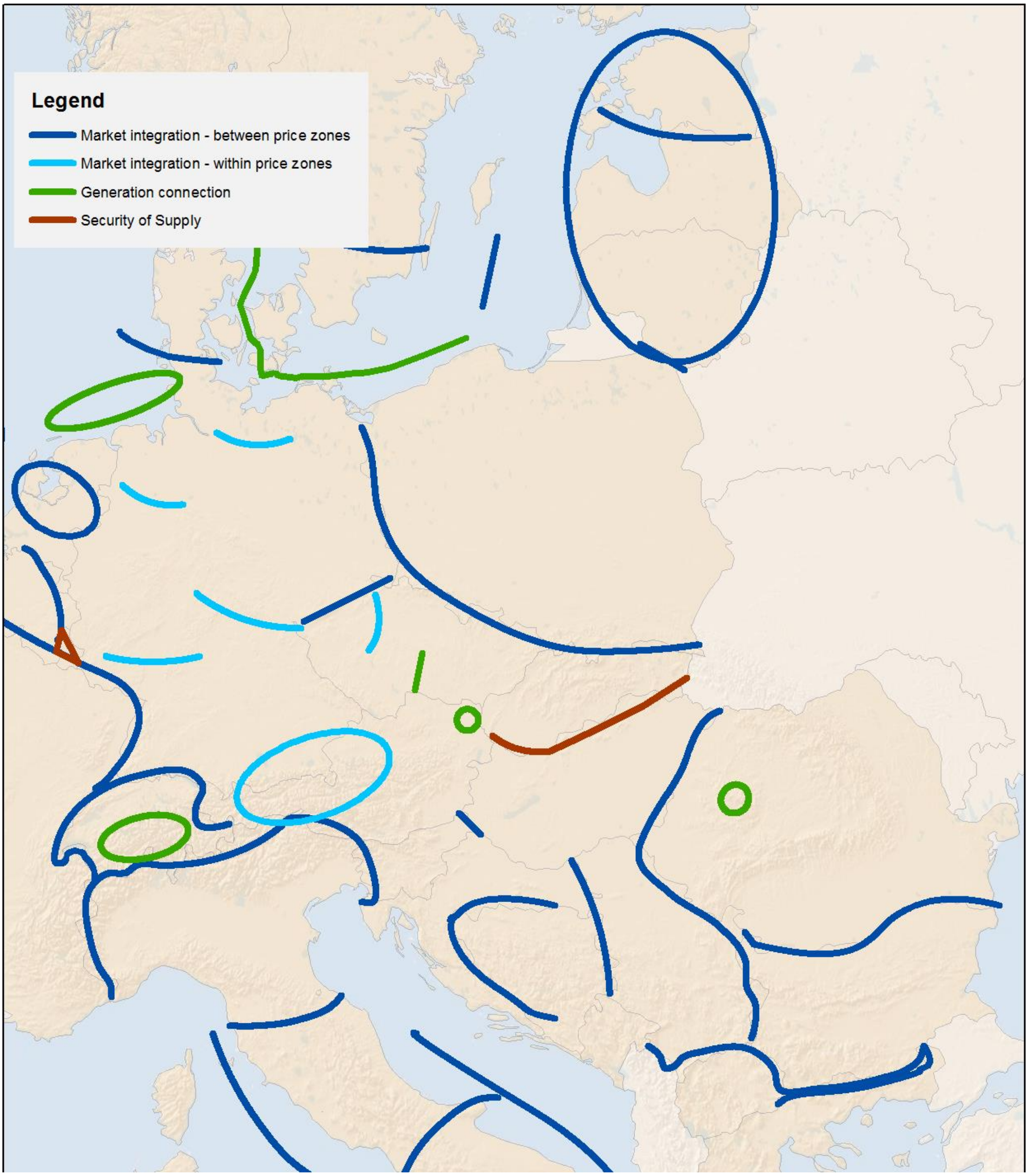

Figure 4-3 Map with remaining bottlenecks in the region

NB: when a boundary can be flagged with more than one concern, market integration prevails over generation connection and security of supply.

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As a result of the market and network study process, about 15 bottlenecks have been identified in the European electricity system in the coming decade (unless new transmission assets are developed) in CCE region. Figure 4-3 shows their locations, i.e. the grid sections (the “boundaries”), the transfer capability of which may not be large enough to accommodate the likely power flows that is foreseen to cross them unless new transmission assets are developed.

In order to ease the understanding, the anticipated bottlenecks are presented according to the following 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).

The mentioned drivers (Security of Supply, Connection of Generation, and Market Integration) are followed by the refurbishment of aging equipment and environmental issues. One of the main drivers bringing the bottlenecks into the grid is the change of the generation mix in Europe. In Germany with the recent decision of a nuclear phase-out by 2022 the structural changes in generation obviously also results in the generation pattern changes which affect the whole region. Nevertheless additional challenges are linked by large uncertainty of generation connection and their size to be connected to the system. Uncertainty in generation capacity and location and expected power output driven by European energy policy framework with its changes in incentives brings additional bottlenecks to the system with varied probability.

More information about bottlenecks and their drivers are described in following chapters.

4.4 Bulk Power Flows in 2030

A Bulk Power Flow is the typical power flow that has been determined by TYNDP studies and is expected to trigger grid development across a boundary. Bulk Power Flows range from approximately 500 MW to more than 10,000 MW. The Bulk Power Flows that are the outputs of the TYNDP studies undertaken for 2030 under each of the four visions are presented in the following sections.

The main drivers for the depicted flows based on the assumptions of ENTSO-E Vision 1 are changes in generation mix and their merit order which is dependent to CO2 price and fuel price. Generally, looking at long-term developments in the EU energy roadmap, the EU has committed to additionally reduce greenhouse gas emissions to 80-95% below 1990 levels by 2050. With higher penetration of intermittent sources the volatility of the power flows shall increase causing more often changes in the country balances. More information can be found in chapter market study results.

4.4.1 Generation Connections

The figure below shows the expected boundaries triggered by connection of new generating facilities.

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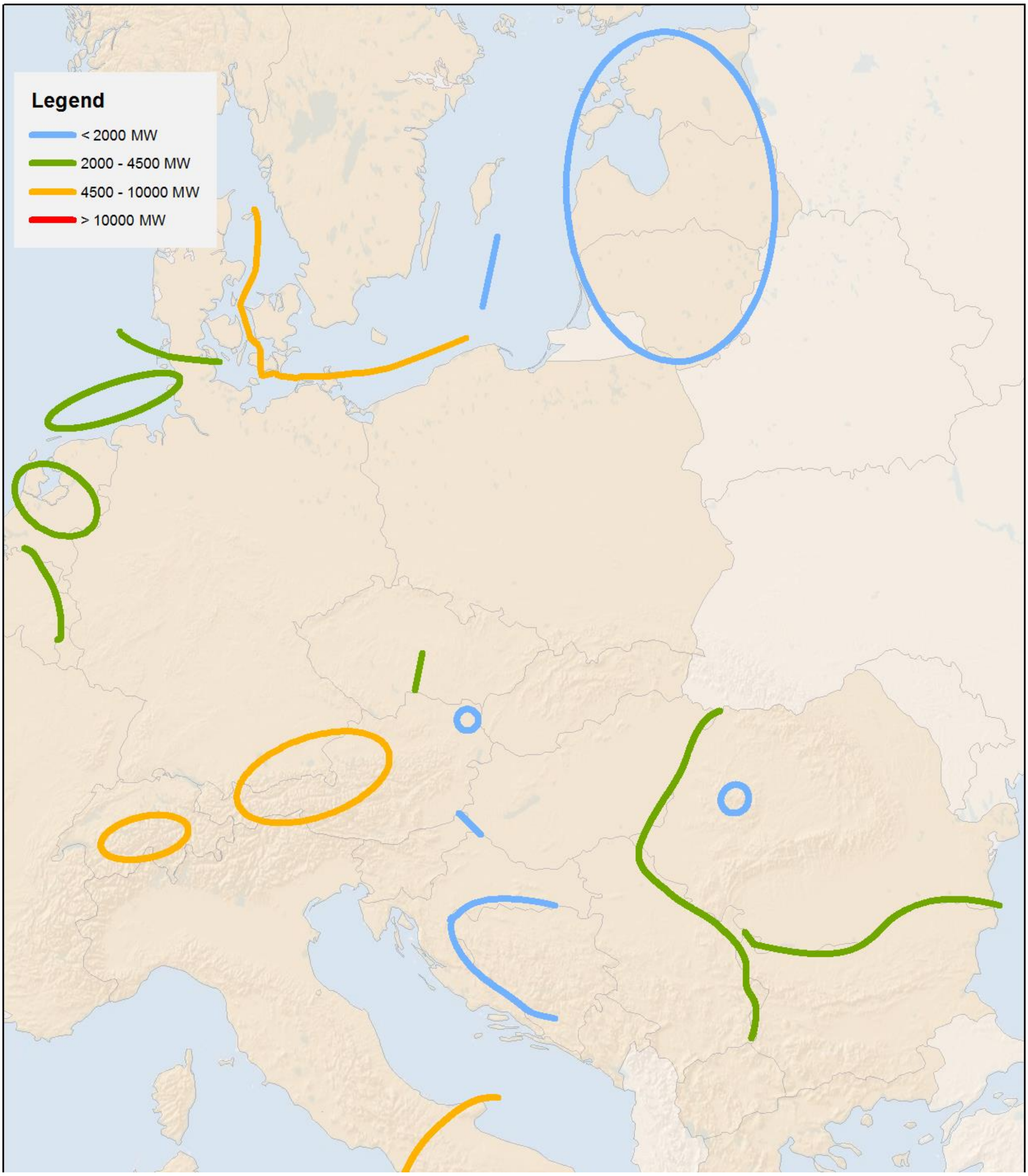

Figure 4-4 Map of bulk power flows related to generation connections (Vision 1)

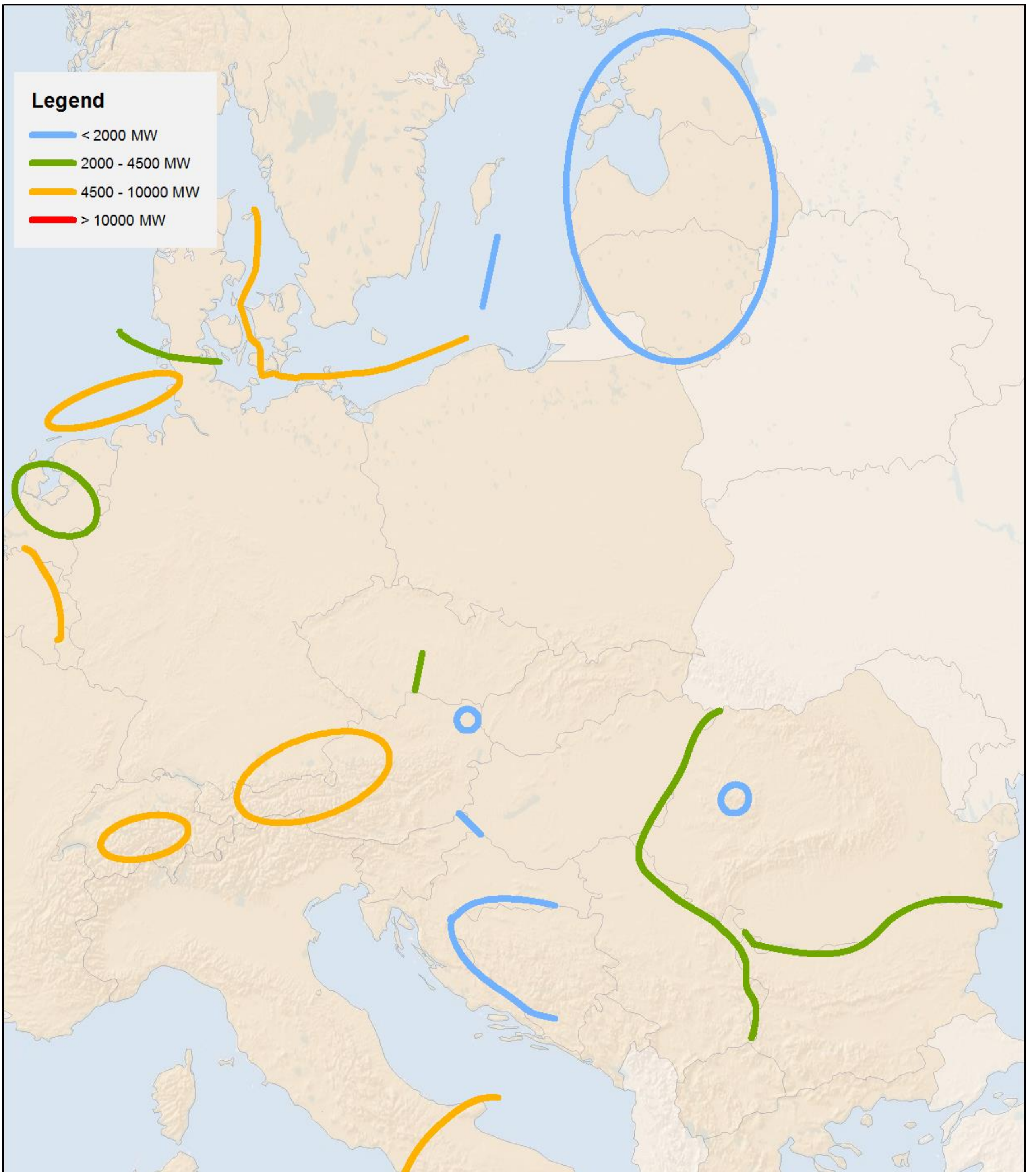

Figure 4-5 Map of bulk power flows related to generation connections (Vision 4)

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

The expected power production from renewable energy sources especially from wind generation in northern Germany, Denmark, the North Sea and the Baltic Sea regions which should be physically transported by the internal grids and also via transmission systems of neighbouring countries to the southern/south-western parts of the continent can cause high transit flows in parts of the CCE region in certain situations.

However, this BPF are concentrated only on direct connection of generation units, mostly large scale wind, pump storages and thermal power plants. As you can see on the two maps considering Vision 1 and Vision 4 assumptions there is difference in large scale connection of offshore wind farms in Germany. Other drivers in generation connection are in the same range.

4.4.2 Market Integration

The creation of the Internal Electricity Market (IEM) will eventually require the harmonisation of all cross-border market rules so that electricity can flow freely in response to price signals. Market integration is leading to more and larger power flows across Europe, it is therefore a driver of grid development. The flows that trigger grid development (BPF) in 2030 are shown with the boundaries related to market integration.

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Figure 4-6 Map of bulk power flows related to market integration (Vision1)

Figure 4-7 Map of bulk power flows related to market integration (Vision 4)

In the medium term market integration is one of the key drivers for grid investments in the Continental East region. More capacity is needed between Germany and Poland to promote the European energy market by the stronger connection of these two countries. In order to enhance market opportunities there are other areas where market integration has been identified by expected power flows, however the additional main boundary with expected increasing flows is Slovakian-Hungarian border.

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Two maps taking into consideration Vision 1 and Vision 4 show additional expectation of electricity flow to support market integration in North-Western part of Germany. Other expected flows are expected in similar range.

4.4.3 Security of Supply

Security of Supply generally represents the main driver and criteria for grid planning in order to accommodate new generation capacity, enhance market opportunities or secure demand in local or extensive areas. Here boundaries with significant bulk power flows in respect to secure extensive areas are depicted as on Figure 4-8 and Figure 4-9. Local and regional issues or other drivers developing Security of Supply issues are not depicted on the following picture.

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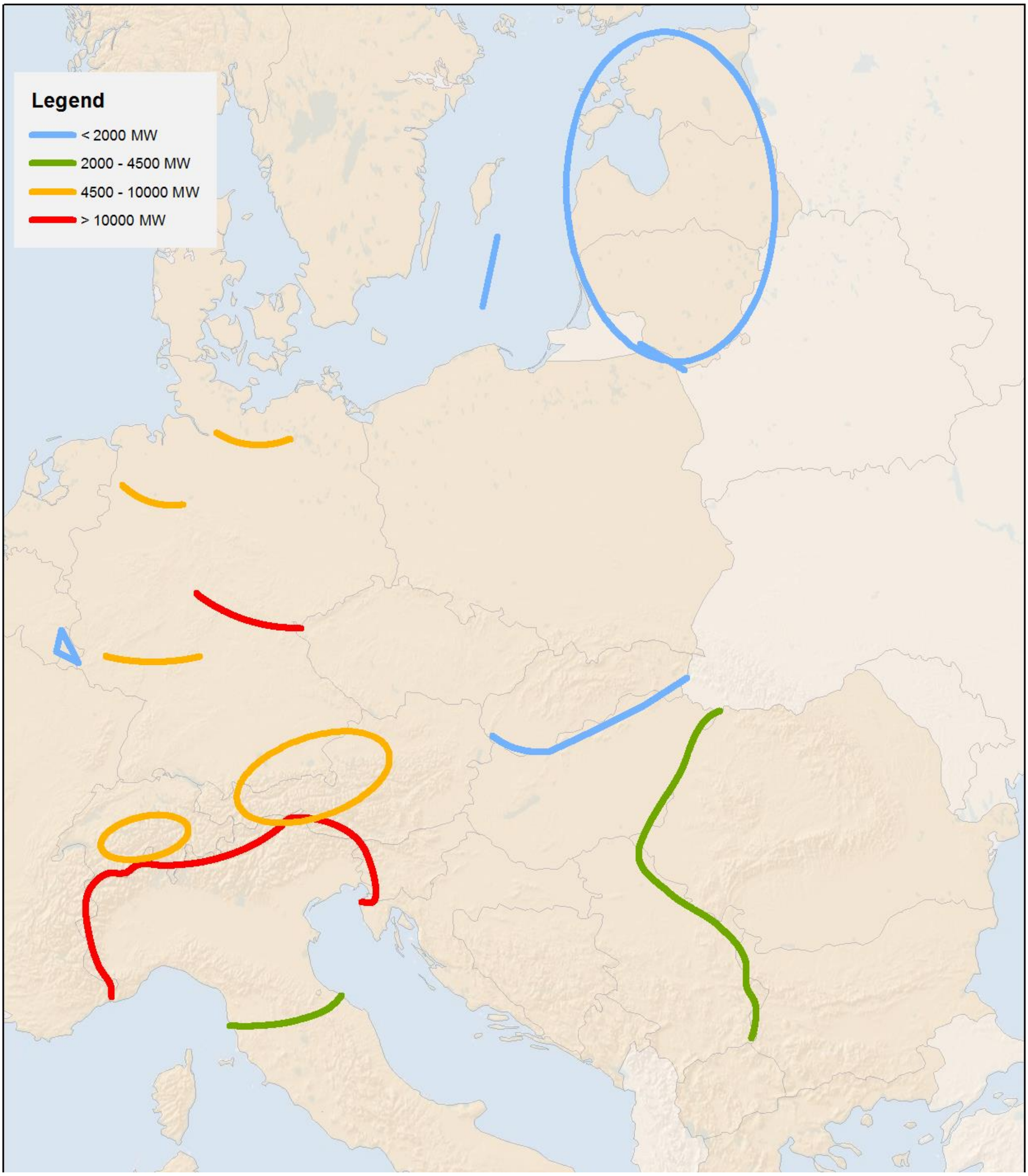

Figure 4-8 Map of bulk power flows related to security of supply (Vision 1)

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Figure 4-9 Map of bulk power flows related to security of supply (Vision 4)

Security of Supply is also a driver for investments in the Central Europe especially in Germany, when there is ongoing change of generation capacity from southern part to North, thus the expected flows to ensure Security of Supply from North to South are depicted.

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5 Assessment of the regional Investment Plan 2012

This chapter presents an overview of the evolution of the investments since the TYNDP 2012 including statistics, as well as an updated table of projects focused on the status, date of commissioning and additional monitoring information (Table and map of Pan-European Projects).

5.1 Portfolio and monitoring statistics

Regional Investment plan of Continental Central East regional group includes list of investments representing projects with European or Regional significance and TYNDP projects, which represents group of investments dealing with some particular European targets and they met the rules to be included in TYNDP list. Regional CCE investment portfolio represents 347 investments in total (together with already commissioned investments). When only projects to be commissioned after year 2014 are taken into consideration, RgIP consists of 316 investments. There are additional 69 investments identified during TYNDP 2014 process as a need to cope with future possible development in electricity sector towards 2030 compared to previous TYNDP document. There are 142 investments having status of Regional significance from those to be commissioned. 174 investments are clustered in 34 projects having status of Pan-European significance. Next paragraph presents the projects evolution since TYNDP 2012 publication for investments already listed in previous TYNDP. As mentioned above new 69 projects are included into RgIP 2014, whilst **18 projects** were **commissioned as planned** and additional **10 commissioned ahead of time**, which represents about **8% of the portfolio**.

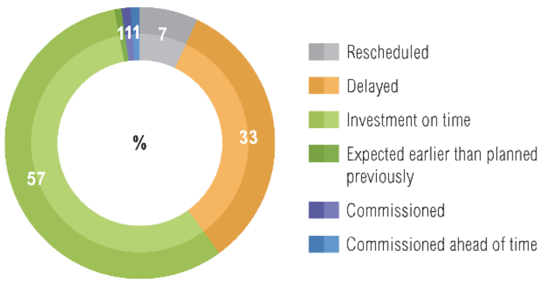

Figure 5-1 Evolution of the pan-EU significance projects of the CCE region

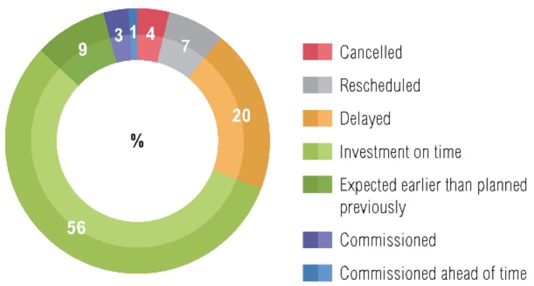

Figure 5-2 Evolution of the CCE region investments portfolio (including pan-EU and regional significance investments)

The evolution of regional CCE investment portfolio leads to conclusion that 28% of all its investments (including both of those of pan-European and regional significance) are delayed or rescheduled. If only projects of pan-European are considered the delay and rescheduling is on the 35% of the projects. 48% of the delayed projects are mid-term projects. Taking into consideration the fact that the reasons behind of the most of the delayed projects are related to permit grant procedures and public negative attitude towards construction of lines (notably overhead lines) the following tasks will remain to be the main challenges for TSOs in the region and for the entire ENTSO-E: minimization of the length of the infrastructure routing, optimization to decrease the number of lines to be build or the corridors to be occupied and divergence of those corridors from sensitive and environmentally protected biodiversity and urban areas. About half of the projects are expected to be commissioned on time or expected ahead of time; mid-term and long-term projects foreseen on time are divided in the 2 groups (76% of projects with status on time are long-term projects).

The group of projects to be commissioned after 2014 is in various periods of their planning phase. About one third is in design a permitting process and 12% in construction phase, so all together 41% of projects are in mature phase.

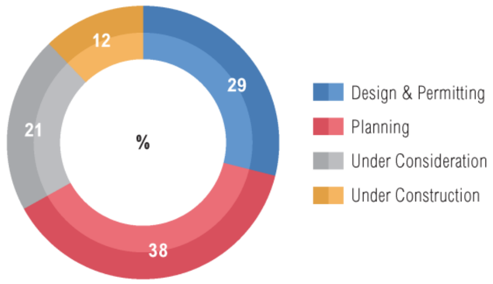

Figure 5-3 *Planning phase of projects in CCE portfolio*

From those mentioned as cancelled there are projects in Polish portfolio having such status and one cross-border project in CCE region:

Implementation of the investment became obsolete due to the implementation of other projects:

- investment no. 94.A70 PST Krajnik (PL) - was cancelled because of agreement signed in first quarter 2014 between PSE S.A. and 50Hertz where both parties agreed to install PST's on Polish – German profile in stations Mikułowa (by PSE S.A.) and Vierraden (by 50Hertz);

- investment no. 94.A69 Upgrade – Mikułowa – was cancelled because scope of this investment is now included in position no. 94.A71 (PST Mikułowa (PL));

- investment no. 94.A68 Upgrade – Krajnik – was cancelled because scope of this investment is now included in position no. 796 upgrade Krajnik.

Project between Vitkov and Mechlenreuth (TenneT TSO GmbH and ČEPS) has been cancelled due to unfeasibility to build the project (environmental aspects and technical difficulty to connect to existing grid).

5.1.1 Specific focus on delayed projects

Investments in TYNDP Project 48

Investments 696, 697, 698 and 699 (formerly 48.A127 and 48.A128) were rescheduled from the previously expected commissioning date, 2016, to the current ECD, 2018. The timing of these investments is driven by that of the main investments in this project cluster, i.e. the cross-border transmission lines, Gabčíkovo - Gönyű and Rimavská Sobota - Sajóivánka. These tie-line investments have been evaluated jointly by the management of SEPS and that of MAVIR, and the ECD was adjusted to reflect the feasibility conditions.

Investment 286: New 400/120 kV transformer station in the area of Szekesfehervar

This investment was rescheduled (from previous ECD 2016 to 2023) because the originally expected demand growth did not realize, in fact, the demand in the area dropped slightly as a result of the economic downturn after 2008. However MAVIR decided not to cancel this project because the area has significant industrial demand growth potential in the next 10 years. The current ECD reflects the currently somewhat pessimistic prognosis about economic and demand growth, which may change in the future.

Investment 287: New 400/120 kV transformer station in Kerepes (former wording: in the area of Godollo)

This investment has 1 year delay (current ECD is 2016 instead of previously expected 2015). The delay was caused by difficulties experienced during the siting of this station and finding routes for connecting lines. Parts of the area have Natura-2000 environmental protection, also the area has a military site and a major gas pipeline in the vicinity of the planned station, which together made the siting complicated and longer than expected.

Investment 290: New 400/120 kV transformer station near Oroszlany

This investment was rescheduled to 1 year later because this investment is directly related to a power plant connection request, and the power plant project itself is rescheduled. This is a 2*400 MW CCGT project and the economic conditions are currently not favourable for gas fuelled plants. This may be the reason why the investor is floating the final decision about starting the investment.

Investment 292: New 750/400 kV transformer station (in the area of Debrecen or elsewhere)

Currently this project has a 4-year delay. The future of the 750 kV voltage level in Hungary has been studied for many years now. Equipment in the existing terminal station at Albertirsa reached the end of their planned lifetime in 2013. The amount of import from Western Ukraine (Burshtyn Island) does not justify the operation of the entire line at 750 kV, thus the project for a new (more eastern) 750 kV terminal location (Debrecen area) had been started. Then for a few years the project did not progress due to lack of decision on financing for the expensive 750 kV voltage level. Then an alternative plan emerged to utilize the full line at 400 kV. But negotiation with the Ukrainian side is rather slow and still in progress. We expect decision by the end of 2014 whether to build a new 750 kV terminal station on Hungarian territory or downgrade the entire tie-line for operation at 400 kV.

Investment 269: New OHL Portile de Fier - Resita 400 kV - it was delayed from 2016 to 2017

The investment was coordinated with OHL 400kV Resita (RO) – Pancevo (RS) (investment 238). The main problems are right of land along the line path and permitting.

Investment 273: New OHL Cernavoda - Stalpu 400kV - it was delayed from 2017 to 2019

Delay longer than expected for clarification needed for legal framework for right of land acquirement and regarding environment permitting procedure.

Investment 712: Upgrade of OHL Stejaru - Gheorghieni 220kV - it was delayed from 2015 to 2021

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.

Investment 718: Upgrade of OHL Gheorghieni – Fantanele 220kV- it was delayed from 2015 to 2021

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.

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Investment 713 OHL 400kV Rahman (RO) - Dobrudja (BG) split and investment 272 OHL 400kV Stupina (RO) - Varna (BG) split (connection in/out in Medgidia S (RO)) were delayed from 2015 to 2016.

Delay longer than expected for clarification needed of legal framework for right of land acquirement and regarding environment permitting procedure.

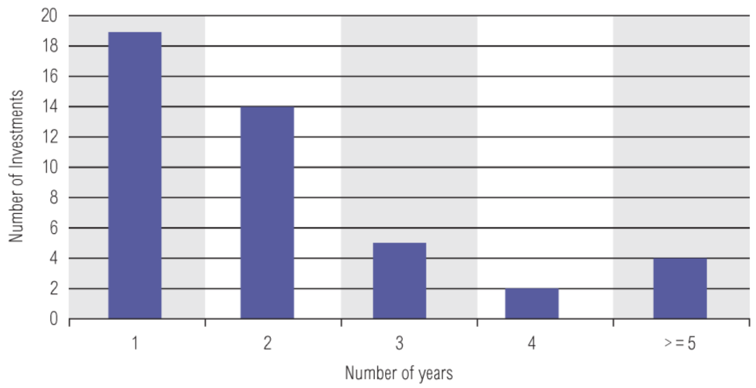

Figure 5-4 *Length of expected delays in CCE portfolio*

Most of the projects in CCE portfolio are delayed 1 or 2 years, which is mostly related to permitting process and changing in commissioning dates of dependent projects.

6 Investments - Project Portfolio

6.1 Criteria for Projects Inclusion

6.1.1 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.

6.1.2 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) No.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 TYNPD 2014 assesses 24 projects proposed by non-ENTSO-E Members (13 transmissions projects and 11 storage projects). Out of the 24 projects accepted in the TYNDP 2014, 19 are listed as Projects of Common Interest (nine transmission and 10 storage projects).

6.1.3 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 projects or bring in cross-border effect. They are not included in the TYNDP

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

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

6.2 Description of portfolio

The Hungarian national grid development plan identifies the following main drivers for new transmission investments: demand growth, risk of domestic generation shortage, risk of loop flows due to inadequate performance of congestion management mechanisms, future of 750 kV connection with Ukraine.

Demand growth is not a very strong driver, the realistic scenario expects 0.5%/a peak load growth, while the optimistic scenario uses an estimate of 1.0%/a.

A much more pronounced driver is the risk of shortage in domestic generation. Due to the falling prices of wholesale electricity gas fired power plants became unprofitable. Existing gas fired plants are considering to pause their operation, while new CCGT investments are being continuously delayed. The result of this tendency is twofold: 1) there is a need for new cross-border investments to securely supply the potentially increasing import, 2) there is a need for new transformer stations from the transmission to the distribution level, as some of the existing gas fired plants are feeding to 120 kV distribution level.

New cross-border investments that are targeting the increase in import capability are contained in the TYNDP projects #48 and #54, new tie-lines between Slovakia and Hungary. (The other cross-border investment, between Slovenia and Hungary as part of TYNDP project #27 is serving market integration purposes but is not directly targeted at increasing the import capacity).

Transformer station projects between transmission and distribution level are as follow. In the mid-term: Perkáta (2015), Kerepes (2016), Szigetcsép (2016), extension to Detk (2017), extension to Győr (2018), extension to Sajóivánka (2018), Oroszlány region (2017) and extension to Albertfalva (2018); the latter two are related to plant connection requests. In the long term: extension to Ócsa (2020), Székesfehérvár (2023), extension to Kerepes (2025), Pomáz region (2025).

The risk of loop flows due to inadequate performance of congestion management mechanisms is considered moderate and to trigger no additional investment, provided that the planned cross-border investments will be realized on time.

The future of 750 kV connection with Ukraine has been an open issue for several years as the existing 750 kV equipment in station Albertirsa are past their planned life time. Reconstruction of 750 kV in station Albertfalva is not considered because part of the right-of-way of the line will have be utilized on 400 kV already in the mid-term to support internal operational security. The possibilities are: 400 kV operation on the full length of the line, or new 750/400 kV station in Eastern-Hungary. Decision is expected in 2014.

As for the Czech Republic the following are revealed to be the main factors for its grid development in the coming 10-year period and beyond:

- **Modernization of the existing traditional coal power plants which are mainly connected into the 400 kV grid and situated in the north-western part of the Czech system; Connection of the new CCGT and brown coal units in the same north-western part of the country**:

  The new 400 kV substation #300 Chotejovice and one circuit of the double-circuit 400 kV overhead line #301 Vyskov-Chotejovice have been already commissioned to ensure evacuation of power generation from the new brown coal unit with installed capacity of 660 MW which is due to be commissioned. Moreover to ensure evacuation of power generation form the new CCGT unit with installed capacity of 880 MW and to securely facilitate power flow in the north-south and west-eastern direction investments included in Cluster 55: 400 kV overhead lines #55.302 (Vyskov-Czech Stred), #55.303 (Babylon-Bezdecin), #55.304 (Babylon-Vyskov) which were already presented in the RgIP 2012 and also outlined in this present RgIP 2014 are planned. While investment #55.302 will commence its construction this year 2014 the other two investments are in the final project preparation phase. Other 400 kV OHL investments like #A150 (Hradec-Chrast), #A151 (Chrast-

Prestice) and #A146 (Hradec-Vyskov) which are in the pre-project preparation phase are also planned for the same purpose.

- **Connection of the largest wind park with an estimated installed capacity of 140 MW into the 400 kV transmission grid in the north-western part and connection of RES into the distribution system**:

  The new 400 kV substations #35.307 Vernerov and #35.306 Vitkov are planned to ensure evacuation of RES power generation from the north-western part of the system but also to provide extra power for connection of RES and consumption into the distribution system in this region. Other 400 kV OHL investments like #35.308 (Vernerov-Vitkov), #35.309 (Vitkov-Prestice) and #35.315 (Kocin-Prestice) are also planned to facilitate power flow in the north-southern and west-eastern direction. Investment #35.307 Vernerov is the final project preparation phase while other investments are in the pre-project preparation phase.

- **Connection of future power generation in southern part of the Czech Republic**:

  The extension and reconstruction of the existing 400 kV substation #35.311 Kocin, extension of the existing substation #35.312 Mirovka together with the new 400 kV OHL investments #35.313 (Kocin-Mirovka), #35.315 (Kocin-Prestice), #35.314 (Mirovka-V413) and #35.316 (Mirovka-Cebin) is planned to ensure evacuation of power generation from the existing and new planned unists in this southern area, to facilitate power flow in the north-southern and west-eastern direction.

- **Increase of consumption in the north-western part of the Czech network system**:

  As explained above besides ensuring connection of RES generation the two new 400 kV substations #35.307 Vernerov and #35.306 Vitkov are planned to ensure security of supply in the region. Consumption is forecasted to increase in the near future for the distribution system in this region. While substation Vernerov is scheduled to be commissioned in the year 2017, substation Vitkov shall be commissioned in 2019.

- **Security of supply of the capital city of Prague**:

  Third transformer 400/110 kV is scheduled this year to be installed in the existing 400 kV substation Chodov ensuring security of supply for the capital city of Prague. The new 400 kV substation #A91Praha Sever is also planned to ensure security of supply for the capital city for the in the coming years. Other 400 kV OHL investments like #56.A92 (Chodov-Cechy Stred), #145 Tynecc-Cechy Stred and #56.A93 (Tynec-Krasikov) are complementing projects to ensure security of supply in the central part of the network system but also to facilitate power flow in the west-eastern direction. These investments are in the pre-project preparation phase.

- **Significant consumption growth in Ostrava region:**

  To ensure security of supply and connection of new forecasted increase of consumption in the industrial region of Ostrava, the new 400 kV substation #305 Kletne was commissioned 3 years ago and the new 400 kV overhead line #299 Krasikov-Horni Zivotice has commence its construction. Other investments which will connection of consumption and ensure reliable and secure of the system network in the region are: new 400 kV substation #A95 Detmarovice to be commissioned by 2020, new 400 kV overhead line #A94 Prosenice-Kletne, #A149 Nosovice-Prosenice and #A148 Krasikov-Prosenice are planned.

- **Support of European internal energy market, RES integration and control of transits and loop-flows:**

  To ensure RES integration and support the European internal market investments: new 400 kV OHL #35.308 (Vernerov-Vitkov), #35.309 (Vitkov-Prestice), #35.315 (Kocin-Prestice), #35.313(Kocin-Mirovka), #35.316 (Mirovka-Cebin) including new 400 kV substations #35.307 Vernerov and #35.306 Vitkov, and extension of existing 400 kV substations #35.311 Kocin and #35.312 Mirovka are planned. These investments are included in the union list of Projects of Common Interest which was published by the European Commission in October 2013.

The Czech Republic system is situated at the crossroads of the prevailing north-south and east-west power flow axes, in the very heart of the countries in the CCE region, between the RES generation in the north and storage capacities in the Alps and therefore to a high degree negatively affected by unplanned transits and loop-flows. To enable to deal effectively with unplanned cross-border flows on the ČEPS-50Hertz profile and to ensure the security of the transmission grid both from a mid-term and a long-term view installation of 4 phase shifting transformers (PSTs) for two lines at the substation Hradec on the interconnector Hradec-Röhrsdorf is planned by ČEPS. The PSTs are scheduled to be commissioned by end of 2016.

- **Ageing of transmission infrastructures which actually built in 60s/70s evoke the need for its refurbishment (mainly the 400 kV transmission grid); Exhaustion of transmission network capacity:**

  Ageing of the existing infrastructures and the need to increase the already exhausted transmission network capacity the current network is one the input factor which is taken into account when planning new investments. This aspect has been also considered in all of the planned investments mentioned above.

Project of regional importance in Poland:

- **400 kV line Dobrzeń (PL) – Wrocław/Pasikurowice (PL)**

  The project allows for the connection of new conventional generation planned in Opole Power Plant for the supply of Wrocław agglomeration area and contributes to the following:

  - secure and reliable power evacuation from Opole power plant and increase in security of supply for Wrocław agglomeration area as well as the lower Silesian region bordering with Czech Republic;
  - creating conditions for export of energy to Czech Republic under normal conditions and in emergency situations - the new generation units are located near the Czech border.

For Germany the so called “Energiewende” is the most important driver for grid extensions. “Energiewende” means the ongoing process to transform a generation system based on nuclear and conventional power plants to a system without nuclear power plants and big amount of RES.

The most important Slovak projects are projects Nr. 48 and 54, which are the projects of Pan-European significance. The main driver for their realization is the market integration in CCE region (congestion on SK-HU profile), handling the unscheduled physical electricity flows across the CCE region and enhancement of transmission systems security of both Slovak and Hungarian system, especially during outages and maintenances on other interconnections between the countries. This transmission border is thus often overloaded and the Slovak TSO is forced to mitigate the unscheduled flows´ impact by the operative measures which do not only help to deal with the mentioned flows but also decrease the operation reliability of the Slovak transmission system and by the market measures as a NTC on the Slovak - Hungarian profile decrease. Both of these projects are thus commonly promoted by Slovak and Hungarian TSOs.

Other Slovak investments mentioned in this RgIP have been already either commissioned (Nr. 293 “Connection of 400kV substation Voľa”, Nr. 295 “2x400kV line Lemešany - Moldava”, Nr. 296 “400/110kV substation Medzibrod”, and Nr. 719 “400/110kV substation Voľa”) or are still planned in a longer term horizon (Nr. 294 “2x400kV line Lemešany – Veľké Kapušany”, Nr. 845 “2x400kV line Križovany – Horná Ždaňa”, and Nr. 297 “400kV substation Bystričany”). The already commissioned investments replaced obsolete and non-perspective 220kV assets in respective region of Slovakia whereas the rest of planned investments will reinforce the 400kV level of the Slovak transmission system. These investments have mainly national significance, but investment Nr. 294 has in addition regional significance and also helps to accommodate trans-regional (trans-European) electricity flows.

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In Romania the main drivers for grid extension are RES integration and transfer capacity improvement with neighbouring countries.

The PCI 138 Black Sea Corridor 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 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 9000 GWh of RES (spillage avoided) 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. It helps integrate about 5000 MW of RES (out of which 1330 MW direct connection) on the Black Sea Coast in Romania and Bulgaria.

The PCI 138 Black Sea Corridor contains investments 273 (new OHL Cernavoda-Stalpu 400kV), 275 (new 400 kV OHL Smardan-Gutinas) , 276 (new 400 kV OHL Suceava – Gadalin).

The PCI 144 Mid Continental East Corridor 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 projects directly connect 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).

The project 108 is a purely Romanian project and consists of two double circuit 400-kV lines that are needed to connect to the grid the future 1000 MW Hydro Pumped Storage Tarnita-Lapustesti, situated in the North-West of Romania. The project will supply reserve/balancing services for Romania and possibly for neighbouring countries (Hungary, Serbia, Bulgaria, other). It will support integration of intermittent RES generation.

The 267 new 400 kV OHL Suceava (RO)-Balti (MD)will increase capacity of transfer between Romania and Republic Moldova.

The following regional investments will allow a large RES integration in Dobrogea and Moldavia regions: investment no. 271 - 400 kV Medgidia S SS upgrade; 272 - Stupina (RO) – Varna (BG) split and 713 - Rahman (RO) - Dobrudja (BG) split and in/out in 400 kV Medgidia S SS; 274 - new 400 kV OHL Medgidia S - Constanta; 712 - upgrade of OHL Stejaru - Gheorghieni; 714 - upgrade of OHL Brazi V - Stalpu; 716 - 220kV Teleajen SS upgrade to 400kV; 717 - upgrade of OHL Fantanele - Ungheni ; 718 - upgrade of Gheorghieni - Fantanele; 913 - new 400 kV OHL Stalpu Brasov.

Figure 6-1 Pan-European Significance and Regional importance investments – Mid-term horizon (<2019)

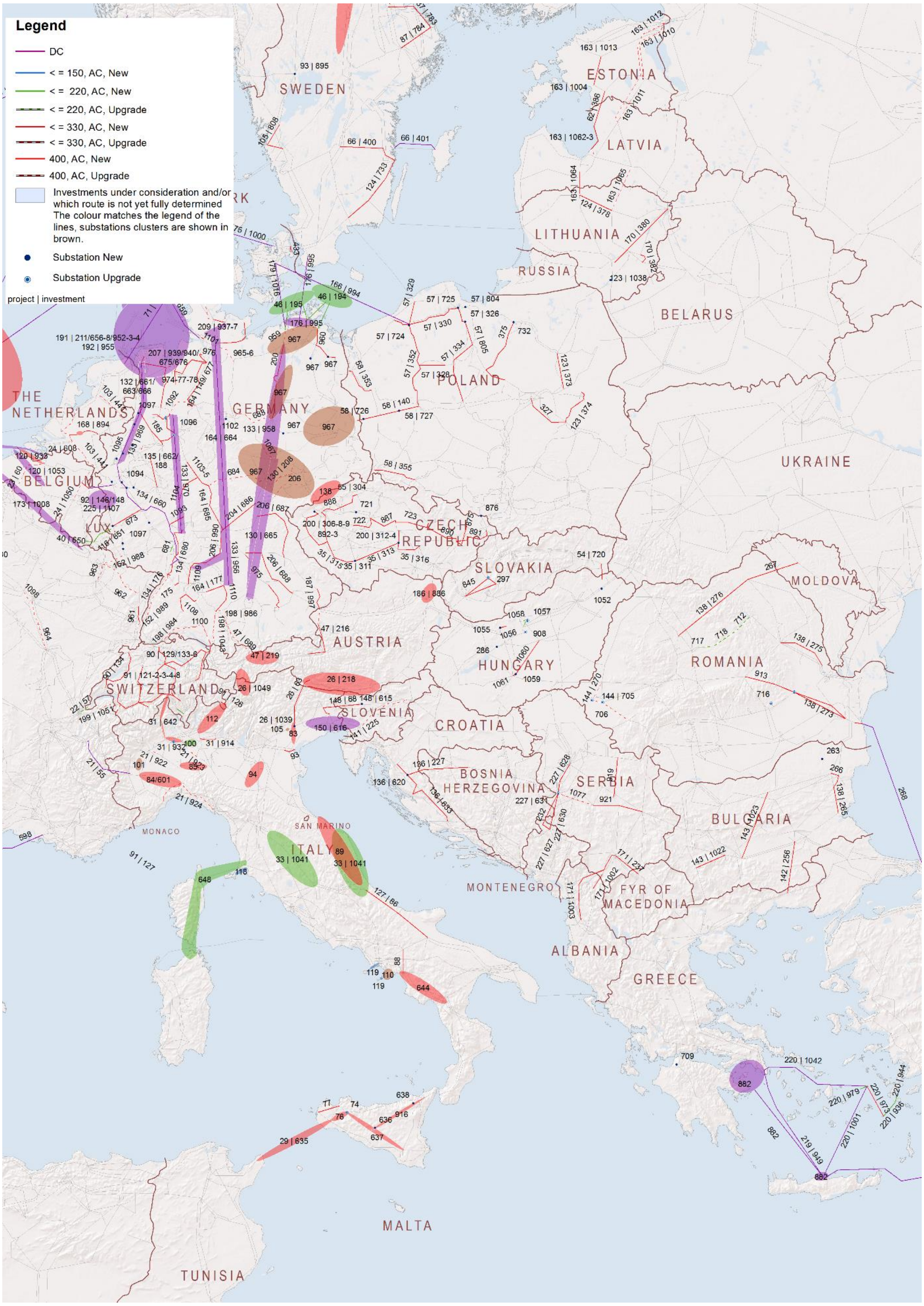

Figure 6-2 Pan-European Significance and Regional importance investments – Long-term horizon (>=2019)

6.3 Assessment of the portfolio

6.3.1 SEW

In order to quantify impact of projects on the European welfare the Social and economic welfare were investigated under all Visions. Based on the Vision 1 assumptions the CCE portfolio having European significance status is divided into 3 nearly same groups when we look at the SEW (34% have SEW lower than 30M€, 34% between 30 and 100 M€ and 32% of projects have SEW higher than 100M€). When consider the assumptions of Vision 4 there is obvious significant change in SEW indicator, The SEW lower than 30M€ has just 12% of project and in rage of 30 to 100M€ 17%, but **71% of projects** has SEW greater than 100M€, which is more than twice more projects than in Vision 1.

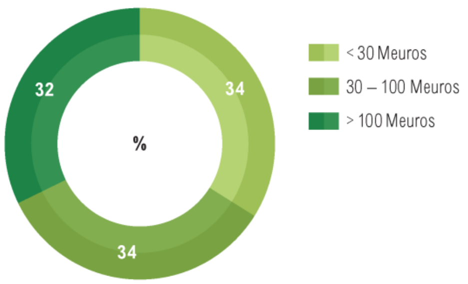

Figure 6-3 SEW of the RG CCE pan-European significance portfolio in 2030 vision 1

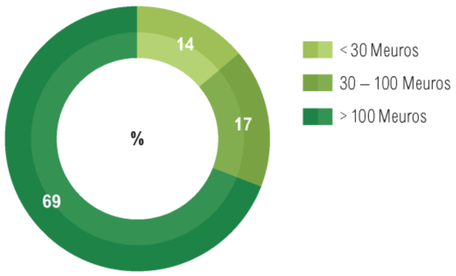

Figure 6-4 SEW of the RG CCE pan-European significance portfolio in 2030 vision 4

6.3.2 CO2

Taking into consideration the one of the most discussed indicators in Europe in relation to the environment CO2 indicator were evaluated. There are also significant changes among Visions when taking into consideration this indicator. About half of the project shows no positive effect (8%) or increase (42%) in CO2 emissions in Vision 1. A decrease lower than 500kt/year is indicated for 26% of projects and greater decrease than 500kt/year for 24%. Vision 4 assumptions brought significant change also for this indicator; there is no project with CO2 emissions increase and 12% of projects with no positive effect. The same number of projects (12%) brings decrease of CO2 emissions less than 500kt/year. 76% of CCE project portfolio has been evaluated as projects with CO2 emissions decrease greater than 500kt/year.

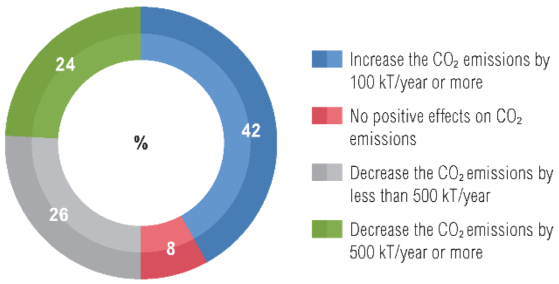

Figure 6-5 CO2 emissions evolution based on the RG CCE pan-European significance portfolio in 2030 vision 1

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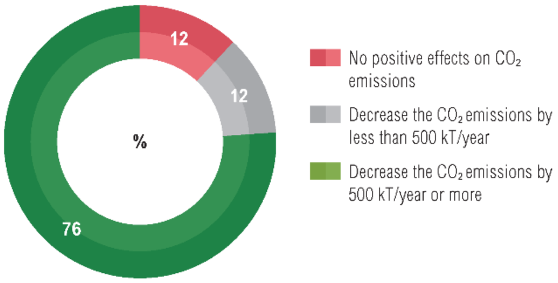

Figure 6-6 CO2 emissions evolution based on the RG CCE pan-European significance portfolio in 2030 vision 4

6.3.3 RES

The amount of the RES integration is assessed by this indicator and as the assumptions of the Visions led to different results, when according to the Vision 1 assumptions 55% of projects have neutral effect, 16% of projects support connection of RES in range 100-500MW or 50-300GWh/year. 29% of projects support evacuation more than 500MW or 300GWh/year. It means that 45% of projects have any importance in RES connection. When considering the assumptions of Vision 4 which is the most challenging Vision in RES connection in Europe, 43% of projects support connection of RES in amount higher than 500MW or >300GWh/year (26% less than 100-500MW or 50-300GWh/year). All together 69% of regional CCE portfolio support RES connection under Vision 4 assumptions.

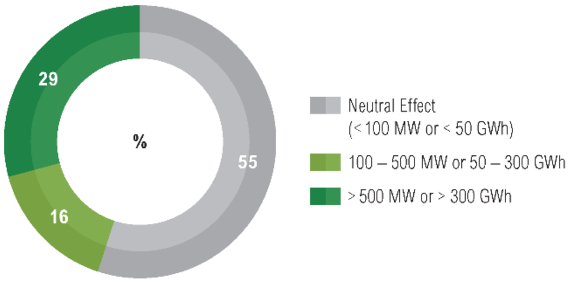

Figure 6-7 RES integration in RG CCE linked to pan-European significance portfolio in 2030 vision 1

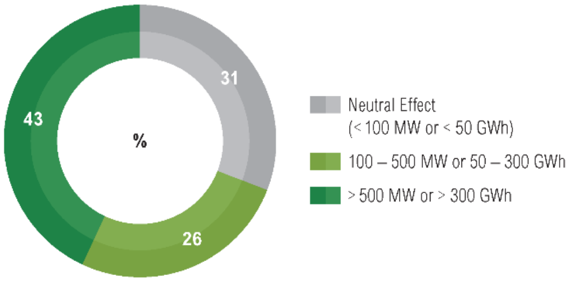

Figure 6-8 RES integration in RG CCE linked to pan-European significance portfolio in 2030 vision 4

6.3.4 SoS

When taking into consideration the definition of SoS indicator there is no specific area supported by any projects in all Visions. However the indicator was calculated by market study. Market studies do not take internal bottlenecks inside one market area into account (e.g. the planned internal German grid extensions increase the SOS of Southern Germany).

6.3.5 Losses

The variation of losses indicator quantifies the contribution of each project to the electrical system efficiency, focusing on the volume of losses variation which each specific project causes in the transmission system. In general for constant transit levels grid development leads to an improvement on efficiency of electrical systems, because of decreasing of impedance of the power system, because of increasing the voltage level or because of using more efficient conductors. On the other hand the development of the interconnection capacity between countries and the RES generation integration along Europe can cause increase of long distance power flows. Therefore, the implementation of new investment projects could lead, in specific situations, to an increase in electrical transmission losses.

Variation in losses indicator can be calculated by a combination of market and network simulation tools on the regional scope. In CCE region the losses variation calculation of pan European significance project was done in the network studies by using the TOOT method, it means compute the value of losses in CCE region with all projects in and then without a particular assessed project and then the difference in MW was multiplied by representativeness values of particular point in time divided we got a value in GWh. We repeat the calculation for each point in time and then sum up all four values and we got the variation of losses in whole year in GWh.

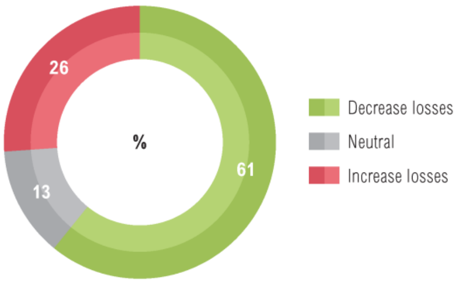

Figure 6-9 Impact of the TYNDP 2014 on the overall losses in 2030 vision 1

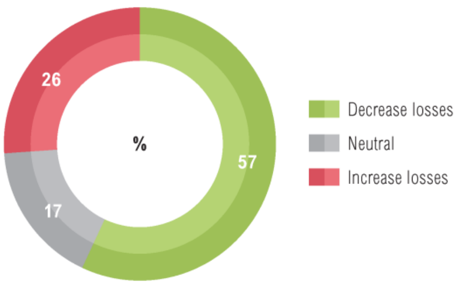

Figure 6-10 Impact of the TYNDP 2014 on the overall losses in 2030 vision 4

The Figure 6-9 provides indication of the impact of Pan-European projects in TYNDP 2014 in CCE region on the losses in the 2030 vision 1. Due to the fact that there is highly meshed transmission grid in CCE region with quite high amount of parallel loops 26 % of pan-European projects in CCE region built in tend to create larger power flows on longer distance hence increase the losses in the CCE region. On the contrary more than 61 % of the pan-E projects in CCE region decrease the losses.

In comparison with the vision 1 assessment results the vision 4 results, depicted on Figure 6-10, show no change in share of the CCE pan-E projects which increase losses in CCE region. It means that the generation dispatch change made in vision 4 compare with vision 1 did not change the share of the "increase losses" projects. The number of pan-E projects in CCE region which have neutral impact on losses in CCE region raised from 13 % in vision 1 to 17 % in vision 4. It can be caused by the generation dispatch change followed by the load flow pattern change in vision 4 compared with vision 1, what could imply closer distance between generation and consumption areas. Due to the above mentioned results of vision 4, share of pan-E projects in CCE region which decrease the losses in CCE region is the same as in vision 1 results (26 %).

6.3.6 GTC

The Grid Transfer Capability (GTC) is one of the most important parameters in transmission systems development which support the fulfilment of European Union set goals regarding RES generation integration into the grid and integration of common European energy market. Therefore for coming decades there is need to facilitate higher power flows across CCE region by means of the designing of the new projects which increase the GTC among main generation and consumption areas and between bidding areas what promotes market integration and security of supply in CCE region therefore the GTC increase is wanted on many boundaries within CCE region. The values of gained GTC are oriented by needs and cover a huge range of transmission capacity increase efforts.

The basic objective of the GTC is to assess the ability of the grid to transport electricity across a boundary between bidding areas or inside bidding area. GTC increase indicator per project is calculated in network assessment by considering stressed network situations. A common grid model is used to assess the future grid transfer capability and behaviour with and without the planned projects. The delta GTC value takes into account congestions in the grid, both inside and between bidding areas and in experience based suitable observation perimeter.

In comparison with others regions the transmission grid in CCE region is highly meshed. The Pan-European projects in CCE region generally strengthen transmission system of CCE region but there are also few projects increasing interconnection capacity with neighboring regions.

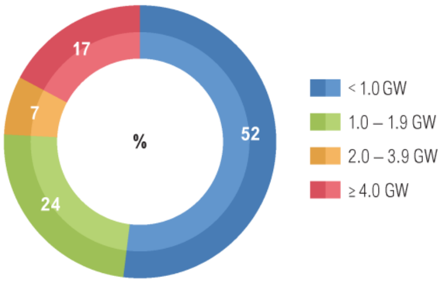

Figure 6-11 GTC increases by 2030 in Vision 4

More than a half of the all Pan-European significance projects in CCE region have GTC contribution less than a 1000 MW and more than 20 % from 1000 up to 2000 MW. It is because of highly meshed grid in CCE region therefore projects do not have such significant impact on GTC increase but have other contributions to future grid development in CCE region. The projects with GTC increase over 2000 MW are mainly German projects to strengthen internal German transmission grid to cope with huge RES integration, long distances between main generation and consumption areas and nuclear power plants decommissioning.

6.3.7 Technical resilience

Technical resilience or system safety margin improves a project's ability to deal with the uncertainties in relation to the final development and operation of future transmission systems and contributes to system security during contingencies and extreme scenarios.

This indicator shows the ability of the system to withstand increasingly extreme system conditions called also exceptional contingencies and measures ability of the different projects:

- to comply with failures combined with maintenance (N-1 calculation during maintenance),
- to cope with steady state criteria in case of exceptional contingencies,
- to cope with voltage collapse criteria.

The assessment scale is divided from 0 to 6 whereas 0 is the minimum value and 6 is the maximum value, where fulfilment of each of the three above mentioned statements can gain maximum 2 KPI points. These technical characteristics depend on the technology of each project no on the scenario therefore one value is presented for all visions globally for each project.

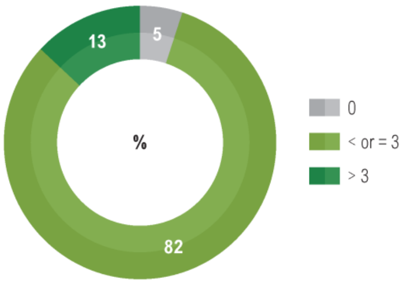

Figure 6-12 Technical resilience/system safety margin indicator

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There are couple of projects in CCE region “scored” more than 3 KPI indicators. All these projects are German projects to reinforce internal transmission grid in Germany, only one is HVDC subsea cable interconnection between Germany and Norway. The internal Germany corridors gained so high score because they are necessary to enable switch-off of assets for maintenance. The corridors includes VSC-DC-Links, which are necessary for (n-1)-security, voltage control and system stability in this area.

6.3.8 Flexibility

Robustness and Flexibility indicator is the ability of the proposed reinforcement to be adequate in different possible future development or scenarios, including trading of balancing services.

In addition, this indicator shows the ability of each project to withstand very wide conditions, measures the different projects ability:

- to comply with important sensitivities,
- to comply with commissioning delays and local objection to the construction of the infrastructure and
- to share balancing services in a wider geographical area (including between synchronous areas).

Scores for each KPI are added to the table and are summated to give an overall score for the project. Each KPI can be given a score of 0, ‘+’, or '++' so one projects can gain maximum 6 KPIs points in this indicator assessment whereas 0 is the minimum value and 6 is the maximum value.

In the TYNDP 2014 assessment process in the CCE region, the ability of each project to comply with important contingencies was analysed based on the four extreme 2030 visions, whether the project is necessary in a limited number of visions or in all the visions. Indeed, these visions were constructed so as to have a wide enough set of scenarios to encompass all the possible futures.

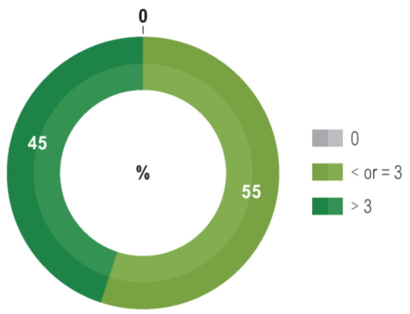

Figure 6-13 Technical resilience/system safety margin indicator

None of the on-E projects in CCE region score maximum 6 KPIs score but 45 % of the projects score more than 3 KPIs points and it implies high contribution of these projects to all of the three above mentioned conditions in this indicator are needed in all visions, are resistant to a commissioning delays and contribute in share of balancing services. Other projects have minor contributions to robustness indicator conditions.

6.3.9 S1-S2 indicators

Projects identified as a crucial to support electricity market and possible future energy mix have to connect the areas with energy surplus and areas lack of production capacity. The ENTSO-E members are planning their infrastructure to minimize the length of the infrastructure, optimize routing to decrease needed number of lines (corridors) and avoid conflict with protected or urban areas. Due to high density of population and high biodiversity in Europe the effort of TSOs to mitigate this influence is challenging but manageable. These additional indicators aim to provide non-technical information about routing of lines or cables in among European urban and environmentally protected areas. One could say that due to a connection of energy

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sources dependent on suitable weather conditions (mostly wind) the need for lines construction in nature is increasing.

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 effects of projects on environmentally protected or urban areas, 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 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 knowledge 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]).

Projects in CCE region mostly correspond to the limited area affected by the project, mostly due to effort of TSOs to mitigate such influence. For more than 2/3 of projects the indicators show very limited line length having any potential impact on urban or environmentally protected areas.

The group of projects with indicator higher than 15km are mostly related to the long corridors to transmit significant amount of energy from RES to demand especially in Germany. On the other hand these projects and their particular routing are not fix yet and therefore by detailed assessment the indicator can be harmonized and mat changed.

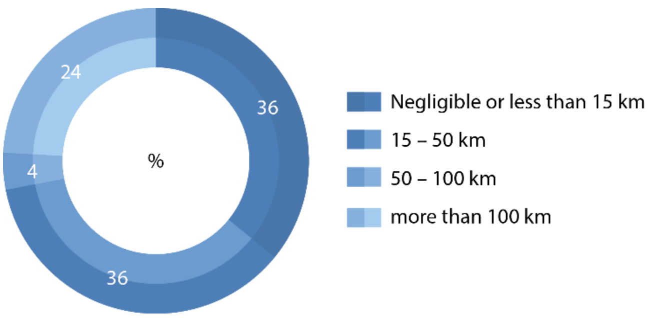

Figure 6-14 RG CCE project portfolio with relation to protected areas

[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

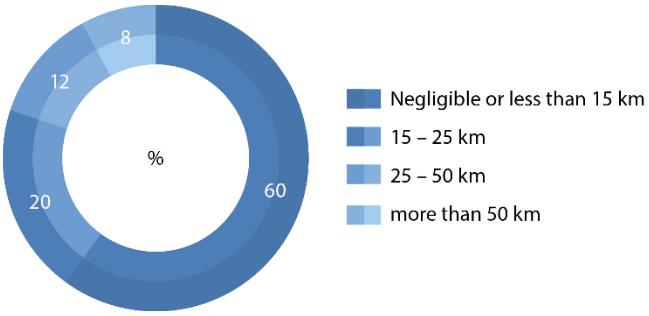

Figure 6-15 RG CCE project portfolio with relation to urban areas

6.4 About €50 billion by 2030 in CCE region: a financial challenge

Total investments costs for the portfolio of projects of pan-European significance in CCE region amount to about €50 billion. The breakdown of the total investment cost per country for all projects of pan-European significance is supplied in Table 6-1:

Table 6-1 Investment cost breakdown in billion Euros in CCE region

AT	1.9
CZ	1.5
DE	34.8-54.2
HR	0.2
HU	0.1
PL	1.9
RO	0.5
SI	0.6
SK	0.3
Total	**41.8-61.2**

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

- A focus in the TYNDP 2014 process on a longer term horizon, 2030 instead of 2020
- The integration of more RES, especially the costly offshore production
- The interconnection of different regions via long distance connections (e.g. German corridors)
- The use of cutting edge technologies (e.g. HVDC VSC) mainly to enable more power to be shifted over a longer distance

The portfolio of projects of pan-European significance must however be completed at the regional or national level to achieve an overall consistent development of the whole energy system. Some additional infrastructure

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may also be required to completely support the Vision 4 environment. More precise location of generation in particular would be required to supply a more comprehensive picture of the grid infrastructure.

The financial challenge

The European transmission infrastructure will require massive investments in the coming decades in order to achieve the European Energy policy targets. Approximately 80% of the TYNDP 2014 projects contribute to RES integration, thus reducing CO2 emissions in Europe. TYNDP 2014 projects furthermore facilitate European Market Integration and improve the overall system reliability. In addition, transmission investments in the TYNDP 2014 will pave the way for the attainment of the forthcoming 2030 and 2050 EU Energy and Climate goals.

Financial significance of TYNDP 2014 projects for consumers and for investors

Even though TYNDP projects directly contribute to the achievement of crucial policy goals, they only constitute a small percentage of the total electricity bill. Total TYNDP 2014 investments amount to approximately "1.5 – 2" €/MWh of the power consumption in Europe by 2030, i.e. about 2% of the bulk power prices or less than 1% of the total end user´s electricity bill".

Nevertheless, TYNDP 2014 projects impose a significant financial challenge on TSOs and investors. This is due to the large volume of the TYNDP 2014 investment portfolio and the fact that TYNDP 2014 projects represent only a subset of all transmission investments needed in Europe.

The challenge

TYNDP 2014 investments will take place in a challenging context. Rising investment volumes are likely to be accompanied by higher risk profiles, thus leading to increased capital costs (debt and/or equity) for TSOs and investors. For instance, many TYNDP 2014 investments are based on innovative technologies, which incur more uncertainties than proven technologies. Moreover, there is a lack of incentives within the current regulatory framework of most European countries, which tend to focus on lowering tariffs and setting relatively low returns for transmission investments. Similarly, most of current regulatory regimes fail to take into account finance-ability issues sufficiently. This reduces current cash flows and delays the payment of investments for the future.

At the same time, existing financial instruments are insufficient to bridge the financial gap. Project bonds with subordinated debt and guarantee facilities may represent a viable option in specific circumstances, but they have limited applicability to transmission investments due to the scarce availability of resources and the fact that the majority of TSO projects cannot be ring-fenced. More importantly, project financing may be more expensive when compared to traditional corporate finance options for most TSOs. Grants may also help to overcome difficulties in raising capital for TSOs or projects with severe financial problems. However, their volume is scant and their applicability is restricted to projects being "commercially not viable". In addition, they represent a more costly option, as grants are direct subsidies with no significant leveraging.

In this challenging framework, projects promoters face the risk of having their credit ratings lowered and their financial ratios deteriorating.

The solution

In order to prevent the transmission business from being perceived as unattractive for investors in the global financial market, regulatory frameworks need to provide stable and investor-friendly conditions and instruments. The long lifetime of network assets requires long-term capital commitment. Transmission investments should generate a stable and predictable regulatory return throughout their lifetime, thus keeping the costs of capital as low as possible. Moreover, the return on investments should equal the remuneration for comparable investments so that generated cash flows are sufficient to maintain the ability of project promoters to raise funds in global capital markets. Once again, by improving the risk-reward balance of projects, lower costs of capital will be achievable for the development of the necessary transmission investments.

One efficient, simple, cheap and effective solution to attract investors and help finance the required transmission investments is the Priority Premium, i.e. an add-on or supplement on top of the typical regulatory rate of return which could be applied to important projects. This mechanism would improve the ability of investors to raise the funds necessary for the timely delivery of the transmission investments which are vital for achieving the EU energy policy goals.

Other possible solutions to these issues have been identified in the ENTSO-E public position paper "Incentivising European investments in transmission networks"[20].

[20] [See https://www.ENTSO-E.eu/fileadmin/user_upload/_library/position_papers/130523__Incentivising_European_Investments_in_Transmission_Networks_Final.pdf]

7 2030 transmission capacities and adequacy

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

7.1 Target capacities by 2030

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

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

- In a meshed grid, parallel boundaries are interdependent and for a very similar optimum, different set of values can be envisaged although only one is displayed.
- The value of additional capacity derives directly by nature 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 based on 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[21] for interconnection development, asking from every Member State a minimum import capacity level equivalent to 10% of its installed generation capacity 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 single values can only be misleading. Globally, the maps displayed in this section should be considered rather as illustrative.

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

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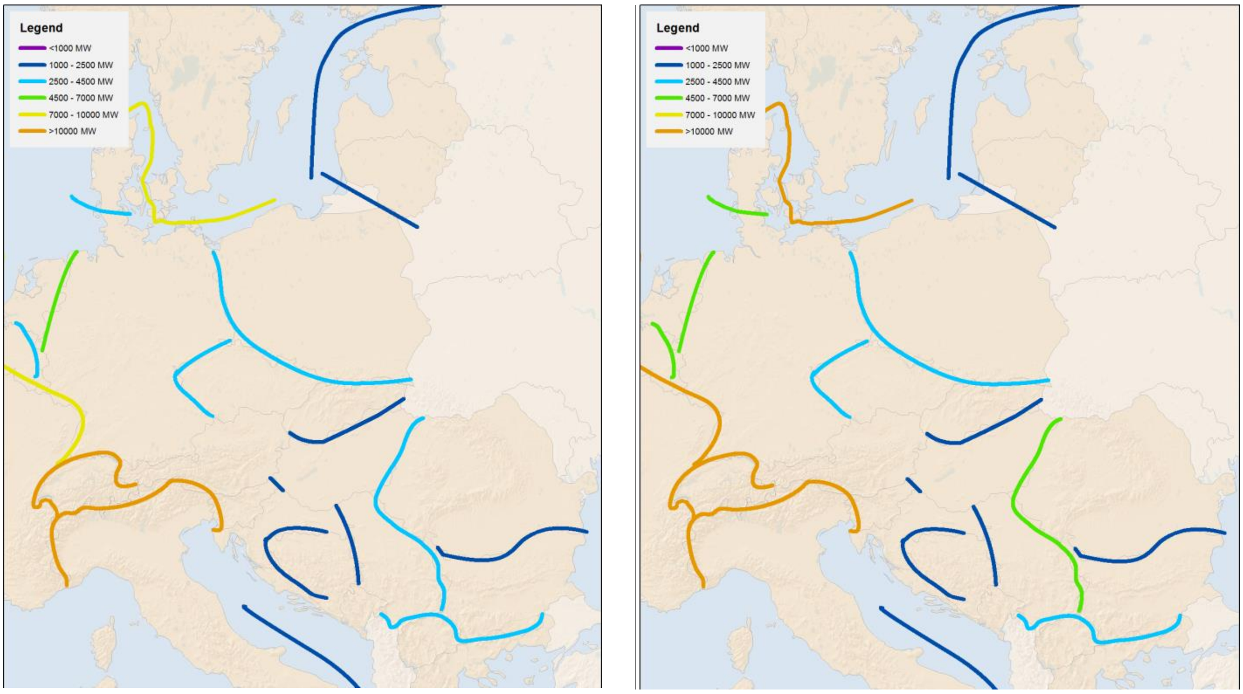

Figure 7-1 Target capacities by 2030 in Vision 1 (left) and in Vision 4 (right)

Both maps show similar patterns, when we consider the differences between areas with higher and lower needs, however the magnitude of the target capacities is relatively higher under the assumption of Vision 4. The areas with higher magnitude are located on the RG CCE border mostly in the North-South direction and from East to West.

On the other hand, target capacities fall in the same range of magnitude in both Visions for other boundaries in the CCE region, with the exception of the boundary between Romania, Bulgaria. Otherwise, moving from Vision 1 to Vision 4 – i.e. basically, integrating more RES – makes the magnitude of the target capacities basically increase by one range category.

7.2 Transmission adequacy by 2030

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

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

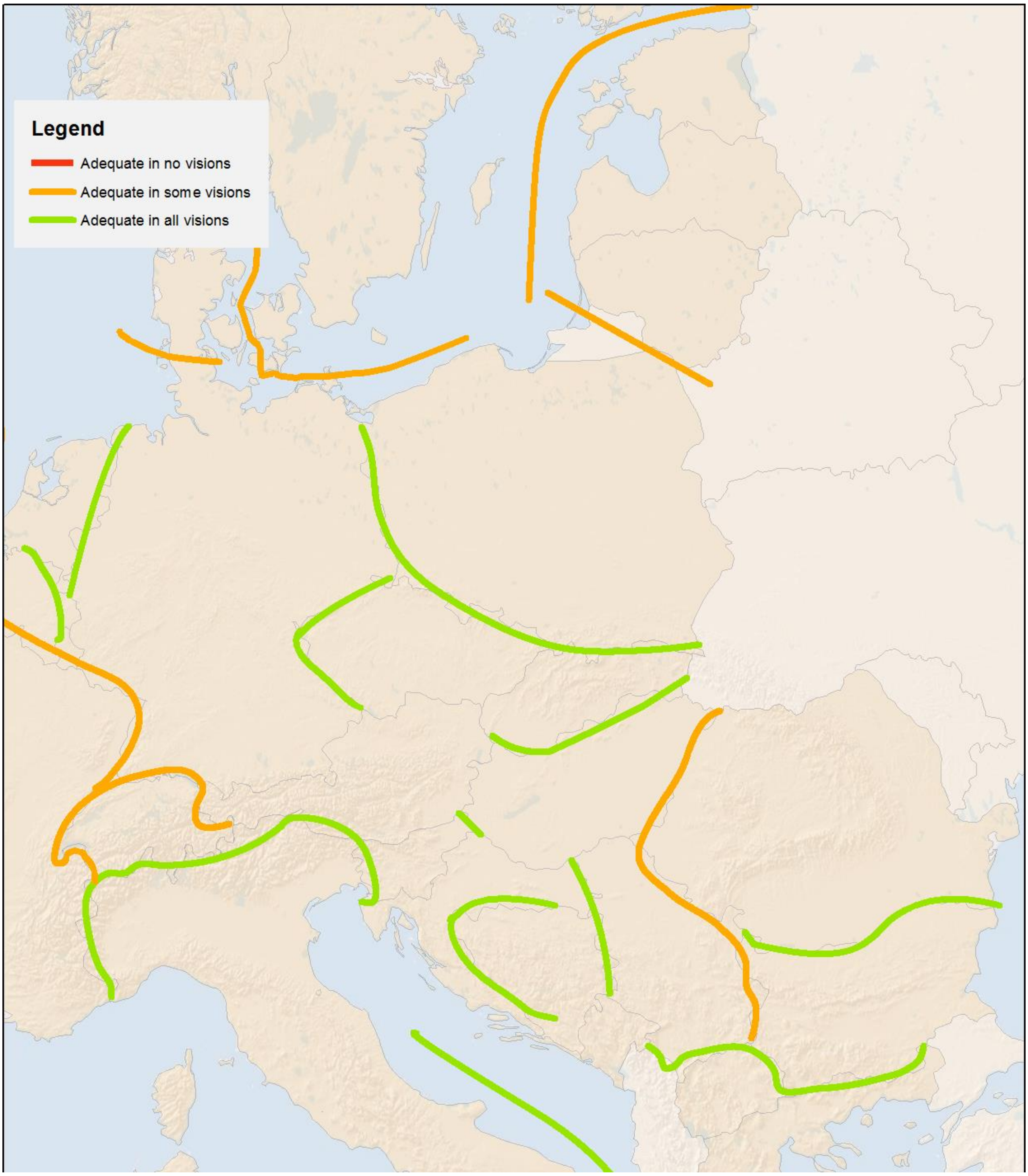

Figure 7-2 Transmission adequacy by 2030

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

Some boundaries are orange on the border of RG CCE and Romania-Hungary: there, all the listed projects are prerequisite to meet target capacities goals, but some additional grid reinforcements are required to cover investment needs specific to the most ambitious scenarios of RES development by 2030 (especially by challenging assumptions of Vision4).

Especially, Vision 4 could only be used to assess the already identified projects' portfolio; investment needs investigation in this Vision requires additional input and feedback from stakeholders (more precise location of generation especially) so that a more comprehensive picture of the grid infrastructure can be supplied. Such interaction and continuous adaptation is normal, considering uncertainties regarding the realisation of the challenging transformation of the generation mix, or interconnection of Europe with Africa or Russia.

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8 Environmental assessment

This chapter supplies a synthetic overview of the environmental assessment of the grid development depicted in the CCE 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 CCE 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 8.3.9.
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.

Assessment results of social and environmental indicator are described in chapter 8.3.9 therefore here another key statistics and parameters for environmental assessment are to be shown.

8.1 Grid development is key for RES development in CCE region (Europe)

One of the most important drivers for the 2030 Visions is RES development. Along with RES development, the grid development is needed accordingly, especially if RES are going to be developed in such a high amount as in 2030 Visions is indicated. In the Vision 1 there is 72 GW installed capacity of RES in CCE region and in the Vision 4 it represents 275 GW. The share of the load covered by RES in CCE region varies from 21 % in Vision 1 to 46 % in Vision 4.
As a result, roughly 55 % of the all projects of Pan-European significance in CCE region help integrate RES. Other projects which do not have any result in CBA assessment of RES also help to integrate RES, in this case there is a comment how project helps to integrate RES. Besides, projects improving market integration, developing especially new interconnection capacity, help actually integrate RES: basically they enable any RES surplus in one area to find outlets in a neighbouring one, and make market more resilient and less subject to price tensions (e.g. prices equals to zero).
In most severe cases, projects of pan-European significance avoid RES spillage. The German corridors show the largest benefits with respect to avoiding RES spillage (avoided RES spillage about 10 TWh/yr in Vision 1 and about 30 TWh/yr in Vision 4).

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Figure 8-1 Yearly amount of RES generation and demand along with share of yearly RES generation and yearly consumption energy in Vision 1

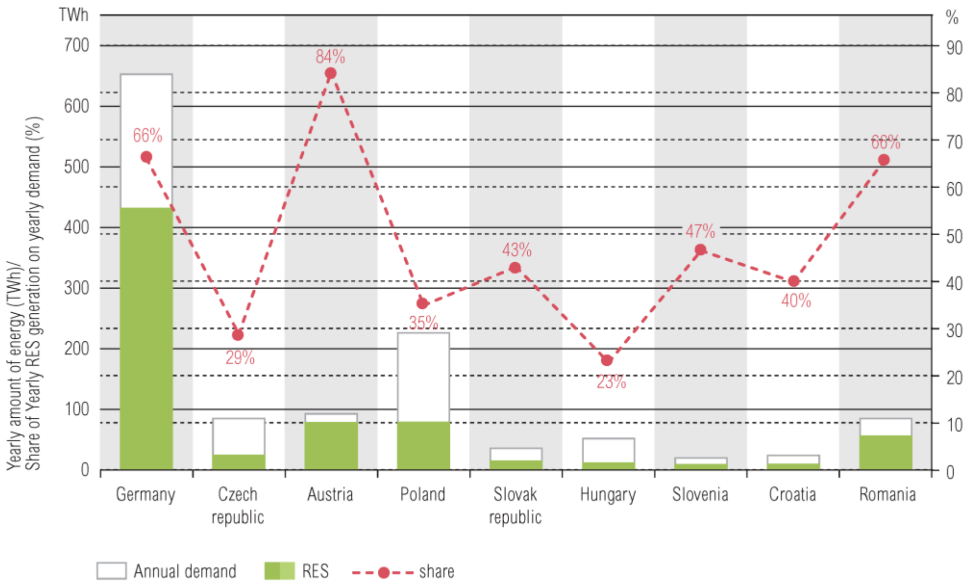


Figure 8-2 Yearly amount of RES generation and demand along with share of yearly RES generation and yearly consumption energy in Vision 4

8.2 The Plan make ambitious CO2 emissions mitigation targets possible

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

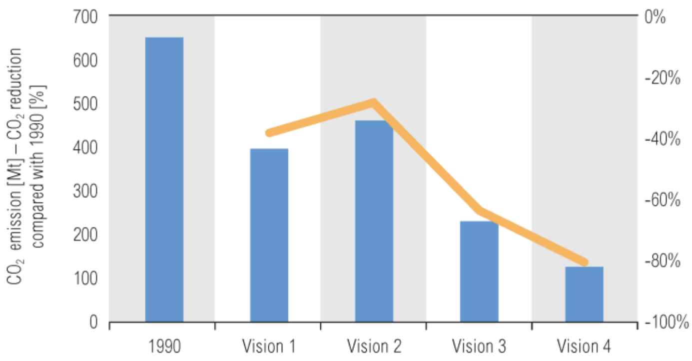
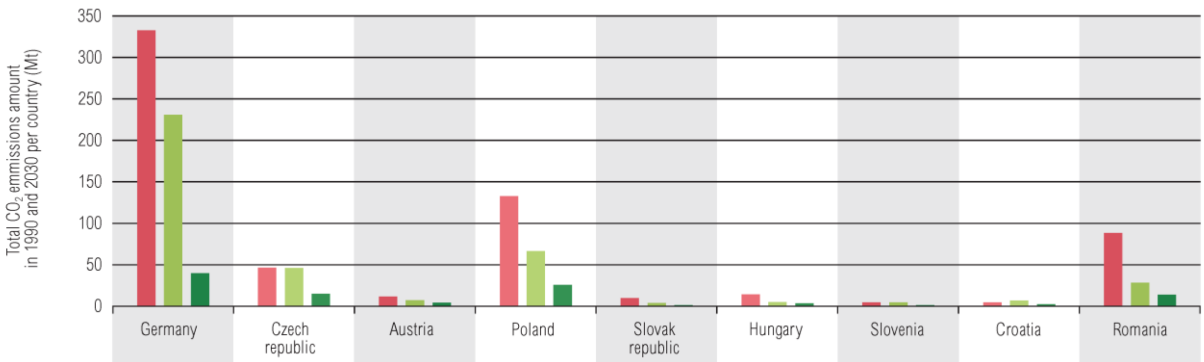


Figure 8-3 CO2 emissions volumes and reductions in CCE region in comparison with 1990 through the 2030 Visions



	Germany	Czech republic	Austria	Poland	Slovak republic	Hungary	Slovenia	Croatia	Romania
1990	332	46	12	133	10	14	4	4	88
Vision 1	231	46	7	66	4	5	5	7	28
Vision 4	40	15	4	26	1	4	1	3	14

Figure 8-4 CO2 emissions volumes and reductions in CCE region in comparison with 1990 through the 2030 Visions per country

A lower consumption and the development of carbon-free technology (RES, nuclear, carbon capture and storage) instead of fossil fuel technology without carbon capture and storage are the two keys to reducing CO2 emissions in the power industry.

The grid has an indirect but essential positive effect on CO2 emissions as it is a prerequisite to implement clean generation technologies: the grid gives them 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. 50 % of the projects of pan-European significance in CCE region contribute to CO2 reduction.

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

By 2030, the generation fleet will experience a major shift. The net generating capacity is expected to grow in the future. The construction effort will have to account not only for the net increase but also for the replacement of almost half of the present units, which will come to the end of their life-time within the coming 15 years.

On the other hand climate change mitigation and competition will require energy efficiency measures but also transfer from fossil-fuel based end-users to CO2-free energy sources (i.e. more trains, electric vehicles and heat pumps for instance).

The major driver for grid development is generation. In case of long distance between new generating capacities, especially RES (wind generation develops mostly as large wind farms, also offshore) and load centres, development of new transmission grid reinforcements is expected. 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.

8.4 New transmission capacities with optimised routes

In the transmission grid of the CCE region there will be approximately 28000 km of the new transmission lines built and approximately 3500 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, such as Germany, this is a challenge. The assessment of the urbanized and protected areas affected by the new lines is also described.

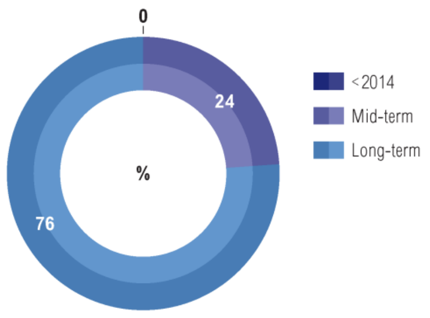


Figure 8-5 Division of the investment in the CCE region per commissioning horizon according to length

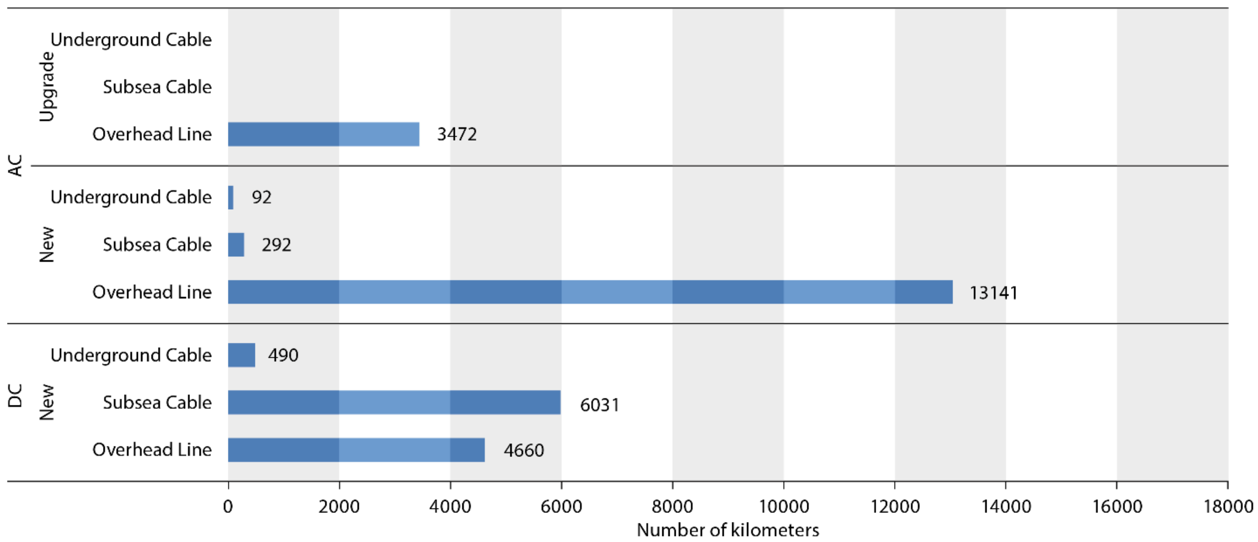


Figure 8-6 Division of the investment in the CCE region per technology

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8.5 Mitigation measures

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.

9 Assessment of resilience

9.1 The general framework

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

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

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

RESILIENCE TO SEVERE CONTINGENCIES

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

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

consequences. These investigations are of particular relevance for network equipment which may be unavailable for a considerable period of time due to a failure, maintenance or overhaul.

MITIGATION MEASURES

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

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

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

NEW OR EFFICIENT TECHNOLOGIES

The easiest step required in order to increase the capacity of an existing grid is partly the optimization of the present system components - reallocate power flows on power lines, for example with the implementation of FACTs and PSTs;
PSTs and FACTs can help to allocate the flows from high loaded elements in the grid to lower loaded ones and can contribute to the capacity of the existing grid being used in an optimal way. Both technologies are available and well researched. These technologies are complementary to grid expansion since they only add limited transfer capacity through the control of power flows but they do not cancel the need for new transmission lines.

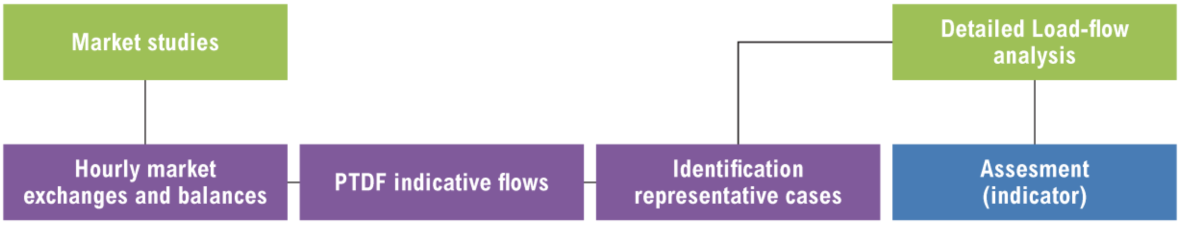
MULTIPLE SCENARIOS CONSIDERED FOR IDENTIFICATION/JUSTIFICATION OF PROJECTS

The next section describes the process of the selection of representative cases based on market simulation results for TYNDP Visions.

9.2 Visions studied in CCE region

Visions studied by regional group CCE was prevailed concentrated onto main TYNDP 2014 visions, which were used afterwards for project assessment. Theses visions represent group of scenarios which cover some possible extremes of future generation and load development.

For each Vision the 8736 hours (equivalent to 52 weeks) were simulated by market simulation tool, it means ca. 35 000 cases for further load-flow analysis. All these cases were analysed first by PTDF matrix tool, which provides first overview, how can be loaded particular profiles upon the assumptions without any detailed analysis of individual line loading or N-1 or even voltage analysis.



Set of criteria were discussed and set up to further detailed analysis to cover all 8736 cases by 4 representative ones. The criteria followed the situation within the CCE region (e.g. German Export/Import, RES production, Demand in Poland, Market Exchanges over the particular borders, …) and its threshold for each criteria were defined (e.g. Export/Import has threshold 0). Further steps led to identification of 4 Points in Time to represent situations with e.g. high export other with import and so on according to the criteria defined among 8736 hours taking into the consideration defined thresholds. Those representative cases represent starting points for project assessment in respect to indicator technical resilience (in total 16 cases for detailed analysis represented about 35000 market exchanges eventualities).

10 Conclusion

Looking forward, up to 2030, the TYNDP 2014 package confirms the conclusions of the TYNDP 2012 package.

Following the substantial increase of RES deployment which is foreseen for the year 2030, and in Vision 4 the so called “Green Revolution”, decommissioning of a large proportion of traditional units due to ageing or policy change is becoming increasingly common. It is being replaced by different units, comprising more variable power generation, located differently and in most cases far away from load centres which will cause significant change in today’s generation portfolio. This renewal of the generation infrastructure is the major challenge for the transmission grid. As a result, ENTSO-E forecast larger, more volatile power flows, over larger distance across Europe.

As outlined in this CCE RgIP report the connection of new generation mainly from RES (Wind and Solar) shall continue to be for the CCE region among the main drivers for grid development, complemented by the need to ensure market integration by erecting new transmission infrastructures between profiles and maintaining security of supply. Germany will continue to be the dominant country with the highest share of RES in the region and for the entire ENTSO-E. However, countries such as Poland, Austria and Romania also foresee a noticeable increase of RES in its generation portfolio. Furthermore, while Germany intends to shut all its nuclear plants, a substantial increase for year 2030 from nuclear power generation is foreseen from countries like the Czech Republic, Hungary, Romania, Slovakia and Poland.

With approximately one-third share of the total expected installed generation capacity in the entire ENTSO-E area, the CCE region shall continue to play in Europe a core role in the system adequacy and energy sector at large.

One should take note that, from the performed analyses, the importing and exporting characteristic of the CCE region as a whole depends on the behaviour of the assessed Visions. In visions with large share of RES the CCE region behaves like a net importer while in visions where fuel and CO2 are in favour, i.e. Vision 1 and 2, the CCE region behaves like a net exporter. In the studies it has been revealed and due to its location that the CCE region is at the crossroads of the prevailing North-South and East-West power flow axes, between RES wind sources in the North and storage capacities in the Alps.

Roughly more than half of all the projects of Pan-European significance in CCE region help integrate RES. Moreover, in most severe cases, projects of pan-European in significance avoid RES spillage.

The evolution of regional CCE investment portfolio leads to the conclusion that about less than one-third of all its investments (including those of pan-European and regional significance) are delayed. All delays are related to permit grant procedures and negative public attitude towards construction of lines (notably overhead lines). About half of the projects are expected to be commissioned on time or expected ahead of time.

From the medium-term market integration perspective more capacity is needed between Germany and Poland. Following future possible power flows with more emphasis on the exploration and enhancement of the market opportunities between borders, such as Slovakia-Hungary is among those border candidates, which are necessary for additional interconnection capacity.

Regional Group Continental Central East system is characterized by its interconnected systems, where all countries have at least 4 interconnections to adjacent TSO (including DC connection). Majority of these TSOs inner systems are AC systems; thus their systems and capacities are influenced by unscheduled power flows. Looking to the development of market capacities; increase of peak values is revealed in the TYNDP 2014 in comparison to the TYNDP 2012. Particularly this increase of peak NTCs applies to Hungarian-Romanian border, where the NTC went above 1GW in both directions. Related to the Hungarian-Croatian border there was also an increase over 1GW in the import direction from Croatia to Hungary. NTC peak increase was also reached on the Czech-German border in the German export direction to the Czech Republic and on the Czech-Austrian border in the Czech export direction to Austria also over 1GW for both borders. Target capacities

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are therefore proposed as requested by EU. The unplanned loop-flows will continue to be an issue which TSOs in the region will have to tackle in a coordinated manner.

From a Security of Supply perspective for a control area like Germany, the issue of unflagging movement of generation capacity from southern part (with concentrated demand) to northern part is a trigger for grid investments which will facilitate the expected flows from North to South to ensure Security of Supply.

Generally, a major regional concern is that the grid development may not be in time if the RES targets are met as planned by 2020 and 2030. Permit granting procedures are lengthy, and often cause commissioning delays. If energy and climate objectives are to be achieved, it is of upmost importance to smooth the authorization processes.

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

Transit flows which rank significantly among problems in the region have and will continue to trigger short- and medium-term measures besides grid extensions which are inevitable in order to ensure operational security of the transmission power system. Because of the above mentioned reasons installation of PSTs (Phase Shifting Transformers) is considered as an inevitable measure with which to solve congestion in Poland, Czech Republic and on their heavily loaded connections to Germany (50Hertz) and possibly also in other countries (TSOs) in the CCE region. The next step, although more difficult and much more costly, shall be the new infrastructure erection mainly in the Germany North-South and Northeast/Southwest direction.

To conclude, large scale penetration of renewable energies in the CCE region can only be realized along with the extension of transmission networks' infrastructure.

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Appendices

11 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 displays the detailed assessment of Projects of Pan-European significance within the Continental Central East 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 11.2 displays the list of all projects and investments within the Continental Central East region, including latest information on the evolution of each investment since TYNDP and RgIPs 2012.
- Section 11.3 displays the list of all commissioned investments within the Continental Central East region.
- Section 11.4 displays the list of all cancelled investments within the Continental Central East region.
- Section 11.5 displays the assessment of storage projects within the Continental Central East region, complying with Reg 314/2013.

11.1 Transmission projects of pan-European significance

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

11.1.1 Transmission projects of pan-European significance

All projects (but one) presented in Section 11.1 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.

11.1.2 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.

11.1.3 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.

11.1.4 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, CO2 emissions variations;
- Additional comments, especially regarding the computation of CBA indicators.

Remarks

- Uncertainties are attached to these forecasts, hence assessment figures are presented as ranges.
- In the same respect, a ‘0’ for losses or CO2 emissions variations means a neutral impact, sometimes positive or negative and not a strict absence of variation.
- Some projects of pan-European significance build on already commissioned investment that were mentioned in the TYNDP (as well as they all build on the existing grid assets), or other investments that are of regional importance. This is mentioned in the ‘additional comments’ as the case may be.

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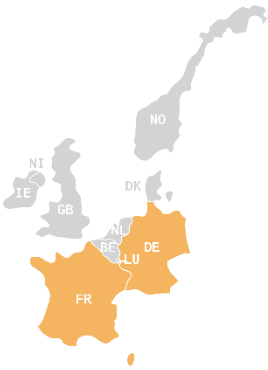
11.1.5 Assessment of projects of pan-European significance

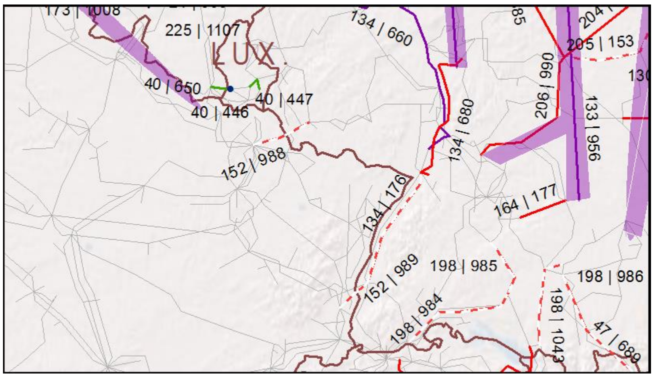
Project 152: France Germany Interconnection

Description of the project

The project aims at increasing the cross-border capacity between Germany and France by reinforcing the existing axes in Lorraine-Saar and Alsace-Baden areas. Studies in progress showed positive impact, with main benefits in terms of market and RES generation integration.

Detailed timeline is under discussion between RTE, Amprion and TransnetBW.





Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
988	Vigy	Ensdorf or further (tbd)	Upgrade of the existing transmission axis between Vigy and Ensdorf (Uchtelfangen) to increase its capacity.	1500	Under Consideration	2030	New Investment	Studies in progress showed positive impact on FR-DE exchange capacity (investment contribution to GTC highly dependent on the scenario and on generation/load pattern). Technical feasibility under investigation. Commissioning date depends on the scope of the investment.
989	Muhlbach	Eichstetten	Operation at 400 kV of the second circuit of a 400kV double circuit OHL currently operated at 225 kV; some restructuration of the existing grid may be necessary in the area.	300	Under Consideration	2026	New Investment	Studies in progress showed the feasibility of upgrading the existing asset in order to provide mutual support to increase exchange capacity between FR and DE.. The detailed timeline of the investment is under definition.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
FR=>DE: 1000-2000	DE=>FR: 1000-2000	1	4	NA	NA	100-140

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[18;22]	0	0	0
Scenario Vision 2 - 2030	-	[48;59]	0	0	[1200;1400]
Scenario Vision 3 - 2030	-	[140;170]	[130000;160000] MWh	0	[-860;-700]
Scenario Vision 4 - 2030	-	[220;270]	[200000;250000] MWh	0	[-1400;-1100]

Additional comments

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

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

Comment on the Losses indicator: basically, the project enables power exchanges over greater distances (increasing losses), and conversely reduce the overall resistance of the grid. Losses variation is hence symbolically 0, with depending on the point in times losses being lower or greater, with variation close to the model accuracy range.

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

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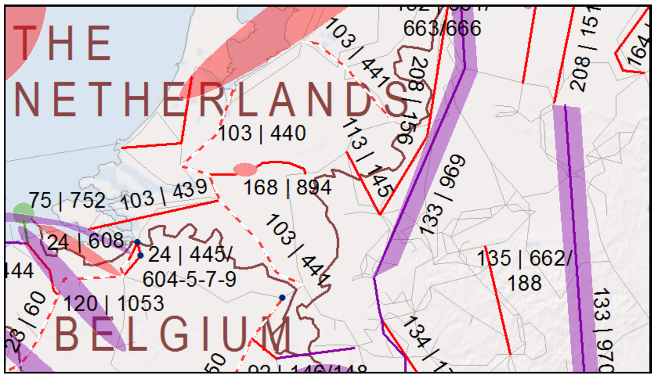
Project 113: Doetinchem - Niederrhein

Description of the project

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

PCI 2.12



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
NL=>DE: 1400	DE=>NL: 1400	3	3	15-50km	25-50km	190-220

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[0;10]	[4500;5500] MWh	[-39000;-32000]	[-11;-9]
Scenario Vision 2 - 2030	-	[4;5]	0	[-39000;-32000]	[-27;-22]
Scenario Vision 3 - 2030	-	[15;65]	[100000;130000] MWh	[-180000;-150000]	[-770;-630]
Scenario Vision 4 - 2030	-	[40;60]	[63000;77000] MWh	[-180000;-150000]	[-1000;-1200]

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Additional comments

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

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

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Project 92: ALEGrO

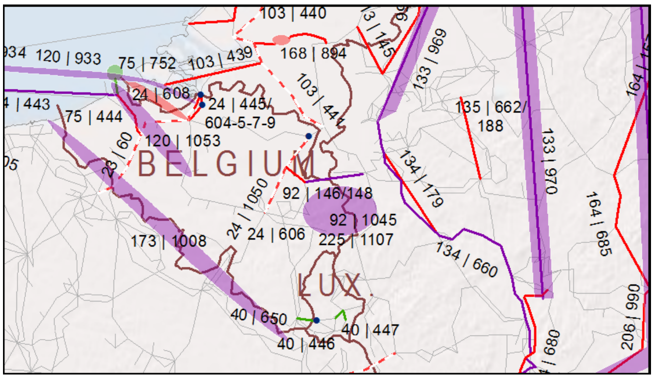
Description of the project

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

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

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

The project has been selected as PCI 2.2.



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
BE=>DE: 1000	DE=>BE: 1000	3	3	Negligible or less than 15km	Negligible or less than 15km	450-570

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[5;15]	[9000;11000] MWh	[150000;180000]	[140;170]
Scenario Vision 2 - 2030	-	[5;15]	[4500;5500] MWh	[150000;180000]	[-22;-18]
Scenario Vision 3 - 2030	-	[35;45]	[100000;130000] MWh	[120000;140000]	[-800;-650]
Scenario Vision 4 - 2030	-	[45;75]	[180000;210000] MWh	[120000;140000]	[-1100;-900]

Additional comments

Comment on the security of supply: A new interconnector contributes to the security of supply of Belgium as a whole, due to the diversification it offers to the market players to import energy from countries where excess generation could be available. Given the changing production mix with ongoing nuclear phase out and decommissioning of old power plants, this benefit materializes itself as soon as the project is realized.

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

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

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

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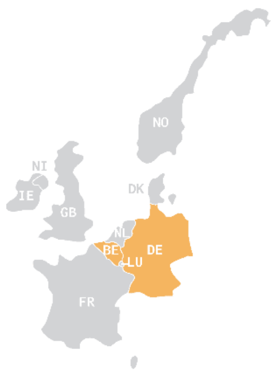
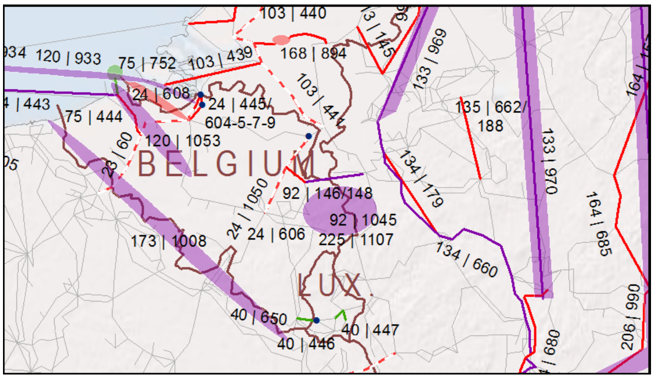
Project 225: 2nd Interconnector Belgium – Germany

Description of the project

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





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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
BE=>DE: 1000	DE=>BE: 1000	2	1	NA	NA	400-600

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 4 - 2030	-	[45;55]	[150000;180000] MWh	[120000;140000]	[-850;-690]

Additional comments

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

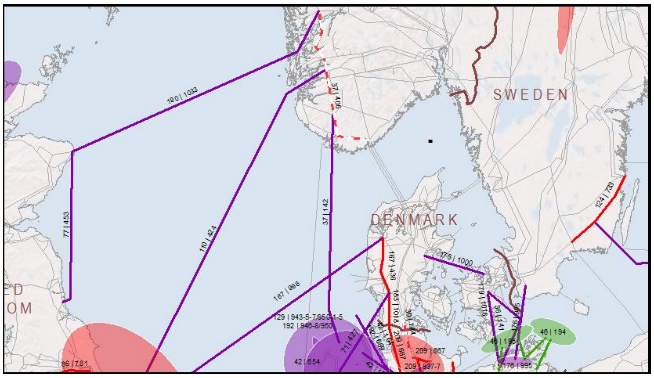
Comment on the S1 and S2 indicators: no indicator can be assessed as the project is still under consideration.

Project 37: Southern Norway - Germany

Description of the project

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

PCI 1.8



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

CBA results

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

CBA results non scenario specific

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GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
DE=>NO: 1400	NO=>DE: 1400	3	4	50-100 km	Negligible or less than 15km	2500

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[120;140]	[510000;620000] MWh	[910000;1100000]	[-930;-760]
Scenario Vision 2 - 2030	-	[65;110]	[950000;1200000] MWh	[910000;1100000]	[-670;-550]
Scenario Vision 3 - 2030	-	[210;280]	[1500000;1800000] MWh	[910000;1100000]	[-2200;-1800]
Scenario Vision 4 - 2030	-	[350;400]	[1700000;2100000] MWh	[910000;1100000]	[-3400;-2800]

Additional comments

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

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

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

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

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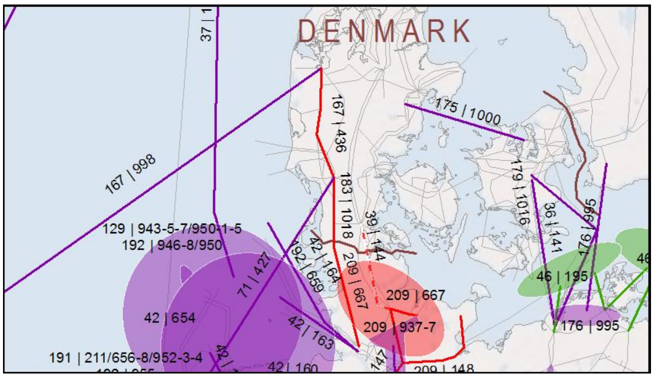
Project 183: DKW-DE, Westcoast

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DKW=>DE: 500	DE=>DKW: 500	2	3	Negligible or less than 15km	Negligible or less than 15km	170-210

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[0;10]	[14000;17000] MWh	[-11000;-9000]	[-88;-72]
Scenario Vision 2 - 2030	-	[4;5]	[14000;17000] MWh	[-11000;-9000]	[-22;-18]
Scenario Vision 3 - 2030	-	[20;60]	[120000;140000] MWh	[-12000;-9900]	[-440;-360]
Scenario Vision 4 - 2030	-	[80;100]	[260000;310000] MWh	[-12000;-9600]	[-830;-680]

Additional comments

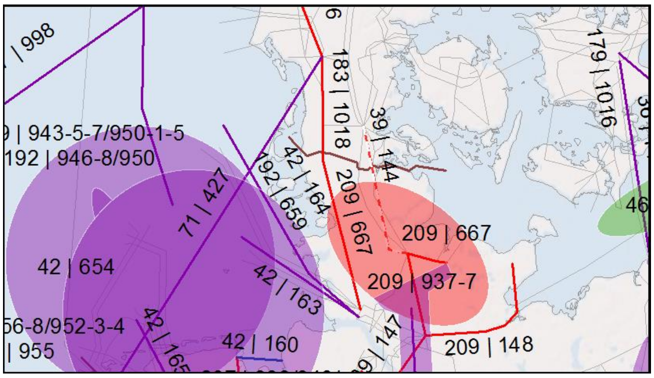
Comment on the security of supply: the project improves the SoS of Western Denmark and the area of Schleswig Holstein in Germany.

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

Project 39: DKW-DE, step 3

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DKW=>DE: 720	DE=>DKW: 1000	3	3	15-50km	15-25km	220-270

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[10;30]	[54000;66000] MWh	[-46000;-38000]	[-120;-94]
Scenario Vision 2 - 2030	-	[0;10]	[110000;130000] MWh	[32000;39000]	[-38;-31]
Scenario Vision 3 - 2030	-	[35;95]	[190000;230000] MWh	[50000;62000]	[-680;-560]
Scenario Vision 4 - 2030	-	[120;150]	[370000;460000] MWh	[51000;62000]	[-1300;-1000]

Additional comments

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

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

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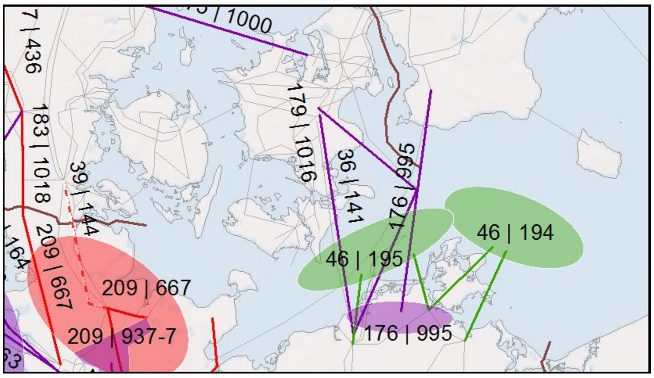
Project 179: DKE - DE

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DKE=>DE: 600	DE=>DKE: 600	3	3	NA	NA	500-610

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[31;38]	[54000;66000] MWh	[17000;21000]	[82;100]
Scenario Vision 2 - 2030	-	[22;27]	[54000;66000] MWh	[-2200;-1800]	[73;90]
Scenario Vision 3 - 2030	-	[22;27]	[63000;77000] MWh	[120000;150000]	[-890;-720]
Scenario Vision 4 - 2030	-	[140;170]	[63000;77000] MWh	[120000;150000]	[-1900;-1600]

Additional comments

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

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

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

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

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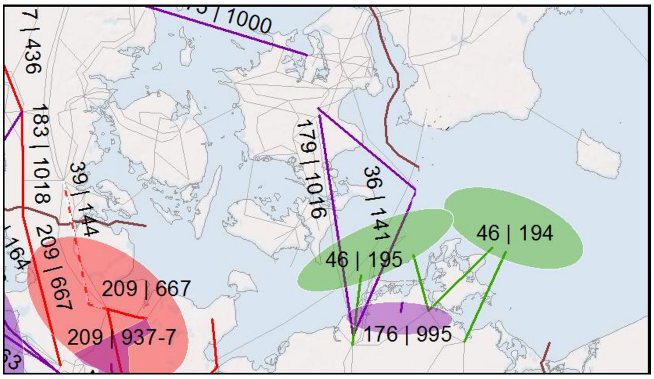
Project 36: Kriegers Flak CGS

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DKE=>DE: 400	DE=>DKE: 400	3	3	Negligible or less than 15km	Negligible or less than 15km	300

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[19;24]	[54000;66000] MWh	[-62000;-51000]	[-130;-110]
Scenario Vision 2 - 2030	-	[7;8]	[9000;11000] MWh	[-62000;-50000]	[-4;-3]
Scenario Vision 3 - 2030	-	[10;13]	[18000;22000] MWh	[4500;5500]	[-390;-320]
Scenario Vision 4 - 2030	-	[36;44]	[18000;22000] MWh	[4500;5500]	[-760;-620]

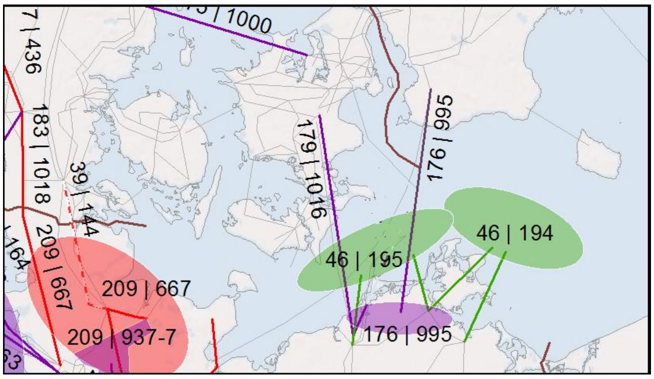
Additional comments

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

Project 176: Hansa PowerBridge

Description of the project

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



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
995	Station SE4	Station DE	New DC cable interconnector between Sweden and Germany.	-	Under Consideration	2025	New Investment	RGBS common investigations for TYNDP 2014

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DE=>SE: 600	SE=>DE: 600	3	3	NA	NA	200-400

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[72;88]	[36000;44000] MWh	[420000;520000]	[590;720]
Scenario Vision 2 - 2030	-	[15;18]	[36000;44000] MWh	[190000;230000]	[340;420]
Scenario Vision 3 - 2030	-	[28;35]	[90000;110000] MWh	[62000;75000]	[-710;-580]
Scenario Vision 4 - 2030	-	[220;270]	[90000;110000] MWh	[280000;350000]	[-2200;-1800]

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Additional comments

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

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

LitPol

“LitPol” consists of two projects (59, 123), representing its 2 phases spanning from now to 2020, and each adding a 500 MW interconnection capacity.
The LitPol Link Project is an HVDC interconnection between Poland and Lithuania. It removes an energy island by connecting the Baltic States to the Continental Europe and completes Baltic Sea ring.
The assessment of project 123 is complementary to the one presented for project 59.

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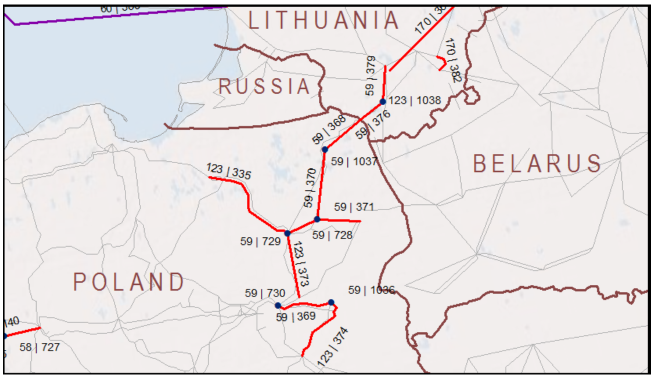
Project 59: LitPol Link Stage 1

Description of the project

The LitPol Link Project is an interconnection between Poland and Lithuania. The first stage of the LitPol Link interconnection project is realized by the construction of new double circuit 400 kV interconnector between Ełk and Alytus together with 500 MW back-to-back convertor station in substation Alytus and strengthening of the internal high voltage transmission grid in Poland and Lithuania in order to utilize the capacity of the interconnection. The capacity increase in first stage is 500 MW (on the direction from Lithuania to Poland; the capacity in opposite direction is curtailed by the limitations of the internal Polish transmission grid) and the expected commissioning date is 2015. The project removes an energy island by connecting the Baltic States to the Continental Europe and completes Baltic Sea ring.

PCI 4.5.1



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
368	Elk (PL)	PL-LT border	Construction of a new 400 kV interconnector line from Ełk to PL-LT border.	400	Under Construction	2015	Investment on time	Progress as planned.
369	Siedlce Ujrzanów (PL)	Milosna (PL)	Construction of new 400 kV line Siedlce Ujrzanów - Miłosna.	100	Under Construction	2015	Investment on time	The project is in the construction phase.
370	Elk (PL)	Lomza (PL)	Construction of new 400 kV line Ełk-Łomża.	400	Under Construction	2015	Investment on time	The project is under construction.
371	Ostroleka (PL)	Narew (PL)	Construction of new 400 kV line Ostrolęka-Łomża-Narew + extension of substation Narew.	400	Under Construction	2015	Investment on time	The project is under construction.
376	Alytus (LT)	PL-LT border	Construction of 500 MW Back-to-Back convertor station near Alytus 330kV substation. Construction of double circuit 400kV OHL between Alytus and PL-LT border (51 km).	500	Under Construction	2015	Investment on time	Progress as planned.
379	Kruonis (LT)	Alytus (LT)	New double circuit 330kV OHL Alytus–Kruonis (2x1080 MVA, 53km).	300	Design & Permitting	2016	Delayed	Several months delay due to difficulties with the acquisition of the land
728	Lomza (PL)		Construction of new substation Łomża to connect the line Ełk-Łomża.	400	Under Construction	2015	Investment on time	The project is under construction.

729	Ostroleka (PL)		A new 400 kV switchgear in existing substation Ostroleka (in two stages) with transformation 400/220kV 500 MVA and with transformation 400/110kV 400 MVA.	400	Under Construction	2015	Investment on time	The project is under construction.
730	Stanislawów (PL)		New substation 400kV Stanisławów will be connected by splitting and extending existing line Miłosna-Narew and Miłosna-Siedlce.	400	Under Construction	2015	Expected earlier than planned previously	In TYNDP 2012 the building of the substation Stanisławów was reported as part of a line Ostrołęka-Stanisławów. The commissioning time has been aligned with the construction of the line Miłosna-Siedlce Ujrzanów which is expected in 2015.
1036	Siedlce Ujrzanów		New Substation Siedlce Ujrzanów will be connected by new line Miłosna-Siedlce Ujrzanów and later by new line Kozienice-Siedlce Ujrzanów	100	Under Construction	2015	Investment on time	The investment was previously included in the investment no. 369 as "new 400 kV switchgear in existing Substation Siedlce". The concept has changed and there is a new substation in a different location.
1037	Elk Bis		New 400/110 kV Substation Ełk Bis connected by two double 400 kV lines Łomża-Ełk and Ełk-Alytus creating an interconnector Poland-Lithuania.	400	Under Construction	2015	Investment on time	The inv. was part of inv. no 370 in TYNDP2012 as "new 400kV switchgear in existing Substation Ełk". The concept has changed, it is not possible to extend the existing substation and there is a new substation in a different location, expected in 2015.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
PL=>LT: 0-0	LT=>PL: 0-500	3	5	50-100km	25-50km	510

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[40;49]	[54000;66000] MWh	[170000;200000]	[-280;-230]
Scenario Vision 2 - 2030	-	[52;63]	[9000;11000] MWh	[200000;240000]	[750;920]
Scenario Vision 3 - 2030	-	[23;28]	[9000;11000] MWh	[-1100000;-890000]	[-2000;-1700]
Scenario Vision 4 - 2030	-	[160;200]	[9000;11000] MWh	[-1100000;-900000]	[-2500;-2000]

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Additional comments

Comment on the RES integration:
The analysis shows that the project helps integrating RES – avoided spillage (equivalent to installed capacity of 5-30 MW, assuming capacity factor of 2000 h/a) in the region of Baltic States and Poland.

Comment on the flexibility indicator: the project appears useful in all visions, depends on a key-investment and interconnects two synchronous areas.

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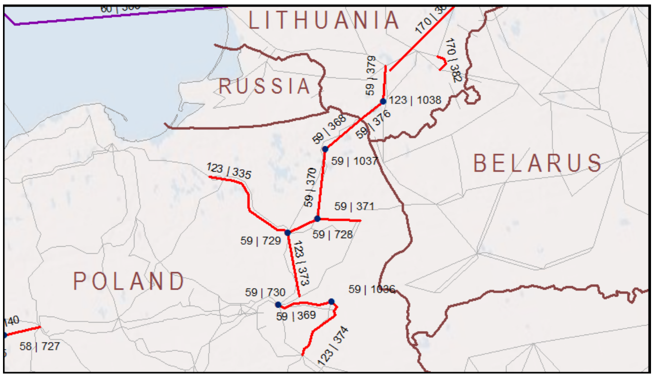
Project 123: LitPol Link Stage 2

Description of the project

The LitPol Link Stage 2 is a continuation of building of the interconnection between Poland and Lithuania in order to achieve the planned transmission capacity of 1000 MW in both directions. Building of additional internal investments in Poland and Lithuania are necessary. In Poland three additional lines will be erected (Ostrołeka-Olsztyn Mątki, Ostrołęka-Stanisławów and Kozienice-Siedlce Ujrzanów). In Lithuania a second 500 MW back-to-back converter station will be built in substation Alytus.

The project improves connection the Baltic States to the Continental Europe and Baltic Sea ring.

PCI 4.5.2 and 4.5.3



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
335	Ostroleka (PL)	Olsztyn Matki (PL)	Construction of new 400 kV line Ostrołęka - Olsztyn Mątki after dismantling of 220kV line Ostrołęka - Olsztyn with one circuit from Ostrołęka to Olsztyn temporarily on 220 kV.	500	Design & Permitting	2017	Investment on time	The investment in on time.
373	Ostroleka (PL)	Stanislawów (PL)	Construction of new 400 kV line Ostrołęka-Stanisławów.	500	Design & Permitting	2020	Investment on time	The project is at the design stage.
374	Kozienice (PL)	Siedlce Ujrzanów (PL)	Construction of new 400 kV line Kozienice-Siedlce Ujrzanów.	300	Design & Permitting	2019	Expected earlier than planned previously	The commissioning date has been adjusted compared to the previous national plan and TYNDP.
1038	Alytus		Construction of the second 500 MW back-to-Back converter station in Alytus	500	Planning	2020	New Investment	This investment was missing not explicitly mentioned in TYNDP 2012, but was already foreseen.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
PL=>LT: 0-1000	LT=>PL: 0-1000	1	5	15-50km	25-50km	310

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[36;45]	[18000;22000] MWh	[190000;230000]	[-350;-290]
Scenario Vision 2 - 2030	-	[32;39]	[18000;22000] MWh	[170000;210000]	[290;360]
Scenario Vision 3 - 2030	-	[36;44]	[27000;33000] MWh	[-670000;-550000]	[-1900;-1600]
Scenario Vision 4 - 2030	-	[150;180]	[27000;33000] MWh	[-290000;-240000]	[-2200;-1800]

Additional comments

Comment on the RES integration:
The analysis shows that the project helps integrating RES – avoided spillage (equivalent to installed capacity of 10-15 MW, assuming capacity factor of 2000 h/a) in the region of Baltic States and Poland.

Comment on the flexibility indicator: LitPol appears useful in all visions, depends on a key-investment and interconnects two synchronous areas.

Project 58: GerPol Power Bridge

Description of the project

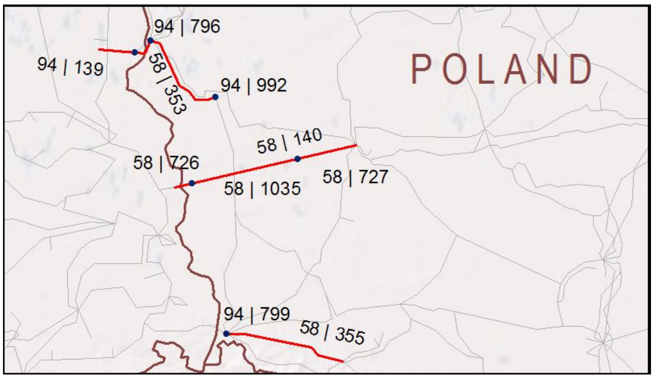
The construction of a new (third) interconnection between Polish and German power systems includes the construction of the interconnector between Eisenhuetenstadt and Plewiska as well as two internal lines (Mikułowa-Świebodzice and Krajnik -Baczyna) and substations Plewiska BIS, Gubin and Zielona Góra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

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

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

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

PCI 3.14



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
PL=>DE: 0-500	DE=>PL: 0-1500	1	4	15-50km	Negligible or less than 15km	390-400

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[69;84]	0	[-170000;-140000]	[760;930]
Scenario Vision 2 - 2030	-	[67;82]	0	[-160000;-130000]	[1000;1200]
Scenario Vision 3 - 2030	-	[99;120]	[300000;370000] MWh	[-770000;-630000]	[-81;-66]
Scenario Vision 4 - 2030	-	[98;120]	[650000;800000] MWh	[-910000;-740000]	[87;110]

Additional comments

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

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

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

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

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

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

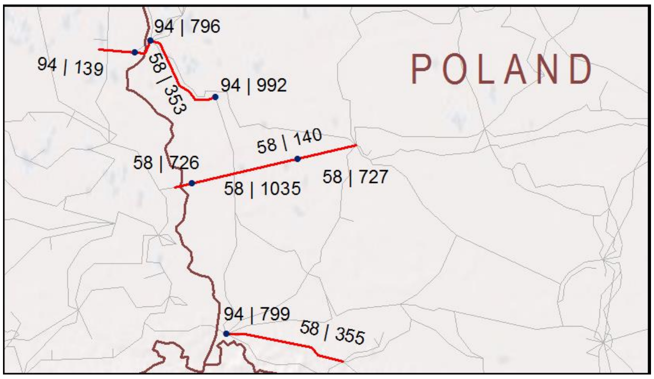
Project 94: GerPol Improvements

Description of the project

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

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

PCI 3.15



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
PL=>DE: 0-1500	DE=>PL: 0-500	2	3	Negligible or less than 15km	Negligible or less than 15km	150

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[250;300]	[110000;130000] MWh	[-60000;-49000]	[2000;2400]
Scenario Vision 2 - 2030	-	[240;300]	[41000;50000] MWh	[-49000;-40000]	[2800;3400]
Scenario Vision 3 - 2030	-	[75;92]	[130000;160000] MWh	[-140000;-110000]	[1300;1600]
Scenario Vision 4 - 2030	-	[270;330]	[800000;970000] MWh	[-190000;-150000]	[50;61]

Additional comments

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

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

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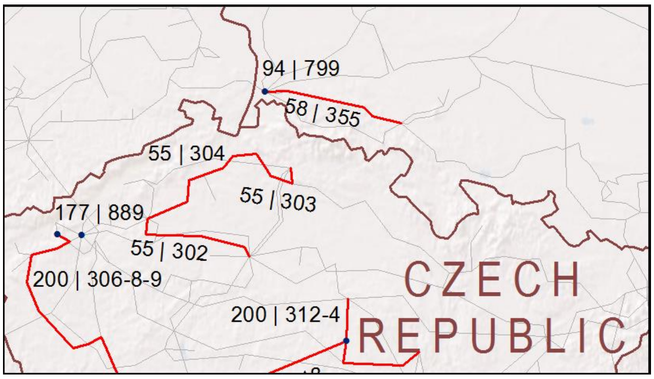
Project 55: CZ West-east corridor (West)

Description of the project

This project is required to ease power flows West to East and enables market integration of generation with high flexibility in to the power grid. Project consists of 400kV OHL lines in existing corridors by building new double circuit with target capacities of 1700MVA per circuit. Project also brings ability to current and new connected generation free access to cross-border ancillary market.



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
302	Vyskov (CZ)	Cechy stred (CZ)	New second circuit 400kV OHL; Target capacity 2x1730 MVA.	1000	Design & Permitting	2016	Delayed	Delayed due to permitting procedured difficulty
303	Babylon (CZ)	Bezdecin (CZ)	New second circuit 400kV OHL; 1385 MVA.	350	Design & Permitting	2018	Delayed	Delay caused by permitting process difficulty
304	Babylon (CZ)	Vyskov (CZ)	New second circuit 400kV OHL; 1385 MVA.	750	Design & Permitting	2021	Delayed	Delayed due to permitting procedure difficulty

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: 1250-1750	East=>West: 1400-1600	2	3	15-50km	Negligible or less than 15km	230-290

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[77;97]	0	[-88000;-110000]	[210;260]
Scenario Vision 2 - 2030	-	[79;99]	0	[60000;72000]	[280;350]
Scenario Vision 3 - 2030	-	[67;87]	0	[-48000;-58000]	[-2200;-2600]
Scenario Vision 4 - 2030	-	[35;45]	0	[-19000;-36000]	[-1600;-2000]

Additional comments

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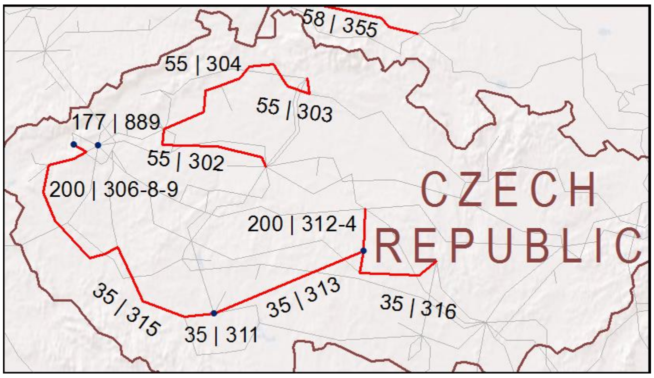
Czech North South Corridor

Description of the corridor

The “Czech North South Corridor” consists of two projects (200, 35), representing its 2 phases spanning from 2016 to 2028.
This reinforcement strategy enables the power flow from northwester border to southeastern border. This project is required to facilitate power flows in the direction North-South and East-West, enhance the grid transfer capability between Czech Republic and Germany and supports the future thermal generation evacuation and RES - connection point of wind generation is substation Vernerov. In addition the project ensures security of supply of the North-western part of Czech Republic in general terms.
The two projects have been assessed as a whole and share the same common assessment.

PCI 3.11



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
Project 200								
306	Vitkov (CZ)		New 400/110kV substation equipped with transformers 2x350MVA.	500	Design & Permitting	2020	Delayed	Complication of permitting procedure
307	Vernerov (CZ)		New 400/110kV substation equipped with transformers 2x350MVA.	500	Design & Permitting	2017	Delayed	Complication with permitting procedure.
308	Vernerov (CZ)	Vitkov (CZ)	New 400kV double circuit OHL, 1385 MVA.	500	Design & Permitting	2019	Investment on time	Progress as planned.
309	Vitkov (CZ)	Prestice (CZ)	New 400kV double circuit OHL, 2x1730 MVA.	500	Design & Permitting	2021	Investment on time	Progress as planned.
312	Mirovka (CZ)		Upgrade of the existing substation 400/110kV with two transformers 2x350MVA.	300	Design & Permitting	2020	Delayed	Project delayed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side
314	Mirovka (CZ)	V413 (CZ)	New double circuit OHL with a capacity of 2x1385 MVA and 26.5km length.	200	Design & Permitting	2020	Delayed	Project delayed due to reschedulling of transmission projects together with commission rescheduled

								on the generation investor's side
Project 35								
311	Kocin (CZ)		Upgrade of the existing substation 400/110kV; upgrade transformers 2x350MVA.	500	Design & Permitting	2024	Delayed	Project commissioning date postponed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side
313	Kocin (CZ)	Mirovka (CZ)	Connection of 2 existing 400kV substations with double circuit OHL having 120.5km length: and a capacity of 2X1700 MVA.	500	Design & Permitting	2024	Delayed	Project commissioning date postponed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side. Permitting procedure issues and wiring change.
315	Kocin (CZ)	Prestice (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 115.8km. Target capacity 2x1700 MVA.	500	Design & Permitting	2028	Delayed	Project commissioning date postponed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side. Wiring change to higher capacity.
316	Mirovka (CZ)	Cebin (CZ)	Adding second circuit to existing single circuit line (88.5km, 2x1700 MVA).	100	Design & Permitting	2028	Delayed	Project is dependent on other investments which are 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)
CZ=>DE: 0-500	DE=>CZ: 0-500	2	3	15-50km	Negligible or less than 15km	190-450

CBA results	for each scenario				
Scenario	B1 SoS (MWh/year)	B2 SEW (MEuros/year)	B3 RES integration	B4 Losses (MWh/year)	B5 CO2 Emissions (kT/year)
Scenario Vision 1 - 2030	-	[250;310]	[200000;250000] MWh	[-220000;-260000]	[-2100;-2500]
Scenario Vision 2 - 2030	-	[270;330]	[200000;240000] MWh	[-260000;-320000]	[-1800;-2100]
Scenario Vision 3 - 2030	-	[1400;1700]	[210000;260000] MWh	[-340000;-580000]	[-7900;-9500]
Scenario Vision 4 - 2030	-	[1200;1500]	[210000;260000] MWh	[-280000;-300000]	[-7000;-8600]

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Additional comments

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

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

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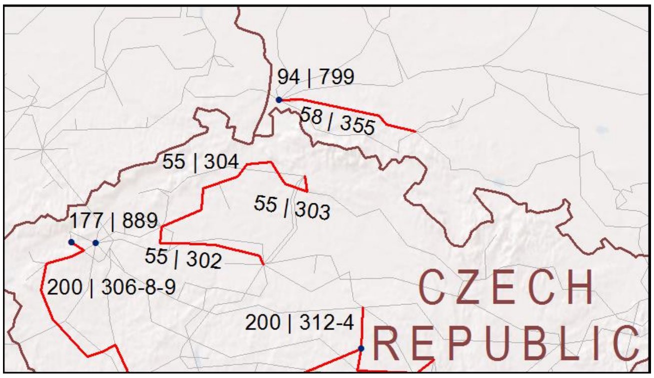
Project 177: PST Hradec

Description of the project

Construction of this project enables control of power flow on the border to support system security - in terms of N-1 security, effective utilization of the infrastructure and cross-border market exchanges. The target capacity of phase shifting transformers is 1700MVA per each circuit of tie-lines between CEPS and 50Hertz, that means 3400MVA of thermal capacity. Devices are located in 400kV substation Hradec.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
889	Hradec		Construction of new PST in substation Hradec with target capacity 2x1700MVA	-	Design & Permitting	2016	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)**
CZ=>DE: 0-500	DE=>CZ: 0-500	2	3	NA	NA	87-110

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[10;14]	0	[110;150]	[140;160]
Scenario Vision 2 - 2030	-	[79;99]	0	[110;160]	[170;210]
Scenario Vision 3 - 2030	-	[14;18]	[62000;76000] MWh	[130;230]	[-58;-78]
Scenario Vision 4 - 2030	-	[20;24]	[210000;250000] MWh	[190;320]	[-120;-140]

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Additional comments

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

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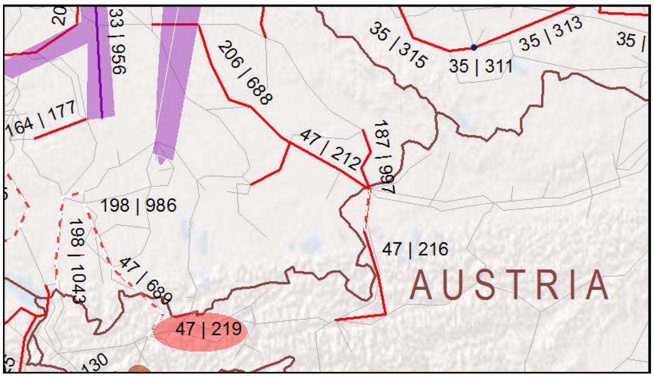
Project 47: AT - DE

Description of the project

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

PCI 2.1, 3.1.1 and 3.1.2



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DE=>AT: 2900	AT=>DE: 2900	1	4	15-50km	15-25km	830-1400

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[53;64]	0	[-450000;-370000]	[530;650]
Scenario Vision 2 - 2030	-	[110;140]	0	[-420000;-340000]	[390;480]
Scenario Vision 3 - 2030	-	[310;380]	[300000;360000] MWh	[-330000;-270000]	[-1500;-1300]
Scenario Vision 4 - 2030	-	[470;490]	[690000;850000] MWh	[-300000;-330000]	[-1300;-1500]

Additional comments

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

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

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

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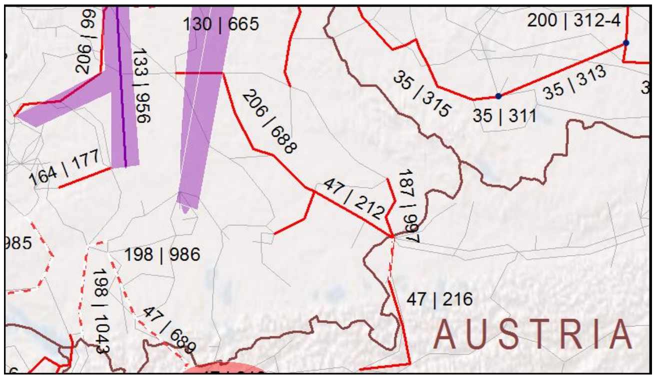
Project 187: St. Peter - Pleinting

Description of the project

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



Investment index	Substation 1	Substation 2	Description	GTC contri bution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
997	Pleinting (DE)	St. Peter (AT)	new 380-kV-line Pleinting (DE) - St. Peter (AT) on existing OHL corridor	-	Under Consideration	2022	New Investment	new investment

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
AT=>DE: 1500	DE=>AT: 1500	1	3	Negligible or less than 15km	Negligible or less than 15km	130-190

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[13;16]	0	[-79000;-65000]	[140;170]
Scenario Vision 2 - 2030	-	[15;18]	[4400;5400] MWh	[-83000;-68000]	[560;680]
Scenario Vision 3 - 2030	-	[100;130]	[140000;170000] MWh	[-88000;-72000]	[-520;-420]
Scenario Vision 4 - 2030	-	[190;230]	[220000;260000] MWh	[-110000;-90000]	[-720;-590]

Additional comments

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

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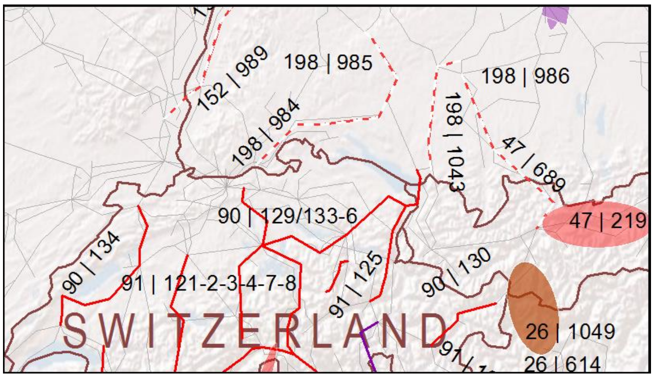
Project 198: Area of Lake Constance

Description of the project

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

PCI 2.11.2



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
DE=>CH: 3400	CH=>DE: 1400	1	4	50-100km	Negligible or less than 15km	390-530

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[90;110]	0	[-99000;-81000]	[820;1000]
Scenario Vision 2 - 2030	-	[140;170]	0	[-140000;-110000]	[1900;2400]
Scenario Vision 3 - 2030	-	[310;380]	[450000;550000] MWh	[-91000;-75000]	[-1200;-950]
Scenario Vision 4 - 2030	-	[480;580]	[900000;1100000] MWh	[-180000;-150000]	[-2100;-1700]

Additional comments

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

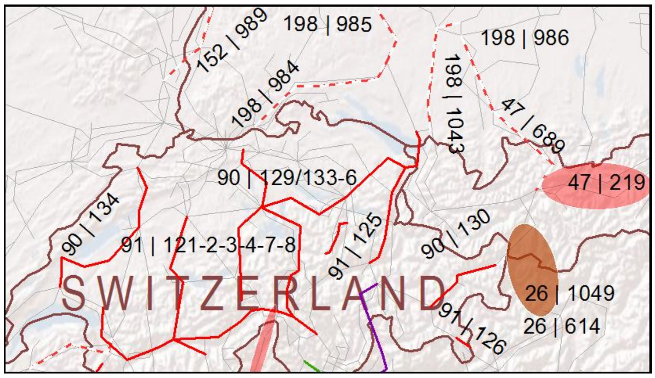
Comment on the RES integration: avoided spillage concerns RES in Germany mostly.

Project 90: Swiss Roof

Description of the project

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

PCI 2.11.1



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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
upstream=>upstream: 0	upstream=>upstream: 0	1	4	Negligible or less than 15km	Negligible or less than 15km	490

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[90;110]	0	[-200000;-160000]	[820;1000]
Scenario Vision 2 - 2030	-	[140;170]	0	[-270000;-220000]	[1900;2400]
Scenario Vision 3 - 2030	-	[310;380]	[450000;550000] MWh	[-180000;-150000]	[-1200;-950]
Scenario Vision 4 - 2030	-	[480;580]	[900000;1100000] MWh	[-360000;-300000]	[-2100;-1700]

Additional comments

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

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

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

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

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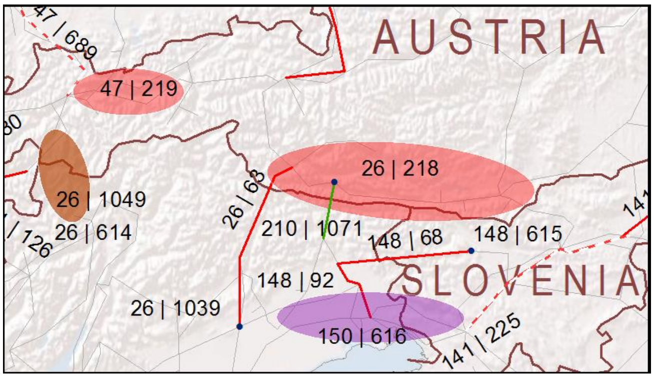
Project 26: Austria - Italy

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/year)**	**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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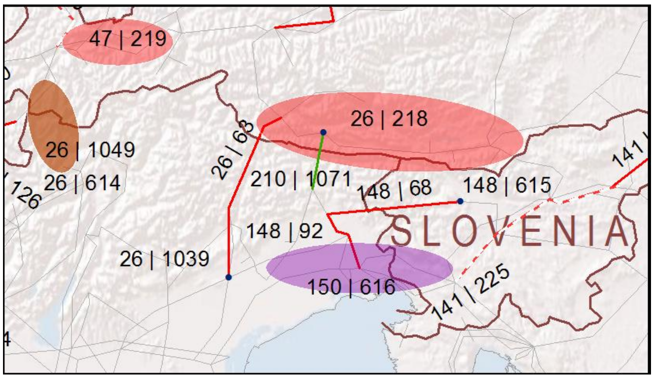
Project 210: E15

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 contribution (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/year)**	**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

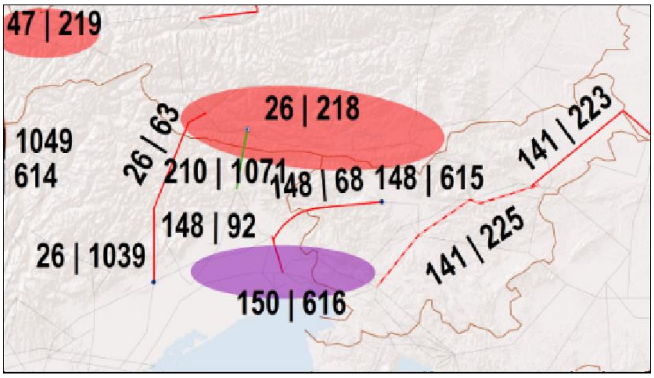
Additional comments

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/year)**	**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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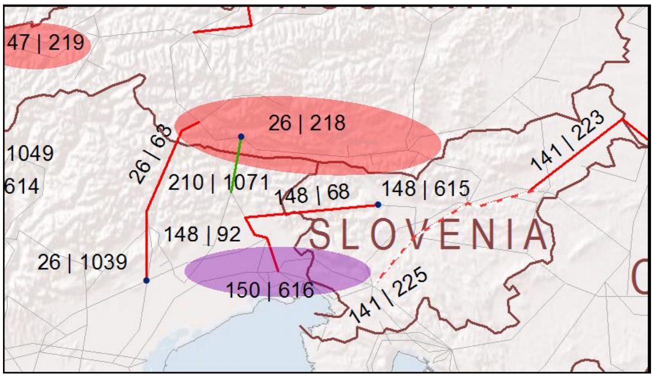
Project 150: CCS new 10

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 contribution (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.

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/year)	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 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/year)**	**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]

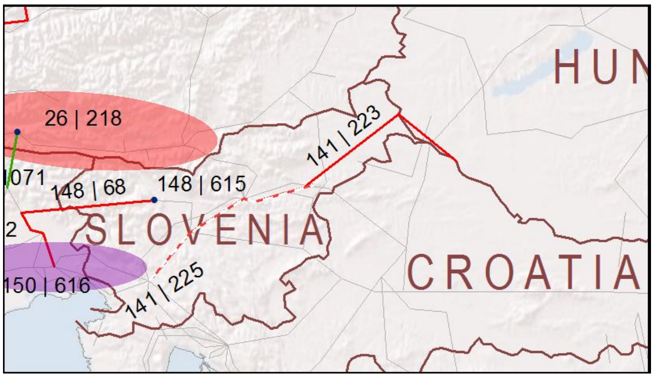
Additional comments

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

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/year)**	**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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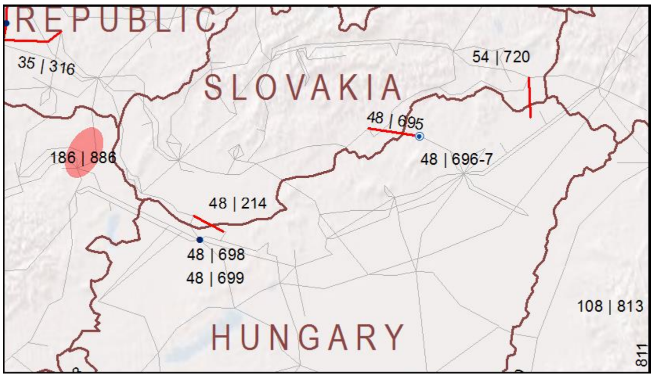
Project 48: New SK-HU intercon. - phase 1

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/year)**	**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.

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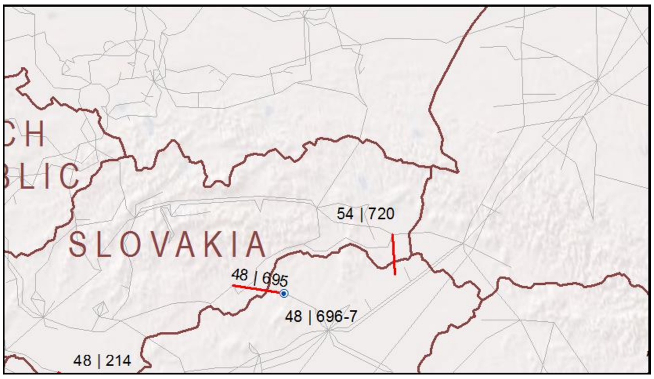
Project 54: New SK-HU intercon. - phase 2

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 contri bution (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/year)**	**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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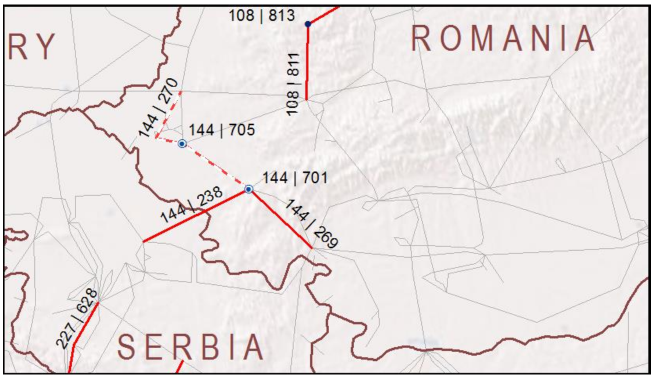
Project 144: Mid Continental East corridor

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/year)**	**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.

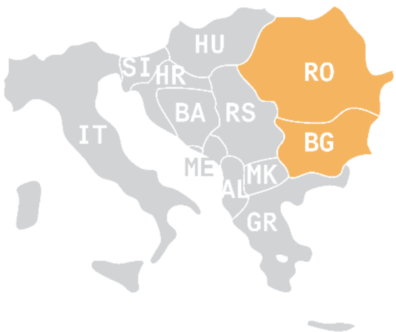
Comment on the RES integration: The projects directly connects 258 MW of RES in 400 kV substation Vrani (connected in-out to 400 kV line Resita-Pancevo, in Romania). The project helps integrate about 1000 MW of RES in the region of South-West Romania and North-East Serbia. It avoids 100-800 GWh of RES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

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/year)**	**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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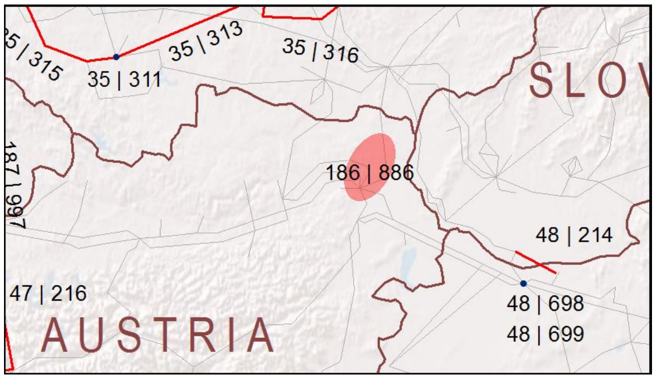
Project 186: east of Austria

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	GTC direction 2 (MW)	B6 Technical Resilience	B7 Flexibility	S1 - protected areas	S2 - urban areas	C1 Estimated cost (Meuros)
outside=>inside: 1500	inside=>outside: 1500	1	2	NA	NA	120-280

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[220;260]	1100 MW	[-5500;-4500]	[-1000;-840]
Scenario Vision 2 - 2030	-	[130;160]	1100 MW	[-1100;-900]	[-320;-260]
Scenario Vision 3 - 2030	-	[300;370]	1500 MW	[-2600;-2200]	[-1200;-990]
Scenario Vision 4 - 2030	-	[230;280]	1500 MW	[-7900;-6500]	[-1200;-990]

Additional comments

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

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

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

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German Offshore wind parks connection

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

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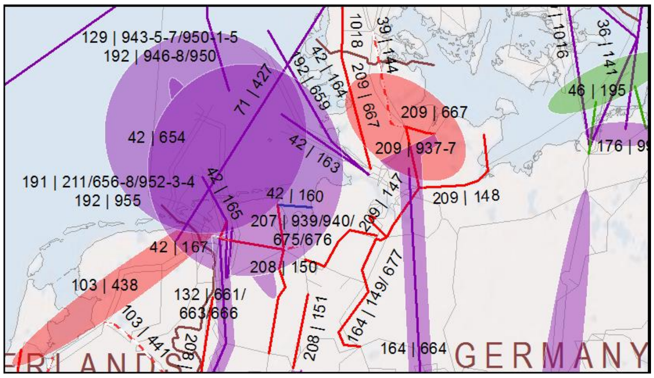
Project 42: OWP TenneT Northsea part 1

Description of the project

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



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

657	Cluster HelWin2	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133 km. Line capacity: 690 MW	690	Under Construction	2015	Investment on time	Progress as planned.

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 5750	South=>North: 5750	2	3	More than 100km	Negligible or less than 15km	6000-8000

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[1300;1600]	4033 MW	0	[-13000;-11000]
Scenario Vision 2 - 2030	-	[620;760]	4033 MW	0	[-8500;-7000]
Scenario Vision 3 - 2030	-	[1900;2300]	5748 MW	0	[-10000;-8400]
Scenario Vision 4 - 2030	-	[1600;2000]	5748 MW	0	[-8900;-7300]

Additional comments

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

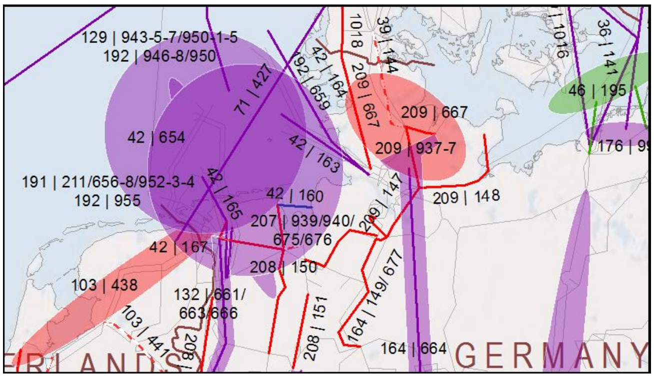
Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

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

Project 191: OWP TenneT Northsea Part 2

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>DE: 5400	DE=>inside: 5400	4	3	More than 100km	Negligible or less than 15km	8000-10000

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[520;640]	3788 MW	0	[-6200;-5100]
Scenario Vision 2 - 2030	-	[330;400]	3788 MW	0	[-5600;-4500]
Scenario Vision 3 - 2030	-	[1700;2100]	5401 MW	0	[-9400;-7700]
Scenario Vision 4 - 2030	-	[1500;1900]	[5300;5500] MW	0	[-8700;-7100]

Additional comments

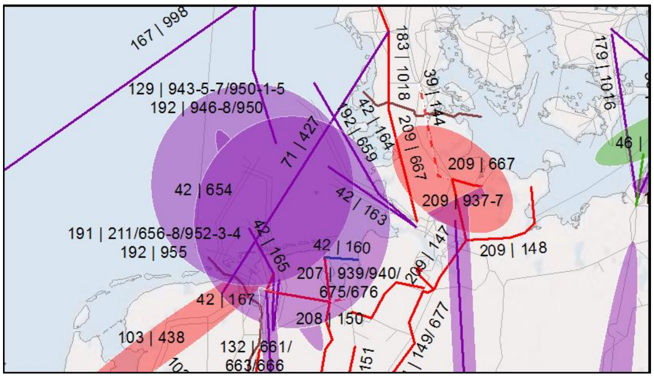
Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

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

Project 192: OWP Northsea TenneT Part 3

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>DE: 4500	DE=>inside: 4500	4	3	More than 100km	Negligible or less than 15km	5500-9500

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 3 - 2030	-	[1400;1700]	4499 MW	0	[-7400;-6000]
Scenario Vision 4 - 2030	-	[1100;1400]	[4400;4600] MW	0	[-6100;-5000]

Additional comments

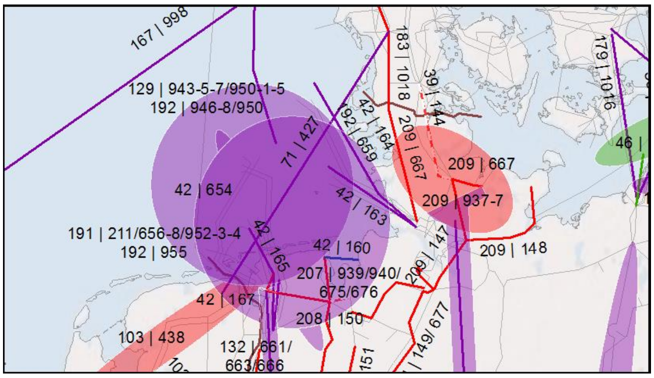
Comment on the CO2 indicator: the very high scores reflect that the project directly connects RES sources

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

Project 129: OWP Northsea TenneT Part 4

Description of the project

Germany is planning to build a big amount of wind offshore power plants in the Northsea. The OWP will help to reach the European goal of CO_2 reduction and RES integration. This project is for the connection of the OWP with the German grid. This project becomes necessary in case of further long-term strong increase in OWP generation like in Vision 3 and 4. The project is not in focus of Vision 1 and 2.



Investment index	Substation 1	Substation 2	Description	GTC contribution (MW)	Present status	Expected date of commissioning	Evolution since TYNDP 2012	Evolution driver
943	NOR-9-1	Cloppenburg	Connection of new offshore wind park. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 255 km. Line capacity: 900 MW	900	Under Consideration	2028	New Investment	new investment
945	NOR-10-1	Cloppenburg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	900	Under Consideration	2029	New Investment	new investment
947	NOR-11-2	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 270km. Line capacity: 900 MW	900	Under Consideration	2031	New Investment	new investment
951	NOR-13-2	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	900	Under Consideration	2030	New Investment	new investment

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
inside=>DE: 3600	DE=>inside: 3600	2	3	More than 100km	Negligible or less than 15km	4000-8000

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 3 - 2030	-	[900;1100]	3074 MW	0	[-4900;-4000]
Scenario Vision 4 - 2030	-	[770;940]	3074 MW	0	[-4300;-3500]

Additional comments

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

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

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

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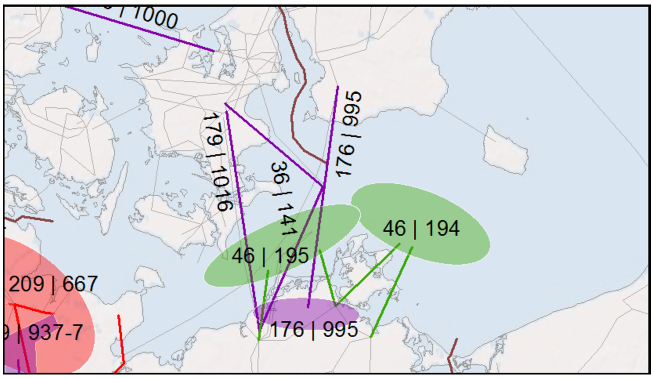
Project 46: Offshore Wind Baltic Sea

Description of the project

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



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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 4500	South=>North: 4500	0	3	NA	NA	1700-4500

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[300;360]	1568 MW	0	[-3300;-2700]
Scenario Vision 2 - 2030	-	[210;250]	1568 MW	0	[-3000;-2400]
Scenario Vision 3 - 2030	-	[1300;1600]	4342 MW	0	[-7300;-6000]
Scenario Vision 4 - 2030	-	[1100;1400]	4342 MW	0	[-6400;-5200]

Additional comments

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

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

North South Eastern German Corridor

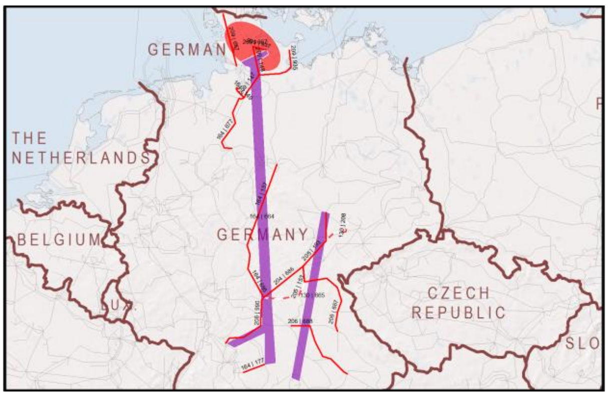
Description of the corridor

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

The corridor consists of 6 projects:

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

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



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

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

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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 11800	South=>North: 11800	5	5	More than 100km	More than 50km	6200-8600

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[340;420]	[3100000;3700000] MWh	[-4200000;-3400000]	[-1500;-1200]
Scenario Vision 2 - 2030	-	[310;380]	[3000000;3600000] MWh	[-4300000;-3500000]	[110;130]
Scenario Vision 3 - 2030	-	[1300;1600]	[8700000;11000000] MWh	[-5200000;-4200000]	[-7300;-6000]
Scenario Vision 4 - 2030	-	[2000;2400]	[14000000;17000000] MWh	[-6400000;-5200000]	[-12000;-9700]

Additional comments

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

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

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

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

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

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

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

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North South Western German Corridor

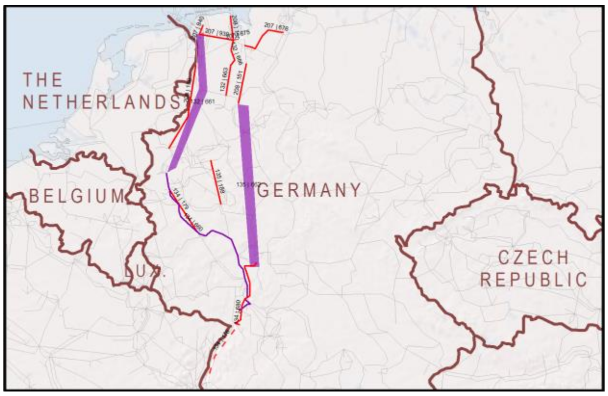
Description of the corridor

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

The Corridor consist of 5 projects:

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

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



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

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

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

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 5500	South=>North: 5500	5	4	More than 100km	More than 50km	4900-6600

CBA results	**for each scenario**				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 1 - 2030	-	[410;500]	[6000000;7300000] MWh	[-2500000;-2100000]	[-4600;-3800]

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

Additional comments

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

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

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

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

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

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

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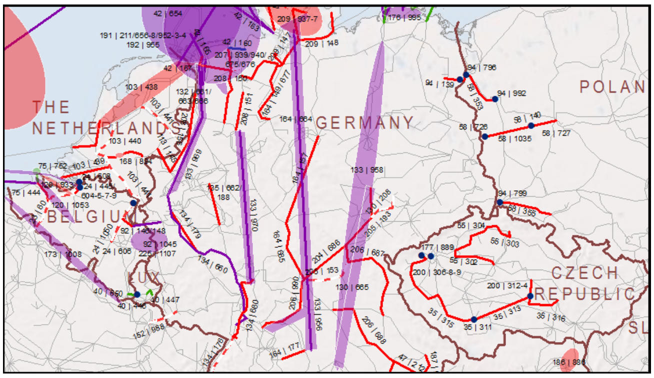
Project 133: Longterm German RES

Description of the project

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



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

970	lower saxony	Hessen/Baden-Würtemberg	New HVDC line to integrate new wind generation especially from North Sea towards South Germany for consumption and storage. Connections points north: Cloppenburg, Elsfelth/West. South: Bürstadt, Philipsburg	4000	Under Consideration	2030	New Investment	new investment

CBA results

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

CBA results non scenario specific						
GTC direction 1 (MW)	**GTC direction 2 (MW)**	**B6 Technical Resilience**	**B7 Flexibility**	**S1 - protected areas**	**S2 - urban areas**	**C1 Estimated cost (Meuros)**
North=>South: 18000	South=>North: 18000	5	4	NA	NA	5100-6800

CBA results	for each scenario				
Scenario	**B1 SoS (MWh/year)**	**B2 SEW (MEuros/year)**	**B3 RES integration**	**B4 Losses (MWh/year)**	**B5 CO2 Emissions (kT/year)**
Scenario Vision 3 - 2030	-	[57;140]	[860000;1000000] MWh	[-3300000;-2700000]	[-380;-310]
Scenario Vision 4 - 2030	-	[180;260]	[1600000;2000000] MWh	[-4000000;-3200000]	[-1200;-960]

Additional comments

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

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

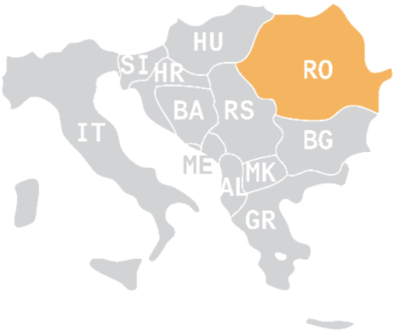
Comment on the S1 and S2 indicators:
Values for this project are not available due to the early state in the planning process

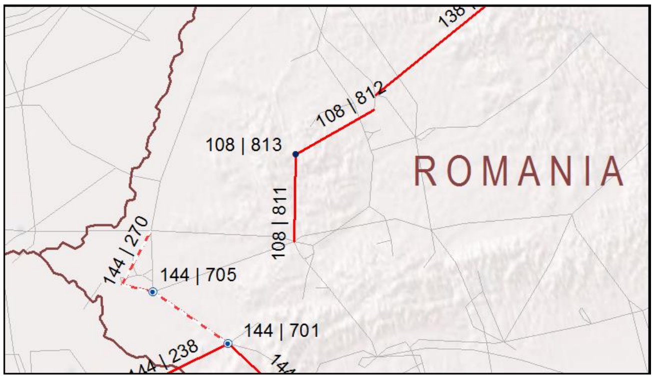
Comment on the technical resilience indicator:
The project is necessary to enable switch-off of assets for maintenance. The project includes VSC-DC-Links, which are necessary for (n-1)-security, voltage control and system stability.

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/year)**	**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

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11.2 List of projects and investments within the region

The table below depicts all projects and investments of pan-European and Regional significance within the Continental Central 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.

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Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
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	-
35	**North-South corridor**								
		311	Kocin (CZ)		Upgrade of the existing substation 400/110kV; upgrade transformers 2x350MVA.	2024	Design & Permitting	Delayed	Project commissioning date postponed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side

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
		313	Kocin (CZ)	Mirovka (CZ)	Connection of 2 existing 400kV substations with double circuit OHL having 120.5km length: and a capacity of 2X1700 MVA.	2024	Design & Permitting	Delayed	Project commissioning date postponed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side. Permitting procedure issues and wiring change.
		315	Kocin (CZ)	Prestice (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 115.8km. Target capacity 2x1700 MVA.	2028	Design & Permitting	Delayed	Project commissioning date postponed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side. Wiring change to higher capacity.
		316	Mirovka (CZ)	Cebin (CZ)	Adding second circuit to existing single circuit line (88.5km, 2x1700 MVA).	2028	Design & Permitting	Delayed	Project is dependent on other investments which are delayed.
36	**Kriegers Flak CGS**								
		141	Ishøj / Bjæverskov (DK)	Bentwisch (DE)	Three offshore windfarms connected to shore combined with 400 MW interconnection between both countries	2018	Design & Permitting	Investment on time	Commisioning date must be achieved in order to ensure grid connection for further renewable energy.
37	**Southern Norway - Germany**								
		142	Tonstad (NO)	Wilster (DE)	A 514 km 500 kV HVDC subsea interconnector between southern Norway and northern Germany.	2018	Design & Permitting	Investment on time	Agreement between the two TSOs on commissioning date.

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
		406	(Southern part of Norway) (NO)	(Southern part of Norway)(NO)	Voltage uprating of existing 300 kV line Sauda/Saurdal - Lyse - Ertsmyra - Feda - 1&2, Feda - Kristiansand; Sauda-Samnanger in long term. Voltage upgrading of existing single circuit 400kV OHL Tonstad-Solhom-Arendal. Reactive power devices in 400kV substations.	2020	Design & Permitting	Delayed	Revised progress due to less flexible system operations in a running system (voltage upgrade of existing lines). Commissioning date expected 2019-2021.
39	**DKW-DE, step 3**								
		144	Audorf (DE)	Kassö (DK)	Step 3 in the Danish-German agreement to upgrade the Jutland-DE transfer capacity. It consists of a new 400kV route in Denmark and In Germany new 400kV line mainly in the trace of a existing 220kV line.	2019	Planning	Delayed	Planning ongoing - minor delay due to coordination with project 183.1018
40	**Luxembourg-Belgium Interco**								
		446	Schifflange (LU)		BELUX INTERIM As a first interim step a PST will be integrated in Schifflange, and connected to an existing OH-line to control the transit flows from Germany to Belgium as from end 2015.	2015	Planning	Investment on time	Studies for interim step are finalized; Investment decision has been taken mid-2014 and PST is planned to be operational end 2015.
		447	Heisdorf (LU)	Berchem (LU)	Erection of a new 20km 225kV double-circuit mixed (cable+OHL)line with 1000 MVA capacity in order to create a loop around Luxembourg city including substations for in feed in lower voltage levels.	2017	Design & Permitting	Investment on time	Substation Blooren is authorized and under construction, Authorization for line section is still pending
		650	Bascharage (LU)	Aubange (BE)	BELUX LT In a second step: new 220 kV interconnection with neighbour(s) between Creos grid in LU and ELIA grid in BE via a 16km double circuit 225kV underground cable with a capacity of 1000 MVA.	2020	Under Consideration	Investment on time	An ongoing network study investigates the robustness of the planned 220kV connection between LU and BE.
42	**OWP TenneT Northsea part 1**								

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
		160	Offshore- Wind park Nordergründe (DE)	Inhausen (DE)	New AC-cable connection with a total length of 32km.	2016	Under Construction	Delayed	Delay due delay of windfarms
		163	Cluster HelWin1 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133km. Line capacity: aprox. 576 MW.	2014	Under Construction	Investment on time	
		164	Cluster SylWin1 (DE)	Büttel (DE)	New line consisting of underground +subsea cable with a total length of 206 km. Line capacity: aprox.864MW.	2015	Under Construction	Delayed	
		165	Cluster DolWin1 (DE)	Dörpen/West (DE)	New line consisting of underground +subsea cable with a total length of 167 km. Line capacity: 800MW.	2014	Under Construction	Delayed	
		167	Cluster BorWin2 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205km. Line capacity: 800MW.	2015	Under Construction	Delayed	
		654	Cluster DolWin2 (DE)	Dörpen/West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 138 km. Line capacity: 900 MW	2015	Under Construction	Investment on time	
		655	Cluster DolWin3 (DE)	Dörpen/West (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 162 km. Line capacity: 900 MW	2017	Under Construction	Investment on time	
		657	Cluster HelWin2	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 133 km. Line capacity: 690 MW	2015	Under Construction	Investment on time	
46	**Offshore Wind Baltic Sea**								

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
		194	OWF Cluster Baltic Sea East (DE)	Lüdershagen/Lubmin (DE)	Grid Connection of offshore wind farms (using AC-technology). According to german law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).	2031	Design & Permitting	Investment on time	The investment is split into different stages with different commissioning dates (starting in 2017) depending on the predicted installed capacity of offshore wind. For further informations see the national "Offshore Grid Development Plan"
		195	wind farm cluster Baltic Sea West (DE)	Bentwisch/Lüdershagen (DE)	Grid Connection of offshore wind farms (using AC-technology). According to german law, the grid connection has to be constructed and operated by the TSO (50Hertz Transmission).	2032	Design & Permitting	Investment on time	The investment is split into different stages with different commissioning dates (starting in 2026) depending on the predicted installed capacity of offshore wind. For further informations see the national "Offshore Grid Development Plan"
47	**AT - DE**								
		216	St. Peter (AT)	Tauern (AT)	Completion of the 380kV-line St. Peter - Tauern. This contains an upgrade of the existing 380kV-line St. Peter - Salzburg from 220kV-operation to 380kV-operation and the erection of a new internal double circuit 380kV-line connecting the substations Salzburg and Tauern (replacement of existing 220kV-lines on optimized routes). Moreover the erection of the new substations Wagenham and Pongau and the integration of the substations Salzburg and Kaprun is planned.	2020	Design & Permitting	Investment on time	In Sept. 2012 the application for granting the permission (EIA) was submitted to the relevant authorities. According to the experience of similar projects the commissioning is expected for 2020.

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
		212	Isar (DE)	St. Peter (AT)	New 400kV double circuit OHL Isar - St. Peter including new 400kV switchgears Altheim, Pirach, Simbach and St. Peter. Also including 4. circuit on line Ottenhofen - Isar.	2018	Design & Permitting	Delayed	delaye due to long permitting process
		219	Westtirol (AT)	Zell-Ziller (AT)	Upgrade of the existing 220kV-line Westtirol - Zell-Ziller and erection of an additional 220/380kV-Transformer. Line length: 105km.	2021	Planning	Investment on time	The upgrade of the line and substation Westtirol is currently in the planning process.
		689	Vöhringen (DE)	Westtirol (AT)	Upgrade of an existing over head line to 380 kV, extension of existing and errection of new 380-kV-substations including 380/110-kV-transformers. Transmission route Vöhringen (DE) -Westtirol (AT). This project will increase the current power exchange capacity between the DE, AT.	2020	Planning	Investment on time	Progess as planned.
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.

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
		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.
55	**CZ West-east corridor (West)**								
		302	Vyskov (CZ)	Cechy stred (CZ)	New second circuit 400kV OHL; Target capacity 2x1730 MVA.	2016	Design & Permitting	Delayed	Delayed due to permitting procedured difficulty
		303	Babylon (CZ)	Bezdecin (CZ)	New second circuit 400kV OHL; 1385 MVA.	2018	Design & Permitting	Delayed	Delay caused by permitting process difficulty
		304	Babylon (CZ)	Vyskov (CZ)	New second circuit 400kV OHL; 1385 MVA.	2021	Design & Permitting	Delayed	Delayed due to permitting procedure difficulty
57	**PolBaltic Integration**								
		326	Pelplin (PL)		Construction of new 400/110kV substation Pelplin between existing substation Grudziądz and planned substation Gdańsk Przyjaźń.	2019	Planning	Expected earlier than planned previously	The change in commissioning date stems from the recent update of National Development Plan and the schedule of planned generation connection.

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
		805	Grudziadz (PL)	Gdansk Przyjazn (PL)	Construction of new 400 kV line Grudziądz Węgrowo - Pelplin - Gdańsk Przyjaźń for planned generation connection.	2019	Planning	Expected earlier than planned previously	Investment on time.
		334	Patnów (PL)	Grudziadz (PL)	New 174 km 400 kV 2x1870 MVA double circuit OHL line Pątnów - Grudziądz after dismantling of 220kV line Pątnów - Jasiniec (two parallel lines) and Jasiniec - Grudziądz with extension of existing substations Patnów and Jasiniec. One circuit from Pątnów to Grudziądz via Jasiniec temporarily on 220kV.	2020	Planning	Investment on time	The project is in the planning phase.
		804	Gdansk Blonia (PL)		Extension and upgrade of an existing 400/110 kV substation Gdańsk Błonia for connection of planned 900 MW power plant.	2020	Planning	Investment on time	The project is in the planning phase.
		328	Pila Krzewina (PL)	Bydgoszcz Zachód (PL)	New 400 kV double circuit line Piła Krzewina - Bydgoszcz Zachód temporarily on 220kV.	2019	Design & Permitting	Delayed	The commissioning date of the investment has been adopted to meet the schedule of generation connection in the region of northern Poland. The project is in the process of obtaining permits.
		329	Zydowo Kierzkowo (PL)	Slupsk (PL)	New 70km 400kV 2x1870 MVA OHL double circuit line Żydowo - Słupsk	2019	Planning	Expected earlier than planned previously	The change in the comissioning date due to rescheduling introduced in the latest investment plan. Investment is in the planning phase.
		724	Zydowo Kierzkowo (PL)		Construction of new AC 400/110kV substation Żydowo Kierzkowo next to existing 220/110kV substation in Northern Poland with transformation 400/110kV 450 MVA.	2019	Planning	Expected earlier than planned previously	The expected date of commissioning change to meet the schedule of generation connection.

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
		330	Zydowo Kierzkowo(PL)	Gdansk Przyjazn (PL)	New 150 km 400 kV 2x1870 MVA double circuit OHL line Żydowo Kierzkowo - Gdańsk Przyjaźń with one circuit from Żydowo to Gdańsk temporarily on 220 kV.	2019	Planning	Expected earlier than planned previously	Investment is in the planning phase.
		725	Gdansk Przyjazn		New 150 km 400 kV 2x1870 MVA double circuit OHL line Żydowo Kierzkowo - Gdańsk Przyjaźń with one circuit from Żydowo to Gdańsk temporarily on 220 kV.	2019	Planning	Expected earlier than planned previously	Investment on time.
		352	Dunowo (PL)	Plewiska (PL)	Construction of a new double circuit 400kV OHL Dunowo - Żydowo (2x1870 MVA) partly using existing 220 kV line + Construction of a new 400kV OHL Plewiska - Piła Krzewina - Żydowo (2x1870 MVA); single circuit temporarily working as a 220kV + A new AC 400kV switchgear in existing substation Piła Krzewina + upgrade of substation Dunowo	2020	Planning	Investment on time	Investment is in the planning phase.
58	**GerPol Power Bridge**								
		1035	Baczyna		Construction of new 400/220 kV Substation Baczyna to connect the new line Krajnik-Baczyna.	2018	Planning	Investment on time	The investment was part of n°58.353 in TYNDP 2012 and is now presented stand alone. It is in the tendering procedure (design and build scheme).
		140	Eisenhüttenstadt (DE)	Plewiska (PL)	Construction of new 400 kV double circuit line Plewiska (PL)-Eisenhüttenstadt (DE) creating an interconnector between Poland and Germany.	2022	Planning	Rescheduled	The investment in planning phase. Expected problems with the routing cause adoption of commissioning date.
		727	Plewiska (PL)		Construction of new substation Plewiska Bis (PL) to connect the new line Plewiska (PL)-Eisenhüttenstadt (DE).	2020	Planning	Investment on time	The project is at the planning stage.
		353	Krajnik (PL)	Baczyna (PL)	Construction of new 400 kV double circuit line Krajnik – Baczyna.	2020	Planning	Investment on time	Investment is in the tendering procedure.

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
		355	Mikulowa (PL)	Swiebodzice (PL)	Construction of new 400 kV double circuit line Mikułowa-Świebodzice in place of existing 220 kV line.	2020	Planning	Investment on time	Investment on time.
		726	Gubin (PL)		New 400 kV substation Gubin located near the PL-DE border. The substation will be conntected by the new line Plewiska (PL)-Eisenhüttenstadt (DE).	2020	Planning	Investment on time	The project is at the planning stage.
59	**LitPol Link Stage 1**								
		1036	Siedlce Ujrzanów		New Substation Siedlce Ujrzanów will be connected by new line Miłosna-Siedlce Ujrzanów and later by new line Kozienice-Siedlce Ujrzanów	2015	Under Construction	Investment on time	The investment was previously included in the investment no. 369 as "new 400 kV switchgear in existing Substation Siedlce". The concept has changed and there is a new substation in a different location.
		1037	Elk Bis		New 400/110 kV Substation Ełk Bis connected by two double 400 kV lines Łomża-Ełk and Ełk-Alytus creating an interconnector Poland-Lithuania.	2015	Under Construction	Investment on time	The inv. was part of inv. no 370 in TYNDP2012 as "new 400kV switchgear in existing Substation Ełk". The concept has changed, it is not possible to extend the existing substation and there is a new substation in a different location, expected in 2015.
		368	Elk (PL)	PL-LT border	Construction of a new 400 kV interconnector line from Ełk to PL-LT border.	2015	Under Construction	Investment on time	Investment is under construction.
		369	Siedlce Ujrzanów (PL)	Milosna (PL)	Construction of new 400 kV line Siedlce Ujrzanów - Miłosna.	2015	Under Construction	Investment on time	The project is in the construction phase.
		370	Elk (PL)	Lomza (PL)	Construction of new 400 kV line Ełk-Łomża.	2015	Under Construction	Investment on time	The project is under construction.

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
		728	Lomza (PL)		Construction of new substation Łomża to connect the line Ełk-Łomża.	2015	Under Construction	Investment on time	The project is under construction.
		371	Ostroleka (PL)	Narew (PL)	Construction of new 400 kV line Ostrolęka-Łomża-Narew + extension of substation Narew.	2015	Under Construction	Investment on time	The project is under construction.
		729	Ostroleka (PL)		A new 400 kV switchgear in existing substation Ostroleka (in two stages) with transformation 400/220kV 500 MVA and with transformation 400/110kV 400 MVA.	2015	Under Construction	Investment on time	The project is under construction.
		730	Stanislawów (PL)		New substation 400kV Stanisławów will be connected by splitting and extending existing line Miłosna-Narew and Miłosna-Siedlce.	2015	Under Construction	Expected earlier than planned previously	In TYNDP 2012 the building of the substation Stanisławów was reported as part of a line Ostrołęka-Stanisławów. The commissioning time has been aligned with the construction of the line Miłosna-Siedlce Ujrzanów which is expected in 2015.
		376	Alytus (LT)	PL-LT border	Construction of 500 MW Back-to-Back convertor station near Alytus 330kV substation. Construction of double circuit 400kV OHL between Alytus and PL-LT border (51 km).	2015	Under Construction	Investment on time	As planned.
		379	Kruonis (LT)	Alytus (LT)	New double circuit 330kV OHL Alytus–Kruonis(2x1080 MVA, 53km).	2016	Design & Permitting	Delayed	Several months delay due to difficulties with the acquisition of the land
90	**Swiss Roof**								
		1099	Rüthi	Bonaduz - Grynau	Rüthi - Grynau 2 x 380 kV Rüthi - Bonaduz 1 x 380 kV	2022	Planning	Investment on time	Investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.

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
		129	Beznau (CH)	Mettlen (CH)	Upgrade of the existing 65km double circuit 220kV OHL to 400kV.	2020	Design & Permitting	Delayed	long permitting procedure (comprising several phases). In this case, Federal Court decision for partial cabling.
		130	La Punt (CH)	Pradella / Ova Spin (CH)	Installation of the second circuit on existing towers of a double-circuit 400kV OHL (50km).	2017	Planning	Investment on time	none
		133	Bonaduz (CH)	Mettlen (CH)	Upgrade of the existing 180km double circuit 220kV OHL into 400kV.	2020	Under Consideration	Investment on time	none
		134	Bassecourt (CH)	Romanel (CH)	Construction of different new 400kV line sections and voltage upgrade of existing 225kV lines into 400kV lines; total length: 140km. Construction of a new 400/220 kV substation in Mühleberg (= former investment 132 'Mühleberg Substation')	2020	Design & Permitting	Delayed	lines: long permitting procedure (comprising several phases)- Mühleberg substation: under construction
		136	Border area (DE-AT)	Rüthi (CH)	380 kV Rüthi – Meiningen and 380 kV Meiningen - Border Area AT-DE	2022	Planning	Investment on time	investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.
92	ALEGrO								

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
		1045	Lixhe	Herderen	AC BE Reinforcements Internal reinforcements in AC network in Belgium have started in the context of securing infeed from the 380kV network into the Limburg & Liège area's. These reinforcements are also needed to facilitate the integration of ALEGrO into the Belgian grid. The reinforcements consist of - extension of an existing single 380 kV connection between Lixhe and Herderen by adding an additional circuit with high performance conductors (HTLS) - creation of 380kV substation in Lixhe, including a 380/150 transformator - creation of 380kV substation in Genk (André Dumont), including a 380/150 kV traformator	2017	Design & Permitting	Investment on time	This investment item is split off from the generic Alegro investment item which up to now included also the internal reinforcements
		1048	Lixhe	Herderen	Potentially additional AC BE Reinforcements Envisions the installation of a second 380 kV overhead line between Herderen to Lixhe. And the installation of a 2nd 380/150 transformator in Limburg area (probably substation André Dumont). These reinforcements are conditional to the evolution of production in the Limburg-Liège area and to the evolution of the physical (transit)flux towards 2020-2025.	2020	Under Consideration	New Investment	Evolution of generation in the Limburg-Liège must be accounted for in the perimeter of the Alegro project. This conditional project has a commissioning date set to 2020 as indication for further monitoring of the need.

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
		146	Area of Oberzier - Aachen/Düren (DE)	Area of Lixhe - Liège (BE)	ALEGrO Connection between Germany and Belgium including new 100 km HVDC underground cable with convertor stations and extension of existing 380 kV substations. The assessment of the Final Investment Decision is planned in 2015.	2019	Design & Permitting	Delayed	BE: Several months delay due to authorisation procedure in Belgium longer than expected (modification of "Plan de secteur" in Wallonia). DE: Delay due to unclear permitting framework (legal framework for planning approval is presently under development
94	**GerPol Improvements**								
		992	Vierraden		Installation of new PSTs in Vierraden	2017	Planning	New Investment	Based on a common agreement between PSE and 50Hertz the investment was specified in more detail in close cooperation between PSE and 50Hertz. The common solution consists of PST in Vierraden (DE) and PST in Mikułowa (PL) Investment 799.
		139	Vierraden (DE)	Krajnik (PL)	Upgrade of existing 220 kV line Vierraden-Krajnik to double circuit 400 kV OHL.	2017	Design & Permitting	Investment on time	A delay in the permit process for the line Neuenhagen-Bertikow-Vierraden (DE) as a prerequisite caused an adaptation in the time schedule for the line between Vierraden and Krajnik from to 2017.
		796	Krajnik (PL)		Upgrade of 400/220 kV switchgear in substation Krajnik (new 400/220 kV switchyard).	2017	Design & Permitting	Delayed	The comissioning time of the investment has been aligned with the schedule for the investment 139.

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
		799	Mikulowa (PL)		Installation of new Phase Shift Transformer in substation Mikułowa and the upgrade of substation Mikułowa for the purpose of PST installation.	2015	Design & Permitting	Delayed	Investment postponed because of prolongation of the tendering process. Due to complexity of the technical solutions more time is needed for the tendering procedure.
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.
113	**Doetinchem - Niederrhein**								
		145	Niederrhein (DE)	Doetinchem (NL)	New 400kV line double circuit DE-NL interconnection line. Length:57km.	2016	Design & Permitting	Delayed	Permitting procedures take longer than expected
116	**LUXEMBOURG 400 KV**								
		446	Schifflange (LU)		As a first interim step a PST is commissioned in 2016 in Schifflange and connected to an existing OH-line with an additional 3.5km cable between Biff(CREOS-LU) and Substation Bascharage (CREOS-LU).	2016	Planning	Investment on time	Studies for interim step are finalized, Investment decision expected by mid of 2014

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
		447	Heisdorf (LU)	Berchem (LU)	Erection of a new 20km 225kV double-circuit mixed (cable+OHL)line with 1000 MVA capacity in order to create a loop around Luxembourg city including substations for in feed in lower voltage levels.	2017	Design & Permitting	Investment on time	Substation Blooren is authorized and under construction, Authorization for line section is still pending
		651	Bascharage (LU)	Niederstedem (DE) or tbd (DE)	Upgrading and new construction of an interconnector to DE, in conjunction with the interconnector in the south of LU; Partial upgrading of existing 220kV lines and partial new construction of lines; With power transformer station in LU	2032	Under Consideration	Rescheduled	Further market studies after 2018 needed
123	**LitPol Link Stage 2**								
		1038	Alytus		Construction of the second 500 MW back-to-Back converter station in Alytus	2020	Planning	New Investment	This investment was missing not explicitly mentioned in TYNDP 2012,but was already foreseen.
		335	Ostroleka (PL)	Olsztyn Matki (PL)	Construction of new 400 kV line Ostrołęka - Olsztyn Mątki after dismantling of 220kV line Ostrołęka - Olsztyn with one circuit from Ostrołęka to Olsztyn temporarily on 220 kV.	2017	Design & Permitting	Investment on time	The investment in on time.
		373	Ostroleka (PL)	Stanislawów (PL)	Construction of new 400 kV line Ostrołęka-Stanisławów.	2020	Design & Permitting	Investment on time	The project is at the design stage.
		374	Kozienice (PL)	Siedlce Ujrzanów (PL)	Construction of new 400 kV line Kozienice-Siedlce Ujrzanów.	2019	Design & Permitting	Expected earlier than planned previously	The commissioning date has been adjusted compared to the previous national plan and TYNDP.
129	**OWP Northsea TenneT Part 4**								
		943	NOR-9-1	Cloppenburg	Connection of new offshore wind park. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 255 km. Line capacity: 900 MW	2028	Under Consideration	New Investment	new investment

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
		945	NOR-10-1	Cloppenburg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	2029	Under Consideration	New Investment	new investment
		947	NOR-11-2	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 270km. Line capacity: 900 MW	2031	Under Consideration	New Investment	new investment
		951	NOR-13-2	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	2030	Under Consideration	New Investment	new investment
130	**N-S Eastern DE_section East**								
		665	Lauchstädt (DE)	Meitingen (DE)	New DC- lines to integrate new wind generation from control area 50Hertz especially Mecklenburg-Vorpommern, Brandenburg and Sachsen-Anhalt towards Central/south Europe for consumption and storage.	2024	Planning	Investment on time	Result from National Grid Development Plan
		208	Pulgar (DE)	Vieselbach (DE)	Construction of new 380kV double-circuit OHL in existing corridor Pulgar-Vieselbach (103 km). Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	2024	Planning	Investment on time	The project is part of the results of the national grid development plan and included in the list of national interest (Bundesbedarfsplan). With in this process the commissioning dates of the included projects have been aligned with the current situation.
132	**N-S Western DE_section North_2**								

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
		661	Emden East (DE)	Osterath (DE)	New HVDC-lines from Emden to Osterath to integrate new wind generation especially from North Sea towards Central Germany for consumption.	2022	Planning	Investment on time	Progess as planned.
		663	Cloppenburg East (DE)	Merzen (DE)	New 380-kV double circuit over-head-line Cloppenburg East - Merzen with a total length of ca. 55 km. New errection of a 380-kV substation Merzen.	2022	Planning	Investment on time	Progess as planned.
		666	Conneforde (DE)	Cloppenburg (DE)	New 380-kV-line in existing OHL corridor for integration of on- and offshore Wind generation. Incl. new 380-kV-switchgear in Cloppenburg and new transformers in Cloppenburg	2022	Planning	Investment on time	TYDNP 2012 investment 43.A89 is divided in serveral parts
133	**Longterm German RES**								
		956	Schleswig-Hostein	Baden-Würtemberg / Bavaria	new DC- line in HVDC technology to integrate new wind generation from northern Germany toward soutern Germany and southern Europe for consumption and storage. Connections points north: Brunsbüttel, Wilster, Kreis Segeberg, Stade, Alfsted. South: Großgartach, Goldshöfe, Raitersaich, Vöhringen	2030	Under Consideration	New Investment	new investment
		969	lower saxony	NRW	New HVDC line to integrate new wind gerneration especially from North Sea towards Central Germany for consumption and storage. connections points north: Emden, Conneforde. South: Oberzier, Rommerskirchen	2030	Under Consideration	New Investment	new investment
		970	lower saxony	Hessen/Baden-Würtemberg	New HVDC line to integrate new wind gerneration especially from North Sea towards South Germany for consumption and storage. Connectionspoints north: Cloppenburg, Elsfelth/West. South: Bürstadt, Philipsburg	2030	Under Consideration	New Investment	new investment

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
		958	Güstrow (DE)	Meitingen (DE)	New DC- lines to integrate new wind generation from Baltic Sea and control area 50Hertz especially Mecklenburg-Vorpommern towards Central/south Europe for consumption and storage.	2034	Under Consideration	New Investment	New Investment
134	**N-S Western DE_section South**								
		660	Osterath (DE)	Philippsburg (DE)	New HVDC-lines from Osterath to Philippsburg to integrate new wind generation especially from North Sea towards Central-South Germany for consumption and storage.	2019	Design & Permitting	Investment on time	Progess as planned.
		179	Rommerskirchen (DE)	Weißenthurm (DE)	New380 kV overhead line in existing route. Extension and erection of substations incl. erection of 380/110kV-transformers.	2017	Under Construction	Delayed	The section Rommerskrichen to Sechtem is delayed because the permitting procedures take longer than planned. The 36 km section from Sechtem to Weißenturm is already commissioned.
		680	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 380 kV double circuit overhead line Urberach - Weinheim - Daxlanden. Extension of existing substations are included.	2021	Planning	Investment on time	Progess as planned.
		176	Daxlanden (DE)	Eichstetten (DE)	This AC project is necessary in order to evacuate the energy arriving from HVDC corridors towards southern Germany and reinforce the interconnection capacity with Switzerland	2020	Under Consideration	Investment on time	No significant change
135	**N-S Western DE_parallel lines**								

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
		662	Wehrendorf (DE)	Urberach (DE)	New lines in HVDC technology from Wehrendorf to Urberach to integrate new wind generation especially from North Sea towards Central-South Europe for consumption and storage.	2022	Under Consideration	Rescheduled	The need for this long-term investment was not confirmed by the regulatory authority within the national grid development plan 2012. Therefore further studies on this project are ongoing.
		188	Kruckel (DE)	Dauersberg (DE)	New 380 kV over head lines in existing rout. Extension of existing and erection of several 380/110kV-substations.	2020	Design & Permitting	Investment on time	Progress as planned.
		680	Urberach (DE)	Daxlanden (DE)	New line and extension of existing line to 380 kV double circuit overhead line Urberach - Weinheim - Daxlanden. Extension of existing substations are included.	2021	Planning	Investment on time	Progess as planned.
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**								

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
		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.

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
		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.
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.

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
		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.
148	**CCS new**								
		68	Okroglo (SI)	Udine (IT)	New 120km double circuit 400kV OHL with PST in Okroglo.The thermal rating will be 1870 MVA per circuit.	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.

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152	**France Germany Interconnection**								
		988	Vigy	Ensdorf or further (tbd)	Upgrade of the existing Vigy Ensdorf (Uchtelfangen) 400 kV double circuit OHL to increase its capacity.	2030	Under Consideration	New Investment	Commissioning date will result from the on-going technical feasibility under investigation.
		989	Muhlbach	Eichstetten	Operation at 400 kV of the second circuit of a 400kV double circuit OHL currently operated at 225 kV ; some restructuration of the existing grid may be necessary in the area.	2026	Under Consideration	New Investment	Studies in progress showed the feasibility of upgrading the existing asset in order to provide mutual support to Alsace and Baden and some exchange capacity increase between France and Germany. The detailed timeline of the investment is under definition.
164	**N-S Eastern DE_central section**								
		149	Dollern (DE)	Stade (DE)	New 380kV double circuit OHL Dollern - Stade including new 380kV switchgear in Stade. Length:14km.	2022	Design & Permitting	Delayed	The investment is delayed because of changes in the investment driver
		664	Brunsbüttel, Wilster, Kreis Segeberg	Großgartach, Goldshöfe, Grafenrheinfeld	New DC-lines to integrate new wind generation from Northern Germany towards Southern Germany and Southern Europe for consumption and storage.	2022	Planning	Investment on time	The expected commissioning date is 2017 - 2022
		157	Wahle (DE)	Mecklar (DE)	New 380kV double circuit OHL Wahle - Mecklar including two new substations. Length: 210km.	2018	Design & Permitting	Delayed	delay due to long permitting process
		677	Dollern (DE)	Landesbergen (DE)	New 380 kV line in existing OHL corridor Dollern-Sottrum-Wechold-Landesbergen (130 km)	2022	Planning	Investment on time	
		177	Goldshöfe (DE)	Bünzwangen (DE)	AC-extension of the "C corridor" at one ending point in Southern Germany towards the consumption areas allowing the existing grid to deal with the additionnal flows from DC-link	2020	Design & Permitting	Investment on time	Anticipation of design and permitting phase due to foreseen difficulties (protected area in the Swabian Alps)

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		685	Mecklar (DE)	Grafenrheinfeld (DE)	New double circuit OHL 400-kV-line (130 km)	2022	Planning	Investment on time	
166	**DKE-PL interconnection**								
		994	Bjæverskov	Dunowo	This project candidate investigates the possibility of establishing an interconnector between Bjæverskov (Denmark) and Dunowo (Poland). This very first conceptual study looks at a 500 kV 600 MW HVDC subsea connection, testing the idea of connecting these markets.	2030	Under Consideration	New Investment	This is a conceptual project. In case the assessment is promising, it might be taken to a next step, in case it is not, it will be cancelled.
176	**Hansa PowerBridge**								
		995	Station SE4	Station DE	New DC cable interconnector between Sweden and Germany.	2025	Under Consideration	New Investment	RGBS common investigations for TYNDP 2014
177	**PST Hradec**								
		889	Hradec		Construction of new PST in substation Hradec with target capacity 2x1700MVA	2016	Design & Permitting	Investment on time	Progress as planned
179	**DKE - DE**								
		1016	Bjæverskov (DK2)	Bentwisch (DE)	new 600 MW HVDC subsea cable connecting DK2 and DE	2030	Under Consideration	New Investment	RGBS common investigations for TYNDP14
183	**DKW-DE, Westcoast**								
		1018	Niebüll (DE)	Endrup (DKW)	new 380 kV cross border line DK1-DE for integration of RES and increase of NTC	2022	Planning	Investment on time	in TYNDP12 this investment was part of 43.A90
186	**east of Austria**								
		886	tbd	tbd	To allow the grid integration of the planned renewable energy generation (mainly wind power) in the north-eastern part of Austria ("Weinviertel") and to cover the foreseen load growth in that region the transmission grid infrastructure has to be enforced and new substations for the connection need to be erected	2021	Planning	Rescheduled	The development of wind energy in Lower Austria was temporarily stopped by the federal state government to establish a concept for land use. Final concept was published in beginning of 2014 – project now continues

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
									with planned commissioning in 2021.
187	**St. Peter - Pleinting**								
		997	Pleinting (DE)	St. Peter (AT)	new 380-kV-line Pleinting (DE) - St. Peter (AT) on exting OHL corridor	2022	Under Consideration	New Investment	new investment
191	**OWP TenneT Northsea Part 2**								
		952	Cluster DolWin 5 (NOR-1-1)	Halbemond	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 250 km. Line capacity: 900 MW	2021	Under Consideration	New Investment	new investment
		953	Cluster DolWin 6 (NOR-3-3)	Halbemond	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 60km. Line capacity: 900 MW	2021	Under Consideration	New Investment	new investment
		954	Cluster BorWin 5 (NOR-7-1)	Halbemond	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 260km. Line capacity: 900 MW	2022	Under Consideration	New Investment	new investment
		211	Cluster DolWin 4 (NOR 3-2)	Unterweser	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 190km. Line capacity: 900 MW	2020	Under Consideration	Investment on time	on time
		656	Cluster BorWin3	Emden/Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 160 km. Line capacity: 900 MW	2018	Design & Permitting	Investment on time	

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		658	Cluster BorWin4 (DE)	Emden/Ost (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 172 km. Line capacity: 900 MW	2019	Design & Permitting	Investment on time	
192	OWP Northsea TenneT Part 3								
		946	NOR-11-1	Elsfleth/West	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 230km. Line capacity: 900 MW	2026	Under Consideration	New Investment	new investment
		948	NOR-12-1	Wilhelmshafen	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 230km. Line capacity: 900 MW	2027	Under Consideration	New Investment	new investment
		950	NOR-13-1	Kreis Segeberg	Connection of new offshore wind parks. New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 330km. Line capacity: 900 MW	2025	Under Consideration	New Investment	new investment
		955	Cluster BorWin6 (NOR-7-2)	Unterweser	Connection of new offshore wind parks.New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 180km. Line capacity: 900 MW	2023	Under Consideration	New Investment	new investment
		659	Cluster SylWin2 (DE)	Büttel (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205 km. Line capacity: 900 MW	2023	Under Consideration	Investment on time	
198	Area of Lake Constance								

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
		984	Herbertingen	Tiengen	Herbertingen – Tiengen: Between the two substations Herbertingen and Tiengen a new line will be constructed in an existing corridor. Enhancement of the grid, which will increase transmission capacity noticeably, is needed at the substation Herbertingen.	2020	Planning	Investment on time	Progess as planned. This project is a concretion of TYNDP12 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
		985	point Rommelsbach	Herbertingen	Rommelsbach – Herbertingen: Between point Rommelsbach and substation Herbertingen a new line will be constructed in an existing corridor. This will significantly increase transmission capacity (grid enhancement).	2018	Planning	Investment on time	Progess as planned. This project is a concretion of TYNDP12 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
		986	point Wullenstetten (DE)	point Niederwangen (DE)	Point Wullenstetten – Point Niederwangen Between point Wullenstetten and point Niederwangen an upgrade of an existing 380-kV-line is necessary (grid enhancement). Thereby, a significantly higher transmission capacity is realized. The 380 kV substation station Dellmensingen is due to be extended (grid enhancement).	2020	Planning	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. Due to the ongoing planning stage, this section was developed and an own investment item was created.
		1043	Neuravensburg	border area (AT)	Point Neuravensburg – Point Austrian National border (AT) Between switching point Neuravensburg and Austrian National border (AT) a new line with a significantly higher transmission capacity will be constructed in an existing corridor (grid enhancement).	2023	Planning	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. This investment is caused by the investment 136 "Bodensee Studie". Due to the ongoing planning stage, this section was developed and an own investment item was created.

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
		136	Border area (DE-AT)	Rüthi (CH)	380 kV Rüthi – Meiningen and 380 kV Meiningen - Border Area AT-DE	2022	Planning	Investment on time	investment 136 now comprises the cross-border part of former investment 136, and investment 1099 is the Swiss part of former investment 136.
200	**North-South corridor**								
		306	Vitkov (CZ)		New 400/110kV substation equipped with transformers 2x350MVA.	2020	Design & Permitting	Delayed	Complication of permitting procedure
		307	Vernerov (CZ)		New 400/110kV substation equipped with transformers 2x350MVA.	2017	Design & Permitting	Delayed	Complication with permitting procedure.
		308	Vernerov (CZ)	Vitkov (CZ)	New 400kV double circuit OHL, 1385 MVA.	2019	Design & Permitting	Investment on time	As planned
		309	Vitkov (CZ)	Prestice (CZ)	New 400kV double circuit OHL, 2x1730 MVA.	2021	Design & Permitting	Investment on time	As planned
		312	Mirovka (CZ)		Upgrade of the existing substation 400/110kV with two transformers 2x350MVA.	2020	Design & Permitting	Delayed	Project delayed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side
		314	Mirovka (CZ)	V413 (CZ)	New double circuit OHL with a capacity of 2x1385 MVA and 26.5km length.	2020	Design & Permitting	Delayed	Project delayed due to reschedulling of transmission projects together with commission rescheduled on the generation investor's side
201	**Upgrade Meeden - Diele**								
		1066	Meeden		Increase of the interconection capacity between NL and DE by approximately 1000 MW by adding two new phase shifting transformers and upgrade of an existing tie line between Meeden and Dielen	2018	Planning	New Investment	In a crossborder study the investment along the existing Meeden - Diele corridor has been identified as feasible and cost effective
204	**N-S transmission DE_par_line_2**								

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
		686	Schalkau / area of Altenfeld (DE)	area of Grafenrheinfeld (DE)	New double circuit OHL 380-kV-line (130 km)	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
205	**N-S transmission DE_par_line_1**								
		153	Redwitz (DE)	Grafenrheinfeld (DE)	Upgrade of 220kV connection Redwitz - Grafenrheinfeld to 380kV, including new 380kV switchgear Eltmann. Line length: 97km.	2015	Design & Permitting	Delayed	Delayed due to delaye of related investment 45.193 and unexspected long permitting process of the investment itself
		193	Vieselbach (DE)	Redwitz (DE)	New 380kV double-circuit OHL between the substations Vieselbach-Altenfeld-Redwitz with 215km length combined with upgrade between Redwitz and Grafenrheinfeld (see investment 153). The Section Lauchstädt-Vieselbach has already been commissioned. Support of RES integration in Germany, annual redispatching cost reduction, maintaining of security of supply and support of the market development. The line crosses the former border between Eastern and Western Germany and is right downstream in the main load flow direction. The project will help to avoid loop flows through neighboring grids.	2015	Design & Permitting	Delayed	Previously "mid term" is now updated to specific date. Partly under construction (section Vieselbach – Altenfeld). 3rd section (Altenfeld – Redwitz) in permitting process, long permitting process with strong public resistance.
206	**Reinforcement Southern DE**								
		682	Großgartach (DE)	Endersbach (DE)	AC-extension of the "C corridor" at one ending point in Southern Germany towards the consumption areas allowing the existing grid to deal with the additionnal flows from DC-link	2019	Planning	Investment on time	Standard processing 2018-2019
		687	Redwitz (DE)	Schwandorf (DE)	New double circuit OHL 380 kV line in existing OHL corridor Redwitz-Mechlenreuth-Etzenricht-Schwandorf (185 km)	2020	Planning	Investment on time	

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
		688	Raitersaich (DE)	Isar (DE)	New 380 kV line in existing OHL corridor Raitersaich - Ludersheim - Sittling - Isar or Altheim (160 km)	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
		990	Grafenrheinfeld (DE)	Großgartach (DE)	AC-extension of the "C corridor" between two of its ending points in Southern Germany allowing the existing grid to deal with the additionnal flows from DC-link	2019	Planning	New Investment	Standard processing
207	**Reinforcement Northwestern DE**								
		939	Conneforde	Emden/Ost	New 380-kV-line in existing OHL corridor for integration of RES	2019	Planning	Delayed	In TYNDP 2012 part of investment 43.A89
		940	Emden/Ost	Halbemond	New 380-kV-line Emden - Halbemond for RES integration incl. new transformers in Halbemond	2021	Under Consideration	Rescheduled	In TYNDP 2012 part of investment 43.A89
		675	Conneforde (DE)	Unterweser (DE)	Upgrade of 220-kV-circuit Unterweser-Conneforde to 380kV , Line length: 32 km.	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
		676	Dollern (DE)	Elsfleht/West (DE)	New 380 kV line in existing OHL corridor Dollern - Elsfleht/West Length:100 km	2024	Under Consideration	Rescheduled	Delay due to missing confirmation by the regulator
208	**N-S Western DE_section North_1**								
		150	Conneforde (DE)	Fedderwarden (DE)	New 380kV double circuit (OHL, partly underground) Conneforde - Wilhelmshaven (Fedderwarden, former Maade) including new 400kV switchgear Fedderwarden. Length: 35 km.	2018	Design & Permitting	Investment on time	
		151	Wehrendorf (DE)	Ganderkesee (DE)	New line (length: ca. 95km), extension of existing and erection of substations, erection of 380/110kV-transformers.	2017	Design & Permitting	Delayed	delay due to long permitting process
		156	Niederrhein (DE)	Dörpen/West (DE)	New 380 kV double circuit overhead line Dörpen - Niederrhein including extension of existing substations.	2018	Design & Permitting	Delayed	The project is delayed due to delays in public-law and civil-law licensing procedures.
209	**Reinforcement Northeastern DE**								
		935	Kreis Segeberg	Göhl	New 380-kV-lineKreis Segeberg - Lübeck - Siems - Göhl, including five new transformers	2021	Under Consideration	Rescheduled	Investment was part of investment 43.A90 in

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
									TYNDP 2012. Now seperatly
		937	Audorf	Kiel	New 380-kV-line in existing OHL corridor including 4 new transformers and new 380-kV-switchgears in Kiel/West and Kiel/Süd	2021	Under Consideration	Rescheduled	In TYNDP 2012 this investment was part of investment 43.A90
		667	Brunsbüttel (DE)	Niebüll	About 135 km new 380-kV-lines and around 10 new transformers for integration of onshore Wind in Schleswig-Holstein and increase of NTC between DE and DK	2018	Planning	Delayed	The old investment 43.A90 is now divided in several parts.
		147	Dollern (DE)	Hamburg/Nord (DE)	New 380kV double circuit OHL Dollern - Hamburg/Nord. Length:43km. First circuit 2015, second cicuit 2017	2017	Under Construction	Delayed	Delay due to long permitting process
		148	Audorf (DE)	Hamburg/Nord (DE)	New 380kV double circuit OHL Audorf - Hamburg/Nord including two new 380/220kV transformers in substation Audorf and new 380 kV Switchgear in Kummerfeld. Length: 65km.	2017	Design & Permitting	Delayed	delay due to long permitting process
210	**E15**								
		1071	Würmlach (AT)	Somplago (IT)	Würmlach - Somplago	2017	Design & Permitting	New Investment	Project application to TYNDP 2014.
225	**2nd Interconnector Belgium – Germany**								
		1107	BE (TBD)	DE (TBD)	This investment item envisions the possibility of a second 1 GW interconnection between Belgium and Germany. Subject to further studies.	2030	Under Consideration	New Investment	Preliminary studies on high RES scenario's have indicated potential for further regional welfare & RES integration increase by further increasing the interconnection capacity between Belgium & Germany towards time horizon 2025-2030.

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		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.
		959	Lubmin (DE)	Güstrow (DE)	380-kV-grid enhancement and structural change Lubmin-Lüdershagen-Bentwisch-Güstrow	2024	Under Consideration	New Investment	New Investment
		960	Lubmin (DE)	Pasewalk (DE)	380-kV-grid enhancement and structural change area Lubmin-Iven-Pasewalk.	2030	Under Consideration	New Investment	New Investment
		965	Hamburg/Nord (DE)	Hamburg/Ost (DE)	AC Enhancement Hamburg	2024	Under Consideration	New Investment	New Investment
		966	Krümmel (DE)	Hamburg/Nord (DE)	AC Enhancement Krümmel	2024	Under Consideration	New Investment	New Investment
		967	control area 50Hertz		Contructions of new substations, Var-compensation and extension of existing substations for integration of newly build power plants and RES in 50HzT control area	2023	Planning	New Investment	Commisioning date for different substations varies from 2015 to 2023 depending on local increase of RES or

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

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		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.
		1067	Klostermannsfeld (DE)	Lauchstädt (DE)	TBA	2024	Planning	New Investment	New Investment
		1088	Mengede (DE)	Wanne (DE)	Reconductering of existing 380kV line Mengede - Herne - Wanne.	2014	Under Construction	Investment on time	Progress as planned
		1089	Point Ackerstraße	Point Mattlerbusch	Reconductering of existing 380kV line between Point Ackerstraße-Mattlerbusch	2014	Under Construction	Investment on time	Progress as planned
		1090	Niederhein (DE)	Utfort (DE)	New lines and installation of additional circuits, extension of existing and erection of several 380/110kV-substations.	2018	Design & Permitting	Investment on time	Progess as planned
		1091	Günnigfeld (DE)	Wanne (DE)	Reconductering of existing 380kV line	2018	Design & Permitting	Investment on time	Progress as planned
		1092	Landesbergen (DE)	Wehrendorf (DE)	Installation of an additional 380-kV circuit between Landesbergen and Wehrendorf	2023	Planning	New Investment	Due to high RES infeed in the north of Germany additional grid reinforcements are necessary.
		1093	Point Okriftel	Farbwerke Höchst-Süd	The 220kV substation Farbwerke Höchst-Süd will be upgraded to 380kV and integrated into the existing grid.	2022	Planning	Investment on time	Progress as planned

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		1094	Several		This investment includes new 380/220kV transformes in Walsum, Sechtem, Siegburg, Mettmann and Brauweiler.	2024	Planning	New Investment	In order to avoid bottlenecks within transmission grid new 380/220kV transformes are needed in Walsum, Sechtem, Siegburg, Mettmann and Brauweiler.
		1095	Lippe (DE)	Mengede (DE)	Reconductering of existing 380kV line between Lippe and Mengede.	2024	Under Consideration	New Investment	Additional grid reinforcements between Lippe and Mengede are needed.
		1096	Lüstingen and Gütersloh	Gütersloh	The subsations Lüstingen to Güthersloh will be upgrade to use the line Lüstingen to Güthersloh with 380 kV.	2024	Planning	New Investment	New Investment.
		1097	Several		This investment includes several new 380/110kV transformers in order to integrate RES in Erbach, Gusenburg, Kottigerhook, Niederstedem, Öchtel, Prüm and Wadern. In addition a new 380kV substation and transformers in Krefeld Uerdingen are included.	2019	Planning	New Investment	In order to integrate RES several new 380/110kV transformers are needed in Erbach, Gusenburg, Kottigerhook, Niederstedem, Öchtel, Prüm and Wadern. In addition a new 380kV substation and transformers in Krefeld Uerdingen are included.
		1100	Herbertingen (DE)	point Neuravensburg (DE)	Between the 380-kv-station Herbertingen and point Neuravensburg a new line with a significantly higher transmission capacity will be constructed (Grid enhancement).	2034	Under Consideration	Investment on time	This project is a concretion of TYNDP 2012 project 44.A77. The need for this long-term investment was not confirmed by the regulatory authority within the national grid development plan 2012. Therefore further studies on this project are ongoing.

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		1101	Büttel	Wilster	new 380-kV-line in extisting corridor in Schleswig - Holstein for integration of RES especially wind on- and offshore	2021	Under Consideration	New Investment	new investment due to German NDP 2014
		1102	junction Mehrum	Mehrum	new 380-kV-line junction Mehrum (line Wahle - Grohnde) - Mehrum including a 380/220-kV-transformer in Mehrum	2019	Under Consideration	New Investment	new investment due to German NDP 2014
		1103	Borken	Mecklar	new 380-kV-line Borken - Mecklar in existing corridor for RES integration	2021	Under Consideration	New Investment	new investment due to German NDP 2014
		1104	Borken	Gießen	new 380-kV-line Borken - Gießen in existing corridor for RES integration	2022	Under Consideration	New Investment	new investment due to German NDP 2014
		1105	Borken	Twistetal	new 380-kV-line Borken - Twistetal in existing corridor for RES integration	2021	Under Consideration	New Investment	new investment due to German NDP 2014
		1106	Wahle	Klein Ilsede	new 380-kV-line Wahle - Klein Ilsede in existing corridor for RES integration	2018	Under Consideration	New Investment	new investment due to German NDP 2014
		1108	Metzingen-Oberjettingen	Oberjettingen-Engstlatt	New 380kV OHL Metzingen-Oberjettingen (32 km) and new 380kV OHL Oberjettingen-Engstlatt (34 km)	2020	Planning	New Investment	New investment
		1109	Großgartach	Pulverdingen	New circuit 380kV OHL Großgartach-Pulverdingen (30 km) combined with reconductering existing circuit 380kV OHL Großgartach-Pulverdingen (30 km)	2024	Planning	New Investment	New investment
		1110	Dellmensingen	Rotensohl-Niederstotzingen	New circuit 380kV OHL Dellmensingen-Rothensohl (67 km) combined with reconductering existing circuit 380kV OHL Dellmensingen-Niederstotzingen (41 km)	2024	Planning	New Investment	New investment

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		327	Kozienice (PL)	Oltarzew (PL)	New 130 km 400 kV 2x1870 MVA OHL double circuit line Kozienice - Ołtarzew + upgrade and extension of 400 kV switchgear in substation Kozienice for the connection of new line.	2019	Design & Permitting	Delayed	The investment has been postponed due to prolonged tendering process (land acquisition). The line is planned on very densely populated area. The benefit of the investment is recognized on the regional and local scale (supply of Warsaw area, export needs).
		168	Goldshöfe (DE)	Dellmensigen (DE)	Upgrade the line Goldshöfe - Dellmensigen from 220kV to 380kV . Line length:114km. Included in the investment : 3x 380kV substations, 2 transformers.	2014	Under Construction	Investment on time	No change to be reported
		217	Dürnrohr (AT)	Sarasdorf (AT)	Installation of the 3rd and 4th circuit on the existing line Dürnrohr - Sarasdorf. Total length: 100km.	2014	Under Construction	Investment on time	No status change since TYNDP 2012; the construction process is on time
		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.
		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	-
		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

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									extension of the existing 330/35 kV substation).
		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.
		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)

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		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.
		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.
		297	Bystricany (SK)		Upgrade of the existing 220/110kV substation Bystričany. The substation will be connected to the 400kV system by two new 2x400kV lines from Horná Ždaňa and Križovany substations by splitting only one circuit into Bystričany substation.	2019	Planning	Investment on time	No change.
		845	Bystricany (SK)	Horná Ždana (SK)	It is the Investment deeply connected to the investment Bystričany substation reconstruction. The new substation Bystričany will be connected to the 400kV system by two new 2x400kV lines from Horná Ždaňa and Križovany substations by splitting only one circuit in Bystričany substation. Line length will be approximately 112km.	2019	Planning	Investment on time	No change.
		299	Krasikov (CZ)	Horni Zivotice (CZ)	New single circuit 400kV OHL, 1385 MVA in North-western part Czech Republic	2016	Under Construction	Delayed	Due to the problems during permitting procedure there is 2 years delay
		138	tbd (CZ)	tbd (DE) - South-Eastern 50 Hertz	Possible increase of interconnection capacity between CEPS and 50Hertz Transmission is under consideration: either a new 400kV tie-line (OHL on new route) or a reinforcement of the existing 400kV tie-line Hradec (CEPS) – Röhrsdorf (50Hertz Transmission).	2032	Under Consideration	Investment on time	Thisinvestment item is possible after all projects in CZ area related to the are commissioned - still under consideration

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
		174	Bruchsal Kändelweg (DE)	Ubstadt (DE)	A new 380kV OHL Bruchsal Kändelweg - Ubstadt. Length:6km.	2014	Under Construction	Investment on time	The permitting procedure has allowed the beginning of the construction
		175	Birkenfeld (DE)	Ötisheim (DE)	A new 380kV OHL Birkenfeld-Ötisheim (Mast 115A). Length:11km.	2020	Planning	Investment on time	No change to be reported
		178	Goldshöffe and Engstlatt		Installation of 2x250 MVAr 380kV capacitance banks (1x250 MVar Goldshöfe and 1x250MVar Engstlatt).	2014	Under Construction	Investment on time	No significant change
		182	Kriftel (DE)	Obererlenbach (DE)	New 400 kV double circuit OHL Kriftel - Obererlebenbach in existing OHL corridor.	2015	Design & Permitting	Delayed	The project is delayed due to delays in public-law and civil-law licensing procedures.
		185	Hanekenfähr (DE) and Ibbenbüren (DE)	Uentrop (DE)	In order to facilitate the integration of RES (especially wind) several grid reinforcements in the area of Münsterland/Westphalia are needed. This project will affect mainly the following substations: Hanekenfähr, Uentrop, Gütersloh, Wehrendorf, Lüstringen, Westerkappeln and Ibbenbüren. Within this area new lines and installation of additional circuits are planned. In addition the necessity for extension of existing and erection of several 380/110kV-substations is given.	2020	Design & Permitting	Investment on time	Major section will be commissoned in 2014. Last sections are planned to be commissoned 2020.
		186	Gütersloh (DE)	Bechterdissen (DE)	New lines and installation of additional circuits, extension of existing and erection of 380/110kV-substation.	2014	Under Construction	Investment on time	Progess as planned.
		187	Utfort (DE)	Rommerskirchen (DE)	New lines and installation of additional circuits, extension of existing and erection of several 380/110kV-substations.	2018	Under Construction	Delayed	The investment is delayed due to delays in public-law and civil-law licensing procedures. Serveral section will be commissioned before 2018.
		189	Niederrhein (DE)	Utfort (DE)	New 400 kV double-circuit OHL Niederrhein-Utfort	2017	Design & Permitting	Investment on time	In the moment no delays are known.

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		190	St. Barbara (DE)	Mittelbexbach (DE)	New lins, extension of existing and erection of several 380/110kV-substations	2014	Design & Permitting	Investment on time	Progress as planned.
		170	Großgartach (DE)	Hüffenhardt (DE)	New 380kV OHL Großgartach Hüffenhardt. Length: 23km. Included in the project : 1 new 380kV substation, 2 transformers.	2013	Under Construction	Delayed	Delay in the authorization process due to protest from local landowners
		172	Mühlhausen (DE)	Großgartach (DE)	Upgrade of the line Mühlhausen-Großgartach from 220kV to 380kV. Length: 45km.	2014	Under Construction	Investment on time	The permitting has allowed the beginning of the construction
		173	Hoheneck (DE)	Endersbach (DE)	Upgrade of the line Hoheneck-Endersbach from 220kV to 380kV. Length:20km.	2014	Under Construction	Investment on time	The permitting procedure has allowed the construction to begin
		678	Hamm/Uentrop (DE)	Kruckel (DE)	Extension of existing line to a 400 kV single circuit OHL Hamm/Uentrop - Kruckel and extension of existing substations.	2018	Planning	Investment on time	Progess as planned.
		679	Pkt. Blatzheim (DE)	Oberzier (DE)	New 400 kV double circuit OHL Pkt. Blatzheim - Oberzier including extension of existing substations.	2018	Under Consideration	Investment on time	The need for this investment was not confirmed by the German Network development Plan 2012. Therefore further studies on this project are ongoing.
		681	Bürstadt (DE)	BASF (DE)	New line and extension of existing line to 400 kV double circuit OHL Bürstadt - BASF including extension of existing substations.	2024	Planning	Rescheduled	Rescheduled: Investemt was not confirmed by the national regulatory authority within the national grid development plan 2012. Further studies are ongoing.
		673	Pkt. Metternich (DE)	Niederstedem (DE)	Construction of new 380kV double-circuit OHLs, decommissioning of existing old 220kV double-circuit OHLs, extension of existing and erection of several 380/110kV-substations. Length: 108km.	2021	Planning	Investment on time	Progress as planned.

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		672	Area of West Germany (DE)		Installation of reactive power compensation (eg. MSCDN, SVC, phase shifter). Devices are planned in Kusenhorst, Büscherhof, Weißenthurm and Kriftel. Additional reactive power devices will be evaluated.	2016	Planning	Investment on time	Progess as planned.
		191	Neuenhagen (DE)	Vierraden (DE)	Project of new 380kV double-circuit OHL Neuenhagen-Vierraden-Bertikow with 125km length as prerequisite for the planned upgrading of the existing 220kV double-circuit interconnection Krajnik (PL) – Vierraden (DE Hertz Transmission).	2017	Design & Permitting	Delayed	longer than expected permitting procedure
		197	Neuenhagen (DE)	Wustermark (DE)	Construction of new 380kV double-circuit OHL between the substations Wustermark-Neuenhagen with 75km length. Support of RES and conventional generation integration, maintaining of security of supply and support of market development.	2018	Under Construction	Investment on time	Previously "mid-term" updated to specific date.
		199	Lubmin (DE)	Bertikow (DE)	Construction of new 380kV double-circuit OHLs in North-Eastern part of 50HzT control area and decommissioning of existing old 220kV double-circuit OHLs, incl. 380-kV-line Bertikow-Pasewalk (30 km). Length: 135km.Support of RES and conventional generation integration in North Germany, maintaining of security of supply and support of market development.	2018	Design & Permitting	Delayed	The investment is split into two investments with different commissioning dates. From Lubmin to Pasewalk long term. From Pasewalk to Bertikow in 2018.
		200	Güstrow (DE)	Wolmirstedt (DE)	380-kV-grid enhancement and structural change Magdeburg/Wolmirstedt, incl. 380-kV-line Gustrow-Wolmirstedt (195 km).	2020	Planning	Investment on time	Investment on time

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		202	Bärwalde (DE)	Schmölln (DE)	Upgrading existing double-circuit 380kV OHL in the South-Eastern part of the control area of 50Hertz Transmission. Bärwalde-Schmölln length approx. 50km. Support of RES and conventional generation integration in North-Eastern Germany, maintaining of security of supply and support of market development.	2015	Under Construction	Expected earlier than planned previously	Investment is needed earlier, commissioning is being prepared.
		206	Röhrsdorf (DE)	Remptendorf (DE)	Construction of new double-circuit 380-kV-overhead line in existing corridor Röhrsdorf-Remptendorf (103 km)	2021	Planning	Delayed	
		158	Irsching (DE)	Ottenhofen (DE)	Upgrade of 220kV connection Irsching - Ottenhofen to 380kV, including new 380kV switchgear Zolling. Length 76km.	2017	Planning	Delayed	
		683	Wolmirstedt (DE)	Wahle (DE)	New double circuit OHL 380 kV; Line length 111 km	2022	Planning	Investment on time	
		684	Vieselbach (DE)	Mecklar (DE)	New double circuit OHL 400 kV line in existing OHL corridor . (129 km)	2022	Planning	Investment on time	
		298	Velký Dur (SK)	Gabcíkovo (SK)	Erection of new 2x400kV line between two important substations within Slovakia (Gabčíkovo and Veľký Ďur), including extension of the substation Veľký Ďur (SK). Line length:approx. 93km.	2016	Design & Permitting	Investment on time	The process of this Investment preparation has been speed up - the process of building permission obtaining was faster as expected.
		694	Velký Dur (SK)	Levice (SK)	The erection of new 1x400 kV line between two important Veľký Ďur and Levice substations, including extension of the V.Ďur and Levice substation. The driver for this project is expected connection of to new generation units in Veľký Ďur area.	2018	Under Consideration	Cancelled	The decision to omit this investment has been confirmed by the internal network analysis. The added value of this line has been shown as low as the desired network reinforcement in this

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
									area will be sufficiently obtained by the project Nr. 48.298.
		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.
		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	Comisssioning estimated on time

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		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 Stalpu-Teleajen-Brazi V(RO), upgraded to operate at 400kV, from 220kV.	2018	Planning	Investment on time	Investments 714 and 716 are complementary with investments 273 and 715.
		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.

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
		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.
		293	Vola (SK)	point of splitting (SK)	The Investment aims at connection of the new 400kV substation Voľa with transformation 400/110kV (replacing existing 220kV substation). This will be done by splitting of the existing single 400kV line between Lemešany and Veľké Kapušany substations. The new 400kV double circuit OHL will be of approximately 23km length.	2014	Under Construction	Delayed	Investment slightly delayed due to transformers´ procurement issues.
		719	Vola (SK)		Upgrade of the existing 220/110kV substation Voľa with transformation 400/110kV (replacing existing 220kV substation).	2014	Under Construction	Delayed	Investment slightly delayed due to transformers´ procurement issues.
		294	Lemešany (SK)	Velké Kapušany (SK)	Reinforcement of the existing single 400 kV line between Lemešany and Veľké Kapušany substations. The project includes the extension both substations Lemešany and V.Kapušany. Line length: approximately 100 (including the loop erected under the Investment "Connection of substation Voľa").	2018	Planning	Investment on time	No change.
		721	Praha Sever (CZ)		New 400/110kV substation equipped with transformers 2x350MVA .	2025	Planning	Rescheduled	Delayed due to delay of projects which this one is dependent on.
		722	Chodov (CZ)	Cechy stred (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 35.1km. Target capacity 2x1385 MVA.	2024	Design & Permitting	Delayed	Delayed due to permitting procedure difficulty

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
		723	Tynec (CZ)	Krasikov (CZ)	Adding second circuit to existing single circuit line OHL upgrade in length of 103.8km. Target capacity 2x1385 MVA.	2025	Design & Permitting	Investment on time	Progress as planned
		375	Plock (PL)	Olsztyn Matki (PL)	New 400 kV line Płock-Olsztyn Mątki.	2030	Under Consideration	Rescheduled	In depth analysis showed lower than anticipated utilization of the line. The implementation of this project is under consideration.
		732	Olsztyn Matki (PL)		Development 400 kV switchgear in Olsztyn Mątki substation.	2019	Design & Permitting	Expected earlier than planned previously	The investment is at the design stage.
		324	Dobrzen (PL)	Wroclaw/Pasikurowice (PL)	New 76 km 400 kV 2x1870 MVA double circuit line from Dobrzeń to splitted Pasikurowice - Wrocław + upgrade and extension of 400 kV switchgear in substation Dobrzeń for purpose of generation connection.	2017	Design & Permitting	Investment on time	The investment is built mainly for purpose of power evacuation from planned new generation in Opole power plant. The benefit of the investment is recognized on the regional and local scale (supply of Wrocław agglomeration area, export needs).
		873	Albertfalva (HU)		New 220/120kV 160MVA transformer at substation Albertfalva (HU).	2018	Design & Permitting	Expected earlier than planned previously	-
		887	Tynec (CZ)	Cechy stred (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 46.2km. Target capacity 2x1730MVA.	2025	Planning	Investment on time	Progress as planned
		888	Hradec (CZ)	Vyskov (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 45.3km. Target capacity 2x1730MVA.	2024	Planning	Investment on time	Progress as planned
		890	Prosenice (CZ)	Krasikov (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 87.5km. Target capacity 2x1730MVA.	2026	Design & Permitting	Investment on time	Progress as planned

Project ID	Project name	Investment ID	from substation name	to substation name	description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
		891	Nosovice (CZ)	Kletne (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 79.4km. Target capacity 2x1730MVA.	2024	Design & Permitting	Investment on time	The route of line was changed due to different routing of other lines - better utilization of existing corridors
		892	Hradec (CZ)	Chrast (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 82.4km. Target capacity 2x1730MVA.	2026	Planning	Investment on time	Progress as planned
		893	Prestice (CZ)	Chrast (CZ)	New second circuit to existing single circuit OHL, upgrade in length of 32.8km. Target capacity 2x1730MVA.	2025	Planning	Investment on time	Progress as planned
		875	Prosenice (CZ)	Nosovice (CZ)	New connection between existing substation a new substation (see investment 299)	2022	Design & Permitting	Commissioned ahead of time	Change in schedule and routing to efficiently use existing corridor.
		876	Detmarovice (CZ)		New substation equipped with transformers 2x350MVA	2021	Design & Permitting	Investment on time	Progress as planned

11.3 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
338	101. 338	Kozienice (PL)	Mory/ Piaseczno (PL)	Replacement of conductors (high temperature conductors) on existing 2x220 kV OHL.	2013	Commissioned	Commissioned ahead of time	The investment has been carried out since 2008. Commissioned in 2013.
180	180	Mengede (DE)	Kruckel (DE)	Installation of a second circuit 380kV OHL from Mengede to Kruckel	2012	Commissioned	Commissioned	Investment is commissioned.
192	192	Hamburg/Krümmel (DE)	Schwerin (DE)	This 380kV double-circuit OHL project will close the missing gap in North-East German grid infrastructure. Only 65km of new line must be constructed, 22km already exist.	2012	Commissioned	Commissioned	Project is completed and now in service. Could be removed from TYNDP projects list.
220	26. 47. 220	Lienz (AT)		Erection of a new 220/220kV- PST in the substation Lienz (AT)	2012	Commissioned	Commissioned	PST commissioned on 23.05.2012
224	27. 224	Krsko (SI)	Bericevo (SI)	New 400kV double circuit OHL between Krsko and Bericevo.	2014	Commissioned	Commissioned	Progresses as planned.
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	
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	-
296	296	Medzibrod (SK)		Reconstruction of the Medzibrod substation to the 400kV system.	2013	Commissioned	Commissioned	No change.
321	321	Kromolice (PL)	Patnów (PL)	New 79km 400kV 1870 MVA OHL interconnection line Kromolice - Pątnów - with one circuit from Plewiska to Koninn temporarily on 220kV after dismantling of 220kV line Plewiska - Konin.	2012	Commissioned	Commissioned	Commissioned.

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
322	322	Kromolice (PL)		A new AC substation between existing substations Plewiska and Ostrów and Pątnów in Poznań Agglomeration Area with transformation 400/110kV 400 MVA. New substation Kromolice is connected by splitting and extending existing line Ostrów-Plewiska and Pątnów -	2012	Commissioned	Commissioned	Commissioned
854	333	Swiebodzice (PL)		New 400kV Świebodzice substation with 1x500MVA, 400/220kV transformation and 1x400 MVA, 400/110kV transformation.	2013	Commissioned	Commissioned ahead of time	Commissioned
855	333	Pasikurowice (PL)	Swiebodzice (PL)	New 400kV OHL interconnection line Pasikurowice - Wrocław, including new Wrocław substation.	2013	Commissioned	Commissioned ahead of time	Commissioned.
856	333	Pasikurowice (PL)	Swiebodzice (PL)	New 400kV Wrocław substation with 2x400 MVA, 400/110kV transformation.	2013	Commissioned	Commissioned ahead of time	Commissioned
857	333	Wroclaw (PL)	Swiebodzice (PL)	New 400kV 1870 MVA line Świebodzice - Wrocław.	2013	Commissioned	Commissioned ahead of time	Commissioned
858	333	Wroclaw (PL)	Swiebodzice (PL)	New 400kV 1870 MVA line Pasikurowice-Wrocław.	2013	Commissioned	Commissioned ahead of time	Commissioned
859	333	Pasikurowice (PL)	Swiebodzice (PL)	A new AC substation in Wrocław Agglomeration Area. New substation Wrocław is connected to new 135km (sum) 400kV 1870 MVA lines: Pasikurowice-Wrocław and Świebodzice - Wrocław. New 400kV Wrocław substation with 2x400 MVA, 400/110kV transformation. New 400k	2013	Commissioned	Commissioned ahead of time	Commissioned
333	333	Pasikurowice (PL)	Swiebodzice (PL)	New 400kV OHL line Wrocław - Świebodzice after dismantling of 220kV line Świebodzice - Biskupice.	2013	Commissioned	Commissioned ahead of time	Commissioned
152	42. 152	Dörpen/West (DE)		New substation for connection of offshore wind farms.	2013	Commissioned	Commissioned	
159	42. 159	Cluster BorWin1 (DE)	Diele (DE)	New HVDC transmission system consisting of offshore platform, cable and converters with a total length of 205km. Line capacity: 400MW.	2013	Commissioned	Commissioned	

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
653	42. 163	Büttel (DE)		New substation Büttel and connection of this new substation with the existing OHL Brünsbüttel - Wilster.	2013	Commissioned	Commissioned	
181	44. 181	Dauersberg (DE)	Limburg (DE)	New line from Dauersberg to point Fehl-Ritzhausen	2012	Commissioned	Commissioned	Investment is commissioned.
221	47. 221	St. Peter (AT)	Ernsthofen (AT)	Upgrade from 220kV-operation to 380kV.	2014	Commissioned	Commissioned	Due to some technical problems, the commissioning date was shifted from 2013 to mid 2014.
372	59. 372	Oltarzew (PL)		372-Ołtarzew	2014	Commissioned	Commissioned ahead of time	The project has been commissioned.
166	42. 166	Offshore Wind park Riffgat (DE)	Emden /Borßum(DE)	New AC-cable connection	2014	Commissioned	Commissioned	

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

Investment ID	TYNDP 2012 index	from substation name	to substation name	short description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
833	168a	Region South-West Bavaria (DE)	Region South-West Bavaria (DE)	Upgrading the existing 220kV OHL to 380kV,length 100km and the extension of existing substations, erection of 380/110kV-transformers.	-	Cancelled	Cancelled	Originally the investment was very unprecise. It has been replaced by more precise OHL upgrade investments
198	198	Wuhlheide (DE)	Thyrow (DE)	Berlin South Ring: replacement of an existing old 220kV double-circuit OHL by a 380kV double-circuit OHL. Length: 50km.	-	Cancelled	Cancelled	Project is cancelled because at present no necessity is seen.
64	26. 64	Bressanone (IT)	New substation near Innsbruck (AT)	New double circuit 400kV interconnection through the pilot tunnel of the planned Brenner Base Tunnel.	-	Cancelled	Cancelled	Further studies led to abandone the scheme from Bressanone to Innsbruck via the Brenner tunnel (previous investment 26.64 in TYNDP 2012)
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	-
291	291	Sajószöged (HU)		New 400/120kV 250MVA transformer with PST.	-	Cancelled	Cancelled	-
341	341	Patnów (PL)	Wloclawek (PL)	Upgrading of sag limitations OHL 220kV (389 MVA).	-	Cancelled	Cancelled	Cancelled.
346	346	Halemba (PL)		Halemba substation is connected by splitting and extending of existing 220kV lines Kopanina - Katowice.	-	Cancelled	Cancelled	Cancelled
137	35. 137	Vitkov (CZ)	Mechlenreuth (DE)	New 400kV single circuit tie-line between new (CZ) substation and existing (DE) substation. Length: 70km.	-	Cancelled	Cancelled	Project was cancelled due to unfeasibility to built the project (enviromental aspects and technical difficulty to connect to existing grid).

Investment ID	TYNDP 2012 index	from substation name	to substation name	short description	current tyndp expected commissioning	current tyndp status name	evolution since last tyndp	evolution driver description
171	44. 171	Hüffenhardt (DE)	Neurott (DE)	Upgrade of the line from 220kV to 380kV. Length: 11km. Included with the investment : 1 new 380kV substation.	-	Cancelled	Cancelled	The need for this long-term investment was not confirmed by the German Network development Plan 2012 and therefore it has been cancelled. The Plan 2012 has set up more global solutions for long-term
154	45. 154	Redwitz (DE)		New 500 MVAr SVC in substation Redwitz.	-	Cancelled	Cancelled	new concept
155	45. 155	Raitersaich (DE)		New 500 MVAr SVC in substation Raitersaich.	-	Cancelled	Cancelled	new concept
694	48. A125	Velký Dur (SK)	Levice (SK)	The erection of new 1x400 kV line between two important Veľký Ďur and Levice substations, including extension of the V.Ďur and Levice substation. The driver for this project is expected connection of to new generation units in Veľký Ďur area.	-	Cancelled	Cancelled	The decision to omit this investment has been confirmed by the internal network analysis. The added value of this line has been shown as low as the desired network reinforcement in this area will be sufficiently obtained by the project Nr. 48.298.
310	55. 310	Vyskov (CZ)	Reporyje (CZ)	New 400kV OHL	-	Cancelled	Cancelled	This line was cancelled due to the unfeasibility to built it caused by enviromental reasons.
798	94. A70	Krajnik (PL)		PST in Krajnik	-	Cancelled	Cancelled	The PST on the interconnector Krajnik-Vierraden will be instaled by 50Hertz Transmission GmbH in substation Vierraden.
320	57. 320	Dargoleza (PL)		A new AC 400/110kV substation	-	Cancelled	Cancelled	The investment's driver was RES connection. The investment was removed from the plans due to change on generation (RES) side.

11.5 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]
215	Li-ion battery based energy storage unit. Project promoter: Tisza Power Ltd.	225	NA	NA	0	1	Scenario Vision 1 - 2030	-	0	0	[-1600;2600]	[15;18]
							Scenario Vision 2 - 2030	-	0	0	[-1600;2600]	[13;16]
							Scenario Vision 3 - 2030	-	0	0	[-11000;12000]	0
							Scenario Vision 4 - 2030	-	[0;1]	0	[-8200;9200]	[-5;-4]

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12 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
PEMMDB	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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