Regional Reports

TYNDP 2018 Regional Insight Report

North-South Interconnections East

Final version after public consultation and ACER opinion - October 2019

entsoe
Reliable Sustainable Connected

Contents

ENTSO-E Reports 2018

As an improvement to the TYNDP 2018 package, the Insight Reports have been categorised in order to help readers navigate through the document and focus on what readers might find of interest. The category of reports are:

— Executive Report – Contains the key insights of the whole TYNDP package through its two-year cycle.

— Regional Reports – Based on the four projects of common interest (PCI) regions, the reports focus on the regional challenges of the energy transition.

— Communication – These reports communicate how we have interacted with our stakeholders and improved the TYNDP package from 2016 to 2018.

— Technical – These reports give a deeper insight into the technical subjects, including how we use our data, and the technical challenges of energy transition.

We hope this guide is of benefit to all stakeholders.

Main Report

Regional Reports
– North-South Interconnections East
– North-South Interconnections West
– Northern Seas Offshore Grid
– Nordic & Baltics

Communication
– Stakeholder Engagement
– Improvements to TYNDP 2018

Technical
– Data and Expertise
– Technologies for
– Transmission
– Viability of the Energy Mix
– CBA Technical

Adequacy
– Mid-Term Adequacy Forecast

Section 1

Executive summary

The generation portfolio in the power systems across Europe has undergone a substantial structural change – the same change applies in the whole North-South Interconnections (NSI) East Region where a rapid shift from traditional generation to carbon-free has gained a strong momentum.

Installed capacities of renewable sources have grown significantly in some countries so they can supply a substantial part of electricity consumption. That growth has mainly come from variable weather generation depending on variable weather conditions, such as wind and sun, not forgetting a share from hydro. Therefore the main challenge and driver for grid development in the NSI East Corridor is assigned to large-scale renewable energy sources (RES) development and integration, together with the different consideration of nuclear and thermal power plants in national energy policies of particular countries, leading to potentially higher risks in terms of security of supply.

Given the expected structural changes of the future NSI East power system, TYNDP 2018 delivers and outlines future needs of the Region in the mid-term and long-term perspectives. The different analysed scenarios show different future capacity needs, which indicate that the needs are strongly dependent on the scenario assumptions. The long-term 2040 capacity needs have been particularly analysed and delivered in the Regional Investment Plans which were published by ENTSO-E at the end of 2017. The 2040 needs preceded by the mid-term 2030 needs stem from the above-mentioned main drivers for grid development in the NSI East Corridor.

These needs are mainly related to the following phenomena:
- — Wide area power flows caused by the change of the generation capacities location
- — Insufficient renewable energy sources (RES) integration
- — Insufficient system stability and security of supply
- — Cross-border and internal bottlenecks in the transmission grid
- — Insufficient market integration
- — High CO_2 emissions.

The mid-term 2030 and long-term 2040 analyses clearly show that if the proposed transmission grid infrastructure is built, then significant positive effects in power system operation will be seen, which will support and facilitate the three core European energy objectives “Security of supply”, “Market integration” and “Renewable energy sources integration into the grid”.

As in other parts of Europe, deployment and integration of large fluctuating RES generation in NSI East Corridor requires a wide extension of the current electricity transmission grid. The TSOs in the NSI East Corridor are therefore already making transmission grid development plans in order to meet the above-mentioned needs. The national development plans are coordinated on bilateral as well as on Regional and pan-European levels through the TYNDP process. The most important projects assessed in the TYNDP belonging to the NSI East Corridor are eligible for inclusion in the projects of common interest (PCI), projects of energy community interest (PECI) and projects of mutual interest (PMI) lists, due to their pan-European significance.

The main focus of the present document is therefore priority projects necessary to implement the NSI East Corridor. As highlighted in the following sections, these projects are of utmost importance to meet the identified needs in terms of market integration (reduction of market differentials between bidding zones), bottleneck relief, RES integration (reduction of curtailed renewable energy), and increase of adequacy, flexibility and operational security. At the same time, strategic cross-border projects respond to the interconnection targets and priority criteria established by the European Commission (EC) in the Expert Group Report published in November 2017.

In this respect, most of the projects identified in the document are connected to the main European boundaries of the NSI East Corridor, which are:
- — Central East integration between Poland, Germany, Czech Republic and Slovakia
- — South East integration between Czech Republic and Slovakia, Austria, Hungary, Croatia and Slovenia
- — Italian Peninsula integration between Italy and all neighbouring countries (including Balkans and North Africa countries)
- — Eastern Balkan between Romania, Bulgaria, Greece and West Balkan countries.

In order to achieve the expected transmission capacity targets on these boundaries, it is therefore essential to overcome any barrier that risks preventing a timely implementation of the priority projects.

Section 2

Key messages of the region

2.1
Definition of the region

This document addresses grid development issues in the geographical area covered by the North-South electricity interconnections in Central Eastern and South Eastern Europe ('NSI East Electricity') established by Regulation (EU) No. 347/2013 on guidelines for trans-European energy infrastructure ('The Energy Infrastructure Regulation').

In addition, some non-EU countries represented in the framework of ENTSO-E membership under the System Development Committee have been included in the NSI East Corridor evaluations, in order to keep the consistency with already developed ENTSO-E analyses.

In more detail, the document is based on the achievements explored in the Regional Investment Plans 2017 and TYNDP 2018, which build on the close coordination of all the concerned TSOs within three ENTSO-E Regional Groups – Continental Central East, Continental Central South and Continental South East – in order to ensure an adequate and timely grid development.

Given the aforementioned, this report considers 19 countries shown in Figure 2.1:

- 13 EU countries: Austria, Bulgaria, Cyprus, Czech Republic, Germany, Greece, Croatia, Hungary, Italy, Poland, Romania, Slovenia, Slovakia;
- 6 non-EU countries: Albania, Bosnia-Herzegovina, Montenegro, Macedonia, Serbia, Tunisia.

Due to its high-grade meshed transmission system, there is a relatively coherent interaction on the electricity transmission level between countries of the corridor and their neighbours throughout the entire NSI East Corridor perimeter. However, in the central-eastern part of the corridor (especially in the peripheral areas), the transmission infrastructure is currently less developed and this leads to regional limitations of power transits.

Figure 2.1: ENTSO-E countries included in NSI East Corridor investigations

2.2
Key drivers in the region

The transmission grid development in the region is planned while reflecting the European energy policy built on three core objectives: security of supply, market integration (taking into account the expected evolution of the generation capacity and energy mix) nd RES integration into the grid.

The European interconnected power systems in the NSI East Corridor are facing a challenging energy transition phase, which is already in progress, mainly caused by:
— large-scale renewable energy sources development, featured by hig uctuation generation from wind and photovoltaic power plants
— nuclear power plants decommissioning in some countries of the region[1]
— coal and ga red thermal power plants decommissioning or mothballing in some countries of the region
— a need to ef ciently connect and integrate new additional or renewed generation capacity from thermal and hydro power plants that are developed according to the energy policies of some countries in the NSI East Corridor.

The above-mentioned facts are causing the following challenges in the power systems and further needs which have to be met by the transmission grid development in order to maintain the security and reliability of the future European interconnected transmission systems operation:
— Change of the generation capacities location, causing the change of the wide area power ow exchanges which TSOs have to cope with by the grid development
— Insuf cient RES integration as huge amounts of curtailed energy occur in the systems
— Insuf cient system stability and security of supply;
— Occurrence of cross-border and internal bottlenecks in the transmission grid
— Insuf cient market integration, as high price differentials occur in some market areas
— High CO_2 emissions.

[1] In certain countries in the region, based on different energy policies, further development of nuclear capacities or replacing the existing plants by new ones is foreseen, which opens up different long-term perspectives regarding the generation mix structure in future scenarios.

2.3
Main boundaries in the region

According to the above-mentioned needs, the main projects of the NSI East Corridor identified in this document are connected to the main European boundaries.

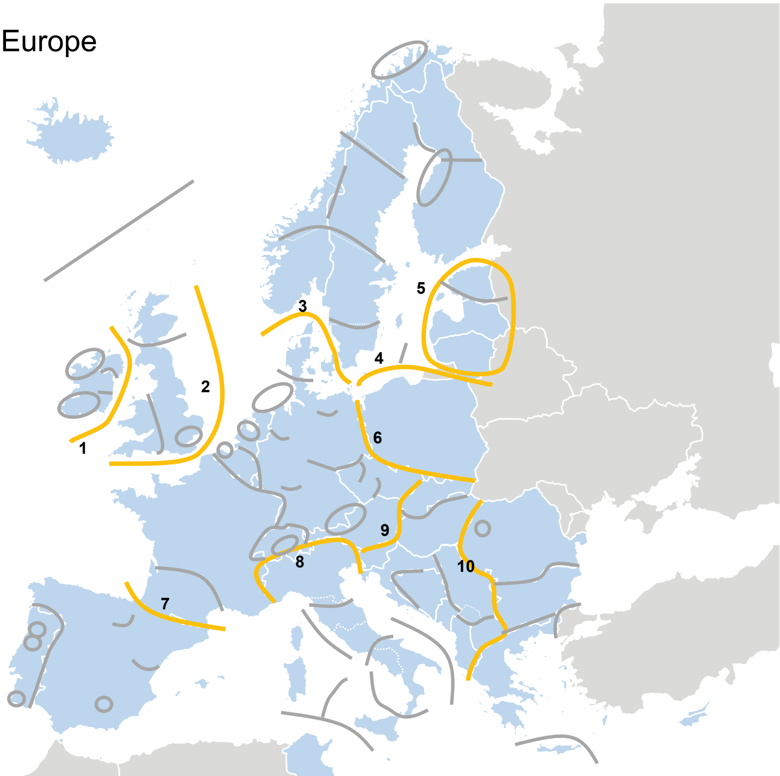
These boundaries, representing the most important barriers for power exchanges in future grid development scenarios, are depicted in yellow in Figure 2.2:

- **Central East integration:** between Poland, Germany, Czech Republic and Slovakia in order to increase the market capacities between these power systems.
- **South East integration:** between Czech Republic and Slovakia, Austria, Hungary, Croatia and Slovenia for further increase of interconnection capacities of South East Europe with Central Europe, in order to manage the north-west to south-east powe ows.
- **Italian Peninsula integration:** between Italy and all neighbouring countries in order to integrate the Italian market, ensure security of supply and full integration of RES capacities by improvin exibility, also through the exploitation of the hydro-pumped storage plants in the Alps, and to connect the Italian system and main islands to the heart of the European market, as well as to the Balkans and North African countries.
- **Eastern Balkan:** between Romania, Bulgaria, Greece and West Balkan countries in order to further increase interconnection capacities across the Balkan Peninsula, taking advantage of the high RES potential in the East (e.g. Romanian wind, Greek solar) to supply load centres in the West, from Central-Eastern Europe, through Serbia and Montenegro, to Italy.

In addition, also the following boundaries are of primary importance in the NSI East Corridor:

- **Turkey – South Balkan:** enlargement of the synchronously connected European power system by increasing the transmission capacity between the Turkish system on one side and Bulgarian and Greek power systems on the other side, from which Europe could bene t from additional, cheap, generation surpluses at its outskirts, South and East.
- **Italy – North Africa:** asynchronous interconnection of European and North African power systems through the Italy – Tunisia corridor, which also has a strategic signi cance and leads to important bene ts in terms of market integration exibility and security of supply.
- **Italy – Balkans:** increase of the transmission capacity between Italy and Montenegro, which contributes to integrate the Italian RES potential to the grid and also to improve Balkan countries' security of supply. Besides that, increase of the transmission capacity between Italy and Montenegro will enable market integration as there are still high price differences between market areas of Italy on one side and the Balkans on the other side.

Figure 2.2: Map of boundaries in the NSI East Corridor



Like in the TYNDP 2016, we have identified and analysed the following main boundaries:

1. Ireland – Great Britain and Continental Europe
2. Great Britain – Continental Europe and Nordics
3. Nordics – Continental West Europe
4. Nordic/Baltic to Continental East Europe
5. Baltic integration
6. Central East integration
7. Iberian Peninsula integration
8. Italian Peninsula integration
9. South East integration
10. Eastern Balkan

Boundaries

Main boundaries

Other important boundaries

The other boundaries in the NSI East Corridor, depicted by grey in Figure 2.2, are also important as project implentation on these borders contributes to the removal of all identified bottlenecks, improve the security of supply and reliability of the interconnected power systems, as well as achieving market and RES integration goals. Boundaries are identified not only on the borders among different countries, but also internally within some countries where they affect the market structure (like in Italy, where the day ahead energy market is split in 6 different bidding zones due to internal congestions on the south to north axis and between the main islands and the Italian Peninsula). In addition, the NSI East Corridor could be significantly affected by the extensions of the ENTSO-E system to the East and South. Synchronous connection of Ukrainian (UA) and Moldavian (MD) power systems to Continental Europe system at the eastern part, as well as asynchronous connection of Cyprus (CY) and Israel (IL) power systems at the southern part of the region, are under consideration. Synchronous connection of Baltics power systems to Continental Europe at the northern part of the region, which is one of the possible variants of the Baltics connection to neighbouring areas, is also under consideration. The recent synchronous connection of the Turkish power system also has significant influence, mainly to the SE Balkan system. Significant power flows throughout Germany (north-south power flows) and towards Austria have already generated a need for a transmission capacity increase within the same price zone.

In order to efficiently integrate the dispersed RES generation units, improve relations with the public and mature applications for connecting large generation and storage plants, it is necessary to link such critical sections to the actual boundaries as well in areas with high penetrations of RES.

All the future connections on these boundaries have been analysed in detail in the TYNDP 2018, confirming the need to further strengthen the east-west and north-south infrastructure corridors within the region.

Therefore, the priority projects necessary to implement the NSI East Corridor are those projects that can relieve the transmission boundaries/borders depicted above[2].

Moreover, all transmission grid infrastructure projects on the above-mentioned boundaries are also contributing to achieving the interconnection target levels for the 2020 time horizon of 10% and 2030 time horizon of 15%.

Finally, it must be noted that the Central Europe transmission grid is densely meshed, therefore any transmission infrastructure development, even if concentrated in a specific part of a region, could have substantial influence on the whole perimeter.
In contrast, in the southern part of a region (especially in the Balkans), the transmission grid is rather sparse. The main drivers for grid development, resulting needs, main boundaries and interconnection targets are described and assessed in more detail in subsequent sections of this document.

[2] For the NSI East system, an important amount of internal grid reinforcements and especially cross-border transmission infrastructure are planned. These are both shown in the national grid developments plans and in Regional Investment Plans 2017.

Section 3

Regional scenario overview – Future perspectives

3.1

Scenario overview and main storyline

The TYNDP 2018 scenarios include a Best Estimate scenario for the short-term (2020) and medium-term time horizon 2025, and three storylines for the longer-term time horizon (2030 – 2040) to reflect increasing uncertainties. The scenario pathways from 2020 to 2030 can be seen in Figure 3.1 and all the scenarios are on track to meet the decarbonisation targets set out by the EU by 2030.

The full storylines, parameters and price assumptions supporting these possible futures, and the methodology for building the scenarios, are explained in detail in the TYNDP 2018 Scenario Report[3].

The Best Estimate scenarios for 2020 and 2025 are based on a TSO perspective, reflecting all national and European regulations in place, whilst not conflicting with any of the other scenarios. A sensitivity analysis regarding the merit order of coal and gas in the power sector is included for 2025 and the results are given as 2025 Coal Before Gas (CBG) and 2025 Gas Before Coal (GBC).

The present study analysed the three following main scenarios for the 2030:

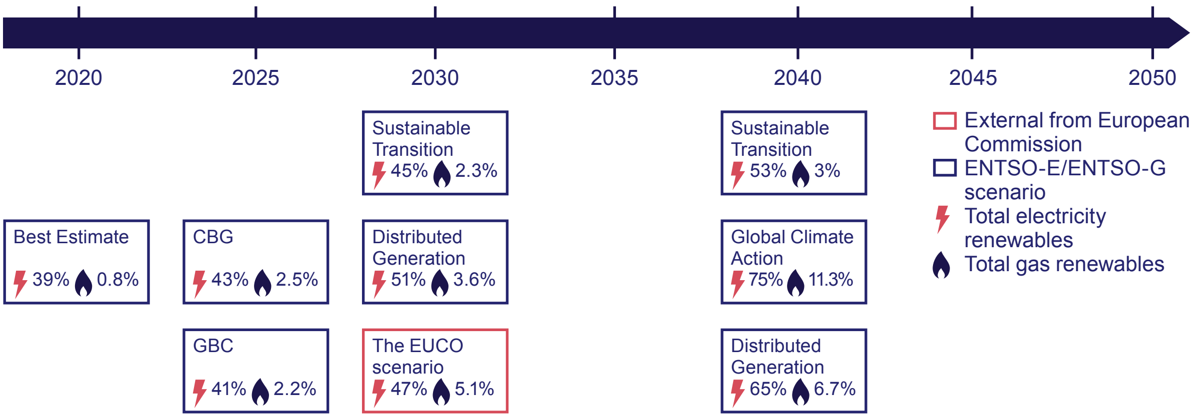
Sustainable Transition (ST)
This scenario will be achieved by replacing coal and lignite by gas in the power sector, leading to a quick and economically sustainable CO_2 reduction. The targets are reached through national regulation, emission trading schemes and subsidies, steady RES growth, moderate economic growth, and moderate development of electrification of heating and transport. The scenario is in line with the EU 2030 target, but slightly behind the EU 2050 target.

Distributed Generation (DG)
In this scenario, prosumers are centrally placed. The scenario DG represents a more decentralised development with focus on end user technologies. Smart technology, electric vehicles, battery storage systems and dual fuel appliances, such as hybrid heat pumps, allow consumers to switch energy depending on market conditions. An efficient usage of renewable energy resources is enabled at the EU level as a whole. The 2030 and 2050 EU emission targets are reached.

Scenario "EUCO 2030"
In addition, for the year 2030 there is a third scenario based on the European Commission's (EC) EUCO scenario for 2030 (EUCO 30). The EUCO scenario is designed to reach the 2030 targets for RES, CO_2 and energy savings, taking into account current national policies, like German nuclear phase-out. The EUCO 30 already models the achievement of the 2030 climate and energy targets as agreed by the European Council in 2014, but includes an energy efficiency target of 30%.

Global Climate Action (GDA)
In the 2040 scenarios, an additional scenario is provided. Global Climate Action is characterised by full speed global decarbonisation and large-scale renewables development in both electricity and gas sectors. The 2030 and 2050 EU emission targets are reached.

Figure 3.1: 2020 to 2030 scenario building framework for TYNDP 2018



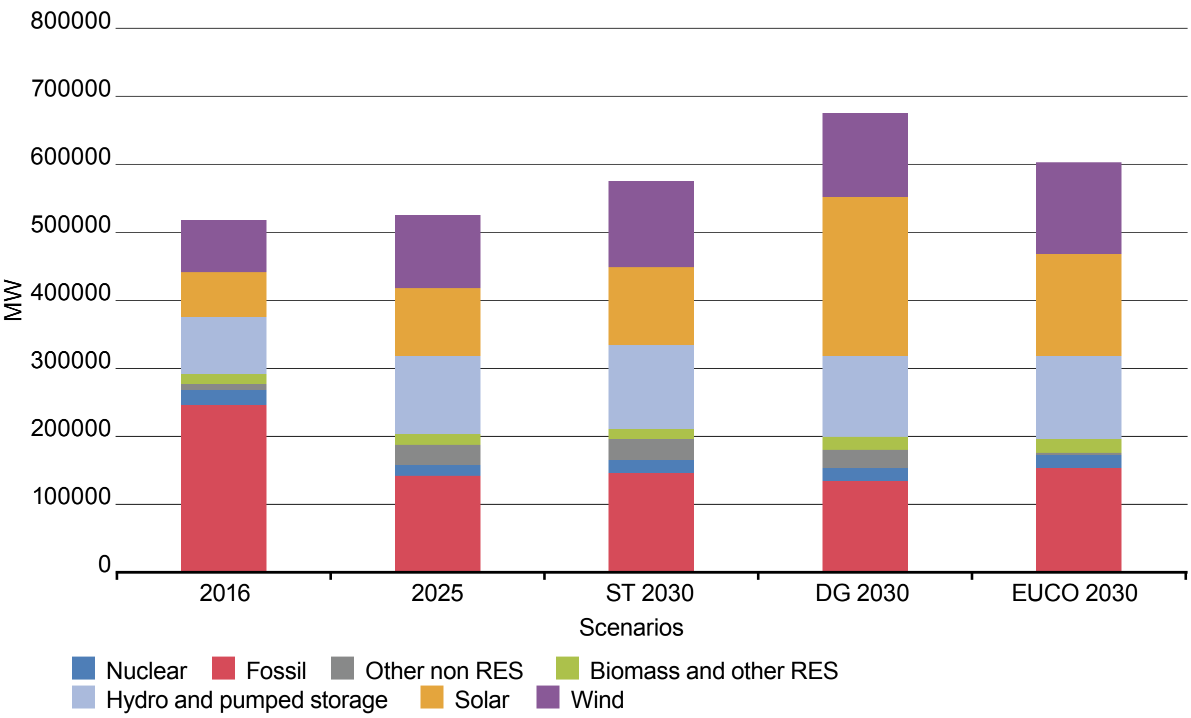
[3] https://docstore.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/Scenario_Report_2018_Final.pdf

3.2
Scenario results and comparison

The results of the scenario analyses are summarised i gures below, covering the electricity sector in terms of installed capacities, generation mix, demand and balances. These results are displayed at the NSI East regional level as explained in this document. Th gures per country resolution are given in the Annex – Section 7.

A key driver for network expansion is the increase in total installed capacity in the region. Compared to 2016, total installed capacity will increase by up to 30% by 2030. Figure 3.2 clearly shows this increase. However, there are signi cant differences between the individual technology categories. The share of nuclear is falling from 4% to 3% in all scenarios. The share of fossil capacities also decreases from 50% down to 25%. The decrease in nuclear and fossil fuels is more than compensated by the expansion of renewables. The share of renewables rises to over 70%. This will be achieved by increasing installed wind capacities by 70% and tripling solar capacities.

Figure 3.2: Installed capacities in the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



Re ecting the changes in installed generation capacities, Figure 3.3 shows a signi cant reduction in thermal generation production and a corresponding increase in wind generation production from 2016 to the 2025 and 2030 scenarios. Solar generation production also increases, but at a more moderate growth compared to production from wind generation, in spite of the large increase in installed solar capacity; this re ects the lower load factor associated with solar generation.

The general trends that can be seen throughout the years are a reduction in nuclear (besides the EUCO 2030 scenario where there is a similar level as in the 2025 scenario), a noticeable reduction in fossil, and a strong increase in wind and solar. The levels of hydro and pumped storage slightly increase, while biomass and other RES remain relatively constant throughout. The highest share of renewable generation is displayed in the DG 2030.

Based on the above-mentioned scenario assumptions regarding installed capacities, generation, demand, CO_2 prices, coal/gas prices etc, the scenario analyses have shown the expected energy balances for the different scenarios, resulting in different wide area ows, which TSOs have to manage and ensure the secure and reliable transmission system operation. In the 2030 scenarios, the following countries in the NSI East Corridor are dramatically changing their balances:

— Poland: Due to decarbonisation of generation and the scenario assumptions, Poland is showing a tendency to be a large importer in ST 2030 and EUCO 2030 scenarios, while in the DG 2030 scenario Poland is becoming a net exporter.
— Germany: Despite decommissioning nuclear generation, Germany is likely to be a net energy exporter. This is due to a high growth of wind and solar production. In the EUCO 2030 scenario, however, the RES is growing less rapidly; hence Germany becomes a net importer.
— Countries such as Hungary, Bulgaria and the Czech Republic are also changing their balances throughout the scenarios, but this has a lower impact on the wide area powe ows in comparison with the “large” power systems of Germany and Poland.

Figure 3.3: Generation and demand in the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030

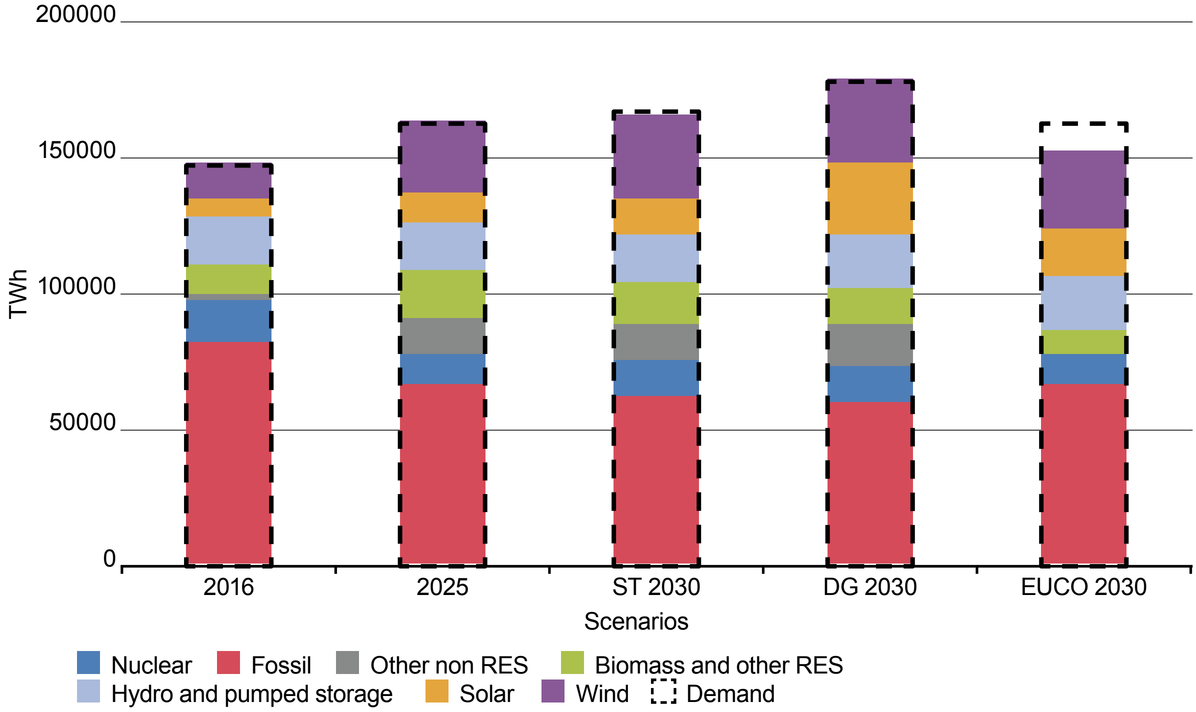
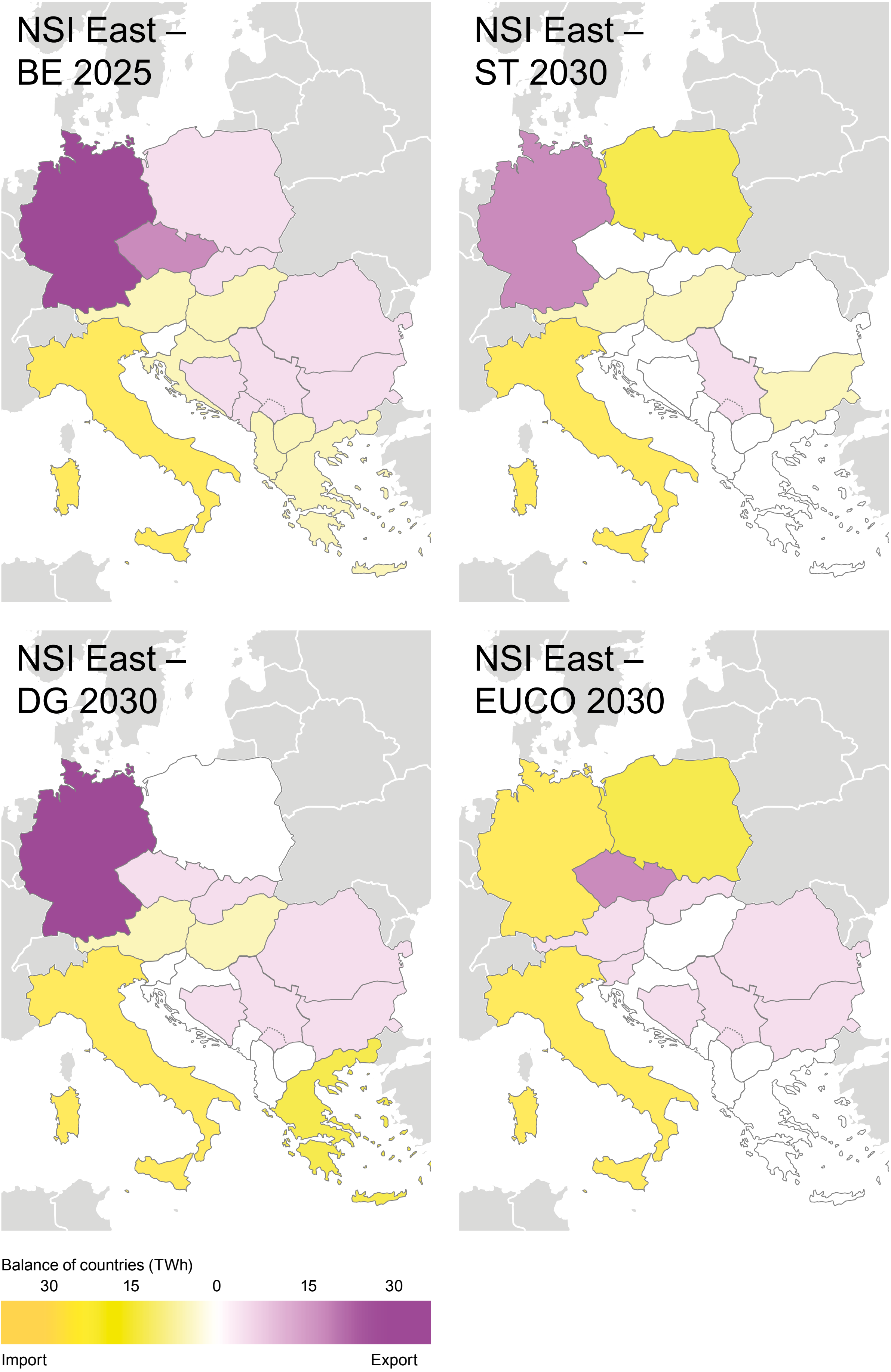


Figure 3.4: Balances of the countries in the NSI East Corridor for the BE 2025 and ST 2030, DG 2030, EUCO 2030 scenarios



Section 4

Regional needs, main boundaries and mid-term targets

This section bridges the regional long-term needs 2040 (identified in the Regional Investment Plan 2017), via the interconnection targets for 2030 to the list and description of European and regionally significant boundaries. The storyline of this section is schematically depicted in Figure 4.1.

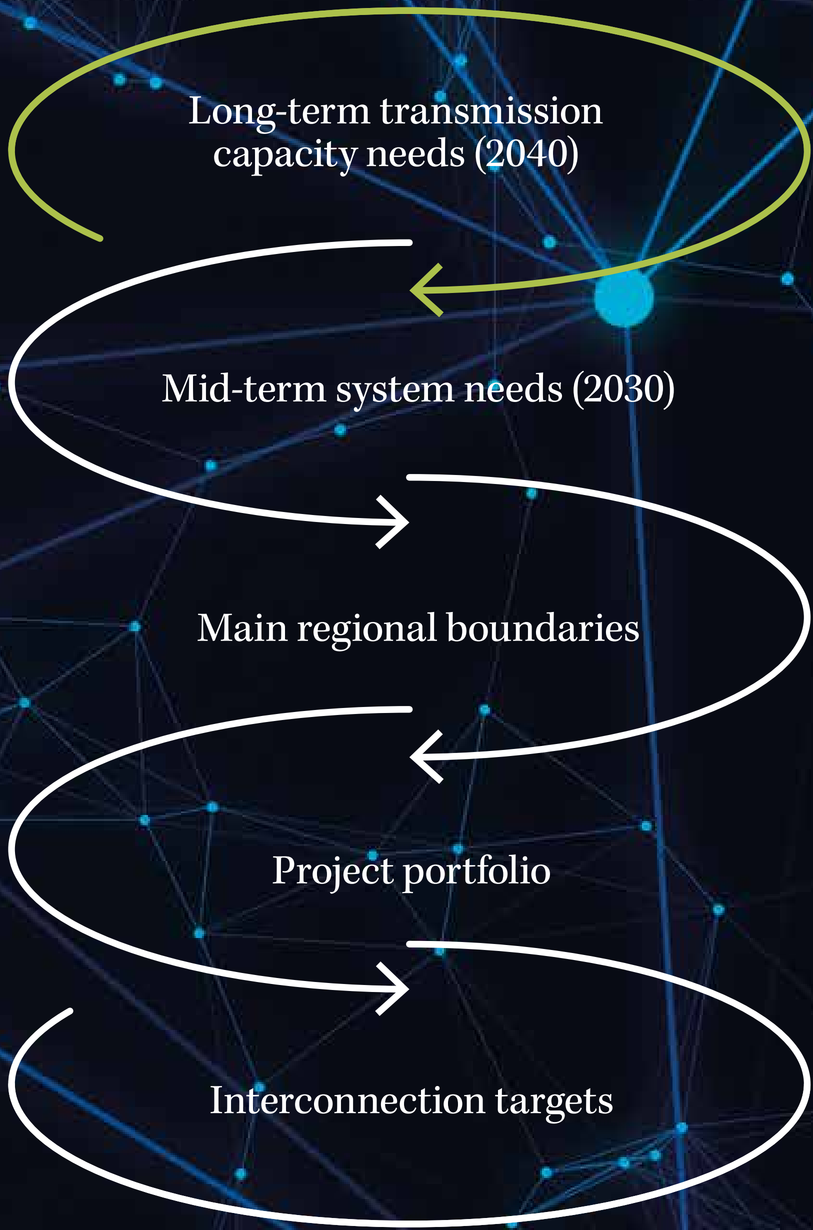


Figure 4.1: Study overview, needs targets and projects

4.1
Main needs in the region

In order to identify challenges leading to the development needs behind the main projects planned in the region, all the 2030 scenarios with the expected grid of 2020 have been simulated.

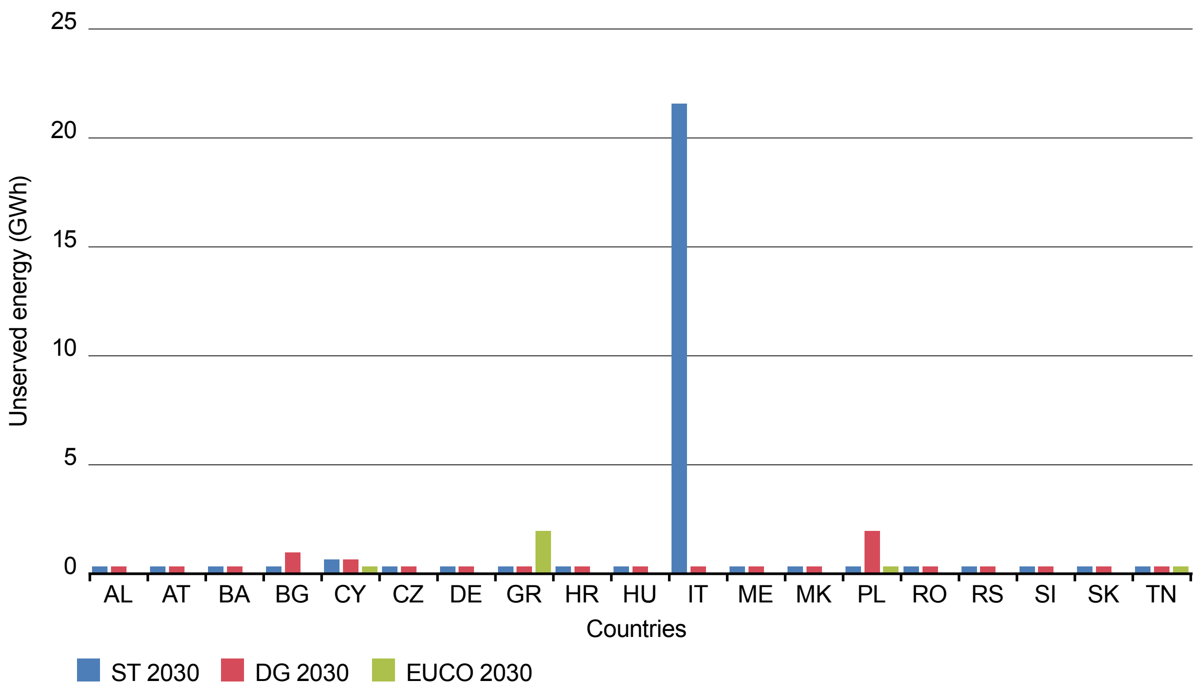
The analyses have found out that the most important investment needs expected in the NSI East Corridor are related to the three main pillars of the EU Regulation 347/2013, which are:
— insuf cient system stability and security of supply as Energy Not Served occurs in the power system's operation
— insuf cient integration of renewables into the grid as high amounts of curtailed energy occur in the power system's operation, which leads to higher CO_2 emissions
— insuf cient market integration as high price differences between market areas occur in the power system's operation, which is the consequence of cross-border and internal bottlenecks in the transmission grid.

Apart from jeopardising the three main energy target pillars, the change of generation capacities location causes the change of the wide are ows which TSOs have to cope with through the grid development.

Such needs can be mostly addressed through investment in transmission infrastructures planned in the mid-term horizon.

The charts below describe the most important regional needs identi ed by the simulations as mentioned above. They show average results based on ranges of simulations of three different climate years for all of the three mid-term 2030 scenarios.

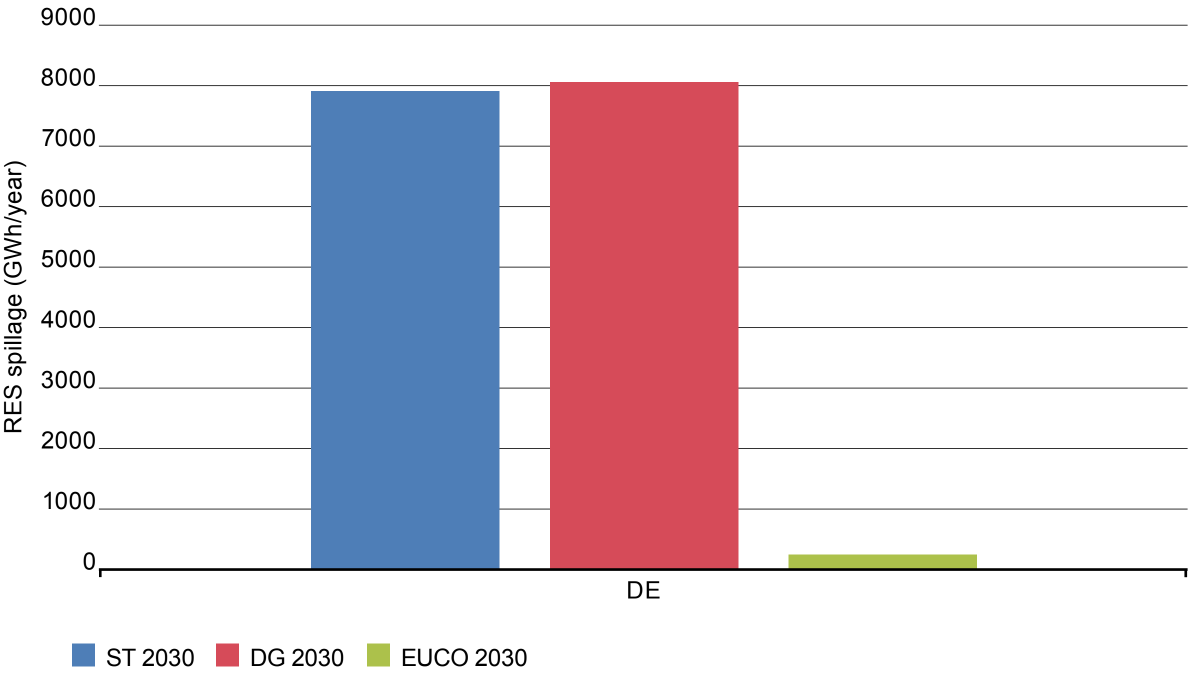
Figure 4.2: NSI East Corridor overview of unserved energy in 2030 scenarios with 2020 grid

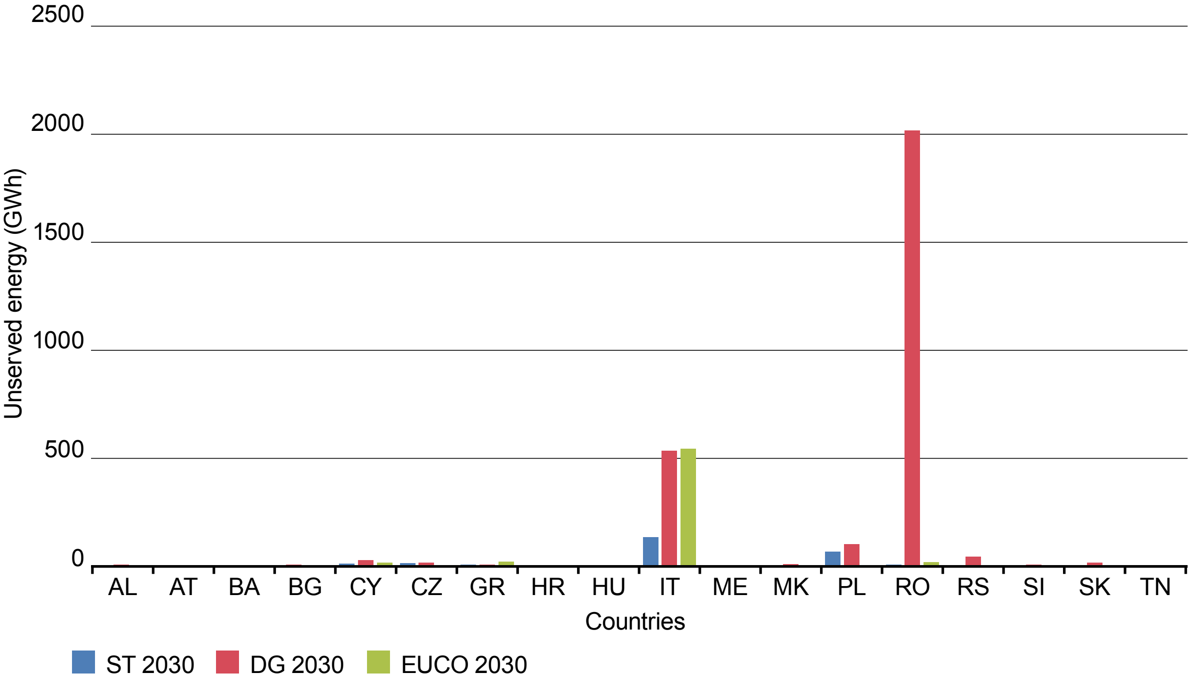


The analyses performed con rm that the secure supply of the load throughout the year is one of the main needs in the region. Without an appropriate extension of the transmission system, the countries that experience major problems in terms of unserved energy are mainly Italy, then Poland, Greece and Bulgaria. Not insigni cant values are found also in Cyprus and Tunisia.

It is worth noting that the scenarios are constructed to be in line with adequacy standards and that to reach these standards ne ctitious peaking units are assumed in the scenarios. In case thes ctitious peaking units are not present in the future scenarios, the values of unserved energy are higher.

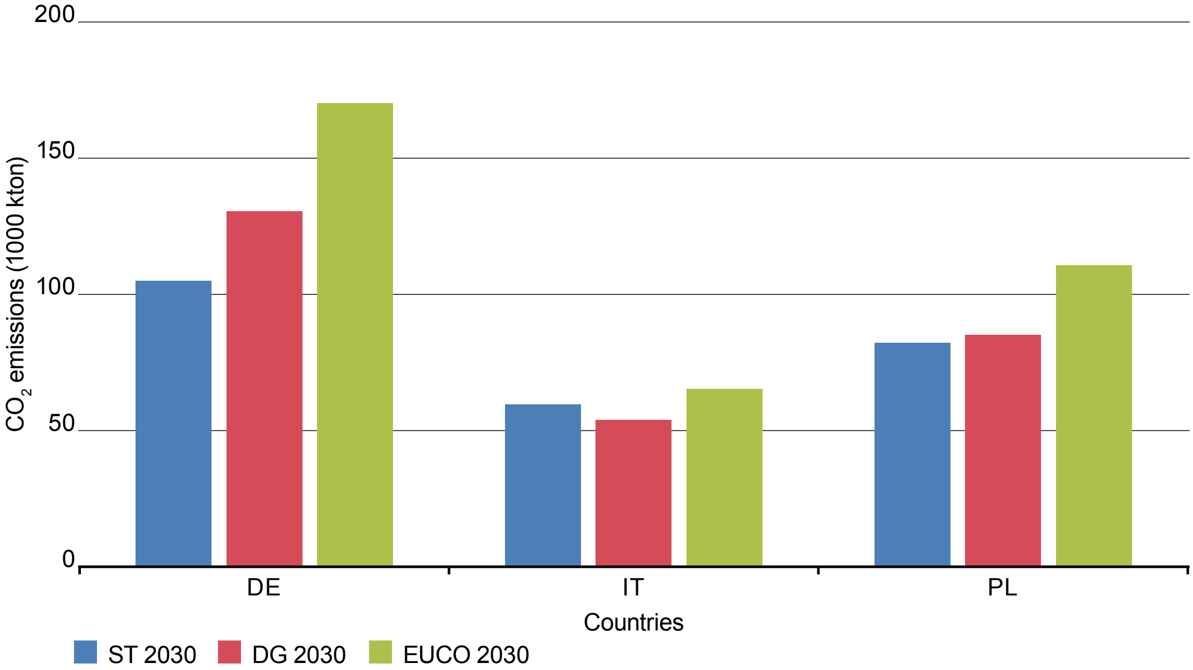
Figure 4.3: NSI East Corridor overview of curtailed RES energy in 2030 scenarios with 2020 grid

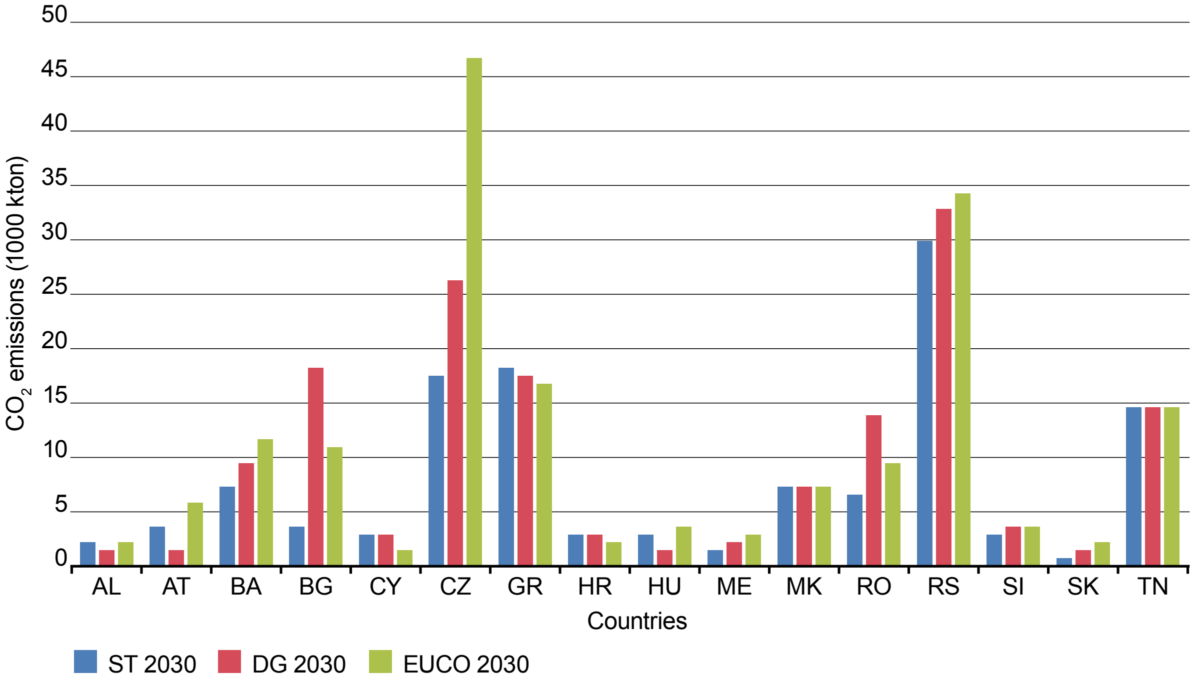




The goal of renewable energy integration is to improve the sustainably of the electric grid, also reducing carbon emissions and emissions of other air pollutants. The NSI East Corridor, due to its geographical position and con guration, presents a wide availability of several renewable energy sources (mainly sun, wind and hydro) and has a key role in the transition to a more sustainable system. According to the analyses performed, the curtailed energy in the countries across the region presents remarkable values primarily in Germany, Romania and Italy, where the amount of energy produced from renewable sources that cannot be fed into the grid is expected to be up to several TWh.

Figure 4.4: NSI East Corridor overview of CO_2 emissions in 2030 scenarios with 2020 grid

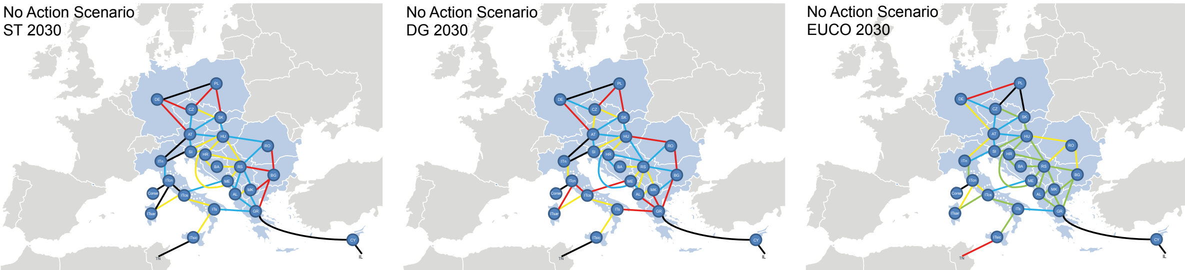




Price difference values, higher than a few euros, between different market areas demonstrate an insuf cient market integration and give a hint as to the necessity to invest in additional interconnections. As stated in a report by the Interconnection Target Expert Group (ITEG), set up by the European Commission in 2017, “A well-integrated energy market is considered a fundamental prerequisite to achieve the EU energy and climate objectives in a cost-effective way. Interconnectors are therefore a vital physical component of Europe’s energy transition and offer capacity for energy trade”. If the transmission grid does not evolve beyond 2020, the highest price differences in 2030 scenarios will be found in borders involving the Italian Peninsula that, given also its geographical characteristic, is one of the most isolated systems in Europe. Also Cyprus presents critical price spreads, as well as borders between Poland and neighbouring countries (Germany, Slovakia and the Czech Republic). After 2030, thanks to all the projects planned to be commissioned by 2034 (and especially thanks to the con rmed planned projects of TYNDP 2016), the price spreads in the region will decrease, maintaining values higher than 2€/MWh on the majority of the borders, however.

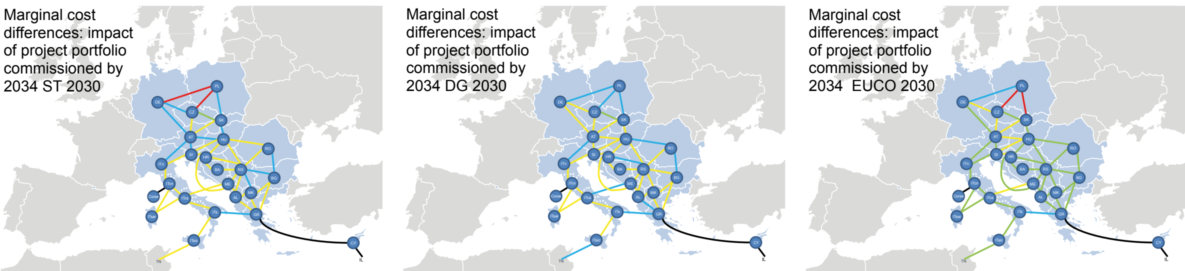
Therefore, the analyses performed con rm that market integration is a main driver for grid development in the region.

Figure 4.5: NSI East Corridor overview map of price differences on the borders in 2030 scenarios with 2020 grid



Avg. hourly marginal cost differences (€/MWh)
- From 0 to 2
- From 2 to 5
- From 5 to 10
- From 10 to 15
- More than 15

Figure 4.6: NSI East Corridor overview map of price differences on the borders in 2030 scenarios with all the projects commissioned by 2034

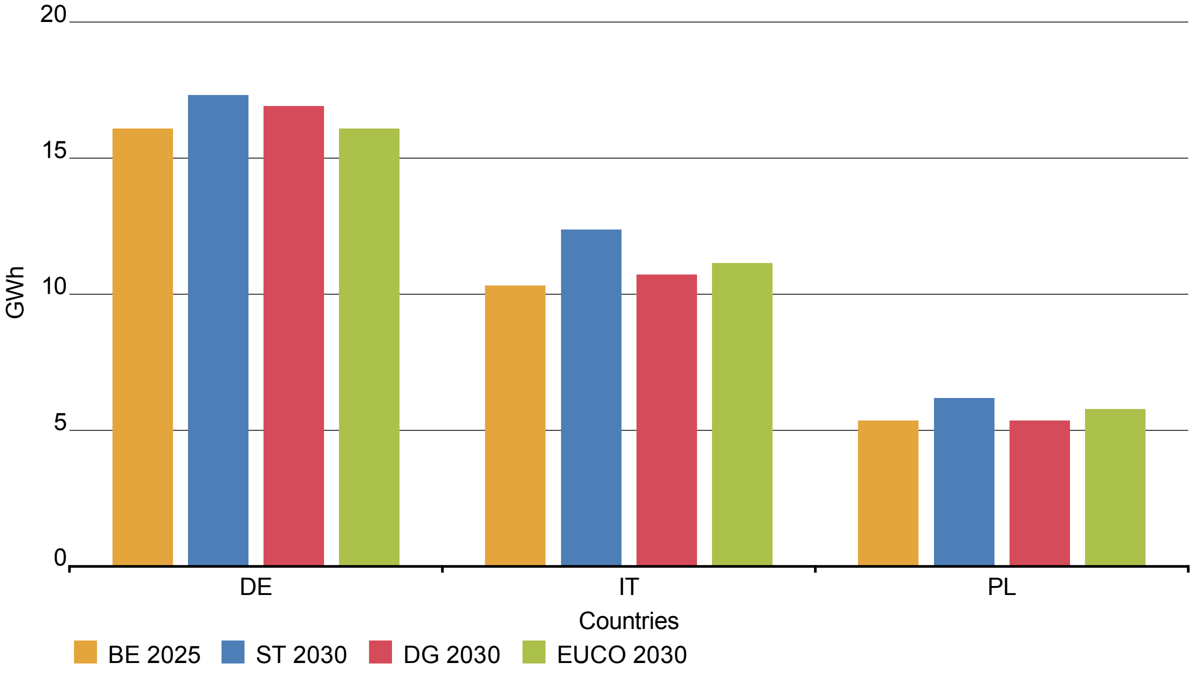


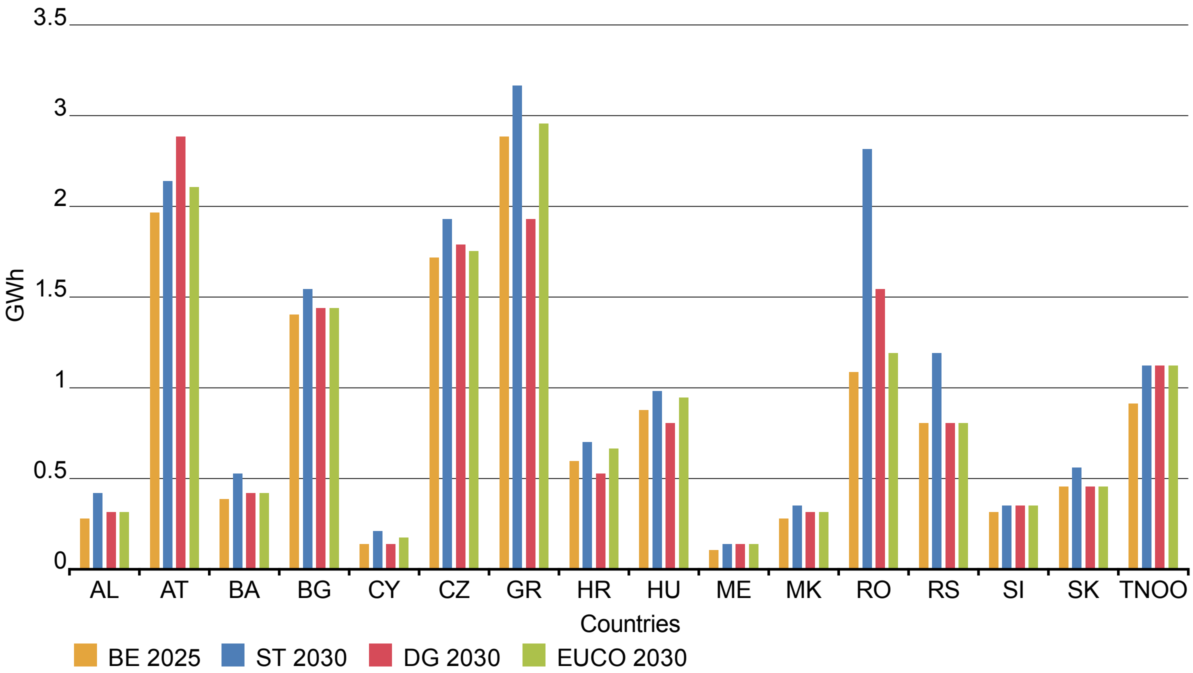
Avg. hourly marginal cost differences (€/MWh)
- From 0 to 2
- From 2 to 5
- From 5 to 10
- From 10 to 15
- More than 15

Unlike conventional generation with costly but controllable sources of primary energy, RES utilise primary energy sources with variable nature, hence the energy produced by RES plants must be balanced in order to maintain the equilibrium of the system.

In this regard, in mid/long-term scenarios, the increase of energy produced by RES, and the decommissioning of thermal plants, will cause high residual load ramps, de ned as the remaining load after subtracting the production of variable renewable energy sources (wind and solar production).

Figure 4.7: NSI East Corridor overview of the residual load ramps in 2030 scenarios 2020 grid





More in detail, the figure above reveals a high value of load ramps for some countries.

If the power system cannot face such strong ramps, consequences could be load shedding leading, in extreme cases, to blackouts. Therefore, the strong necessity to improve the flexibility of the system is a strong driver for investments in transmission infrastructure.

Additionally, with regard to the above-mentioned analyses, investing in transmission infrastructure is also essential for guaranteeing satisfying values of security of supply, for increasing the amount of RES integrated and for improving the market integration in the region, thanks to the improvement in sharing resources between different areas that interconnection makes possible. The mentioned needs can be mostly addressed in the mid term, thanks to the confirmed planned projects of TYNDP 2016 even if, according to additional analyses and the expert view of the TSOs of the region, these projects are not completely sufficient to reach an adequate security of supply in the long-term scenarios.

PCI projects are of particular primary importance in this path toward a more secure, sustainable and integrated transmission system, such as planned interconnections on the northern Italian boundary, links between Southern Europe and North Africa and between Italy and the Balkans. Internal lines in each of the concerned countries and links between mainland and major islands (like Corsica and Sardinia) are important in overcoming problems due to scarcely meshed grid and isolation. The PCI projects of the NSI East Corridor that are of primary importance to integrate the Italian Peninsula and to mitigate the needs in the area are: Interconnection between Salgareda (IT) and Divača – Bericevo region (SI), Interconnection between Villanova (IT) and Lastva (ME); Interconnection between Sicily (IT) and Tunisia node (TU) [currently known as “ELMED”], Interconnection between Wurmlach (AT) and Somplago (IT).

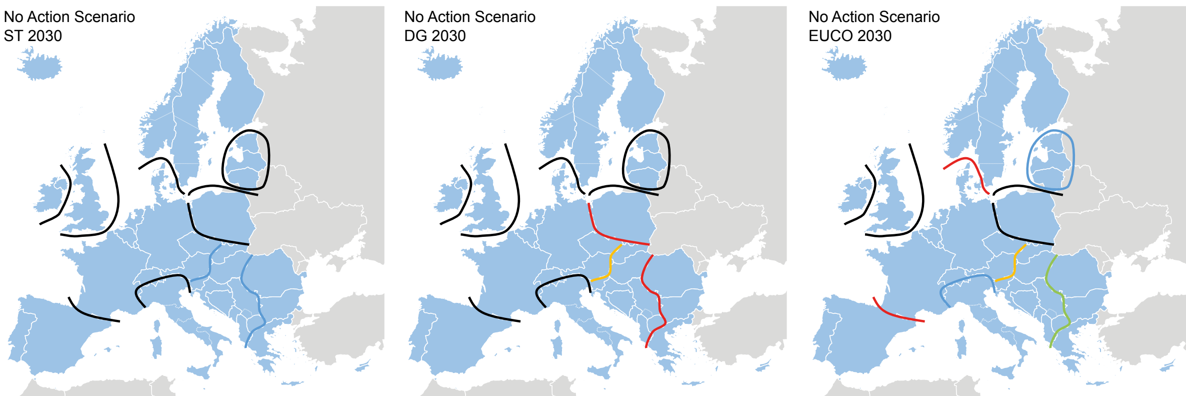
4.2
Boundary impact from a regional focus

A boundary is identified as a major barrier, preventing optimal power exchanges between countries or market nodes. As described in more detail in Section 1, most of the boundaries identified in the previous TYNDP 2016 are also valid for this TYNDP 2018.

These main boundaries cause tensions in the transmission grid between particular areas of Europe, where potential for RES is high – hydro and wind mainly in the north and solar in Mediterranean countries – and in densely populated areas with large power consuming areas. These barriers appear mostly where geography has set natural barriers: seas and mountain ranges, more dif cult to cross. More details about the boundaries in the NSI East Corridor are provided in Section 1.3.

In order to provide a quick overview of one of the main development needs affecting the region, th gures below show the aggregated price differences on the main boundaries. Thes gures highlight the very high values of price spreads expected if the grid did not evolve beyond 2020, and the mitigation that the planned projects will introduce. It must be underlined that even considering all the projects commissioned by 2034 the price differences present remarkable values on the main boundaries of the region.

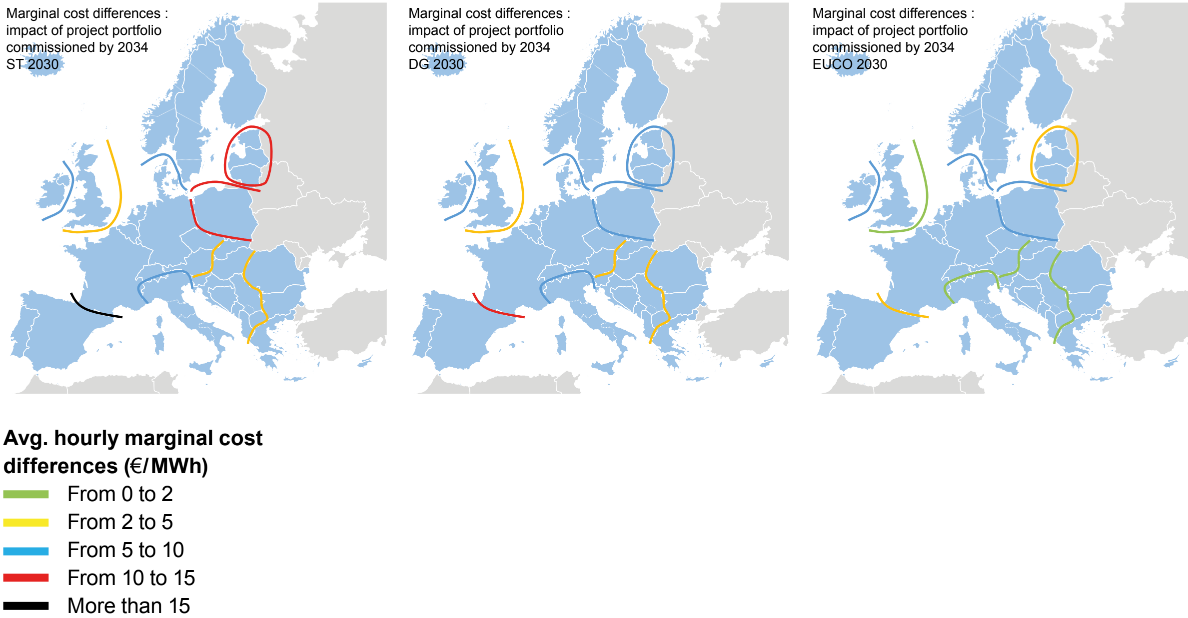
Figure 4.8: NSI East Corridor overview map of price differences on the main boundaries in 2030 scenarios with 2020 grid



Avg. hourly marginal cost differences (€/MWh)

- From 0 to 2
- From 2 to 5
- From 5 to 10
- From 10 to 15
- More than 15

Figure 4.9: NSI East Corridor overview map of price differences on the main boundaries in 2030 scenarios with all the projects commissioned by the 2034



4.3

Socio-economic benefits due to capacity increases on boundaries

The following figures show the variation of the socio-economic welfare due to commercial flows in the energy-only market, when transmission capacity across the four main boundaries of the NSI East Corridor is developed.

The benefits depicted in the figures are not exhaustive (they do not include all the other benefits provided by the transmission projects like increase of security of supply, RES integration, increase of flexibility and operational security, reduction of ancillary services cost, reduction of emissions, etc.) and are significantly dependent on the scenario. In addition, it is worth noting that the variation of the socio-economic welfare on one boundary – due to the variation of the transmission capacity across that boundary – is strongly related to the grid considered in the entire pan-European perimeter. For the analyses reported in this section, the reference grid at year 2027 has been considered, and the results depend on the real commissioning of the planned projects outside the boundary under evaluation. In fact, despite the SEW/GTC curves not being very steep, according to the results reported in Section 4.1 and 4.2, the 2030 scenarios with 2020 grid analyses show considerably high price differences, highlighting the strong need to improve market integration.

4.3.1 Central East integration boundary

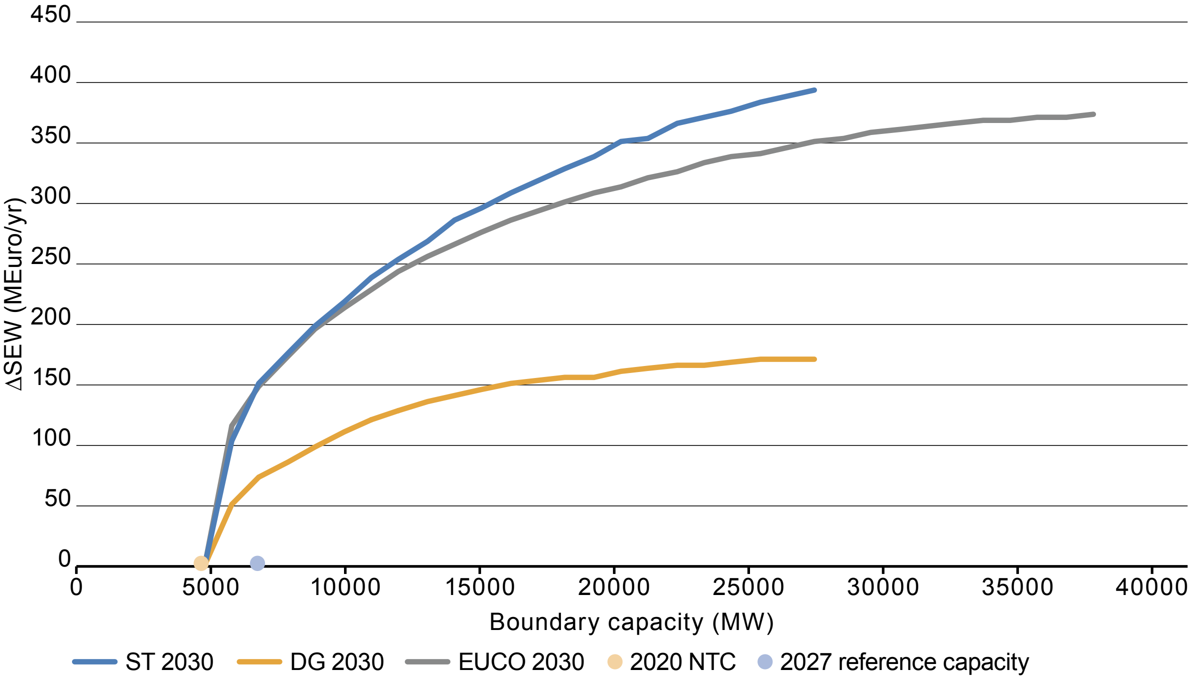
The aim of this boundary is to develop projects which will strengthen the East and South interconnection of Poland with Germany, the Czech Republic and Slovakia, to increase market capacities and to decrease price differences between Poland and the neighbouring countries as well as to increase security of supply.

The analyses show that prices in Poland are strictly related to CO_2 prices, as a high amount of fossil power plants are considered in 2025 and 2030 scenarios in Poland. Poland's self-sufficiency allows a high level of security of supply to be sustained at the expense, however, of high energy prices. The CO_2 emissions are dependent on the particular scenarios, where low CO_2 prices lead to increased coal-fired thermal production, hence increased emissions. Implementation of high-efficiency coal technology in Poland allows a significant decrease of emissions levels.

In 2030 DG scenario, the curve is flatter and the benefits are lower, which are due to the assumptions of this scenario, where generation is distributed, i.e. close to the consumption, and therefore there is less need to move the energy via the transmission grid.

It is difficult to estimate the optimal capacity at this border as the costs of the projects behind the capacity increases have to be considered as well.

Figure 4.10: Central East integration boundary SEW/capacity curve



The following projects are planned on the Central East integration boundary.

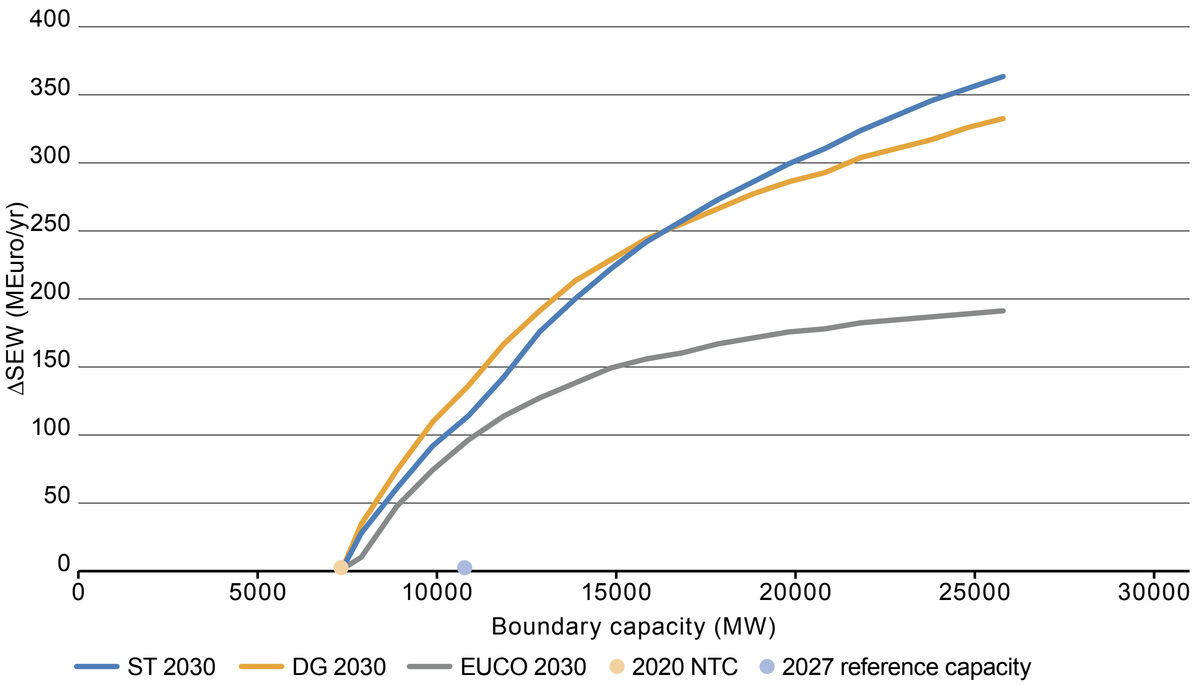
Border	Project ID	Name	ΔNTC Direction1 [MW]	ΔNTC Direction2 [MW]	Expected commissioning year
Central East integration	94	GerPol Improvements	DE-PL: 500	PL-DE: 1500	2020
Central East integration	229	GerPol Power Bridge II	DE-PL: 1500	PL-DE: 0	2035
Central East integration	230	GerPol Power Bridge I	DE-PL: 1500	PL-DE: 500	2024

4.3.2 Italian Peninsula integration

The integration of the Italian Peninsula, one of the main barriers for the power exchange in this pan-European perimeter, is related to the connection of the Italian system and main islands to the heart of the European market and to the Balkans and North African countries.

The SEW/GTC curve depicted in Figure 4.11 refers to the impact of reinforcing the interconnection at the North Italian boundary, while the SEW/GTC curves related to the Italy – Balkans and Italy – North Africa boundaries are shown in Figure 4.15 and Figure 4.16.

Figure 4.11: Italian Peninsula integration SEW/boundary capacity curve



The following projects are planned on the "Italian Peninsula integration" boundary

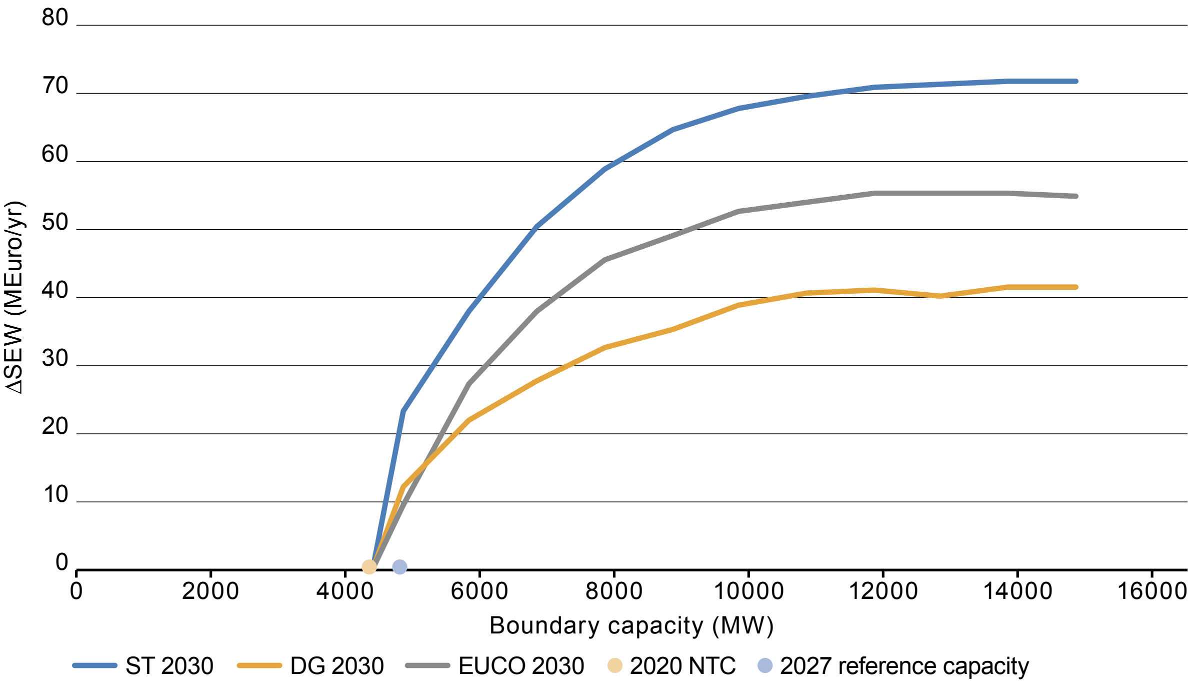
Border	Project ID	Name	ΔNTC Direction1 [MW]	ΔNTC Direction2 [MW]	Expected commissioning year
Italian Peninsula integration	21	Italy – France	IT-FR: 1000	FR-IT: 1200	2019
Italian Peninsula integration	26	Austria – Italy	IT-AT: 300	AT-IT: 300	2021
Italian Peninsula integration	31	Italy – Switzerland	IT-CH: 750	CH-IT: 750	2025
Italian Peninsula integration	150	Italy – Slovenia	SI-IT: 1000	IT-SI: 1000	2025
Italian Peninsula integration	174	Greenconnector	IT-CH: 850	CH-IT: 850	2022
Italian Peninsula integration	210	Wurmlach (AT) – Somplago (IT) Interconnection	IT-AT: 150	AT-IT: 150	2021
Italian Peninsula integration	250	Merchant line "Castasegna (CH) – Mese (IT)"	IT-CH: 100	CH-IT: 100	

4.3.3 South East integration boundary

The driver for increasing the capacities on this boundary is integrating high potentials of renewables into a relatively sparse network in order to accommodate west-east wide area powe ows.

Based on the results of the SEW/boundary capacity results, the curve for ST 2030 scenario is the steepest, so for the same capacity increase in this scenario we will get the highest bene t in comparison with DG 2030 scenario where the curve i at. Based on Figures 4.8 and 4.9 showing price differences on the boundaries, the price differences on the "South East integration" boundary are not so high in comparison with other boundaries, so the capacity on this boundary in the 2030 scenarios could be considered as suf cient. From the SEW/GTC curve, it could be seen that, from the SEW point of view, the further increases of the capacity could be bene cial, but the costs and other bene ts are not included, therefore this SEW/GTC curve should be considered as a theoretical possibility to increase the capacity on this boundary.

Figure 4.12: South East integration SEW/boundary capacity curve



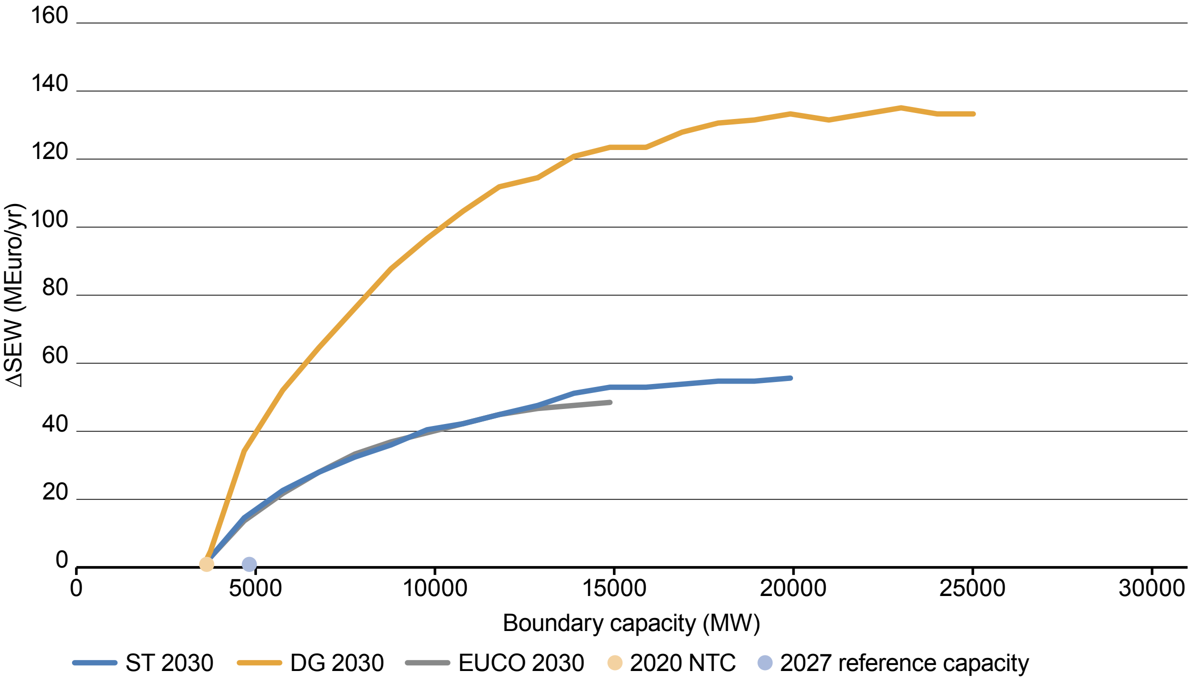
The following projects are planned on the "South East integration" boundary.

Border	Project ID	Name	ΔNTC Direction1 [MW]	ΔNTC Direction2 [MW]	Expected commissioning year
South East integration	320	Slovenia – Hungary/Croatia interconnection	SI-HU: 1200 SI-HR: 0	HU-SI: 1200 HR-SI: 150	2021
South East integration	343	CSE1 New	HR-BA: 644	BA-HR: 298	2030
South East integration	330	4th 400kV CZ-SK interconnector	CZ-SK: 490	SK-CZ: 550	2034

4.3.4 Eastern Balkan integration boundary

SEW/Boundary capacity diagram for Eastern Balkan boundary shows that the curve for 2030 DG scenario is steepest compared to curves for 2030 ST and 2030 EUCO scenarios. Although 2030 DG scenario assumes distributed generation, results shows that a signi cant amount of energy will come from nuclear and fossil capacities, especially in Romania, Bulgaria, Hungary and Serbia. This could be one of the reasons for the steepness of the SEW/capacity curve for 2030 DG scenario. It is hard to estimate the optimal capacity, but from the diagrams, it could be concluded that optimum is in the range of 10 to 14 GW depending on the scenario.

Figure 4.13: Eastern Balkan SEW/boundary capacity curve



The following projects are planned on the “Eastern Balkan”

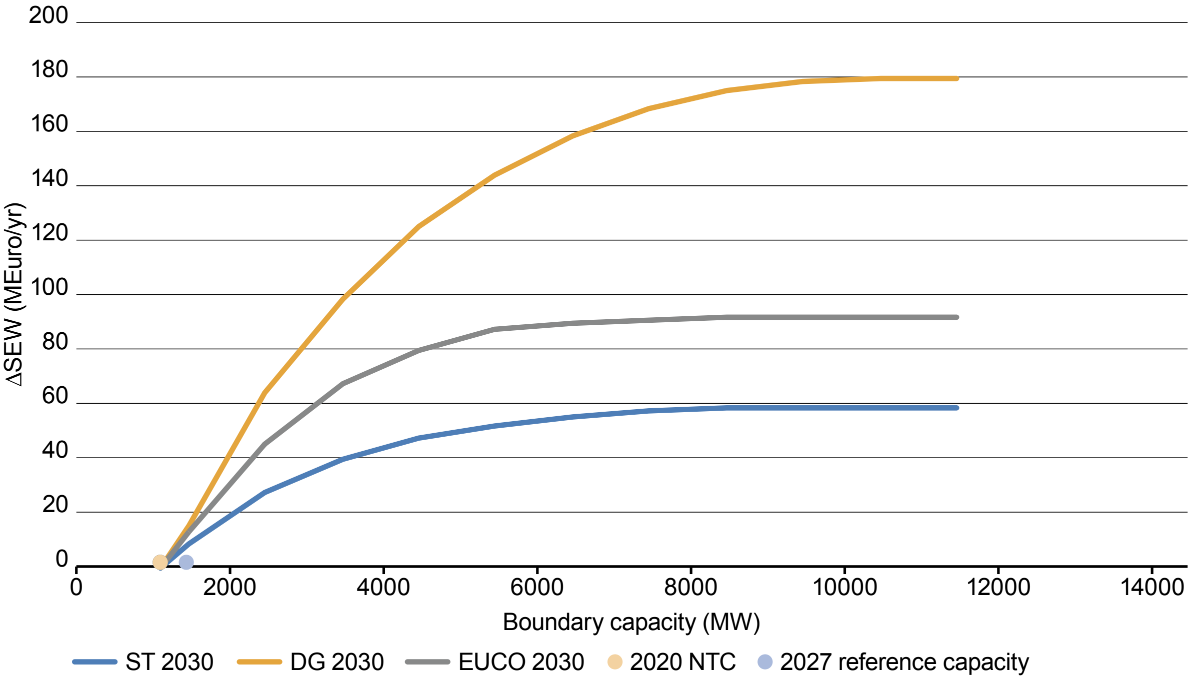
Border	Project ID	Name	ΔNTC Direction1 [MW]	ΔNTC Direction2 [MW]	Expected commissioning year
Eastern Balkan	144	Mid Continental East corridor (RO-RS)	RO-RS: 844	RS-RO: 600	2027
Eastern Balkan	144	Mid Continental East corridor (RO-HU)	RO-HU: 335	HU-RO: 617	2027
Eastern Balkan	259	HU-RO	HU-RO: 1117	RO-HU: 685	
Eastern Balkan	341	North CSE corridor (RO-RS)	RO-RS: 347	RS-RO: 622	2030
Eastern Balkan	342	Central Balkan corridor (BG-RS)	BG-RS: 730	RS-BG: 186	2034
Eastern Balkan	376	Refurbishment of the OHL Meliti (GR) – Bitola (MK)	GR-MK: 0	MK-GR: 479	2030

The following boundaries are of importance to the NSI East Corridor and analysis of the socio-economic bene ts of further capacity increases on these boundaries has been carried out.

4.3.5 Turkey – South Balkan boundary

Diagram shows that the steepest SEW/Boundary capacity curve is for 2030 DG scenario. Optimal capacity for this boundary is in the range of 3 to 6 GW depending on the scenario. There are no projects nominated for TYNDP 2018 on the "Turkey – South Balkan" boundary.

Figure 4.14: Turkey – South Balkan SEW/boundary capacity curve

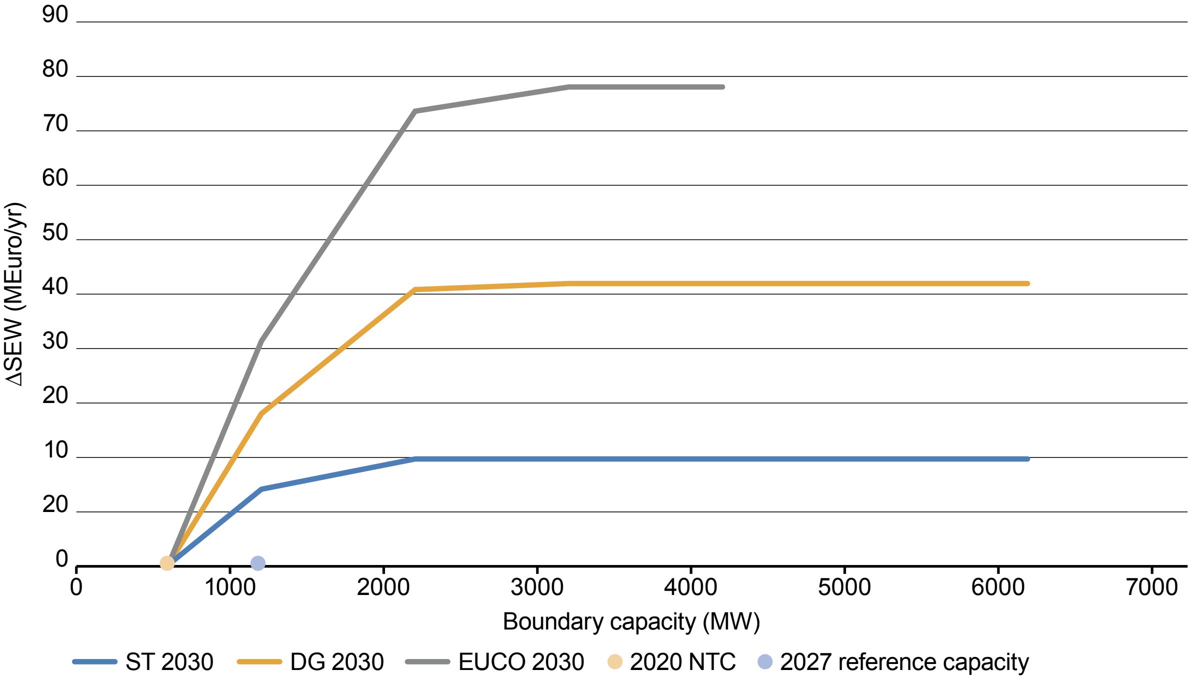


4.3.6 Italy – Balkans

The connection of the Italian system to the Balkans countries is related to the integration of the Italian Peninsula, which is one of the main barriers for the power exchange in the pan-European perimeter.

The SEW/GTC curve depicted in Figure 4.15 refers to the impact of reinforcing the interconnection at the Italy – Balkans boundary.

Figure 4.15: Italy – Balkans SEW/boundary capacity curve



The following projects are planned on the "Italy – Balkans" boundary. The second pole of the Italy – Montenegro interconnection is related to the "TransBalkan corridor".

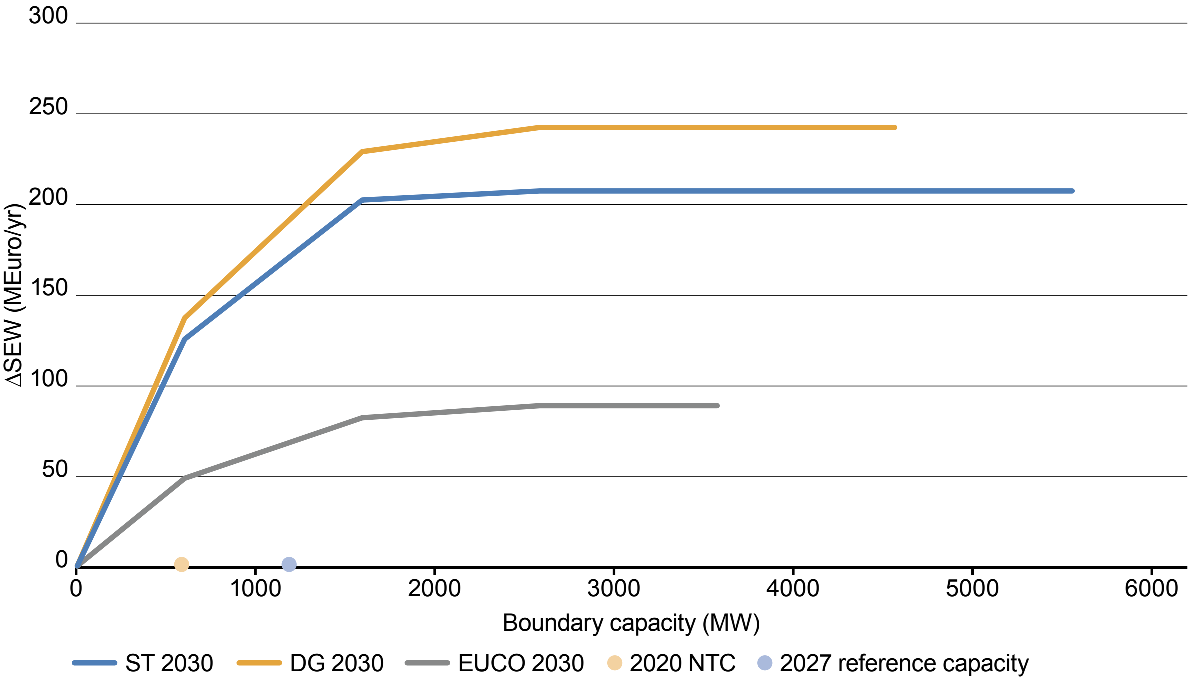
Border	Project ID	Name	ΔNTC Direction1 [MW]	ΔNTC Direction2 [MW]	Expected commissioning year
Italy – Balkans	28	Italy – Montenegro	ME-IT: 1200	IT-ME: 1200	2019 pole) 2026 (second pole)

4.3.7 Italy – North Africa

The connection of the Italian system to the North African countries is related to the integration of the Italian Peninsula, which is one of the main barriers for the power exchange in the pan-European perimeter.

The SEW/GTC curve depicted in Figure 4.16 refers to the impact of reinforcing the interconnection at Italy – North Africa boundary.

Figure 4.16: Italy – North Africa SEW/boundary capacity curve



The following projects are planned on the "Italy – North Africa" boundary.

Border	Project ID	Name	ΔNTC Direction1	ΔNTC Direction2	Expected commissioning year
Italy – North Africa	29	Italy – Tunisia	TN-IT: 600	IT-TN: 600	2025

The table below gives an overview of the different capacities for short, mid and long-term time horizons on the European regional boundaries of the NSI East Corridor. These capacities represent the sum of all cross-border interconnectors crossing a boundary. The three 2040 scenario capacities were identi ed during the Identi cation of System Need phase and are mentioned here just for information in order to provide a complete picture about the capacities on the boundaries from today to a very long-term outlook. The 2040 transmission capacities are therefore considered as a future possible theoretical very long-term capacity increases, where majority of them do not have any real projects behind. More detailed information about these future long-term capacity increases can be found in the Regional Investment Plan 2017.

Figure 4.17: Boundary capacity overview table

Year/Scenario	Capacity at main European boundaries (GW)				Capacity at NSI East Corridor boundaries (GW)		
	Central East integration	Italian Peninsula integration	South East integration	Eastern Balkan	Turkey – South Balkan	Italy – Balkans	Italy – North Africa
	Export/ Import[4]	North/ South[6]	East/West[5]	East/West[5]	North/ South[6]	East/West[5]	North/ South[6]
2016	1,3/0,45	8,53/3,63	2,95/3,75	2,55/2,41	1,36/0,88	0,0/0,0	0,0/0,0
2020	2,5/0,5	9,73/5,00	2,85/3,55	4,35/3,20	1,86/1,08	0,60/0,60	0,00/0,00
2027 (Reference capacity for CBA)	3.0/2,0	13,30/8,37	3,10/4,20	5,00/4,75	1,86/1,08	1,20/1,20	0,60/0,60
2035 ST, DG, EUCO	3.0/2,0	13,90/8,87	4,25/5,44	6,76/7,15	4,60/4,10	1,20/1,20	0,60/0,60
ST 2040 capacity	3,0/4,5	13,85/8,86	4,10/5,50	6,80/5,50	4,60/4,10	1,20/1,20	0,60/0,60
DG 2040 capacity	3,0/3,5	13,85/8,86	4,10/5,50	8,80/7,50	4,60/4,10	1,20/1,20	0,60/0,60
GCA 2040 capacity	3,0/4,5	14,85/9,86	5,10/6,50	11,30/10,00	4,60/4,10	1,20/1,20 1,20/1,20	0,60/0,60

[4] With consideration of pro les Poland export and Poland import
[5] Displays the source of ow ("East" direction from East to West, "West" direction from West to East)
[6] Displays the source of ow ("North" direction from North to South, "South" direction from South to North)

4.4
Regional mid-term targets

On 15 and 16 March 2002, the European Council established the objective of reaching a minimum interconnection ratio of at least 10% of the installed generation capacity in every Member State[7].

In the European Commission's view, the EU energy policy goals and the 2020 and 2030 energy and climate targets will not be achievable without a fully interconnected European electricity grid with more cross-border interconnections, storage potential and smart grids to manage demand and ensure a secure energy supply in a system with higher shares of variable renewable energy. In this respect, the gradual construction of the pan-European electricity highways will also be crucial.

In October 2014, the European Council put forward an initial interconnection target of 10% for Member States by 2020[8]. The target is de ned as total import capacity divided by installed generation capacity. In November 2017, the EU Commission set up an Expert Group (EG) composed of industry experts, organisations, academia, NGOs, ACER and ENTSO-E/G. The EG presented a report[9] recommending criteria for the assessment of needs to develop interconnection capacity further. The proposed new interconnection target is 15% by 2030, based on the same de nition as before. Additionally, the EG also proposed a multi-criteria assessment, using the following 3 criteria:

- Minimizing price differentials: Recommendation of 2€/MWh for the wholesale price between market areas as the indicative threshold to consider developing additional interconnectors. This trigger focuses on increased market integration and lower prices for the bene t of all.
- Meeting electricity demand, through domestic generation and imports: Recommendation that the sum of all nominal transmission capacity is at least above 30% of the peak load. This trigger contributes to guaranteeing suf cient security of supply.
- Decarbonisation of the EU energy system by enabling export potential of excess renewable production: Recommendation that the sum of all nominal transmission capacity is at least above 30% of all renewable installed generation capacity. This trigger ensures effective renewable integration is maximised.

A very important precondition for the effective commitment to further development of interconnection capacity remains a positive Cost Bene t Analysis (CBA) assessment (socio-economic and environmental on pan-European level) of any projects facilitating cross-border interconnection capacity. The multi-criteria assessment above will help to indicate the urgency with which further developments needs to be analysed. Countries above the 30% targets but below 60% are also recommended to regularly investigate possible options for future interconnection.

The following two sets of maps show the results for the NSI East Corridor when these above criteria are utilised on the three 2030 scenarios of TYNDP 2018. Important hypotheses taken are:

- I rst set of maps depicted on Figure 4.14, the nominal transmission capacities of the 2020 grid
- In a second set of maps depicted on Figure 4.15, the nominal transmission capacities of the 2030 grid
- Scenarios are assumed adequate – using the 2027 reference grid
- Nominal transmission capacity used is the physical interconnection capacity.

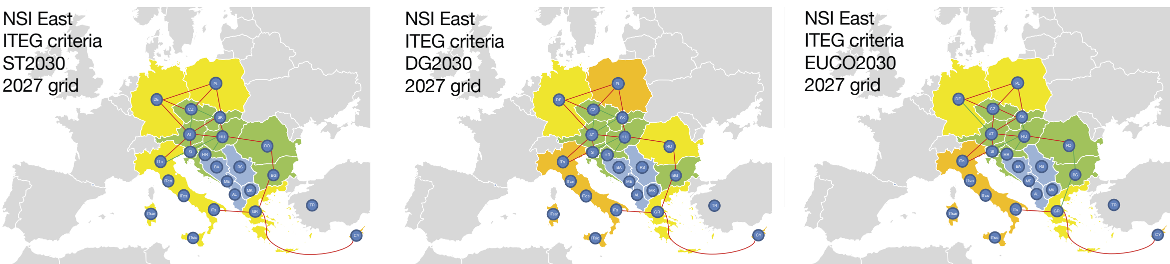
Price differentials between bidding zones shown on the map are limited to those for which either direct interconnection exists or projects are currently being assessed in the CBA phase of TYNDP 2018. They are hence not necessarily fully exhaustive.

[7] The COM (2001) 775 establishes that "all Member States should achieve a level of electricity interconnection equivalent to at least 10% of their installed generation capacity". This goal was con rmed at the European Council of March 2002 in Barcelona and chosen as an indicator as shown in the EU Regulation 347/2013 (annex IV 2.a) The interconnection ratio is obtained as the sum of importing GTCs/total installed generation capacity
[8] Also known as the Barcelona criterion
[9] https://ec.europa.eu/energy/sites/ener/ les/documents/report_of_the_commission_expert_group_on_electricity_interconnection_targets.pdf

In the NSI East Corridor in 2030 scenarios with 2020 nominal transmission capacities on the cross-border lines, depicted in Figure 4.18, the following market areas and cross-country sections in the region might need to be investigated:

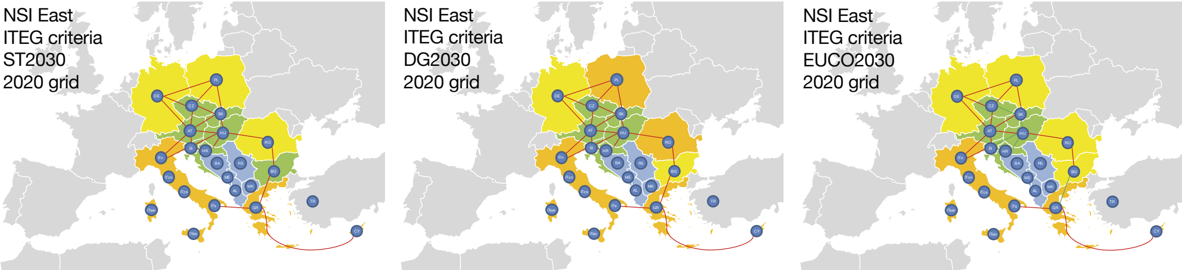
- Immediate assessment of interconnection development (criteria below 30%) appears in Poland in one scenario, in Italy in two scenarios and in Greece in all scenarios.
  - Italy: due to its geographical con guration (rounded by sea and the Alps on the northern border) implying higher complexity with the realisation of new interconnections.
  - Poland: due to the CO_2 prices dependent generation mix and due to the weak interconnection capacities in comparison with the peak load and RES installed capacity.
  - Due to its geographical position, Greece has electrical connection wit ve countries by six lines concentrated at the north part of the country's physical boarders. Two of these countries are EU members. Considering the current rule of interconnection, the four interconnections with non-EU countries were not taken into account causing the problem of having less than 30% of interconnection target criteria in all scenarios.
- Germany: Ful lment of the interconnection target criteria between 30 and 60% appears in all scenarios in Germany and in one in Italy and Romania.
- The 8 EU States satisfy interconnection target criteria above 60% in all 2030 scenarios, and based on this are green in all scenarios.
- Non-EU countries which are not obliged to ful l the EU interconnection target criteria are depicted by blue in thi gure.
- In all 2030 scenarios, large price differentials (>2€/MWh) exist between most Member States showing the need for possible additional interconnection development based on this third criterion.

Figure 4.18: NSI East Corridor interconnection targets overview in 2030 scenarios with 2020 nominal transmission capacities



- Yearly average marginal cost difference <2€MWh
- Yearly average marginal cost difference >2€MWh
- At least one of the 30% criterias show <30%
- At least one of the 30% criterias show >30% but <60%
- Both criterias show >60%
- No interconnection targets

Figure 4.19: NSI East Corridor interconnection targets overview in 2030 scenarios with 2030 nominal transmission capacities



- Yearly average marginal cost difference <2€ MWh
- Yearly average marginal cost difference >2€MWh
- At least one of the 30% criterias show <30%
- At least one of the 30% criterias show >30% but <60%
- Both criterias show >60%
- No interconnection targets

In the NSI East Corridor in 2030 scenarios with 2027 nominal transmission capacities, including the projects to be commissioned between 2020 and 2027, is not able to meet the interconnection targets at least by 30%. In Poland this is the case in one scenario and in Italy is the case for two scenarios.

Greece and Germany in all scenarios and Poland in two scenarios are meeting the interconnection criteria between 30 and 60%.

The remaining countries are meeting two interconnection criteria over 60%, which are orange in 2030 scenarios with 2020 grid, and therefore are all depicted by green in the Figure 4.19 maps.

In all 2030 scenarios with 2030 grid, price differentials higher than 2€/MWh between most Member States occurred, showing the need for possible additional interconnection development based on this third criterion.

Section 5

Grid development in the region

5.1
Overview of project portfolio

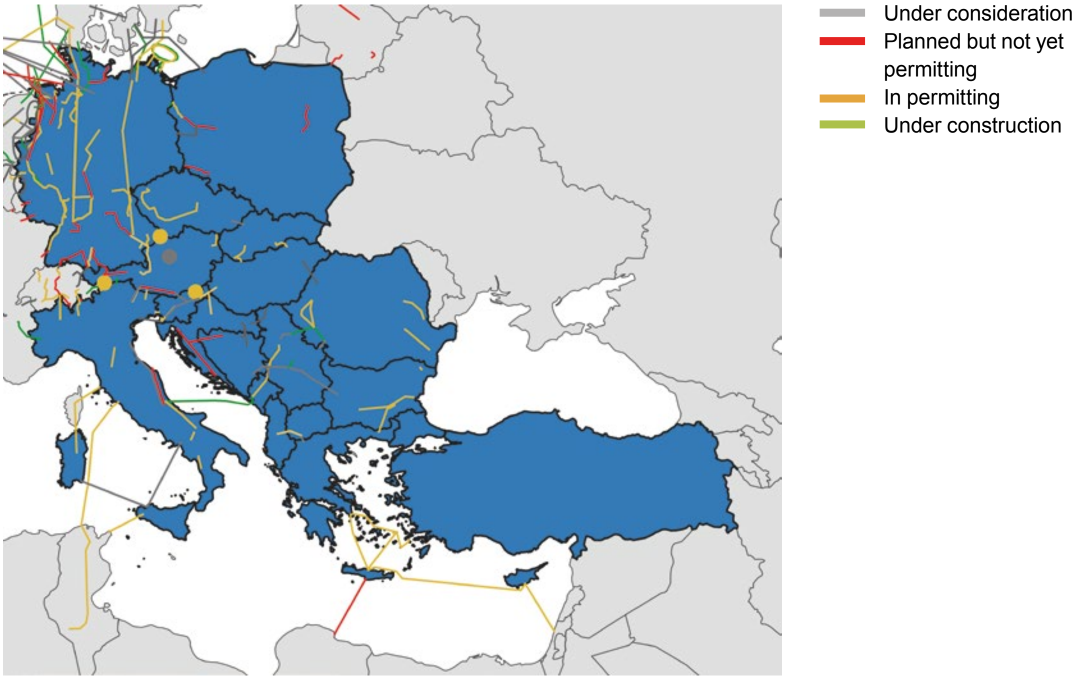
The TSOs in the region are already preparing transmission systems development plans in order to meet the identified needs mentioned in Section 4.

Projects under construction, applying for permissions and in the planning phase are among the projects being CBA assessed in TYNDP 2018. There may still be a way to go before reaching the potential 2040 needs, but the region's TSOs are well on the way to forming the future power system. Figure 5.1 below shows projects in the NSI East Corridor being assessed by the CBA analysis in TYNDP 2018. A lot of projects connecting the south Continental Europe power systems with North Africa, as well as increasing the interconnection capacities of the islands in the Mediterranean Sea.

The reinforcements are based on increased north-south and west-eas ows, implementation of renewables, further connection to other synchronous areas as well as keeping the security of supply to an adequate level.

All the studied scenarios include a large increase in renewable generation and decrease of CO_2 emissions, but, without additional grid development, the price spread between market areas in the region would explode, and some of the climate bene ts would not be realised. The bene ts of increased capacities in the scenarios are clearly visible in the market result, to sum up the main bene ts of implementing the identi ed capacity needs if the scenarios would realize the summed results are shown below. Increasing the capacities at the borders would have a signi cant impact on the electrical system and society.

Figure 5.1: Pan-European signi cance projects map of NSI East Corridor



T nd out more about a particular project, just click on the country you're interested in on the interactive map for more information about the particular investments of the pan-European project portfolio, which has been assessed in the TYNDP 2018 process.

5.2

Monitoring the projects of the region

In this section, different types of statistics about the TYNDP 2018 project investments are listed in order to give a complete picture about the transmission grid development in NSI East Corridor.

In Figure 5.2, the status of the NSI East Corridor investments is depicted. The vast majority of the investments that are currently “Under construction” and “In permitting” are expected to be commissioned by the end of 2029. Planned commissioning dates of investments currently with the status “Planned but not yet permitting” and “Under consideration” are 2030 and 2035.

Figure 5.2: Status and expected commissioning year for investments in NSI East Corridor

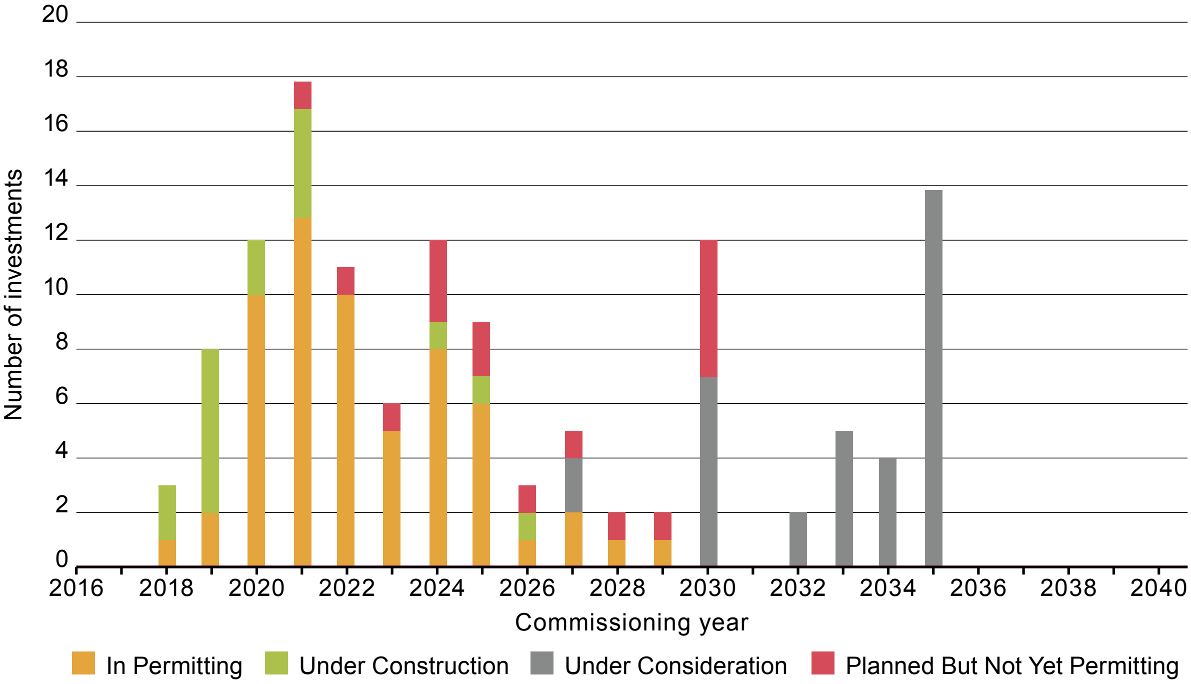


Figure 5.3 shows that approximately 42% of all investments in NSI East Corridor will be commissioned on time. Almost 23% of investments in the region will be delayed and 25% have been rescheduled, which could indicate that several obstacles (e.g. related mainly to the permit granting procedure, public acceptance, etc.) to commissioning the investment on time have been identi ed by the project promoters.

Figure 5.3: Evolution driver of the investments in the NSI East Corridor

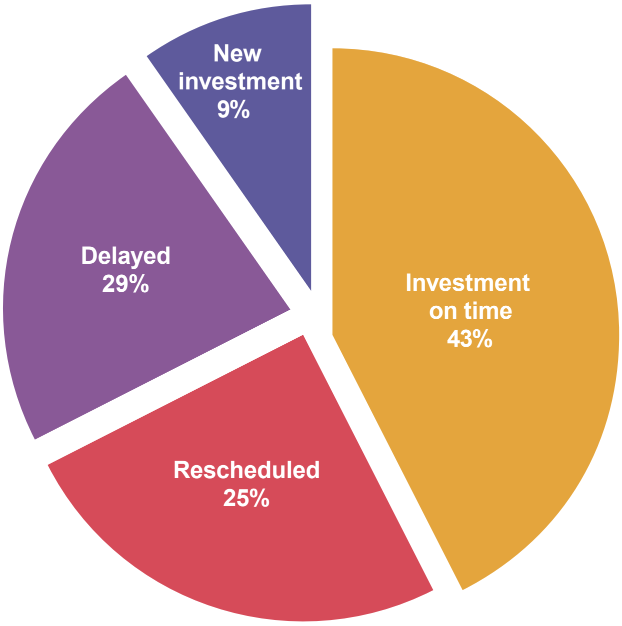
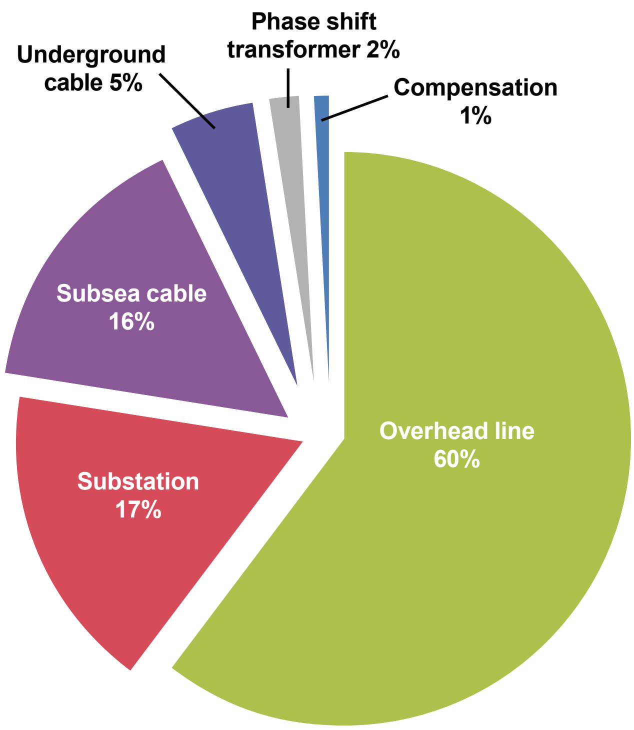


Figure 5.4 shows the share of different types of investments on total number. Approximately 60% of the investments are overhead lines, which indicates that the vast majority of internal and cross-border lines are developed in Continental Europe. Almost 20% of the investments are subsea cable, which indicates asynchronous connection of the Continental Europe power system under the sea among each other or with African power systems.

Figure 5.4: Type of investments in the NSI East Corridor



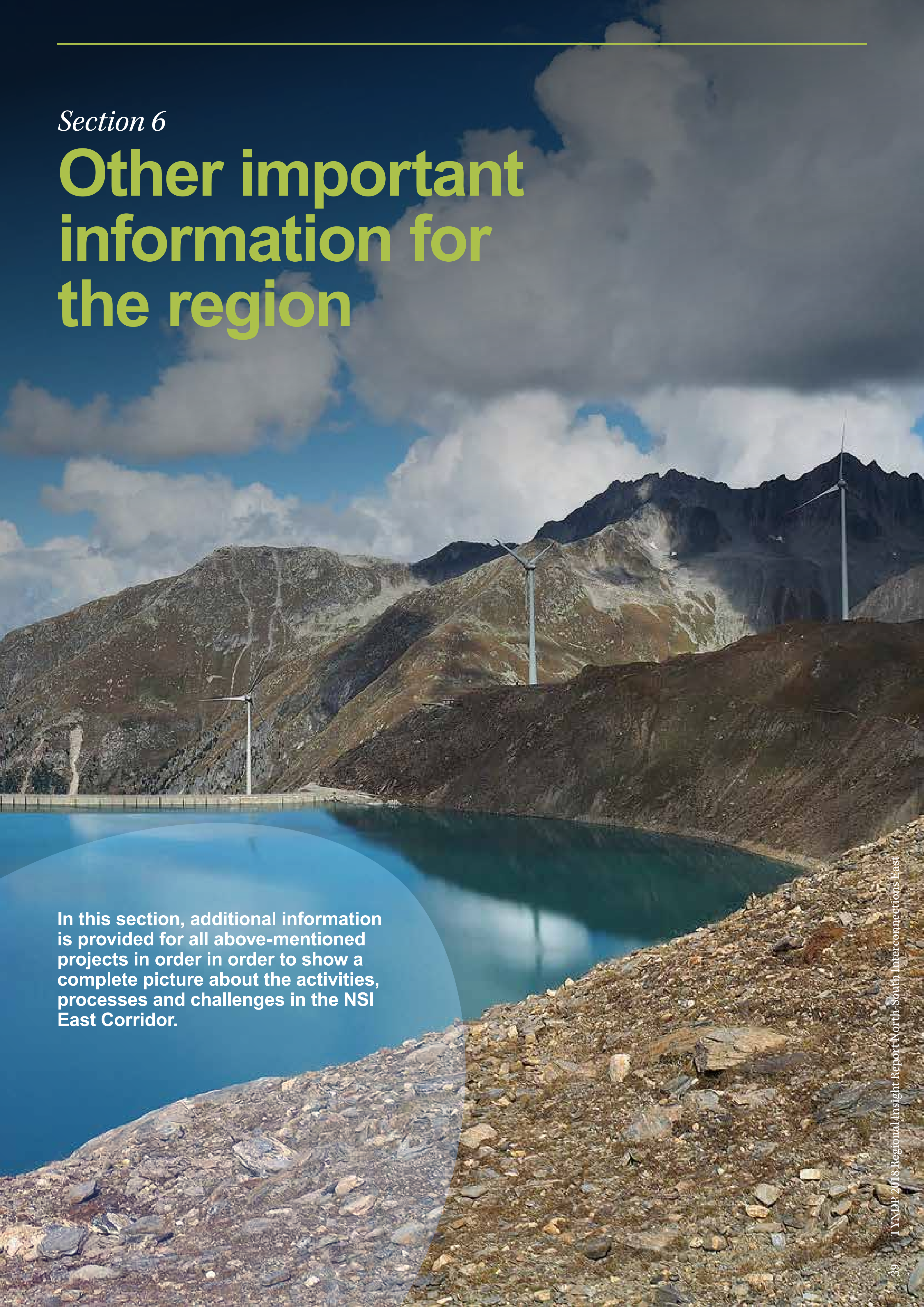
5.3
Description of main sub-corridors in the region

Given the boundaries and challenges reported above/in the previous sections, further interconnections are necessary to overcome these issues. The most relevant sub-corridors of development in the region are:

— **Italy – Balkans corridor, together with the Transbalkan corridor:** projects developed in this corridor will make the integration of the central-eastern and south-eastern markets with the Italian market possible. Moreover, they will also contribute to improving the security of the two interconnected areas.

— **Southern Europe – North Africa corridor:** further interconnection between Europe (Italy) and North Africa (Tunisia) to favour major integration of the two electrical systems, with signi cant bene ts on both sides of the Mediterranean. Projects in this corridor will contribute also to reduce limitations to the power exchanges in Continental Europe, allowing an increase in the transmission capacity there and its exploitation.

— **Eastern side of the North Italy boundary:** as previously explained, the North Italy boundary is one of the main barriers for the power exchange in the pan-European perimeter. Therefore, projects between Italy – Austria and Italy – Slovenia, together with projects between Slovenia – Hungary/ Croatia (supporting the east-west power exchange and markets) are of primary importance for the implementation of an infrastructural corridor of particular strategy for the NSI East Corridor.



Section 6

Other important information for the region

In this section, additional information is provided for all above-mentioned projects in order in order to show a complete picture about the activities, processes and challenges in the NSI East Corridor.

6.1
PECI/PMI process

Aside from the PCI process, non-EU countries projects in this region are covered by similar procedures as de ned in the adapted Regulation 347/2013 on guidelines for trans-European energy infrastructure (PECI – Projects of Energy Community Interest, and PMI – Projects of Mutual Interest).

Assessment of projects and making the PECI/PMI list is done on a two-year basis. In the PECI 2018 selection process two TYNDP 2018 projects obtained PECI label. The PECI label has been obtained for the following two TYNDP 2018 projects from the NSI East Corridor which will enhance cross-border transmission capacity:
- between Serbia, Montenegro and Bosnia and Herzegovina (Transbalkan corridor)— between Macedonia and Albania.

6.2
CESEC Initiative

The Commission Initiative on Central and South Eastern European Energy Connectivity (CESEC) pays special attention to projects which have mutual impact on both EU and non-EU countries.

CESEC is yielding results by strengthening solidarity and enabling a safer and more affordable gas and electricity supply to citizens and business across the region. The Regional Group NSI East projects covered by this initiative include:
- Enhancement of the transmission capacity along the East-West corridor in South East Europe from Italy to Romania via the Balkans
- Enhancement of the cross-border transmission capacity between Bulgaria, Romania and Greece
- Electricity interconnections between Hungary and Slovakia
- Infrastructures supporting the integration of Ukraine and Moldova power systems into European electricity market
- Interconnection Slovenia-Hungary/Croatia
- Slovenia – Croatia Smart Grids Project – SINCRO.GRID.

6.3
Enlarging synchronously connected Europe

Beside above-mentioned future challenges, drivers and resulting grid development projects, the synchronous connection of the Ukrainian and Moldovan power systems and Baltics to CE will also have an impact on the further grid development in this region.

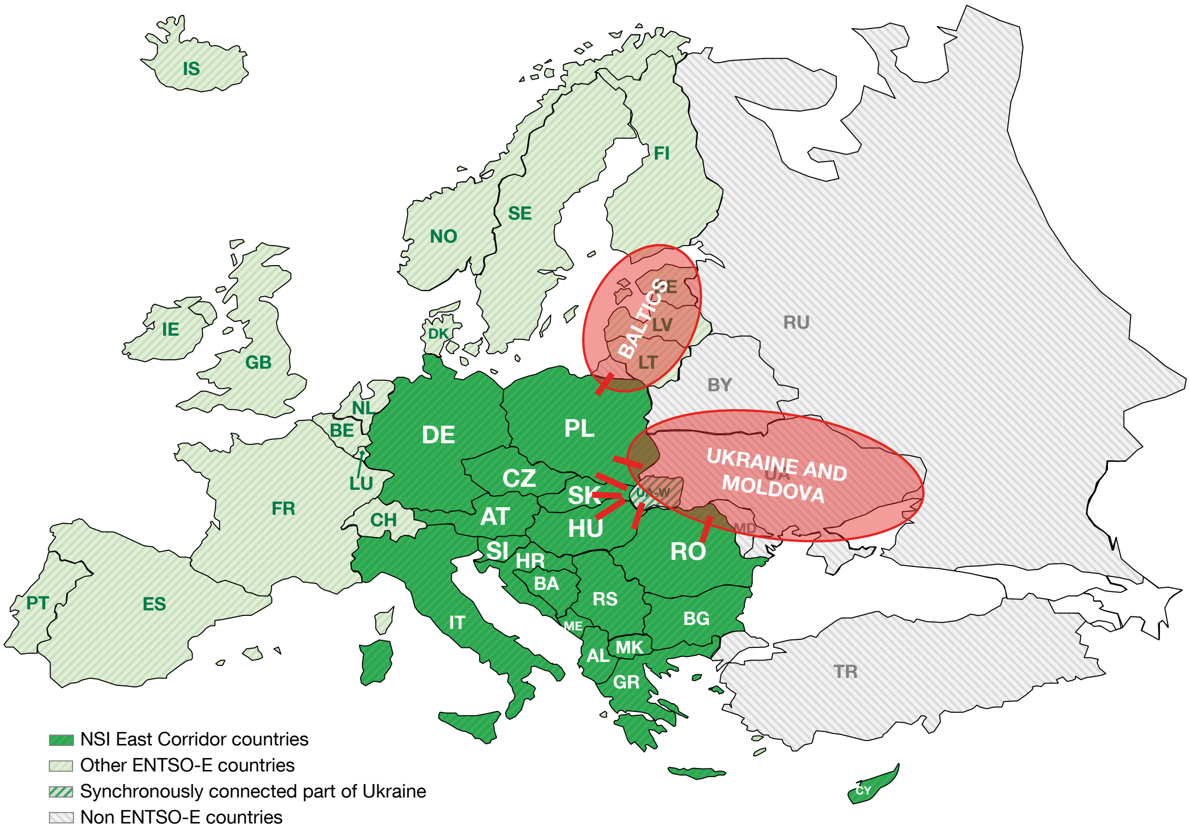
Currently, Ukrainian and Moldavian power systems are synchronously connected with IPS/UPS system from Russia and Belorussia, but one part of the IPS of Ukraine, so-called “Burshtynska TPP Island”, is synchronously operated with Slovakia, Hungary and Romania by the 220, 400 kV and 750 kV transmission lines.

Regarding the Ukraine and Moldavia power systems synchronous connection to CE, the feasibility study was carried out in 2016, where the possibility of synchronous integration of Ukraine’s and Moldova’s power systems into ENTSO-E have been analysed. The study has con rmed the absence of fundamental obstacles but revealed a couple of technical problems, which require detailed analysis an xing. All these issues resulting from the study, together with the conditions of synchronous interconnection to Continental power grid that need to be ful lled, are introduced in the “Agreement on the conditions of the future interconnection of the power system of Ukraine with the power system of Continental Europe” and “Agreement on the conditions of the future interconnection of the power system of Moldova with the power system of Continental Europe“. These agreements were signed in June 2017 and entered into force on 7 July 2017 and are considered as a starting point for Ukraine and Moldavian power systems synchronous integration to European power system.

Baltics States are in the present situation synchronized with the IPS/UPS system from Russia and Belorussia. Interconnection through the direct current lines is done with the Nordic synchronous area and Poland. The Baltic States have expressed their interest in synchronously connecting to Continental European synchronous area by 2025. Th rst technical study "Baltic States' synchronisation with the system of CE" related to the dynamic stability of the interconnection which started in 2017, with results available by spring 2018. In order to evaluate how the synchronous or asynchronous interconnection of the power systems in the Baltic States affects the power systems in CE or Nordic countries, a more detailed analysis will need to be carried out. One of the possible technical variants of future connection of Baltics to the surrounding power systems is "Synchronous interconnection with the Continental Europe power systems, through Lithuania-Poland interconnection and also soft coupling supported by existing HVDC links". The substantial impact of the other two "asynchronous Baltics connection" variants on the Region is not foreseen.

In Figure 6.1 below, the schematic visualisation of the Ukrainian, Moldavian and Baltics power systems future synchronous integration to CE power system is crucial for the CCE region, as above-mentioned power systems will be interconnected with the CCE power systems.

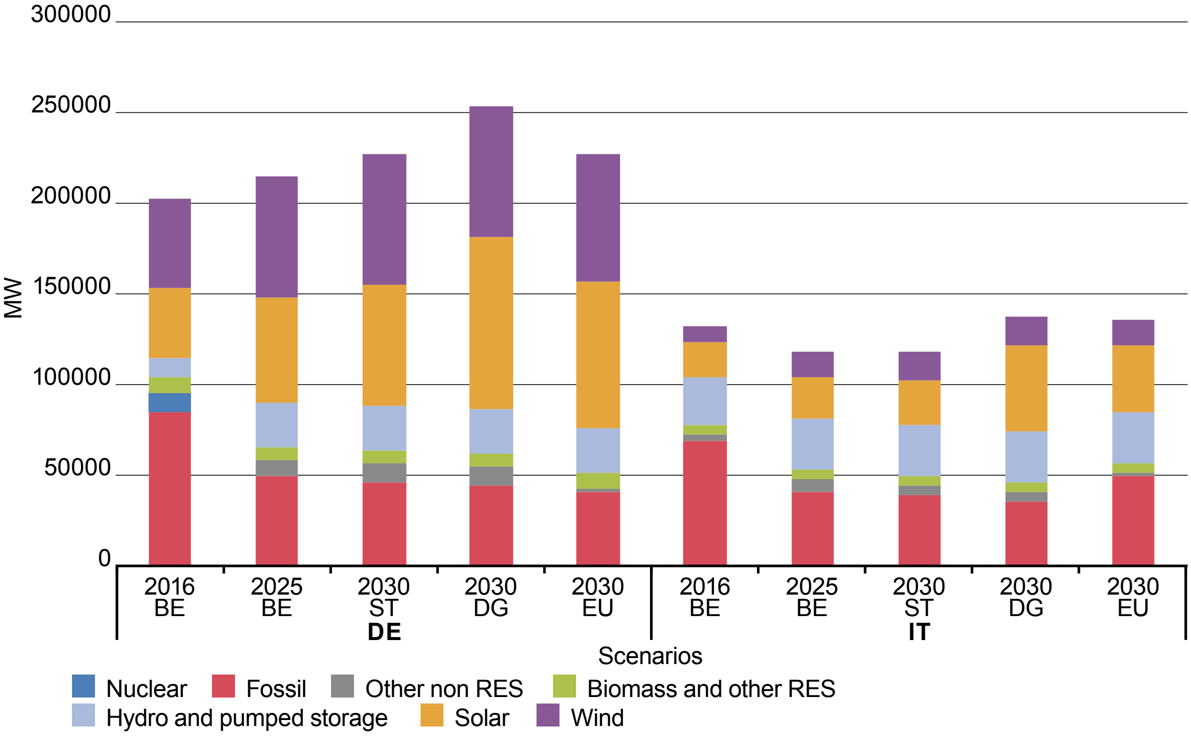
Figure 6.1: Schematic visualisation of future extension of synchronous Continental European grid, affecting NSI East Corridor



Section 7

Annex

Figure 7.1: Installed capacities for the countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



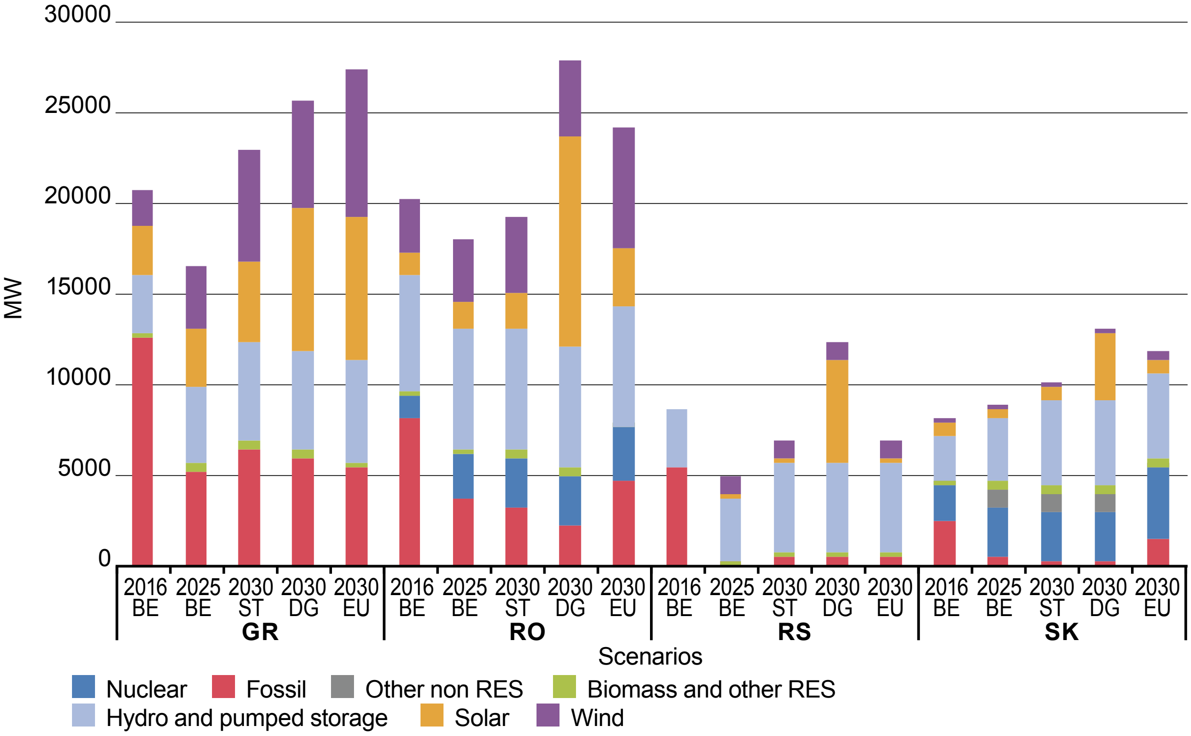
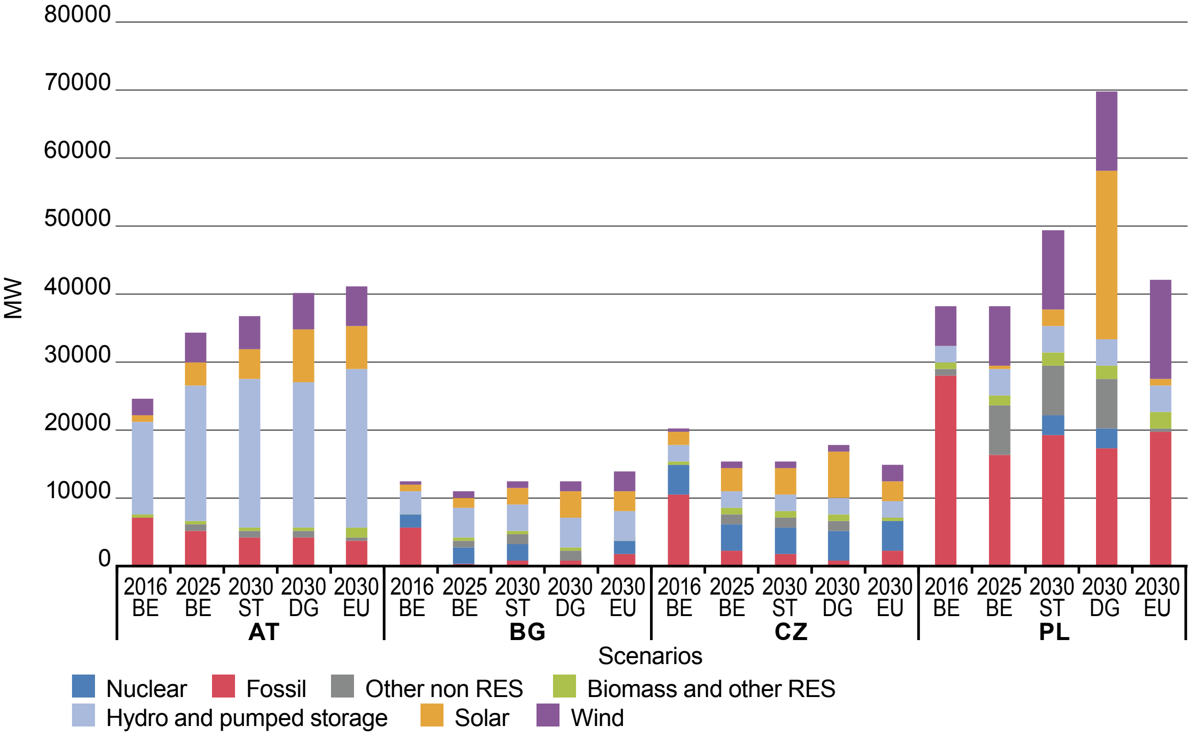


Figure 7.1 continued: Installed capacities for the countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



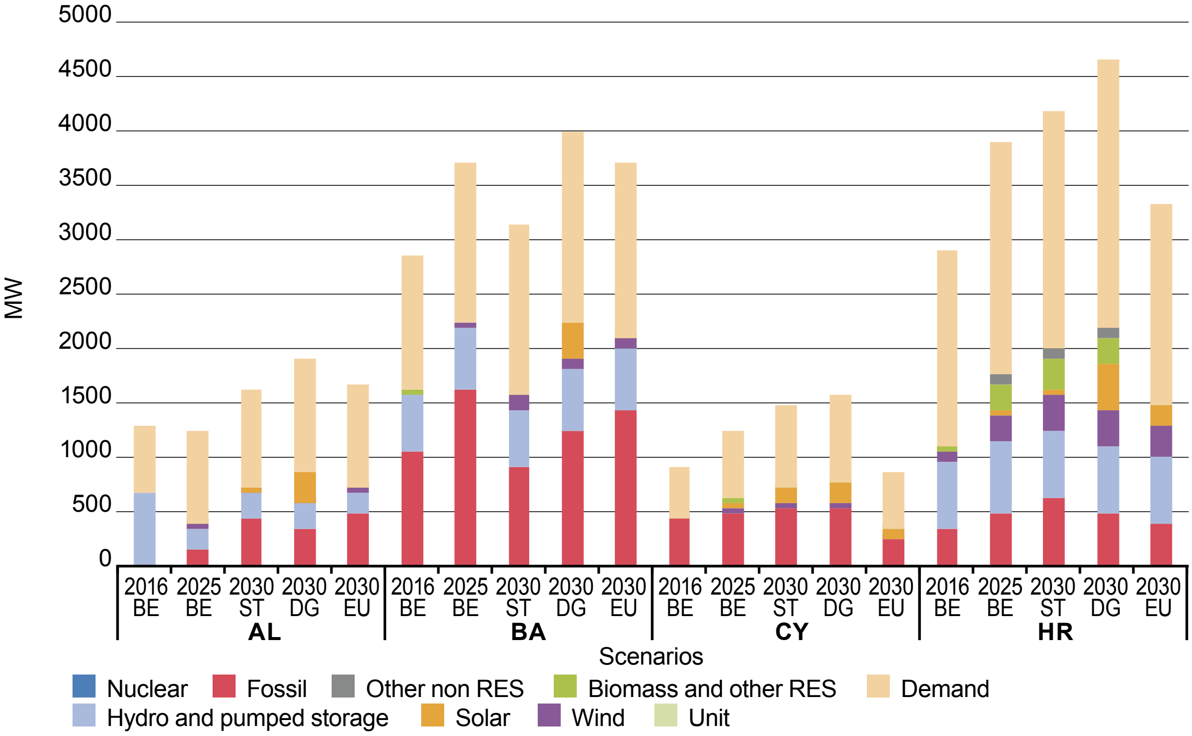


Figure 7.1 continued: Installed capacities for the countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030

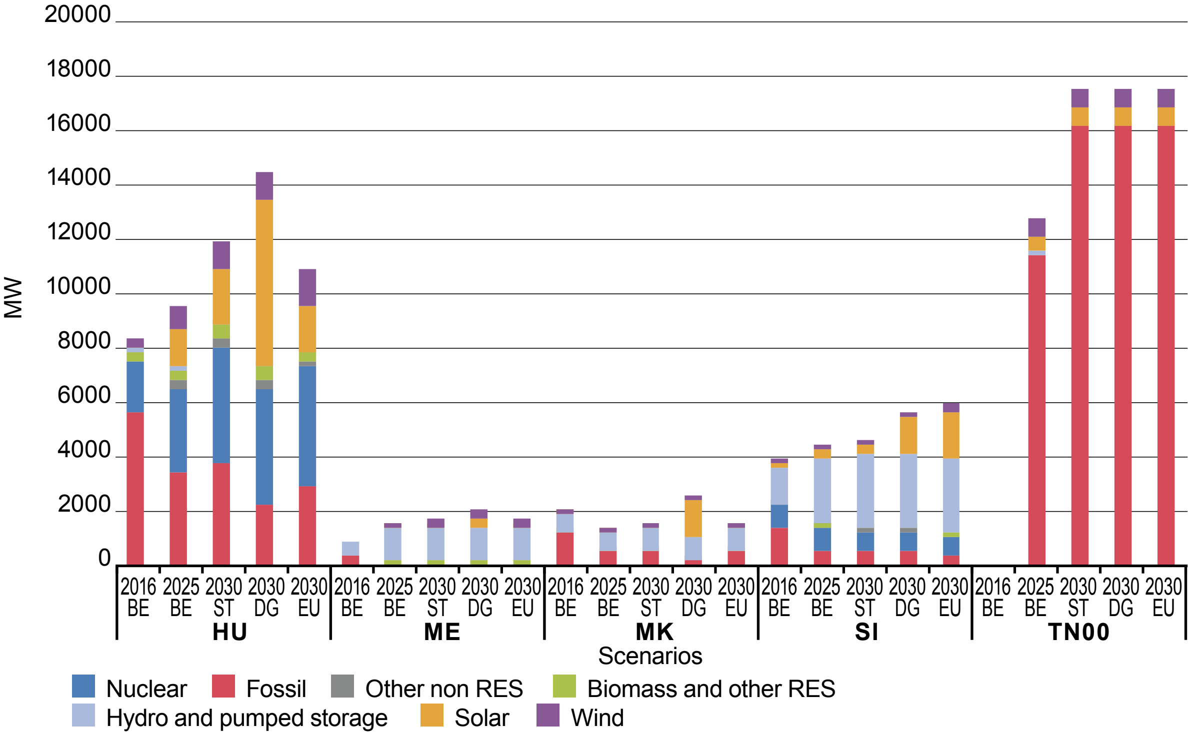


Figure 7.2: Generation in the countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030

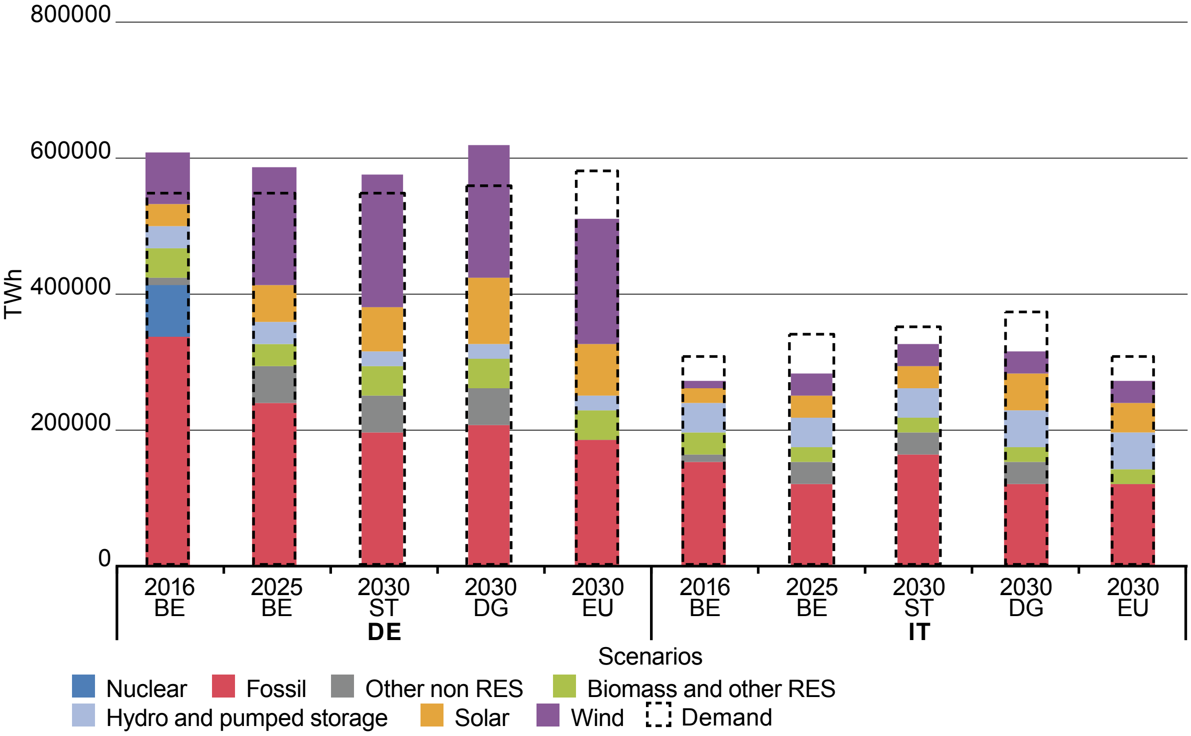
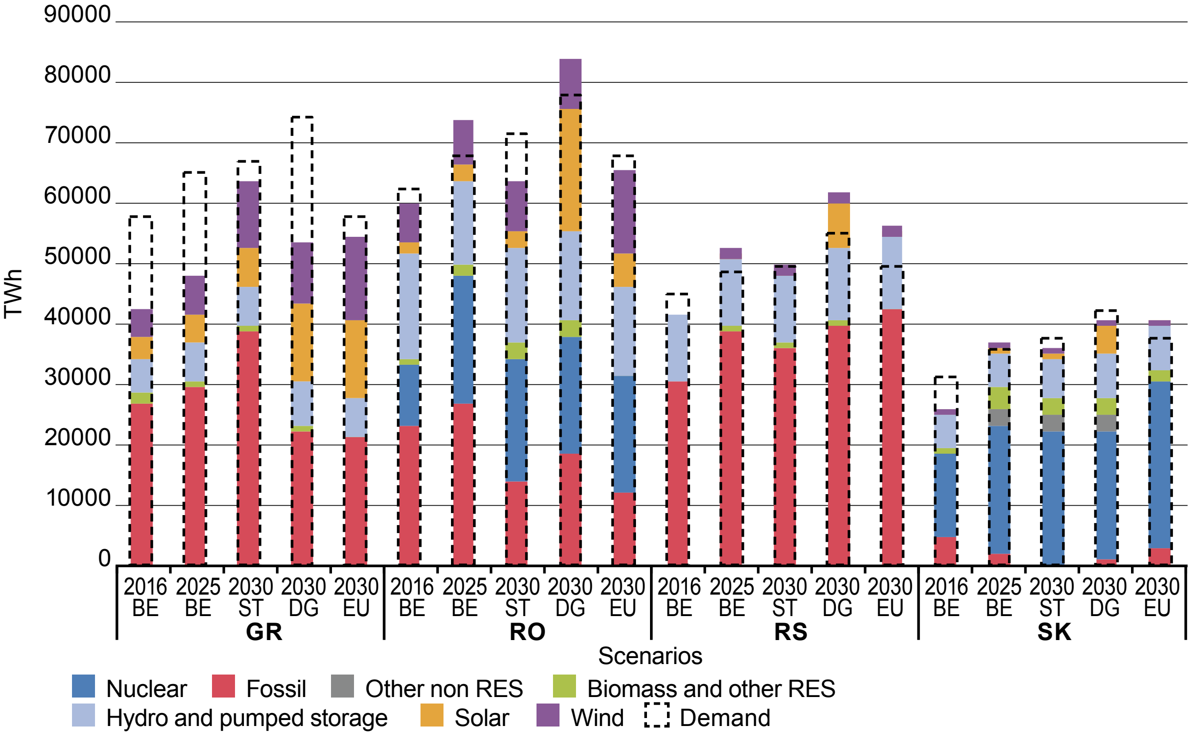


Figure 7.2 continued: Generation in the countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



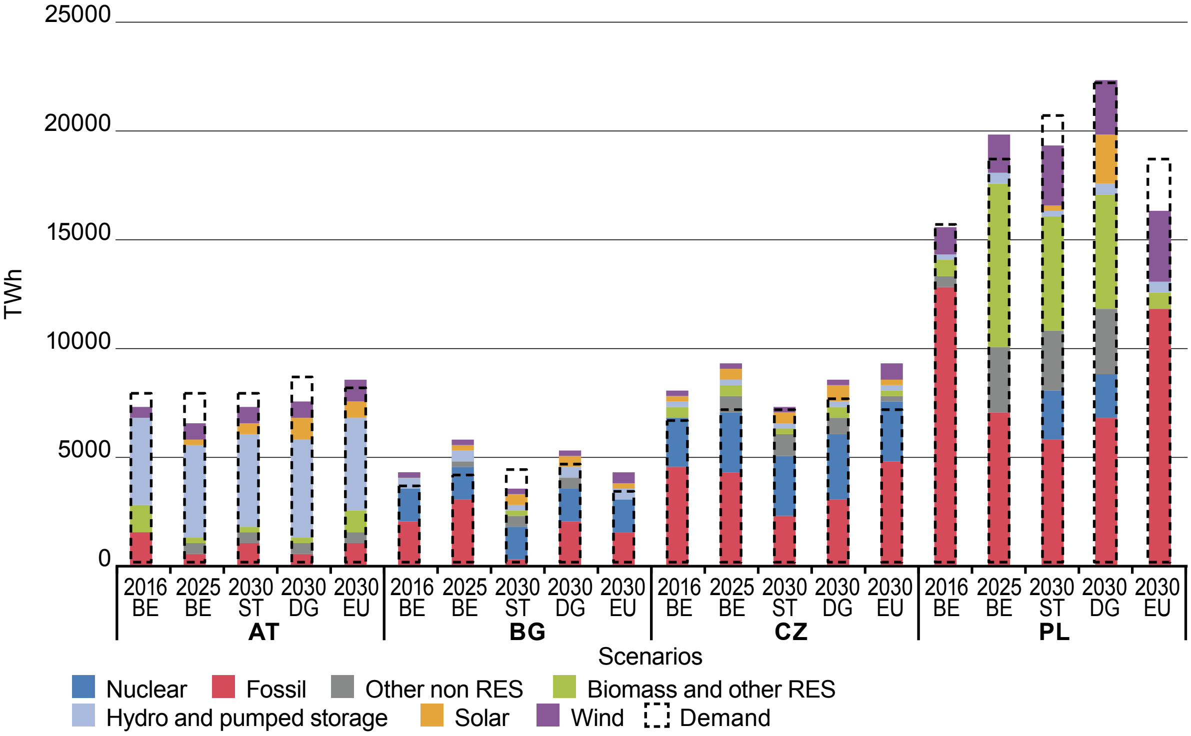
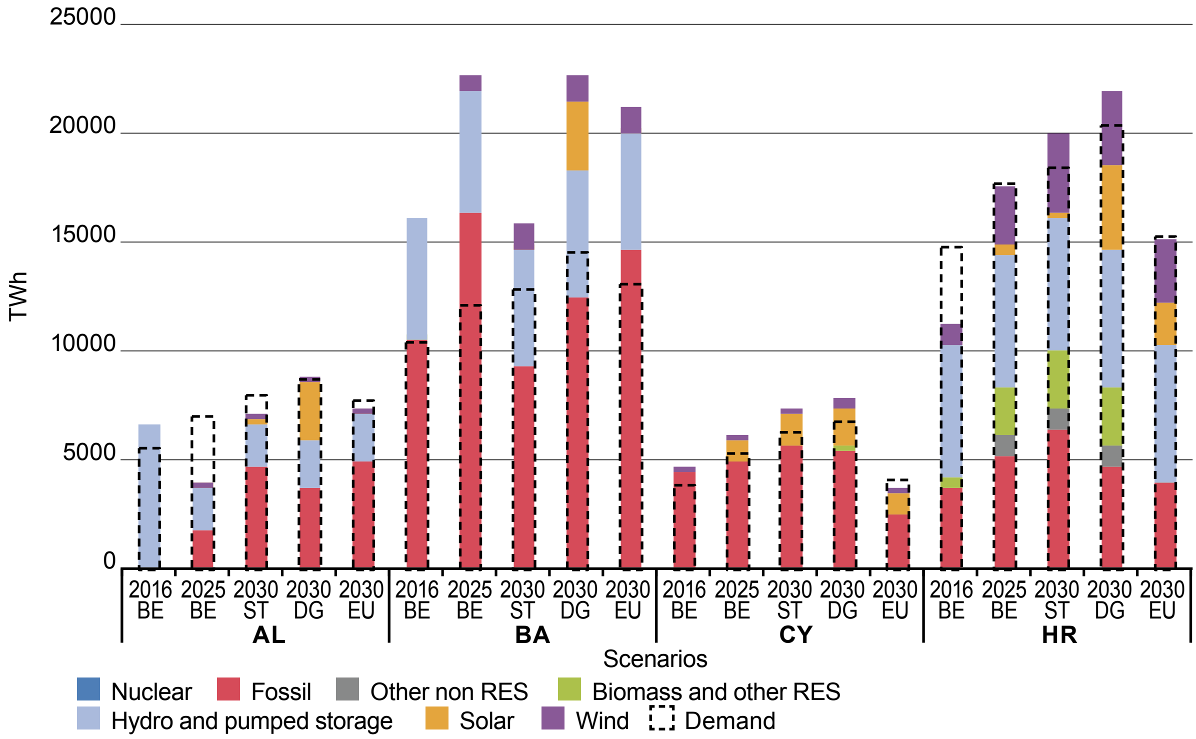


Figure 7.2 continued: Generation in the countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



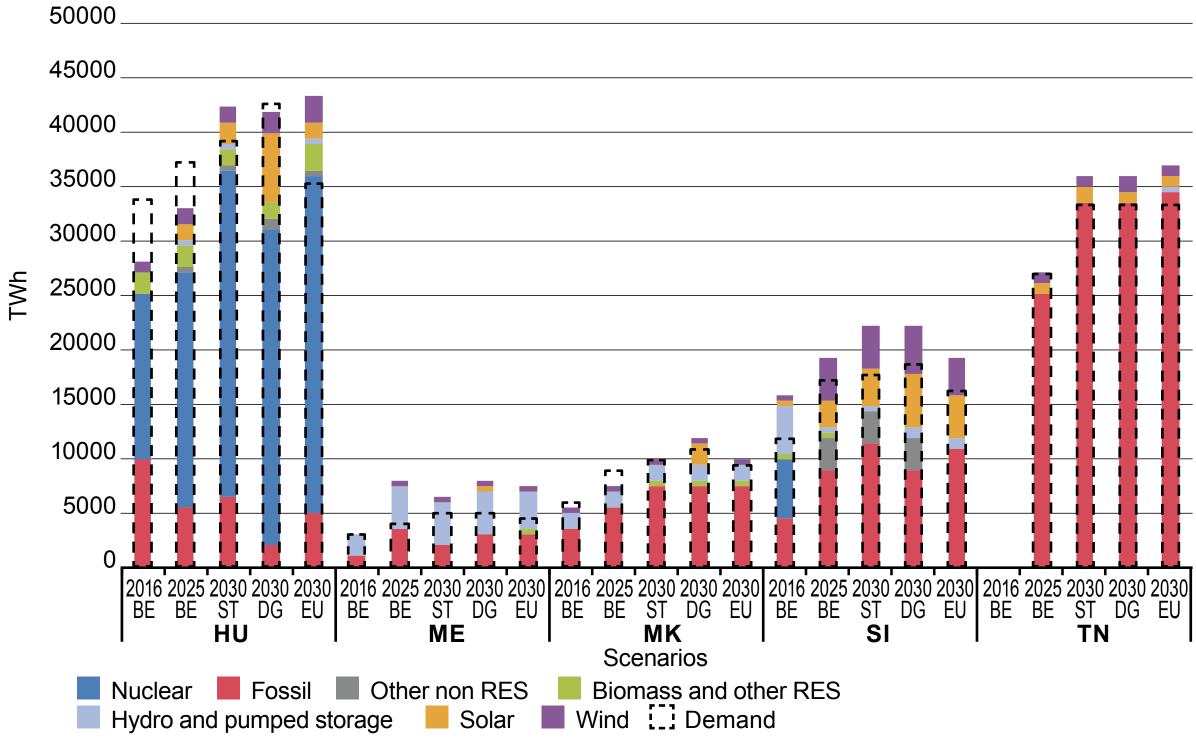
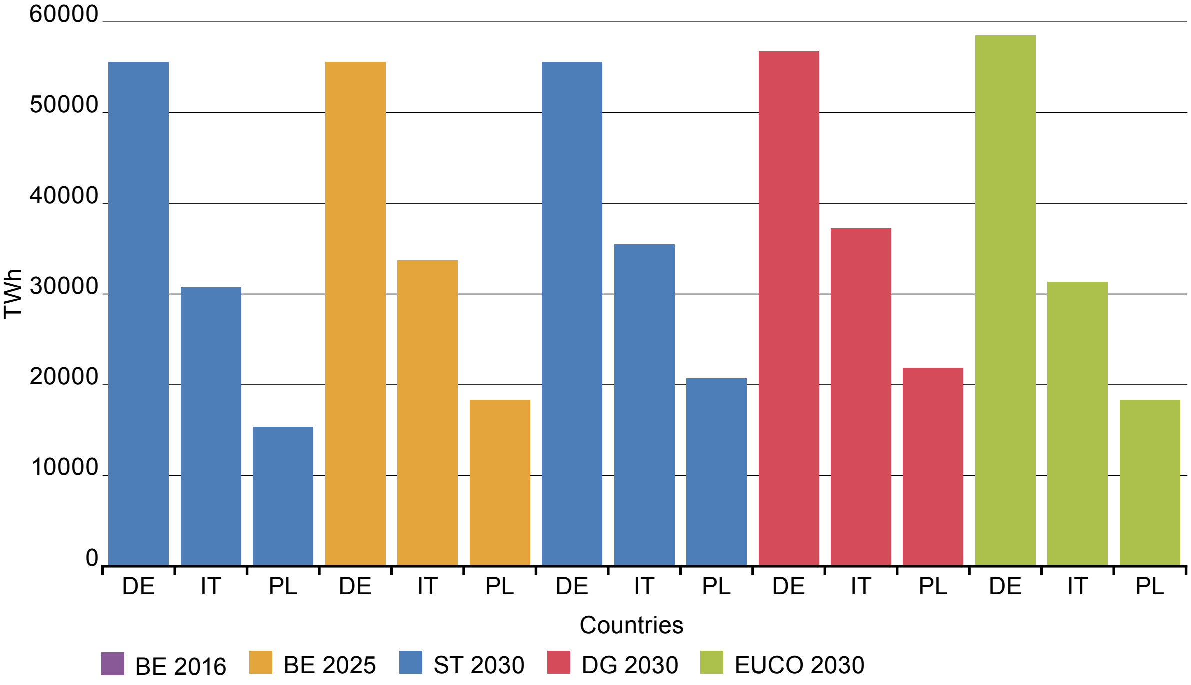


Figure 7.3: Demand in countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



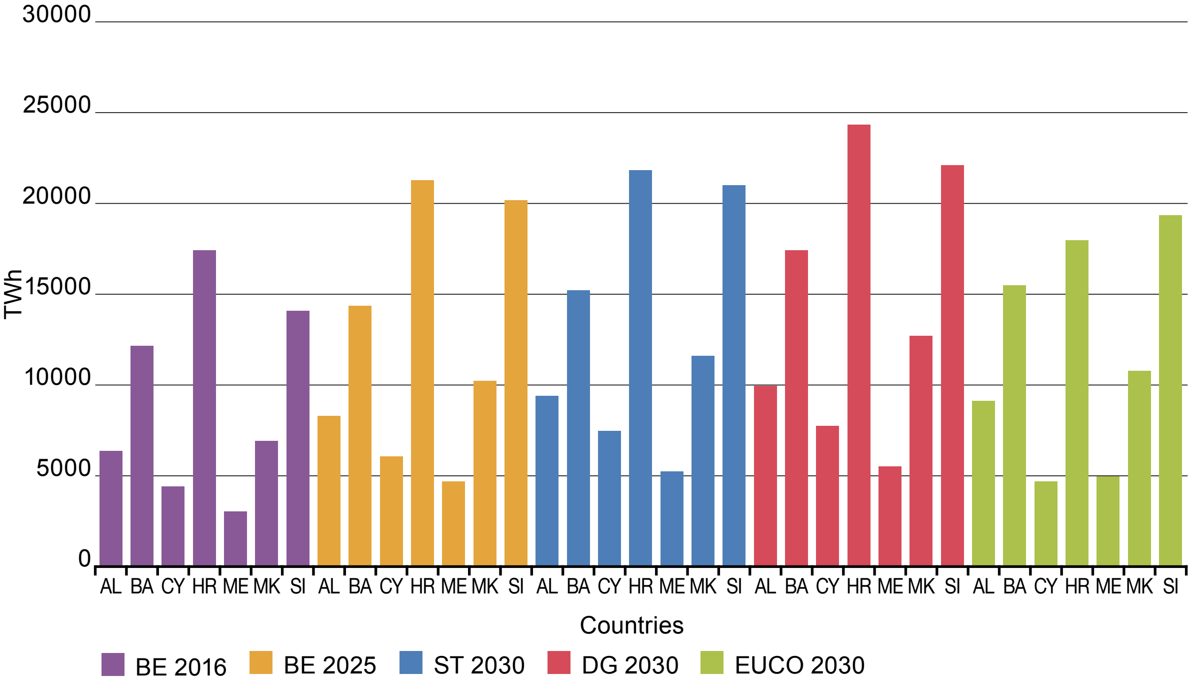
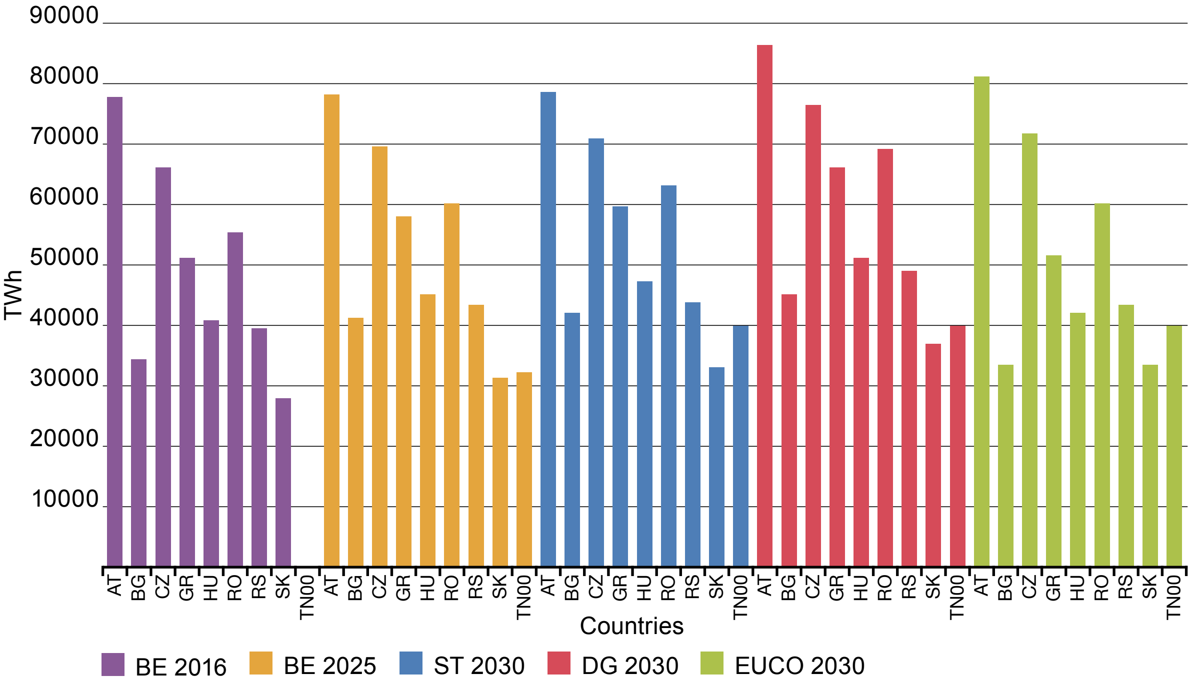


Figure 7.3 continued: Demand in countries of the NSI East Corridor for the year 2016 and the scenarios BE 2025 and ST 2030, DG 2030, EUCO 2030



Section 8

Useful information

For queries about this report, the TYNDP 2018 or the ongoing consultation, please contact the ENTSO-E team which coordinated the release of this report:
Jean-Baptiste Paquel, Dante Powell and Andriy Vovk
TYNDP2018@entsoe.eu

For press queries, please contact:
Claire Camus
media@entsoe.eu

ENTSO-E – European Network of Transmission System Operators for Electricity
Avenue de Cortenbergh 100
1000 Brussels Belgium
Phone: +32 2 741 09 50
Fax: +32 2 741 09 51

General queries: **info@entsoe.eu**

ENTSO-E AISBL
Avenue de
Cortenbergh 100,
1000 Brussels,
Belgium

Tel (+32) 2 741 09 50

info@entsoe.eu
www.entsoe.eu

entsoe
Reliable Sustainable Connected