In-short

Regional Investment Plans

Final version after public consultation and ACER opinion - October 2019

entsoe

Reliable Sustainable Connected

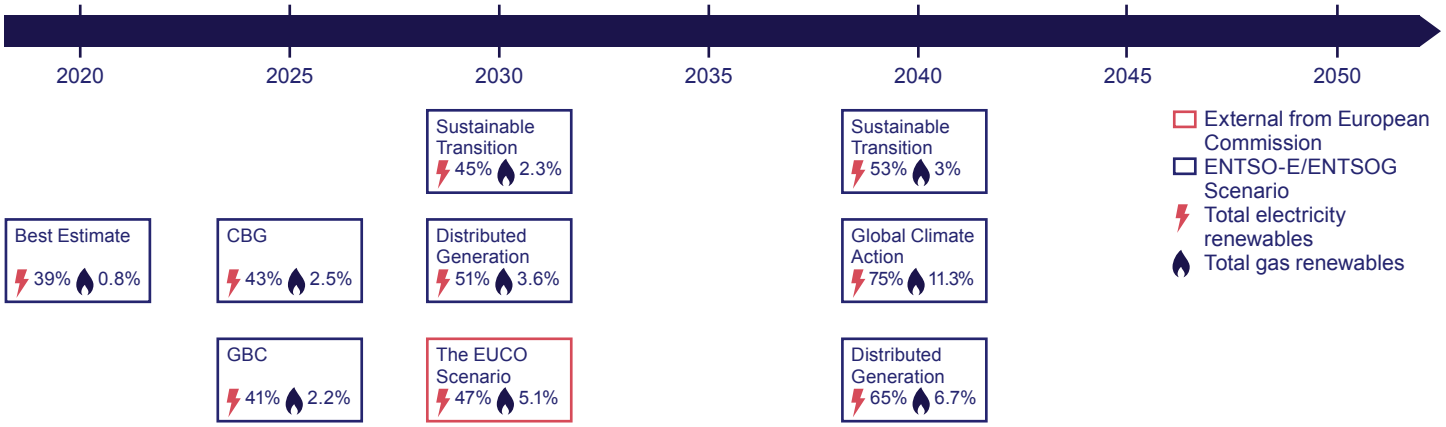
Contents

Our infrastructure is the backbone for the delivery of gas and electricity to citizens across all of the EU.

It aims to connect countries and ensure secure, competitive and sustainable access to energy for customers throughout the year.

As the EU voluntarily undertakes the energy transition, this infrastructure will have a key role to play in supporting the uptake of new technologies and meeting ambitious decarbonisation challenges. The ENTSO-E and ENTSOG TYNDPs are here to assess the requirements for these aims, in terms of the infrastructure. The starting point for that is to define scenarios depicting the future which the EU strives to achieve.

For the first time ENTSO-E and ENTSOG have jointly built their TYNDP scenarios, so that they are realistic, consistent between the sectors and technically sound. The scenarios are built through close engagement with stakeholders; they are based on forward looking policies, whilst also being ambitious in nature and aiming at reducing emissions by 80 to 95% in line with EU targets for 2050. The scenarios provide the ENTSO-E study teams with generation and demand mixes that are realistic yet challenging, so that they can identify future network needs.



The TYNDP 2018 Scenario Storylines

Sustainable Transition

Targets reached through national regulation, emission trading schemes and subsidies, maximising the use of existing infrastructure.

Distributed Generation

Prosumers at the centre – small-scale generation, batteries and fuel switching society engaged and empowered.

Global Climate Action

Full speed global decarbonisation, large-scale renewables development in both electricity and gas sectors.

External Scenario: Based On EUCO 30

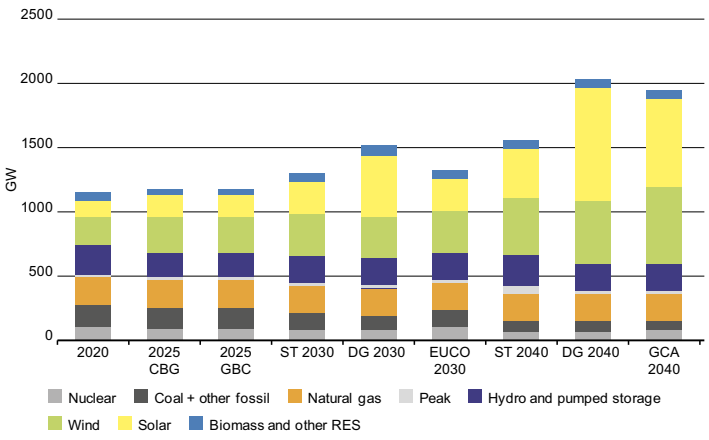
EUCO 30 is a core policy scenario produced by the European Commission. The scenario models the achievement of the 2030 climate and energy targets as agreed by the European Council in 2014, but including an energy efficiency target of 30%. The ENTSOs both welcome this new collaboration with the European Commission and encourage further cooperation.

The chart (right top) shows the installed generation capacities for every production technology. The chart (right bottom) shows the generation mixture and consumption for every scenario. The general trends that can be seen throughout the years are a reduction in nuclear (with the exception of the EUCO 2030 scenario where there is a similar level as in the 2020 scenario), a reduction in coal which is less exaggerated in Distributed Generation, and an increase in wind and solar. The levels of Hydro + Pumped Storage and Biomass + other RES remain relatively constant throughout

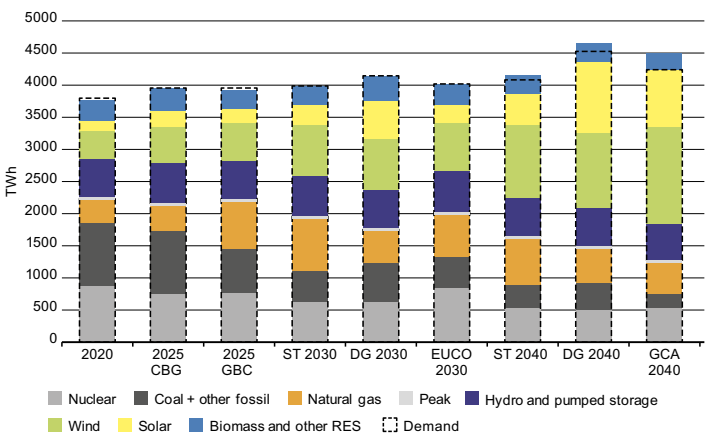
More information can be found in the TYNDP 2018 Scenario Report 2018.

— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/scenario_report.pdf

Installed production capacities per scenario



Generation and consumption per scenario



The TYNDP package is delivering the masterplan for an electrically interconnected Europe and its citizens.

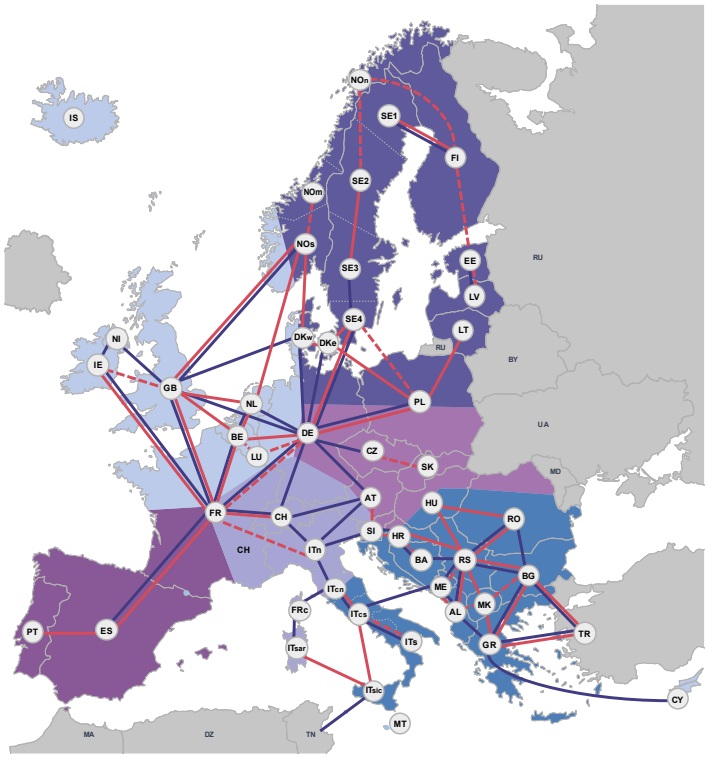
This is done by exposing the challenges for the EU energy transition and by providing next steps. An efficient transition requires efficient markets and efficient markets require sufficient infrastructure which will create value.

While the final TYNDP report will identify the most important projects for Europe, the System Need Report shows future capacity needs for the three 2040 scenarios of the TYNDP 2018. It continues the evolution of the TYNDP and contains analyses of stability issues, SoS, CO_2 emissions, integration of renewables in the grid and integration of markets with each other – all done in several scenarios and climate years.

2040 Needs of System Development

The map below shows potential needs for additional capacity increases in 2040 – beyond the 2020 grid.

Summary of capacity increases from 2020 to 2040



Increases already identified in TYNDP 2016[1]
Increases beyond 2030 in only one scenario
Increases beyond 2030 in at least 2 scenarios

CSW CCS CSE
CCE BS NS

More information can be found in the European System Need Report 2018

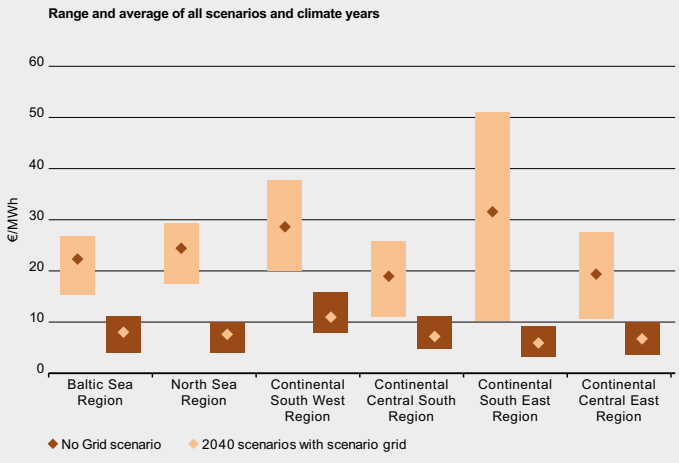
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf in the Scenario Report
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/scenario_report.pdf and in the Regional Investment Plans 2017 of the ENTSO-E regional groups
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_BS.pdf
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CCE.pdf
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CCS.pdf
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CSE.pdf
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CSW.pdf
- https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_NS.pdf

[1] Reference capacities of TYNDP 2016 for 2030 which for some borders had been adjusted for the TYNDP 2018 purpose. Projects commissioned in 2020 are not included as increases.

The chart below shows the average marginal costs of electricity production per regional group as summary for all three 2040 scenarios and with the scenario grids implemented **(2040 scenarios with scenario grid)**. The chart also shows the values if the capacity increases were not implemented **(No Grid scenario)**.While some of the needs for capacity increases shown to the left are needed for reasons like increases in security of supply and integration of renewables, many of them also integrate the European electricity markets which can be seen in reduced average marginal cost differences of electricity production.

All 2040 Scenarios

European – Average hourly differences of marginal costs



Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

3 to 14 €/MWh
reduction in marginal costs of electricity generation

58 to 156 TWh
less curtailed renewable energy

37 to 59 Mton
reduction in CO_2

24 to 471 GWh
reduction in Energy Not Served

The Baltic Sea (BS) region comprises the following countries: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland and Sweden.

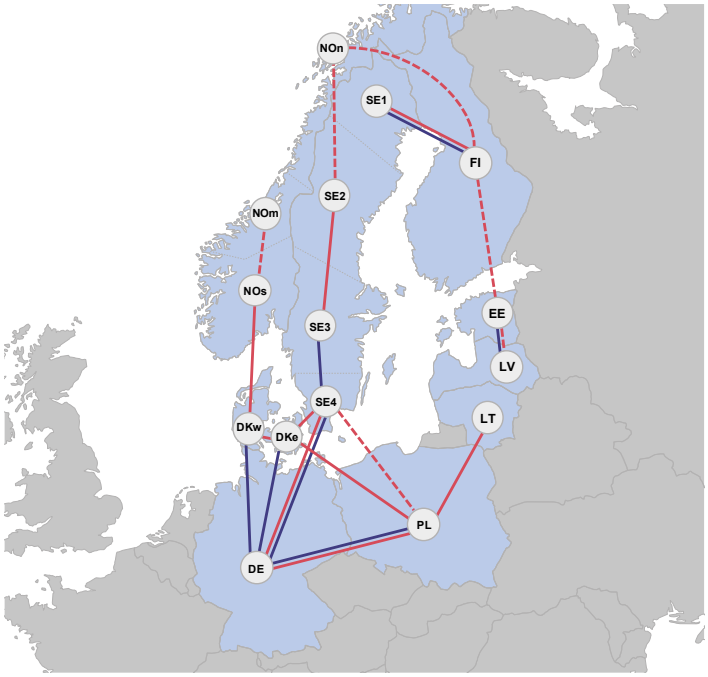
Within the region, there are three separate synchronous systems: the Nordic system, the Continental system, and the Baltic power system which is currently part of the IPS/UPS system.

The electricity system in the Baltic Sea region is undergoing an unprecedented change as the electricity generation structure is rapidly becoming carbon-free and simultaneously more variable according to the weather.

2040 Needs

The map below shows potential needs for additional capacity increases in 2040 – beyond the 2020 grid.

Summary of capacity increases from 2020 to 2040



Increases already identified in TYNDP 2016[1]
Increases beyond 2030 in only one scenario
Increases beyond 2030 in at least 2 scenarios

— Stronger integration Germany-Poland ⟶ increase market integration and facilitate thermal decommissioning.
— Further integration Sweden-Finland ⟶ increase Nordic market integration.
— Further integration Norway-Denmark ⟶ lower price differences and increase Danish security of supply.
— Further integration Sweden/Denmark-Germany ⟶ lower price differences and optimise RES generation (hydro/wind).
— Further internal integration in the Baltics ⟶ increase security of supply.

More information can be found in the Regional Investment Plan 2017 of this regional group and in the European System Need Report 2017.

— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_BS.pdf
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf

[1] Reference capacities of TYNDP 2016 for 2030 which for some borders had been adjusted for the TYNDP 2018 purpose. Projects commissioned in 2020 are not included as increases.

The main challenges and drivers of grid development in the region are:

— Integration of renewables.
— Nuclear and thermal decommissioning.
— Flexibility-need between synchronous areas.
— Security of supply for the Baltic countries.
— New consumption due to electrification.

These challenges are reflected in the planned projects and also in the simulated grid development needs for 2040.

Projects

The map below shows all the promoted projects that will be analysed with the CBA methodology in the TYNDP 2018.

Under consideration
Planned but not yet permitting
In permitting
Under construction

Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

Up to 27 €/MWh
reduction in marginal costs of electricity generation

13 to 77 TWh
less curtailed renewable energy

9 to 30 Mton
reduction in CO_2

Up to 65 GWh
reduction in Energy Not Served

The regional group Continental Central East (CCE) consists of the following countries: Austria, Croatia, Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and Slovenia.

The main drivers and challenges that the CCE region will have to cope with in the future development scenarios are mainly generation mix change and extension of synchronously connected Europe–Ukrainian and Moldovan power systems, as well as the Baltic's synchronous connection to Continental Europe.

These challenges are imposing the need for transmission grid development, in order to maintain the security and reliability of the future European interconnected transmission system's operation.

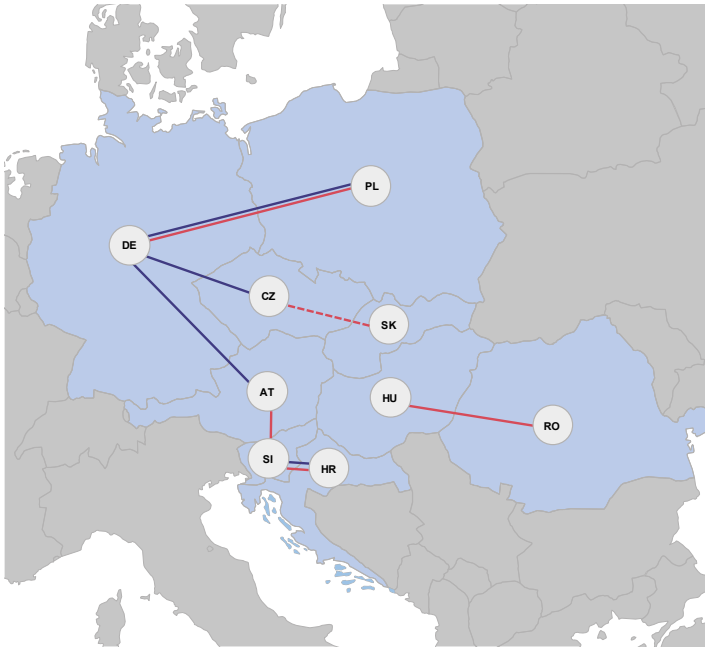
The following system needs have been identified:

— Insufficient integration of renewables into the power systems, as high amounts of curtailed energy occurred in a couple of the power systems.
— Insufficient security of supply, as high amounts of Energy Not Served occurred in a couple of the power systems.
— High price differences between the market areas.
— High CO_2 emissions.
— Cross-border and internal bottlenecks.

2040 Needs

The map below shows potential needs for additional capacity increases in 2040 – beyond the 2020 grid.

Summary of capacity increases from 2020 to 2040



Increases already identified in TYNDP 2016[1]
Increases beyond 2030 in only one scenario
Increases beyond 2030 in at least 2 scenarios

— The capacity increase on DE-PL, DE-CZ, DE-AT and SI-HR cross-border profiles have already been identified in the TYNDP 2016 by introduction of the new transmission projects.
— Further capacity increase to improve market integration has been identified on the cross-border profiles DE-PL, AT-SI, SI-HR and HU-RO and to improve security of supply on the CZ-SK cross-border profile too.

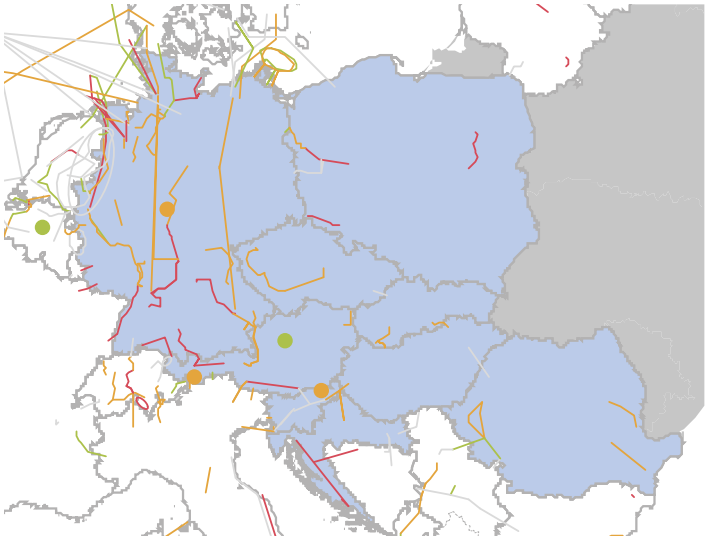
More information can be found in the Regional Investment Plan 2017 of this regional group and in the European System Need Report 2017.

— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CCE.pdf
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf

[1] Reference capacities of TYNDP 2016 for 2030 which for some borders had been adjusted for the TYNDP 2018 purpose. Projects commissioned in 2020 are not included as increases.

Projects

The map below shows all the promoted projects that will be analysed with the CBA methodology in the TYNDP 2018.



Under consideration
In permitting
Planned but not yet permitting
Under construction

Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

Up to 33 €/MWh
reduction in marginal costs of electricity generation

12 to 45 TWh
less curtailed renewable energy

11 to 36 Mton
reduction in CO_2

Up to 180 GWh
reduction in Energy Not Served

The regional group Continental Central South (CCS) consists of the following countries: Austria, France, Germany, Italy, Slovenia and Switzerland.

Key messages/main challenges/drivers for the evolution of the region are:

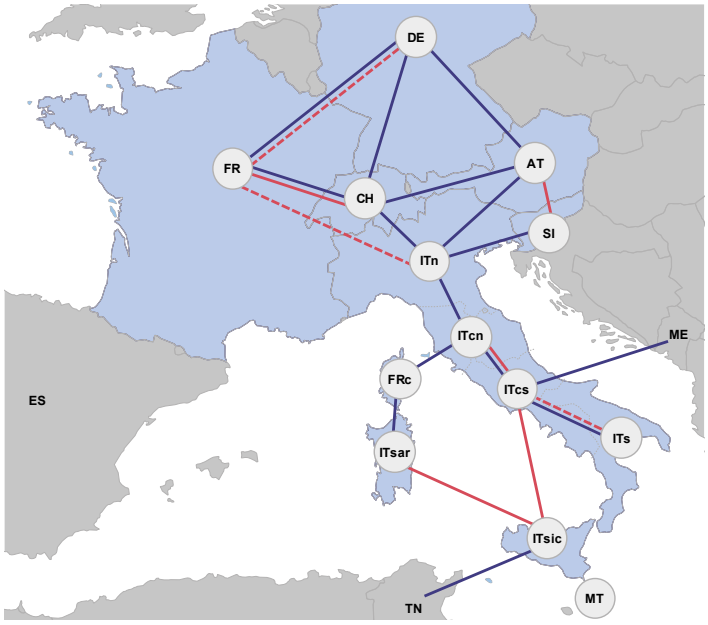
— Massive RES integration.
— Efficient integration of storage plants in order to facilitate the full exploitation of RES.
— Nuclear phase-out and existing thermal capacity dismissing or mothballing.
— Gas dependence of thermal generation.
— Wide area power flows.
— System stability and security of supply.

Large developments of variable wind and photovoltaic power, especially at the corners of the CCS region, the nuclear phase-out, mainly gas-based thermal generation, and the pump storage potentials in the Alps are some of the outstanding characteristics of the region that will challenge the whole future electricity system and especially the transmission system.

2040 Needs

The map below shows potential needs for capacity increases in 2040 – beyond the 2020 grid. These increases concern:
— projects already planned in previous TYNDP to be commissioned from 2020 to 2030
— additional increases resulting from market and network analyses in 2040 scenarios.

Summary of capacity increases from 2020 to 2040



Increases already identified in TYNDP 2016[1]
Increases beyond 2030 in only one scenario
Increases beyond 2030 in at least 2 scenarios

Based on additional assessment carried out to understand the probability of occurrence of the identified needs and their concrete feasibility, the following four new transmission projects were proposed for inclusion in the TYNDP 2018, on top of TYNDP 2016 confirmed projects:
— ITcs-ITcn: 1000 MW (project HVDC internal Adriatic link).
— ITsar-ITsic-ITcs: 1000 MW (project tri-terminal HVDC link connecting main Italian islands).
— AT-SI: 500 MW (improvement of the existing cross-border network).
— CH-FR: 1500 MW (the three following projects: PST Foretaille, Lake Geneva South and upstream reinforcements in France).

More information can be found in the Regional Investment Plan 2017 of this regional group and in the European System Need Report 2017.
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CCS.pdf
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf

[1] Reference capacities of TYNDP 2016 for 2030 which for some borders had been adjusted for the TYNDP 2018 purpose. Projects commissioned in 2020 are not included as increases.

Projects

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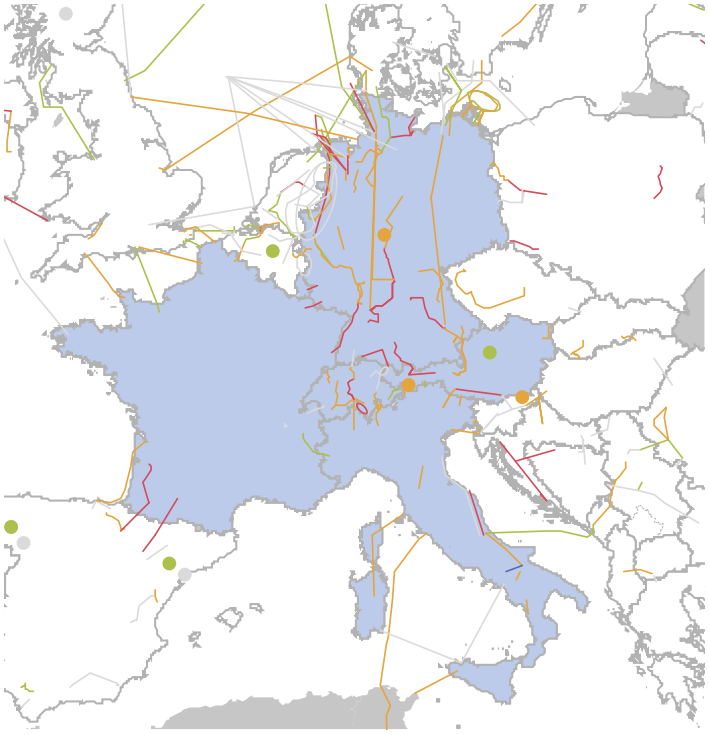


Under consideration
In permitting
Planned but not yet permitting
Under construction

Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

Up to 20 €/MWh
reduction in marginal costs of electricity generation

12 to 36 TWh
less curtailed renewable energy

3 to 24 Mton
reduction in CO_2

Up to 175 GWh
reduction in Energy Not Served

The regional group Continental South East (CSE) consists of the following countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Hungary, Italy, FYR of Macedonia, Montenegro, Romania, Serbia and Slovenia. Turkey participates in the group as an observer.

Today, the grid in the CSE region (especially in the Balkan area) is rather sparse compared to the rest of the Continent. This leads to insufficient transfer capacities; the increase of existing transfer capacities (both cross-border and internal) is a prerequisite for market integration.

The main challenges and drivers of transmission grid development in the region are:

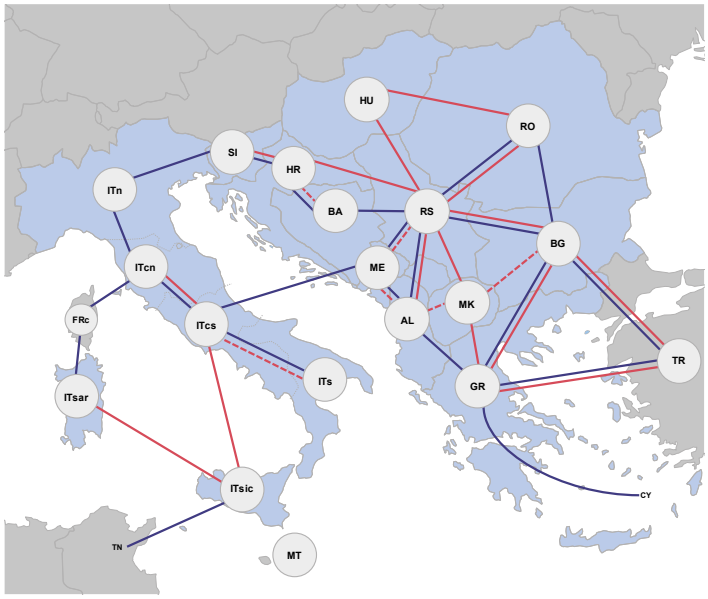
— Increase of Transfer Capacities and Market Integration facilitation.
— Massive RES integration in order to achieve EU and national targets.
— Flexibility needs, especially for the countries with the highest RES penetration in the region.
— Extensions of ENTSO-E system to the East and South.

These challenges are reflected in the planned projects and are confirmed by the system needs identified for 2040.

2040 Needs

The map below shows potential needs for additional capacity increases in 2040 – beyond the 2020 grid.

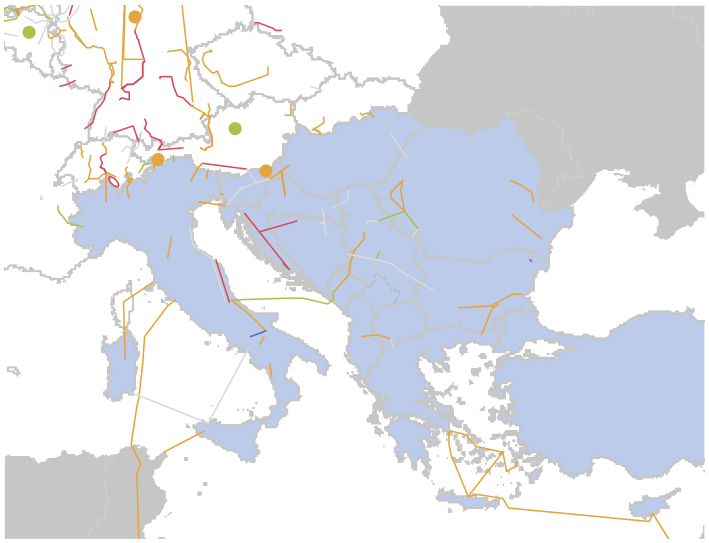
Summary of capacity increases from 2020 to 2040



— Increases already identified in TYNDP 2016[1]
— Increases beyond 2030 in only one scenario
— Increases beyond 2030 in at least 2 scenarios

Projects

The map below shows all the promoted projects that will be analysed with the CBA methodology in the TYNDP 2018.



— Under consideration
— Planned but not yet permitting
— In permitting
— Under construction

Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

Up to 30 €/MWh
reduction in marginal costs of electricity generation

2 to 41 TWh
less curtailed renewable energy

0 to 31 Mton
reduction in CO_2

Up to 480 GWh
reduction in Energy Not Served

More information can be found in the Regional Investment Plan 2017 of this regional group and in the European System Need Report 2017.

— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CSE.pdf
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf

[1] Reference capacities of TYNDP 2016 for 2030 which for some borders had been adjusted for the TYNDP 2018 purpose. Projects commissioned in 2020 are not included as increases.

The regional group Continental South West consists of the following countries: France, Portugal and Spain.

The interconnected network in the Continental South West region is a synchronous network with the rest of Central Europe.

Key messages for the evolution of the region are:

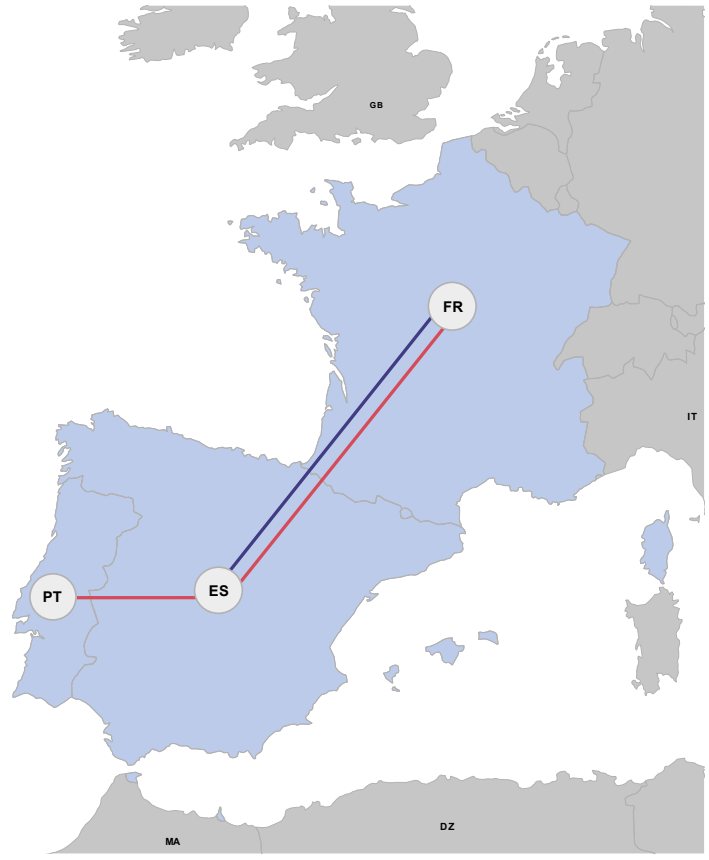
— The need for further market integration in the region is still something to resolve, and will go on to be an issue in the future.
— 10% interconnection target still won't be fulfilled by 2020 for Spain, and 2030 interconnection targets also provide signals to analyse additional connections beyond planned projects.
— Under the considered scenarios, the region will experience an important change in the generation portfolio towards a more carbon-free system, due mainly to a high potential of solar.
— The RES integration will be an issue to tackle and it will not have a unique solution.
— The regional system will experience wide area power flows and also new power flow patterns for which the existing grid was not designed, and therefore important internal investment will be needed.
— The security of supply will have a new dimension, with issues related to flexibility, inertia, etc.

The main challenges and drivers of transmission grid development in the Continental South West region are therefore market integration facilitation to get a complete functioning Iberian Electricity Market (MIBEL) and reduce the isolation of the Iberian Peninsula, change of the generation portfolio with reduction of nuclear in France and massive RES integration, as well as a higher need for flexibility. These challenges are reflected in the already planned projects and also in the identified grid development needs for 2040.

2040 Needs

The map below shows potential cross-border needs for additional capacity increases in 2040 – beyond the 2020 grid.

Summary of capacity increases from 2020 to 2040



Increases already identified in TYNDP 2016[1]
Increases beyond 2030 in only one scenario
Increases beyond 2030 in at least 2 scenarios

More information can be found in the Regional Investment Plan 2017 of this regional group and in the European System Need Report 2017.

— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_CSW.pdf
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf

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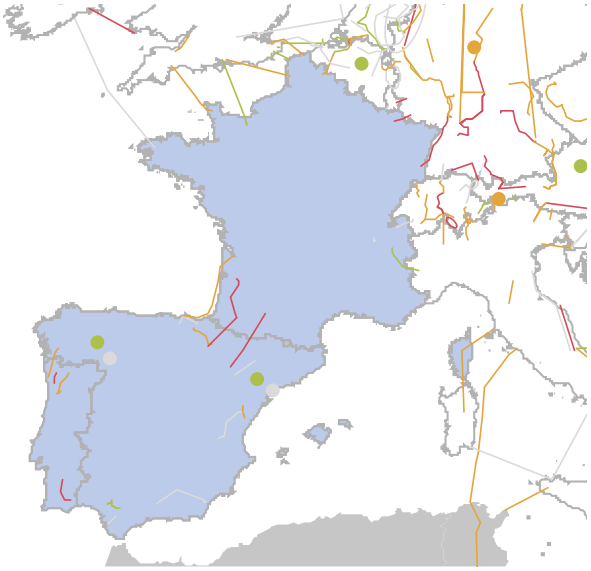


Under consideration
In permitting
Planned but not yet permitting
Under construction

Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

Up to 6 €/MWh
reduction in marginal costs of electricity generation

9 to 39 TWh
less curtailed renewable energy

-3 to +4 Mton
reduction in CO_2

Up to 5 GWh
reduction in Energy Not Served

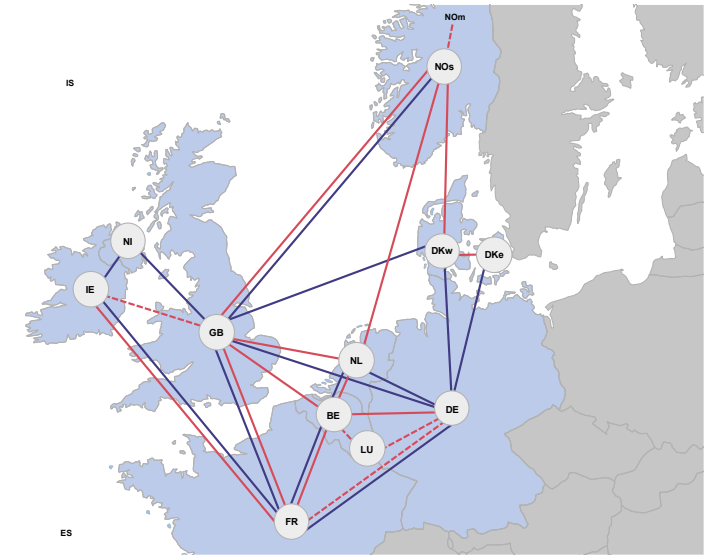
The regional group North Sea consists of the following countries: Belgium, Denmark, France, Germany, Great Britain, Republic of Ireland, Northern Ireland, Luxembourg, Netherlands and Norway.

The region comprises four synchronous areas (the island of Ireland, the British island, the Nordic system and the Continental system), which can be interconnected using HVDC technology.

2040 Needs

The map below shows potential needs for additional capacity increases in 2040 – beyond the 2020 grid.

Summary of capacity increases from 2020 to 2040



Increases already identified in TYNDP 2016[1]
Increases beyond 2030 in only one scenario
Increases beyond 2030 in at least 2 scenarios

— Further integration between Norway and Great Britain, due to price differences and the need for flexibility to optimize the RES generation (hydro/wind).
— Further integration between Norway and the synchronous Continental system, due to i) price differences, ii) the need for flexibility to optimise the RES generation (hydro/wind) and iii) provision of support to continental security of supply in low-wind periods.
— Further integration between Great Britain and the Continental system, due to i) price differences, ii) better optimisation of the RES generation and iii) challenged security of supply in high demand/low-variable RES (wind and solar) periods.
— Further integration between Germany and France, Belgium, and the Netherlands (east-west) due to i) optimisation of the production system and ii) challenged security of supply in high demand and low-variable RES (wind and solar) periods.
— Further integration between Ireland and Great Britain/France, due to i) price differences, ii) optimisation of the RES generation and iii) poor challenged security of supply in low-wind periods.

More information can be found in the Regional Investment Plan 2017 of this regional group and in the European System Need Report 2017.
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/rgip_NS.pdf
— https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP2018/energy_power_system_2040.pdf

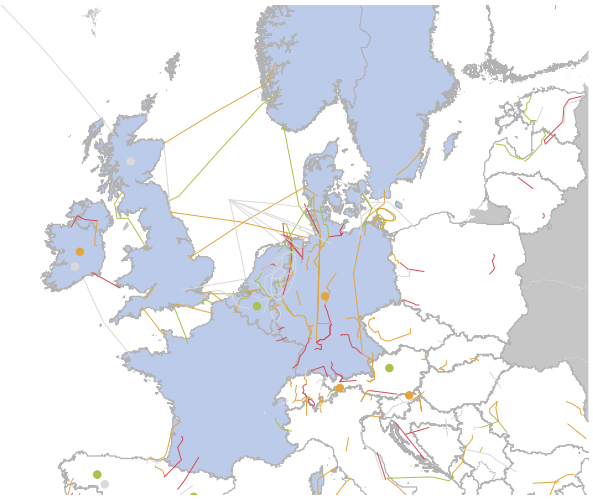
[1] Reference capacities of TYNDP 2016 for 2030 which for some borders had been adjusted for the TYNDP 2018 purpose. Projects commissioned in 2020 are not included as increases.

Key messages for the evolution of the region are:

— Continued structural changes in the generation fleet are expected, including i) a shift from thermal to RES generation, ii) a reduction of nuclear generation and iii) a shift from coal to gas.
— The development of offshore RES and related off- and onshore infrastructure contributes to these changes.
— The weather continues to have an increasing impact on the hourly adequacy situation, requiring stable mechanisms ensuring generation sharing.
— Flexibility in the system is needed to support adequacy and to avoid curtailment of RES.
— Closer connection across the region's main boundaries is needed to support adequacy and further integrate markets.

Projects

The map below shows the promoted cross-border projects that will be analysed with the CBA methodology in the TYNDP 2018.



Under consideration
In permitting
Planned but not yet permitting
Under construction

Benefits

Increasing capacities at the borders, as shown on the map to the left, would have a significant impact on the ENTSO-E electrical system and society as a whole.

Up to 16 €/MWh
reduction in marginal costs of electricity generation

19 to 97 TWh
less curtailed renewable energy

-5 to +23 Mton
reduction in CO_2

Up to 180 GWh
reduction in Energy Not Served

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Reliable Sustainable Connected