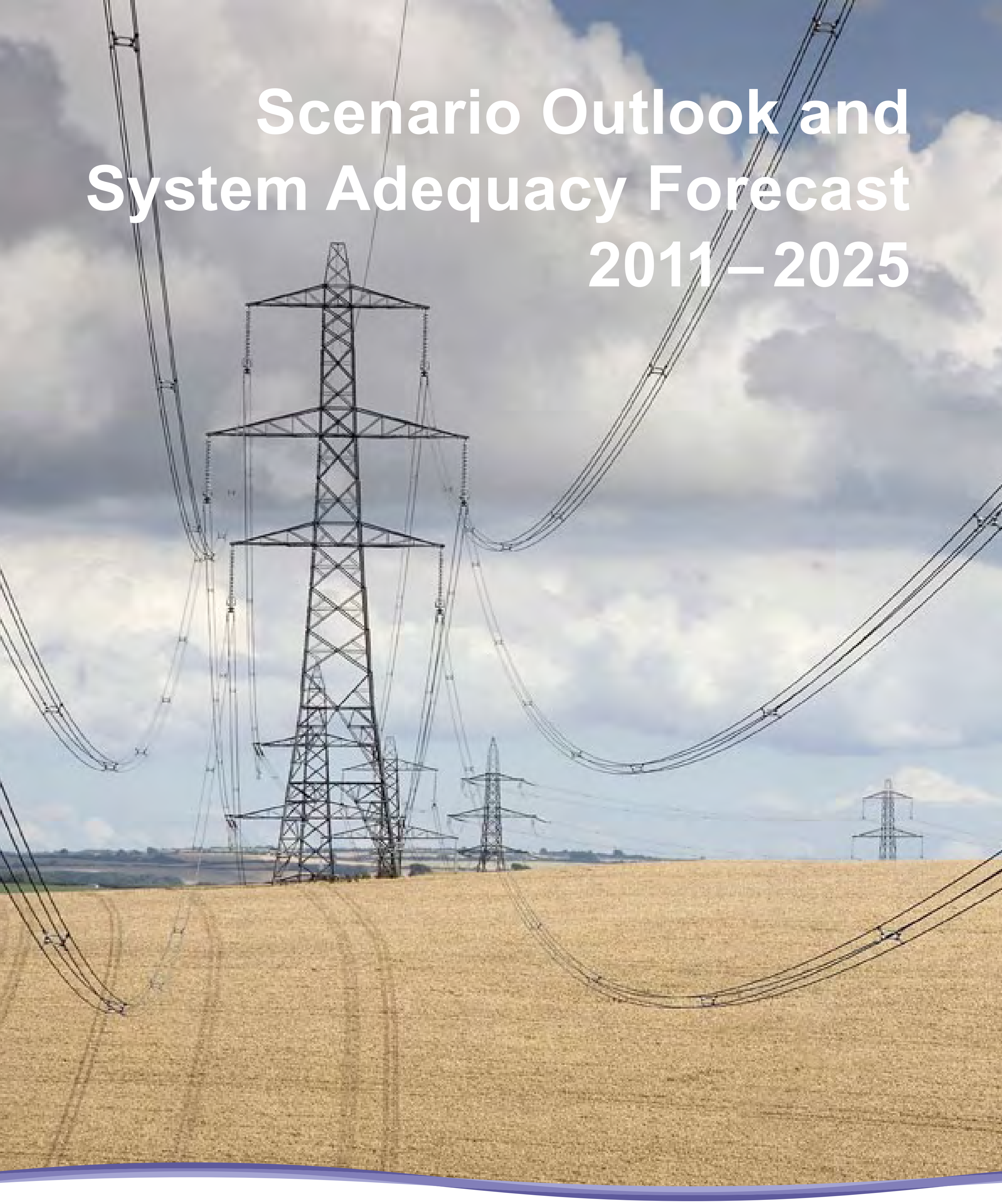
Scenario Outlook and System Adequacy Forecast 2011 – 2025



European Network of
Transmission System Operators
for Electricity

entsoe

Content

1 General Introduction

About ENTSO-E

ENTSO-E is a pan-European association with 41 members – 41 TSOs from 34 countries. It is an association which continues to co-ordinate TSO work in the wake of its six predecessor associations.[1] The different committees, working groups and task forces have transferred their work to the new ENTSO-E structure where the well established work continues, but is also enhanced through the new pan-European perspective of ENTSO-E.

The ENTSO-E association has been established in line with EU legislation (Third liberalization energy package). More precisely, the ground for establishing ENTSO-E is Regulation (EC) No 714 / 2009 which sets conditions for access to the network for cross-border exchanges of electricity.

According to the above-mentioned regulation the main purpose of ENTSO-E is:
- to pursue the co-operation of the European TSOs on both the pan-European and the regional level,
- to promote the TSOs' interests and
- to play an active and important role in the European rule-setting process in compliance with EU legislation.

The main objective of ENTSO-E is to promote the reliable operation, optimal management and sound technical evolution of the European electricity transmission system in order to ensure security of supply and to meet the needs of the Internal Energy Market.

ENTSO-E activities include:
- Coordination of the development of an economic, secure and environmentally sustainable transmission system. The emphasis is on the coordination of cross-border investments and meeting the European requirements for security and quality of supply, whereas the implementation of investments rests with the TSOs.
- Development of technical codes for the interoperability and coordination of system operation in order to maintain the reliability of the power system and to use the existing resources efficiently.
- Development of network-related market codes in order to ensure non-discriminatory access to the grid and to facilitate consistent European electricity market integration.
- Monitoring and, where applicable, enforcing the compliance of the implementation of the codes.
- Monitoring network development, promotion of R & D activities relevant to the TSO industry and promotion of public acceptability of transmission infrastructure.

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[1] **ATSOI** (Association of the Transmission System Operators of Ireland),
BALTSO (Baltic Transmission System Operators),
ETSO (European Transmission System Operators),
NORDEL (Association of TSOs from Norway, Finland, Denmark and Sweden),
UCTE (Union for the Coordination of the Transmission of Electricity),
UKTSOA (UK Transmission System Operators Association)

- Taking positions on issues that could have an impact on the development and operation of the transmission system or market facilitation.
- Enhancing communication and consultation with stakeholders and transparency of TSO operations.

The main objective of the report

The ENTSO-E Scenario Outlook & Adequacy Forecast (SO&AF) assesses the mid- and long-term time horizon. It has developed as the successor to the former UCTE System Adequacy Forecast Report and ETSO Power System Adequacy and is focused on adequacy analyses of ENTSO-E interconnected transmission systems through an overview of generation adequacy.

The SO&AF report will be used as a basis for the next issue of the Ten-Year Network Development Plan[1)] (TYNDP) and also for Regional Investment Plans[2)] (RgIP). The objectives of the TYNDP are to ensure transparency regarding investments in the electricity transmission network and to support decision-making processes at regional and European level. The TYNDP is the most comprehensive and up-to-date European-wide reference for the development of the transmission network. It also deals with issues regarding the environmental goals of the European Union (EU) in relation to renewable electricity targets.

Therefore the structure and content of the SO&AF report have changed compared with the previous System Adequacy Forecast Report for 2010 – 2025 (SAF 2010) published in January 2010 on the ENTSO-E webpage.[3)] Some chapters of SO&AF have been directly absorbed by the TYNDP and RgIPs. A third scenario reflecting the European energy policy objectives has been introduced, thus changing the name of the report.

Previous ENTSO-E System Adequacy Forecast 2010 – 2025 Report

Data quality has been improved compared with the last System Adequacy Forecast Report for 2010 – 2025 (SAF 2010), which was the very first adequacy report published by ENTSO-E and also the very first report for some ENTSO-E member countries.

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1) https://www.entsoe.eu/index.php?id=311

2) RgIPs are internal documents of each regional group working under the System Development Committee and are also one of the basic documents for TYNDP preparation

3) https://www.entsoe.eu/index.php?id=228

2.1 Objectives, Background and Scenarios

The Scenario Outlook and Adequacy Forecast (SO&AF) 2011 – 2025 report is an ENTSO-E annual publication (the successor to the System Adequacy Forecast), with three objectives:

- To detail at an early stage the scenarios (generation and load evolution) that will form the foundation of the market and network analyses in the ENTSO-E Ten-Year Network Development Plan (TYNDP), to be released in June 2012.
- To assess the generation adequacy of the countries served by ENTSO-E's TSO members for the period 2011 – 2025 by providing an overview of the generation adequacy analysis for ENTSO-E as a whole and for each of the six regional groups defined by the ENTSO-E System Development Committee.
- To describe the generation adequacy assessment for each individual country based on national comments received from member TSOs.

The first two objectives are responses to the requirements that Regulation (EC) 714 / 1999 has set for the TYNDP, as described in Art. 8.10 of the Regulation: "The Community-wide network development plan shall include the modelling of the integrated network, scenario development, a European generation adequacy outlook and an assessment of the resilience of the system". This strong link to the TYNDP has led to the new structure and name of the SO&AF report.

The adequacy analysis was carried out over three contrasting scenarios covering different evolutions for generating capacity and load. It is based on the comparison between the reliably available generation and load at two given reference points in time in the year (the third Wednesday in January at 7 p.m. and the third Wednesday in July at 11 a.m.) over the monitored time period under standard conditions.

Unlike the previous System Adequacy Reports put together by ENTSO-E, the SO&AF, on top of the usual bottom-up Scenarios A and B (conservative and best estimate respectively), presents and analyses a top-down scenario (EU 2020) that is based, to a large extent, on the National Renewable Energy Action Plans (NREAPs). These were delivered by most of the European Union (EU) member states during the summer of 2010 and were targeted at the fulfilment of the EU's climate and energy policy targets.

These targets are focused on the reduction of energy consumption by 20 % of the projected levels for 2020, increasing the use of renewable energy sources (RES) to 20 % of the total energy consumption and cutting greenhouse gases by at least 20 % of the levels from 1990.

2.2 Main Results

If the Scenario EU 2020 is considered as the reference for the translation of the aforementioned policy targets into the electricity sector, this report confirms that generation adequacy was maintained for the monitored period throughout all of the ENTSO-E regions. The penetration of RES into the electricity mix seems to be consistent with most experts' estimations, as is the reduction of CO_2 emissions. Energy efficiency, on the other hand, is more difficult to assess when only looking at the electricity sector. However, the EU 2020 results can be better appreciated when contrasted with Scenario B of the report, which demonstrates the effectiveness of the anticipated national policies.

During 2011, ENTSO-E will build on the results of the SO&AF report in order to prepare six Regional Investment Plans and ultimately the TYNDP in 2012, illustrating the necessary transmission infrastructure which will enable the fulfilment of the energy and climate policy targets. At the same time, the SO&AF 2011 – 2025 is timely with the forthcoming debate on the Energy Infrastructure Package as it provides hard data and experts' estimates for the outlook of the European electricity industry over the next 15 years.

2.3 Scenario EU 2020, Built to Meet 20-20-20 Targets

The Scenario EU 2020 is a special top-down scenario designed in accordance with the EU's climate and energy policies and is based on national targets set out in the NREAPs. Therefore, the main sources of information for this scenario are national policies, and the scenario is built on a national basis and then aggregated at the sub-regional or regional level.

Load, when considered at the ENTSO-E level, increases continuously in the Scenario EU 2020 at both reference points (Tables 2.1 and 2.2). This increase is expected to affect most countries, with the exceptions of Germany (during the entire forecast period, load in the German NREAP is expected to decrease), Poland and Luxembourg (where a decrease in load is reported after 2015). The highest growth rates are expected in Cyprus and the Former Yugoslav Republic of Macedonia (FYROM).

The energy consumption at the ENTSO-E level in this scenario is growing at a fairly constant and smooth rate (Figure 2.1), and exceeds 3500 TWh before 2020.

The load and consumption forecasts in this scenario were based on the NREAPs and do not always mirror the expectations of TSOs.

[GW]	2011	2015	2016	2020
January	523	540	545	563
July	423	441	446	466

Table 2.1:
ENTSO-E load for Scenario EU 2020

[%]	2011 to 2015	2015 to 2020
January	0.8	0.8
July	1	1.1

Table 2.2:
ENTSO-E average load increase rate for Scenario EU 2020

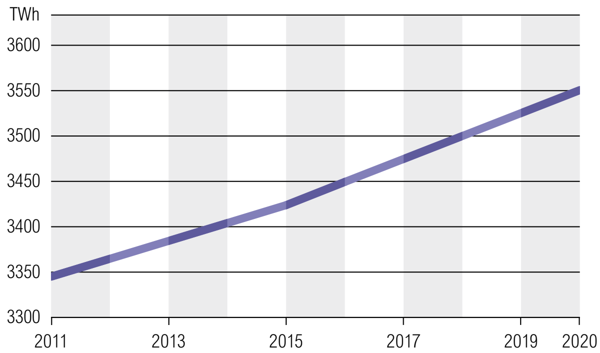


Figure 2.1:
ENTSO-E consumption forecast for the Scenario EU 2020

The total Net Generating Capacity (NGC) for the ENTSO-E as a whole is also increasing. The most rapidly developing energy sources are RES (including renewable hydro power plants). The NGC of nuclear and non-renewable hydro power plants (pure pumped storage power plants) increases slightly over the whole forecasted period as well, whereas the NGC of fossil fuel power plants is expected to decrease (Figure 2.2).

Within the total RES capacity mix, wind, solar and biomass power plants fill an increasing share of the overall capacity, while the share of renewable hydro power plants is expected to decrease. On-shore wind farms play the major role in the wind power plants category; in each year being monitored, their share reaches about least 80 %. Off-shore wind generation is foreseen to become more and more significant.

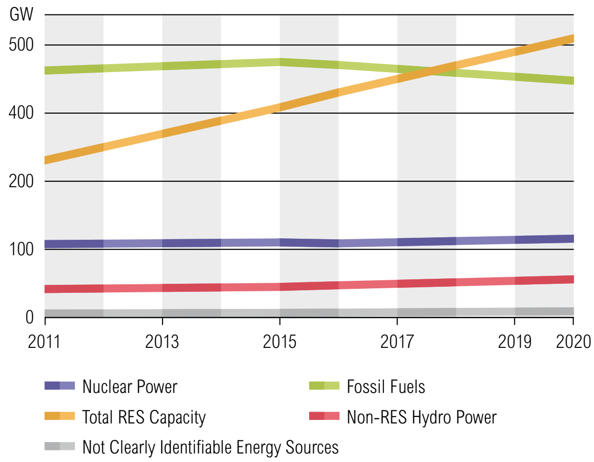


Figure 2.2:
ENTSO-E total NGC breakdown in the Scenario EU 2020, January 7 p.m.

The NGC of the fossil fuels category is expected to grow continuously up to 2015, but starts to decrease after that year. This seems to be a logical consequence of the increasing share of RES in the Scenario EU 2020. However, the effects of the Large Combustion Plants Directive[1] (LCP Directive), which forces individual countries to shut down their oldest fossil fuel power plants, should also be considered. Within the fossil fuel category, gas power plants have the highest share of the capacity (from 38 % in 2011 to 45 % in 2020).

On the other hand, the share belonging to hard coal power plants should decrease from 27 % to 24 %. At the ENTSO-E level, the capacity share of fossil fuels amounts to 44 % of the total NGC in 2015 and 37 % in 2020.

The **Reliable Available Capacity (RAC)** in January and July is expected to increase during the entire forecasted period. The RAC in January is higher than in July because the unavailable capacity in July is much higher than in January, due mostly to maintenance schedules. The final average share of RAC in the total ENTSO-E NGC is expected to be about 65 % at the reference point in January (and about 60 % in July). Among the countries, Austria, Iceland, Luxembourg, the FYROM and Serbia have the highest share of RAC in NGC in 2015 (more than 80 %).

[1] Directive 2001 / 80 / EC of the European parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants

The **Remaining Capacity (RC = RAC - load)** increases continuously over the period between 2011 and 2020; generation adequacy is ensured within the whole ENTSO-E system in most situations and for each reference point of the forecast period (not considering capacity limitations between countries and / or regions; see Figure 2.3).

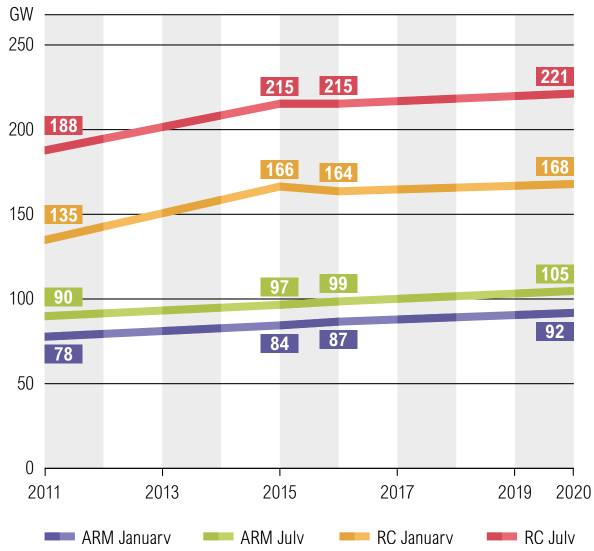


Figure 2.3:
ENTSO-E RC and ARM comparison, from the Scenario EU 2020

2.4 Best Estimate Scenario B by the TSOs and Conservative Scenario A

Load in both Scenario B and Scenario A increases continuously at both reference points in January and July (Tables 2.3 and 2.4).

[GW]	2011	2015	2016	2020	2025
January	531	557	565	600	637
July	425	450	457	489	523

Table 2.3:
ENTSO-E load forecast for Scenario B

[%]	2011 to 2015	2015 to 2020	2020 to 2025
January	1.2	1.5	1.2
July	1.5	1.7	1.4

Table 2.4:
ENTSO-E average load increase rate for Scenario B

The highest load increase between 2011 and 2015 is expected in Cyprus (9.1% a year), Slovenia and FYROM (between 3% and 4% a year).

The average annual energy consumption growth rate between 2011 and 2020 is expected to be about 1.3% (Figure 2.4), almost twice as high as in the Scenario EU 2020. After 2020, a slower increase in the rate of consumption (by only about 0.8% a year) is foreseen. Energy consumption in best estimate Scenario B is predicted to rise to 3519 TWh by 2016, instead of 3450 TWh in the Scenario EU 2020. For 2011, the annual energy consumption in the Scenario EU 2020 (3345 TWh) is higher than in Scenario B (3310 TWh). By 2016, this situation is reversed due to the growth rate in Scenario B (the Scenario EU 2020: 3450 TWh; Scenario B: 3519 TWh).

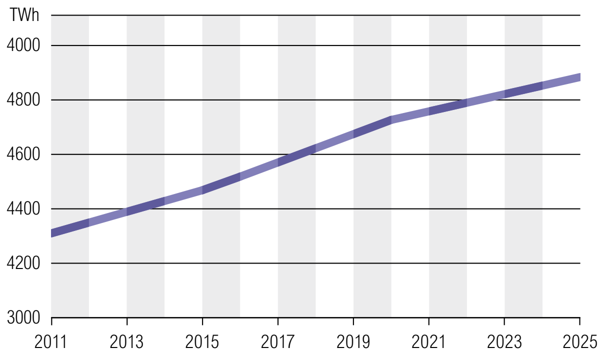


Figure 2.4:
ENTSO-E consumption forecast for Scenario B

TSOs have mainly reported the influence of the gradual recovery of the economy after the financial crisis as the main reason for load and consumption growth. In addition, energy efficiency measures play an important role in load forecasting in many countries.

Regarding NGC, the most rapidly developing energy sources are renewable ones (Figure 2.5). In Scenario B, their capacity share almost doubles in the next 15 years (278 GW in 2011 and 489 GW in 2025). Every other type of capacity except fossil fuels increases during the entire forecast period as well, but at a lower rate.

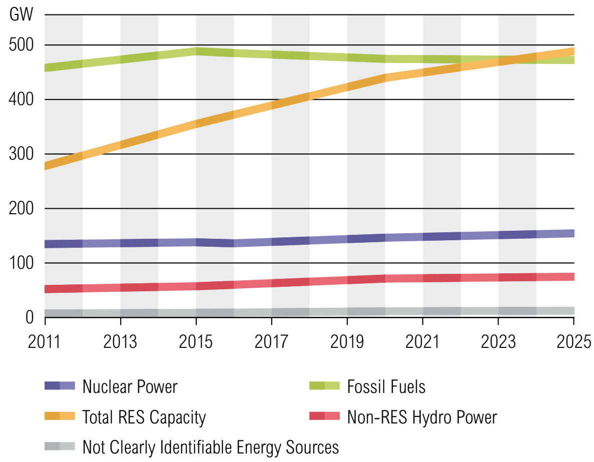


Figure 2.5:
ENTSO-E total NGC breakdown, Scenario B, January 7 p.m.

In best estimate Scenario B, wind power plants and other RES hydro power plants have the largest share of the total RES installed capacity in 2015 and 2020. Germany, Spain, Great Britain, Norway, Sweden, Latvia and Portugal can be named here as countries with the highest share of RES in their generating capacity mix. Such strong RES development is mainly influenced by the legislation within each country, which encourages the development of RES power plants (excluding or including hydro power plants) by the implementation of policies such as advantageous feed-in tariffs or special conditions for access and connection to the grid or other additional subsidies.

The NGC of the fossil fuels category in Scenario B is expected to increase only until 2015 at a rate of about 7 %. The maximum value is then expected to reach 489 GW (47 % of the total NGC). After 2015, fossil fuel capacity starts to decline, reaching 475 GW in 2020 (42 % of the total NGC) and then to 472 GW in 2025 (39 % of the total NGC).

Gas fired plants have the largest share within the fossil fuels category (as in the Scenario EU 2020). This share increases from 37 % in 2011 to 49 % in 2025. Other fossil fuel categories show either more or less visible decreases, or remain fairly stable.

By definition, the conservative Scenario A includes more cautious expectations for the NGC of fossil fuels. From 2011 to 2015, a negligible decrease of about 0.4 % is foreseen, whereas after 2015 a notable decrease begins (from 454 GW in 2015 to 380 GW in 2025 at a rate of 16 %).

The expectation of such a development within the fossil fuels category is much more pessimistic than in the previous SAF 2010. In SAF 2010 (also in reference to Scenario B, January), this category showed a clear increase over the course of the entire reported period. The reason for a decrease after 2015 in SO & AF 2011 could be a more precise assessment of the application of the LCP Directive (even in SAF 2010, its effect seemed to be only temporary) or other (national) political decisions regarding the decommissioning of fossil fuels power plants, lifetime extension or retrofitting.

In this conservative Scenario A, the installed capacity of gas power plants is expected to increase until 2016 and then to start to decrease due to the lack of firm long-term projects.

Reliable Available Capacity in the best estimate Scenario B increases continuously at both reference points. Therefore, the Remaining Capacity (RC) is higher than the Adequacy Reference Margin (ARM) during the whole forecast period, and generation adequacy is met in most of the situations within the whole ENTSO-E system. The adequacy level (measured by the difference between the RC and the ARM) is almost at the same level in 2020 compared to 2011 at the reference point in January. However, in 2025, it is lower compared to the same point in 2011. In order to reach the minimum of today's level of adequacy, an amount of about 21 GW in RAC will be needed, which means approximately 32 GW of the NGC with the equivalent capacity mix in 2025.

The average share of RAC in the total ENTSO-E NGC is expected to be about 65 % in January (60 % in July). Unavailable capacity occupies an increasingly larger share of NGC as a consequence of the share of RES in generating capacity increasing. Similarly, as in the Scenario EU 2020, Austria, Iceland, Luxembourg, the FYROM and Serbia have the highest share of RAC in their NGC in both 2015 and 2020 (more than 80 %).

In contrast, RAC starts to decrease after 2015 in conservative Scenario A. Generation adequacy is expected to be met until 2016 in January. After these years, additional generation units seem to be necessary in Europe (not considering the possible capacity limitations between countries and / or regions). At the reference point in January, about 73 GW of the RAC in 2020 is necessary to reach a minimum of today's level of adequacy. In 2025, this value is 159 GW. This represents, however, about 112 GW of the NGC in 2020 and 244 GW in 2025 when considering the equivalent capacity mix at these times. The situation is illustrated in Figure 2.6.

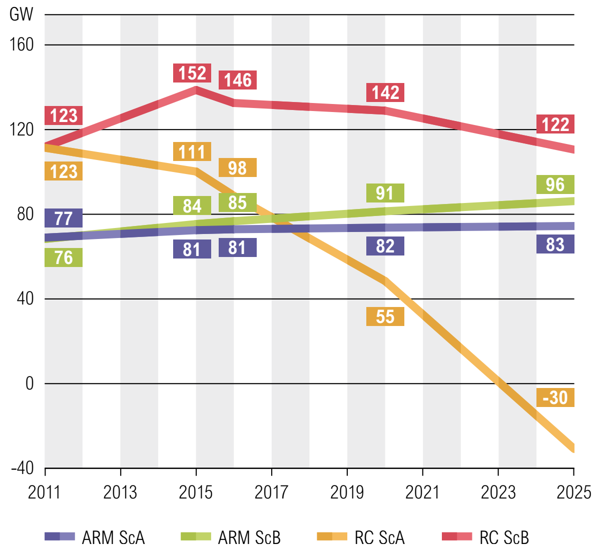


Figure 2.6:
ENTSO-E RC and ARM comparison, Scenarios A & B, January 7 p.m.

2.5 Comparison with EU 2020 Indicators

The EU's climate and energy policy sets the following ambitious targets for 2020:

- Cutting energy consumption by 20 % of the projected levels for 2020 by improving energy efficiency,
- increasing the use of renewable energy sources (wind, solar, biomass, etc.) to 20 % of the total energy consumption and
- cutting greenhouse gases by at least 20 % of the levels from 1990.

Three indicators for 2020 were calculated using the data collected for this SO&AF report in order to assess how the scenarios match the 20-20-20 objectives. These indicators reflect the impact of efficiency measures on electricity consumption, the RES share and CO_2 emissions.

Indicator reflecting the impact of efficiency measures on electricity consumption: This indicator is simply calculated as (x - y) / y where x is the electricity consumption as forecast in a particular scenario (the Scenario EU 2020 or Scenario B) in 2020 and y is the electricity consumption as forecast in a 'business as usual' scenario for 2020 that is based on the reference scenario of the NREAP for EU countries.

The impact of efficiency measures on electricity consumption at the EU level is estimated at -9.6 % for the Scenario EU 2020 and -4.8 % for Scenario B. The assessment at the ENTSO-E level without Ukraine West gives values of -8.8 % for the Scenario EU 2020 and -4.3 % for Scenario B.

RES indicator: The European commission has indicated that the share of electricity from RES is expected to be over 30 % for the EU to reach its overall renewable energy target of 20 % of the total energy consumption by 2020.

The proposed RES indicator is simply the ratio of the power generated by RES in a particular scenario (the Scenario EU 2020 or Scenario B) in 2020 to the electricity consumption of that particular scenario in 2020.

This assessment leads to the conclusion that in 2020, RES production may reach generation levels of approximately 1351 TWh for the ENTSO-E (without Ukraine West (UA-W)) and 1159 TWh for the EU (without Malta) in Scenario EU 2020 and 1218 TWh for the ENTSO-E (without UA-W) and 1026 TWh for the EU (without Malta) in Scenario B.

This very rough estimation shows that the share of the overall electricity consumption of the ENTSO-E and the EU (without Malta) generated by RES is foreseen to be 38 % and 36 % respectively in 2020 in the Scenario EU 2020 and 33 % and 30 % respectively in 2020 in Scenario B. This leads to the conclusion that the Scenario EU 2020 is compliant with the objective of increasing the use of RES (wind, solar, biomass etc.) to reach 20 % of the total energy consumption.

CO_2 emissions indicator: The proposed CO_2 indicator is a simplified approach that assumes that a representative average CO_2 emission per MWh generated can be relied upon. The amount of CO_2 emissions from electricity production is derived by multiplying the electricity consumption not compensated by RES or nuclear production by a representative average CO_2 content per MWh.

This indicator is a very rough estimation, as it is based on standard emission factors that are valid for the current generation technologies. Therefore, a prudent interpretation is advisable. For that reason, a comparison has been made with the emissions calculated for 2009 using these standard emission factors. In 2009, 49 % of the consumption not covered by RES or nuclear units was produced using coal or lignite. Furthermore, a range of possible reductions have been estimated using two representative figures for the average CO_2 content per MWh, namely the average CO_2 content per MWh as valid in 2009 and the CO_2 content per MWh, assuming that consumption not met by RES or nuclear units is covered by gas units.

Combining the aforementioned parameters, the reduction in CO_2 emissions in electricity production has been estimated as follows, compared to the emissions calculated for 2009:

For the Scenario EU 2020
- From 52 % to 19 % for the ENTSO-E level (without UA-W)
- From 57 % to 26 % for the EU (without Malta)

For Scenario B
- From 41 % to 0 % for the ENTSO-E level (without UA-W)
- From 45 % to 7 % for the EU (without Malta)

2.6 Conclusions

The ENTSO-E SO&AF 2011 – 2025, in addition to the usual bottom-up scenarios (conservative A and best estimate B) that have been employed in its predecessor, the ENTSO-E publication SAF, presents for the first time a top-down scenario (EU 2020) built on the basis of the NREAPs made available by EU member states, as well as on the basis of official publications and TSO experts' estimations for the ENTSO-E non-EU countries. These three scenarios will form the foundation for market and network studies that will lead to the identification of the necessary transmission infrastructure in the next TYNDP in 2012.

The second contribution of the SO&AF relates to the elaboration of the generation adequacy outlook for the next five to 15 years that will also form part of the next TYNDP. According to this outlook, for the Scenario EU 2020, generation adequacy will be maintained over the course of the entire reported period. However, 244 GW of additional NGC would be required by 2025, according to Scenario A (112 GW by 2020). For Scenario B, an additional 32 GW of NGC would be needed by 2025 in order to reach today's level of adequacy.

Finally, the SO&AF proposes a set of three indicators (an indicator reflecting the impact of efficiency measures on electricity consumption, an RES share indicator and a CO_2 emissions indicator) in order to appreciate how these scenarios relate to the overall EU 20-20-20 targets. It has been concluded that the Scenario EU 2020 is indeed consistent with most experts' estimations concerning the penetration of RES into the electricity generation mix, while it significantly out-performs Scenario B with respect to CO_2 emissions and energy efficiency targets. However, these indicators have been constructed based on rough assumptions and these numbers should be interpreted accordingly.

The SO&AF is a significant precursor of the next ENTSO-E TYNDP, which will be publicised in 2012, and as such fulfils two of the TYNDP's major requirements: the elaboration of scenarios and the generation adequacy outlook. It is also timely, as European policy is focusing the debate on assisting the implementation of a new transmissions infrastructure. The ENTSO-E continues to contribute to this debate, as do its member TSOs that plan, build and operate the transmissions network.

3 Introduction

3.1 Aims & Perimeters

As SO&AF 2011 – 2025 is to be the basis of the TYNDP report and RgIPs, its structure and content are subjected to the demands of the TYNDP and the ENTSO-E regional groups (RG) which are fully responsible for the preparation of these plans. As a consequence the SO&AF report assesses the adequacy of the ENTSO-E transmission system for the period 2011 to 2025 by providing an overview of:

- Generation Adequacy Analysis for the whole of ENTSO-E (power and energy approach),
- Generation Adequacy Analysis for each regional group (power and energy approach) and
- Generation Adequacy Assessment for each individual country / control area based on national comments received from TSOs / national data correspondents (power approach only)

The power approach is based on the assessment of indicators such as Adequacy Reference Margin, Remaining Capacity or Reliable Available Capacity (as per the previous SAF 2010). The energy approach is based on market analyses performed on the basis of a Pan-European market database created within ENTSO-E.

In addition to the adequacy analyses this report contains an assessment of EU policy regarding political goals called the "3 × 20 objective" (it includes cutting greenhouse gases by at least 20 % of 1990 levels, increasing use of renewable energy sources (wind, solar, biomass, etc.) to 20 % of total energy consumption (currently ± 8.5 %), increasing energy efficiency by 20 %.). This assessment of 3 × 20 indicators has been done on both the ENTSO-E and regional level.

The division of the ENTSO-E system into regions for all system development purposes is as follows:

- **NORTH SEA (NS)**:
  Belgium (BE), Denmark (DK), France (FR), Germany (DE), Great Britain (GB), Luxembourg (LU), the Netherlands (NL), Northern Ireland (NI), Norway (NO), the Republic of Ireland (IE)
- **BALTIC SEA (BS)**:
  Denmark (DK), Estonia (EE), Finland (FI), Germany (DE), Latvia (LV), Lithuania (LT), Norway (NO), Poland (PL), Sweden (SE)
- **CONTINENTAL SOUTH WEST (CSW)**:
  France (FR), Portugal (PT) and Spain (ES)
- **CONTINENTAL SOUTH EAST (CSE)**:
  Bosnia-Herzegovina (BA), Bulgaria (BG), Croatia (HR), Former Yugoslav Republic of Macedonia (MK), Greece (GR), Hungary (HU), Italy (IT), Montenegro (ME), Republic of Serbia (RS), Romania (RO), Slovenia (SI)
- **CONTINENTAL CENTRAL SOUTH (CCS)**:
  Austria (AT), France (FR), Germany (DE), Italy (IT), Slovenia (SI), Switzerland (CH)
- **CONTINENTAL CENTRAL EAST (CCE)**:
  Austria (AT), Croatia (HR), Czech Republic (CZ), Germany (DE), Hungary (HU), Poland (PL), Romania (RO), Slovak Republic (SK), Slovenia (SI)

In addition to the regions and countries listed above, analyses are reported on other countries / control areas:

- **ISOLATED SYSTEMS**:
  Cyprus (CY), Iceland (IS)
- **ADDITIONAL CONTRIBUTING CONTROL AREAS**:
  Ukraine West (UA-W)

All the above-mentioned regions are depicted in Figure 3.1.

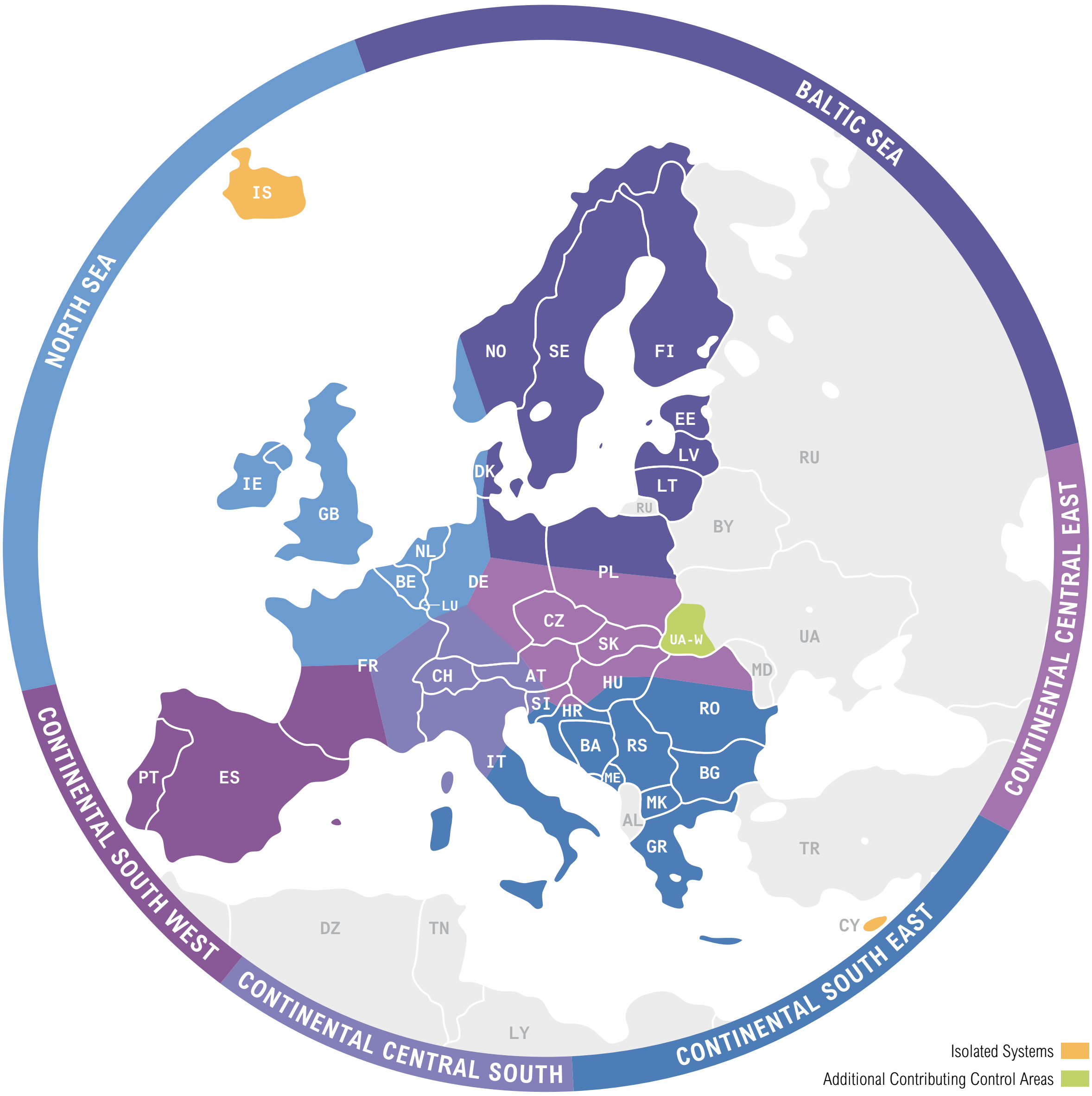


Figure 3.1:
Map displaying ENTSO-E regions in frame of system development

3.2 Other Important Facts / Information

All input data for this report have been provided by the TSOs (and their respective correspondent), on a national basis, for the years 2011, 2015, 2016, 2020 and 2025. Any other years depicted in graphs or shown in figures are calculated by linear extrapolation and are only estimations. The data collection process finished at the end of September 2010; however, after that date substantial corrections to the database were made until the beginning of December 2010.

Furthermore, data provided for the period after the year 2020 should be considered as having quite a high level of uncertainty. It is caused by data being unavailable to the respective TSO along with the fact that a lot of different national policies and important documents do not cover such long-term periods, etc. Therefore the data used and shown after 2020 should be considered in the light of this fact. When available, the data are supplemented by national comments.

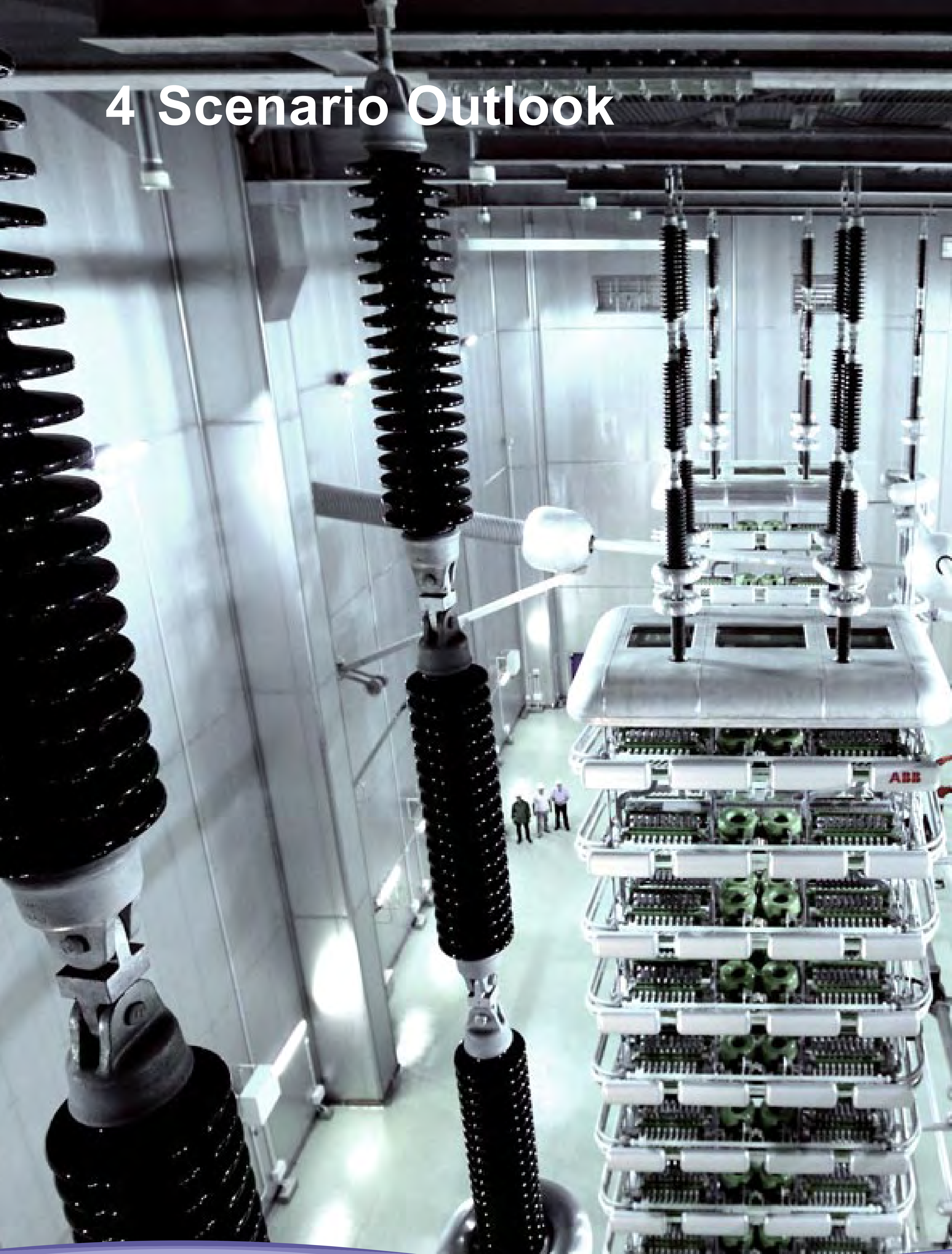
Data have been provided for the three scenarios for generating capacity evolution (Conservative Scenario or Scenario A, Best Estimate Scenario or Scenario B and Scenario EU 2020), and for two reference points: the third Wednesday in January at 7 p.m. (winter) and the third Wednesday in July at 11 a.m. (summer).

Unless otherwise stated, in all calculations and assessment for the whole ENTSO-E system also data for contributing control area of Ukraine West were considered.

If no data were provided for a particular country, substitute data were used for calculations and assessment.

At the request of WG TYNDP the structure and content of SO&AF 2011 have been changed. Bearing this fact in mind, calculations and comparisons used in the report to characterize the reliability of a power system are calculated mainly for the third Wednesday in January at 7 p.m. for Scenario B and Scenario EU 2020, unless otherwise indicated.

4 Scenario Outlook



4.1 Basic definitions

Reference Points

Reference points are the specific dates and times for which power data are collected. These points are characteristic enough of the whole studied period to limit the data to be collected to those at the reference points.

Conservative Scenario or Scenario A

This scenario takes into account the commissioning of new power plants considered as certain to be built and the shutdown of power plants expected during the study period.

It shows the evolution of the potential imbalances if no new investment decisions are taken in the future and allows the identification of the investments necessary to maintain the expected security of supply over the forecast period.

Best Estimate Scenario or Scenario B

This scenario takes into account the generation capacity evolution described in Scenario A as well as future power plants whose commissioning can be considered as reasonably credible according to the information available to the TSOs.

This gives an estimation of potential future developments, provided that market signals give adequate incentives for investments, and may include extensions to operating lifetimes of existing generation plants.

Scenario EU 2020

This top-down scenario derives from the EU policies on climate change and is based on national targets set in the National Renewable Energy Action Plans.

The main sources of information are the national policies. Therefore, the forecast scenarios are built on a national basis (and often discussed on a national basis with the governmental or administrative bodies) and then aggregated at the sub-regional or regional level. Such an approach is the easiest way for national stakeholders to agree on the national forecast scenario.

Load

Load on a power system is the net consumption (excluding consumption of power plants' auxiliaries, but including network losses) corresponding to the hourly average active power absorbed by all installations connected to the transmission or distribution grid, excluding the pumps of the pumped-storage stations.

Net Generating Capacity (NGC)

The NGC of a power station is the maximum electrical net active power it can produce continuously throughout a long period of operation in normal conditions.

The NGC of a country is the sum of the individual NGC of all power stations connected to either the transmission grid or to the distribution grid.

Unavailable Capacity

This is the part of the NGC that is not reliably available to power plant operators owing to the limitations of the output power of power plants. It consists of Non-Usable Capacity (resulting from the variability of the primary sources like wind, hydro or solar sources), Maintenance and Overhauls, Outages and System Services Reserve.

Reliably Available Capacity (RAC)

RAC on a power system is the difference between NGC and Unavailable Capacity. RAC is that part of the NGC actually available to cover the load at a reference point.

4.2 ENTSO-E Scenario Outlook

4.2.1 Load Forecast

Scenario EU 2020

Load in this scenario is increasing during the whole forecast period, both for January (at 7 p.m.) and for July (at 11 a.m.). Figure 4.1 and Table 4.1 show the trend.

The difference in expected load between both reference points (January and July) is almost constant and is approximately 99 GW on average in each monitored year. The annual increase rates are shown in Table 4.2.

In Scenario EU 2020 the highest annual increase of load up to 2015 is expected in Cyprus (about 4 %), FYROM (3 %), Slovenia (3 %), Spain (2.6 %), and Croatia (2.5 %). In the period between 2015 and 2020 Cyprus (almost 3 %), Spain (2.7 %), Romania (2.6 %), Italy, Lithuania, Republic of Ireland and Latvia (all 2.4 %) expect the highest load rises.

The only country with an expected decrease of load in both forecast periods is Germany (0.3 % fall between 2011 and 2015 and 1.1 % fall between 2015 and 2020, owing to the national policy reflected in the German NREAP). Decreases of about 2.8 % and 0.5 % are also expected between 2011 and 2015 in Luxembourg and Poland respectively (Polish Scenario EU 2020 assumes significant increase in additional energy efficiency which will allow for achieving the national target of RES generation share in the final energy consumption). The situation is illustrated on the next page (Figure 4.2 and Figure 4.3).

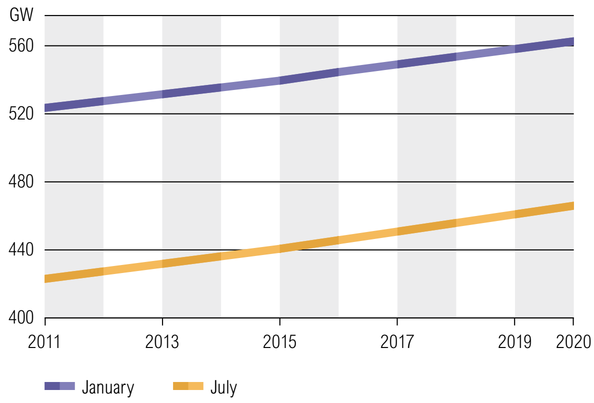


Figure 4.1:
ENTSO-E load forecast for Scenario EU 2020

[GW]	2011	2015	2016	2020
January	523	540	545	563
July	423	441	446	466

Table 4.1:
ENTSO-E load for Scenario EU 2020

[%]	2011 to 2015	2015 to 2020
January	0.8	0.8
July	1	1.1

Table 4.2:
ENTSO-E average annual load increase rate for Scenario EU 2020

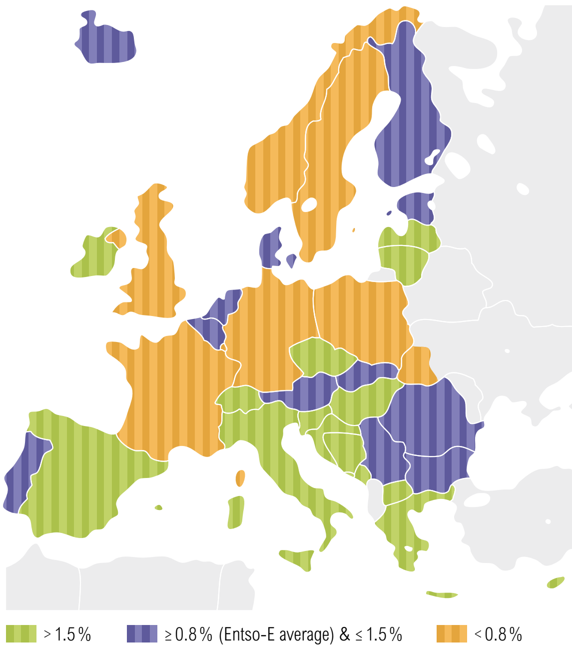


Figure 4.2:
ENTSO-E average annual load growth between 2011 and 2015, Scenario EU 2020, January 7 p.m.

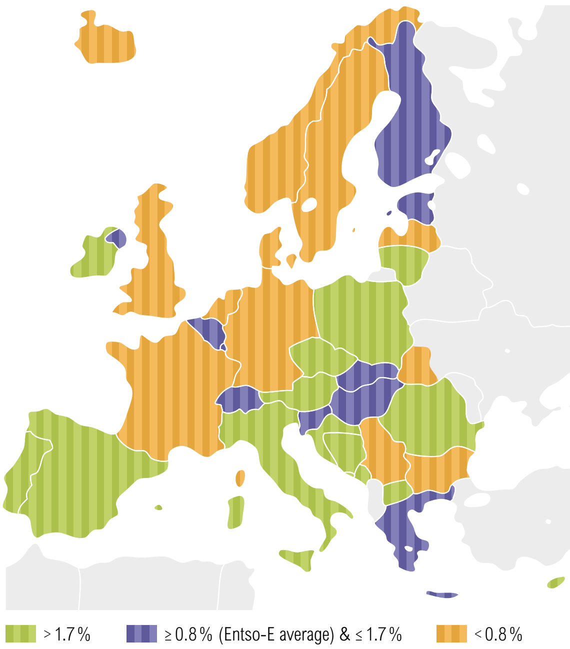


Figure 4.3:
ENTSO-E average annual load growth between 2015 and 2020, Scenario EU 2020, January 7 p.m.

Load in Scenario EU 2020 is based primarily on the "Additional energy efficiency scenario" of National Renewable Energy Action Plans.[1)2)] It takes into account the national plans for complete mix of energy consumed in national economy in order to meet national target value according to the goals of renewable energy sources utilization in total energy consumption defined in the third energy legislation package of the European Union. For some countries the values mentioned in the NREAP are adapted to take into account the reduced synchronous perimeter reported to ENTSO-E.

NREAPs however are not available for each ENTSO-E country as not every ENTSO-E country is an EU member. For ENTSO-E countries not belonging to the EU and without an NREAP the latest official documentation describing the long-term vision of the country or the TSO's best estimate was used.

1) According to the article 4 of the Directive 2009/28/EC member states are supposed to submit national renewable energy action plans by 30 June 2010. These plans have to provide detailed roadmaps of how each member state expects to reach its legally binding 2020 target for the share of renewable energy in their final energy consumption.

2) NREAP for Hungary was still missing till the mid of December 2010

Comparison of load between Scenario EU 2020 and Scenario B is shown in Figure 4.4 (reference point January, 7 p.m.). The differences could be caused by the fact that Scenario EU 2020 is based on NREAPs and therefore tends to reflect the political targets of each respective national government regarding the fulfilment of European goals for climate protection whereas Scenario B is the best estimation of each respective TSO within ENTSO-E and reflects rather the view and expectations of TSOs. These two approaches do not have to be necessarily coherent and lead to the same results. Scenario B does not eventually take into account future additional measures envisaged by the national authorities to comply with the 2020 objectives; therefore the scenarios lead to the different results shown in Figure 4.4.

The load in Scenario B is not only higher but its increase is sharper (Table 4.3). In addition to these assumptions, the differences could be caused by different assumptions regarding usage of new electric cars or heat pumps' electricity consumption. That could well result in higher growth rates.

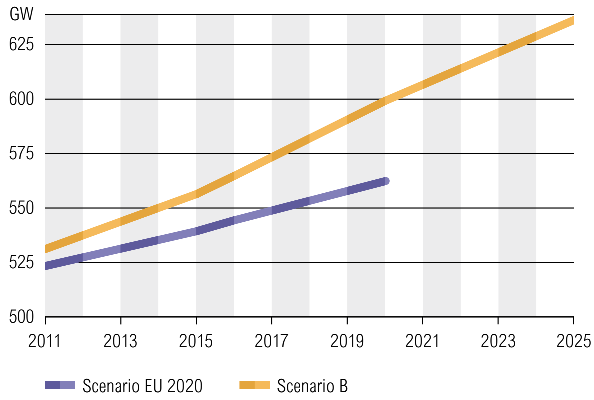


Figure 4.4:
ENTSO-E load forecast,
comparison of Scenario EU 2020 and Scenario B, January 7 p.m.

[%]	2011 to 2015	2015 to 2020	2020 to 2025
Scenario B	1.2	1.5	1.2
Scenario EU 2020	0.8	0.8	—

Table 4.3:
ENTSO-E average annual increase rate for load for Scenario EU 2020 and Scenario B

Scenario A and Scenario B

Load values in Scenario B[1] rise continuously in both reference points of January and July. Figure 4.5 shows only values for Scenario B for both reference points. The difference in load between reference points in absolute values is between 106 GW and 114 GW. A similar behaviour of load (shape and increase rate of the curve) was reported last year in SAF 2010, where the difference between January and July was approximately 107 GW on average.

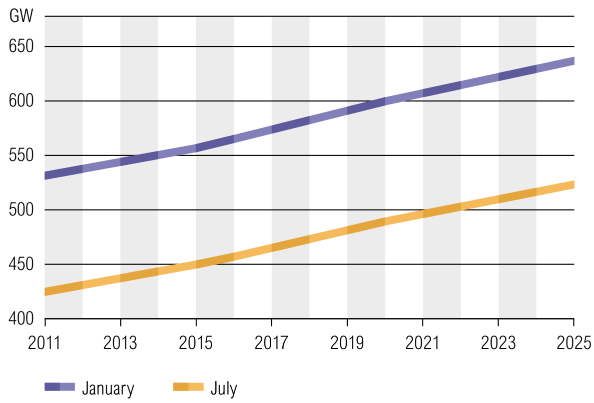


Figure 4.5:
ENTSO-E load forecast for Scenario B,
reference point January 7 p.m. and July 11 a.m.

[1] Load values were according to the methodology supposed to be the same in both Scenarios A and B. However some TSOs have reported different figures for Scenario A and for Scenario B (e. g. Germany, Czech Republic) because of the agreement between TSO, some stakeholders and national ministries. Although load values in Scenario A and B differ, further in this document only values and assessment for Scenario B is made.

The annual increase rate of load in respective periods is shown in Table 4.4. The figures correspond with Figure 4.5, i.e. the most rapid increase is expected between 2015 and 2020.

The highest annual load increase between 2011 and 2015 is expected in Cyprus (9.1%), Slovenia and the Former Yugoslavian Republic of Macedonia (between 3% and 4%) together with Estonia, Spain, Croatia and the Republic of Ireland (between 2% and 3%).

During the period between 2015 and 2020 the biggest increase of load is expected in Cyprus (5%) and Greece (4.3%). Remarkably, between 2011 and 2015 the load is expected to decrease in Germany (-0.3%) and Romania (-0.8%). This is shown in Figures 4.6 and 4.7.

[%]	2011 to 2015	2015 to 2020	2020 to 2025
January	1.2	1.5	1.2
July	1.5	1.7	1.4

Table 4.4:
ENTSO-E average increase rate for load for Scenario B

[GW]	2011	2015	2016	2020	2025
January	531	557	565	600	637
July	425	450	457	489	523

Table 4.5:
ENTSO-E load for Scenario B

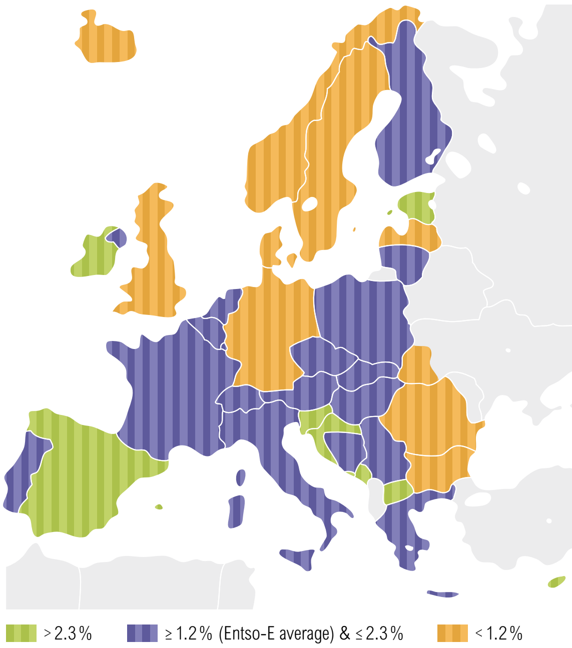


Figure 4.6:
ENTSO-E average annual load growth between 2011 and 2015, Scenario B

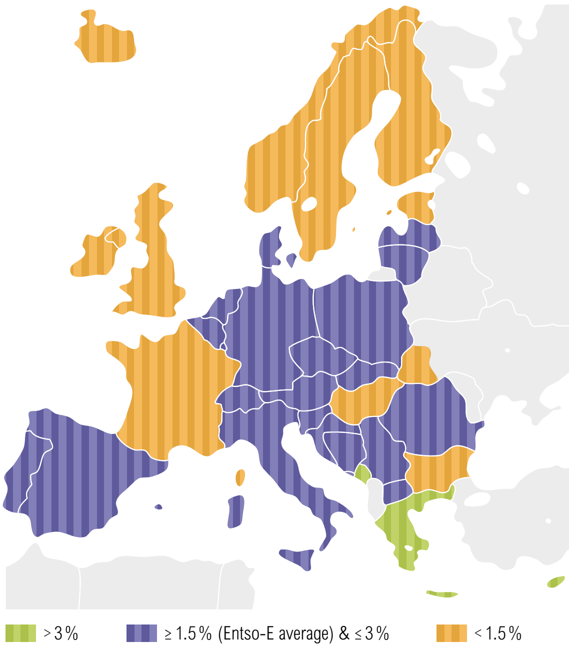


Figure 4.7:
ENTSO-E average annual load growth between 2015 and 2020, Scenario B

As a main factor influencing the load (in Scenarios A and B) most of the TSOs reported the influence of energy efficiency measures to be taken at the national level in future. The recovery of national industry after the financial crisis, linked with more rapid evolution of GDP and the influence of expected weather conditions (based on past experience), was also reported.

4.2.2 Demand Forecast

Scenario EU 2020

The energy consumption forecast is shown in Figure 4.8. It is evident that the growth of consumption is quite constant and smooth and the annual increase rate is between 0.6 % and 0.7 % (Tables 4.6a and 4.6b).

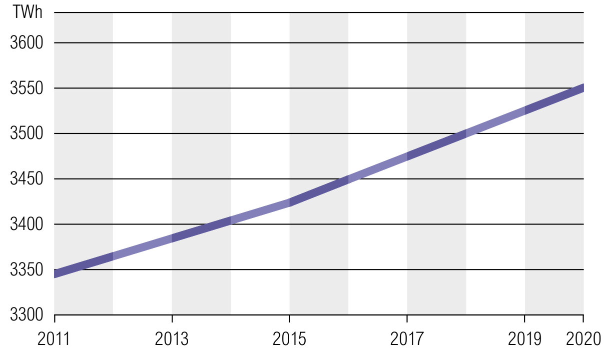


Figure 4.8:
ENTSO-E consumption forecast for Scenario EU 2020

[%]	2011 to 2015	2015 to 2020
Annual rate	0.6	0.7

Table 4.6a:
ENTSO-E consumption annual increase rate, Scenario EU 2020

[TWh]	2011	2015	2016	2020
Consumption	3345	3425	3450	3552

Table 4.6b:
ENTSO-E consumption, Scenario EU 2020

The highest annual increase rate between 2011 and 2020 is expected in Cyprus and FYROM (each about 3 %) followed by Bosnia-Herzegovina, Lithuania, Latvia, and Slovenia (more than 2 % each). The only country expecting a decrease of consumption in this period is Germany (0.8 %: 0.6 % before 2015 and 0.9 % after 2015). Poland and Luxembourg also expect a decline of energy consumption before 2015 only (about 0.2 % each). Annual consumption growth per country between 2011 and 2020 is shown in Figure 4.9.

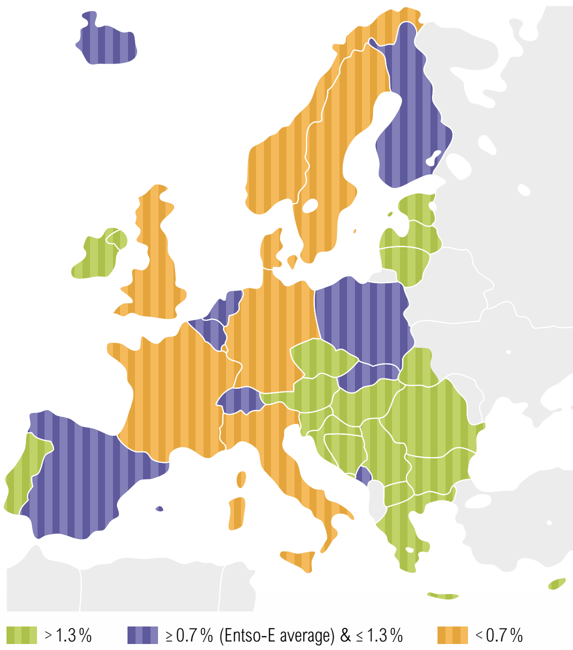


Figure 4.9:
ENTSO-E average annual consumption growth between 2011 and 2020, Scenario EU 2020

Comparison of consumption growth in Scenario EU 2020 and Scenario B is shown in Figure 4.10.

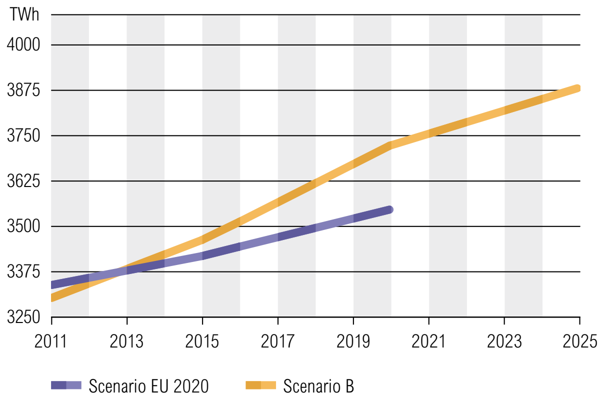


Figure 4.10:
ENTSO-E consumption forecast for Scenario EU 2020 and Scenario B

Scenario A and Scenario B

The average annual consumption growth rate between 2011 and 2020 for Scenario B for the whole ENTSO-E is expected to be about 1.3 % (Figure 4.11), almost twice that of Scenario EU 2020. Between 2020 and 2025 an annual increase of about 0.8 % is foreseen (Tables 4.7a and 4.7b).

[%]	2011 to 2015	2015 to 2020	2020 to 2025
Annual rate	1.2	1.4	0.8

Table 4.7a:
ENTSO-E annual load increase rate for Scenario B

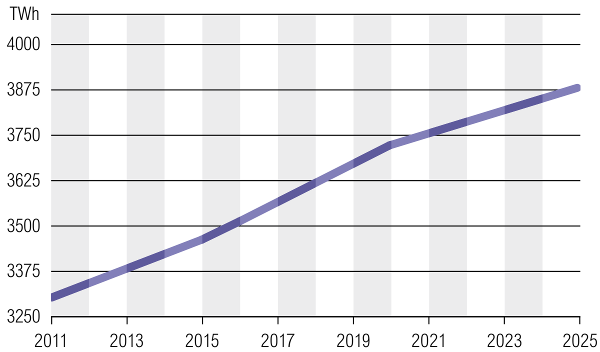


Figure 4.11:
ENTSO-E consumption forecast for Scenario B

[TWh]	2011	2015	2016	2020	2025
Consumption	3310	3469	3519	3727	3885

Table 4.7b:
ENTSO-E load for Scenario B

Cyprus, Greece, Slovenia, FYROM and Bosnia-Herzegovina expect the highest annual increases between 2011 and 2020 (between 2.8 % and 3.1 %). Only Germany foresees a consumption fall of about 0.3 % between 2011 and 2015. Increase rates per country are shown in Figure 4.12.

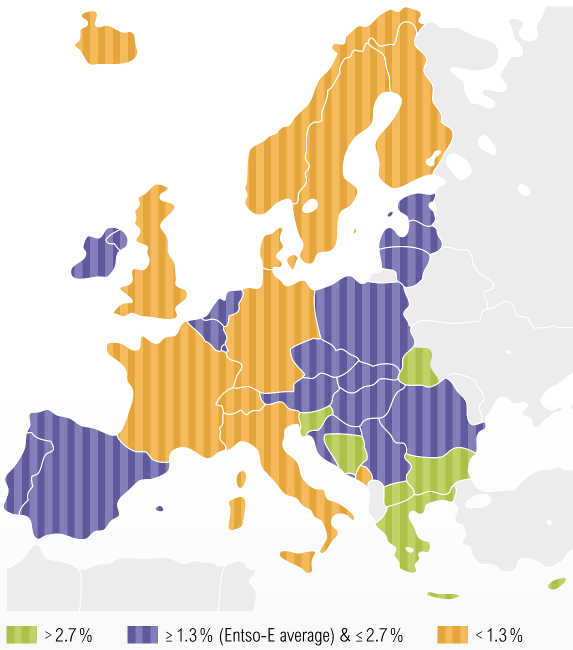


Figure 4.12:
ENTSO-E average annual consumption growth between 2011 and 2020, Scenario B

4.2.3 Generating Capacity Forecast

4.2.3.1 Total ENTSO-E Net Generating Capacity (NGC)

This chapter contains a description and assessment of each fuel category. More details are available within each sub-paragraph dealing with particular kinds of fuel.

Scenario EU 2020

The evolution of total NGC for the whole ENTSO-E is shown in Figures 4.13 and 4.14. The fastest growth registered in energy sources is reported in renewable power plants[1)] whose amount expressed in total NGC is almost double (from 288 GW in 2011 to 512 GW in 2020). Nuclear and non-renewable hydro power plants, together with energy sources that are not clearly identifiable, are increasing during the whole forecast period as well, but their rise is not as fast as in the case of renewable power plants. Only fossil fuels are expected to diminish.

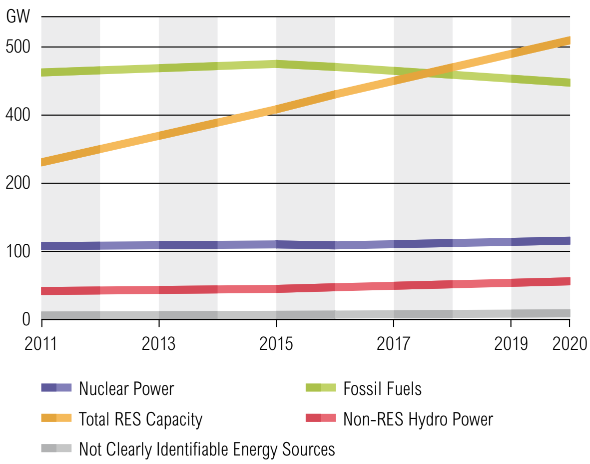


Figure 4.13:
ENTSO-E total NGC breakdown, Scenario EU 2020, January 7 p.m.

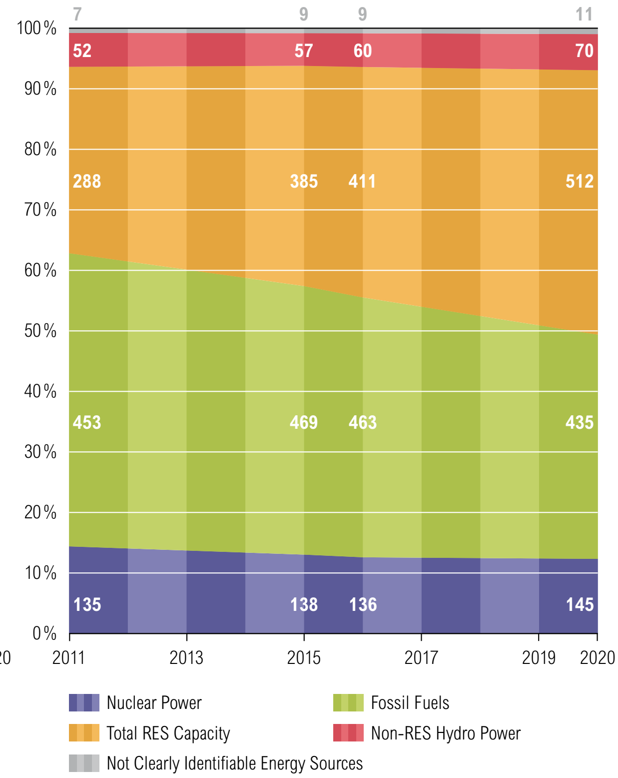


Figure 4.14:
ENTSO-E total NGC mix, Scenario EU 2020, January 7 p.m., values in GW

1) For the purposes of this report wind, solar, biomass and renewable hydro power plants are considered in this category.

The total NGC situation in each respective ENTSO-E member country is depicted in Figures 4.15 and 4.16.

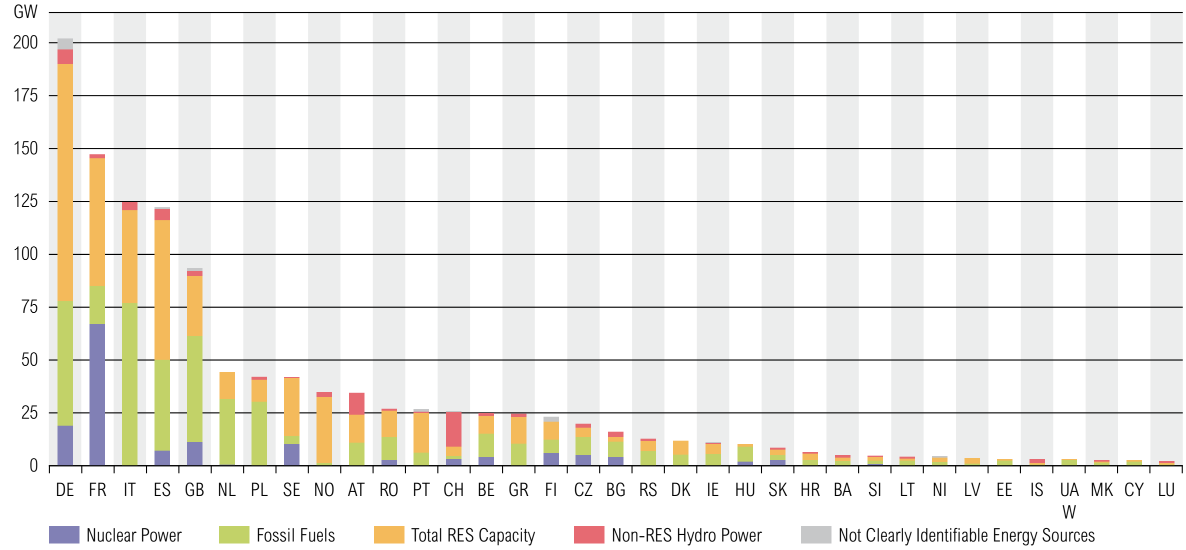


Figure 4.15:
Total NGC breakdown per country in 2020, Scenario EU 2020, January 7 p.m.

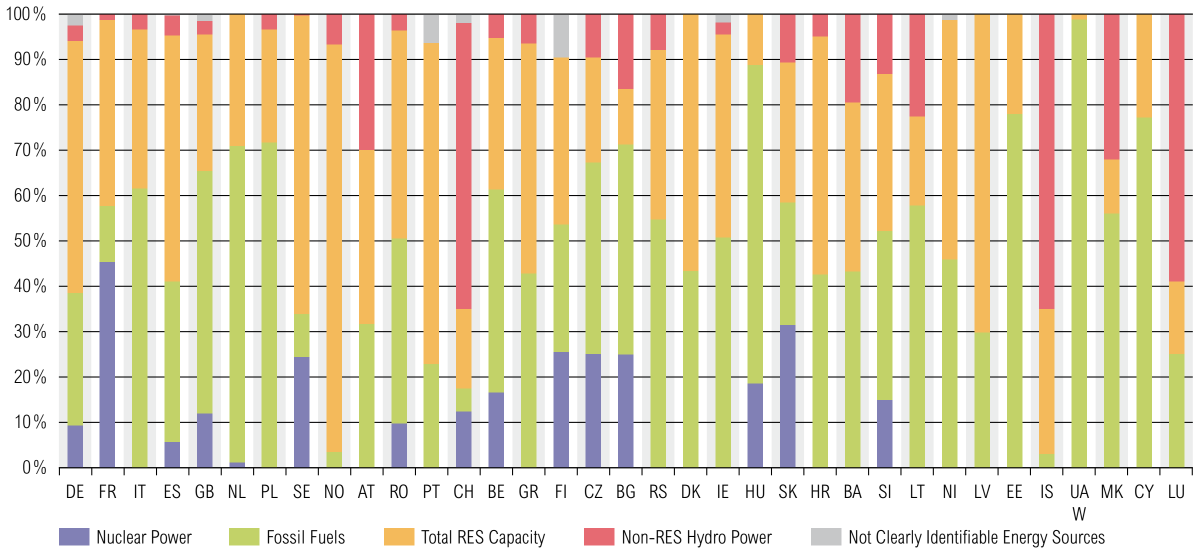


Figure 4.16:
Total generation capacity mix per country in 2020, Scenario EU 2020, January 7 p.m.

Comparison of Scenario EU 2020 with Scenario B is shown in Table 4.8. In both scenarios RES are increasing, albeit with different rates of growth. The increase is more rapid in Scenario EU 2020 (78 % until 2020) than in Scenario B (58 % until 2020).

Non-renewable hydro power plants and not clearly identifiable energy sources show in both scenarios the same increase rates up to 2020 (about 35 % or 56 % respectively). The same observation also pertains to nuclear power plant installed capacity with an increased rate between 7 % and 8.5 % in both scenarios.

Fossil fuels' installed capacity in Scenario EU 2020 declines (4 % up to 2020), whereas in Scenario B it grows at the same rate of about 4 %.

	Scenario EU 2020				Scenario B				
[GW]	**2011**	**2015**	**2016**	**2020**	**2011**	**2015**	**2016**	**2020**	**2025**
Nuclear Power	135	138	136	145	135	138	136	146	154
Fossil Fuels	453	469	463	435	458	489	485	475	472
Total RES Capacity	288	386	411	512	278	355	372	440	489
Non-RES Hydro Power Plants	52	56	60	70	52	57	60	71	75
Not Clearly Identifiable Energy Sources	7	9	9	11	7	9	9	11	12
NGC	**936**	**1057**	**1079**	**1173**	**930**	**1048**	**1062**	**1143**	**1203**

Table 4.8:
The comparison of ENTSO-E total NGC between Scenario EU 2020 and Scenario B, January, 7 p.m.

Scenario A and Scenario B

The forecast evolution of total NGC for the whole ENTSO-E for Scenario A and Scenario B is shown in Figures 4.17 to 4.20.

The most rapidly developing energy sources are renewable power plants, whose installed capacity in total NGC almost doubles (from 278 GW in 2011 up to 489 GW in 2020) in Scenario B.

In Scenario A this development of renewable power plants is less optimistic even though the increase of this category is obviously the most rapid.

In Scenario B every other sub-category increases during the whole forecast period as well, but their absolute growth is not as fast as in the case of renewable power plants. The share of these sub-categories is expected to remain almost the same. On the other hand, only the amount of fossil fuels in total ENTSO-E NGC is expected to decrease.

In Scenario A the amount of fossil fuels' installed capacity and that of nuclear power plants is gradually falling; non-renewable hydro power plants, together with not clearly identifiable energy sources, slightly raise their share of total ENTSO-E generating capacity.

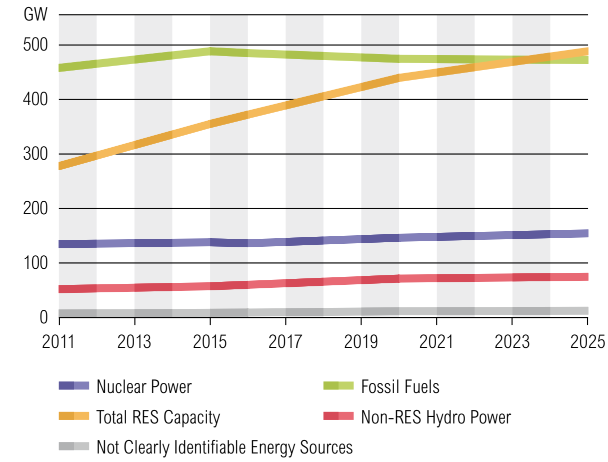


Figure 4.17:
ENTSO-E total NGC breakdown, Scenario B, January 7 p.m.

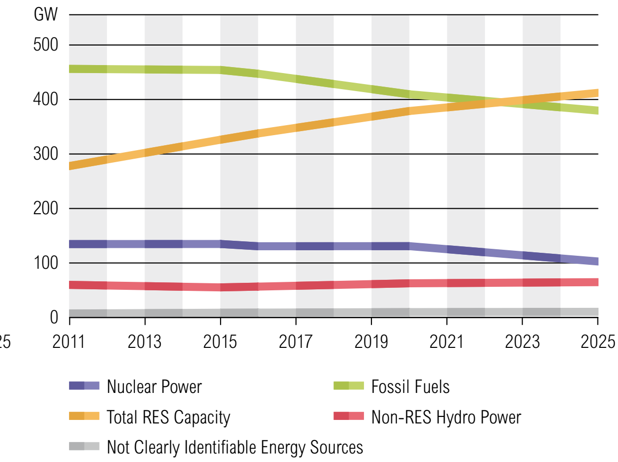


Figure 4.19:
ENTSO-E total NGC breakdown, Scenario A, January 7 p.m.

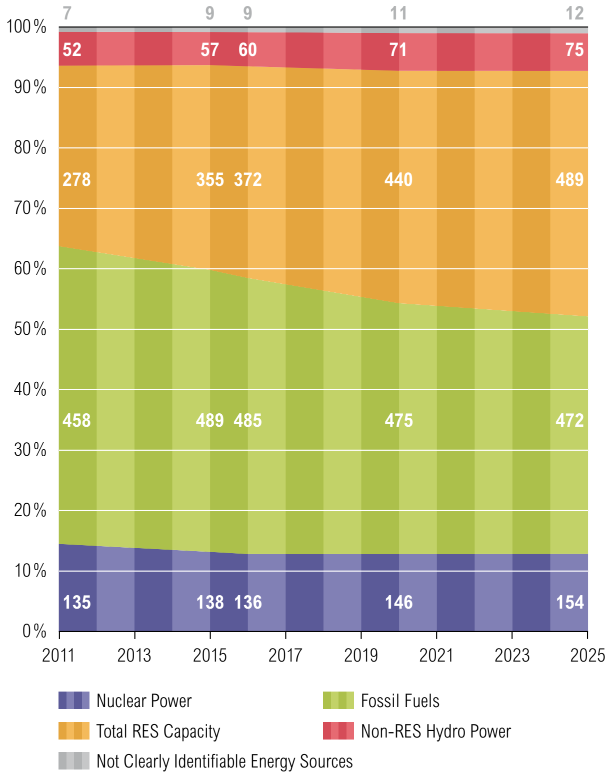


Figure 4.18:
ENTSO-E total NGC mix, Scenario B, January 7 p.m.,
values in GW

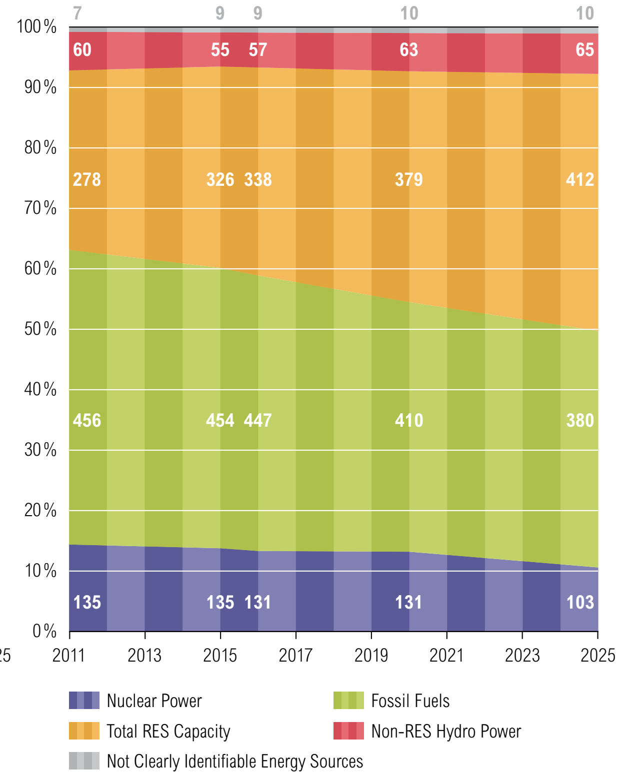


Figure 4.20:
ENTSO-E total NGC mix, Scenario A, January 7 p.m.,
values in GW

The total NGC situation in each respective ENTSO-E member country for Scenario B is depicted in Figures 4.21 and 4.22.

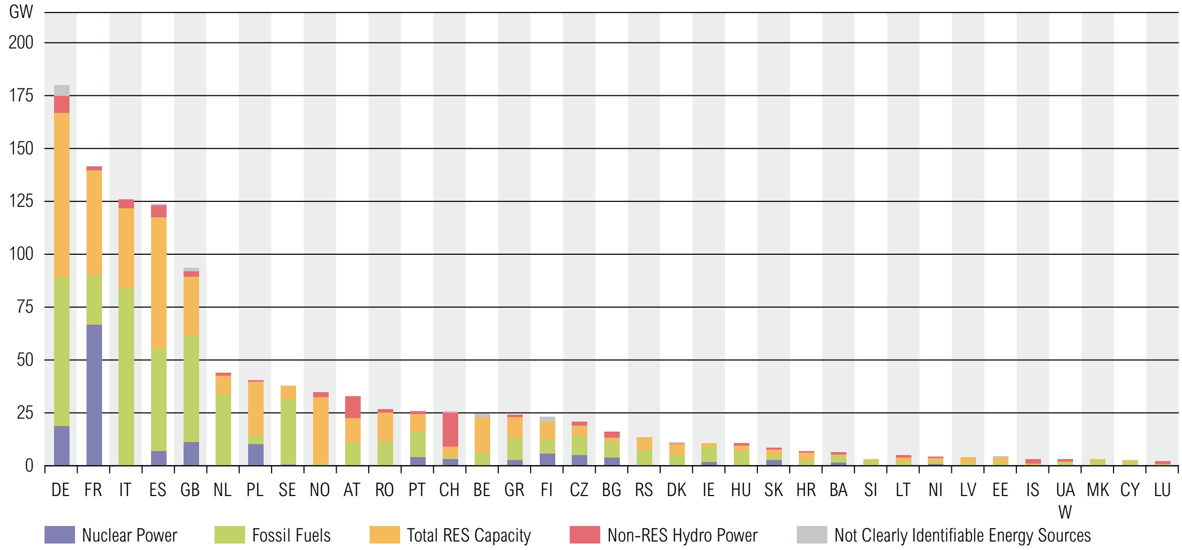


Figure 4.21:
Total NGC breakdown per country in 2020, Scenario B, January 7 p.m.

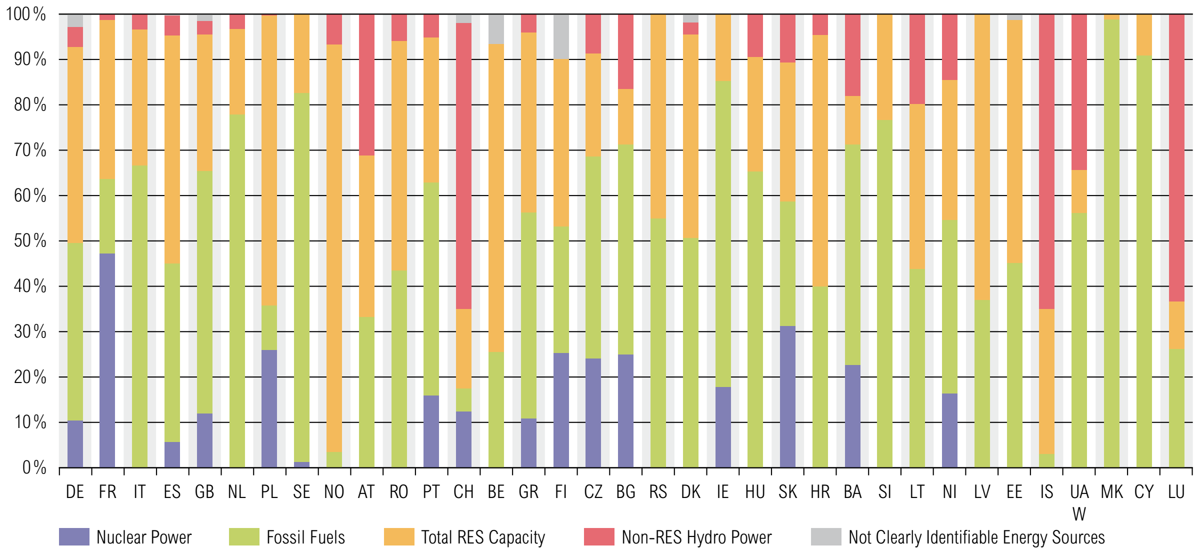


Figure 4.22:
Total generation capacity mix per country in 2020, Scenario B, January 7 p.m.

4.2.3.2 NGC – Fossil Fuel Power Plants

Scenario EU 2020

The NGC of the fossil fuel category is expected to increase continually up to 2015 (increase rate is about 3 % for both monitored reference times; the maximum is 469 GW for January and July) and falls after that year to approximately 435 GW by 2020 (decrease rate is about 7 % in both cases; see Figure 4.23). The decrease in 2020 is a direct consequence of the higher share of RES expected in each country in this scenario.

On the other hand, the Large Combustion Plants Directive[1)2)] (hereinafter "LCP Directive"), which forces the generators to shut down old fossil fuel power plants (under certain conditions) seems to have a limited influence. This LCP Directive enters into force in 2015 but some countries may have an exemption period so the effect of this Directive is postponed in their case. Assessing the fossil fuels category based on the information in NREAPs is not without its difficulties as this kind of information is not included in these documents.

Figure 4.24 depicts the fossil fuels' generating mix in Scenario EU 2020. The picture shows that the highest share within this category belongs to gas power plants. Their share increases from 38 % in 2011 up to 45 % in 2020.

On the other hand, other categories are expected to reduce their share:
- Hard coal power plants' share falls from 27 % to 24 %
- For the oil category the fall is from 10 % to 7 %
- Lignite decreases from 14 % to 12 %

Mixed fuels and unattributable fossil fuel categories show a fairly stable course (deviation only about 1 %).

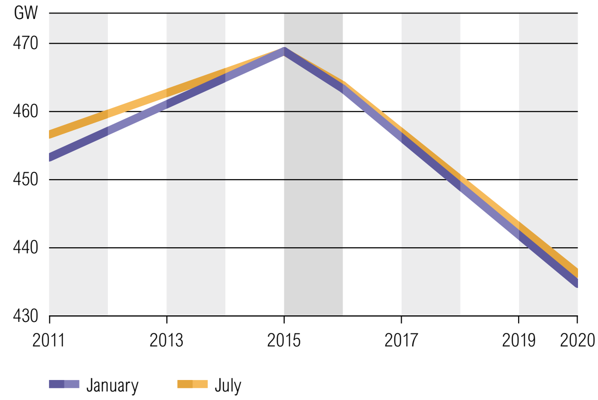


Figure 4.23:
ENTSO-E fossil fuels generating capacity forecast, Scenario EU 2020

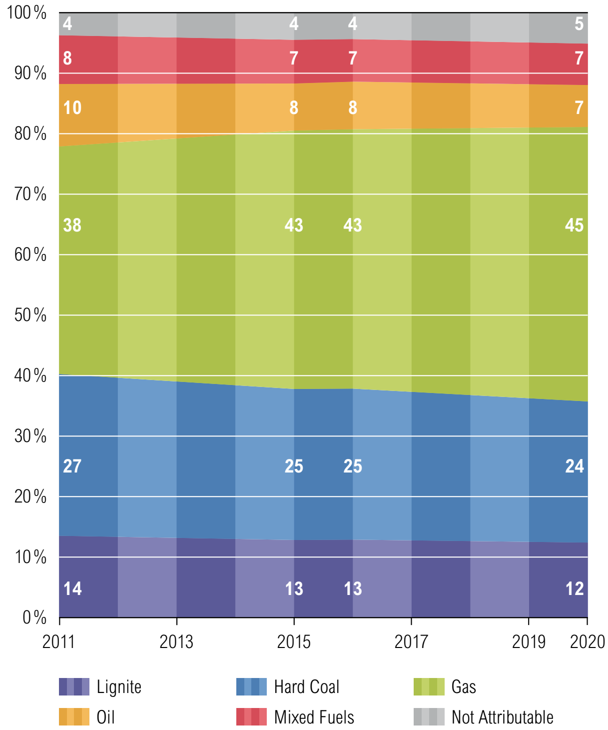


Figure 4.24:
ENTSO-E fossil fuels generating capacity breakdown, Scenario EU 2020, January 7 p.m.

1) Directive 2001/80/EC of the European parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants

2) The Commission adopted on 21 December 2007 a Proposal for a Directive on industrial emissions. The Proposal recasts seven existing Directives (including the IPPC Directive, the Large Combustion Plants Directive, the Waste Incineration Directive, the Solvents Emissions Directive and 3 Directives on Titanium Dioxide the IPPC) into a single clear and coherent legislative instrument.

On the ENTSO-E level, the share of fossil fuels in total NGC is 44 % in 2015 and 37 % in 2020. More than half of the ENTSO-E countries will exceed the aforementioned values. The country with the highest levels of fossil fuels in both forecast years, i. e. 2015 and 2020, is Cyprus (89 % and 77 % respectively) followed by Estonia (88 % and 79 %), Poland (81 % and 72 %), the Netherlands (81 % and 70 %) and Northern Ireland (76 % in 2015; in 2020 less than 50 %). Austria, Belgium, Denmark, Hungary, Italy, Norway and Slovenia keep their fossil fuels' share almost stable. The overall picture is shown in Figures 4.25 and 4.26.

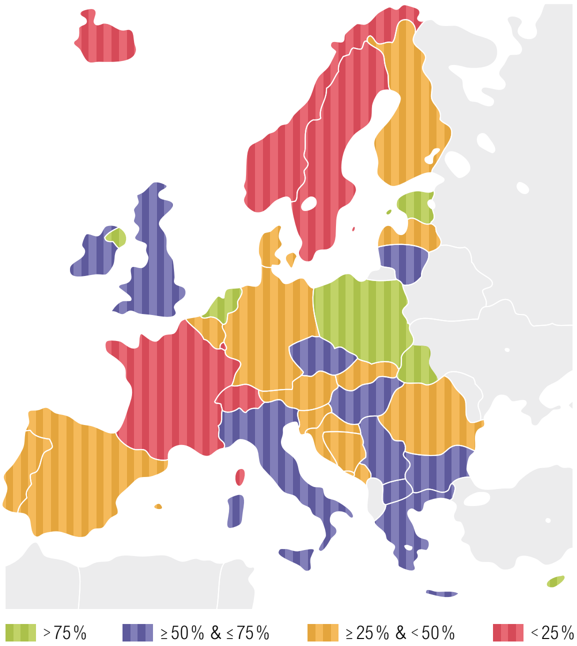


Figure 4.25:
Fossil fuels as a part of NGC per country in 2015, Scenario EU 2020

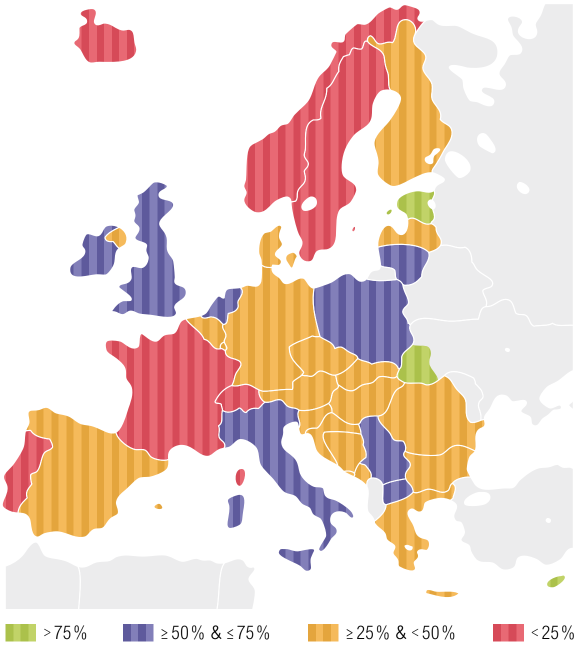


Figure 4.26:
Fossil fuels as a part of NGC per country in 2020, Scenario EU 2020

NGC of gas power plants

NGC of gas-generating power plants is expected to grow only until 2015; after this year the trend changes and a decline of roughly 3 GW is visible up to 2020 (see Table 4.9 and Figure 4.27).

[%]	2011 to 2015	2015 to 2016	2016 to 2020
January	18	-0.8	-0.8
July	16	-1	-0.3

Table 4.9:
Gas generating capacity increase / decrease (in %)

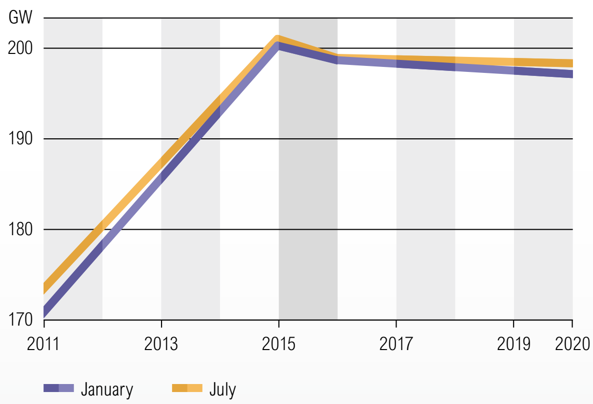


Figure 4.27:
ENTSO-E gas generating capacity forecast, Scenario EU 2020

This behaviour is perceptible in the majority of the countries where gas power plants contribute to the generating mix. The highest share of this increase before 2015 is that of Germany (+4.4 GW), the Netherlands (+4.2 GW) and Spain (3.1 GW). On the other hand, Slovakia and Denmark expect a decrease in this period of 0.4 GW and 0.26 GW respectively. The total ENTSO-E rise before 2015 is almost 18 % (about 30 GW).

Between 2015 and 2016 a total decrease of 1.6 GW is expected, although in most of the countries gas NGC is expected to remain stable.

After 2015, the total decrease results from two opposite trends:

- Gas NGC is expected to rise in Spain (1.5 GW), Belgium (1.1 GW) and Romania (1 GW), among others, with increases between 1 % and 55 %.
- Gas NGC is expected to fall mainly in Germany (8.5 GW), in Great Britain (3.4 GW) and in Italy (2 GW). Decreasing gas NGC shares are between 1 % and 37 %.

In the whole ENTSO-E, the final balance is a decrease of about 3 GW between 2015 and 2020. Figures 4.28 and 4.29 below show the number of gas units in each national generation capacity mix for 2015 and 2020.

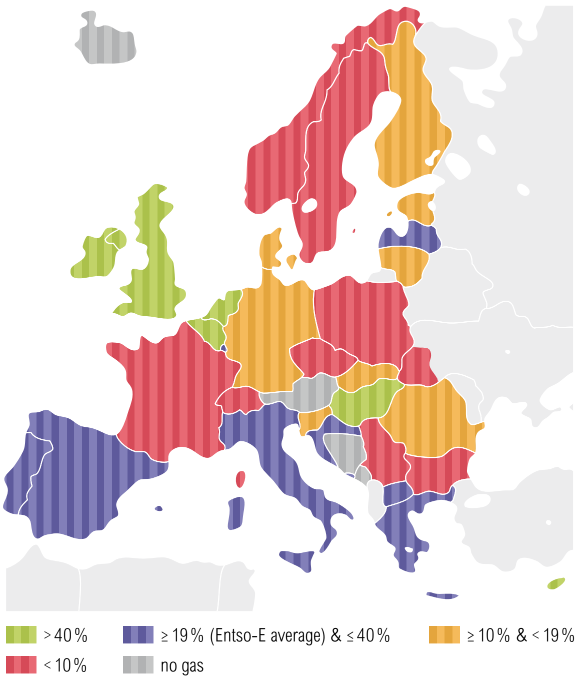


Figure 4.28:
Share of Gas power plants in net generating capacity per country in 2015, Scenario EU 2020, January 7 p.m.

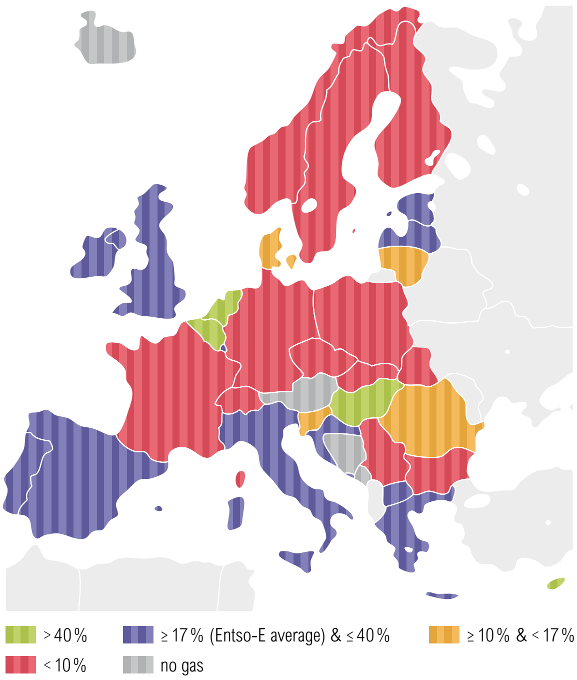


Figure 4.29:
Share of Gas power plants in net generating capacity per country in 2020, Scenario EU 2020, January 7 p.m.

The highest shares of gas units in NGC for the years 2015 and 2020 are expected to be those of Cyprus (63 % and 69 % respectively), the Netherlands (about 57 % and 49 %), Hungary (46 % and 47 %), the Republic of Ireland (47 % and 40 %) and Belgium (41 % in both cases).

Comparison of Scenario EU 2020 and Scenario B

Comparing Scenario EU 2020 with Scenario B we see the total fossil fuels situation in January, 7 p.m. is as follows (Figure 4.30).

The shape of the curve in both scenarios is similar; the only difference is the level of increase / decrease rate in each particular period (Table 4.10).

In Scenario EU 2020 the amount of total fossil fuels' installed capacity is always lower than for Scenario B. The increase rate before 2015 in terms of NREAPs is slower than in Scenario B and after 2015 the decrease is more striking.

Also, the amount of fossil fuels' generating capacity in total NGC of the whole ENTSO-E is lower in the Scenario EU 2020 in 2015 as well as 2020 (see Table 4.11). The difference between scenarios in 2015 is twice as low as in 2020. It means that the share of fossil fuels in total NGC in Scenario EU 2020 is not only lower but decreases with a higher slope (Figure 4.30). The same applies to absolute values. The difference in 2015 is 19 GW and in 2020 it is 39 GW, i. e. more than twice as much again.

The difference between Scenario EU 2020 and Scenario B is positive or zero for most of the ENTSO-E countries in both years. Nevertheless, negative differences (NGC of fossil fuels in Scenario EU 2020 is lower than in Scenario B) are reported for Germany, Italy and Poland (and from Spain, France, Belgium and Greece only in 2020). These countries represent an important share of the total ENTSO-E NGC value and mean that the total amount of fossil fuel in Scenario EU 2020 is lower than in Scenario B.

One reason for this could be that the RES capacity is lower in Scenario B and hence more fossil fuel units are needed in this scenario. Also, the Scenario EU 2020 is based on long-term top-down visions that may underestimate the need for back-up capacity.

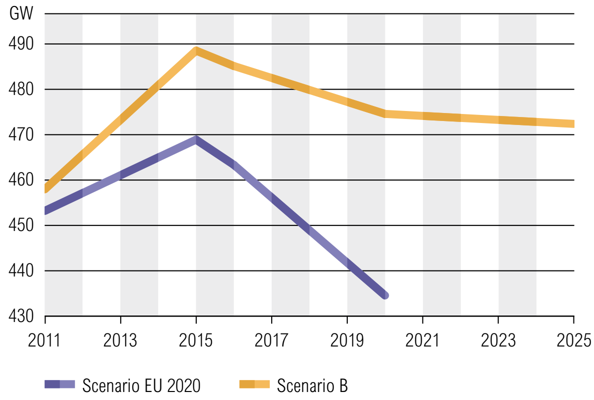


Figure 4.30:
ENTSO-E fossil fuels generating capacity breakdown in 2015 and 2016, Scenario EU 2020, January 7 p.m.

[%]	2011 to 2015	2015 to 2020	2020 to 2025
Scenario B	7	-3	-0.5
Scenario EU 2020	3	-7	—

Table 4.10:
Total fossil fuels installed capacity increase / decrease between for January, 7 p.m.

	Scenario EU 2020		Scenario B	
2015	44 %	469 GW	47 %	489 GW
2020	37 %	435 GW	42 %	475 GW

Table 4.11:
Comparison of fossil fuels share in total NGC for Scenario EU 2020 and Scenario B

NGC of gas power plants

Comparing Scenario EU 2020 and Scenario B in terms of gas power plants (Figure 4.31) shows that the amount of their installed capacity is higher in Scenario B and its trend in this scenario is also much ambitious. In Scenario EU 2020 the trend after 2015 marks a negligible decrease up to 1 % (about 3 GW).

Gas units in most countries are supposed to replace the old thermal units largely as a result of the impact of the LCP Directive (gray frame). Although this concerns Scenario B primarily, in Scenario EU 2020 fossil fuel power plants generally are forced out by renewable energy sources and this assumption could also be applied to gas power plants (each sub-category in fossil fuels is decreasing in terms of its installed capacity).

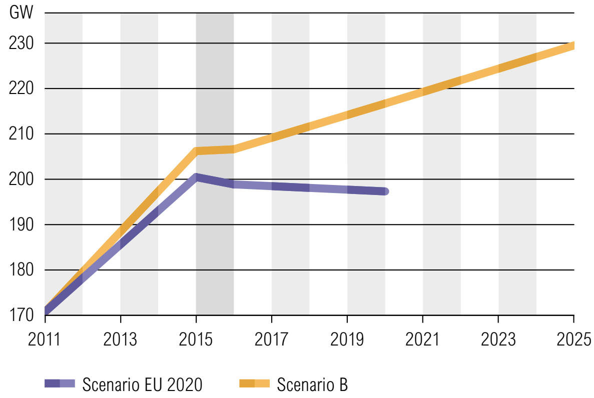


Figure 4.31:
Comparison of ENTSO-E gas generating capacity forecast in Scenario EU 2020 and Scenario B

Scenario A and Scenario B

The NGC of fossil fuels category in Scenario B is expected to be increasing until 2015 (the increase rate is about 7 %, about 489 GW at the top of the curve). After that year it starts to decrease to the value of 475 GW (in 2020) at a rate of 3 % and in the next five years it goes down to 472 GW (in 2025) at a rate of 0.5 %. A similar trend is also expected for July.

Scenario A for the reference point of January shows more pessimistic expectations of fossil fuel NGC. From 2011 to 2015 only a negligible decrease is foreseen (0.4 % from 456 GW to 454 GW) but after 2015 a notable decline starts (from 454 GW in 2015 up to 380 GW in 2025 at a rate of 16 %). Similar values with similar trends are reported at both reference points. These facts are also visible in Figure 4.32.

Big differences can be seen, befitting the nature of the two scenarios. Scenario B reflects the best estimate of the TSO including a higher number of new units that are not necessarily certain to replace the estimated number of decommissioned power plants. These units are not included in Scenario A since they are not confirmed. Other reasons for differences between A and B could be the lifetime extension, retrofitting, etc. that are considered in Scenario B.

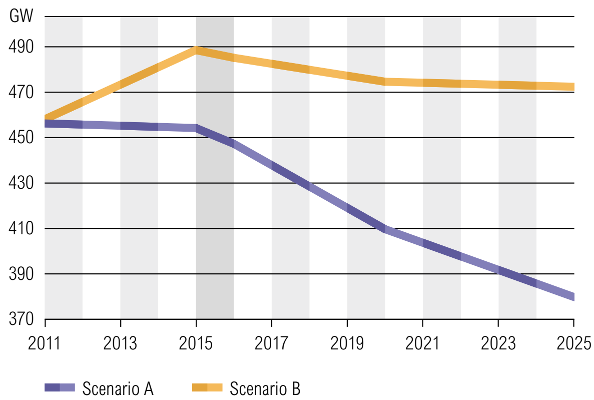


Figure 4.32:
ENTSO-E fossil fuels generating capacity forecast, Scenarios A & B

The trend of the fossil fuels category is much more pessimistic than in SAF 2010 (see Figure 4.33). It is evident that in SAF 2010 (Scenario B, January) this category showed a clearly increasing tendency during the whole reported period with only a negligible decrease between 2015 and 2016 of about 1 GW (0.2 %). On the other hand, in SO&AF 2011 the trend is the opposite. Before 2015 the increase rate is about 7 % but after this the generating capacity of fossil fuels starts to decrease at a rate of about 3 % up to 2025.

In both cases the reason for the decrease after 2015 could be the LCP Directive, although in SAF 2010 it seemed to be only temporary and the TSOs expected further development of fossil fuel technology whereas in SO&AF 2011 fossil fuels seem to be decreasing in general.

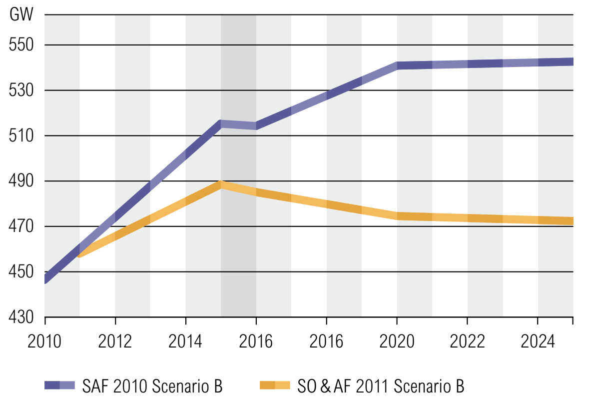


Figure 4.33:
ENTSO-E Fossil fuels generating capacity forecast, comparison of Scenario B in SO & AF 2011 and SAF 2010

Cases of countries like Germany, the Netherlands, Great Britain and Spain are interesting for each year reported, as is France for 2020 and 2025 where TSOs in SAF 2010 expected the total amount of fossil fuels' installed capacity to be much higher than in SO&AF 2011. In the case of France, for example, Scenario B in SO&AF 2011 is based on cautious hypotheses for the development of new thermal capacity, in a general context of strong development of renewable energy sources and thermal capacities elsewhere in Europe and therefore installed capacity in this kind of power plant is expected to be lower.

There are also a few countries expecting more installed capacity in fossil fuels in SO&AF 2011 than in SAF 2010 (depending on the year, e. g. Poland or Romania), but the final effect is that in SO&AF 2011 the fossil fuels' installed capacity is expected to be significantly lower compared with the SAF 2010.

The highest share within fossil fuels is gas (as in Scenario EU 2020). Its share continuously increases from a percentage rate of 37 % in 2011 up to 49 % in 2025. It is the only kind of fossil fuel which shows such behaviour. Other categories show a visible decrease or a stable state as in the case of unattributable fossil fuels (see Figure 4.34).

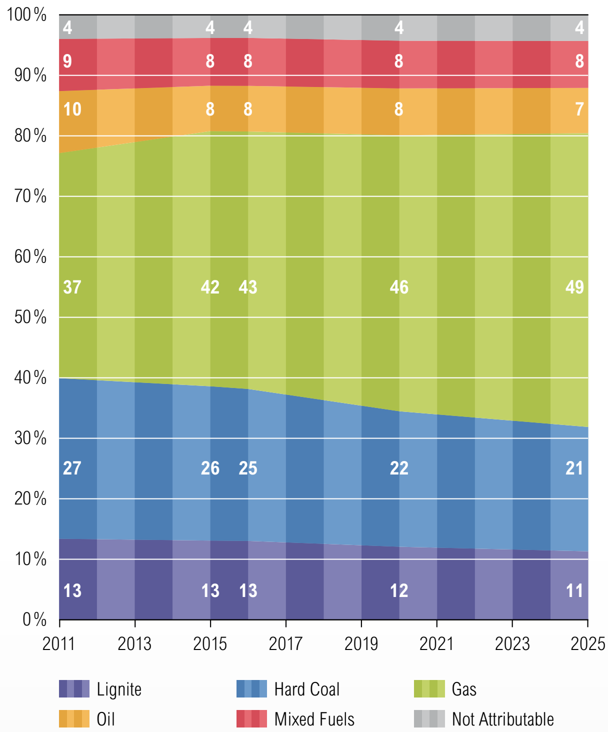


Figure 4.34:
ENTSO-E fossil fuels generating capacity breakdown, Scenario B

On the ENTSO-E level, the share of fossil fuels in total NGC is 47 % in 2015 and 42 % in 2020, and more than half of the ENTSO-E countries exceed the aforementioned values.

Fossil fuel share in NGC per country in 2015 and 2020 is shown in Figures 4.35 and 4.36.

The highest share in 2015 is expected in Cyprus (94 %), the Netherlands (86 %), Estonia and Poland (both about 81 %) followed by Northern Ireland (74 %). Iceland, Norway and Switzerland conversely have a fossil fuel share between 3 % and 4 % in their national NGC.

The situation in 2020 differs from that of 2015 mainly for Lithuania, Romania, Bulgaria, Greece, the Republic of Ireland and Northern Ireland. In all these countries the share of fossil fuels in 2020 is lower (less than 50 %) than in 2015.

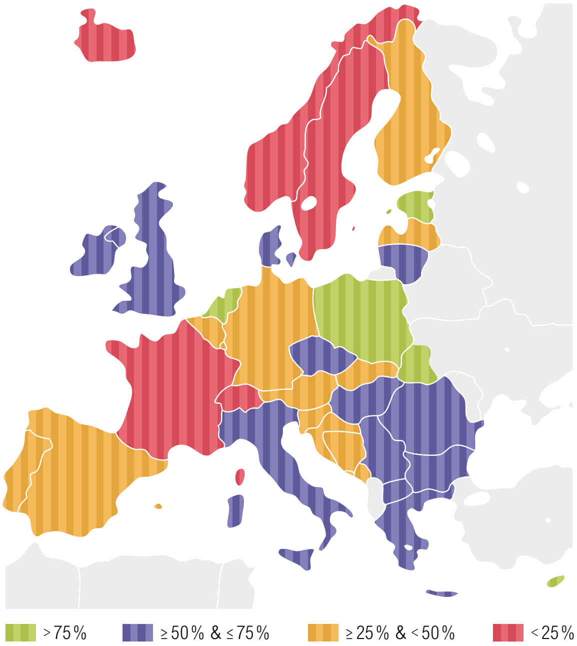


Figure 4.35:
Fossil fuels as a part of NGC per country in 2015, Scenario B, January

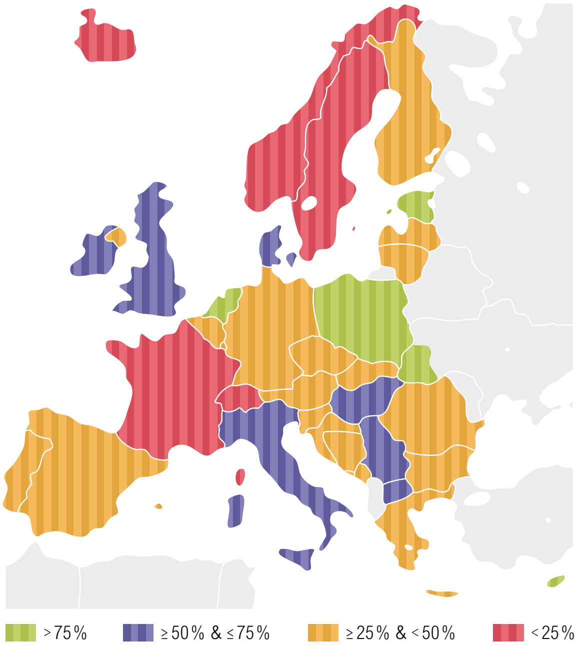


Figure 4.36:
Fossil fuels as a part of NGC per country in 2020, Scenario B, January

NGC in gas power plants

Gas power plant installed capacity trend is depicted in Figure 4.37.

In Scenario A, gas NGC is expected to increasing until 2016, after which it starts to decline. In Scenario B gas power plant installed capacity is expected to increase in each forecast period. The most rapid increase within ENTSO-E is expected before 2015 (21 %) and is caused by Germany (8.6 GW), Spain and the Netherlands (both about 3 GW), followed by Greece, Poland, Italy and Great Britain (between 2 GW and 2.5 GW each). Only a negligible decrease is reported for Slovakia (0.35 GW) and Denmark (0.04 GW).

After 2015, growth on the whole ENTSO-E level is expected to slow down to 5 % (period between 2015 and 2020) and 6 % (period between 2020 and 2025). The reason is that the decommissioning of gas units in countries like Germany, Great Britain, the Republic of Ireland and Northern Ireland reduces the growing contribution from Spain where a significant increase of about 16 GW in installed capacity is expected. This can be seen in Table 4.12.

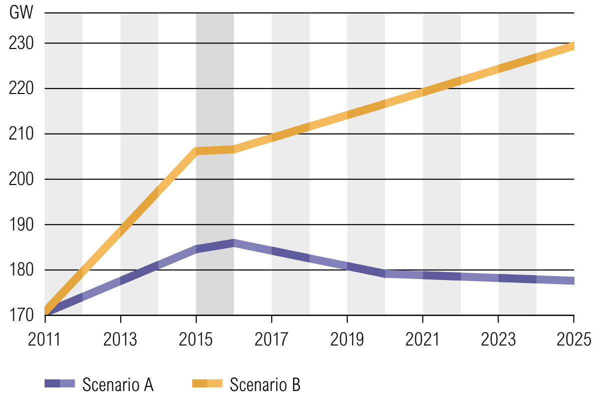


Figure 4.37:
ENTSO-E gas generating capacity forecast, Scenarios A & B

[%]	2011 to 2015	2015 to 2016	2016 to 2020	2020 to 2025
Scenario A	8	0.8	-4	-0.9
Scenario B	21	0.2	5	6

Table 4.12:
ENTSO-E gas generating capacity increase/decrease (in %)

The figures on the next page show the share of gas power plant installed capacity in total NGC per country in 2015 and 2020 (Figures 4.38 and 4.39). Among the countries with the highest share of gas power plants in their total capacity mix in both monitored years we can count Cyprus (67 % in 2015 and 82 % in 2020), Hungary (about 45 % in both years), the Republic of Ireland (48 % and 39 %), Great Britain (43 % and 34 %) and the Netherlands (57 % and 54 %).

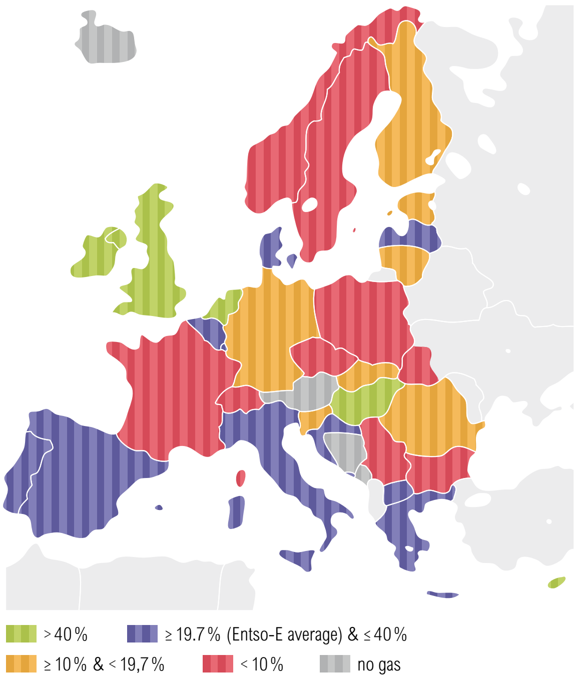


Figure 4.38:
Share of gas power plants in net generating capacity per country in 2015, Scenario B

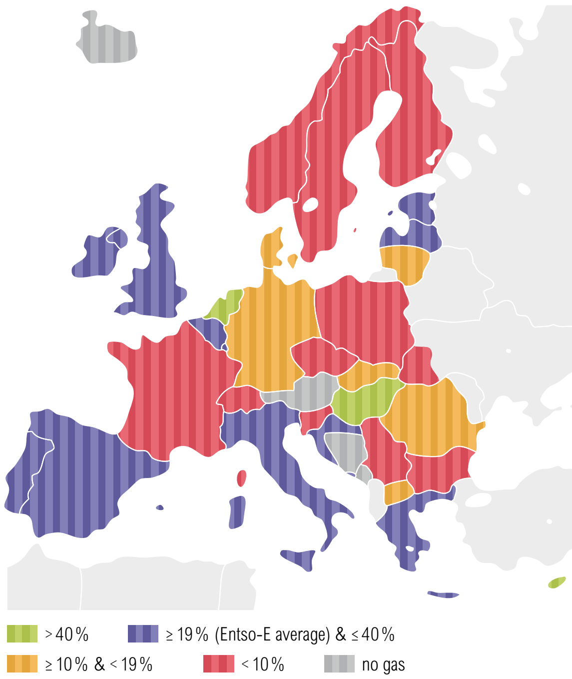


Figure 4.39:
Share of gas power plants in net generating capacity per country in 2020, Scenario B

Large Combustion Plant Directive and fossil fuel power plants decommissioning

The LCP Directive applies to combustion plants with a rated thermal output equal to or greater than 50 MW, irrespective of the type of fuel used. The Directive sets pollution thresholds for NOX, SOX, emissions, etc. Existing units must abide by these standards by December 31, 2015, at the latest or must be shut down. Defined limits will be revised downwards again in 2016.

If an operator of an existing plant seeks exemption from compliance with the requirements set in the Directive, their output is limited to 20000 operational hours starting from January 1, 2008, and ending no later than December 31, 2015.

The LCP Directive applies only to European Union (EU) member states. Therefore ENTSO-E member countries outside the EU perimeter do not have to adopt its goals.

Only very general information on the amount of decommissioning that will take place is available with the exception of units mentioned in IPPC[1)] directives (Directive 2008 / 1 / EC, Integrated Pollution Prevention and Control), LCP Directives or national laws. Some units under the IPPC and LCP Directive have operational limits, yet these are not always clear to the TSO. More generally, the operational availability of older units is not always clear.

1) http://europa.eu/legislation_summaries/environment/air_pollution/l28028_en.htm

The anticipated decommissioning affects mainly coal and oil. The anticipated substitution capacities are mainly gas-fired.

It is interesting to focus on 2015 and 2016 in this report, when a decrease of fossil fuel installed capacity is expected for all EU countries (gray frame in some figures). Thus, a decrease in almost every category in terms of the fossil fuel generation capacity mix can be observed (see Figure 4.40 and Table 4.13). The one exception is the gas category, where a negligible increase of about 0.2 % is expected.

The aforementioned and expected decreases in the rest of the categories in the SO&AF 2011 report is not as strong as in the SAF 2010 (see Figures 4.40 and 4.41). At the same time it has to be said that the values for 2015 in SO&AF 2011 are a little lower than the values in SAF 2010.

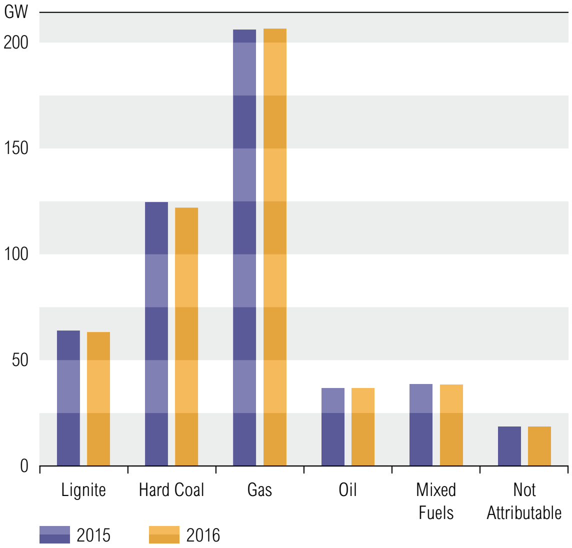


Figure 4.40:
ENTSO-E fossil fuels generating capacity breakdown in 2015 and 2016, Scenario B

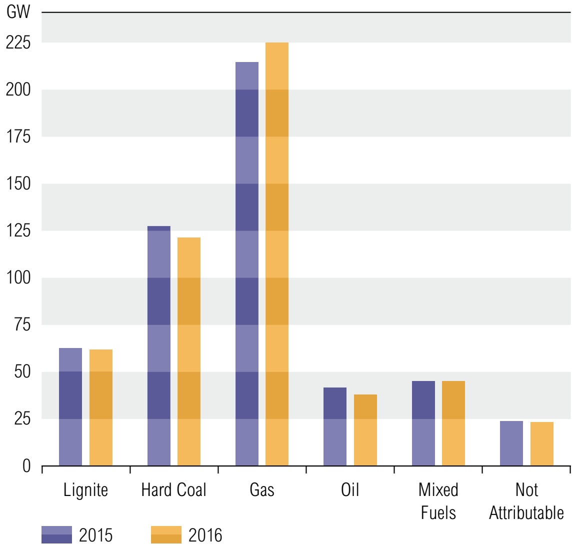


Figure 4.41:
ENTSO-E fossil fuels generating capacity breakdown in 2015 and 2016, Scenario B, data from last SAF 2010

		Lignite	Hard Coal	Gas	Oil	Mixed Fuels	Not Attributable
SAF 2010	[%]	-0.8	-10	1.4	-9	-0.7	-2.4
	[GW]	-0.5	-13	2.7	-3.7	-0.3	-0.5
SO&AF 2011	[%]	-1.1	-2.2	0.2	-0.1	-0.3	-0.9
	[GW]	-0.7	-2.8	0.4	-0.04	-0.1	-0.2

Table 4.13:
Fossil fuels increase / decrease between 2015 and 2016 per individual category in Scenario B, comparison between SAF 2010 and SO & AF 2011

The most striking difference between both reports is in the hard coal (e. g. Germany) and oil categories. The reason is probably the same as for fossil fuels in SAF 2010 and SO&AF 2011 for Scenario B (see also Figure 4.33).

4.2.3.3 NGC – Nuclear Power Plants

Scenario EU 2020

The nuclear power plant installed capacity in Scenario EU 2020 is expected to increase all the time with the exception of the period between 2015 and 2016. (See Figure 4.42, Table 4.14 and Table 4.15.)

[GW]	2011	2015	2016	2020
January	135	137	136	145
July	135	138	136	145

Table 4.14:
ENTSO-E nuclear generating capacity in Scenario EU 2020

[%]	2011 to 2015	2015 to 2016	2016 to 2020
January	2	-1	6
July	2	-1	6

Table 4.15:
ENTSO-E nuclear generating capacity increase / decrease in Scenario EU 2020

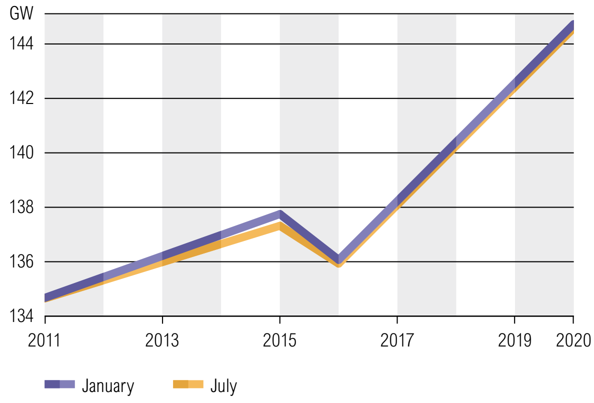


Figure 4.42:
ENTSO-E nuclear generating capacity forecast, Scenario EU 2020

The number of nuclear power plants in total NGC per country in 2015 and 2020 is depicted in the maps on the next page (Figures 4.43 and 4.44). The countries with the highest share of nuclear power in the national NGC are France (48 % in 2015 and 45 % in 2020) and Slovakia (about 31 % in both years) followed in 2015 by Belgium (27 %) and Sweden (25 %) and in 2020 by Finland (26 %) and the Czech Republic (25 %). The average value for the whole ENTSO-E is about 13 % in both years.

The biggest increase of nuclear capacity between 2015 and 2020 is expected in Romania (102 %) and Bulgaria (100 %) followed by the Czech Republic (43 %) and Finland (37 %). Only Belgium (31 %) and Germany (1.5 %) report a decrease in nuclear NGC. The implementation of the nuclear phase-out is taken into consideration for Belgium, although a revision of this law is currently under discussion and a postponement by ten years of the nuclear phase-out is very probable.

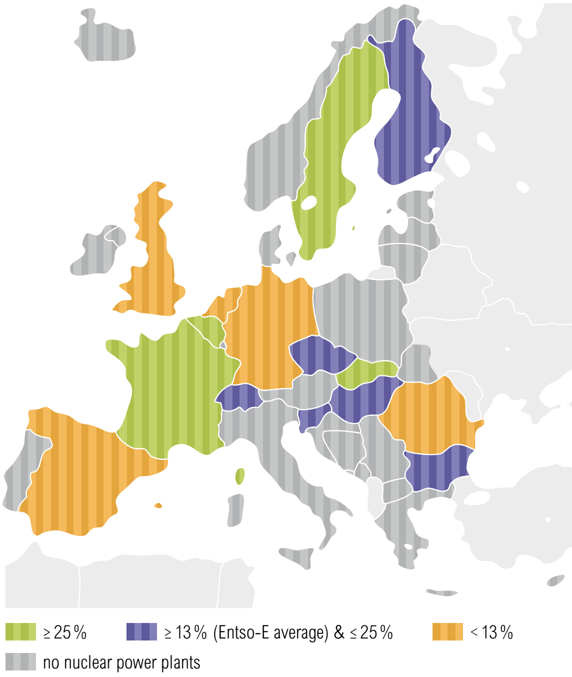


Figure 4.43:
Share of nuclear power plants in net generating capacity per country in 2015, Scenario EU 2020

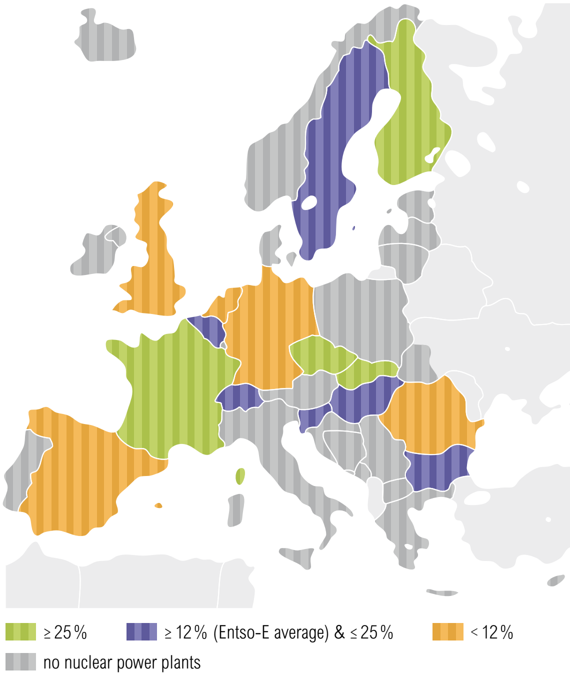


Figure 4.44:
Share of nuclear power plants in net generating capacity per country in 2020, Scenario EU 2020

Comparison of Scenario EU 2020 with Scenario B is shown in Figure 4.45. The installed capacity in Scenario B is slightly higher than in Scenario EU 2020. The difference in 2015 only applies to Sweden (surplus 200 MW in Scenario B). By 2020 the difference is mainly caused by Lithuania, where a new NPP (1.5 GW) is expected to come into operation in Scenario B: also, Sweden expects a surplus of 300 MW. On the other hand, in Germany TSOs expect the decrease of NPP installed capacity in Scenario B by 1.46 GW in 2020 (whereas in SAF 2010 it was about 7.6 GW).

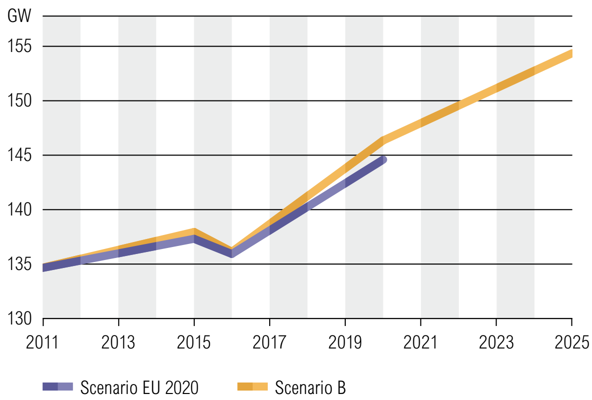


Figure 4.45:
ENTSO-E nuclear generating capacity forecast, Scenarios EU 2020 & B

Scenario A and Scenario B

In Scenario A the forecast of nuclear power plants' NGC is more pessimistic than in Scenario B (see Figure 4.46 and Table 4.16). In this scenario the capacity first slowly increases and then rapidly decreases. Conversely, in Scenario B the nuclear capacity is increasing all the time (with the exception of the period between 2015 and 2016).

[GW]	2011	2015	2016	2020	2025
Scenario A	135	135	131	131	102
Scenario B	135	138	136	146	153

Table 4.16:
ENTSO-E nuclear generating capacity in Scenarios A & B, January 7 p.m

[%]	2011 to 2015	2015 to 2016	2016 to 2020	2020 to 2025
Scenario A	< 1	-3	< 1	-22
Scenario B	2	-1	8	5

Table 4.17:
ENTSO-E nuclear generating capacity increase / decrease in Scenarios A & B, January 7 p.m.

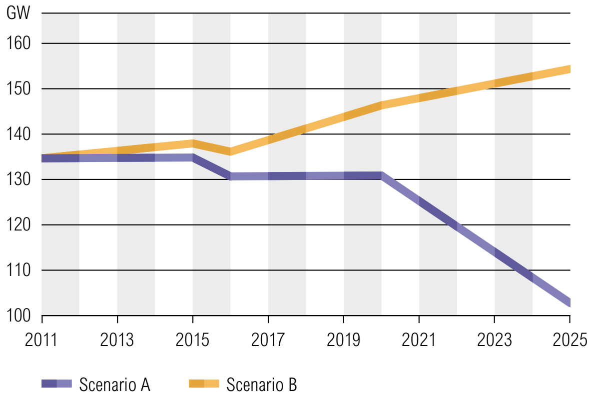


Figure 4.46:
ENTSO-E nuclear generating capacity forecast, Scenarios A & B

The biggest difference between Scenarios A and B in 2020 is reported by Great Britain (-7.6 GW), France (-3.7 GW), Finland (-1.6 GW) and Lithuania (-1.46 GW). In 2025 is the difference is mainly France (24 GW; in Scenario A, the lifetime of the nuclear power plants is under 40 years, whereas in Scenario B it is more than 40 years) and Great Britain again (-11.5 GW) followed by Finland (-3.2 GW), Lithuania (-2.9 GW) and Switzerland (-2.1 GW). It is important to note that the difference between Scenario B and Scenario A for the whole ENTSO-E in the period from 2020 to 2025 increases from 15.5 GW to more than 50 GW, probably because the TSOs did not include in Scenario A new projects with unconfirmed investment or they included a shorter lifetime for nuclear units.

The share of nuclear power plants in total NGC per country in 2015 and 2020 is depicted in the maps on the next page (Figures 4.47 and 4.48). The highest share of nuclear power plants in the national NGC show France (50 % in 2015 and 47 % in 2020), Slovakia (about 31 % in both years) and Sweden (26 % in both years) followed in 2015 by Belgium (27 %) and in 2020 by Finland (25 %). Lithuania has reported no nuclear power plants in 2015, but in 2020 it accounts for about 22 % of NGC being produced by this kind of power. Average ENTSO-E value for both years is about 13 %.

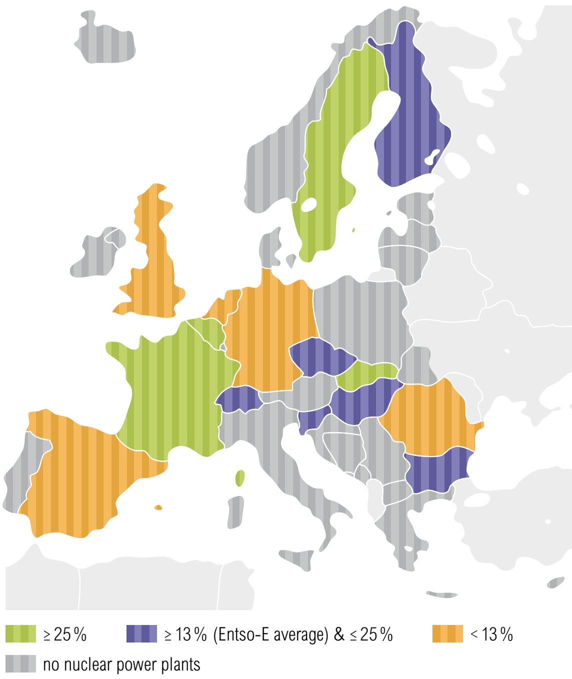


Figure 4.47:
Share of nuclear power plants in net generating capacity per country in 2015, Scenario B

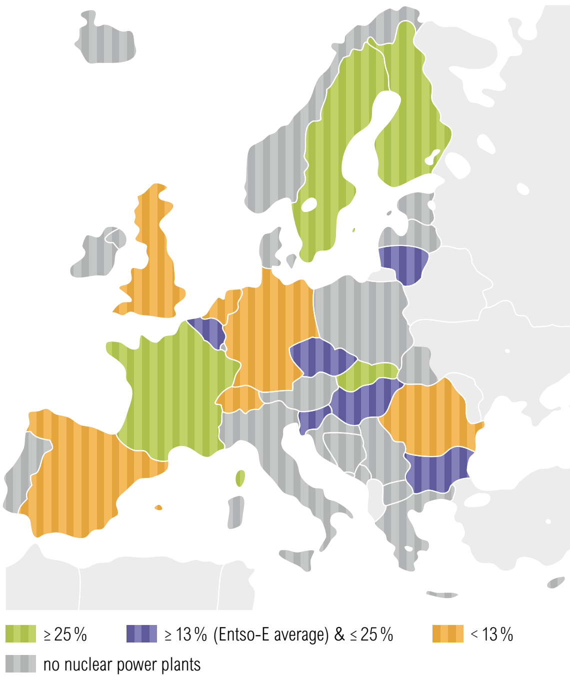


Figure 4.48:
Share of nuclear power plants in net generating capacity per country in 2020, Scenario B

In general, figures regarding increase / decrease of nuclear capacity between 2015 and 2020 are almost the same as in Scenario EU 2020. The biggest increase is expected in Romania (102 %) and Bulgaria (100 %) followed by the Czech Republic (43 %), Finland (37 %) and others. A decrease is only reported by Belgium (31 %; with the same remark as in Scenario 2020) and Germany (7 %) again.

4.2.3.4 NGC – Renewable Energy Sources

In this chapter, renewable energy sources (hereafter "RES") including renewable hydro power plants (hereafter "HPP") are assessed and jointly termed "total RES." The evaluations, statements and maps in this paragraph may be slightly biased, however, as not every TSO was able to divide total hydro power plant installed capacity into the requested sub-categories, which made proper distinction between individual sub-categories of hydro power plants impossible.

The main issue is for TSOs to identify the renewable generating capacity in hydro power units that combine the possibility of pump storage with natural inflow (pure pump storage is not recognized as RES). Hence TSOs are not always able to identify if the hydro capacity can be classified as a RES capacity, although this is not true for actual generation. When the result or evaluation in the text is influenced by this fact, the reader is warned in advance.

As RES HPP, the run-of-river and natural inflow storage HPP were considered. As non-RES HPP, pure pumped storage HPP and the pumping part of mixed natural inflow and pump storage power plants were considered.

Scenario EU 2020

Figure 4.49 shows the evolution of total RES installed capacity in Scenario EU 2020 for January and July. The increase rates are reported in Table 4.18.

The biggest increase is expected before 2015 (about 33 % in January as well as July). It is caused by the rise in Germany (about 29 GW compared with 2011) followed by Spain, Great Britain, France (between 9 GW and 14 GW) and Italy (5.7 GW). The highest increase is expected in Great Britain (180 %), Estonia (163 %), Luxembourg (115 %), the Netherlands (109 %) and Poland (107 %). An increase of more than 50 % is reported for Bosnia and Herzegovina, Belgium, Bulgaria, Germany, Greece, Northern Ireland, Italy, Iceland, Lithuania and Romania (almost 50 %). Obviously, a lot of countries expect ambitious development of RES technology in this scenario and time period.

After 2015, the highest growths are reported by Northern Ireland at 191 % (owing to the high incentives offered for renewable generation), Serbia (152 %), Cyprus (about 140 %), Belgium (98 %), Great Britain (95 %) and the Netherlands (91 %) again. The remaining countries expect a less dramatic trend in new RES power plant development. The higher increases in absolute values are in the same countries as before, i. e. Germany (28 GW), Spain (14 GW), Great Britain (14 GW), France (17 GW) and Italy (8 GW).

Iceland does not expect any increase between 2015 and 2020.

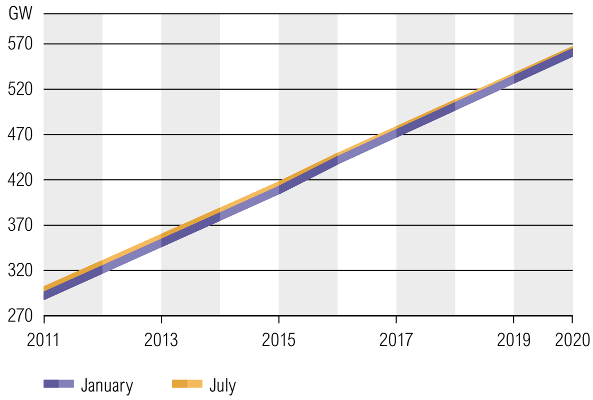


Figure 4.49:
ENTSO-E total RES generating capacity forecast, Scenario EU 2020

[%]	2011 to 2015	2015 to 2016	2016 to 2020
January	33	7	25
July	33	6	24

Table 4.18:
ENTSO-E total RES increase / decrease rate in Scenario EU 2020

[GW]	2011	2015	2016	2020
January	288	385	411	512
July	293	389	415	515

Table 4.19:
ENTSO-E total RES forecast in Scenario EU 2020

The maps below (Figures 4.50 and 4.51) show the share of total RES in NGC of each ENTSO-E country in 2015 and 2020. The majority of countries show a lower share of total RES than the ENTSO-E average in both years. Among the countries with a higher share of total RES in their NGC mix, one can count Germany, Spain, Sweden, Norway, Portugal, etc. which have significant shares of either RES HPP or wind/solar power plants in their national NGC or which expect more or less rapid development of RES power plants.

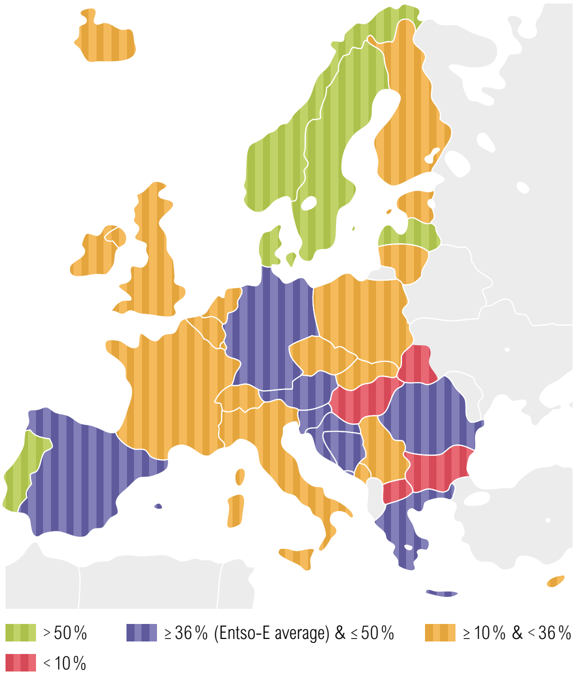


Figure 4.50:
Share of total RES in net generating capacity per country in 2015, Scenario EU 2020

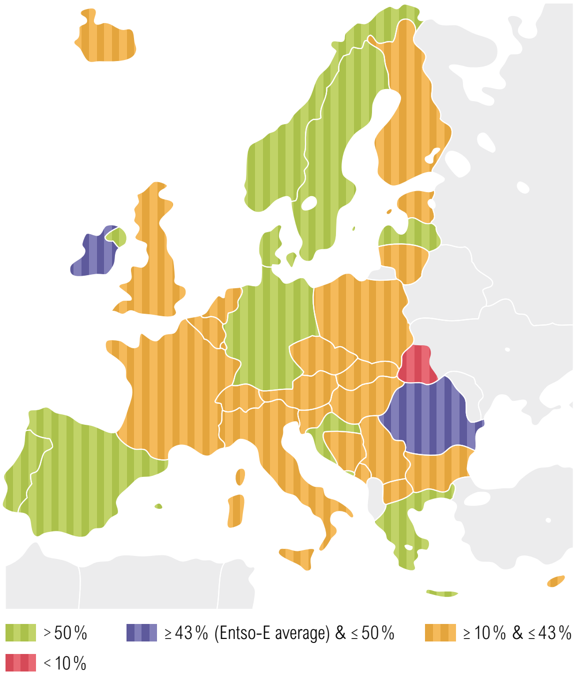


Figure 4.51:
Share of total RES in net generating capacity per country in 2020, Scenario EU 2020

The total RES share in NGC in 2020 is higher than in 2015 in almost every country, as reported by Northern Ireland (surplus of almost 30 %), Great Britain (12 %), Germany (13 %), Belgium (14 %), Greece (7 %), Hungary, Spain and Bulgaria (each up to 2 %), etc. The ENTSO-E total RES capacity mix is shown in Figure 4.52. It shows that wind, solar and biomass sources are increasing their share in total RES installed capacity, against the share of renewable hydro power plants and unattributable[1] RES.

The number of on-shore and offshore wind power plants in total wind installed capacity is shown in Figure 4.53. On-shore wind farms play a major role in the wind power plant category and they account for 78 % in 2020 and 90 % in 2011. On the other hand, the offshore wind farms' growth is visible and this sub-category becomes more important by 2020.

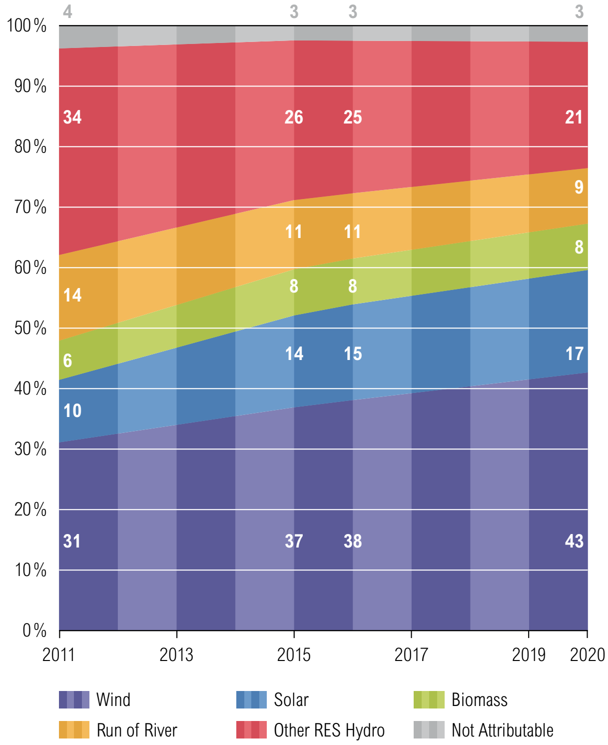


Figure 4.52:
ENTSO-E total RES generating capacity mix,
January 7 p.m., Scenario EU 2020

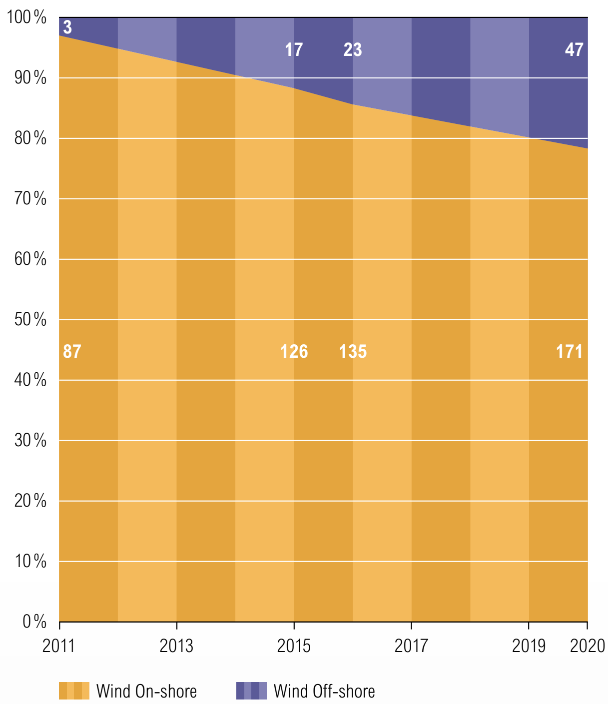


Figure 4.53:
ENTSO-E total wind breakdown,
January 7 p.m., Scenario EU 2020, values in GW

1) Within the category "Not attributable RES" also the renewable hydro power plants installed capacity in Austria is considered.

Table 4.20 reviews RES installed capacity for each category and country. It is evident that in terms of wind and solar energy the leaders are Germany and Spain in both 2015 and 2020. On the other hand, Italy, France, Spain with Norway and Sweden play a central role in the RES hydro power plants, and Germany with Finland, France and Sweden lead in the biomass category.

	2015					2020				
[GW]	Wind	Solar	Bio-mass	Total RES Hydro	TOTAL RES	Wind	Solar	Bio-mass	Total RES Hydro	TOTAL RES
AT	2.00	0.18	1.23	8.42	11.82	2.60	0.32	1.28	9.00	13.20
BA	0.49	0.00	0.00	1.32	1.81	0.49	0.00	0.00	1.32	1.81
BE	2.05	0.71	1.29	0.12	4.17	4.32	1.34	2.45	0.14	8.25
BG	0.85	0.05	0.00	0.35	1.25	1.50	0.16	0.00	0.30	1.96
CH	0.00	0.00	0.00	3.70	4.20	0.00	0.00	0.00	3.70	4.50
CY	0.18	0.05	0.01	0.00	0.24	0.30	0.27	0.02	0.00	0.59
CZ	0.50	1.50	0.90	1.00	3.90	0.70	1.70	1.10	1.10	4.60
DE	**36.60**	**34.28**	**7.73**	4.46	83.16	**46.00**	**52.00**	**9.00**	5.00	112.00
DK	4.18	0.00	1.84	0.01	6.21	3.96	0.00	2.78	0.01	6.75
EE	0.40	0.00	0.02	0.00	0.42	0.65	0.00	0.02	0.00	0.67
ES	**26.00**	**8.10**	0.90	**16.90**	51.90	**35.10**	**12.10**	1.40	**17.30**	66.00
FI	0.70	0.00	**2.20**	3.10	6.00	2.50	0.00	**2.90**	3.10	8.50
FR	**13.40**	2.40	**1.90**	**25.60**	43.30	**25.00**	5.40	**3.00**	**26.90**	60.40
GB	**12.20**	0.00	1.14	1.13	14.46	**25.35**	0.00	1.68	1.13	28.15
GR	3.80	1.10	0.12	2.92	8.10	6.80	2.00	0.25	2.96	12.44
HR	0.40	0.00	0.10	1.80	2.30	0.80	0.10	0.20	2.10	3.20
HU	0.50	0.02	0.32	0.05	0.90	0.74	0.06	0.19	0.07	1.13
IE	3.15	0.00	0.14	0.23	3.52	4.36	0.00	0.15	0.24	4.75
NI	0.69	0.00	0.00	0.00	0.70	1.55	0.00	0.19	0.00	2.04
IT	**9.10**	**5.60**	2.90	**17.20**	35.50	**12.70**	**8.60**	3.80	**17.80**	43.82
IS	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.00	1.03
LT	0.39	0.01	0.15	0.12	0.67	0.50	0.01	0.22	0.12	0.85
LU	0.11	0.09	0.04	0.05	0.28	0.13	0.11	0.06	0.05	0.35
LV	0.39	0.00	0.11	1.54	2.04	0.75	0.00	0.20	1.54	2.49
ME	0.18	0.00	0.00	0.09	0.27	0.18	0.00	0.00	0.54	0.72
MK	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.10	0.30
NL	5.60	0.30	0.70	0.10	6.70	11.20	0.70	0.70	0.20	12.80
NO	1.30	0.00	0.00	**29.20**	30.50	2.50	0.00	0.00	**28.70**	31.20
PL	3.64	0.00	1.39	1.00	6.03	7.00	0.00	2.30	1.15	10.46
PT	5.60	0.59	0.25	6.07	13.20	6.83	1.33	0.25	9.54	18.80
RO	2.90	0.11	0.32	6.94	10.28	4.00	0.26	0.57	7.47	12.30
RS	0.00	0.00	0.00	1.87	1.87	2.50	0.00	0.03	2.19	4.72
SI	0.34	0.00	0.00	1.05	1.39	0.44	0.00	0.00	1.18	1.62
SE	4.50	0.00	**3.50**	**16.30**	24.30	6.60	0.00	**4.30**	**16.30**	27.20
SK	0.15	0.17	0.21	1.67	2.20	0.35	0.30	0.26	1.73	2.64
UA-W	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.03	0.03
ENTSO-E	**142**	**55**	**29**	**154**	**385**	**219**	**87**	**39**	**163**	**512**

Table 4.20:
ENTSO-E RES summary in Scenario EU 2020 for 2015 and 2020

Comparison between Scenario EU 2020 and Scenario B

Figures 4.54 and 4.55 below show the comparison of each RES category for Scenario EU 2020 and Scenario B. In Scenario EU 2020 installed capacity for each one of the RES categories is higher than in Scenario B. This difference is most striking for solar and biomass power plants, whose development in Scenario EU 2020 is expected to be very intensive. More striking changes are expected after 2016 when the difference between scenarios is greater.

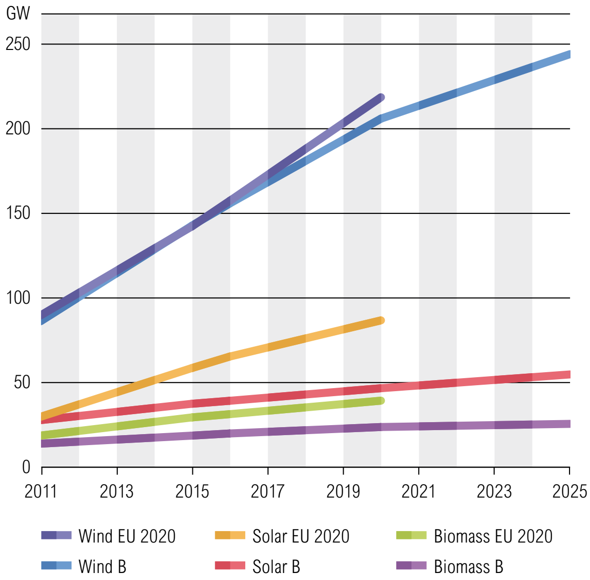


Figure 4.54:
Comparison between Scenario B and Scenario EU 2020 for wind, solar and biomass installed capacity, January 7 p.m.

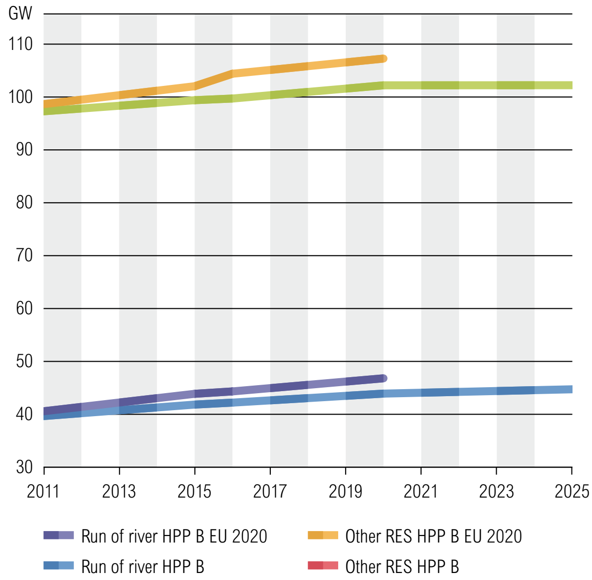


Figure 4.55:
Comparison between Scenario B and Scenario EU 2020 for run of river HPP and other renewable HPP installed capacity, January 7 p.m.

Scenario A and Scenario B

Values for January and July are almost identical (see Table 4.21). Therefore in Figure 4.56 only values for January of both Scenarios A & B are reported.

	[GW]	2011	2015	2016	2020	2025
Scenario A	Jan	278	326	338	379	412
	Jul	285	328	340	380	414
Scenario B	Jan	278	355	372	440	489
	Jul	284	358	375	441	490

Table 4.21:
ENTSO-E total RES forecast in Scenarios A & B

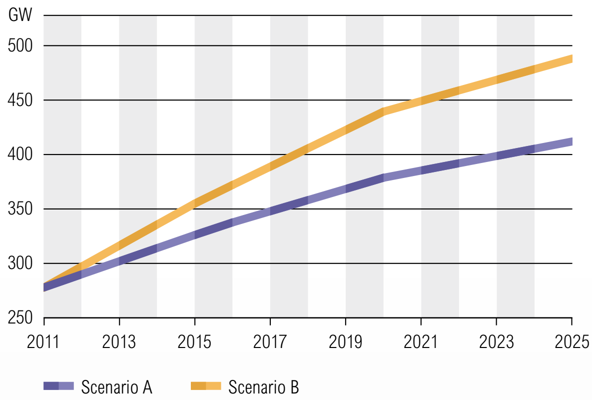


Figure 4.56:
ENTSO-E RES (w/o HPP) generating capacity forecast, Scenarios A & B

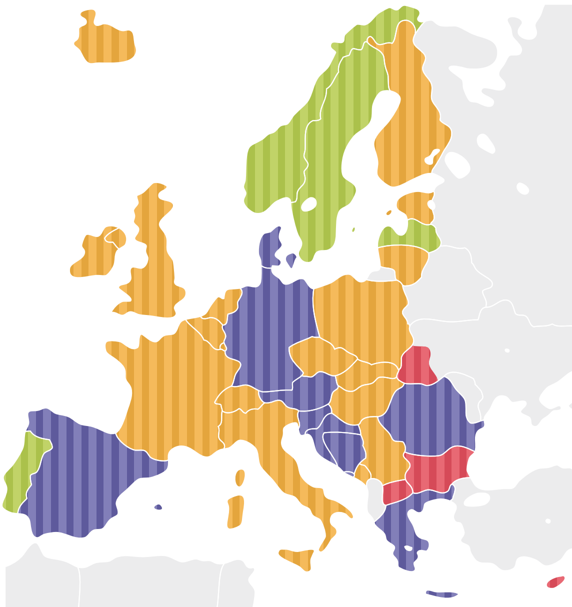
[%]	2011 to 2015	2015 to 2016	2016 to 2020	2020 to 2025
January	28	5	18	11
July	26	5	18	11

Table 4.22:
ENTSO-E total RES increase / decrease rat in Scenario B

The installed capacity of total RES is increasing all the time for Scenario A and B. Increase rates for Scenario B are reported in Table 4.22. Higher increases before 2015 are expected in Poland (130 %), Greece (114 %) or Cyprus (100 %). There are also countries with an increase of more than 80 % (Bulgaria, Iceland and Northern Ireland); in fact, a rise is expected in every ENTSO-E country before 2015. After 2015 only Northern Ireland shows an increase of more than 100 % (namely 189 %). Cyprus, Belgium and Great Britain show a rise of nearly 100 % (100 %, 98 % and 95 % respectively).

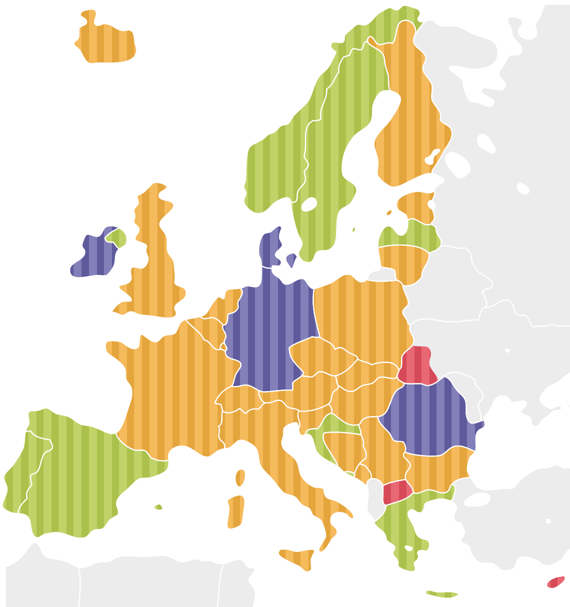
In absolute values Germany and Spain show the biggest increase of installed capacity before 2015 (17 GW and 10 GW respectively). After 2015 faster growing capacity is reported in Great Britain (14 GW), France (12 GW) and Spain again (10 GW).

Maps below (Figures 4.57 and 4.58) show the total RES share in each ENTSO-E country in 2015 and 2020. As for Scenario EU 2020 there are countries which have a significant share of RES. It is remarkable that some countries report a more optimistic RES development trend in Scenario B than in Scenario EU 2020.



> 50 %   ≥ 34 % (Entso-E average) & ≤ 50 %   ≥ 10 % & < 34 %   < 10 %

Figure 4.57:
Share of total RES in net generating capacity per country in 2015, Scenario B



> 50 %   ≥ 39 % (Entso-E average) & ≤ 50 %   ≥ 10 % & < 39 %   < 10 %

Figure 4.58:
Share of total RES in net generating capacity per country in 2020, Scenario B

A share of total RES in national NGC higher than 50 % in both 2015 and 2020 is expected in Norway (about 90 % in both years), Sweden (between 59 % and 64 %), Latvia (66 % and 62 %), and Portugal (between 62 % and 68 %). In 2020 Northern Ireland (54 %), Croatia (55 %), Spain (slightly more than 50 %) and Greece (51 %) will join this group.

Such strong RES development is mainly influenced by the legislation within each country. National governments usually encourage the development of RES power plants (excluding hydro) by implementing policies such as advantageous feed-in tariffs or special conditions for access and connection to the grid or other additional subsidies. All these circumstances also have an impact on investors and their intention to build this kind of power plant (regardless of the scenario).

Wind power plants (40 %) and other RES hydro power plants (28 %) have the biggest share in total RES installed capacity in 2015 followed by run-of-river HPP (12 %) and solar power plants (11 %). In 2020 the order is the same in terms of the first two places but solar power plants and run-of-river HPP will change their positions. Only wind power plants will increase their share in total RES category continuously (from 31 % in 2011 up to 50 % in 2025). Biomass remains at about 5 % during the whole forecast period between 2011 and 2025, as do unattributable RES[1] (about 4 %).

The share of on-shore and offshore wind power plants in total wind installed capacity in January in Scenario B is shown in Figure 4.60. The situation is similar to that of Scenario EU 2020, i. e. on-shore wind farms play a major role in total wind power installed capacity whereas offshore wind farms' growth is clearly visible and becomes more significant by 2020.

The table on the next page shows the order of countries according to their RES capacity mix (Table 4.23). The countries with the highest amount of installed wind generation are Germany, Spain, Great Britain and Italy in 2015 and also

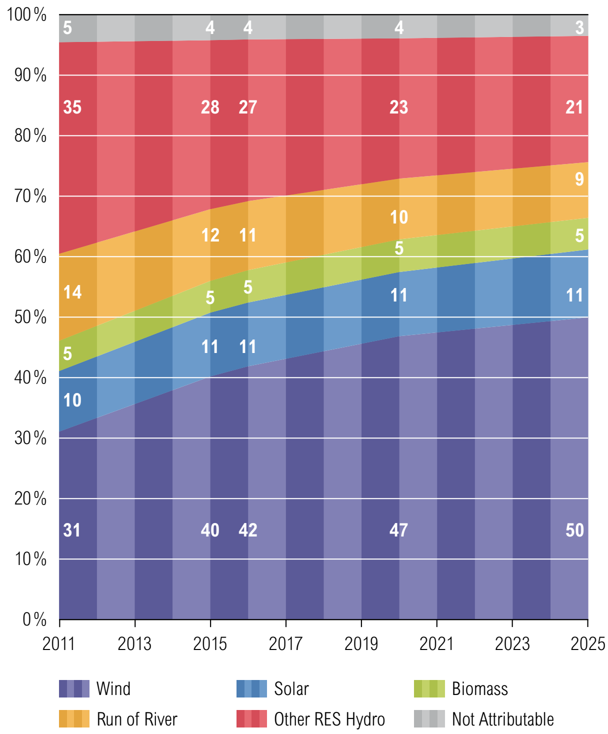


Figure 4.59:
ENTSO-E total RES generating capacity mix,
January 7 p.m.; Scenario B

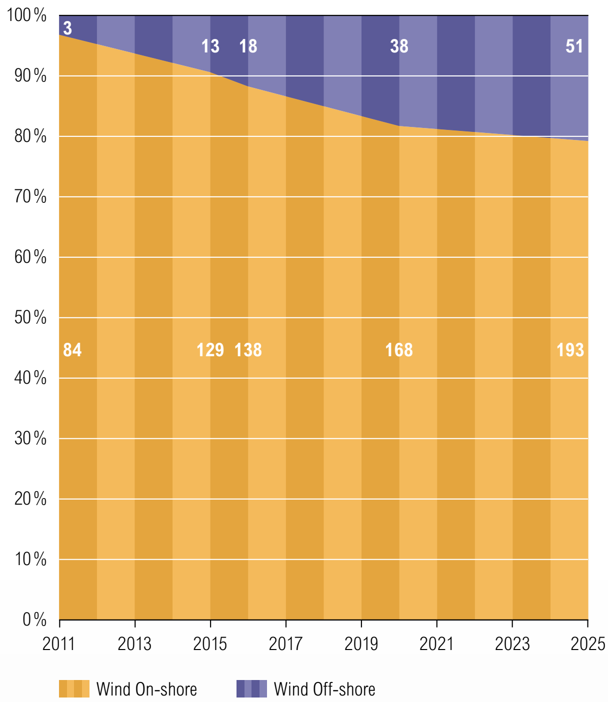


Figure 4.60:
ENTSO-E total wind breakdown,
January 7 p.m.; Scenario B, values in GW

[1] Within the category "Not attributable RES" also the renewable hydro power plants installed capacity in Austria is considered.

2020 (with France). The countries with the highest amount of installed solar generation are Germany in both 2015 and 2020 followed by Spain and France. Finally, the countries with a bigger hydro capacity are Spain, France, Norway and Sweden together with Portugal in 2020.

	2015					2020				
[GW]	Wind	Solar	Bio-mass	Total RES Hydro	TOTAL RES	Wind	Solar	Bio-mass	Total RES Hydro	TOTAL RES
AT	1.50	0.00	0.00	8.42	11.02	1.60	0.00	0.00	9.00	11.70
BA	0.49	0.00	0.00	1.26	1.75	0.49	0.00	0.00	1.26	1.75
BE	2.05	0.71	1.29	0.12	4.17	4.32	1.34	2.45	0.14	8.25
BG	0.85	0.05	0.00	0.35	1.25	1.50	0.16	0.00	0.30	1.96
CH	0.00	0.00	0.00	3.70	4.20	0.00	0.00	0.00	3.70	4.50
CY	0.10	0.00	0.00	0.00	0.10	0.15	0.05	0.00	0.00	0.20
CZ	0.60	2.50	0.30	0.30	3.70	1.10	2.90	0.40	0.30	4.70
DE	**42.50**	**20.00**	**5.40**	3.50	71.40	**48.00**	**20.00**	**6.00**	3.70	77.70
DK	4.59	0.00	0.40	0.01	5.01	5.68	0.00	0.45	0.01	6.14
EE	0.70	0.00	0.02	0.00	0.72	0.70	0.00	0.02	0.00	0.72
ES	**26.00**	**8.00**	0.90	**16.90**	51.70	**33.30**	**10.00**	1.40	**17.30**	62.00
FI	0.70	0.00	**2.20**	3.20	6.10	2.50	0.00	**2.90**	3.20	8.60
FR	**9.50**	**3.50**	1.20	**23.40**	37.60	**17.00**	**8.00**	1.20	**23.40**	49.60
GB	**12.20**	0.00	1.14	1.13	14.46	**25.35**	0.00	1.68	1.13	28.15
GR	3.80	1.10	0.12	2.94	8.10	7.40	2.10	0.25	3.35	13.58
HR	0.70	0.00	0.10	1.80	2.60	1.20	0.10	0.20	2.10	3.60
HU	0.74	0.00	0.40	0.05	1.29	0.90	0.00	0.48	0.05	1.55
IE	3.03	0.00	0.14	0.24	3.41	4.39	0.00	0.15	0.24	4.78
NI	0.72	0.00	0.00	0.00	0.73	1.60	0.00	0.20	0.00	2.11
IT	**9.60**	1.00	0.00	17.20	30.90	**15.40**	1.20	0.00	17.80	37.90
IS	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.00	1.03
LT	0.33	0.00	0.05	0.12	0.50	0.50	0.00	0.07	0.12	0.69
LU	0.06	0.04	0.02	0.05	0.16	0.09	0.05	0.03	0.05	0.21
LV	0.39	0.00	0.11	1.54	2.04	0.75	0.00	0.20	1.54	2.49
ME	0.18	0.00	0.00	0.09	0.27	0.18	0.00	0.00	0.54	0.72
MK	0.10	0.00	0.00	0.10	0.20	0.20	0.00	0.00	0.10	0.30
NL	3.60	0.10	0.70	0.00	4.40	5.80	0.10	0.70	0.00	6.60
NO	1.30	0.00	0.00	**29.20**	30.50	2.50	0.00	0.00	**28.70**	31.20
PL	4.76	0.00	0.40	0.93	6.09	6.89	0.00	0.49	0.95	8.32
PT	5.90	0.29	0.22	6.03	13.12	6.90	0.36	0.25	**8.38**	16.76
RO	2.00	0.00	0.02	6.27	8.29	3.20	0.00	0.02	6.38	9.60
RS	0.00	0.00	0.00	1.87	1.87	0.45	0.00	0.03	2.19	2.67
SI	0.18	0.00	0.00	0.98	1.16	0.18	0.00	0.00	1.14	1.32
SE	3.40	0.00	**3.30**	**16.30**	23.00	5.40	0.00	**3.90**	**16.30**	25.60
SK	0.15	0.17	0.21	1.67	2.20	0.35	0.30	0.26	1.73	2.64
UA-W	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.03	0.03
ENTSO-E	**143**	**37**	**19**	**150**	**355**	**206**	**47**	**24**	**155**	**440**

Table 4.23:
ENTSO-E RES summary in Scenario B for 2015 and 2020

4.2.3.5 NGC – non-RES Hydro Power Plants (HPP)

Scenario EU 2020

In Scenario EU 2020 the installed capacity in non-renewable hydro power plants (non-RES HPP) category is continuously increasing (Figure 4.61). The increase rate before 2015 is 8 % and after 2015 it grows to 25 %.

In both 2015 and 2020 the highest amount of non-RES HPP is reported in Switzerland (12.2 GW and 16.2 GW) and Austria (7.2 GW in 2015 and 10.3 GW in 2020) followed by Germany (5.5 GW and 7 GW).

The share of total HPP (RES HPP + non-RES HPP) installed capacity in NGC per country is shown in Figures 4.62 and 4.63. The highest share in both 2015 and 2020 is for Norway (92 % and 89 %) and Switzerland (76 % and 77 %) followed by Iceland, Luxembourg and Austria with more than 50 % NGC in HPP. In 2015 the countries with a total share of HPP in NGC greater than 50 % are Bosnia-Herzegovina (53 %) and Latvia (almost 50 %).

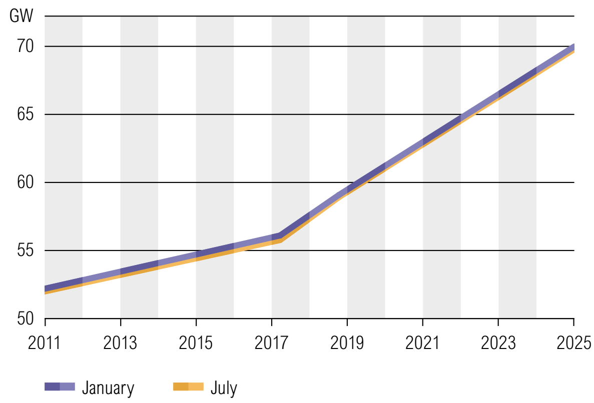


Figure 4.61:
ENTSO-E non-RES HPP generating capacity forecast, Scenario EU 2020

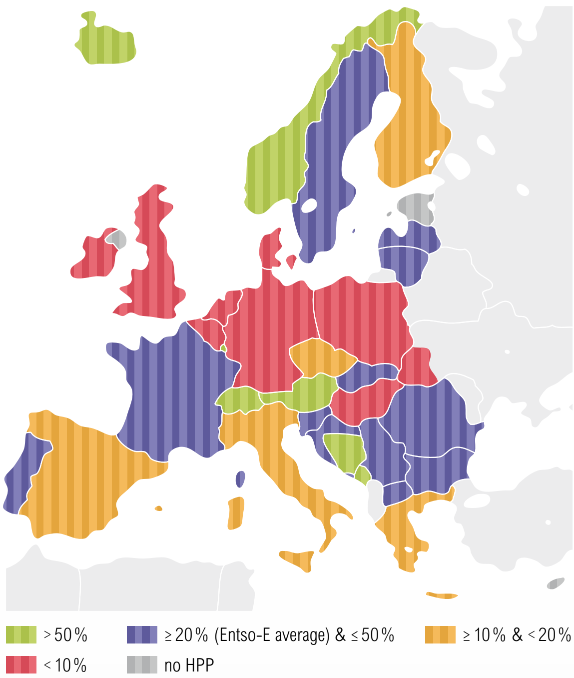


Figure 4.62:
Share of total HPP in net generating capacity per country in 2015, Scenario EU 2020

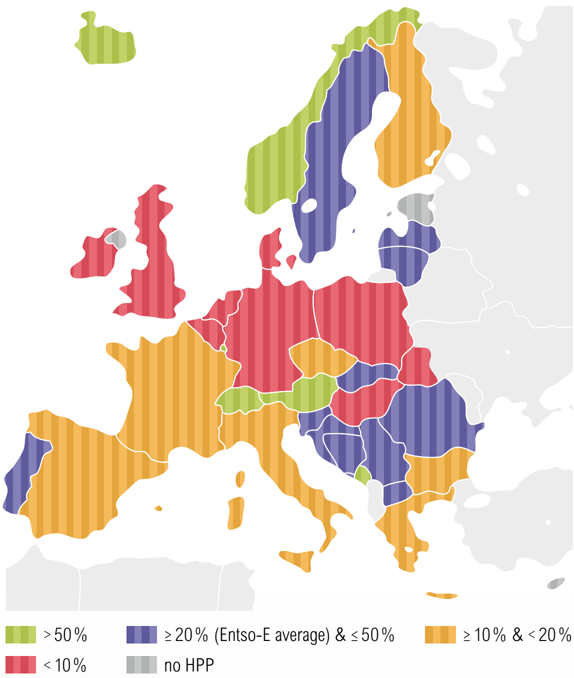


Figure 4.63:
Share of total HPP in net generating capacity per country in 2020, Scenario EU 2020

The total HPP installed capacity mix is depicted below (Figure 4.64). Non-RES HPP have the highest share in total hydro installed capacity, followed by other RES HPP and RES HPP. The figures do not, however, reflect the RES HPP installed capacity in Austria.[1)]

Comparing Scenarios B and EU 2020 (Figure 4.65) we see only slight differences between the scenarios.

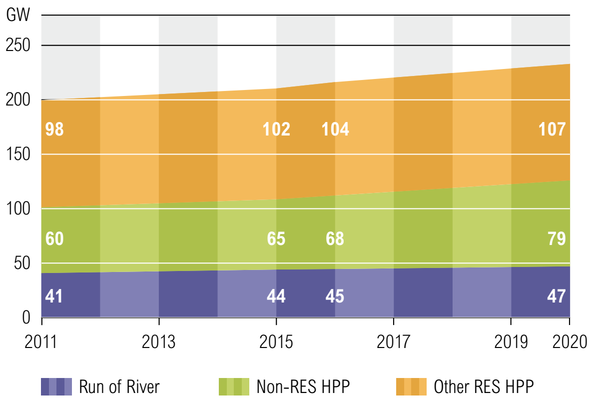


Figure 4.64:
ENTSO-E HPP installed capacity mix,
Scenario EU 2020, January 7 p.m.

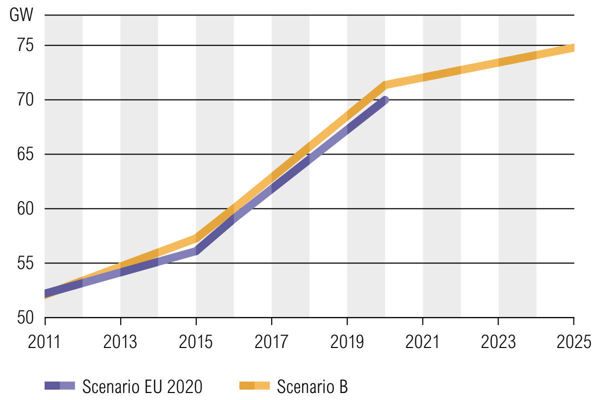


Figure 4.65:
Comparison of non-RES HPP
for Scenario EU 2020 and Scenario B, January 7 p.m.

Scenario A and Scenario B

ENTSO-E non-RES HPP forecasts for January at 7 p.m. for Scenarios A and B are shown in Figure 4.66. In both scenarios installed capacity is increasing continuously. The increase rate before 2015 is 7 % in Scenario A and 10 % in Scenario B. After 2025 it is 3.5 % in Scenario A and 5 % in B. During the period between 2015 and 2020 the increase for Scenario A is slower (14 %) than for Scenario B (25 %).

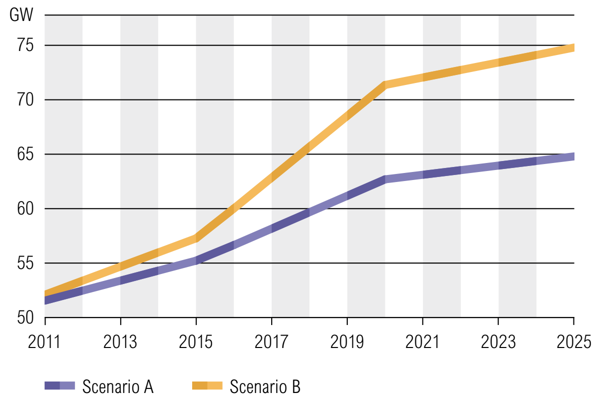


Figure 4.66:
ENTSO-E non-RES HPP generating capacity forecast,
Scenarios A & B

1) Austrian hydro data were divided and provided in subcategories “renewable” and “non-renewable” without division between more detailed subcategories; see also explanation at the beginning of paragraph 4.2.3.4.

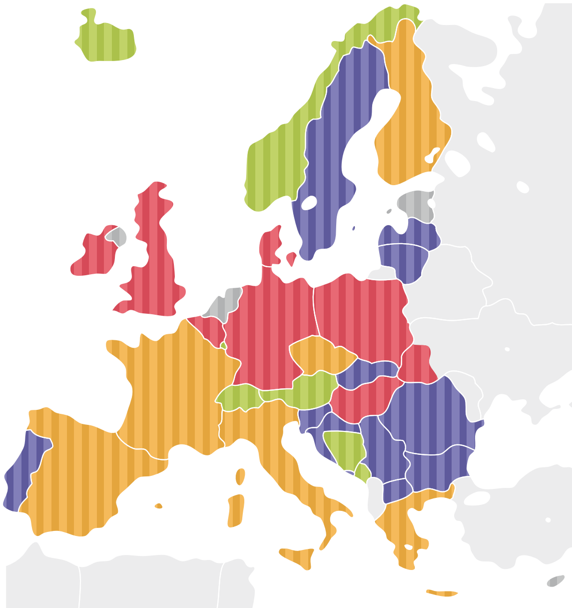


Figure 4.67:
Share of total HPP in net generating capacity per country in 2015, Scenario B

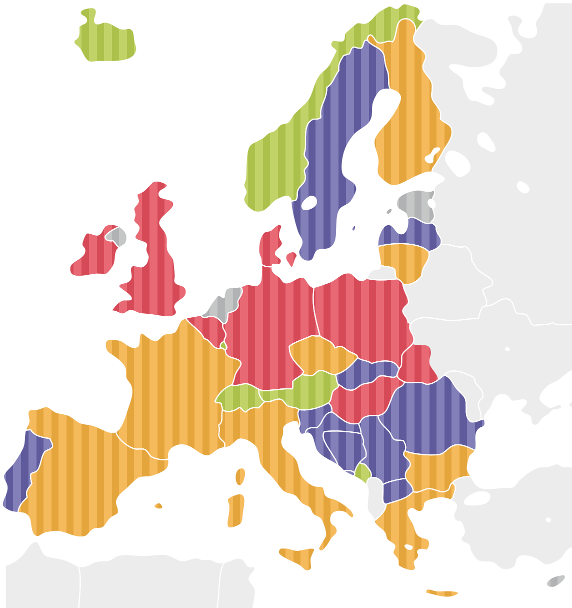


Figure 4.68:
Share of total HPP in net generating capacity per country in 2020, Scenario B

The highest share of total HPP installed capacity in national NGC in both 2015 and 2020 in Scenario B is for Norway (92 % and 89 %) and Switzerland (76 % and 77 %), followed by Austria (57 % and 59 %), Bosnia-Herzegovina (53 % and 45 %), Iceland (64 % and 63 %) and Luxembourg (67 % in both years). This situation is depicted in Figures 4.67 and 4.68.

Figure 4.69 shows the total HPP installed capacity mix. Non-RES HPP have the highest share in total hydro installed capacity and the course of development of total HPP installed capacity is similar to that of Scenario EU 2020. The figures do not reflect the RES HPP installed capacity in Austria.[1)]

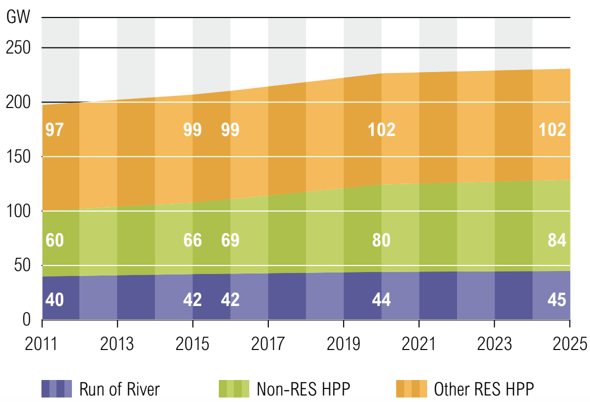


Figure 4.69:
ENTSO-E HPP installed capacity mix, Scenario B, January 7 p.m.

1) Austrian hydro data were divided and provided in subcategories “renewable” and “non-renewable” without division between more detailed subcategories; see also explanation at the beginning of paragraph 4.2.3.4.

4.2.3.6 Reliable Available Capacity

Scenario EU 2020

Reliable Available Capacity (RAC) in January and July increases during the whole forecast period (Figure 4.70). RAC in January is higher by about 7 % than in July, probably because unavailable capacity in July is much higher than in January, due to the influence of RES in unavailable capacity, as several TSOs reported such approach. The increase rates are about 7 % before, and about 5 % after, 2015.

The share of RAC in total ENTSO-E net generating capacity is expected to be 66 % in January 2015 and 61 % in January 2020. Of the ENTSO-E countries, Austria, Iceland, Luxembourg, FYROM and Serbia have the highest share of RAC in NGC in 2015 and 2020.

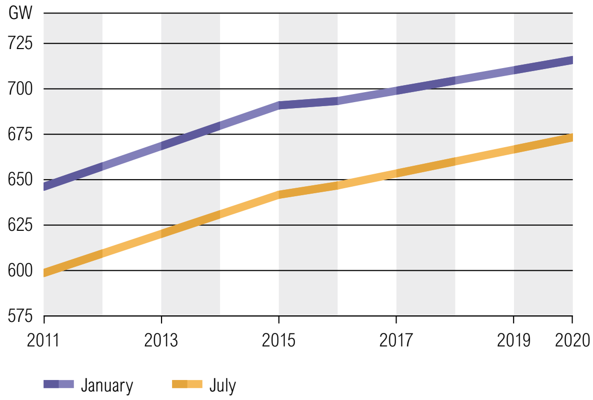


Figure 4.70:
ENTSO-E RAC forecast, Scenario EU 2020

Figures 4.71 and 4.72 show classification of the countries by share of RAC for the whole ENTSO-E in 2015 and 2020.

RAC will decrease between 2015 and 2020 most rapidly in Germany (more than 17 GW), followed by the Republic of Ireland (1.3 GW), Denmark, Estonia, Lithuania, Czech Republic, the Northern Ireland and Slovakia (less than 0.5 GW each). Other countries show an increase of RAC between 2015 and 2020.

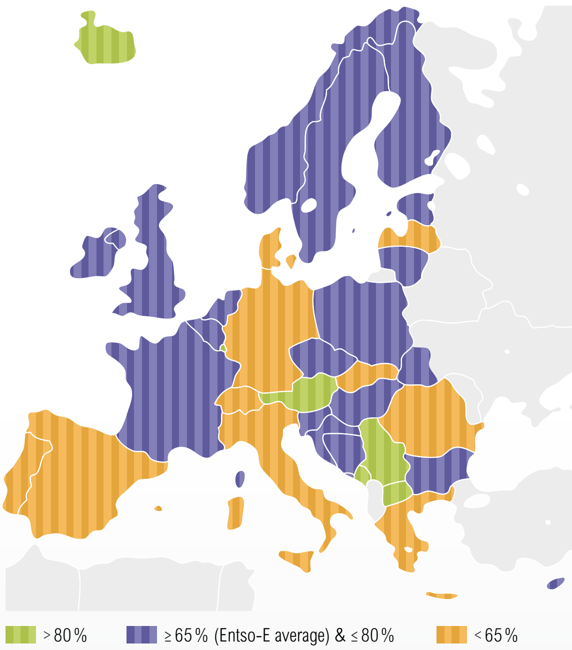


Figure 4.71:
RAC as a part of NGC per country in 2015, Scenario EU 2020

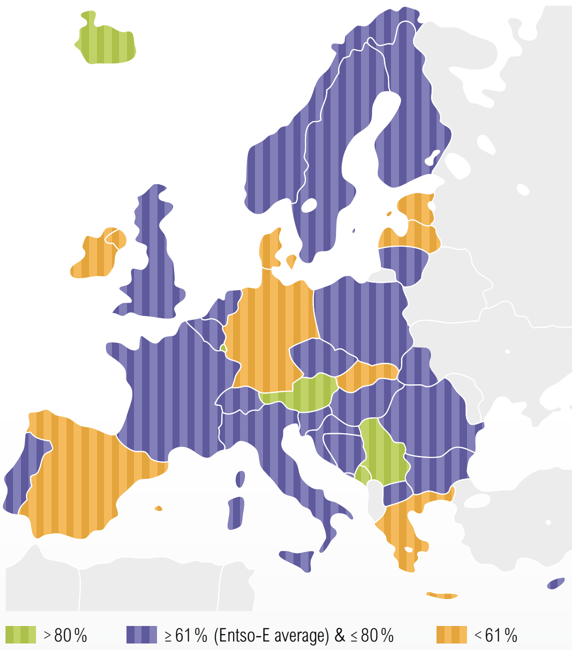


Figure 4.72:
RAC as a part of NGC per country in 2020, Scenario EU 2020

ENTSO-E's unavailable capacity mix is shown in Figure 4.73. The biggest proportion for the whole forecast period is for non-usable capacity, followed by system services reserve and outages. Non-usable capacity is the only category which is increasing its share within unavailable capacity from 2015 to 2020. Figure 4.74 shows the relation between RAC and unavailable capacity on the level of ENTSO-E. Both categories show an increasing rate and unavailable capacity always has a higher proportion. This effect is probably caused by the increasing amount of RES in the total generating capacity mix. Although the percentage of all unavailable capacity's sub-categories except for non-usable capacity is decreasing, in absolute values these sub-categories are growing continuously, but not as fast as non-usable capacity, which is expected to be almost twice as high in 2020 as in 2011 (see Table 4.25). Many TSOs counted RES (wind and solar above all) in the category "non-usable capacity" and therefore the major impact is reported for this category. System Service Reserve (SSR) is not increasing as fast.

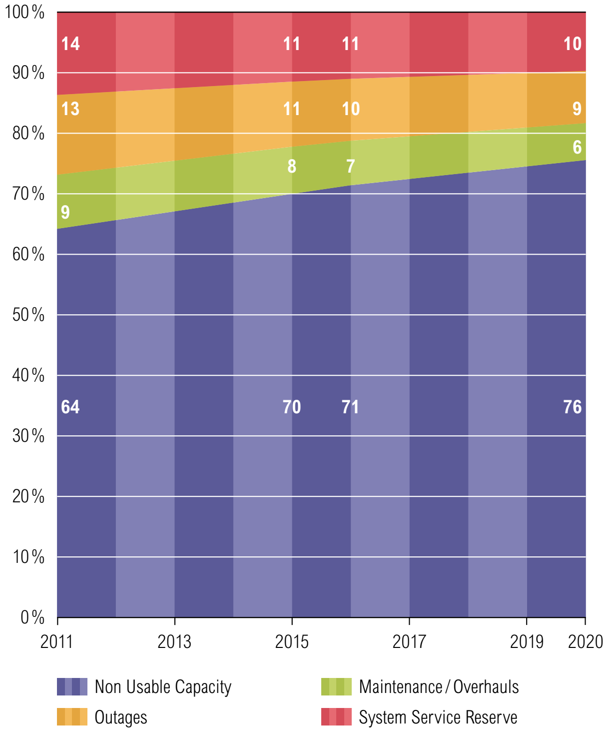


Figure 4.73:
ENTSO-E unavailable capacity mix, Scenario EU 2020

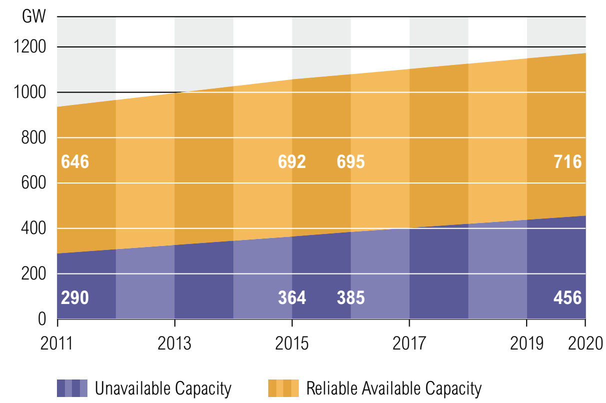


Figure 4.74:
ENTSO-E RAC and unavailable capacity forecast, Scenario EU 2020

[%]	2011	2015	2016	2020
Unavailable Capacity	31	34	36	39
RAC	69	66	64	61

Table 4.24:
ENTSO-E RAC and Unavailable capacity as a share of NGC in January 7 p.m. for Scenario EU 2020

[GW]	2011	2015	2016	2020
Non Usable Capacity	186	255	275	345
Maintenance\Overhauls	26	28	28	28
Outages	38	39	39	39
System Service Reserve	40	42	42	44
Unavailable Capacity	**290**	**364**	**385**	**456**

Table 4.25:
ENTSO-E unavailable capacity breakdown, January 7 p.m., Scenario EU 2020

Comparing Scenarios B and EU 2020 we find only minor differences (Figure 4.75). In both scenarios the average share of RAC in total NGC is about 65 % in January and 60 % in July.

Scenario A and Scenario B

Reliable Available Capacity in January at 7 p.m. in Scenario A and Scenario B is shown in Figure 4.76. In Scenario B the RAC is increasing all the time; conversely, in Scenario A it starts to decrease after 2015. The increase / decrease rates are shown in Table 4.26.

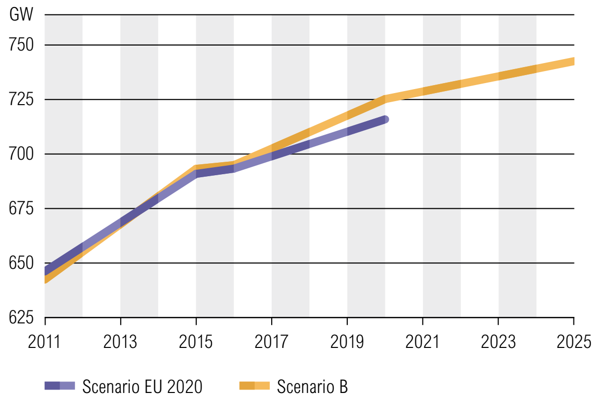


Figure 4.75:
ENTSO-E RAC forecast, Scenarios EU 2020 & B

[%]	2011 to 2015	2015 to 2020	2020 to 2025
Scenario A	2	-4	-8
Scenario B	8	5	2

Table 4.26:
ENTSO-E RAC increase/decrease rate in January 7 p.m. for Scenarios A & B

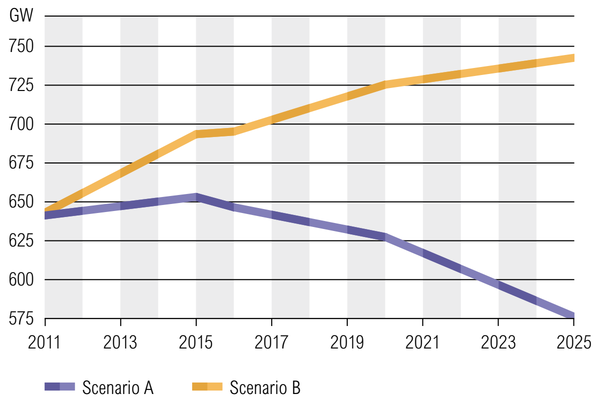


Figure 4.76:
ENTSO-E RAC forecast, Scenarios A & B

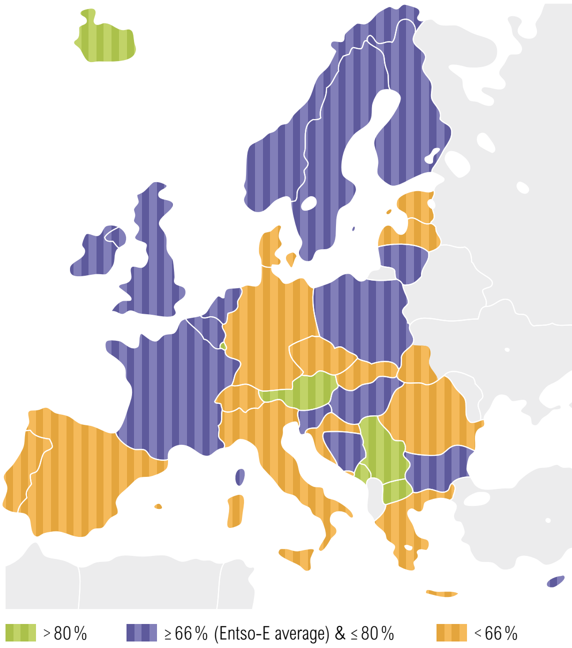


Figure 4.77:
ENTSO-E RAC as a part of NGC per country in 2015, Scenario B

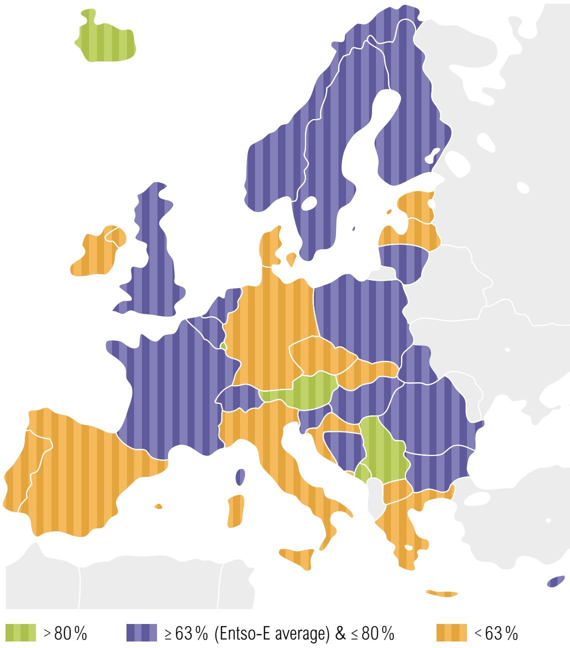


Figure 4.78:
ENTSO-E RAC as a part of NGC per country in 2020, Scenario B

Likewise, in Scenario EU 2020, RAC in January is expected to be higher than in July. The share of RAC in total ENTSO-E NGC is expected to be about 66 % in January 2015 and 63 % in January 2020 (reference point 7 p.m.). Austria, Iceland, Luxembourg, FYROM and Serbia have the highest share of RAC in their NGC in both 2015 and 2020 (more than 80 %). This situation is apparent in Figures 4.77 and 4.78.

Germany reported a decrease in RAC of 17 GW in 2020 compared with 2015. More reductions are also expected for the Republic of Ireland (1 GW), the Czech Republic, Estonia and Slovakia (less than 0.4 GW). In the remaining countries the RAC will increase in this period.

ENTSO-E unavailable capacity mix is shown in Figure 4.79. The biggest share over the whole forecast period is for non-usable capacity, followed by system services reserve and outages.

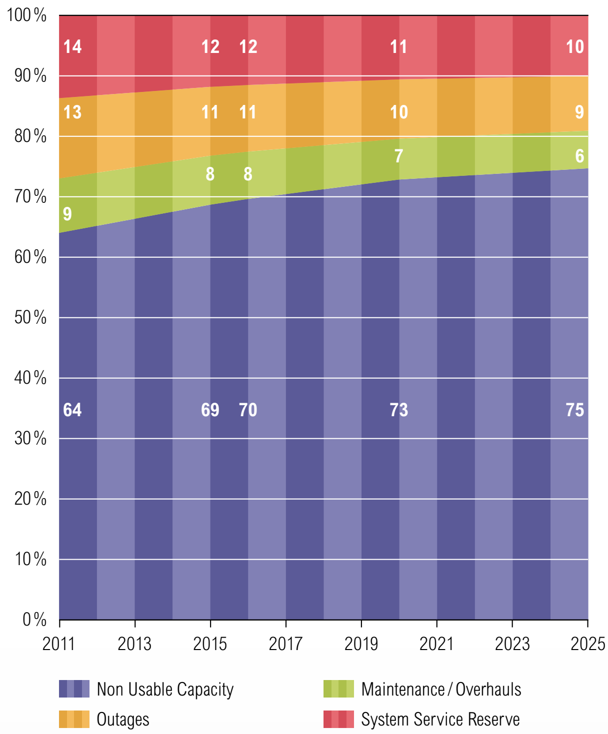


Figure 4.79:
ENTSO-E unavailable capacity mix, Scenario B

Figure 4.80 shows the relation between ENTSO-E reliable available capacity and unavailable capacity. Both categories show an increasing rate, but unavailable capacity is always growing faster, probably because of the increasing share of RES in non-usable capacity.

Similarly to Scenario EU 2020, in Scenario B the absolute values of each sub-category within unavailable capacity are increasing (Table 4.28) for the same reason as before.

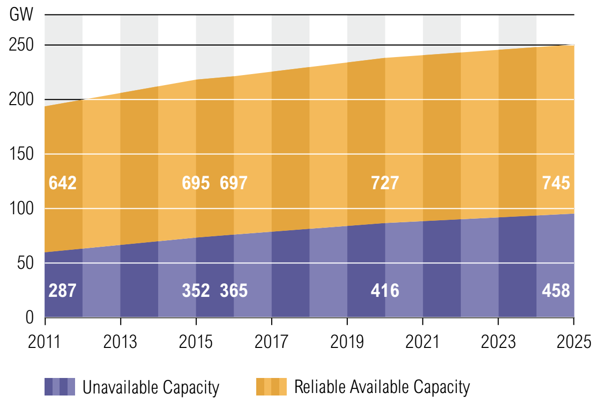


Figure 4.80:
ENTSO-E RAC vs. unavailable capacity, Scenario B

[%]	2011	2015	2016	2020	2025
Unavailable Capacity	31	34	34	36	38
RAC	69	66	66	64	62

Table 4.27:
ENTSO-E RAC and unavailable capacity as a share of NGC in January 7 p.m. for Scenario B

[GW]	2011	2015	2016	2020	2025
Non Usable Capacity	184	242	254	303	342
Maintenance\ Overhauls	26	29	29	28	28
Outages	38	40	40	41	41
System Service Reserve	39	42	42	44	46
Unavailable Capacity	**287**	**352**	**365**	**416**	**458**

Table 4.28:
ENTSO-E unavailable capacity breakdown, January 7 p.m., Scenario B

4.2.4 EU 2020 Indicators

The EU's climate and energy policy sets the following ambitious targets for 2020:

- Cutting energy consumption by 20 % of projected 2020 levels by improving energy efficiency.
- Increasing use of renewable energy sources (wind, solar, biomass, etc.) to 20 % of total energy consumption.
- Cutting greenhouse gases by at least 20 % of 1990 levels.

Three 2020 indicators were calculated from the data collected for this SO&AF report in order to assess how the scenarios match the 3 × 20 objectives, namely an indicator reflecting the impact of efficiency measures on electricity consumption, an RES share indicator and a CO_2 emissions indicator. The following paragraphs describe the calculations performed.

4.2.4.1 Indicator Reflecting the Impact of Efficiency Measures on Electricity Consumption

Since the European objective regarding energy efficiency does not give a specific target for electricity, any estimation is difficult because this objective may mean an increase in electricity consumption. The following general impacts can be identified

- An increase in electricity consumption owing to
  - An increase in lighting / appliances per household
  - An increase in the number of households
  - Some uses relying today on fossil fuels may become electricity-based in the future (development of electric cars, heat pumps, etc.)
- A decrease in electricity consumption owing to
  - Rationalization of energy in traditional electricity use

The proposed indicator reflecting the impact of efficiency measures on electricity consumption is simply the ratio of the electricity consumption forecast in a particular scenario (Scenario EU 2020 or Scenario B) in 2020 to the electricity consumption forecast in a business-as-usual scenario in 2020 based on the reference scenario of the NREAP for EU countries.

The impact of efficiency measures on electricity consumption at EU level is estimated at -6 % for the Scenario EU 2020 and -4.8 % for Scenario B. The assessment for the ENTSO-E level without Ukraine West gives -8.8 % for the Scenario EU 2020 and -4.3 % for Scenario B.

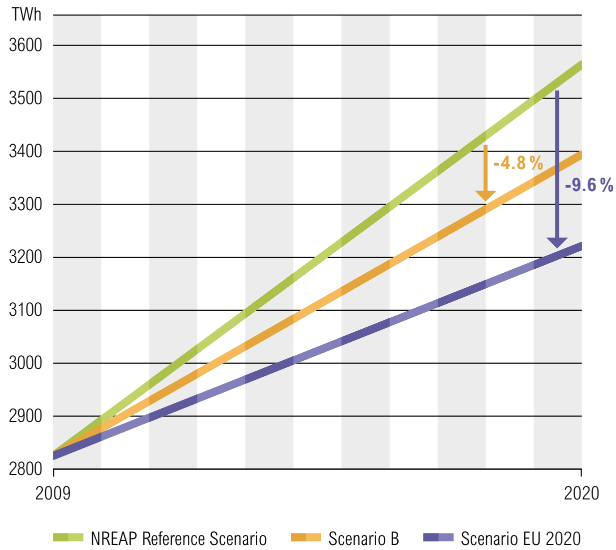


Figure 4.81:
Impact of efficiency measures on electricity demand at EU level

4.2.4.2 RES Indicator

The EU objective to increase the use of renewable energy sources (wind, solar, biomass, etc.) to 20 % of total energy consumption needs to be translated into an objective for the electricity sector.

The European Commission has indicated that the amount of electricity from renewable energy sources is expected to be over 30 % for the EU to reach its overall renewable energy target of 20 % by 2020 (source: http://ec.europa.eu/energy/renewables/electricity/electricity_en.htm).

The proposed RES indicator is simply the ratio of the generated power from Renewable Energy Sources in a particular scenario (Scenario EU 2020 or Scenario B) in 2020 to the electricity consumption of that particular scenario in 2020. The table gives an overview of the results obtained.

The assessment leads to the conclusion that in 2020 the RES production may reach generation levels of approximately 1351 TWh for ENTSO-E (without UA-W) and 1159 TWh for the EU (without Malta) in Scenario EU 2020 and 1218 TWh for ENTSO-E (without UA-W) and 1026 TWh for the EU (without Malta) in Scenario B.

This very rough estimation leads to the conclusion that the share of RES production in the electricity consumption of ENTSO-E and the EU (without Malta) is expected to be respectively 38 % and 36 % in 2020 in Scenario EU 2020 and respectively 33 % and 30 % in 2020 in Scenario B. This suggests that the Scenario EU 2020 is compliant with the objective of increasing use of renewable energy sources (wind, solar, biomass, etc.) to 20 % of total energy consumption.

	EU 2020	Scenario B
ENTSO-E LEVEL (without UA-W)		
Consumption data [GWh]	3543214	3718266
TOTAL renewable energy generation [GWh]	1350790	1217686
RES share in electricity consumption	38 %	33 %
EU 27 LEVEL (without Malta)		
Consumption data [GWh]	3221277	3394007
TOTAL renewable energy generation [GWh]	1159321	1026147
RES share in electricity consumption	36 %	30 %

Table 4.29:
RES share in electricity consumption at EU / ENTSO-E level

4.2.4.3 CO_2 Emissions Indicator

The European objective to cut greenhouse gases by at least 20% of 1990 levels needs to be translated to the electricity sector since it is an objective for the whole economy. There are different factors that have a positive or a negative effect on the emissions of CO_2 from electricity. Many countries are anticipating that carbon emission reductions from the electricity sector will be significantly higher than the whole economy reduction objective.

A reduction in CO_2 emissions can be expected for the electricity sector owing to:

- an improvement in the thermal efficiency of electricity and heat production (e.g. from the closure of old, inefficient power plants and the introduction of new plants based on more efficient combined cycle technologies).
- changes in the fossil fuel mix used to produce electricity (e.g. fuel switching from coal and lignite to natural gas), with much of this being linked to the increased use of the economically attractive gas turbine combined cycle technology and the closure of a number of coal-fired power plants,
- a higher proportion of nuclear and renewable energy (including biomass) in the electricity generation mix and
- decrease in electricity consumption

An increase in CO_2 emissions might come from new applications such as heat pumps and electric vehicles.

The proposed CO_2 indicator is a simplified approach that assumes that a representative average CO_2 content per MWh can be relied upon. The amount of CO_2 emission from electricity production is derived by multiplying the amount of electricity consumption not compensated by RES or nuclear production by a representative average CO_2 content per MWh.

The proposed indicator only reflects the CO_2 emissions resulting from the generation of electricity and does not include the other greenhouse gases that can be expressed as a CO_2 equivalent.

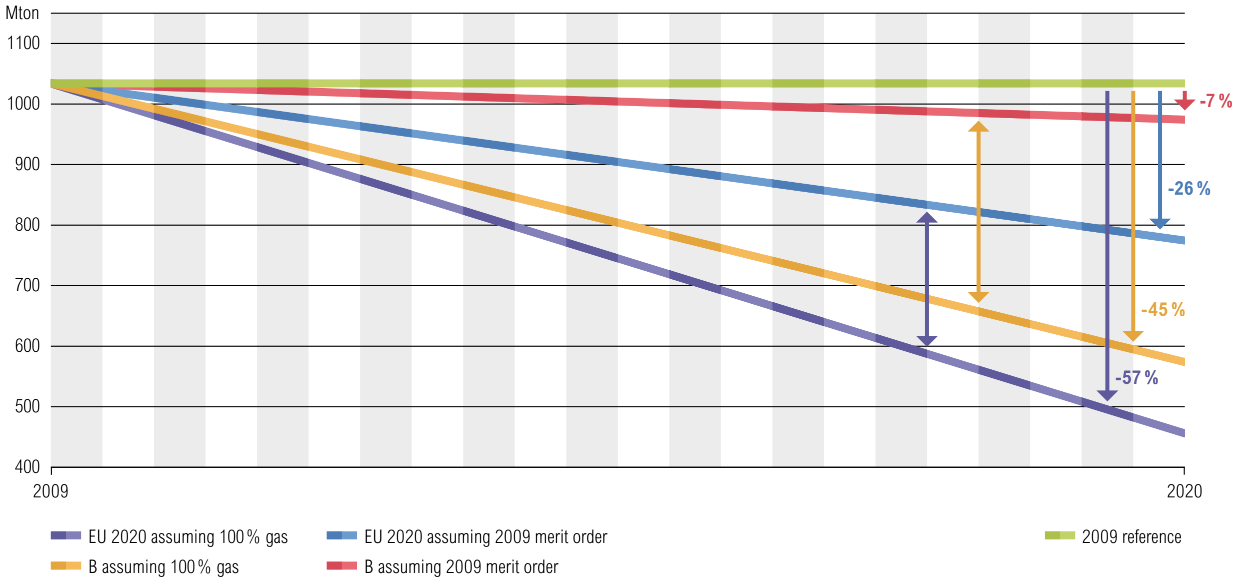


Figure 4.82:
CO_2 emissions indicator at EU level

Furthermore, the indicator is based on standard emission factors that are valid for the current generation technologies and therefore it only gives a very rough estimation; prudent interpretation is therefore advisable. A comparison is made with the emissions calculated for 2009 using these standard emission factors. In 2009, 49 % of the consumption not covered by RES or nuclear units was produced from coal or lignite. Furthermore, a range of possible reductions is estimated by two representative figures for the average CO_2 content per MWh, namely the average CO_2 content per MWh valid in 2009 and CO_2 content per MWh, assuming that consumption not met by RES or nuclear units is covered by gas units.

Combining the above-mentioned parameters, the CO_2 emission reduction in electricity production is estimated to be between 52 % and 19 % for ENTSO-E level (without UA-W) and between 57 % and 26 % for the EU (without Malta) in the case of the Scenario EU 2020 and between 41 % and 0 % for ENTSO-E level (without UA-W) and between 45 % and 7 % for the EU (without Malta) for Scenario B. Hence, the electricity sector will surely be one of the key players in terms of reducing CO_2 emissions in Europe.

5 Adequacy Forecast

5.1 Basic definitions

Generation Adequacy

Generation adequacy of a power system is an assessment of the ability of the generation on the power system to match the consumption on the same power system.

System Adequacy

System adequacy of a power system is a measure of the ability of a power system to supply the load in all the steady states in which the power system may exist under standards conditions.

Remaining Capacity (RC)

RC on a power system is the difference between RAC and load. RC is that part of NGC left on the system to cover any unexpected load variation and unplanned outages at a reference point.

Spare Capacity

Spare capacity is that part of NGC which should be kept available at reference points to ensure the security of supply in most of the situations. Spare Capacity is supposed to cover a 1 % risk of shortfall on a power system, i. e. to guarantee operation in 99 % of situations.

Spare Capacity is estimated by the TSOs in each country depending on its system's features, and for a set of countries (regions or whole ENTSO-E) as 5 % of NGC.

Load Management (LM)

LM is the potential deliberate load reduction available at peak load to balance the system and ensure reliability. Only one long-term forecast scenario for load is referred to.

Margin against Peak Load (MaPL)

MaPL is the difference between load at the reference point and the peak load over the period for which the reference point is representative.

In SO&AF it is actually Margin against Seasonal Peak Load for each reference point. That means one summer value (defined as the difference between the load at the summer reference point and the forecast summer peak load (peak load of quarters 2 and 3 of the reported year) and one winter value (defined as the difference between load at the winter reference point and the forecast winter peak load (peak load of quarters 1 and 4 of the reported year).

Adequacy Reference Margin (ARM)

ARM is that part of NGC that should be kept available at all times to insure the security of supply for the whole period of which each reference point is representative. ARM is calculated in order to cover the increase of load from the reference time point to the peak load and demand variations or longer-term generation outages not covered by operational reserves. ARM accounts for unexpected events affecting load and generation.

ARM in an individual country is equal to spare capacity plus the related MaPL.

ARM in a set of countries (regional blocks or the whole ENTSO-E) is estimated as the sum of all individual MaPL values + spare capacity for a set of countries (as defined before).

5.2 Methodology & Assessment

The power adequacy analysis is based on a comparison between the available generation capacity and the load.

Generation adequacy forecast under normal conditions on a power system is assessed at the reference points with RC value.

- **When Remaining Capacity is positive, it means that some spare generating capacity is likely to be available on the power system under normal conditions.**
- **When Remaining Capacity is negative, it means that the power system is likely to be short of generating capacity under normal conditions.**

Seasonal generation adequacy forecast in most of situations is assessed through the seasonal extension of the generation adequacy forecast on a power system, by comparison of the related Remaining Capacity and Adequacy Reference Margin.

- **When Remaining Capacity is over or equal to Adequacy Reference Margin, it means that some generating capacity is likely to be available for export on the power system.**
- **When Remaining Capacity is lower than Adequacy Reference Margin, it means that the power system is likely to have to rely on import flows when facing severe conditions.**

Simultaneous Interconnection Transmission Capacity (SITC) of a power system is the overall transmission capacity through its peripheral interconnection lines. SITCs are calculated according to the former UCTE Transmission Development Plans. The SITC export value is called Export Capacity and may differ from the SITC import value, called Import Capacity. SITC values are potentially different at every reference point on every time horizon.

Transmission adequacy forecast aims at identifying potential congestion and potential need for development of interconnection lines. In the present study it is limited to the assessment of needs resulting from security issues.

- **When Remaining Capacity is positive and lower than Export Capacity, it means that the spare generating capacity likely to be available on the power system can be exported under normal conditions at reference point.**
- **When Remaining Capacity is negative and its absolute value is lower than Import Capacity, it means that all the necessary import flows to meet load can be imported under normal conditions at reference point.**

Transmission adequacy forecast is assessed at the reference points by comparison of RC, calculated under normal conditions, and SITC. It assesses the ability of a power system to transmit its own positive RC to its neighbouring power systems.

Seasonal transmission adequacy forecast in most situations is assessed through the seasonal extension of Transmission Adequacy Forecast. It assesses the ability of a power system to meet its ARM with the necessary support of import flows from its neighbouring power systems or the ability of a power system to export its positive RM to its neighbouring power systems, if necessary.

- **When Remaining Capacity minus Adequacy Reference Margin is positive and lower than Export Capacity, it means that all the spare generating capacity likely to be available on the power system can be exported in most situations.**
- **When Remaining Capacity minus Adequacy Reference Margin is negative and its absolute value is lower than Import Capacity, it means that all the necessary import flows to meet load can be imported in most situations.**

The Remaining Capacity concept is illustrated below in Figure 5.1.

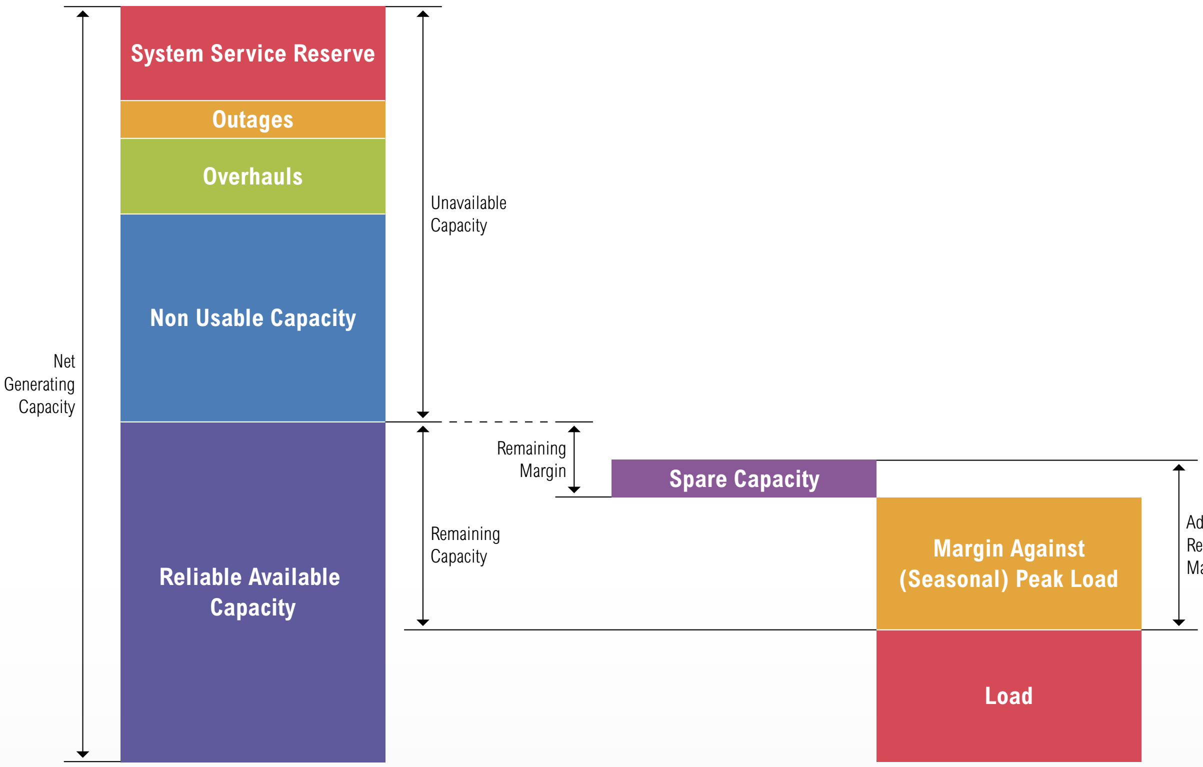


Figure 5.1:
Generation Adequacy Analysis

5.3 ENTSO-E Adequacy Forecast

The reader should bear in mind that not all TSOs / national data correspondents take ARM into account and not all of them have provided these data in the SO&AF data collection process.

Remaining Capacity & Adequacy Reference Margin

Scenario EU 2020

Remaining Capacity (RC) in this scenario is positive and is increasing during the whole forecast period between 2011 and 2020 for both reference points (see Figure 5.2). Only a slight decrease is visible in January 2016 when the RC value falls from 166 GW to 164 GW (see Table 5.1). Furthermore, RC in July is higher by about 33 % on average than in January.

The reason for these differences in RC is that even if RAC in January is higher than RAC in July, the difference in load in these two reference points is opposite and much bigger. According to the formula used for calculation of RC the result is rather as expected.[1]

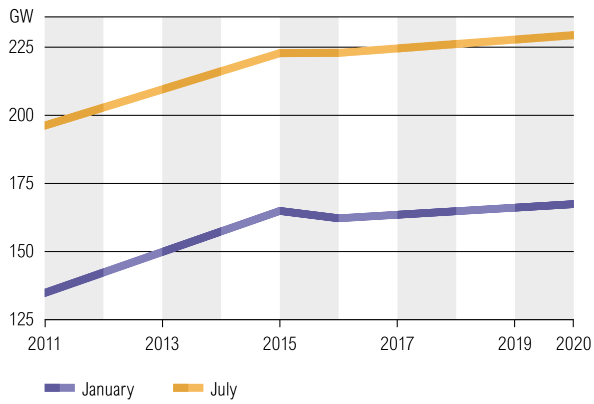


Figure 5.2:
ENTSO-E RC forecast, Scenario EU 2020

[GW]	2011	2015	2016	2020
January	135	166	164	168
July	188	215	215	221

Table 5.1:
ENTSO-E RC for Scenario EU 2020

[1] RC = RAC - Load

RC as part of NGC per country in 2015 and 2020 is shown in Figures 5.3 and 5.4 below. In most of the countries the share of RC in total NGC is higher than average ENTSO-E value.

The highest levels of RC as part of NGC in 2015 are those of Austria and Luxembourg (both about 50 %), Lithuania and the Netherlands (both about 32 %); the lowest values are expected in Finland (2 %), Serbia and Great Britain (between 3 % and 4 %).

In 2020, Austria with Luxembourg shows the highest share of RC in total NGC again (55 %) followed by Cyprus (38 %) and the Netherlands, Bulgaria and Serbia (about 32 % each). On the other hand, the Czech Republic and Belgium (2 %) or Denmark and Great Britain (about 3 %) again have the lower values.

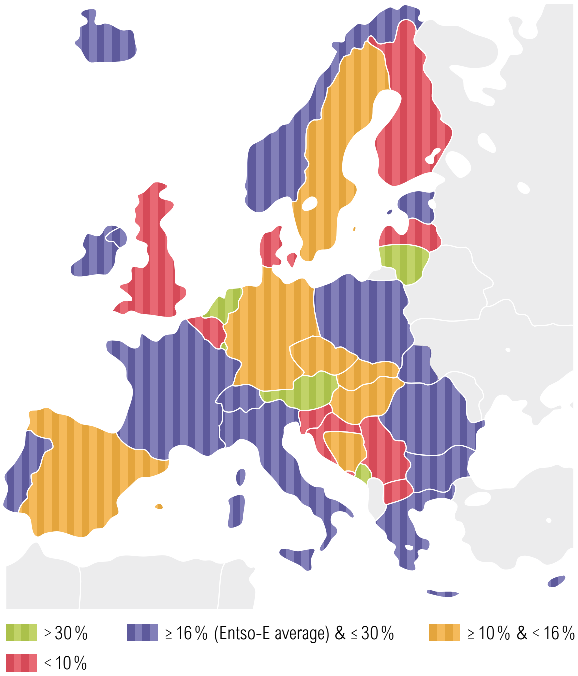


Figure 5.3:
RC as a part of NGC per country in 2015, Scenario EU 2020

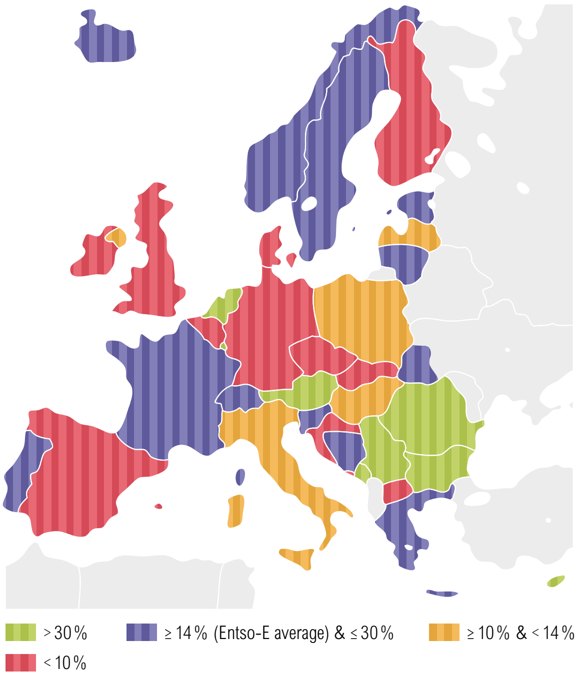


Figure 5.4:
RC as a part of NGC per country in 2020, Scenario EU 2020

Comparing the RC with the Adequacy Reference Margin (ARM) one can see that RC is higher during the whole forecast period in both reference points. In reference point January the situation is less optimistic than in July, as can be seen in Table 5.2.

	[GW]	2011	2015	2016	2020
January	Margin against Peak Load	31	32	33	33
	Spare Capacity	47	53	54	59
	ARM	**78**	**84**	**87**	**92**
	RC - ARM	**57**	**82**	**77**	**76**
July	Margin against Peak Load	43	44	44	46
	Spare Capacity	47	53	54	59
	ARM	**90**	**97**	**99**	**105**
	RC - ARM	**98**	**119**	**117**	**117**

Table 5.2:
ENTSO-E RC and ARM comparison for Scenario EU 2020

Without considering possible transport capacity limitations between countries and / or regions, the generation adequacy in most of the situations within the whole ENTSO-E system in Scenario EU 2020 is expected to be maintained during the whole forecast period and in each reference point, as can be seen in Figure 5.5.

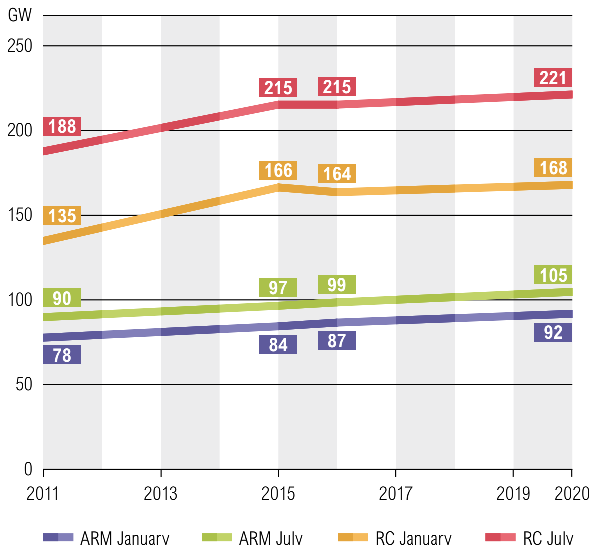


Figure 5.5:
ENTSO-E RC and ARM comparison, Scenario EU 2020

The situation in each ENTSO-E country is depicted in Figures 5.6 and 5.7 below. In most countries the difference between RC and ARM is positive.

The countries with the highest share of RC - ARM in RAC are Austria, Luxembourg (both about 55 % in 2015, and 57 % in 2020) and the Netherlands (about 42 % in 2015, and 44 % in 2020).

The countries with the lowest share of the RC - ARM in RAC are:
- FYROM (-11 %),
- Serbia (-3 %),
- Croatia (-6 %),
- Great Britain (-3 %),
- Finland (-4 %) and
- Belgium (-6 %) in 2015.

In 2020, Belgium, Estonia, Spain, Finland, Great Britain, Croatia and FYROM report negative ratios up to -12 %.

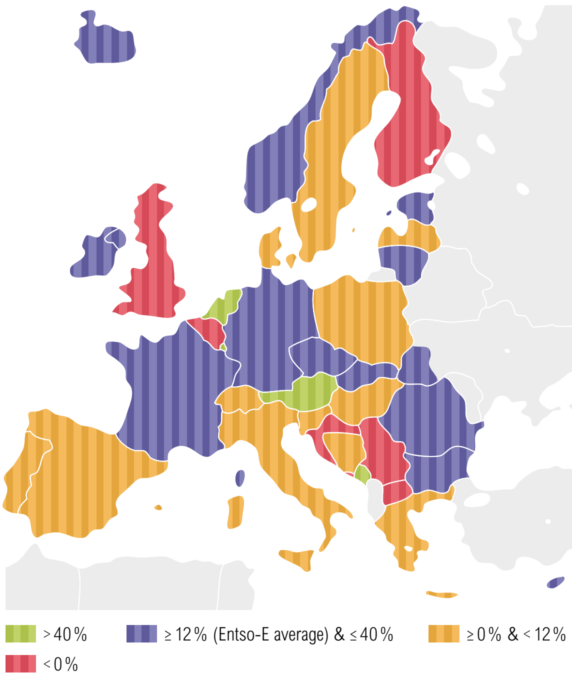


Figure 5.6:
Remaining Capacity minus Adequacy Reference Margin as a part of Reliably Available Capacity per country, January 2015, 7 p.m. Scenario EU 2020

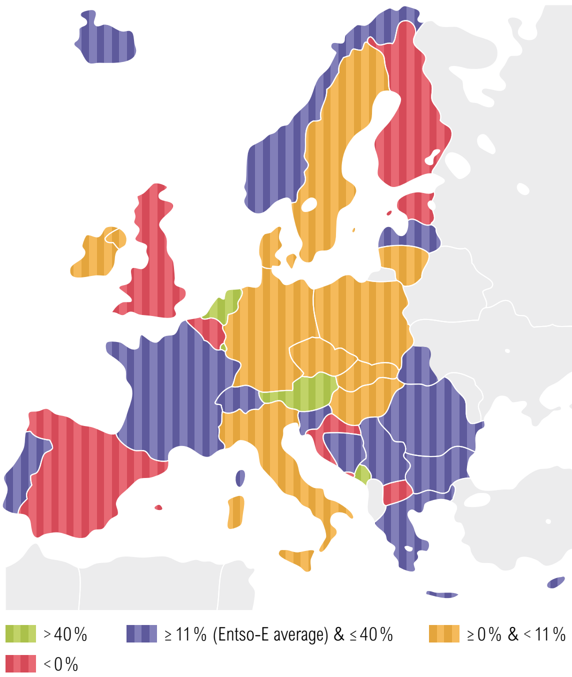


Figure 5.7:
Remaining Capacity minus Adequacy Reference Margin as a part of Reliably Available Capacity per country, January 2020, 7 p.m. Scenario EU 2020

Comparison of Scenario EU 2020 and Scenario B

Comparing RC in Scenarios EU 2020 and B, we see that RC in Scenario EU 2020 is continuously growing in both reference points, whereas Scenario B stops growing and starts to decline after 2015.

As regards generation adequacy, the situation in Scenario EU 2020 is usually significantly better than in Scenario B. It means that more and more RAC on the whole ENTSO-E power system is left to cope with unexpected load variations or outages, etc. This statement is valid for both reference points and also for Scenario B where in 2020 the RC left in the system is higher in each monitored year and for both reference points.

A more exact comparison of these values is given in Table 5.3.

	Scenario EU 2020						Scenario B					
	2011		2015		2020		2011		2015		2020	
[GW]	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul
RC	135	188	166	215	168	221	123	182	152	207	142	204
ARM	78	90	84	97	92	105	76	90	84	97	91	105
RC - ARM	57	98	82	119	76	117	47	92	68	110	51	100

Table 5.3:
Comparison of RC and ARM for Scenario EU 2020 and Scenario B

Scenario A and Scenario B

Remaining Capacity shows different trends in Scenario A and Scenario B according to the different assumptions made for each of them. In Scenario A the commissioning rate of new units is expected to be much lower (only for guaranteed units) whereas a higher level of decommissioning of older units is expected. In addition to this, in Scenario B there is a higher development of RES capacity and some kinds of fossil fuels expected, which influences the amount of RC.

The expected values for the whole forecast period can be seen in Table 5.4. The above-described details are shown in Figure 5.8.

	[GW]	2011	2015	2016	2020	2025
Jan	Scenario A	123	111	98	55	-30
	Scenario B	123	152	146	142	122
Jul	Scenario A	181	167	160	123	46
	Scenario B	182	207	206	204	191

Table 5.4:
ENTSO-E RC for Scenarios A & B

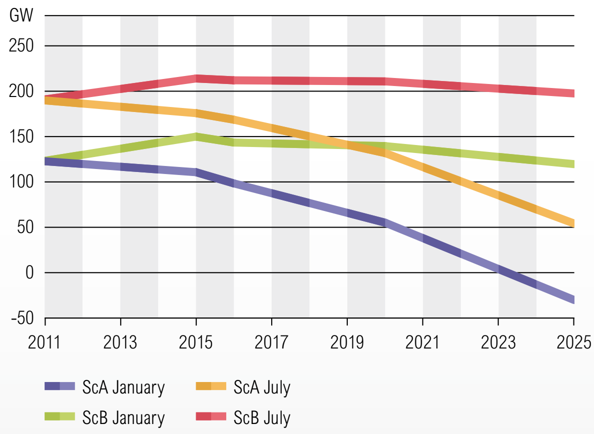


Figure 5.8:
ENTSO-E RC forecast, Scenarios A & B

Figures 5.9 and 5.10 show RC as part of NGC per country in 2015 and 2020.

In the majority of the ENTSO-E countries the share of RC in total NGC is higher than the average ENTSO-E value in 2015; in 2020 it is more than half.

The highest levels of RC as part of NGC in 2015 are in Austria (47 %) and Luxembourg (40 %), followed by Lithuania and the Netherlands (about 32 % each). The lowest values are expected in Latvia and Slovenia (zero for both), Serbia (1 %) and Finland (2 %).

In 2020 Austria with Lithuania (51 %) followed by Bulgaria with Luxembourg (about 33 % each) expect the highest share of RC in NGC. On the other hand, the Czech Republic (2 %), Denmark, Great Britain, Germany and Finland (between 3 % and 5 %) show the lowest values.

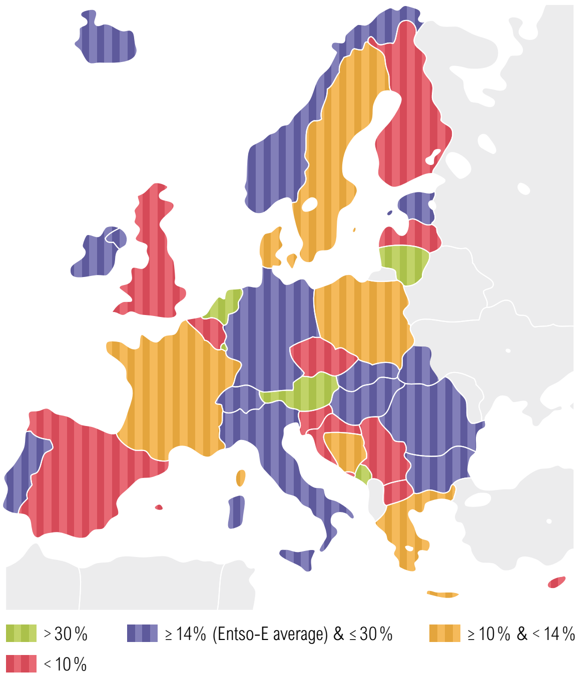


Figure 5.9:
RC as a part of NGC per country in 2015, Scenario B

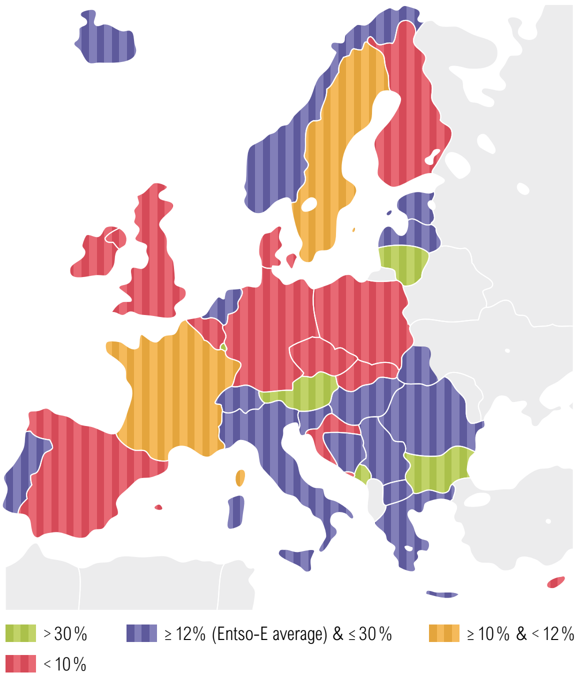


Figure 5.10:
RC as a part of NGC per country in 2020, Scenario B

Table 5.5 shows the values of RC - ARM for Scenarios A & B in both reference points. It is significant that in Scenario A, RC is lower than ARM after 2016 in winter and after 2020 in summer. Scenario B retains positive values during the whole period.

		[GW]	2011	2015	2016	2020	2025
January	Scenario A	MaPL	31	32	32	33	35
		Spare Cap.	46	49	49	50	48
		ARM	**77**	**81**	**81**	**82**	**83**
		RC - ARM	**46**	**30**	**17**	**-27**	**-113**
	Scenario B	MaPL	30	32	32	33	36
		Spare Cap.	46	52	53	57	60
		ARM	**76**	**84**	**85**	**91**	**96**
		RC - ARM	**47**	**68**	**60**	**51**	**26**
July	Scenario A	MaPL	45	46	45	46	49
		Spare Cap.	47	49	49	50	49
		ARM	**92**	**95**	**94**	**96**	**97**
		RC - ARM	**90**	**72**	**66**	**27**	**-52**
	Scenario B	MaPL	43	45	45	47	50
		Spare Cap.	47	53	53	57	60
		ARM	**90**	**97**	**98**	**105**	**110**
		RC - ARM	**92**	**110**	**107**	**100**	**81**

Table 5.5:
ENTSO-E RC and ARM comparison for Scenario EU 2020

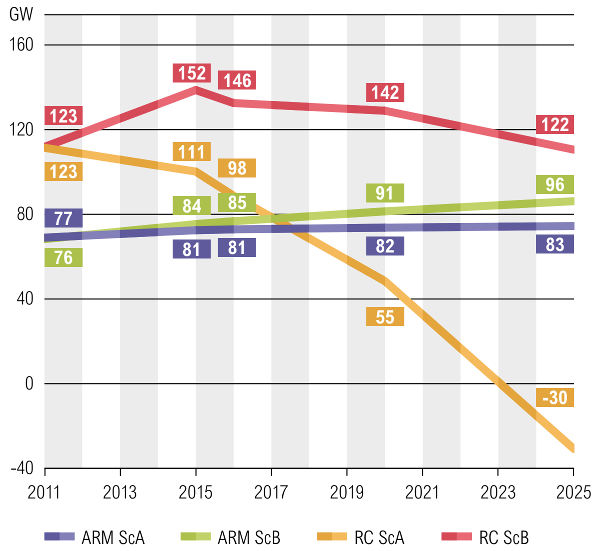


Figure 5.11:
ENTSO-E RC and ARM comparison, Scenarios A & B, January 7 p.m.

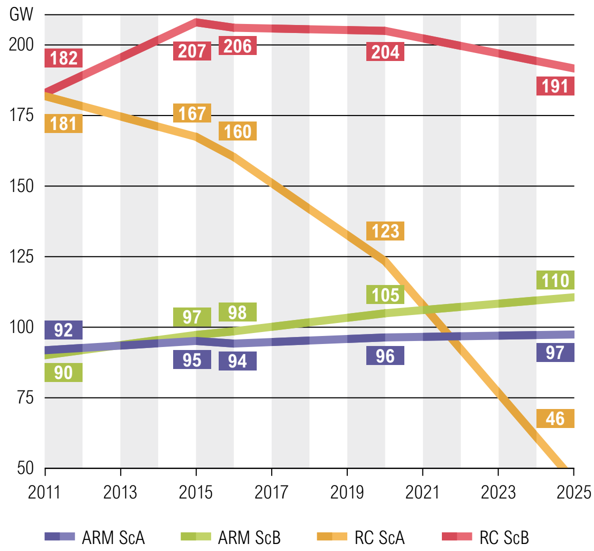


Figure 5.12:
ENTSO-E RC and ARM comparison, Scenarios A & B; July 11 a.m.

Based on Figures 5.11 and 5.12 on the next page, the generation adequacy in most situations within the whole ENTSO-E system in Scenario B is expected to be maintained during the whole forecast period between 2011 and 2025 in both reference points. In Scenario A the generation adequacy is expected to remain until 2016 in January and until 2020 in July. After this year some new generation units may be necessary to deal with unexpected load variations within the ENTSO-E power system in this scenario. No previous statements consider possible transport capacity limitations between countries and / or regions.

As stated in Paragraph 4.2.3.6, approximately 65 % of NGC can be considered as RAC for the reference point January 7 p.m.[1] for both scenarios.

Based on this fact, in 2020 for Scenario A and reference point January, about 73 GW of RAC is necessary to reach at least today's level of adequacy. In 2025 it will be 159 GW, which makes about 112 GW in NGC in 2020 and 244 GW in 2025. In July, however, the RC is sufficient until 2020. In 2020 about 63 GW in RAC seems to be needed to reach today's level of adequacy (105 GW in NGC if 60 % of NGC is to be left as RAC) and in 2025 it is 141 GW AC (236 GW in NGC).

In Scenario B the RC is higher than ARM during the whole forecast period. Adequacy should be maintained in each monitored year. The adequacy level in 2020 is expected to be higher than in 2011 by about 4 GW in RAC. In 2025 the adequacy level is lower than today's; therefore, in order to reach today's level of adequacy an amount of about 21 GW in RAC will be needed, which means approximately 32 GW of NGC.

[1] For July 11 a.m. it is 60 %

The situation in each ENTSO-E country is depicted in Figures 5.13 and 5.14 below. In most countries the difference between RC and ARM is positive.

In 2015 the countries with the highest share of the RC - ARM in their national RAC are Austria (50 %) and Luxembourg (about 42 %) together with the Netherlands (39 %). In 2020 Austria (54 %) and Luxembourg (37 %) have the highest values again.

The countries with the lowest share in 2015 are Cyprus (-17 %), FYROM (-11 %) and Slovenia (-9 %), followed by Serbia, Croatia, Great Britain, Finland and Belgium, with ratios between 0 % and 6 %, and Estonia. Cyprus, the Czech Republic, Estonia, Spain, Finland, Great Britain, Croatia and Poland show a share between zero and -8 % each in 2020.

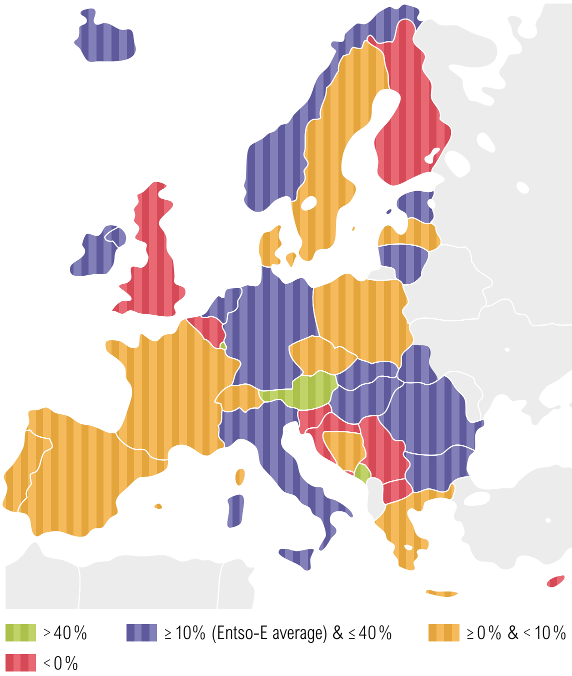


Figure 5.13:
Remaining Capacity minus Adequacy Reference Margin as a part of Reliably Available Capacity per country, January 2015, 7 p.m. Scenario B

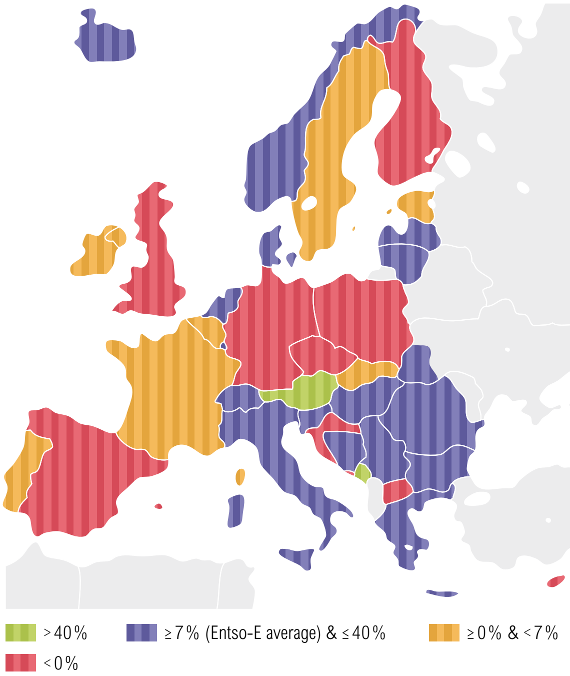


Figure 5.14:
Remaining Capacity minus Adequacy Reference Margin as a part of Reliably Available Capacity per country, January 2020, 7 p.m. Scenario B

5.4 Regional Adequacy Forecast

The colours displayed in the following maps illustrate the difference between Remaining Capacity and the Adequacy Reference Margin for each country in the respective region in 2020, Scenario B (possibly also Scenario EU 2020), at the reference points:

- **Red** colour means that RC - ARM is negative at both reference points,
- **yellow** colour means that RC - ARM is negative at one of reference points,
- **green** colour means that RC - ARM is positive at both reference points.

More detailed information about each respective country can be found in National Adequacy Forecast section.

5.4.1 Regional Group North Sea (RG NS)

Remaining Capacity & Adequacy Reference Margin

In Scenario EU 2020 the RC is forecast to be higher than the Adequacy Reference Margin for the Regional Group North Sea (Belgium, Denmark, Germany, Great Britain, France, the Republic of Ireland, Luxembourg, the Netherlands, Northern Ireland and Norway) from now on until 2020 at all reference points. In 2020 the prognosis is expected to be negative for Great Britain and Belgium both for the summer and the winter reference. For all the other countries both the summer and the winter prognosis are expected to be positive.

The Remaining Capacity in Scenario B is forecast to be higher than the Adequacy Reference Margin for the whole RG NS from now on until 2025 at all reference points. In 2020 the prognosis is expected to be negative for Great Britain both for the summer and the winter reference. For Belgium and Germany the winter reference is slightly negative. For all the other countries both the summer and the winter prognosis are expected to be positive.

The regional assessment for the Regional Group North Sea in both scenarios indicates that if no constraints affect the transmission network, some generating capacity should be available for exports out of the Regional Group North Sea, in all time horizons and at all reference times.

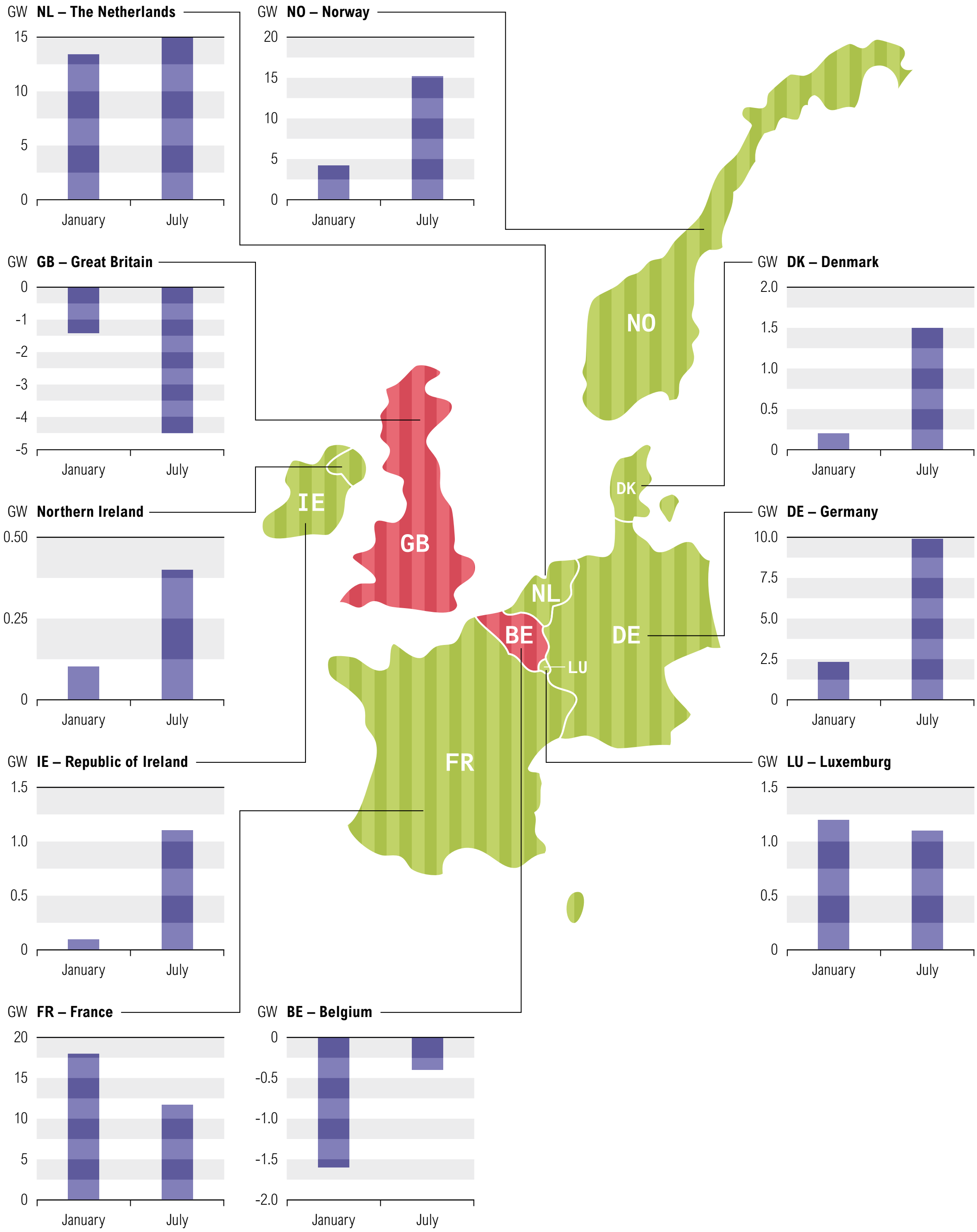


Figure 5.15:
Remaining Capacity minus Adequacy Reference Margin for each country within RG NS
for January and July 2020, Scenario EU 2020

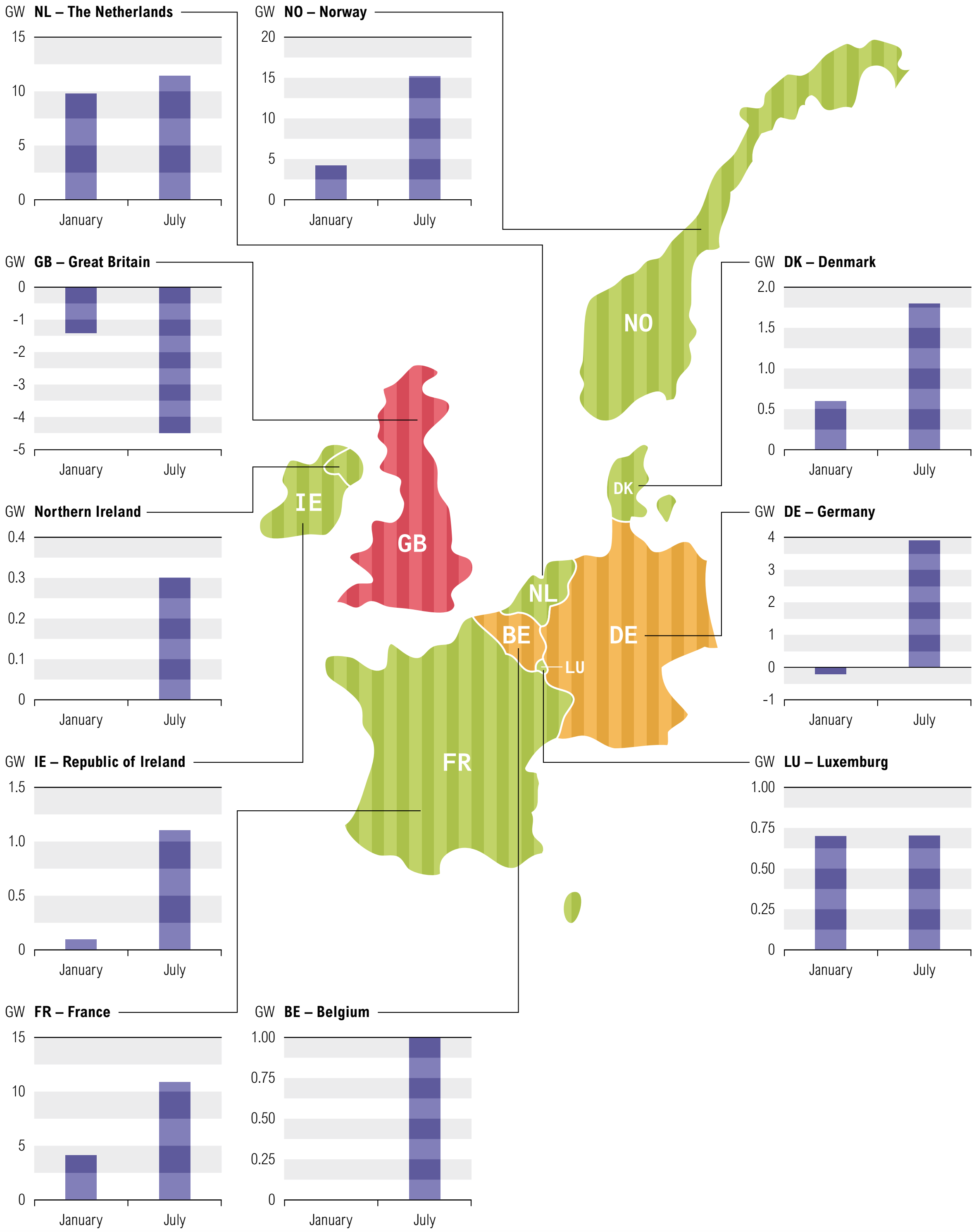


Figure 5.16:
Remaining Capacity minus Adequacy Reference Margin for each country within RG NS for January and July 2020, Scenario B

5.4.2 Regional Group Baltic Sea (RG BS)

Remaining Capacity & Adequacy Reference Margin

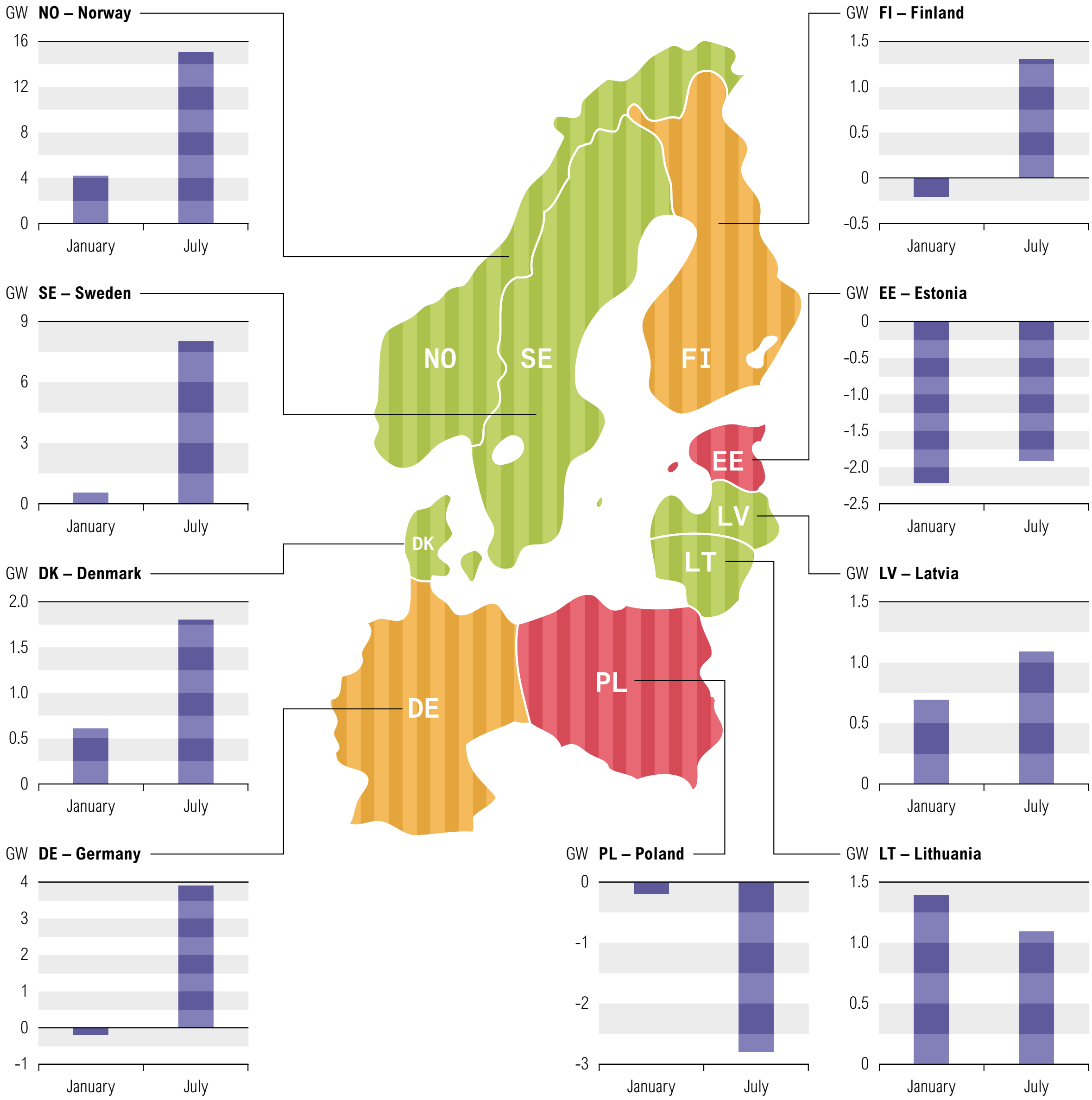


Figure 5.17:
RC - ARM for each country within RG BS for January and July 2020, Scenario B

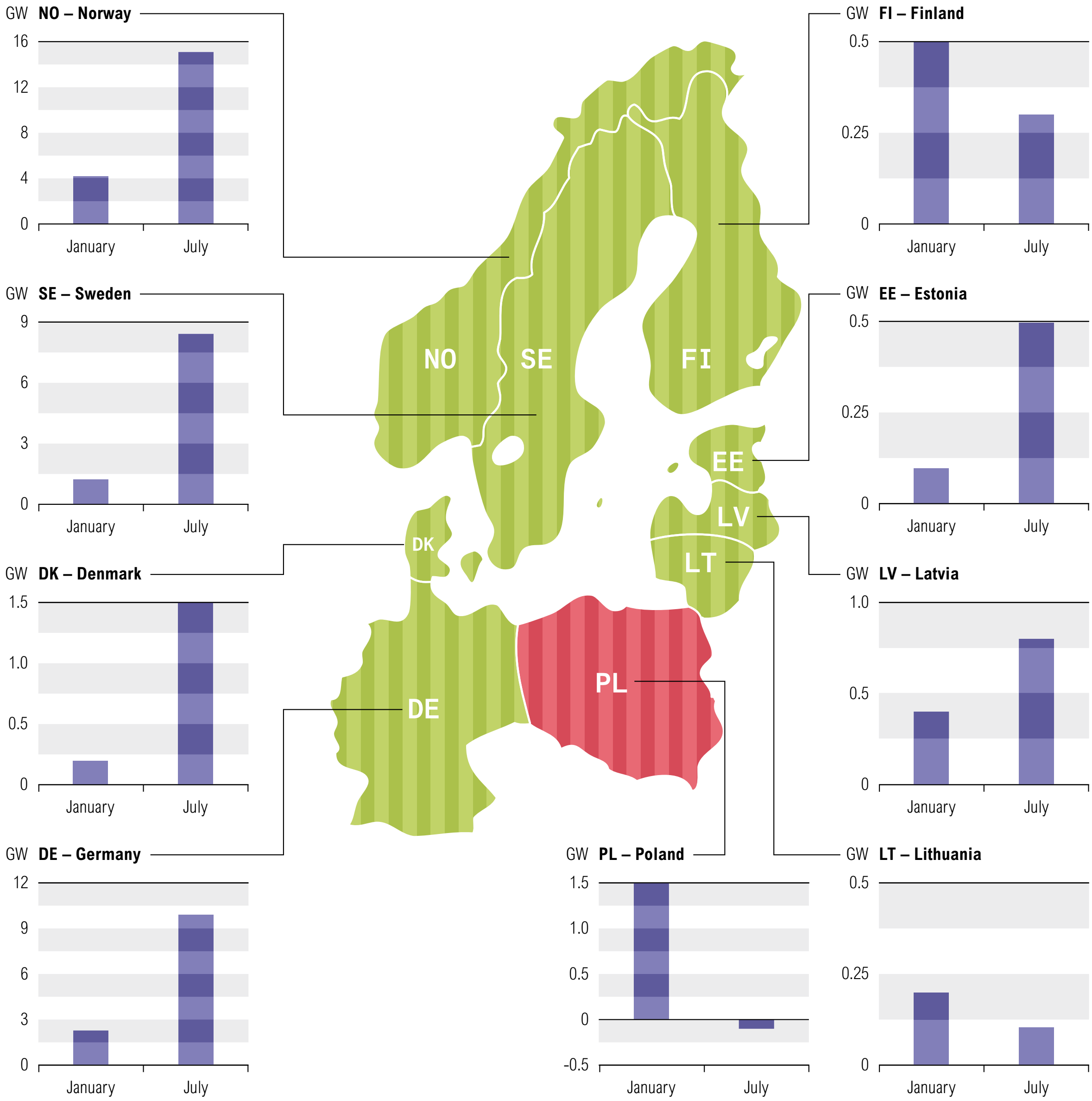


Figure 5.17a:
RC - ARM for each country within RG BS for January and July 2020, Scenario EU 2020

Most countries expect positive values for the indicator Remaining Capacity minus Adequacy Reference Margin. In Scenario B for 2020, Poland is expected to have a negative RC - ARM value. In winter time, Finland and Estonia also expect to have negative RC - ARM values. In 2020, for Scenario EU 2020, negative RC - ARM values are expected in Poland during summer and in Denmark during winter.

Taking into account possible import from neighbouring countries, however, the regional assessment for the Baltic Sea Region indicates an adequate regional power balance as the necessary power surplus and transmission capacities are expected to be available.

For more information about energy balance in group Baltic Sea refer to Appendix.

5.4.3 Regional Group Continental South West (RG CSW)

Remaining Capacity & Adequacy Reference Margin

In the Regional Group South West (France, Portugal and Spain), under Scenario EU 2020, Remaining Capacity is expected to be higher than Adequacy Remaining Margin during the analysed period, except for Portugal in January 2011 and Spain in January from 2016 onwards.

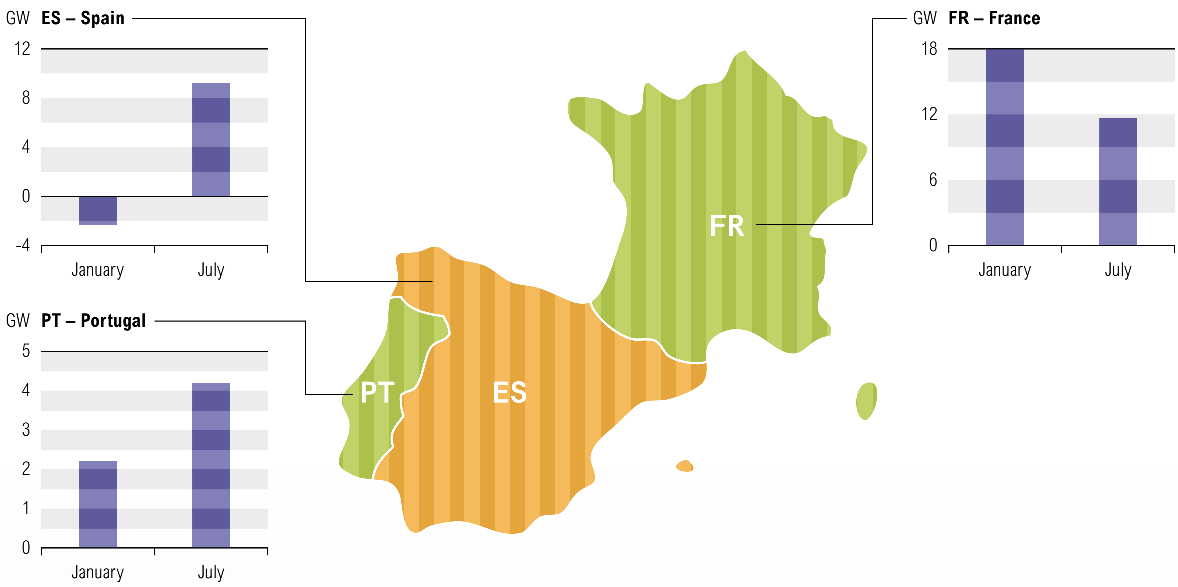


Figure 5.18:
RC - ARM for each country in RG CSW for January and July 2020, Scenario EU 2020

In spite of the deficit (of 1.4 GW) foreseen for Spain in January 2020, there is extra capacity of about 21 GW in the region under this situation.

Should no constraints occur in the transmission network, the overall capacity that can be potentially exported to other regions (i.e. that result from subtracting ARM from RC) is expected to remain always above 15.5 GW during the period from 2011 to 2020. Since annual peak load is observed during the winter period for the three countries, exportable capacity is particularly high (> 21.8 GW) during the summer reference point.

In Scenario B, the main conclusions are not very different from the above-mentioned. Actually, for Spain, this Scenario B is exactly the same as Scenario EU 2020. Deficits are foreseen for Portugal and Spain in the same periods and generally Remaining Capacity is expected to be higher than Adequacy Remaining Margin between 2011 and 2025.

In January 2020, however, the extra capacity in the Regional Group South West is no higher than 6.2 GW. This is the consequence of the French and Portuguese perspectives on the Remaining Capacity not being as optimistic as is Scenario EU 2020. Furthermore, in January 2025, no exportable capacity to other regions is foreseen.

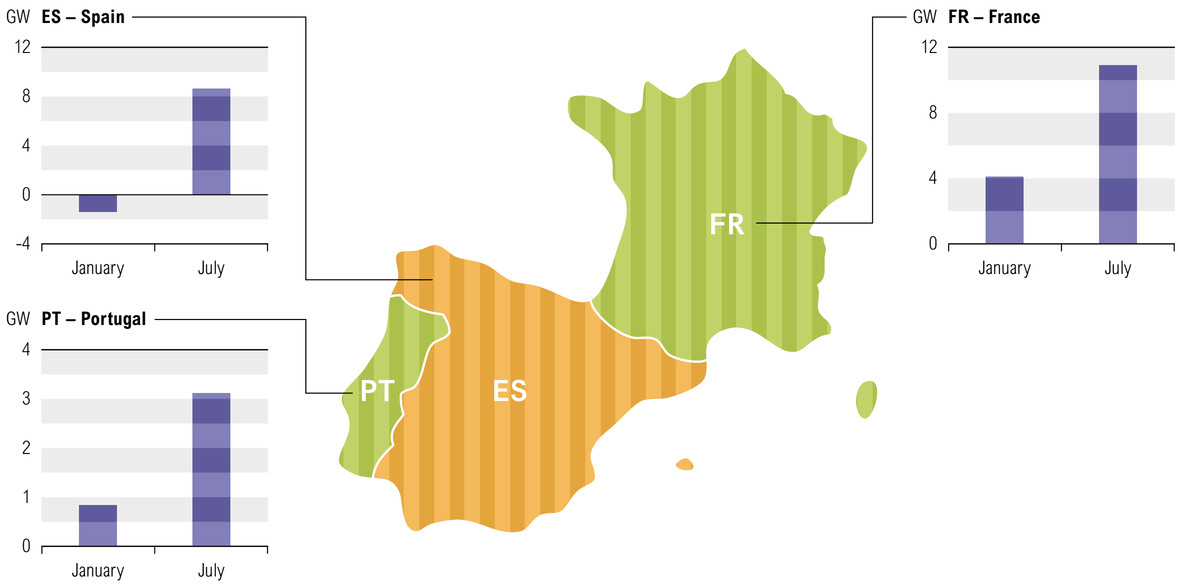


Figure 5.19:
RC - ARM for each country in RG CSW for January and July 2020, Scenario B

5.4.4 Regional Group Continental South East (RG CSE)

Remaining Capacity & Adequacy Reference Margin

The RC in Scenario B is forecast to be higher than the ARM for the RG CSE (Bosnia-Herzegovina, Bulgaria, Croatia, FYROM, Greece, Hungary, Italy, Montenegro[1]), Romania, Serbia and Slovenia) from now on until 2025 at all reference points.

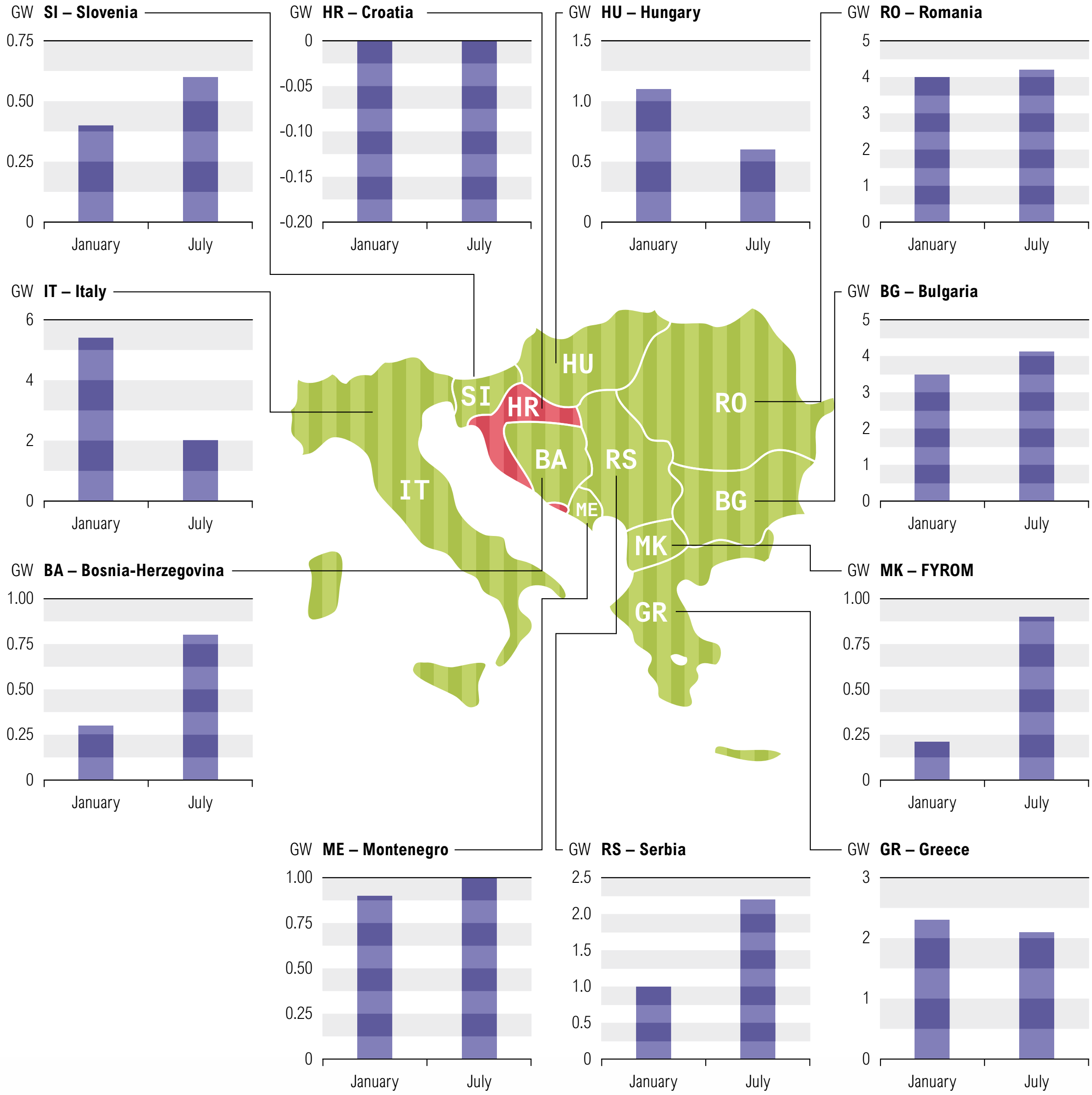


Figure 5.20:
RC - ARM for each country within RG CSE for January and July 2020, Scenario B

1) For Montenegro substitute data was used

In the first three years studied, this regional extra capacity is expected to be lower at the reference point January 7 p.m. (winter peak load), with the absolute lowest additional capacity appearing at reference point January 7 p.m., 2011. From 2020 in advance, the regional extra capacity is expected to be lower at the reference point June 11 a.m. (summer peak load). If no constraints occur in the transmission network, the overall capacity that can be potentially exported to other regions is expected to remain always above 9 GW during the period 2011 to 2025.

In 2020, the worst situation is expected to happen at reference point June, but nevertheless, extra capacity reaches almost 18.3 GW. Furthermore, it can be seen that, in 2020, all countries in the RG CSE have a positive assessment for the RC - ARM criterion for all reference points, with the exception of Croatia.

Almost half of the countries of the RG CSE (Bulgaria, Greece, Hungary, Montenegro and Romania) have a positive assessment for the RC - ARM criterion for all reference points from 2015 onwards. Bosnia-Herzegovina and Italy have a positive assessment for the RC - ARM criterion for all reference points from 2015 onwards, except for the year 2025. More specifically, RC - ARM becomes negative for Bosnia-Herzegovina on the winter reference point and for Italy on the summer reference points. Slovenia has a positive assessment for the RC - ARM criterion for all reference points from 2016 onwards. FYROM and Serbia have a negative assessment of the RC - ARM criterion for all winter reference points (except for the year 2020) and a positive assessment for all summer reference points. Croatia has a negative assessment for the RC - ARM criterion for all reference points up to the year 2020 and a positive assessment for both reference points for 2025.

In Scenario EU 2020 the RC is forecast to be higher than the ARM for the RG CSE (Bosnia-Herzegovina, Bulgaria, Croatia, FYROM, Greece, Hungary, Italy, Montenegro, Romania, Serbia and Slovenia) from now on until 2020 at all reference points.

In the first three years studied, this regional extra capacity is projected to be lowest at the reference point January 7 p.m. (winter peak load), with the absolute lowest additional capacity appearing at reference point January 7 p.m. of 2011, whereas in 2020 the regional extra capacity is projected to be lowest at the reference point June 11 a.m. (summer peak load). Should no constraints occur in the transmission network, the overall capacity that can be potentially exported to other regions is expected to remain always above 8.8 GW during the period from 2011 to 2020.

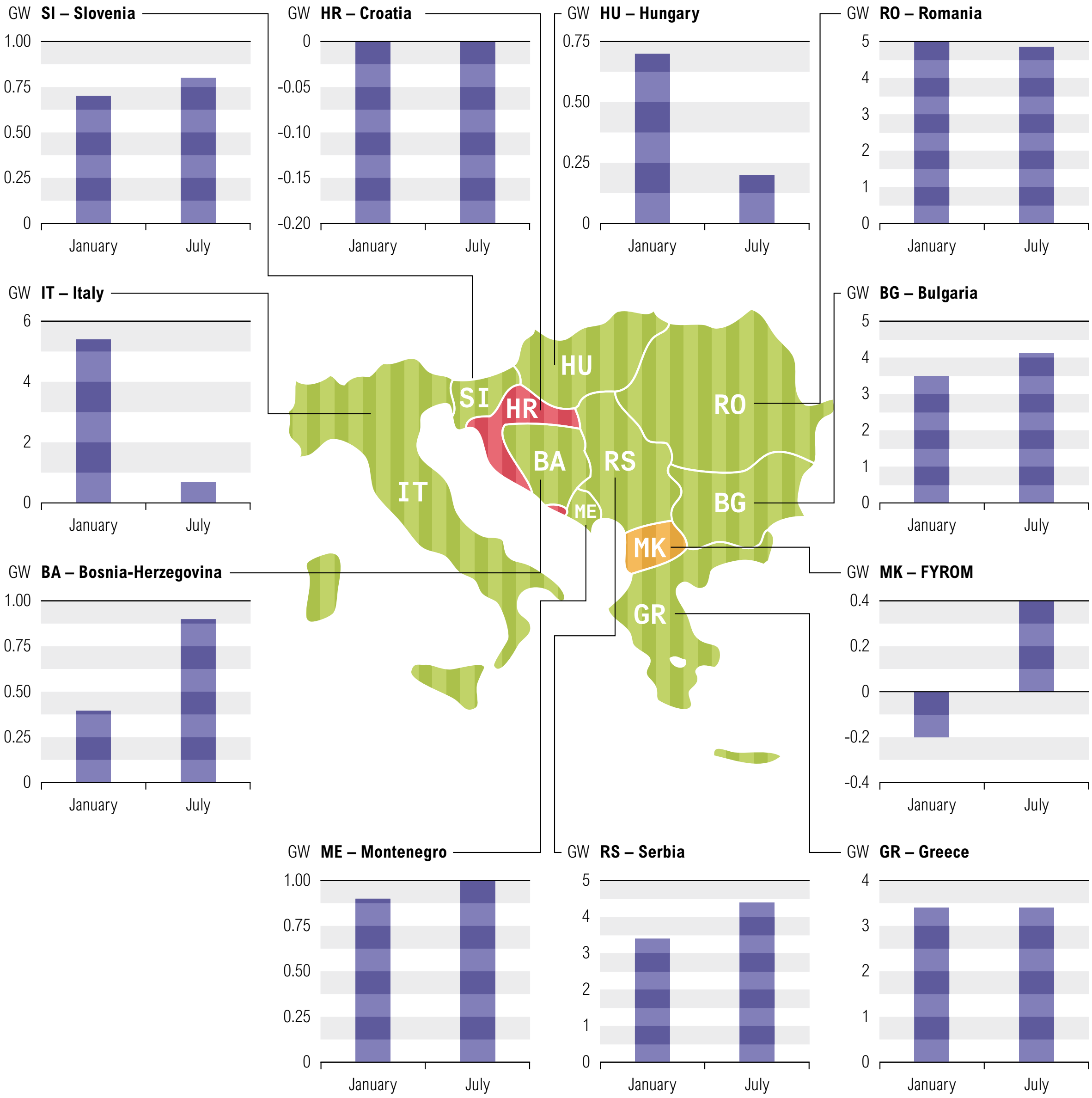


Figure 5.21:
RC-ARM for each country within RG CSE for January and July 2020, Scenario EU 2020

As can be observed, in 2020, there is extra capacity in the worst situation, which is expected to happen during reference point June. At this moment, overall extra capacity reaches nearly 19.6 GW. Furthermore, it can be seen that in 2020 all countries in the Regional Group South East have a positive assessment for the RC-ARM criterion for all reference points, with the exception of Croatia and FYROM.

Most of the countries of the RG CSE (Bosnia-Herzegovina, Bulgaria, Greece, Italy, Romania and Slovenia) have a positive assessment for the RC - ARM criterion for all reference points from 2015 onwards. Hungary has a positive assessment for the RC - ARM criterion for all reference points, with the exception of the year 2016, when both reference points have a negative assessment. Serbia has a positive assessment for the RC - ARM criterion for all reference points from 2016 onwards. RC - ARM becomes negative for FYROM on every winter reference point, but is positive for every summer reference point. Croatia has a negative assessment for the RC - ARM criterion for all reference points up to the year 2020.

5.4.5 Regional Group Continental Central South (RG CCS)

Remaining Capacity & Adequacy Reference Margin

Scenario EU 2020

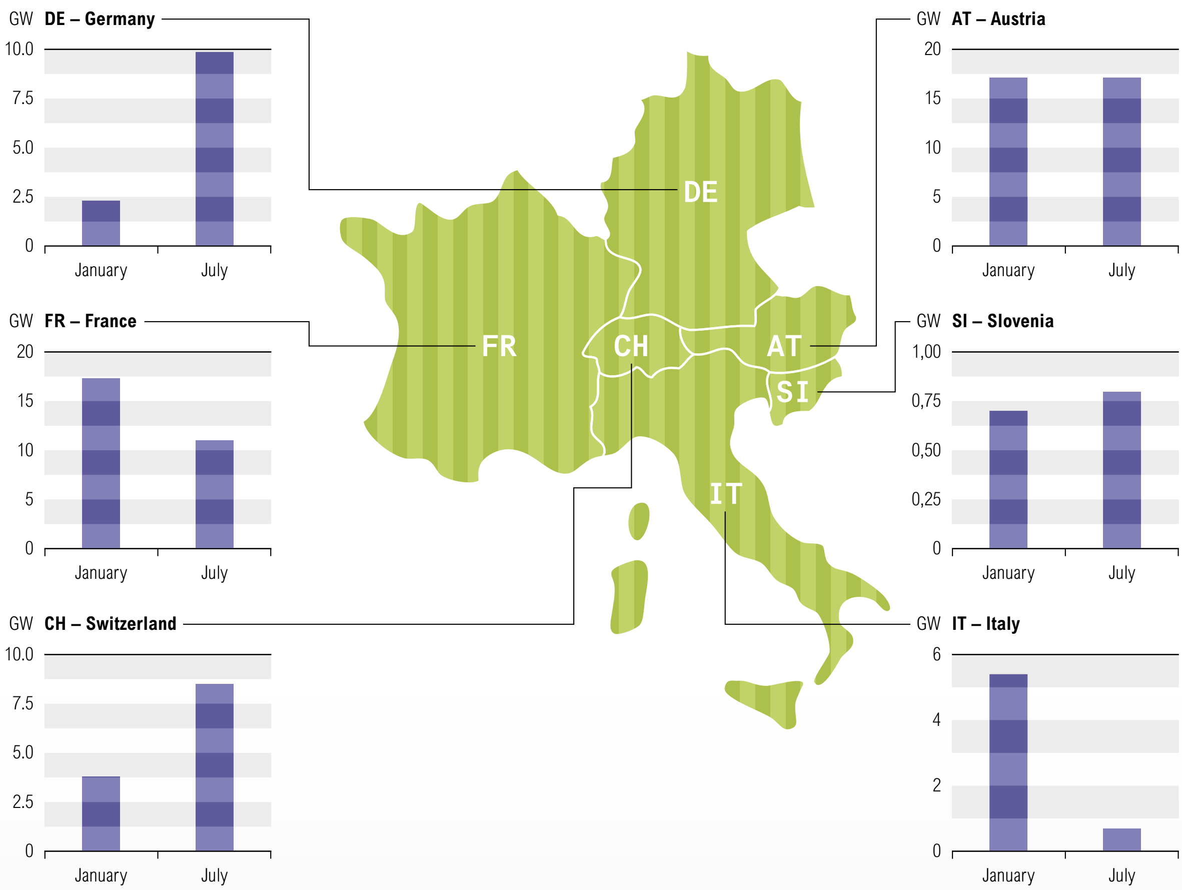


Figure 5.22:
RC - ARM for each country within RG CCS for January and July 2020, Scenario EU 2020

This scenario has been built according to the National Renewable Energy Action Plans publicized in summer 2010 and driven by EU policies on CO_2 emission reduction, energy efficiency and RES development. The most striking deviation from the best estimate scenario is the much smaller increase of load. Indeed, load at the winter reference point should increase no more than 4 % over the next ten years with 10 GW more in 2020 and fewer than 20 GW in the summer reference point. In this scenario, load will be almost stable in France and reduce in Germany, whereas about 20 % more load will affect Italy, and in summer more than in winter. This remarkable regional trend is accompanied by almost 40 GW more solar capacity (in Germany) and a double capacity fuelled by biomass.

As a consequence, although starting with a similar evolution to that of the best estimate scenario, Remaining Capacity excess to Adequacy Reference Margin will stabilize at its highest level from 2016 onwards (Figure 5.22).

Scenario B

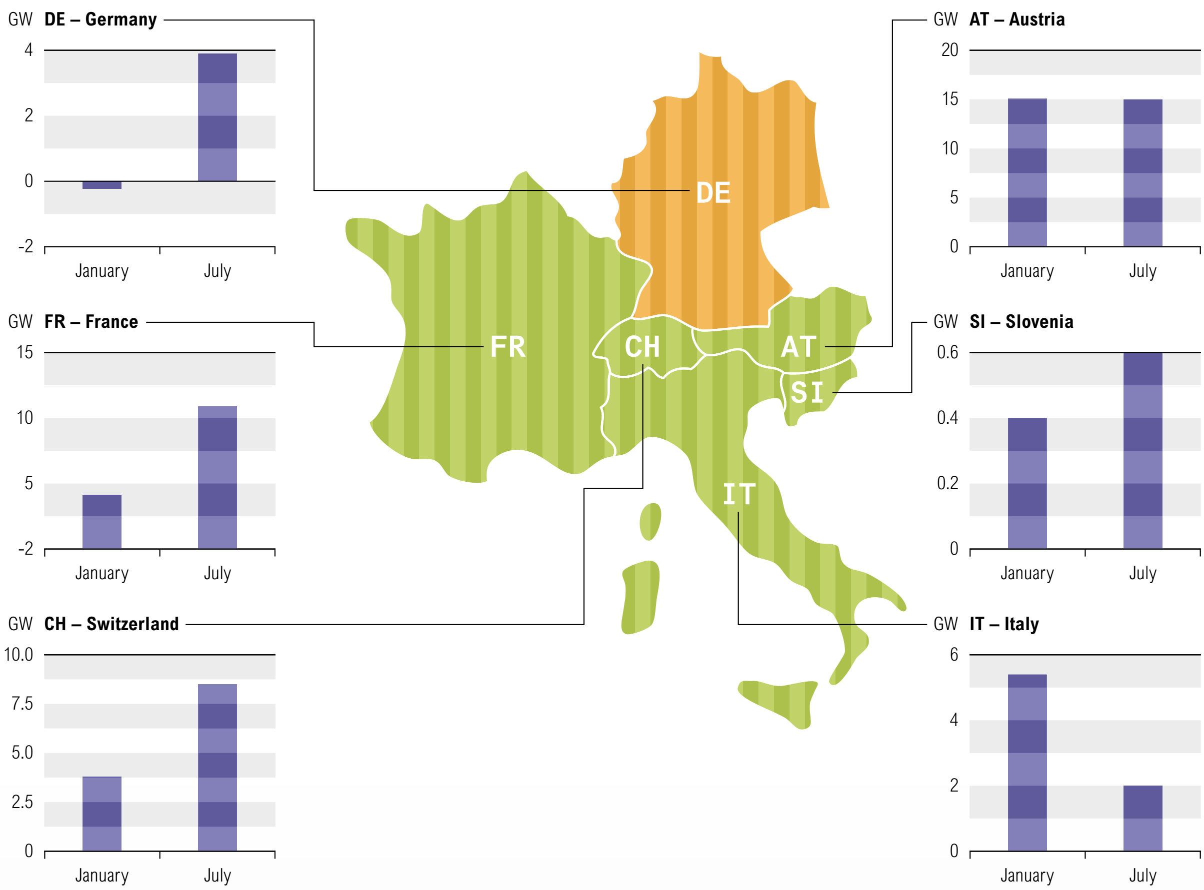


Figure 5.23:
RC - ARM for each country within RG CCS for January and July 2020, Scenario B

In their best estimate scenario (Scenario B), TSOs expect a massive RES capacity development in the region in the next fifteen years, from about 70 GW in 2011 to 125 GW in 2020 and 145 GW y. Fossil fuel capacity should end the period at the same level with a peak by 2015 – 16 when there is some doubt about the strategy to be followed by producers towards the end of the derogations to the LCP Directive. Some 15 GW more hydro capacity is expected and nuclear capacity should be quite stable. Meanwhile, Load is expected to increase by 40 GW in both winter and summer reference points.

As a consequence, Remaining Capacity minus Adequacy Reference Margin of the overall Regional Group is expected to remain positive up to 2025 in the best estimate scenario. Compared with the 2011 starting value, this indicator will increase up to 2016 and then decrease to its initial level later than 2020. The same assessment is foreseen at the national level up to 2020 in both winter and summer reference time (Figure 5.23). Thus, there should be enough available generating capacity in the region to cover load in most of the situations up to 2020.

By 2025, Germany and Italy foresee Remaining Capacity being lower than Adequacy Reference Margin, making these countries more likely to rely on import to balance their load (furthermore, Germany expects in January negative difference between RC and ARM). Yet, as mentioned before, the necessary installed capacity should be available in the region to secure power supply. More details on the national drivers of this assessment are to be found in the related national sections.

5.4.6 Regional Group Continental Central East (RG CCE)

Remaining Capacity & Adequacy Reference Margin

A very brief overview of total RES installed capacity, fossil fuel installed capacity and Load forecast is shown in Figures 5.24, 5.25 and 5.26. The total RES generating capacity is much more ambitious in Scenario EU 2020 than in Scenario B. Such a trend is visible also for most of the countries within the CCE region. The major contributor is Germany followed by Romania (mainly RES HPP) and Poland in both scenarios. The evolution of fossil fuel category is similar in the two scenarios, but with differences in the increase / decrease rates. In Scenario B these rates are steeper in both directions and therefore the total amount of fossil fuels' generating capacity is higher. The main share in fossil fuels is that of lignite, hard coal and gas in both Scenario B and Scenario EU 2020. Major leaders are again Germany (hard coal, gas and lignite mainly) and Poland (lignite and hard coal) followed by the Czech Republic (hard coal) and Romania (hard coal and after 2015 gas as well).

Load appears rather balanced for Scenario EU 2020 (growth between 1 % and 2 %) whereas in Scenario B it starts to increase after 2015 by about 9 %. Only a diminishing load is expected in German Scenario EU 2020 (-1 % before 2015 and -6 % after 2015). In the rest of the countries load is expected to rise. In Scenario B Germany and Romania expect a decrease of load before 2015 but other countries – and also all countries after 2015 – expect only an increase of the load.

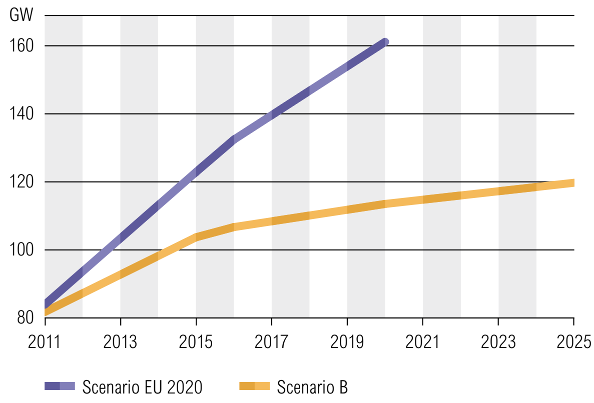


Figure 5.24:
Total RES installed capacity forecast for CCE region

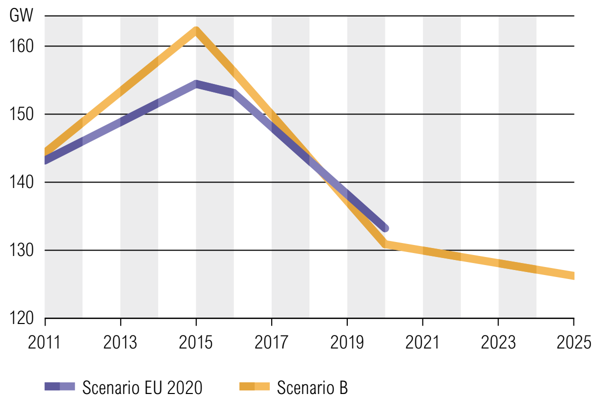


Figure 5.25:
Total fossil fuels installed capacity forecast for CCE region

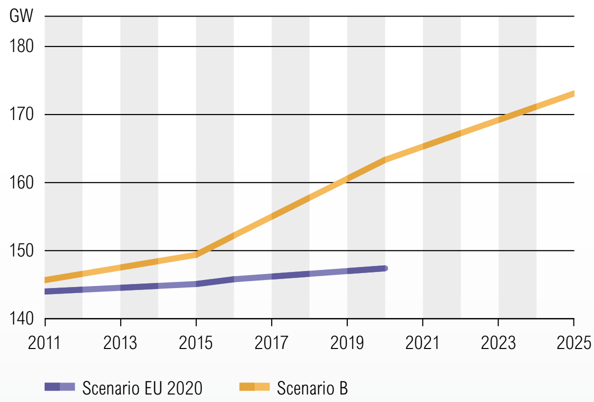


Figure 5.26:
Load forecast for CCE region

Adequacy assessment on the level of RG CCE in 2020 for Scenario B is depicted in Figure 5.27. Austria, Slovakia, Hungary, Germany, Romania and Slovenia do not expect any problem with adequacy of generating capacity in this time period. On the other hand, Poland and Croatia seem to be dependent on imports in both reference points when facing severe conditions. In the Czech Republic such a situation is expected to arise only in January. Each country mentioned here as expecting negative differences between RC and ARM has the possibility of importing the required amount of power from their connected neighbours, as NTC are sufficient.

The situation in 2015 is better in the Czech Republic (all reference points positive RC - ARM) and Poland (positive in January); Slovenia has slightly worse expectations (negative in January).

Figure 5.27:
RC - ARM for each country within RG CCE for January and July 2020; Scenario B

For the whole region, the situation under severe conditions is satisfactory for 2015 and 2020, i.e. no imports will be necessary during 2015 and 2020 on the RG CCE level.

The situation in Scenario EU 2020 looks better for the CCE region. The Czech Republic figures will turn into positive numbers and the situation in Poland improve (difference of RC - ARM is slightly negative only in July 2020). A similar situation obtains in Slovenia where RC - ARM is supposed to be negative only in January 2015, although the value is very low (20 MW).

6 National Adequacy Forecast

This section consists of a graph comparing Import / Export capacity with the difference between Remaining Capacity and Adequacy Reference Margin in Scenarios A, B and EU 2020. When Export / Import capacity differs in scenarios, a separate graph for Scenario EU 2020 is inserted.

Comments provided by national correspondents are included in this chapter. As not every ENTSO-E country is obliged to set its national environmental goals according to the EU third package, many countries do not have their own NREAP or Scenario EU 2020 (or their Scenario EU 2020 is based on a similar document to NREAP). Therefore unless stated to the contrary, these paragraphs are valid for each scenario (A, B and EU 2020).

6.1 AT – Austria

Generating Capacity

Calculations for Scenario B are based on data collected for the "Masterplan 2009 – 2020" (Verbund APG 2009).

Load

Forecast of load in Scenarios A and B is based on the load forecast for the reference scenario of the NREAP 2010.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

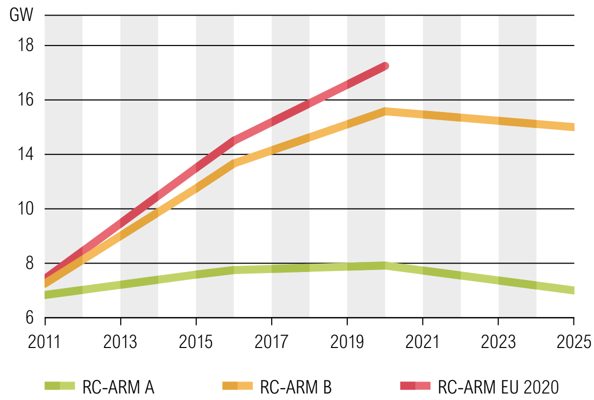


Figure 6.1:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

6.2 BA – Bosnia-Herzegovina

General Comment

Data for Scenarios A and B are taken from the Production Development Indicative Plan (PDIP) 2011 – 2020, and PDIP 2010 – 2019, produced by the Independent System Operator of Bosnia-Herzegovina (www.nosbih.ba).

As Bosnia-Herzegovina is not a member of the European Union, there are no mandatory national targets for 2020. Also, there is no official government plan to reach these targets. Scenario EU 2020 is the same as Scenario B, and it is based on the data from production development indicative plans (www.nosbih.ba).

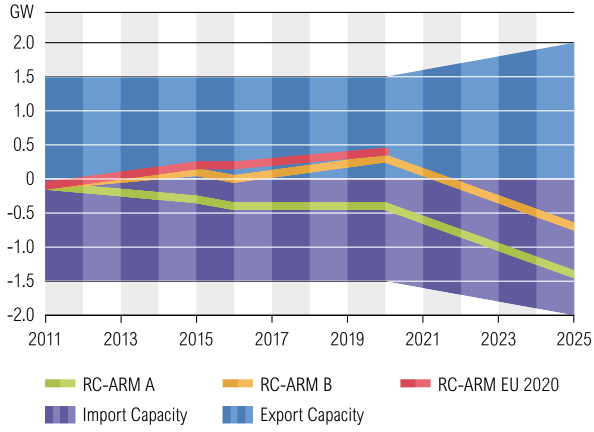


Figure 6.2:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

As regards the thermal power plants it is expected that old thermal units will become obsolete at TPP Tuzla in 2012 and 2014 (total 260 MW), and at TPP Kakanj in 2018 (95 MW). They will be replaced by two new thermal units: TPP Tuzla, unit 7, installed power 450 MW (2017), and TPP Kakanj, unit 8, installed power 300 MW (2018). A new TPP Stanari, installed power 300 MW is expected to be put on in 2014.

In Scenario A there are no generation capacities of wind power plants. During the realization of Production Development Indicative Plan (PDIP) 2011 – 2020, there were 47 applications for wind power plants, with total installed power about 3000 MW, and annual generation about 7500 GWh. These wind power plants did not, however, have appropriate authorization documents which would guarantee predicted dynamics of construction, so they were not balanced. Real dynamics of wind power plant integration in the power system of B & H will be determined by a special study, "Possibilities of integration of wind power plants in transmission system network of Bosnia and Herzegovina," which is planned for 2012.

Load
No comments provided.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

6.3 BE – Belgium

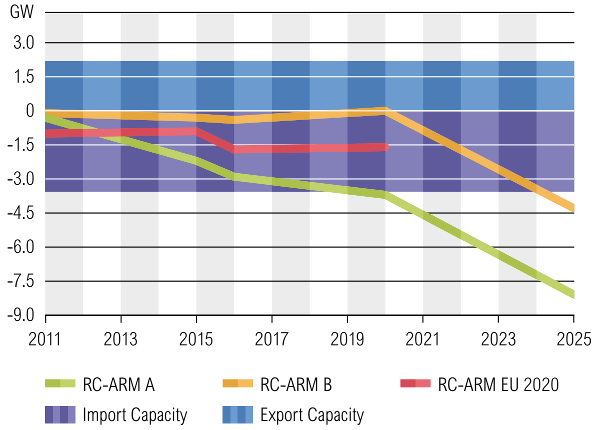


Figure 6.3:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

General Comment

The Belgian figures refer to Belgian territory and reflect the Belgian national figures (including all voltage levels in Belgium). Furthermore, the reference point for the load figures is based on real measurements that were supplemented by estimates to ensure 100 % representativeness.

Generating Capacity

The installed generation capacity of centralized power stations in Scenario A (conservative generation scenario) is obtained by using information from specific confirmed projects (projects whose commissioning decision cannot be cancelled) announced to the TSO as well as information regarding decommissioning derived from laws, directives, information given by generation companies or theoretical maximum lifetimes. (The applied theoretical lifetime per technology is based on the guidelines proposed by the UCTE System Adequacy subgroup but an additional five years was added to the theoretical lifetime of each technology. The following theoretical maximum lifetimes were assumed: coal units 45 years, OCGTs, CCGTs and diesels 35 years, gas turbines 40 years and turbojets 45 years). In Scenario B (best estimate generation scenario) the specific confirmed new power units are complemented with all power units that had obtained a generation license from the Ministry of Energy by September 2010. Furthermore, only information derived from laws, directives or input given by generators was used to estimate the decommissioning of power units in the studied period.

In Scenario EU 2020 the additional thermal capacity needed on top of Scenario A is assessed, taking into account the import level mentioned in the Scenario BASE_HICV of the Prospective Study of Electricity of the Ministry of Energy and the Belgian Federal Planning Bureau (October 2009). This scenario assumes that the nuclear phase-out takes place and that a higher carbon value is implemented, namely 54 €/ton CO_2 in 2020. Coherent with this scenario it is assumed that the missing capacity is filled by new CCGTs.

The increase in decentralized generation capacity is based on a similar methodology. Specific projects announced to the TSO and DSOs are added to the installed generation capacity in Scenarios A, B and EU 2020. The amount of renewable energy sources is based on the installed generation capacity of renewable energy sources that is given in the Belgian National Renewable Action Plan (NREAP), with the exception of the installed capacity of solar panels in 2011. The installed capacity of solar panels in 2011 reflects the actual installed capacity that is higher than the one mentioned in the Belgian NREAP. The level of renewable energy sources in 2025 was obtained by adding the following capacities: 500 MW of onshore wind turbines and 660 MW of solar panels. The capacity of biomass units was set at the level put forward in the 20/20 target scenario of the working paper 21-08 “Impact of the EU Energy and Climate Package on the Belgian energy system and economy - Study commissioned by the Belgian federal and three regional authorities” of the Belgian Federal Planning Bureau. The implementation of the nuclear phase-out is taken into consideration in Scenarios A, B and EU 2020 although a revision of this law is currently under discussion in Belgium and a ten-year postponement of the nuclear phase-out is still probable. An adaptation of the existing law concerning the nuclear phase-out will result in different scenarios.

Load

The winter load value for 2011 is based on the historic load value of the third Wednesday of January 2009 at 7 p.m. augmented by the Belgian electricity growth rate of 2009/10 and 2010/11 in order to simulate the future values of 2011 (the same methodology was used for the load values of the years 2015, 2016, 2020 and 2025). The summer load value for 2011 is based on the historic load value of the third Wednesday of July 2009 at 11 a.m. augmented by the Belgian electricity growth rate of 2009/10 and 2010/11 in order to simulate the future values of 2011 (the same methodology was used for the load values of the years 2015, 2016, 2020 and 2025).

For Scenario EU 2020, the load values used for Scenarios A and B were upscaled and based on the ratio between the energy consumption in the energy efficiency scenario of the Belgian NREAP and the energy consumption forecast by the TSO.

There are numerous load-shedding contacts with industrial customers. These contracts are part of the system services reserve and increase from a contracted volume of 261 MW in 2011 to 300 MW in 2025.

Generation Adequacy

Unavailable capacity will increase over the period 2010 to -2025 mainly owing to a rise in the number of wind farms, biomass power stations and CHPs included in the net generating capacity. This trend will lead to an increase in the volume of non-usable capacity. The wind power capacity considered as non-usable is 90 %; 50 % of the net generation capacity of nuclear units is considered as unavailable one year before their decommissioning. This leads to higher non-usable capacities in 2015 and 2025. The higher net generating capacity of windmills in the future will result in a rise in the volume of the system services reserve.

If the generation development projects of Scenario B (best estimate generation scenario) are realized within the indicated deadlines and no additional decommissioning based on technical lifetimes takes place, the remaining capacity will not insure self-sufficiency in any of the studied years and the system will rely on supplementary generation development projects that are as yet unknown to maintain the remaining capacity at a sufficient level. A level is estimated as sufficient when it insures that Belgium does not rely on structural import from neighbouring countries. Also, in the minimum investment scenario (Scenario A), the interconnection transmission capacity will remain crucial throughout the period 2015 to 2025. Furthermore the simultaneous import capacity based on confirmed interconnection projects from 2020 onwards in Scenario A is not sufficient to compensate the lack of national generation.

In Scenario EU 2020, the remaining capacity will not ensure self-sufficiency during the assessed period of 2011 until 2020. This is compliant with what is foreseen in the Scenario BASE_HICV of the Prospective Study of Electricity of the Ministry of Energy and the Belgian Federal Planning Bureau (October 2009).

For Scenarios A and B, the winter and summer peak load for 2011, 2015, 2016, 2020 and 2025 is obtained by aggregation of the forecasts of the TSO of individual loads at the different nodes of the transmission grid for those years at the peak moment. This methodology results in slightly increasing margins against seasonal peak load over the period 2010 to 2025.

For Scenario EU 2020, the obtained values for Scenarios A and B were upscaled and based on the ratio between the energy consumption in the energy efficiency scenario of the Belgian NREAP and the energy consumption forecast by the TSO

Interconnection Capacity

The simultaneous import and export capacity was obtained by adding the average 2009 NTC values of both commercial borders for the considered month and multiplying this sum by a simultaneous coefficient of 70 percent. The simultaneous import capacity of Belgium will be affected by the commissioning of the second circuit of the 220 kV AC Aubange-Moulaine line (commissioned in 2010). Future possible interconnection reinforcements which are still under study (such as new interconnections between Belgium and Luxembourg, Belgium and Germany and Belgium and the UK) are not considered in the current assessment of the simultaneous import and export capacity. For Scenario EU 2020 the same hypotheses were used.

6.4 BU – Bulgaria

Generating Capacity
No comments provided.

Load
No comments provided.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

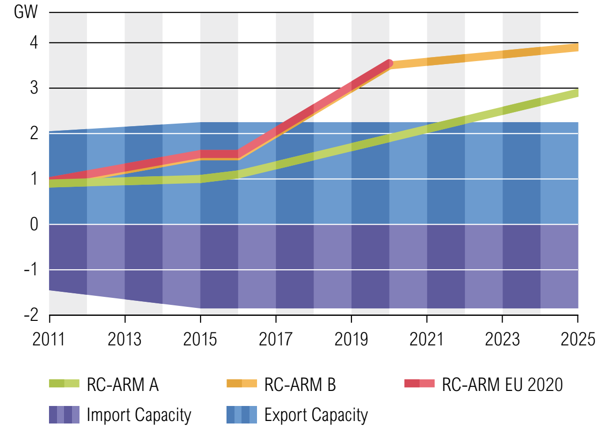


Figure 6.4:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

6.5 CH – Switzerland

Generating Capacity

Calculations for Scenario B are based on data collected for the Swiss strategic grid 2020. The same applies to Scenario A, whereas in the conservative Scenario A only the power plants already under construction are included.

For Switzerland, the Scenario EU 2020 is the same as Scenario B.

Load

The load forecasts in Scenarios A and B are based on a reference load increase.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

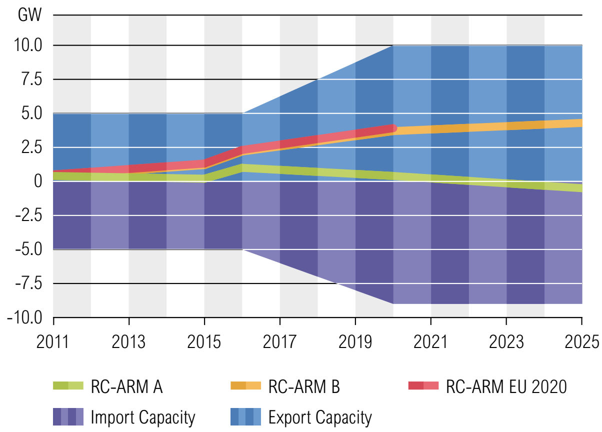


Figure 6.5:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

6.6 CY – Cyprus

Generating Capacity

LNG terminal construction is expected to start in 2014.

Load

Varies substantially owing to weather conditions. As a measure of load management ripple control on water pumps, large A/C units and street lighting are used.

Generation Adequacy

Thermal power stations have reduced generating capacity during summer high temperatures. Wind generation is reduced during summer periods.

Interconnection Capacity

No comments provided.

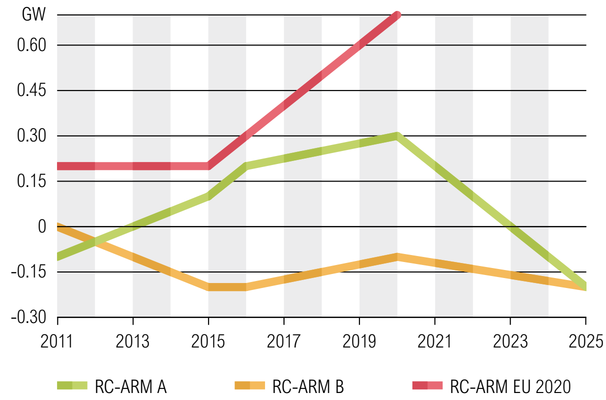


Figure 6.6:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

6.7 CZ – Czech Republic

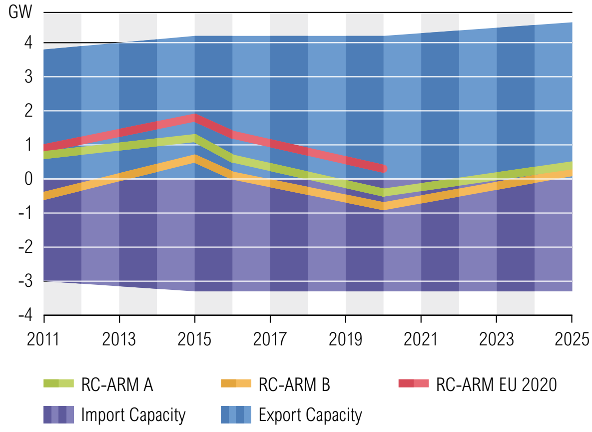


Figure 6.7:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

There was a significant increase in solar generation capacity in 2010 as result of state incentives. The annual growth is expected to be less dramatic in the foreseeable future.

In the conservative Scenario A, the increase of NGC in 2015 corresponds to development of generation capacity of lignite units. New and retrofitted lignite units 660 MW and 400 MW are expected to start operations, the first in 2012 and the second in 2014. After 2020 new nuclear power net generation capacity in the range of 1500 – 3000 MW is expected. In the best estimate Scenario B, additional new gas (CCGT) units 880 MW and 440 MW in the year 2015 are expected to come into operation.

Scenario EU 2020 is based on the National Renewable Energy Action Plan (NREAP), particularly regarding NGC of RES. The increase of NGC in 2015 corresponds to the development of generation capacity of lignite units. New and retrofitted lignite units 660 MW and 400 MW are expected to start operations, the first in 2012 and the second in 2014. After 2020 new nuclear power net generation capacity in the range of 1500 – 3000 MW is expected.

Load

After the economic crisis, load is regaining its growth trend in Scenarios A and B. In Scenario EU 2020, load is slightly different because it is taken from NREAP.

Generation Adequacy

Remaining capacity values show that generation is expected to be sufficient to cover domestic load and to allow some exports. The Spare capacity is calculated as 5 % of NGC rounded in hundreds of MW.

Interconnection Capacity

No comments provided.

6.8 DE – Germany

Generating Capacity

The generating capacities, taken into account in the SO&AF 2011 – 2025 report, vary from one scenario to the other. The following table shows, in a very synthetic way, the differences between the scenario capacity values, and, more precisely, the order of the values according to the scenarios (A, B and EU 2020).

Example: the nuclear power capacities taken into account in the three scenarios are identical. The fossil fuel capacities are higher in Scenario B than in Scenario EU 2020 and Scenario A.

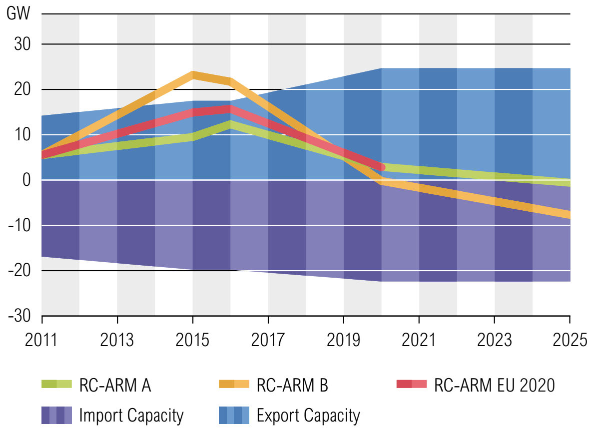


Figure 6.8:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

National Power Data	Difference between Scenario	Difference between January / July
Nuclear Power	A = B = 20	N
Fossil Fuels	A < 20 < B	N
Lignite	20 < A, B	N
Hard Coal	A < B, 20	N
Gas	A < 20 < B	N
Oil	20 < A = B	N
Renewable Energy Sources (other than hydro)	B, A < 20	January < July
Wind	A < 20 < B	N
Solar	B < A < 20	January < July
Biomass	A = B < 20	N
Hydro power (total)	A = B = 20	N
Net generating Capacity	A < B < 20	January < July
Maintenance and Overhauls	A < 20 < B	January < July
Outages	A < 20 < B	N
System Service Reserve	A = B = 20	N
Unavailable Capacity	A, B < 20	January < July
Reliable Available Capacity	A < 20 < B	July < January
Load	A < 20 < B	July < January
Load Management	A = B = 20	N
Remaining Capacity		January < July
Spare Capacity	A < 20 < B	N
Margin Against Seasonal Peak Load	20 = A < B	January < July
Adequacy Reference Margin	A < 20 < B	January < July
Import Capacity	A = B = 20	N
Export Capacity	A = B = 20	N

Table 6.8:
Extract of SAF 2011 – 2025 – differences between generation scenario for Germany

The table also indicates if a difference exists between January and July data, and in what order.

Load

For both Scenario A and Scenario EU 2020, the assumption for load is a decrease for the period 2011 – 20 and until 2025 for Scenario A (decrease of 8 % between 2011 and 2020). For Scenario B, on the other hand, the assumption is an increase of load (7 % between 2011 and 2020).

Generation Adequacy

As indicated in the graphic of the previous page, and also in the forecasts of the SO&AF 2011 – 2025 Report, the Remaining Capacity is positive for the whole period, whatever the scenario. This means that some spare generating capacity is likely to be available on the power system under normal conditions.

Moreover, the Remaining Capacity minus Adequacy Reference Margin is still positive and lower than Export Capacity throughout the period (except for Scenario B after 2020). This means that all the spare generating capacity likely to be available on the power system can be exported in most situations.

Interconnection Capacity
No comments provided.

6.9 DK – Denmark

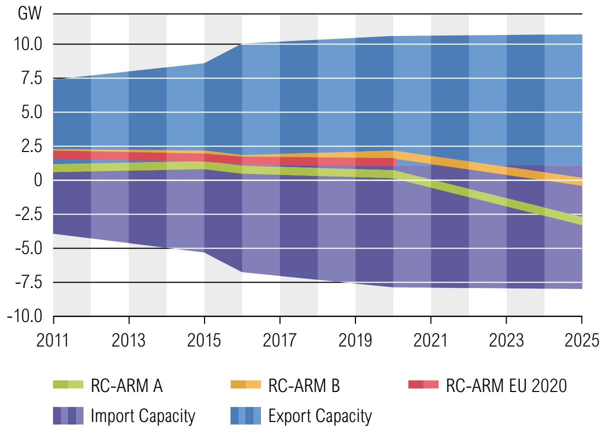


Figure 6.9:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

In 2011 the total net generating capacity in Scenario B is approx. 12.45 GW where approx. 5.3 GW is unavailable. Most of the generating capacity comes from thermal units and wind power. Wind power is considered to be non-usable owing to its unreliable production.

The 2020 Scenario is very similar though it has fewer wind and more other renewable energy sources (biomass).

For 2025 the total net generating capacity for Scenario B is approx. 14.3 GW with approx. 8 GW unavailable capacity, and wind is the dominant part of this.

The most distinct difference between Scenario B and the 2020 Scenario is the development in renewable energy. In Scenario B the increase in renewables comes from wind energy. Wind capacity increases from approx. 4 GW in 2011 to approx. 5.7 GW in 2020. In the 2020 Scenario the increase in renewables comes from biomass. Wind capacity only increases by approx 0.2 GW whereas biomass increases from approx. 0.9 GW in 2011 to approx. 2.8 GW in 2020.

Load

Load is assumed to be the same in both Scenarios A and B. From 2011 (approx. 5.6 GW the third Wednesday of January) to 2016 load increases slowly. From 2016 to 2020 load increases much faster. In 2025 load is expected to be approx. 6.8 GW for the third Wednesday of January.

The EU 2020 load increases very little (under 0.9 GW).

Generation Adequacy

No production plants are considered to be unavailable although approx. 1 GW of the thermal capacity is for system reserves and the wind is considered non-usable.

Interconnection Capacity

During the period the import capacity increases by approx. 80 %. The export capacity increases by approx. 53 %. One of the reasons for this increase in import and export capacity is the fact that reliable production capacity decreases during the analysed period.

The following upgrades and new capacities are assumed to be operational during the analysed period:

- Upgrade to 2000 MW export / 1500 MW import from Germany, 2012 (Decided)
- 700 MW to Norway, 2014 (Decided)
- 700 MW to the Netherlands, 2016
- Upgrade to 2500 to / from Germany, between 201 and 2020 (Decided)

6.10 EE – Estonia

General comment

The information for the Scenario EU 2020 was agreed with the Renewable Energy Department of the Ministry of Economy and Communications. As the NREAP is not yet approved, the draft version was used. Energy demand forecast was also provided by the Ministry of Economy and Communications. Generating capacity in EU 2020 is based on Scenario B for the most part (fossil, mixed fuels, hydro, and biomass), with the main difference being in wind generation capacity. In 2020 according to the Estonian NREAP about 0.9 GW of wind energy is foreseen.

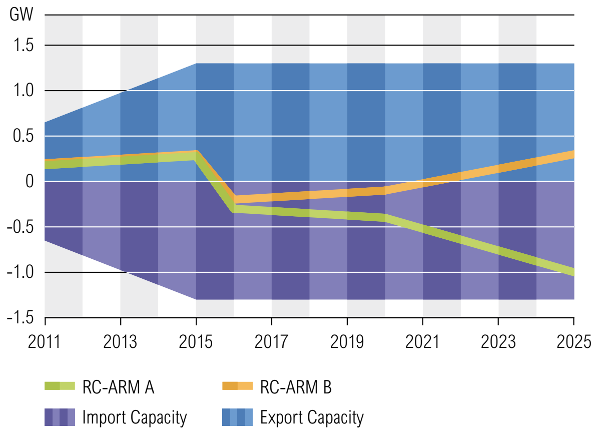


Figure 6.10a:
RC – ARM Comparison, Sc A and Sc B, January 7 p.m.

Generating Capacity

2010 – 2015: There is no particular risk of shortage expected until 2015. The power system of Estonia at present has 2.4 GW of generation capacity installed and that capacity will be sufficient to cover peak loads according to both Scenarios A and B. The most important investments from the supply security perspective of the Elering side will be implementation of a second interconnection between Finland and Estonia with capacity of 650 MW and construction of a new power plant of 250 MW for disturbance reserve. Those projects will be finished by the end of 2014 and 2015 respectively.

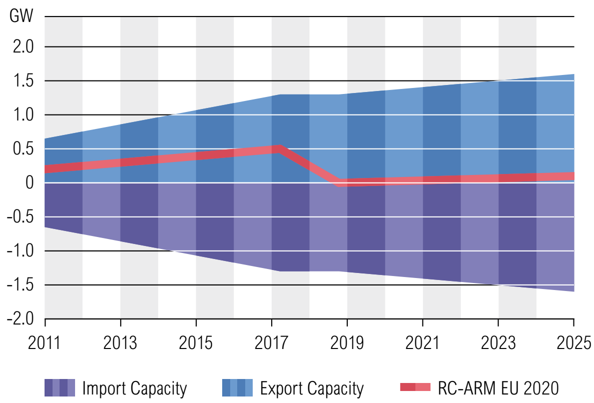


Figure 6.10b:
RC – ARM Comparison, Sc EU 2020, January 7 p.m.

2016 – 2025 Scenario A: the conservative view.
It includes the following assumptions:

- Only those new developments that Estonia TSO currently knows to be under construction have been included.
- Decrease of generating capacity of 0.95 GW owing to the fulfilment of the Large Combustion Plant Directive.
- Installation of SO_2 filters to four existing oil-shale burning units, whose total net capacity is expected to be 0.65 GW by 2016. A new oil-shale unit with NGC of 0.27 GW will be constructed in 2015.

Today 150 MW of wind farms have been connected to the Estonian national grid, and in addition a large number of new wind farms are planned and under construction. A connection of 700 MW (Scenario A) of wind power can be expected during the next ten years. All the wind generation was considered as non-usable generation capacity, however, in both Scenario A and Scenario B. Some of the existing power plants with 700 MW capacity are expected to be decommissioned owing to the anticipated expiry of their technical lifetime after 2022. In case of moderate growth of demand it can be assumed that the shortage will not exceed the 0.2 GW until 2020, after which it could be around 0.8 GW.

Scenario B is consistent with our “Best View” generation background and includes the following assumptions:

- Additional new oil-shale unit with NGC of 0.27 GW in 2020 will be constructed.
- 0.3 GW of new CHP plant based on different fuels (peat and biomass) will be constructed during the next ten years. According to Estonian legislation, power plants with efficient technology of heat and power co-generation are eligible for subsidies. Given this assumption, an increase of construction of new CHP can be expected.
- Construction of a new nuclear power plant after 2022.

Load

The worked-out electricity demand forecast is based on the respective forecast in the main sectors of the economy as well as on the projections of GDP growth rates. The main factors influencing energy demand are changes in GDP. Given average weather conditions, growth during this period is expected to be around 1.7 % annually.

Generation Adequacy

By non-usable capacity we mean mothballed units, all kinds of limitations and all installed wind power. Starting from 2016 the power units that have NGC of about 0.9 GW will be mothballed owing to emission limitations. It was assumed that about 50 % of CHP power would be unavailable owing to maintenance and technological limitations during the summer period. According to hydrological conditions (water inflow), it was assumed that available capacity of hydro power plants would be about 50 % of their net generating capacity.

In terms of Scenario A the situation will get worse from 2016 and inadequacy may be reached up to 0.2 GW in the winter period between 2016 and 2020 and will be increased between 2022 and 2025. Scenario A shows the necessity for constructing new generation units or importing for the period 2016 to 2025. In Scenario B, the remaining capacity would be met with a surplus during the whole period in the case of slow and moderate demand growth.

Interconnection Capacity

The possible export will be in the range of 0.65 – 1.3 GW in winter and 0.6 – 1.25 GW in summer during 2010 – 25. The increase of interconnection transmission capacity will be expected after construction of the new interconnection (Estlink 2) with Finland and reinforcement of the 330 kV network after 2013. Interconnection capacity is forecast to increase with a new connection to Latvia, but this project is still to be confirmed.

6.11 ES – Spain

Generating Capacity

The peninsular Spanish electricity system is characterized by a high degree of penetration of renewable generation. The integration of substantial intermittent renewable generation and the minimization of the curtailment of renewable energy during periods of reduced demand are strategic objectives for the System Operator. These goals are framed in a more general level of development and promotion of electricity generation from renewable sources driven by the government in the context of fulfilling the objectives for 2020 set by the European Union.

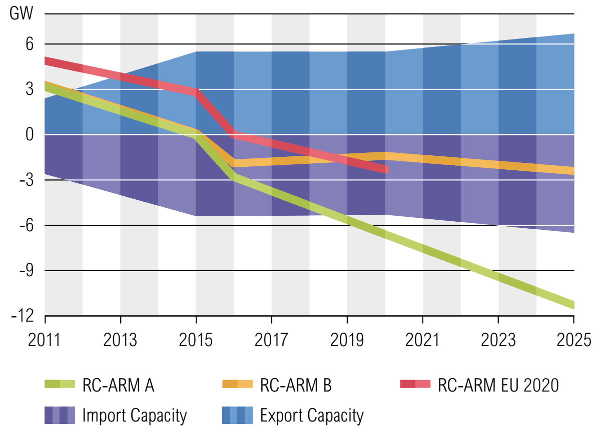


Figure 6.11:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Installed wind power is expected to reach about 34 GW in 2020, including some offshore facilities. Solar energy (both thermoelectric and photovoltaic) is expected to keep growing in the medium term, reaching 10 GW in 2020.

Generation expansion planning is also based on the commissioning of new combined cycle gas turbines (CCGT). At present five additional units are anticipated, representing a total amount of 2.8 GW and expected to be in operation between 2010 and 2011. In the long term, there are some projects concerning coal-fired units with carbon capture and storage (CCS), but apart from the Compostilla demonstration project they are not definite at the moment and hence have not been taken into account.

In the medium term it is not clear whether additional CCGT / OCGT projects will be developed; Scenario A covers the case in which no new gas-fired units are to be built after 2011. The best estimate scenario from the System Operator, which is based on keeping a coverage index equal to 1.1, requires the commissioning of six additional GW by 2020.

As regards hydro generation, new pumping units are expected, adding up to 3 GW of additional installed capacity before 2020. Some repowering of existing hydro units is also being considered.

These are the most important assumptions taken into account for the calculation of non-usable capacity in terms of system adequacy forecast:

- Thermal forced outage rate:
  available thermal capacity with probability of 95 % has been considered
- Dry hydro conditions:
  significant non-usable hydro capacity resulting from lack of water in the reservoirs
- Wind conditions:
  available wind capacity with probability of 90 % has been considered.

Load

Over the last years, demand growth rate has decreased, from historical values of 5 % (period 1995 – 2005) down to a historical minimum of -4.7 % in the year 2009. At present, demand is recovering and growing at a rate of about 3 %.

The demand coverage studies are based on the demand forecast studies carried out by Red Eléctrica. From these studies, values for annual energy and annual peak demand are forecast, values that will define the evolving needs of the generating equipment to meet this demand and to maintain the security and quality of electricity supply. Energy is expected to keep growing at average values slightly above 2 % (y/y), and peak demand is expected to reach 60 TW in the winter of 2020 under severe conditions.

Load forecast for SO&AF 2011 – 2025 is based on the average situation at the reference points during the last four years (that is, % of load with respect to seasonal peak demand). Hence, the demand at the reference points extracted from the data given for the PEMD (Scenario B) might not be equal, as it is based on the year 2007.

Generation Adequacy

In the short term, the situation of the Spanish system is not critical for the next year, and forecast remaining capacity (RC) is higher than adequacy reference margin (ARM) even in case of extreme peak demand.

In Scenario B, RC is positive for all the 2011 – 25 period, but it will be highly dependent on weather conditions (mainly wind), and it is expected to be lower than ARM after 2015. Moreover, if no new thermal capacity is commissioned (Scenario A), this margin (RC - ARM) will be reduced and the system could be in shortage from the year 2016 onwards. This year is also affected by the LCP Directive, which imposes the decommissioning of certain coal and fuel plants by December 2015 at the latest.

Interconnection Capacity

The increase of interconnection transmission capacity between Spain and France (and hence the rest of the UCTE system) is one of the main concerns of Spanish TSO regarding adequacy evolution, as well as the increase of transmission interconnection capacity with Portugal in the framework of the development of the Iberian electricity market. Both simultaneous import and export capacity are expected to grow from values below 2.5 GW (calculated as the sum of NTCs multiplied by a simultaneity factor of 0.8) to reach about 5.5 GW in 2015, thanks to the new Spain-France interconnection (expected in 2014), new Spain-Portugal interconnections (2011, 2012 and 2014) and internal network reinforcements. In the longer term, a new interconnection with France through the Bay of Biscay is expected to raise the bilateral NTC to 4 GW.

Furthermore, the benefits of the development of the Spain-France interconnections include the improvement of the quality and safety of supply, the growth of energy trade between the Iberian Peninsula and the rest of ENTSO-E, as well as allowing a greater integration of renewable energy into the Spanish peninsular system.

6.12 FI – Finland

General comments

Scenario EU 2020 is practically identical with Scenario B until 2020.

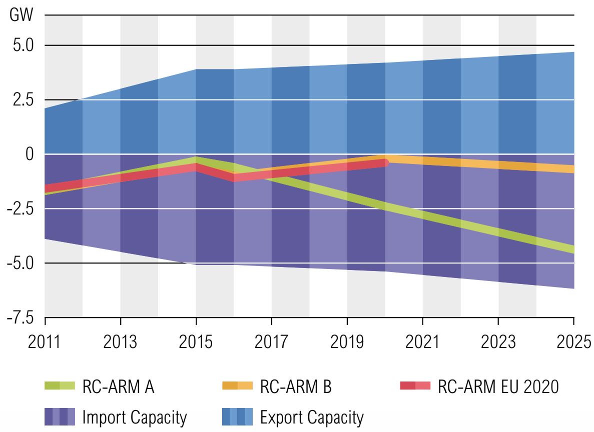


Figure 6.12:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

The renewable generation capacity is based on the National Renewable Energy Action Plan (NREAP) provided to the Commission in June 2010. In May / June 2010 the Finnish government approved and the parliament ratified decisions-in-principle regarding two new nuclear power units. In Scenarios B and EU 2020, one of these units is included in the capacity by 2020 and the other by 2025. The capacity of combined heat and power plants is assumed to remain at about the existing level. The government's aim is that the nation's own capacity should be able to provide for peak consumption and possible import disturbances. The amount of necessary fossil capacity is based on TSO's estimate, taking into account the above-mentioned aim. Many power plants use several different fuels. Hence, power plants are classified according to their main fuel. Renewable (other than hydro, wind and solar) in most cases means black liquor or wood in different forms whereas "non-identifiable" usually means peat is the fuel.

Load

Load forecast is based on the Ministry's latest forecast included in the NREAP. After the economic recession the load has recovered rapidly this year.

Some demand response is included in winter peak load, i. e. it is considered in Margin against Seasonal Peak.

Generation Adequacy

The amount of unavailable capacity is based on TSO's estimates. It is not divided into different categories except for the System Service Reserve. Maintenance and overhauls of major plants are done during the summer; electricity generation in combined heat and power plants is remarkably limited during the summer owing to lack of heat, load, etc. This largely explains the big difference between summer and winter. The availability of wind power is assumed to be small during the peak hours: 6 % of the capacity in winter and 0 % during summer.

In Scenario A the Remaining Capacity in winter remains negative for the whole period except for the years after commissioning of the nuclear power plant in 2013. This plant is now under construction. In Scenario B the Remaining Capacity is positive for the whole period in normal winter conditions. The consumption in Finland is strongly temperature-dependent so that in cold conditions the Remaining Capacity is negative.

In winter the Margin against Seasonal Peak Load takes into account the impact of cold weather; some demand response is assumed, however. The big Margin against Seasonal Peak Load in summer is explained by the fact that the load is at its lowest at the time of the reference day whereas the load notably increases by the end of the season, i. e. the end of September.

Interconnection Capacity

Two new interconnections are under construction at the moment; Fenno-Skan 2800 MW, to Sweden and, Estlink 2650 MW, to Estonia. These are included in all Scenarios by 2015. Two more changes are in the planning stage, one allowing bidirectional power transfer with Russia and the other being a new interconnection to Sweden. These are assumed to be in operation by 2015 and by 2025, respectively. They are included in Scenario B and Scenario EU 2020.

6.13 FR – France

Generating Capacity

The following assumptions have been made to build Conservative Scenario A. Hard coal capacities will be shut down in 2014 and 2015 due to the end of the derogation to the LCP Directive at the end of 2015. In addition, 40-year old hard coal units are taken out. Similarly, two 40-year old 900 MW PWR are foreseen as closed by 2018. More, most of the existing Oil units could close by 2020. Finally, no more CCGT or RES capacities are yet confirmed after 2015. Non-RES hydro capacity refers to pure pumped storage only.

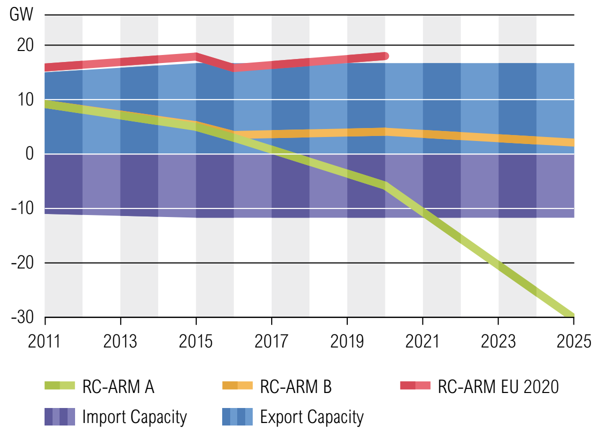


Figure 6.13:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Best Estimate Scenario B derives from Scenario A with 40-year old hard coal capacities being replaced by new CCGTs, without any PWR closure but an additional EPR unit, with the refurbishment or substitution of the existing Oil capacities by similar peak units and finally with a massive development of photovoltaic capacities thanks to lasting supporting policies.

Scenario EU 2020: no thermal park is described in the French NREAP and it had to be adapted from Scenario B to match the demand and the renewable park in the NREAP. As a consequence, gas and oil capacities have been reduced to match the capacities in Scenario A. Only firm CCGTs have been reported and the existing oil units are shut down by 2020. It should be noted that solar capacity in 2011 is slightly lower in Scenario EU 2020 than in Scenarios A and B because of the latest boom in the commissioning of solar capacity in France that cut subsidies.

Load

The demand forecast used in both Scenario A and Scenario B has been reviewed following the recent economic crisis. The year 2009 has shown a decrease of electricity consumption owing to a declining industrial sector. Yet winter peaks are connected to the widespread use of electric space heating in France, making consumption highly sensitive to outdoor temperatures: currently, a drop of one degree Celsius induces a 2100 MW[4] increase in demand. This figure rises over time with the increasing number of housing units using electricity for space heating, through either resistance heaters or heat pumps. Thus, the load forecast for January at 19:00 has not been very much updated since the last report, the overall energy decrease almost balancing the peak increase. On the other hand, the load forecast for July at 11:00 has been significantly decreased.

Demand Response should be understood as mechanisms to manage final consumption of electricity in response to supply conditions, either by delaying the use of electrical appliances or by substituting an alternative fuel for electricity in dual energy schemes. The working group dedicated to reviewing peak demand control issues set up by the Minister in charge of energy, and led by Members of Parliament Poignant and Sido, with the participation of all stakeholders, issued its recommendations on April 2, 2010. Many of these recommendations seek to promote Demand Response. The precise volume of demand response that may realistically be cited in 2015 as a direct consequence of these recommendations cannot be assessed with certainty. As a matter of prudence though, it is assumed that Demand Response potential will remain at 3 GW, a level that is closely comparable to the present capacity and similar to that assumed in the 2009 French Generation Adequacy report.

Scenario EU 2020: the demand in the French NREAP was based on the load in 2005. It does not take into account the recent economic crisis and its lowering or delaying impact on demand forecast. Nor, however, does it take into account the increasing effect of the lasting development of electric heating. Altogether, efficient energy-saving measures make demand much lower than in Scenarios A and B.

Generation Adequacy

The following assumptions have been made to build conservative Scenario A. Hard coal capacities will be shut down in 2014 and 2015 owing to the cessation of the derogation to the LCP Directive at the end of 2015. In addition, 40-year-old hard coal units are taken out. Similarly, two 40-year-old 900 MW PWR are as assumed to be closed by 2018. Moreover, most of the existing oil units could close by 2020. Finally, no more CCGT or RES capacities have been confirmed after 2015. Non-RES hydro capacity refers to pure pumped storage only.

Best estimate Scenario B derives from Scenario A with 40-year-old hard coal capacities being replaced by new CCGTs, without any PWR closure but an additional EPR unit, with the refurbishment of the existing oil capacities or their replacement with similar peak units and finally a massive development of photovoltaic capacities thanks to enduring supporting policies.

Remaining Capacity should be cut by 50 % from now on to 2015. It should be connected to the conclusion of the 2009 update of the French generation adequacy report which states "In light of the new forecasts for consumption and generation, security of supply looks reasonably assured through to the 2013 timeframe."

In Scenario EU 2020 the massive development of wind capacity foreseen in the French NREAP does end up with a higher unavailable capacity.

- http://www.rte-france.com/uploads/media/pdf_zip/publications-annuelles/generation_adequacy_report_update_2010.pdf
- http://ec.europa.eu/energy/renewables/transparency_platform/doc/national_renewable_energy_action_plan_france_en.pdf

Interconnection Capacity
No comments provided.

6.14 GB – Great Britain

General comment

Scenario EU 2020 is identical to Scenario B.

Generating Capacity

Scenario A includes all new plants under construction (as listed in the GB TEC register on September 21, 2010). Plant closures are based on official nuclear closure dates with all other closure assumptions consistent with Scenario B. Some 12 GW of coal and oil plant is forecast to close by 2015 owing to LCPD. Around 6 GW of existing gas stations are forecast to close by 2020, with more expected in the ten- to fifteen-year horizon owing to the age of the stations and the impact of IED.

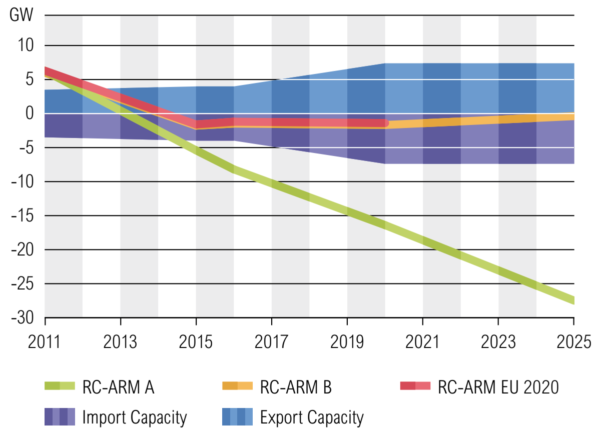


Figure 6.14:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

In Scenario B, the existing AGR plants are forecast to receive ten-year life extensions. This will maintain the level of nuclear capacity at around the 9 GW level until the first new nuclear plants connect in 2019 in this scenario. Scenario B includes 9.3 GW of new CCGT capacity by 2020. Scenario B assumes 3.2 GW of new "clean coal" capacity during the next ten years, with the possibility of existing plants also receiving funding to retrofit CCS. The forecast assumes that existing opt-in coal plants begin to close from around 2020 owing to age, further environmental constraints and the potential cost of retrofitting CCS. In order to meet the 2020 renewable energy targets, around 32 % of annual electricity generation will need to be generated from renewable sources in Scenario B. There is almost 25 GW of wind capacity included in this view, with additional wave, tidal and biomass capacity pushing the total renewable capacity figure up to almost 30 GW by 2020.

Load

Load is forecast to remain relatively flat. Any reductions in load owing to energy efficiency measures and increasing consumer prices may be offset by increased load from new sectors such as electric vehicles and heat pumps.

Generation Adequacy

In this high level analysis for winter 2020, the remaining generation capacity is slightly negative. However we believe that this is not cause for significant concern as within the calculation is an allowance for spare capacity of 5 % of total installed generation capacity plus generation set aside for system operator reserves at 24 hours ahead of real time which in practice might both be utilized to meet demand.

In summer the negative remaining generation capacity arises due to the nature of our load shape and the calculations used here. In practice we do not envisage any issues meeting demand in summer in 2020 as our market operates to flex generation availability to meet demand. We see a profile of generation outages which tracks demand levels with lower levels of outages at the start and end of summer when demands are high and peak levels of outage when demand is at its summer minimum. The calculation here requires a generation surplus at least of magnitude of the difference between the highest demand between April and September and the demand on the reference point in 3rd Wednesday in July at 11 a.m.

Interconnection Capacity

An increase in interconnection capacity is included with further links to France, Belgium, Ireland and Norway.

6.15 GR – Greece

General comment

Data for constructing the Scenario EU 2020 have mainly been obtained from the Greek NREAP and its accompanying Committee Working Paper that provides detailed background information on the assumptions made. It should be noted that the Greek NREAP refers to the entire country and therefore all values have been appropriately scaled down in order to reflect only the interconnected system of the mainland (and the islands interconnected to it). In Scenario EU 2020, only the interconnection of the Cyclades islands is considered by the year 2020, as in the NREAP. All other comments provided for the construction of Scenarios A and B are valid for Scenario EU 2020.

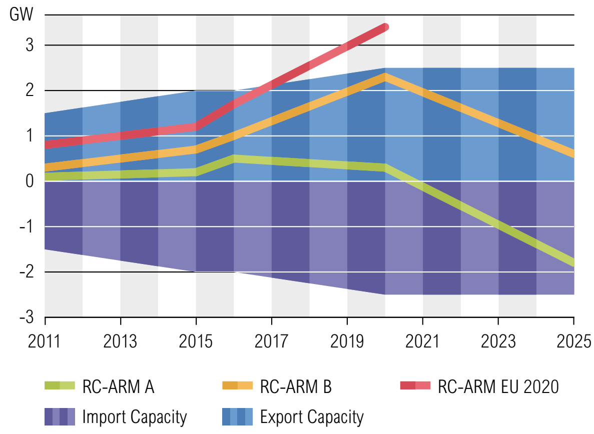


Figure 6.15:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

Currently, there are two mechanisms for new generation in the Greek system: the market-driven mechanism and the use of tenders by HTSO to ensure adequacy. The values presented here for the years after 2016 are indicative. The generation license granted to PPC (Public Power Corporation) and recent legislation allow PPC to replace old generating units with new capacity of the same magnitude. PPC has announced a large-scale program through which it plans to install new generating capacity, while at the same time decommissioning old inefficient units (mainly lignite and oil units). This plan has been taken into account in the construction of both Scenarios (A and B). It should be noted that the oil-fired units that appear in both Scenarios (A and B) in the year 2020 and after are existing and planned units located in Crete, which is expected to be interconnected to the mainland by 2020. It is not known yet whether the existing units will be mothballed or if their operation will continue. It is assumed that planned units and a proportion of the existing ones (about 800 MW) will remain in operation. Considering renewable energy sources, and in view of achieving national set targets for 2020, new legislation has given strong motivation for the installation of RES, as well as simplifying licensing procedures. A large number of RES projects have been announced by investors. Scenario A assumes that a proportion of these will be realized, whereas in Scenario B it is assumed that NREAP targets are met (including RES projects on islands that will be interconnected by 2020).

Load

Types of Load Management measures:

- Industrial customers participate in a "peak shaving" scheme (new legislation since 2006)
- Irrigation management (during high peak hours, if necessary, irrigation is limited through existing contracts)
- Programs for reducing domestic energy consumption are being implemented by the Ministry of Environment, Energy and Climatic Change, including incentives for the replacement of cooling appliances (air-conditioners and refrigerators) with new energy
- Efficient appliances (class A), as well as incentives for improving household efficiency (installation of solar water heaters, replacement of old windows with aluminium ones etc.)

Generation Adequacy

The Non-Usable Capacity includes mainly hydro capacity (which is reduced owing to limited water reserves) and capacity of wind power plants (an average 75 % of which is non-usable during the summer peaks). The water management aims at saving the water reserves to use them at the time of peak demand and only along with irrigation management. Furthermore, it is considered that solar units do not contribute at the first reference point (third Wednesday of January at the nineteenth hour).Additionally, limited availability of thermal units owing to temperature (heat) is considered for the second reference point (third Wednesday of July at the eleventh hour). The overhauls of the thermal power plants are avoided during periods of high demand. In this assessment a provisional overhaul schedule of the thermal units has been considered. The overhauls of the hydro power plants are implemented during periods of low use, that is, low water reserves or low load periods. Therefore, the scheduled outages of the hydro power plants do not affect the remaining generating capacity. System services include primary, secondary and tertiary reserves according to the UCTE OH Policy 1.

Interconnection Capacity
No comments provided.

6.16 HR – Croatia

Generating Capacity

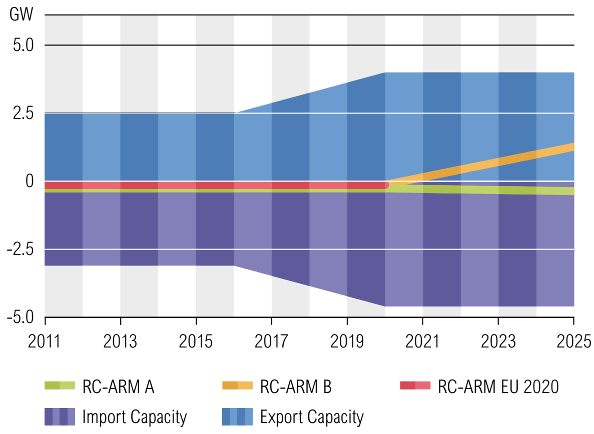


Figure 6.16:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Scenario A: the commissioning of the new gas-fired unit in TPP Sisak of 230 MW nominal power is expected in 2013. Commissioning of the gas-fired TPP Slavonija of 400 MW installed power is expected until the year 2015. The construction finalization of the coal-fired TPP Plomin 3 of 500 MW installed power is planned within 2015, and also the end of the operation of TPP Plomin 1 of 100 MW installed power. Commissioning of gas-fired TPP Dalmacija of 400 MW installed power is expected until the year 2020, as well as commissioning of 400 MW installed power of new units in existing TPPs in continental areas of Croatia. Until 2025, decommissioning of up to 1100 MW of old thermal power plant units that use fuel oil and coal is planned. The installed capacity of new renewable energy sources, mainly wind power plants, will amount to between 400 and 500 MW by the end of 2015. The trend of construction of renewable energy sources will continue, in order for installed capacity to reach the national target of 35 % of total electricity demand in the year 2020. In the 2020 – 25 period, the trend of construction of renewable energy sources will remain stable. In the observed period until 2025 owing to construction of new HPPs and revitalization and increase of the installed capacity of some existing HPPs total installed capacity will increase 250 MW.

Scenario B: in addition to Scenario A in the 2020 – 25 period there is a possibility of nuclear power plant commissioning of 1000 MW installed capacity (a decision is to be taken in 2012) and the coal-fired TPP of 500 MW installed capacity. According to the new national energy strategy (October 2009) the total installed capacity of wind power plants in the year 2020 is expected to be 1200 MW.

Load

In the observed period until 2025 the annual increase of electricity consumption is expected to decrease slightly owing to energy efficiency measures. Load forecast has taken into account medium- and long-term projections of economic growth rate. Growth of the load depends directly on industry development and growth of household consumption.

Generation Adequacy

Depending on hydrological circumstances and availability of renewable energy sources (of which the installed capacity in the amount of net generating capacity will increase constantly) the constant increase of unavailable capacity is expected. A contribution to that will also come from the performance of the regular maintenance works of the generation facilities as well as continuous increase of System Service Reserve. This trend will be more significant than non-usable capacity in old TPP units that will gradually stop operation.

Remaining capacity will show a constant increase by 2015 predominantly owing to increased volume of construction of gas-fired thermal power plants. After the end of that cycle a slow constant decrease is expected, which will cause a need for smaller import of electricity in the period until 2025, and therefore the dependence on imported energy will be reduced in relation to the current situation.

The values of margin against seasonal peak load will remain stable during the observed period.

Interconnection Capacity

A new 400 kV interconnection between Bosnia and Herzegovina and Croatia is under consideration and depends on power plant projects' realization in both countries. Project significance is bilateral and regional; it could enhance security of supply in both systems and strengthen the exchange and transit capacities in the region. Eventual installation of phase shift transformers (PST) in some of the border substations is also under consideration. A construction of 400 kV HVDC submarine cable with a 500 – 1000 MW capacity between Dalmatia in Croatia and Italy is under consideration long term. In accordance with the Agreement on ToR a common feasibility study of both involved TSOs is in the finalization phase.

6.17 HU – Hungary

Generating Capacity
No comments provided.

Load

Load forecast based on the short, intermediate and long-term capacity balances of the Hungarian Power System (MAVIR, 2009), 1.5 % growth rate assumed.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

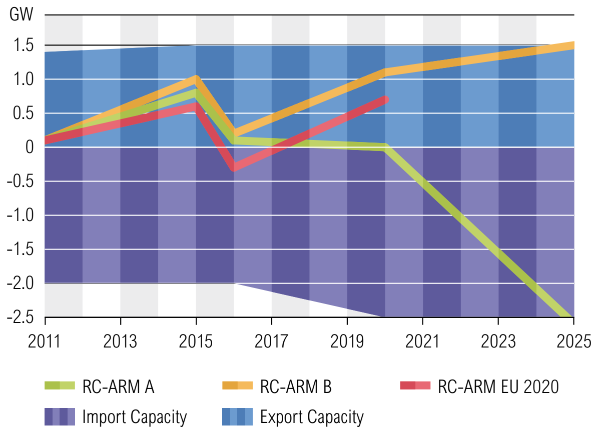


Figure 6.17:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

6.18 IE – Ireland

General comment

After completion of the North-South interconnector in 2015, the transmission systems for both the Ireland and Northern Ireland regions will be essentially consolidated into one. We also currently share reserve requirements. The coordination of responses with Northern Ireland was facilitated as much as possible.

In a realistic scenario (Scenario B), adequacy situation is positive for all years, as well as in Scenario EU 2020.

Generating Capacity

Decommission dates have been estimated and are based on the age of generators. For Scenario EU 2020 assumptions for thermal generators have followed Scenario B inputs and guidelines.

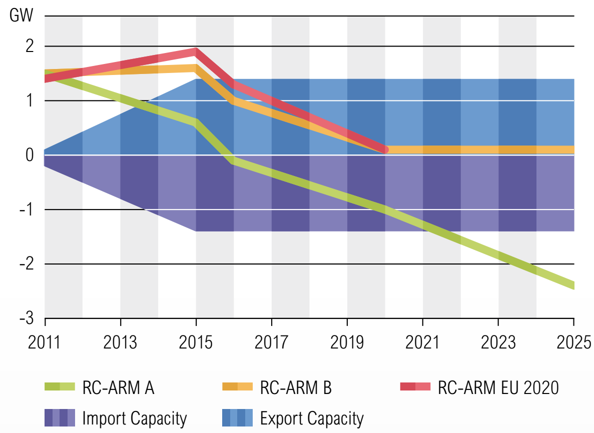


Figure 6.18:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Load

Our load figures are based on an economy-based model, as prepared for our annual generation adequacy report.

In forecasting annual peak and also calculating margin against peak load, our models already account for load management. We have therefore left this as zero to avoid double counting, but it is typically ~150 MW during winter peak hours.

The growth rates used in Scenario EU 2020 follow those presented in Ireland's NREAP report. Overall figures differ slightly, however, as a different starting-point has been used. Estimates for 2010 consumption differ slightly from those presented in NREAP.

Generation Adequacy

Unusable capacity here is owed to wind generation and other small-scale embedded generation. We estimate the value of installed wind capacity in terms of a thermal plant always being operable at full capacity. We call this "wind capacity credit." The difference between installed wind capacity and wind capacity credit is entered as unusable capacity. System Service Reserve is based on the largest generator on the island of Ireland, and is shared 3:1 with Northern Ireland. Our largest generator is expected to be 440 MW, so we provide 330 MW of reserve and NI provides 110 MW.

For 2025, we have assumed that the market will ensure enough generation is available for a secure system. The thermal portfolio for all other years is based on actual planned projects.

Our demand forecast model calculates future peaks. We then look at historical relationships between demand at the reference points and annual peaks. The values assume average winter temperatures.

Interconnection Capacity

After 2011 the figures include a 900 MW interconnection with Northern Ireland and 500 MW with mainland Britain. The Northern Ireland figure is somewhat artificial, since we plan to consolidate both regions into a single transmission region once this interconnector is built. We already operate under a single electricity market with NI.

6.19 IS – Iceland

Generating Capacity

Some 75 % is hydro-based and 25 % is based on geothermal power plants. Thus, the Icelandic power production is based 100 % on renewable energy sources. As of today, it is assumed that the share of geothermal power plants will increase.

Load

Estimated annual growth of domestic load is approx. 1 %.

Curtailable load may be used for load management.

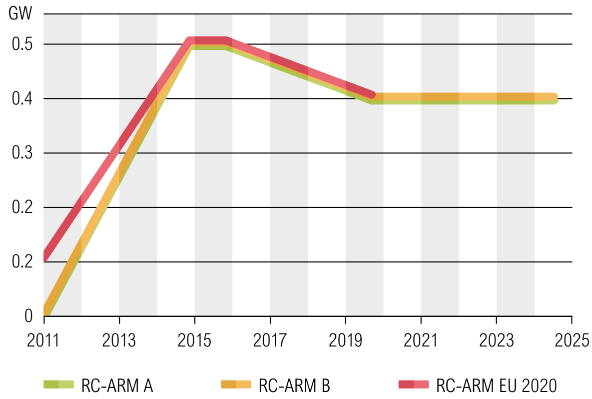


Figure 6.19:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generation Adequacy

Approx. 0.14 GW of capacity is devoted to system services (spinning reserves, etc.).

The seasonal variation curve is fairly flat in Iceland, owing to the large proportion of power-intensive users with high utilization factors.

Interconnection Capacity
No comments provided.

6.20 IT – Italy

Generating Capacity

An increase of more than 10000 MW in conventional thermal power plants is expected between 2011 and 2025 within Scenarios A and B.

The UE 2020 Scenario has been built according to the Italian National Renewable Energy Action Plan in line with Directive 2009/28/EC. The NREAP for Italy was presented by the Ministry of Economic Development on June 30, 2010. In the UE 2020 Scenario, an increase of about 16 GW in renewable energy sources (other than hydroelectricity) should be expected between 2011 and 2020.

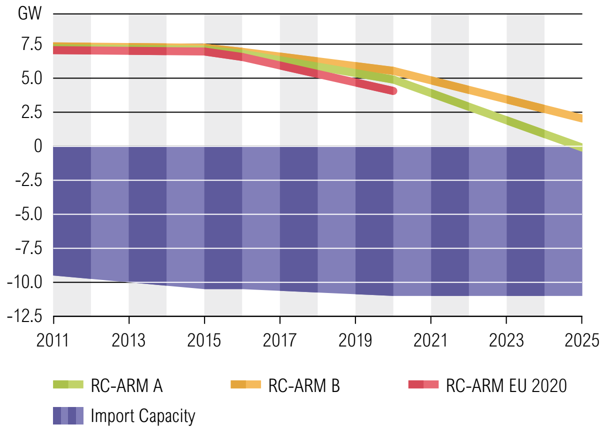


Figure 6.20:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Load

For a better estimation of the power required to cover future demand, we consider the same conservative evolution for both Scenario A and Scenario B. A lower level of load has been proposed for the UE 2020 Scenario, owing to an expected lower level of electricity demand.

Generation Adequacy

In normal conditions the remaining capacity, including only the signed import contracts, will usually be sufficient. This value could be higher with full import capacity. The spare capacity is assumed to be 5%.

Interconnection Capacity

The figures account for all planned facilities included within "Piano di Sviluppo" of Terna.

6.21 LT – Lithuania

Generating Capacity

In conservative Scenario A, only confirmed generation development projects were considered. In Scenario B, from 2013 to 2018 the commissioning of new 900 MW combine cycle gas turbines is expected, replacing old 300 MW units in Lithuanian PP. Also, a new nuclear power plant may be built in 2018 – 21. The majority of the increase in Renewable Energy Sources will be wind power.

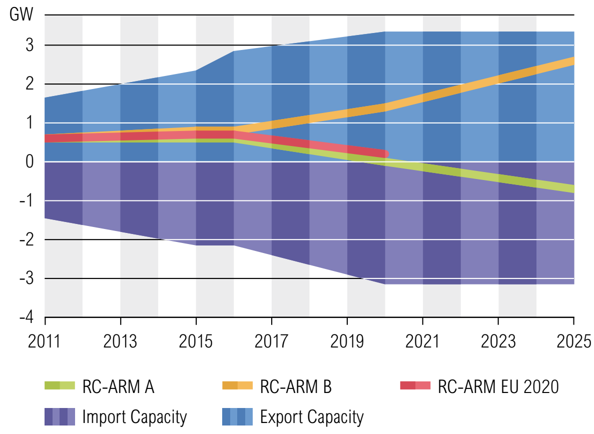


Figure 6.21:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Load

Forecast is based on GDP growth forecast.

Generation Adequacy

Lithuania has enough capacity to cover its peak demand, but generation costs are not competitive compared with imported electricity, mostly from Russia.

Interconnection Capacity

Preparatory works for implementation of construction of a 400 kV double-circuit transmission line Lithuania-Poland (LitPol Link) project have already started. Commissioning of the interconnection is expected in 2015 (stage I) and 2020 (stage II). A new 700 MW capacity submarine cable between Lithuania and Sweden (NordBalt) is expected in 2015. The aforesaid interconnections are very important for ensuring security of supply for both the Lithuanian and the whole Baltic (Lithuania, Latvia, Estonia) region, and for securing fuel diversification in Lithuania.

While Lithuania does not have the LitPol Link and NordBalt interconnections, much consumption is covered by imported energy from Russia, where generation takes place more than 1000 km from the Lithuanian border. Therefore, transfer capacity problems arise in neighbouring cross-sections, especially in maintenance cases, which are not controlled by Lithuanian TSO.

6.22 LU – Luxembourg

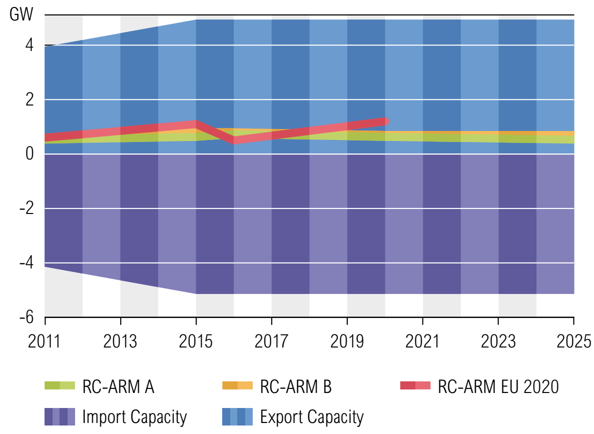


Figure 6.22:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

No comments provided.

Load

We notice a direct correlation between load growth and national gross domestic product of the country. As politicians encourage important measures to maintain gross domestic product growth at a similar level to that in the past, we can assume a further constant growth for the load. Nevertheless, economic stagnation resulted in a load capping in 2008/09. Owing to economic revitalization in the years 2009 and 2010 this capping is compensated by a load growth of > 5 % so that we can assume a continuation of the precrisis situation.

The NREAP report anticipates a reduction of energy consumption owed to efficiency measures until 2015 and a very slow increase (< 1 %) of consumption between 2015 and 2020. Very high efficiency measures have to be put in place to reach the target of NREAP. The load curve for LU is strongly influenced by the load of the industry (about 250 MW) that does not follow the normal daily curve but depends largely on the melting process of iron. The peaks of both loads (public grid and industrial consumer) are not synchronized. These assumptions were also made in Scenario EU 2020.

Generation Adequacy

When we consider the remaining capacity for Luxembourg it is very important to have in mind the grid configuration in this country. The two large power plants located on its territory do not inject their energy into the national public grid. As they are located at the borders they are connected via dedicated lines to the German grid of RWE and to the Belgium grid of ELIA. The public grid of Luxembourg depends highly on re-imports of this energy. The given remaining capacity is a valid contribution to the interconnected ENTSO-E grid only and cannot be considered as isolated value for the grid of Luxembourg.

The values for renewables in Scenario EU 2020 are taken from the NREAP report. This has no impact on the other generation plants in Luxembourg. Non-renewable generation capacity is identical to Scenario B values. To reach the NREAP renewable figures very high provisions have to be made by the government in encouraging investments in renewable energy production.

Interconnection Capacity

The import and export capacity takes into account the lines for the connection of the power plants located at the borders of Luxembourg. The remaining interconnection capacity available for the grid is lower but is sufficient to cover the national load in the grid in normal operation. Transit flows between different countries through Luxembourg are not possible. As Luxembourg is highly dependent on imports of energy, the n-2 case is considered for the security of supply and a reinforcement of the interconnection capacity by 2015 is needed and is being studied.

6.23 LV – Latvia

Generating Capacity

In 2014, the commissioning of a new 400 MW gas-steam unit in RigaCHP2 is planned; this unit will substitute the 220 MW old unit in RigaCHP2. In the best estimate scenario a new solid fuel 400 MW power plant in the Western part of Latvia is also planned. Power generation developments from renewable resources are planned in accordance with the "Latvian Republic Action Plan for Renewable Energy".

Load

Load forecast takes into account the existing economic conditions and the economic recovery process within the country. The load forecast is based on the GDP growth figure provided by the Ministry of the Economy.

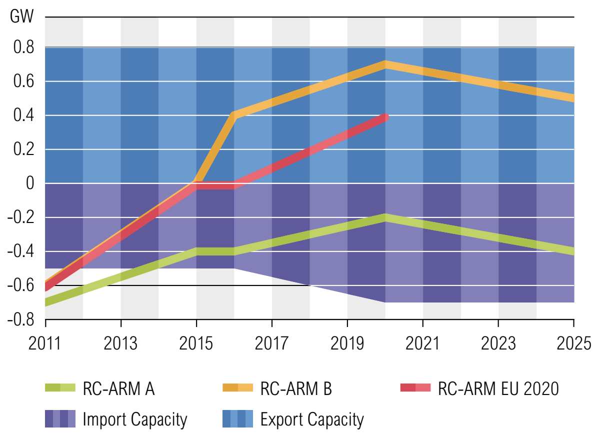


Figure 6.23:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generation Adequacy

Latvian power-generating capacity is based on hydro resources (Daugava cascade) and fossil fuel resources (RigaCHP). Latvian's generation adequacy is characterized in three periods.

– During spring and fall, the Latvian power system is self-sufficient in energy terms, as in the flood period the Daugava river has sufficient water for hydropower.

– Latvia is a net importer of electricity during the summer period, when the CHPs do not work and not enough water in the hydropower cascade is available (low use).

– In the winter period CHPs are operated in heating mode and cannot regulate their load; inflow in hydropower is very small.

Interconnection Capacity

Interconnection capacity is forecast to increase with the new interconnection to Estonia, but this project is still awaiting a decision (perspective 2020).

6.24 MK – Former Yugoslav Republic Of Macedonia (FYROM)

Generating Capacity
No comments provided.

Load
No comments provided.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

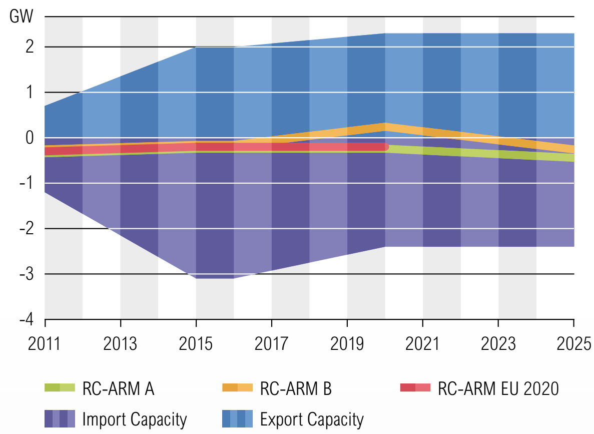


Figure 6.24:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

6.25 ME – Montenegro

The representativeness index is 100 %.

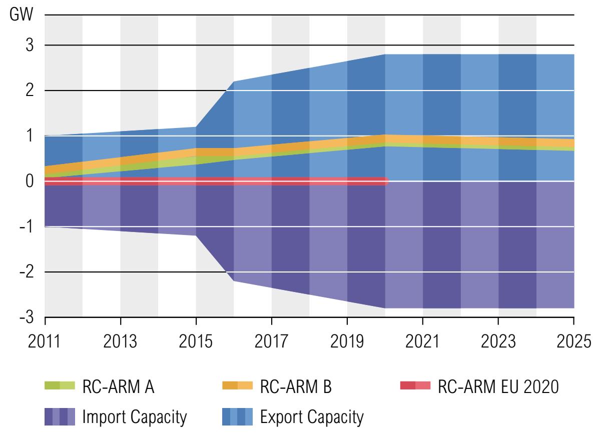


Figure 6.25:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

Generation expansion planning is based on the Energy Strategy Development Plan of Montenegro until 2025. There are plans for several new hydro power and thermal plants:

- HPP Morača, 238 MW installed power
- HPP Komarnica, 168 MW installed power
- TPP Pljevlja2, 225 MW installed power

The installed generating capacity of renewable energy sources:

- WPP, 80 – 180 MW installed power
- Small hydro power plants, 30 MW installed power
- Other (biomass, refusion ,etc.), 10 – 15 MW installed power

The trend of construction of renewable energy sources will continue, in order that such installed capacity enables the national target of 20 % total electricity demand in the year 2025 to be met.

Load

According to the Energy Development Strategy until 2025, mid-scenario, average annual energy consumption growth until 2025 is 1.33 %. Average annual peak load demand growth will be 1.51 %. Annual percentage in these periods will be: 1.41 % (2005 – 2010), 0.9 % (2010 – 2015), 1.52 % (2015 – 2020) and 1.51 % (2020 – 2025). At the beginning of the long-term planning period (2010 – 2015) values are smaller as a result of rigorous energy efficiency measures to be taken.

Owing to the high influence of the aluminium industry on Montenegrin consumption, some inaccuracy in demand prediction can be expected.

Generation Adequacy

During the year 2010 and after, a revitalization of two HPPs, one TPP and an additional small HPP is planned with 868 MW installed power capacity.

Interconnection Capacity

Montenegro will be an exporter of electricity after the year 2020. This would not be possible without the new interconnection lines. In the period 2010 – 25 Montenegro will be interconnected with Italy by an HVDC undersea cable. The OHL 400 kV Podgorica-Tirana will also be constructed. A new OHL 400 kV interconnection between Montenegro-Serbia and Montenegro-Bosnia-Herzegovina is to be planned.

The new interconnections would increase security of supply and capacities for transit and enhance the cross-border market.

6.26 NI – Northern Ireland

Generating Capacity

In all scenarios 510 MW of fossil fuel generation (gas) will be decommissioned by the end of 2015 owing to the Low Carbon Plant Directive. The NI plant portfolio consists of 307 MW of Open Cycle Gas Turbines included as oil; however, it should be noted that this is distillate and not heavy oil. "Not Clearly Identifiable" comprises small-scale embedded renewable generation and customers' private generation.

There has been recent growth of small-scale centrally dispatched generation including an Aggregated Generating Unit of 20 MW made up of a number of small-scale generating units and also some CHP plant. In all instances renewable generation is growing rapidly with many projects committed to connection in the coming years. No conventional generation is contracted to connect.

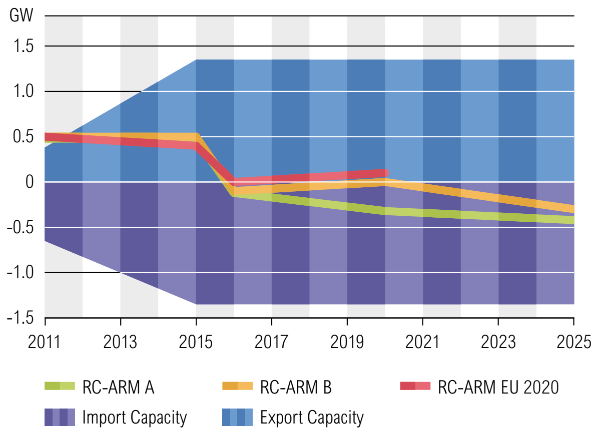


Figure 6.26:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Load

NI load forecasts are regularly reviewed to take account of the current economic conditions. The growth is assumed to return to a normal annual 1.5 % by 2013.

In forecasting annual peak demand and also calculating margin against peak load, our models already account for load management. We have therefore left this as zero to avoid double counting; however, it is approximately 50 MW of small-scale embedded generation during winter peak hours. It should be noted that the System Operator has no control over this 50 MW.

Generation Adequacy

Unusable capacity here is owed to wind generation and other small-scale embedded generation. We estimate the value of installed wind capacity in terms of a thermal plant always operable at full capacity. We call this "wind capacity credit." The difference between installed wind capacity and wind capacity credit is entered as unusable capacity. System Service Reserve is based on the largest generator on the island of Ireland, and is shared in a ratio of 3:1 with Ireland. The largest generator is expected to be 440 MW, so Northern Ireland provides 110 MW of reserve and Ireland provides 330 MW.

For 2025, we have assumed that the market will ensure enough generation is available for a secure system. The thermal portfolio for all other years is based on actual planned projects.

Our demand forecast model calculates future peak demand. Historical relationships between demand at the reference points and annual peaks are analysed and temperature corrected. The values assume average winter temperatures.

Interconnection Capacity

There is an HVDC link to mainland Britain with a capacity of 500 MW which was commissioned in 2001. A second high-voltage tie-line between Ireland and Northern Ireland is due to be completed between 2015 and 2017, increasing the capacity to 900 MW for the two countries.

6.27 NL – The Netherlands

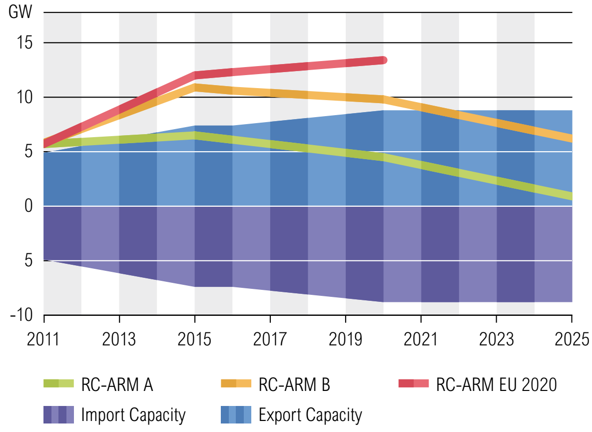


Figure 6.27:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

The installed thermal generation capacity in the Netherlands in the conservative scenario (A) is increasing by 20 % in comparison with 2010 (nearly 22 GW) to more than 26 GW, with present 3 GW renewable power to be constant (wind power 2.3 GW).

Scenario B shows a much higher growth of thermal generation capacity, approximately 40 % in comparison with 2010. This capacity can be distinguished as 4.7 GW coal- and 4.6 GW gas-fired units. This best estimate generation scenario also includes an increasing amount of 3.6 GW of wind power in 2025.

The Scenario EU 2020 was based on the Dutch National Renewable Action Plan (NREAP). In NREAP the total value of renewable supply (15.0 GW, including 1 GW hydro and solar) was translated into Scenario EU 2020 in two separate parts: 12.7 GW renewable by primary fuel capacity and 2.2 GW renewable by secondary fuel capacity, the latter being biomass in coal-fired units. The total amount of wind power in 2020 is estimated at more than 11 GW. In this Scenario EU 2020 one of the coal units expected to be built in Eemshaven (1.3 GW) was envisioned as a gas-fired unit. Other basic principles taken into account were derived from the best estimate scenario.

The NGC in 2025 shows nearly 29 GW in Scenario A and 38 GW in Scenario B; however, 2.5 GW will be mothballed according to the latest reports from producers. For Scenario EU 2020 the NGC in 2025 will be 44 GW assuming the same situation as in 2020.

Load

The development of load in Scenarios A and B was based on historic growth figures of electricity consumption and realized economic growth rates, disregarding the latest year of the economic crisis, i. e. 2009. For each year a 2 % growth rate was used.

In Scenario EU 2020, the load values for Scenario B were downscaled and based on the ratio of the electricity consumption in the energy efficiency scenario of the Dutch NREAP and the electricity consumption forecast by the TSO, resulting in an average growth rate of 0.9 % in this scenario.

Generation Adequacy

The total amount of unavailable capacity in the reporting period will increase from approximately 5 to 8 GW in Scenario A to 11 GW in Scenario B and to 15 GW in Scenario EU 2020 mainly owing to the increasing amount of wind power. The development of the NGC in all scenarios will increase much more, however, and the remaining capacities (RC) will never show a negative value, even in the conservative scenario. Therefore it can be foreseen that there will be a certain comfortable space for updating the installed generation capacity by replacing old or insufficient units. This process will be speeded up when the development of load can be reduced by savings according to the Scenario EU 2020.

Interconnection Capacity

Extending interconnection capacities for the Netherlands

Under construction in 2010 and in commercial operation 2011: a 1290 MW HVDC bipolar installation including 260 km of 450 kV DC subsea cable between the UK (Grain) and the Netherlands (Maasvlakte) with an increase of 1 GW NTC. At the moment there is no connection between the UK and the Netherlands. The work is intended to enhance diversity and security of supply for both markets, open access for all market parties by explicit auction and market coupling increase of interconnection capacity and market transparency.

A new 400 kV double circuit interconnection 60 km line between Germany (Niederrhein) and the Netherlands (Doetinchem) is foreseen in 2013, according to the TYNDP, with increasing NTC as from 1 GW as a result of overloads due to high North-South power flows through the auctioned frontier between the Netherlands and Germany in peak hours of wind in-feed. Progress status TYNDP: design and permitting.

Further on there is COBRA under design & permitting 2016: a new single circuit HVDC connection between Denmark (Jutland) and the Netherlands via a 350 km subsea cable; the DC voltage will be up to 450 kV and the capacity up to 700 MW. There is a need to increase the current transfer capacity for the purpose of allowing for the exchange and integration of wind energy and increasing the value of renewable energy in the Dutch and Danish power systems.

Under consideration 2015 / 2017 is NorNed 2: a second HVDC connection between Norway and the Netherlands via a 570 km 450 kV DC subsea cable with minimal 700 MW capacity. There is a need to increase the current transfer capacity between both countries for diversity of supply: connection between a hydro and a thermal power system.

6.28 NO – Norway

Generating Capacity

In 2010 the total Norwegian generation capacity is about 31000 MW. Of this, 96 % is hydro power plants, 3 % is thermal power plants and 1 % is wind-power plants.

Load

A modest growth is expected. Possible growth areas are within the petroleum sector and power-intensive industry. It is expected that the petroleum sector will increase its load in the north of Norway, and that general consumption will increase gradually. The maximum load for Norway in 2011 is expected to be about 22000 MW in a normal winter and 24000 MW in a severe winter (1 of 10 year, temperature).

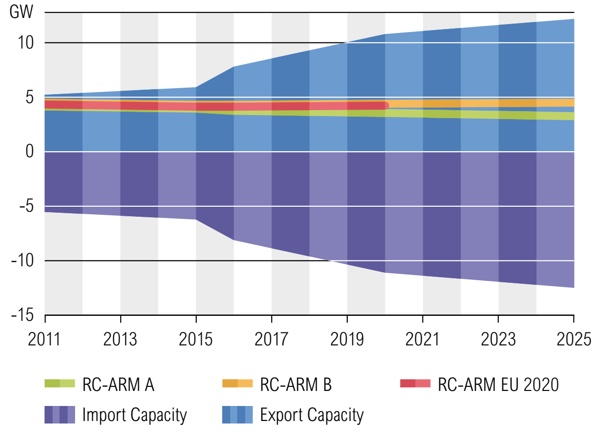


Figure 6.28:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generation Adequacy

The value of unavailable capacity is based on statistical observations and on the following:

- Hydro power is 87 % available, based on historical power registrations. Most of the unavailable capacity is related to river-run power plants which are rather dry in the winter. Another reason is that the lower the reservoir level the lower the available generation. During the winter the reservoir level usually falls lower and lower.
- Wind power is 5 % available. This is based on statistical observations of the different wind-power plants.
- Combined Cycle Gas Turbines (CCGT) are 100 % available.

Interconnection Capacity

In Scenario B the following interconnectors are included:

- DC-link to Denmark 700 MW, 2014 (Decided)
- DC-link to Sweden 1200 MW, 2016
- DC-link to the Netherlands 700 MW, 2016 – 2018
- DC-link to Germany 1400 MW, 2016 – 2018 (License applied for)
- DC-link to Great Britain 1600 MW, 2017 – 2020
- The projects are largely based on an increasing need for interaction between the hydro-dominated Norwegian / Swedish system and the wind / thermal-based continental system.

6.29 PL – Poland

Input data on generation and consumption for Scenario Outlook & Adequacy Forecast (SO&AF) 2011 – 2025 were collected in October 2010. Data for Scenario EU 2020 come from the draft of the National Renewable Action Plan (NREAP). All values from NREAP have been converted into net values.

NGC of biomass represents 100 % renewable installations (co-firing excluded).

Values provided to SO&AF report correspond with data in Pan-European Market Database within the accepted level.

National representativeness is 100 %.

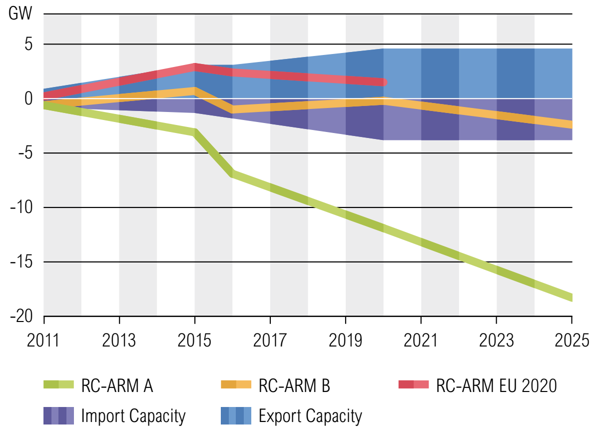


Figure 6.29:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

1) Influence of LCP directive on generating capacity

Poland, during negotiations on its accession to the European Union (joined April 1, 2004), was responsible for the derogation clause from LCP Directive (2001 / 80 / EC), which came into effect in 2008 (for SO2) and 2016 (for NOX). The derogation clause from the directive means the emission limit values shall not apply until January 1, 2016 for SO2 and January 1, 2018 for NOX for selected power stations and combined heat and power plants. No derogation clause is in force for dust.

Polish TSO, based on producers' declaration, assesses that in Poland, as the consequence of entering into effect the results of present LCP Directive as well as exceeding the life span of units the following capacity decommissioning is to take place:

- 5.5 GW – until the end of 2015
- 4 GW between 2016 and 2020 (mainly until the end of 2017)
- 3.5 GW is to be decommissioned between 2021 and 2025 only if its lifespan is at an end

The data on decommissioning, applied in both conservative and best estimate scenarios, does not take into account the decommissioning, which is the result of the new IED (amending the LPCD and the IPPCD) coming into effect from 2016.

2) The conservative Scenario A

Following the ENTSO-E definition, this scenario indicates potential imbalance owing to lack of new investments in the future. For thermal and nuclear power plants PSE Operator S.A. adopted the following criterion of confirmation of the execution of the investment: concluding an agreement (with subcontractors) by an investor for the construction of a unit. For other generating sources, mainly wind farms, Polish TSO has utilized the level of the net generation capacity which is to be reached within a two-year time horizon according to the Yearly Coordination Plans (system balance plans, published on PSE Operator S.A. web page).

Taking into account the criteria mentioned above, commissioning of one thermal unit of 800 MW maximum output capacity is taken into account in the scenario. Its first synchronization is planned for the beginning of 2011. Regular work by the unit is expected in the second half of 2011. It will be the unit with the biggest output capacity in the Polish power system. Development of wind generation up to the level of 2.3 GW installed capacity is envisaged.

3) The best estimate Scenario B

The level of generating capacity (thermal and renewable sources) included in the Best Estimate Scenario (resulting from the units forecast to be commissioned) has been extracted from the present Development Plan in force with the Polish Regulator's approval. The level of generating capacity includes updates as of October 2010 with regard to the investment projects by generators and taking into account the achievable level of power capacity assessed by PSE Operator S.A. For the year 2025 PSE Operator S.A. included the input from the first nuclear unit in Poland that is specified in the "Polish nuclear energy plan" published by the Ministry of the Economy.

4) Top down Scenario EU 2020

Power data for this scenario are based on the following documents:
- Draft of NREAP –
  for NGC of renewable energy for the analysed period (2011 – 2020).
- Annual Coordination Plan –
  for NGC of conventional thermal PPs in 2011.
- Energy Policy of Poland until 2030 (PE2030) –
  for NGC of conventional thermal PPs after 2011. For 2016 the value of thermal NGC is derived as the linear interpolation between 2015 and 2020 (no year 2016 in PE2030).

Load

In Scenarios A and B PSE Operator S.A. forecasts, as in the previous SAF report (2010 – 2025), the yearly increase of load by 2.3 % until 2020 and by 2.6 % between 2020 and 2025. Deployment of additional efficiency measures and tools might influence the level of peak loads and electricity consumption, thus optimizing the level of load increase.

Load in Scenario EU 2020 is calculated on the basis of final energy consumption stemming from an additional energy efficiency scenario in the draft NREAP. Load and consumption data in this scenario are much lower than the prognosis by Polish TSO. For the years 2015, 2016, 2020 the difference between them totals about 12 %. In 2011 the difference amounts to about 3 % as the result of the correction by PSE Operator S.A. of the value from NREAP. The correction was made because of the strong growth of load observed as well as energy consumption in 2009 and 2010 (for 2010 TSO estimation is based on data for the period from January to October).

For the years 2011 to 2025 in all scenarios the load management excluded at the moment.

Generation Adequacy

1) Unavailable capacity

Elements of unavailable capacity and short description:

- Non-usable capacity:
  - average factor of unavailability of wind generation – 75 %
  - technological limitation of production in combined heat power plants (summer season)
  - restrictions owing to cooling water temperature in some thermal power plants (summer season)
  - limitations owing to transmission network capacity constraints caused by high temperature (summer season)
  - increase of the heat production in combined heat power plants (winter season)
  - part (ca. 40 %) of pump storage total availability is treated as non-usable (usage of hydro power determined by duration of peak load in winter season)
- Maintenance and overhauls:
  For 2011 the level of capacity concerning maintenance and overhaul schedules agreed between PSE Operator S.A. and producers is given but for following years the level is estimated in relation to the level of thermal net-generating capacity for these years.
- Outages:
  - forced outages
  - outages owing to unexpected faults during the start of the unit within ongoing maintenance process

– System Services Reserve:
  – power saved for primary and secondary reserves in conventional thermal power plants
  – power saved in pumped storage hydropower as intervention reserves

2) Remaining capacity

In Scenario A remaining capacity significantly decreases, especially after the year 2015, as the result of decommissioning caused by the LCP Directive 2001 / 80 / EC coming into effect as well as the limitation of units' lifespan (NB: no new investments after the year 2012).

In Scenario B until 2020 the level of the remaining capacity oscillates around the present level with a decrease in 2016 as the result of termination of the derogation clause with reference to the SO_2 emission limit values. For the period after 2020 not many projects are taken into account, which, in connection with load growth, causes a decrease in remaining capacity.

Scenario EU 2020, because values of load are significantly lower than in PSE Operator's S.A. scenarios, is characterized by a fairly high level of remaining capacity.

Differences in dynamics of increased NGC and reliable available capacity (RAC) result from the assessed 25 % availability level of wind farms.

3) Spare Capacity

Polish TSO assumes 5 % of NGC minus the sum of maintenance and overhauls.

4) Margin against Seasonal Peak Load

For Poland the representative season for winter comprises December, January and February (peak load usually takes place at 17:15). For summer it is the period between the second half of June and the first half of August with a daily peak load at 13:15. The time of occurrence of this peak load justifies the choice of the representative months for the summer period because statistically, before and after this summer period, the daily peak loads take place in the afternoon. Calculation of Margin against Seasonal Peak Load is based on statistical data and its value is constant for the forecast period.

Simultaneous Interconnection Transmission Capacity (SITC)

The increase of SITC indicated in 2015 for synchronous profile is the result of phase shifter installation in Krajnik and Mikułowa substations (connected PL and DE systems) and change in the voltage level for the Krajnik-Vierraden line from 220 kV to 400 kV. Another increase of SITC for this profile, in 2020, is the result of building a third 400 kV interconnection between PL and DE. For asynchronous profile a 400 kV double circuit line Alytus-Ełk with back-to-back substation (500 MW in 2015 (import to Poland only) and 1000 MW in 2020) is being considered. PSE Operator S.A. follows a single coherent vision of cross-border interconnection development, and therefore the values presented in Scenario A are the same as in Scenario B.

[MW]	2011	2015	2016	2020	2025
PL > DE / CZ / SK [1]	900 / 1100 [2]	2500	2500	3000	3000
DE / CZ / SK > PL	0	500	500	2000	2000
PL > UA [3]	0	0	0	0	0
UA > PL	220	220	220	220	220
PL > LT [4]	not applicable	0	0	1000	1000
LT > PL	not applicable	500 [5]	500	1000	1000
PL > SE	0	600	600	600	600
SE > PL	600	600	600	600	600
PL export	**900 / 1100**	**3100**	**3100**	**4600**	**4600**
PL import	**820**	**1820**	**1820**	**3820**	**3820**

Table 6.29.1:
Cross-border interconnections development

1) The values presented above are the nominal values.
2) PSE Operator S.A. S.A. gives aggregated data for the whole synchronous PL-DE / CZ / SK profile.
3) Winter / summer season.
4) Radial connection using 220 kV Zamosc-Dobrotvir line at the moment.
5) Back-to-back connection. Realisation of the first stage of this investment is planned till June, 2015. Polish as well as Lithuanian TSOs take into account functioning of this connection since July 2015.

6.30 PT – Portugal

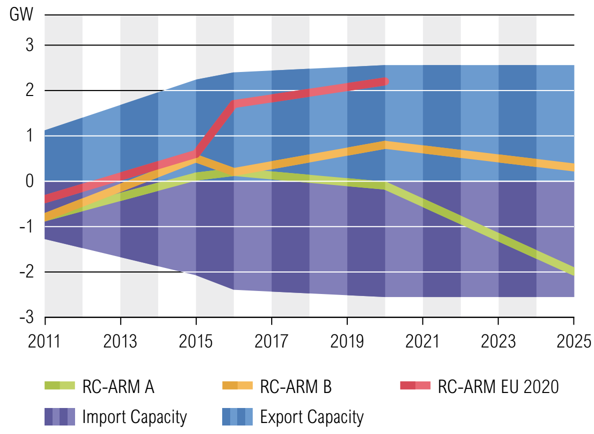


Figure 6.30:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

Scenarios A and B correspond to two evolutions of the Portuguese generating system envisaged by the REN, which estimates a slower growth of supply capacity of the various components of generation, given the developments envisaged in the new National Strategy for Energy (ENE 2020), defined by the government of Portugal. Scenario A is more conservative, limiting the development of the thermoelectric component to the combined cycle units already licensed (six CCGT units within the range of 400 MW). Scenario B estimates the increase of thermoelectric capacity beyond the already licensed units. Until 2020, in order to limit the dependence on natural gas, the integration of two new CO_2 "capture ready" pulverized coal units (which could alternatively be the 2 latter CCGT licensed units) is expected. In the period 2020 – 25, two new CCGT units are being considered in addition to those already licensed and also four new pulverized coal units equipped with CO_2 capture. Both scenarios indicate: the integration of new 3300 MW of large hydro power plants until 2020, which represents approximately 75 % of the total new large hydro capacity that is indicated under ENE 2020; six new CCGT units, with a total capacity of 2500 MW; and a strong development of renewable energy sources, in particular wind power that reaches 8000 MW in 2025. Not Clearly Identifiable sources correspond to the non-renewable share of CHP and urban solid wastes.

Scenario EU 2020 was based on the Portuguese NREAP released in July 2010, which estimates the evolution of the Portuguese generating system as in the National Strategy for Energy (ENE 2020), defined by the government of Portugal. Main developments assumed by this scenario are: the integration of new 4300 MW of large hydro power plants until 2020; six new and already licensed CCGT units, with a total capacity of 2500 MW; and a strong development of renewable energy sources, in particular wind power that reaches almost 7000 MW in 2020. Not Clearly Identifiable sources correspond to the non-renewable share of CHP and urban solid wastes that was estimated by REN, since NREAP does not make any reference to it.

Load

The energy consumption forecast is based on estimations enabling the compliance of the "National Action Plan for Energy Efficiency" that defines for the electric sector a total saving of 7 % of consumption in 2015. After 2015 this saving is maintained.

Generation Adequacy

Non-Usable Capacity:

- wind energy – reflects the average lack of wind power (70 %)
- hydroelectric energy (large power stations) –
  reflects the average lack of primary energy along with the incorporation of new mixed-pump power plants;
- thermal RES and CHP (small independent producers) –
  reflects the average amount of capacity not being delivered to the grid, based on historical values
  - outages:
    the larger unit installed in the Portuguese system was assumed.
  - System Services Reserve:
    2 % of peak load to face load forecast uncertainties;
    Expected sudden decrease of wind power within 1 h period
    (this criterion has revealed more accuracy than the recommended secondary control reserve empirical function)

The progressive decommissioning of current coal power plants (after 2018) means that the evolution of the installed capacity in the system considered in Scenario A is not enough to insure remaining capacity higher than ARM in 2020 and 2025. In Scenario B, RC - ARM is always positive owing to capacity reinforcements assumed.

Given the last five years of demand data, Margin against Seasonal Peak Load is assumed to be 4.9 % and 4.7 % of peak load on the third Wednesday of January at 19.00 and the third Wednesday of July at 11 a.m, respectively.

In Scenario EU 2020 RC - ARM remains positive throughout the analysed period (except for 2011).

Interconnection Capacity

The Iberian Electricity Market (MIBEL) requires interconnection capacity capable of enabling the required market energy exchanges, in both directions and with limited grid congestion. REN and REE have several investment projects in progress that will enable the overcome of existing congestion and, beyond 2014, a total interconnection capacity of 3000 MW between Portugal and Spain reaching 3200 MW in 2020.Simultaneous Interconnection Transmission Capacity was based on 80 % of expected NTC between Portugal and Spain.

6.31 RO – Romania

Generating Capacity

The units' lifetime and the impact of the LCP Directive 2001 / 80 / CE on the lignite and hard coal power plants have been considered in the evolution of the existing generating capacity through the decommissioning and rehabilitation programs.

Two new nuclear units of 665 MW are expected to be in operation by 2020 (in all scenarios) together with a pumped storage hydro power plant.

The Romanian NREAP has no information related to the non-renewable units; therefore thermal units' data for Scenario EU 2020 have been adopted from Scenario B.

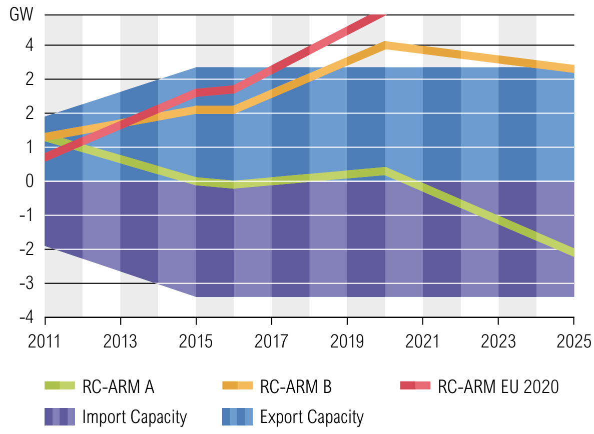


Figure 6.31:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Load

In the period 2010 – 20 the electricity consumption is expected to increase with an annual growth rate of 2.34 %, in Scenarios A and B and 2.74 %, in the Scenario EU 2020. Furthermore, in Scenarios A and B a 2.3 % annual growth rate is assumed for the 2020 – 25 period.

Generation Adequacy

Unavailable capacity will increase over the 2010 – 25 period, mainly owing to the increase of wind capacity. The wind power capacity considered unusable is, on average, 70 % of the installed capacity.

Non-usable capacity also includes:
– temporary limitation of capacity in hydroelectric power stations,
– limitation of electrical capacity directly related to the heat extraction requirements in combined heat and power plants,
– high temperatures of the cooling agent in thermal power plants,
– use of coal with low calorific power,
– retrofitting programs and
– other temporary limitations.

Based on past experience related to the load variation and the generation capacity structure of Romania, a Spare Capacity of 5 % of NGC was adopted to assess the Adequacy Reference Margin.

Interconnection Capacity
No comments provided.

6.32 RS – Republic of Serbia

Generating Capacity

Construction of new hydropower stations is not anticipated during the next ten years. Some small hydropower stations are planned, but their influence on the system will be negligible. Capital operations in existing hydropower stations are planned and that will increase the performance of units. Thermal units will display noticeable changes. Existing gas turbines combined cycle PP Novi Sad will be replaced with the new one of 360 MW till 2015. Next thermal plants will get new units: Kolubara B 2 × 350 MW till 2016; Nikola Tesla B 700 MW, Kolubara A 200 MW and Kostolac B 450 MW till 2020. It is expected that some of the existing units will be withdrawn. The plan is that during the next ten years 1GW (old thermal units) will be withdrawn.

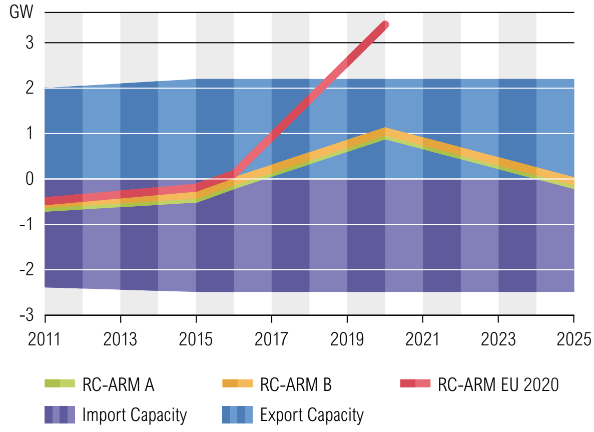


Figure 6.32:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Load

Values calculated for load assume that weather conditions will be normal.

Generation Adequacy

Units which are not in operation for several years are treated as non-usable capacity. Values for maintenance and overhauls are taken from the PC "EPS" repair plan. Outages will be covered from System Reserve. System Reserve is evaluated according to newly adopted rules and real situations that have shown us that we cannot handle more than 450 MW.

Interconnection Capacity

No comments provided.

6.33 SE – Sweden

Generating Capacity

The NGC of nuclear power is expected to increase owing to efficiency upgrades. In addition, a large increase of electricity generation from renewable sources is assumed to be driven by the Swedish green certificates: the electricity certificate system. The increase of the power generation from renewable sources is expected to come mainly from biomass and wind-power generation. The trend of refitting existing fossil fuel plants to biomass is expected to continue. Svenska Kraftnät has been notified of wind-power projects with a total capacity of about 36 GW. Even though the main part of the planned wind power probably will not be built, the huge amount of wind power plans is an indication of a large increase of wind power generation. The NGC of fossil fuels is expected to decrease owing to the decommissioning of oil and coal power plants.

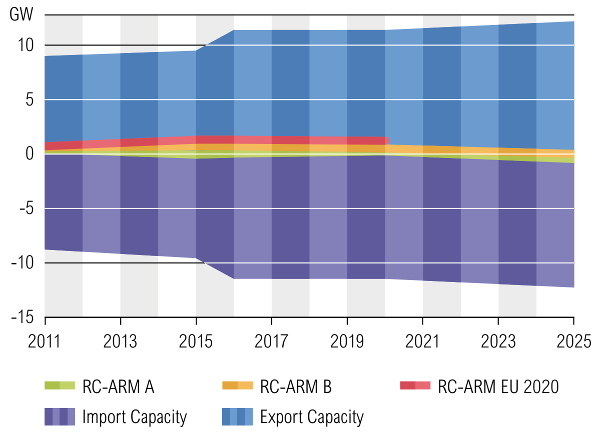


Figure 6.33:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

In Scenario EU 2020 a large increase of electricity generation from renewable sources is expected, mostly from biomass and wind power generation. In the Swedish NREAP in tables 10.a. and 10.b. the NGC biomass increases from 2683 MW in 2010 to 2914 MW in 2020. During the same period the energy increases from 10567 GWh to 16689 GWh. As a large increase of energy is not realistic when the NGC only increases slightly the Swedish Energy Agency was consulted. New NGC for biomass and wind power was calculated from the energies given in NREAP with help from the Swedish Energy Agency.

Load

The prognoses of the demand are used as reference values when the loads of the reference times have been approximated. Swedish electricity consumption has been very low since 2008 owing to the financial crisis as electricity consumption is closely linked to economic activity. The economic situation has not recovered fully from the financial crisis and therefore consumption in 2011 is expected to be relatively low at some 148 TWh. The economic situation is assumed to be better in 2015 and 2016 and therefore the demand is assumed to increase to 153 TWh. Thereafter a lower annual average growth rate has been chosen and the demand only slightly increases between 2016 and 2025. Increased energy efficiency and higher fuel and electricity prices are assumed. It should be mentioned that a large-scale introduction of electric vehicles could increase the demand more than is assumed in Scenarios

A and B. On the other hand, the demand has hovered around 135 to150 TWh during the last decade and there has been a trend in terms of non-growing consumption in Sweden even before the financial crisis.

Load management consists of load that can be disconnected. The Load Management data are based on the information found in the Swedish government's proposal for new legislation concerning Load Management. The document is called "Proposition 2009 / 10: 113 Effektreserven i framtiden." To harmonize the Swedish system with the European the Swedish government wishes to increase the share of load that can be disconnected in the Swedish effect reserve (load that can be disconnected and generation that can be activated at short notice that Svenska Kraftnät has purchased). In 2025 the effect reserve is expected to be handled by the market.

Generation Adequacy

Ten percent of the NGC of nuclear power is assumed to be unavailable in both summer and winter. Normally maintenance is done during summer when the demand is low but this is not reflected in the scenarios. Ten percent of the NGC of fossil fuels and biomass is assumed to be Non-Usable Capacity. About 10 to 15 % of the NGC of fossil fuels and biomass is assumed to be unavailable owing to maintenance during winter. During summer about 30 % of the NGC of fossil fuels and biomass is assumed to be unavailable owing to maintenance. Some 455 MW of the fossil fuel plants are "mothballed" and are included in the Non-Usable Capacity. Ninety-four percent of the NGC of wind power is assumed to be Non-Usable Capacity. This assumption is based on the variable and uncertain characteristics of wind power generation. Some 2.7 GW of the NGC of hydropower is assumed to be Non-Usable Capacity owing to hydrological limitations.

Scenario A: the Adequacy Reference Margin is not met by the Remaining Capacity (RC) in winter 2015, 2016 and 2025. Scenario B: the RC slightly increases until 2016 owing to the increase of NGC of nuclear power, wind power and biomass. In 2020 and 2025 the RC decreases somewhat, mainly owing to decommissioning of oil-power plants. The ARM is not met by the RC in winter 2025 because of the mentioned decommissioning of oil-power plants and also because the load management in 2025 is assumed to be 0 GW. During summertime the ARM is well met by the RC but during wintertime the RC and ARM are almost equal. This means that there is a greater need for import during winter and that there is room for export during summer.

The Margin against Seasonal Peak Load is the difference between the load at the reference point and the peak load of the period of which the reference is a part. The peak loads and the loads at the reference points were approximated from a load curve from 2007 which was up-scaled to the assumed demand.

Interconnection Capacity

The Simultaneous Import and Export Capacities are assumed to be the sum of the maximum Net Transfer Capacities (NTC) between Sweden and neighbouring countries. These capacities might be somewhat higher than the real Simultaneous Import and Export Capacities. Fenno-Skan 2 is assumed to be in operation at the end of 2011. At the beginning of 2016 the South West Link and Nord Balt are expected to be in operation. In 2025 a third AC interconnection between Sweden and Finland is expected to be in operation.

6.34 SI – Slovenia

Generating Capacity

Nuclear power plant Krsko: the table takes into account 100 % of its generation capacity although ownership of the nuclear power plant Krsko is equally divided between Slovenia and Croatia, so half of its generation is delivered to Croatia by international agreement.

Load

Energy forecast is mainly based on GDP growth and demography development.

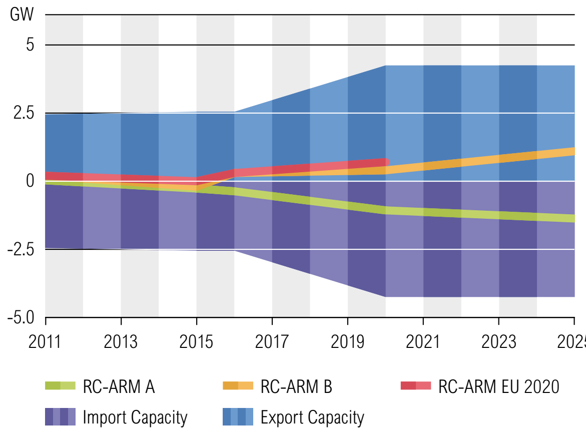


Figure 6.34:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generation Adequacy

Unavailable capacity will increase in the future owing to new wind-generation units. System Service Reserves increase owing to a new major unit in TPP Sostanj and after 2020 a new nuclear unit in Krsko.

Interconnection Capacity

Planned interconnection lines with Hungary (2 × 400 kV OHL Cirkovce-Heviz) and Italy (2 × 400 kV OHL Okroglo-Udine) will have a positive effect on interconnection capacities in the future.

6.35 SK – Slovak Republic

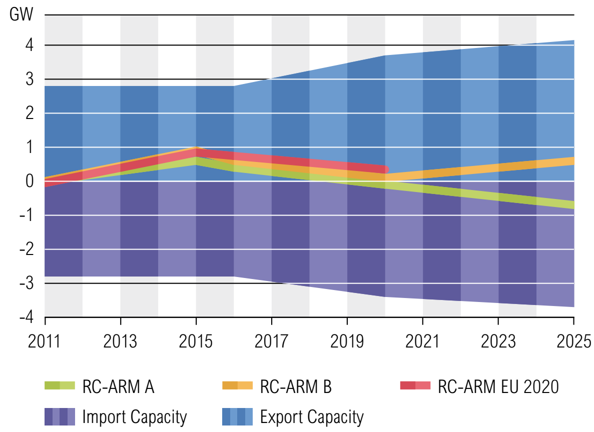


Figure 6.35:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

Generating Capacity

The main generation unit development in Scenario A in the assessed period is expected in 2010 (new CCGT Malženice (430 MW) and Panické Dravce (50 MW)). In Scenario B, apart from the previous units, new CCGTs in Považská Bystrica and Nitra (58 MW and 54 MW respectively) are expected in 2015. In 2020 a new heating plant is planned for Košice (132 MW) and a new nuclear power plant in the location of NPP Jaslovské Bohunice (1200 MW) in 2025 (without considering the existing NPP J. Bohunice). In each scenario, there is also a new thermal power plant (about 400 MW after 2020) under consideration and an increase of installed capacity of the existing NPP in J. Bohunice (until 2012). Renewable power plant development in Scenarios A and B reflects the Slovak NREAP.

In Scenario EU 2020 renewable power plant development is subject to the Slovak NREAP as well whereas development of conventional units is in line with Scenario B.

Concerning decommissioning, up to 2017 some units of existing thermal power plants will be put out of operation owing to environmental factors.

Load

In load and consumption forecasts the influence of worldwide financial and economic crises is considered. Load values for Scenario EU 2020 are based on the Slovak NREAP. These values are a little higher than the load expected by TSO. Therefore there is a difference between values used in Scenarios A and B and Scenario EU 2020.

Generation Adequacy

Generation adequacy will be maintained during the whole forecast period in each scenario with a small negative amount of RC-ARM in Scenario A after 2020. This need for additional capacity can however be covered by imports from neighbouring countries. The load management parameter is not used in Slovakia in the frame of transmission system operation. Values reported in this SO&AF 2011 report are only intended to ensure consistency with the rest of the SO&AF report and other countries.

Interconnection Capacity

In each scenario a new double circuit 400 kV line and a new single 400 kV line from Slovakia to Hungary were assumed to be in operation in 2020. The reconstruction of the line from Slovakia to Ukraine (due to its lifetime) and a new 400 KV line to Poland are expected as well (after 2020). Export/import values, however, must be treated as indicative only and are highly dependent on the actual topology of the Slovak transmission grid (and that in neighbouring countries), the generation mix within the power system and the methodology used for the calculation..

6.36 UA-W – Ukraine West

Generating Capacity
No comments provided.

Load
No comments provided.

Generation Adequacy
No comments provided.

Interconnection Capacity
No comments provided.

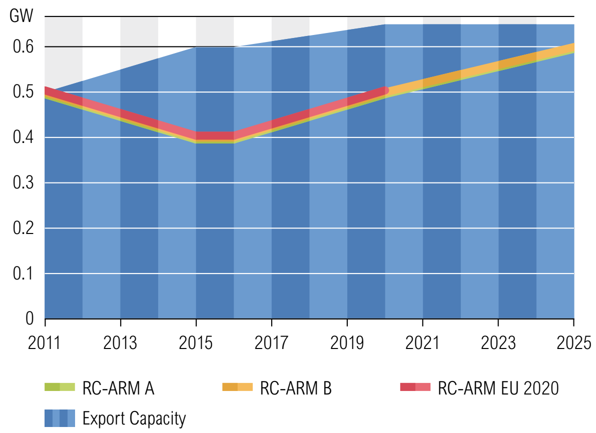


Figure 6.36:
RC – ARM Comparison, Sc A, Sc B and Sc EU 2020, January 7 p.m.

7 General Conclusion

The SO&AF Report (Scenario Outlook and Adequacy Forecast Report) was based on input data provided by TSOs (national data correspondents) from ENTSO-E member countries at the end of September 2010 with modification until the beginning of December 2010 and covers the period from 2011 to 2025. When the data for each respective country were not available, substitute data were used. Assessment and evaluations were done for three scenarios: Scenario EU 2020 (based on NREAPs), Scenario A (conservative scenario) and Scenario B (best estimate scenario). More details about scenarios can be found in paragraph 4.1.

Load is expected to increase throughout the whole forecast period in each scenario. The same expectation applies to consumption as well. The biggest annual average energy consumption growth between 2011 and 2020 in Scenario B is expected in Cyprus, Slovenia, and FYROM and in Scenario EU 2020, for example, it is Cyprus or FYROM again. The total energy consumption growth from 2011 to 2020 for the whole ENTSO-E in Scenario EU 2020 is expected to be about 206 TWh (574 TWh in Scenario B between 2011 and 2025). At the same time, for the whole ENTSO-E area, the expected total load growth in Scenario EU 2020 is about 39 GW from 2011 to 2020 (about 106 GW in Scenario B). Owing, however, to the economic crisis, the increase in Scenario B could be subject to some uncertainty, especially in the period before 2015. Demand and load are at the same time affected by other aspects (e. g. energy efficiency measurements). For more information refer to paragraphs 4.2.1 and 4.2.2.

The total ENTSO-E Net Generating Capacity (NGC) is increasing in each scenario as well. Of all primary energy sources, the biggest development is reported for renewable energy sources (including renewable hydro generation) followed mainly by non-RES hydro power plants in Scenario EU 2020 and Scenario B. In Scenario B fossil fuels and nuclear power plants also show increasing development of their installed capacity in total NGC mix (fossil fuels; generating capacity in Scenario EU 2020 is decreasing).

The increase in RES capacity (regardless of scenario) was expected and it is confirmation of the great "popularity" of this kind of power plant among investors, being promoted by different support schemes on a national or European level. The development of RES capacity (excluding hydro) corresponds mainly with the wind farm, solar and biomass power plant development and it is increasing in each scenario and in all reference points. Also, offshore wind farms are becoming more important within the total wind installed capacity mix. The total increase of RES from 2011 to 2020 in Scenario EU 2020 is 224 GW (of which 129 GW wind, 57 GW solar and 21 GW biomass), whereas in Scenario B within time period 2011 – 2020 it is "only" 162 GW (120 GW wind and 19 GW solar).

The main developing capacities within fossil fuels are gas power units in each scenario. This increase is continuous from 2011 to 2015 regardless of the scenario. Between 2015 and 2020 in Scenario EU 2020 a decrease of about 3 GW is expected whereas in Scenario B an increase of about 23 GW is foreseen (between 2015 and 2025). The given numbers, however, do not necessarily reflect the actual usage of gas power units. The Netherlands and Cyprus are leaders in the installed capacity of gas power units as part of NGC in both scenarios, followed for example by Hungary and the Republic of Ireland. Lignite, hard coal and oil power plants are on the decrease in each scenario, mainly in Scenario EU 2020. For more detailed information about NGC refer to paragraph 4.2.3.

The report also notes that generation adequacy is expected to be maintained during the whole forecast period in Scenario EU 2020 (between 2011 and 2020) and also in Scenario B (between 2011 and 2025) and in each reference point.

Only in Scenario A is the generation adequacy not expected to obtain during the whole period between 2011 and 2025. More precisely, until 2016 no problems are expected in January, but after 2016, in order to reach at least today's levels of generation adequacy in January 2020, about 73 GW of RAC is necessary which will require 112 GW in NGC (when considering 65 % of NGC to be left as RAC). In January 2025, 159 GW in RAC are lacking and about 244 GW in NGC will be required to reach today's level. In July until 2020 the RC is higher than ARM. In 2020 about 63 GW in RAC is needed to reach current levels of adequacy (105 GW in NGC when considering 60 % of NGC to be left as RAC) and in 2025 it will 141 GW in RAC (236 GW in NGC).

8 Appendix

Energy balance for Regional Group Baltic Sea

Power balances assess the ability to cover the demand in a particular hour. In addition to the regional power balance, regional energy balances have been made to assess year-round ability to cover the total energy need.

The energy balances are based on market modelling that assumes an integrated regional market and uses data from the pan-European market database (PEMD). Given that energy constantly flows between countries, it makes sense to look also at regional energy adequacy. The market modelling takes into account the restrictions in the transmission system imposed by the use of NTCs and also that the production units cannot run all hours of the year. This is true for thermal units and in particular also for wind power and hydro power units. As hydro power is a significant energy source in the region, it is relevant to analyse the energy adequacy situation in cases of low inflow (one in ten years) and extremely low inflow (one in 50 years). Hydro power is mainly located in Norway and Sweden.

Based on the regional energy balance analysis, it is concluded that **the regional electricity system is able to meet the estimated consumption and the corresponding typical power demand pattern**. Some areas in Norway could be exposed to a risk of rationing or other measures in case of extremely low precipitation.

Energy balance for each country and the net flows between countries of the Baltic Sea region[1] are presented for 2015 in three cases: average[2], low inflow years and extremely low inflow years. For each country, a small box shows the production (P), consumption (C) and balance (B) in TWh. The arrows between the countries also show the net flow in TWh.

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1) The these analyses, the RGBS-countries, The Netherlands, Slovak Republic and Czech Republic has been included. Balances are only shown for the RGBS-countries.

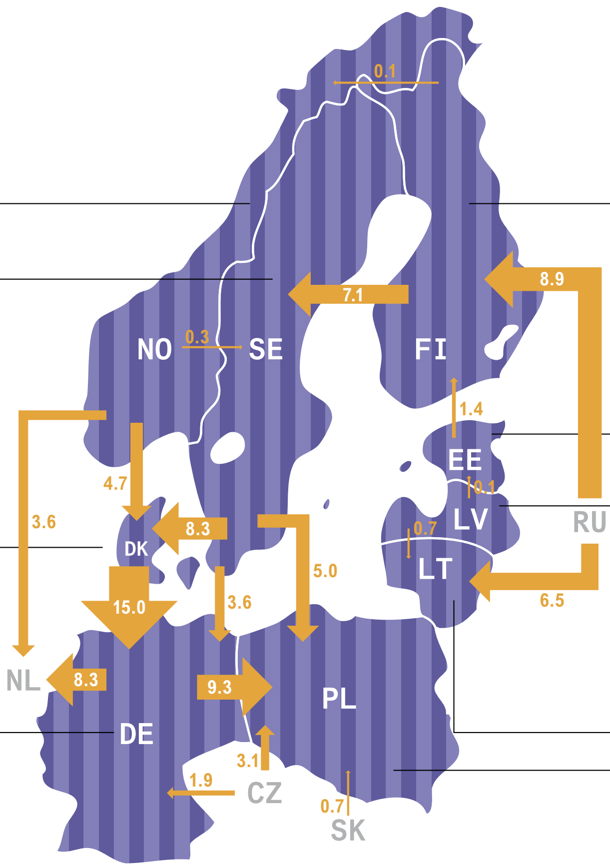
2) The average year is found as the average over 51 different inflow years.

NO – Norway	
P	141.0 TWh
C	132.5 TWh
B	8.5 TWh

SE – Sweden	
P	163.3 TWh
C	153.7 TWh
B	9.6 TWh

DK – Denmark	
P	39.6 TWh
C	37.9 TWh
B	1.7 TWh

DE – Germany	
P	585.5 TWh
C	588.1 TWh
B	-2.6 TWh



FI – Finland	
P	89.0 TWh
C	92.1 TWh
B	-3.2 TWh

EE – Estonia	
P	10.7 TWh
C	9.3 TWh
B	1.4 TWh

LV – Latvia	
P	9.0 TWh
C	8.2 TWh
B	0.8 TWh

LT – Lithuania	
P	3.7 TWh
C	10.9 TWh
B	-7.2 TWh

PL – Poland	
P	147.4 TWh
C	165.6 TWh
B	-18.2 TWh

Area	Balance
Nordic Countries	16.7 TWh
Baltic Countries	-5.1 TWh
Germany + Poland	-20.8 TWh
Exchanges with neighbouring regions	9.2 TWh
Total	0.0 TWh

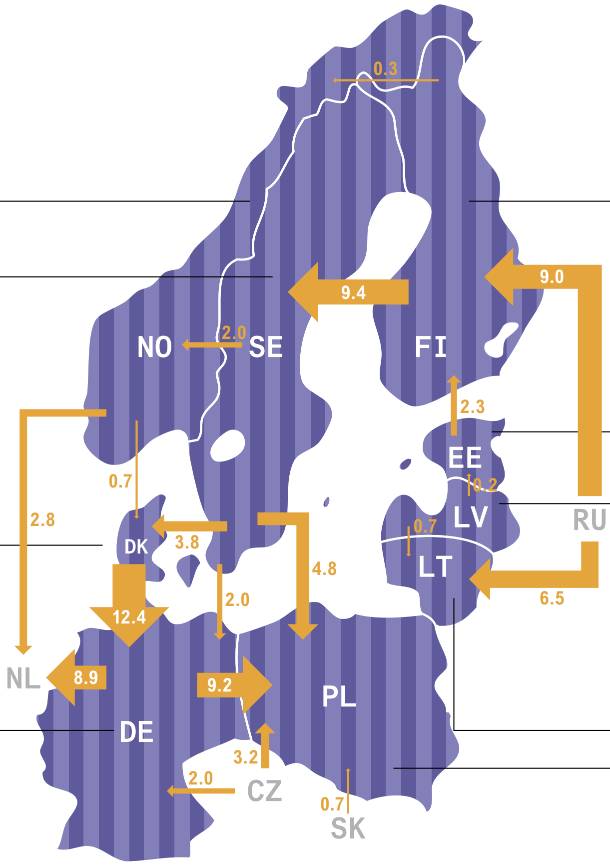
Figure 8.1:
Energy balance and net flows for each country in RGBS in 2015, an average year

NO – Norway	
P	130.8 TWh
C	129.7 TWh
B	1.2 TWh

SE – Sweden	
P	156.6 TWh
C	153.5 TWh
B	3.1 TWh

DK – Denmark	
P	45.8 TWh
C	37.9 TWh
B	7.9 TWh

DE – Germany	
P	589.9 TWh
C	588.1 TWh
B	1.7 TWh



FI – Finland	
P	90.6 TWh
C	92.1 TWh
B	-1.6 TWh

EE – Estonia	
P	11.6 TWh
C	9.3 TWh
B	2.2 TWh

LV – Latvia	
P	9.1 TWh
C	8.2 TWh
B	0.9 TWh

LT – Lithuania	
P	3.7 TWh
C	10.9 TWh
B	-7.2 TWh

PL – Poland	
P	147.7 TWh
C	165.6 TWh
B	-17.9 TWh

Area	Balance
Nordic Countries	10.7 TWh
Baltic Countries	-4.1 TWh
Germany + Poland	-16.2 TWh
Exchanges with neighbouring regions	9.6 TWh
Total	0.0 TWh

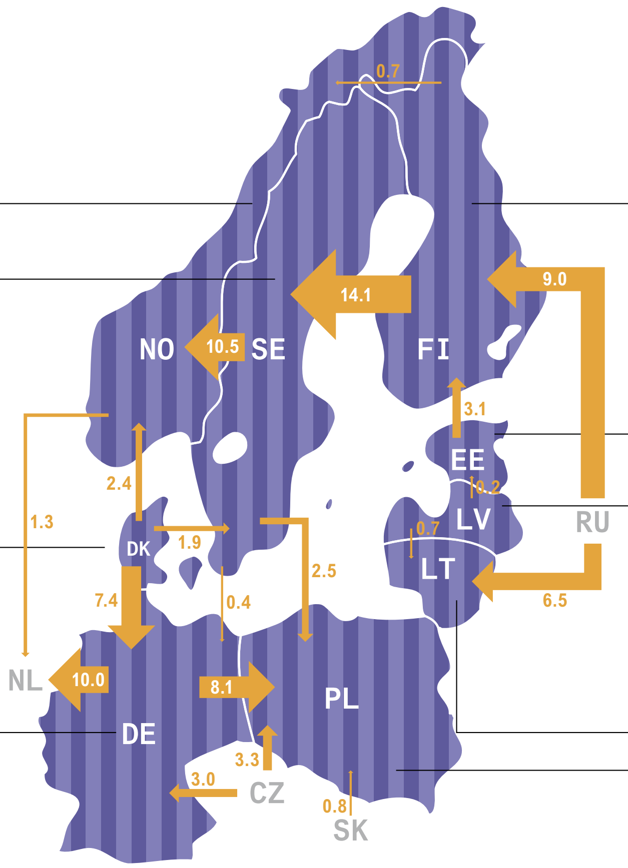
Figure 8.2:
Energy balance and net flows for each country in RGBS in 2015, a year with low inflow

NO – Norway	
P	116.6 TWh
C	128.9 TWh
B	-12.4 TWh

SE – Sweden	
P	151.0 TWh
C	153.5 TWh
B	-2.5 TWh

DK – Denmark	
P	49.6 TWh
C	37.9 TWh
B	11.7 TWh

DE – Germany	
P	595.5 TWh
C	588.1 TWh
B	7.4 TWh



FI – Finland	
P	94.8 TWh
C	92.1 TWh
B	2.7 TWh

EE – Estonia	
P	12.3 TWh
C	9.3 TWh
B	2.9 TWh

LV – Latvia	
P	9.1 TWh
C	8.2 TWh
B	0.9 TWh

LT – Lithuania	
P	3.7 TWh
C	10.9 TWh
B	-7.2 TWh

PL – Poland	
P	150.8 TWh
C	165.6 TWh
B	-14.8 TWh

Area	Balance
Nordic Countries	-0.5 TWh
Baltic Countries	-3.4 TWh
Germany + Poland	-7.4 TWh
Exchanges with neighbouring regions	11.3 TWh
Total	0.0 TWh

Figure 8.3:
Energy balance and net flows for each country in RGBS in 2015, a year with extremely low inflow

As can be seen from the three figures, the changes in inflow have implications for the where the electricity is produced and for the flows between countries.

The most significant impact of the changes in inflow is seen in Norway and Sweden, which change from being large exporters in an average year to being in need of imports in an extremely inflow year. The balance for Norway and Sweden differs by 33 TWh, including a smaller change in consumption owing to demand response when we compare the average year with the extremely low inflow year.

The export to central Europe decreases with less inflow, and more thermal power production is seen in e. g. Denmark, Finland, Estonia and Germany. There is also an increase in the energy transfer from Estonia to Finland.

The energy analyses show a negative balance for the Baltic countries. This is mainly because of the optimization of generation cost. Lithuania has enough capacity to cover its demand, but the market modelling shows that it will be more beneficial for the total economy to import electricity than to run gas-fired condensing power plants. In total, an import from Russia to RGBS of approximately 15.5 TWh is assumed.

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