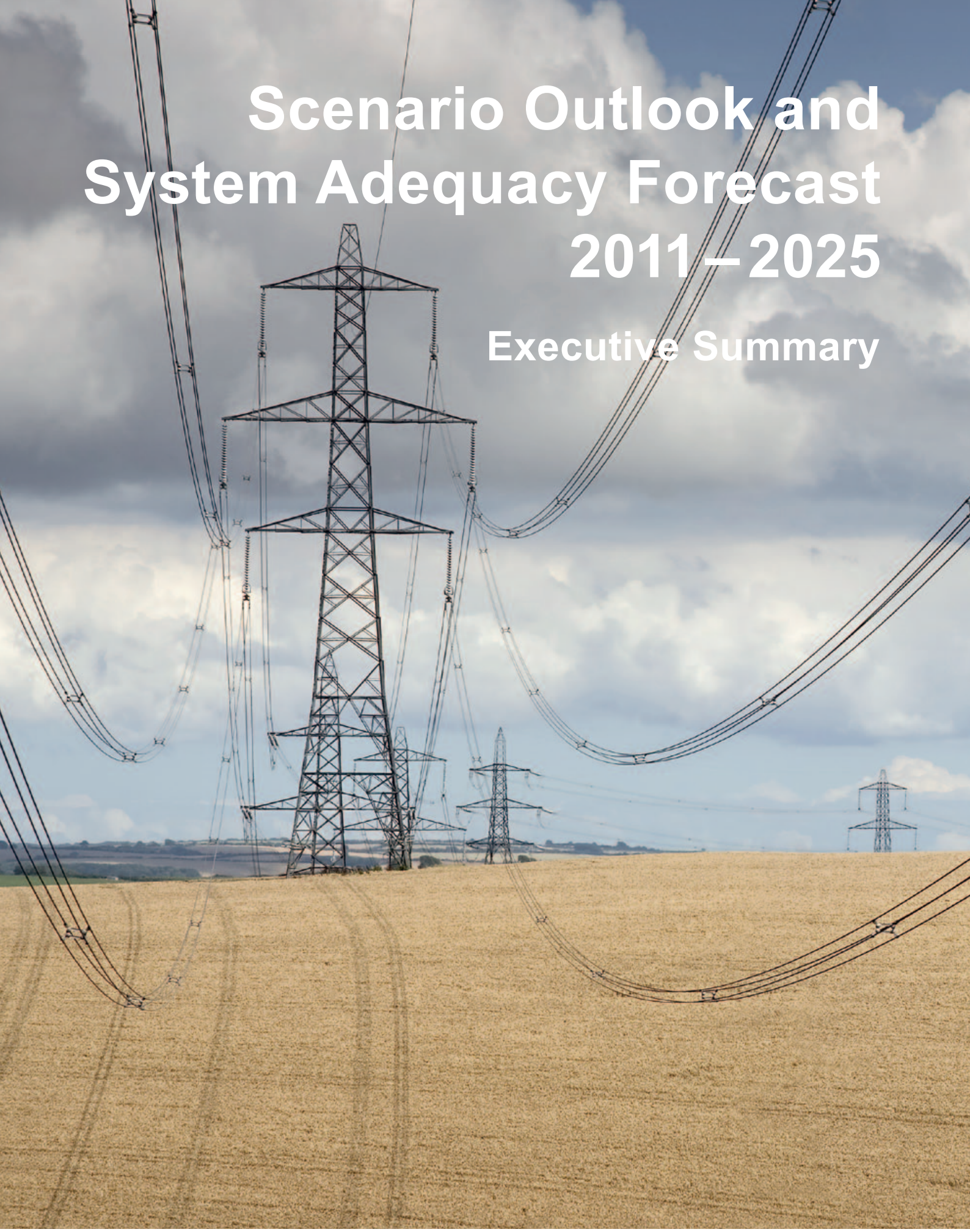
Scenario Outlook and System Adequacy Forecast 2011–2025

Executive Summary



European Network of
Transmission System Operators
for Electricity

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Content

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.

Main Results

If the EU 2020 scenario 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.

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

The EU 2020 scenario 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 EU 2020 scenario at both reference points (Tables 1 and 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).

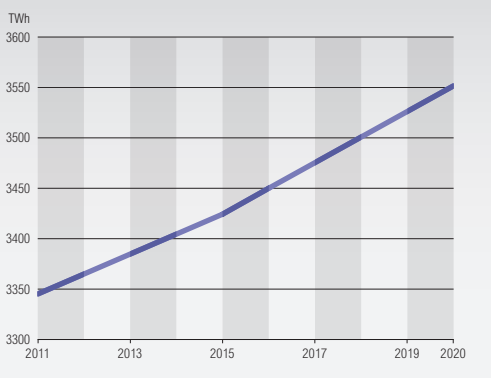

Figure 1:
ENTSO-E consumption forecast for the EU 2020 scenario

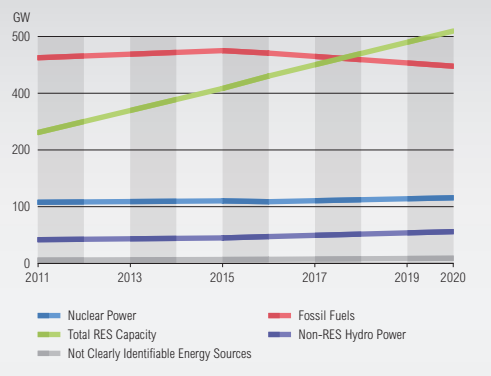

Figure 2:
ENTSO-E total NGC breakdown in the EU 2020 scenario, January 7 p.m.

The energy consumption at the ENTSO-E level in this scenario is growing at a fairly constant and smooth rate (Figure 1), and exceeds 3.500 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.

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).

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.

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 EU 2020 scenario. 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.

[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 **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 %).

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 3).

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

Table 1:
ENTSO-E load for Scenario EU 2020

[%]	2011 to 2015	2015 to 2020
January	0.8	0.8
July	1	1.2

Table 2:
ENTSO-E average load increase rate for Scenario EU 2020

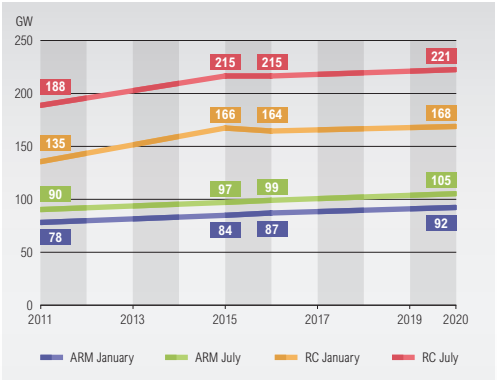

Figure 3:
ENTSO-E RC and ARM comparison, from the EU 2020 scenario

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 (Tables3 and4).

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 4), almost twice as high as in the EU 2020 scenario. 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 EU 2020 scenario. For 2011, the annual energy consumption in the EU 2020 scenario (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 EU 2020 scenario: 3450 TWh; scenario B: 3519 TWh).

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.

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

Table 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 4:
ENTSO-E average load increase rate for Scenario B

Regarding NGC, the most rapidly developing energy sources are renewable ones (Figure 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.

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 EU 2020 scenario). 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 %).

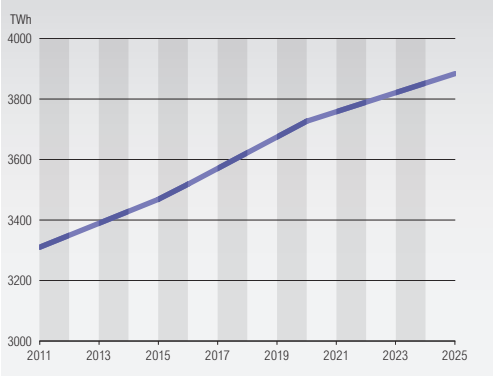

Figure 4:
ENTSO-E consumption forecast for scenario B

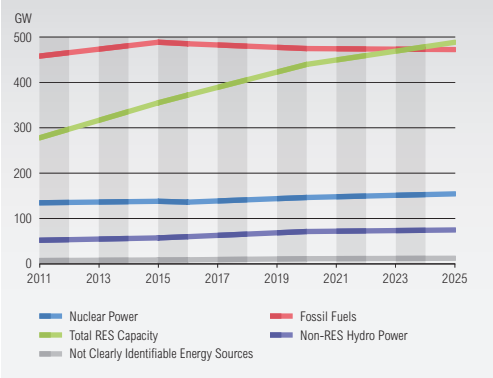

Figure 5:
ENTSO-E total NGC breakdown; scenario B, January 7 p.m.

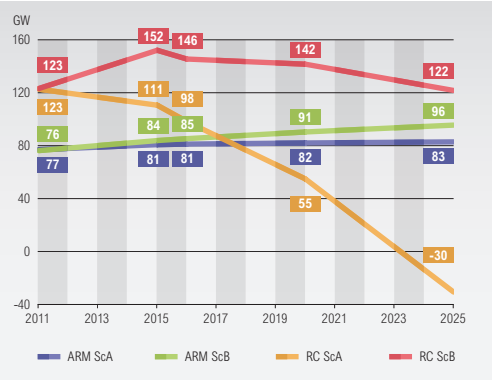

Figure 6:
ENTSO-E RC and ARM comparison; scenarios A & B, January 7 p.m.

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 EU 2020 scenario, 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 6.

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;
- 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 EU 2020 scenario 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 EU 2020 scenario and -4.8 % for scenario B. The assessment at the ENTSO-E level without Ukraine West gives values of -8.8 % for the EU 2020 scenario 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 EU 2020 scenario 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 EU 2020 scenario and 33 % and 30 % respectively in 2020 in scenario B. This leads to the conclusion that the EU 2020 scenario 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 EU 2020 scenario
- 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).

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 EU 2020 scenario, 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 EU 2020 scenario 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.

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