System Adequacy Forecast 2008 - 2020

January 14th, 2008

union for the co-ordination of transmission of electricity

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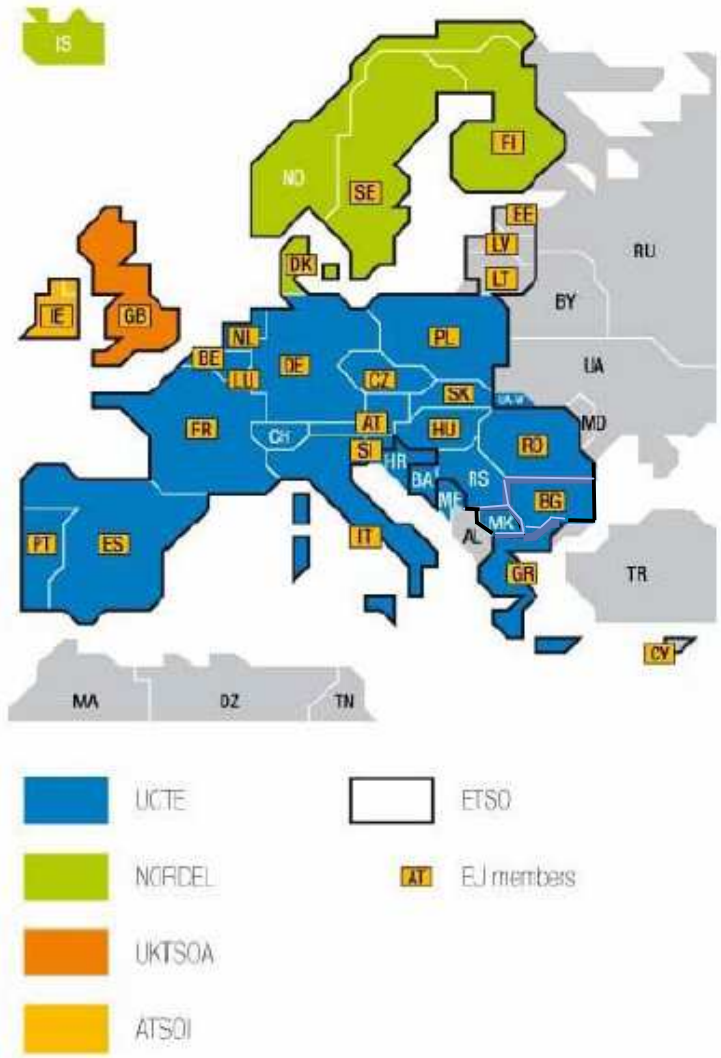
What is UCTE ?

- UCTE is the “Union for the co-ordination of transmission of electricity”
- It is the association of all the Transmission System Operators in charge of the operation of the synchronous interconnected power system of continental Europe.
- UCTE co-ordinates the operation and development of the electricity transmission grid from Portugal to Poland and from Netherlands to Greece.
- It aims to keep the quality and reliability of the UCTE system at high level.

UCTE's perimeter

- 23 countries
- 450 million people
- 643 GW of generation capacity
- ~ 2600 TWh

(15% of world consumption)



Why a system adequacy forecast ?

- The European Directive “Security of supply” adopted in 2005 intends to guarantee:
  - Adequate level of generation capacity (long term issue)
  - Power balance at various time scales (operational issue)
  - Adequate level of interconnection between members states
- The Directive requires to report on security of supply on a 15-year timescale
  - TSO have to provide Investment plans and take account of the effects of demand side management in their investment decisions.
  - TSOs have to report on the system adequacy to the Regulatory Authorities.
- Security of supply, internal market achievement and climate change issues gained importance in the past years:
  - Through the publication of System Adequacy reports UCTE contributes to these issues by releasing detailed data and analysis from TSOs expertise

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System adequacy forecast

- The system adequacy forecast aims to provide electricity market stakeholders with:
  - An overview on generation and load evolution over next 15 years
  - A view on the resources available to cope with them as an early input to investment decisions
  - An overview of the ability of the UCTE transmission grids, especially interconnections to ensure adequate generation demand balance in any part of the system and on network development in order to guarantee security of supply (SoS).

- It aims to provide Transmission System Operators with a prospective view of generation and network developments

What is adequacy ?

- System adequacy measures the ability of a power system to cope with its load in all the steady states it may operate in standard conditions

- Generation adequacy analyses the ability of the generation assets to cover the peak load taking into account uncertainties in the generation availability and on the load level.

  Uncertainties result from planned and unplanned outages, availability of primary sources, weather conditions such as temperatures, wind, water inflows,…

- Transmission adequacy enhances the analysis with the flexibility provided by interconnections and import / export flows.

Adequacy issues – background

- In the liberalised market:
  - Any supplier is responsible for the supply of its customers
  - Market mechanisms should give signals for investments.

- In the present phase:
  - There is no assurance that individual investment decisions will comply with the adequacy requirements at the European level.
  - There is no assurance that necessary investments will be decided in due time.

Adequacy issues – risk mitigation

- In this background, it is necessary:
  - To check the short-term ability to cover the peak load relying on the generating assets already existing, under construction or at an advanced stage of planning
  - To produce long-term forecasts on additional generating capacity likely to be required to achieve generation adequacy

- Efficient monitoring of system adequacy is a prerequisite for a reliable supply.

Main principles

- Adequacy forecast must be international as reliabilities in the different countries are linked through transmission lines and trading.
- Transmission System Operators are in the best position to assess undergoing and future developments on the electric system they operate.
- The SAF report, updated every year is based on information directly collected from UCTE Transmission System Operators.
- The present report covers continental Europe, on the period 2008 – 2020.
- Extension to the whole European system is performed within ETSO.

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Generation forecasts

Forecast deals with 2 scenarios to cover the uncertainties on the future generation capacity.

- **"Conservative" scenario (A):**
  - Assumptions: considering additional generation projects and decommissioning projects, alleged as "firm" only.
  - Goal: to highlight potential unbalances without any new further investment decisions.
- **"Best estimate" scenario (B):**
  - Assumptions : considering further generation developments, as expected from national generation development plans, European Directives, grid connection applications, …
  - Goal: to estimate the potential future developments induced by market signals and adequate incentives for investments.

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Load forecasts and other assumptions

- Forecast deals with 3 reference points:
  - 3rd Wednesday of January, at 11:00
  - 3rd Wednesday of January, at 19:00 *(close to synchronous peak load)*
  - 3rd Wednesday of July, at 11:00

- Load is estimated under *normal climatic conditions*.

- Other assumptions:
  - Long term export/import contracts or participation in foreign power plants are not taken into account
  - Interconnections capacities are the ones declared by UCTE correspondents based on ETSO definitions and calculations.

4 steps to estimate adequacy *[1/4]*

1. Estimate the amount of reliably available generation at the reference time accounting for expected unavailability of generation capacities.
   This amount is called “Reliably Available Capacity” and calculated as:

   Net Generating Capacity (NGC)

   – Non usable, overhauls, outages, reserves

   = Reliably Available Capacity (RAC)

   Estimation is carried with a reasonable probability that is taking into account:

   - Forecasted overhauls
   - Mean level of forced outages
   - Most probable climatic and other operational conditions (hydro, wind,…)

4 steps to estimate adequacy *[2/4]*

2. Estimate the amount of available generation which exceeds the expected load at reference time. This amount is called “Remaining Capacity” and calculated as:

Reliably Available Capacity (RAC)

– **Reference Load (RL) + DSM**

= **Remaining Capacity (RC)**

In the present study, the possibility to reduce load thanks to Demand Side Management (DSM) measures is taken into account to assess the Remaining Capacity.

4 steps to estimate adequacy *[3/4]*

3. Define an indicative level of minimum remaining capacity, considered as sufficient to provide reliable supply at peak load. This level is called "Adequacy Reference Margin" and calculated as:

Margin Against Peak Load (MAPL)

+ [5% or 10%] of National Generating Capacity (NGC)

= Adequacy Reference Margin (ARM)

- MAPL: difference between *peak load* and *load at reference time*
- The reliability criterion is equivalent to a risk of shortfall of about 1%:
  - 5% of National Generating Capacity is assumed to be adequate for UCTE as a whole, for large areas and most of UCTE countries.
  - 10% of National Generating Capacity is taken for systems more sensitive to random factors as France, Greece, Slovenia, Croatia, Serbia, Montenegro, Macedonia, Luxembourg, Austria, Bosnia-Herzegovina, Portugal and Romania.

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4 steps to estimate adequacy *[4/4]*

4. The synthetic criterion is the following:

Remaining Capacity must be higher than the Adequacy Reference Margin in order to ensure the reliability of the system

RC ≥ ARM : generation is available for exports in most of the situations.

RC < ARM : system is likely to have to rely on imports when facing severe conditions.

Methodology summary

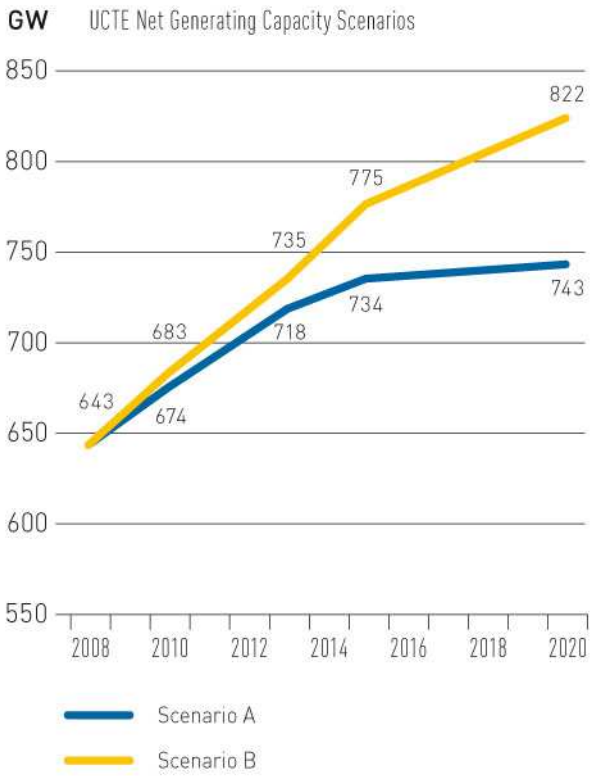
1. Introduction
2. Methodology
3. Generation adequacy
   - Whole UCTE system
   - Regional Blocks
   - National systems
4. Simultaneous interconnection transmission capacity
5. Conclusions

Net Generation Capacity

- From 2008 to 2015, net generating capacity increases.

  - The situation is more optimistic than in the previous SAF 2007-2020 report. This is an illustration of the **steady investments in generating capacity decided and announced in most of the countries in the last few months**.

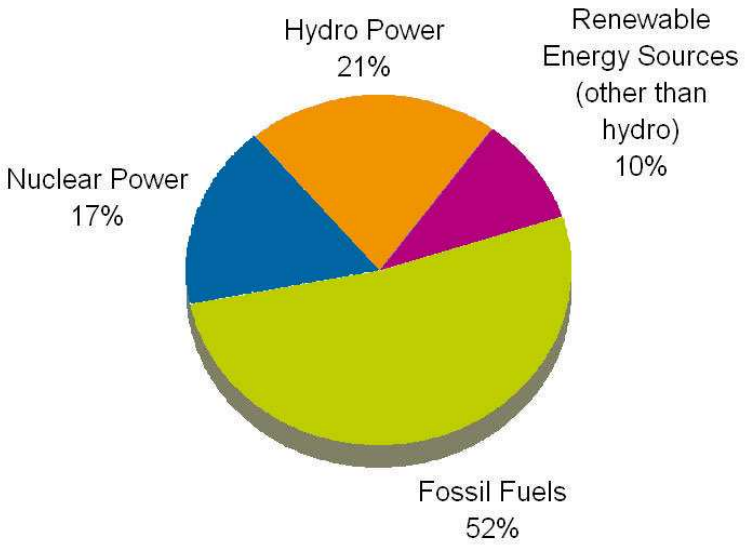
- New capacities relies half on RES and half and fossil fuels



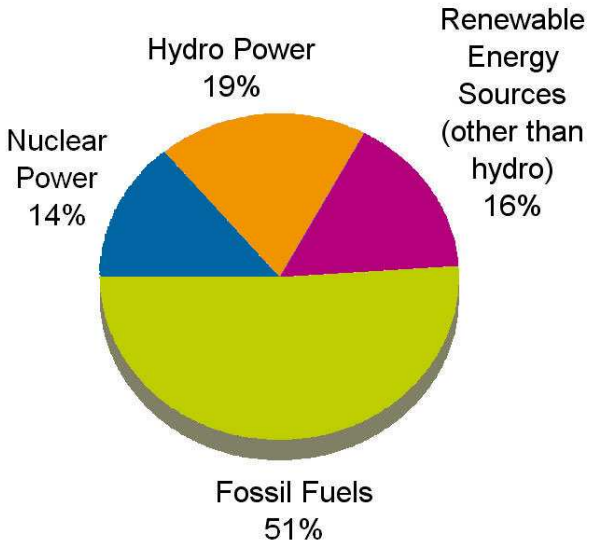
Generating capacity increase 2008 - 2015 in GW	scenario A	scenario B
Total generating capacity	90.6	131.8
Renewable energy (incl. Hydro)	58.4	70.9
Fossil fuel	36.6	65.3
Nuclear	-4.4	-4.4

Generation mix

Scenario A or B 2008, NGC = 643 GW



Scenario B 2015, NGC= 775GW



- Stable share of fossil fuel (about 50% over the period)
- Increasing share of renewable energy sources
  (ca. 75% of which, wind power)
- Reduction of the nuclear share, with a planned phase-out in Germany.

Reliably Available Capacity

- "Conservative" scenario A:
  While Generating Capacity is increasing by + 90 GW in 2015, Reliably Available Capacity is increasing by 50 GW only.

- "Best estimate" scenario B:
  While Generating Capacity is increasing by + 132 GW in 2015, Reliably Available Capacity is increasing by 84 GW only.

  About 70% of Net Generating Capacity can be turned into Reliably Available Capacity (based on the whole UCTE generation mix average)

  Regarding additional generation capacities forecasts, the ratio appears however lower, because of the high share of wind power, the contribution of which to Reliably Available Capacity being quite low.

  e.g.: Non-reliably available wind power capacity for some countries:

CH	CZ	ES	DE	FR	NL	PT
100%	100%	95%	90%	75%	75%	73%

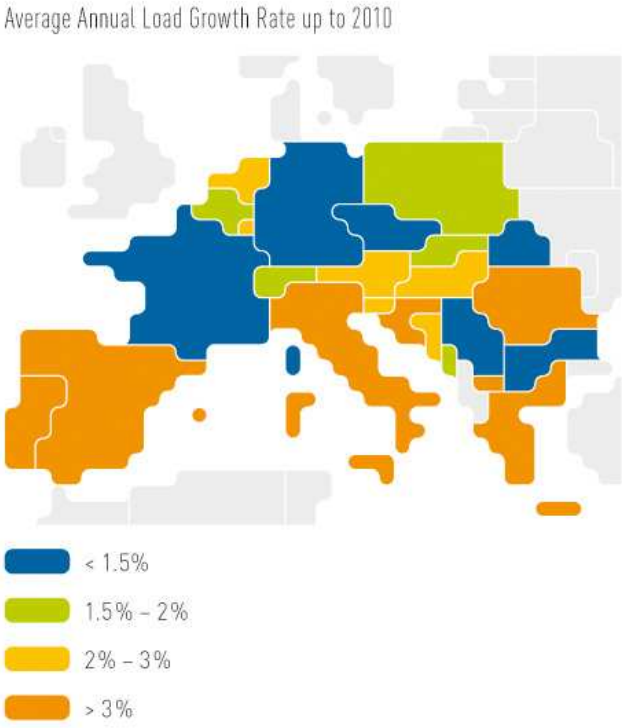
Consumption and load

- The consumption growth may differ from one country to another, and is generally higher in the south and eastern part of UCTE.

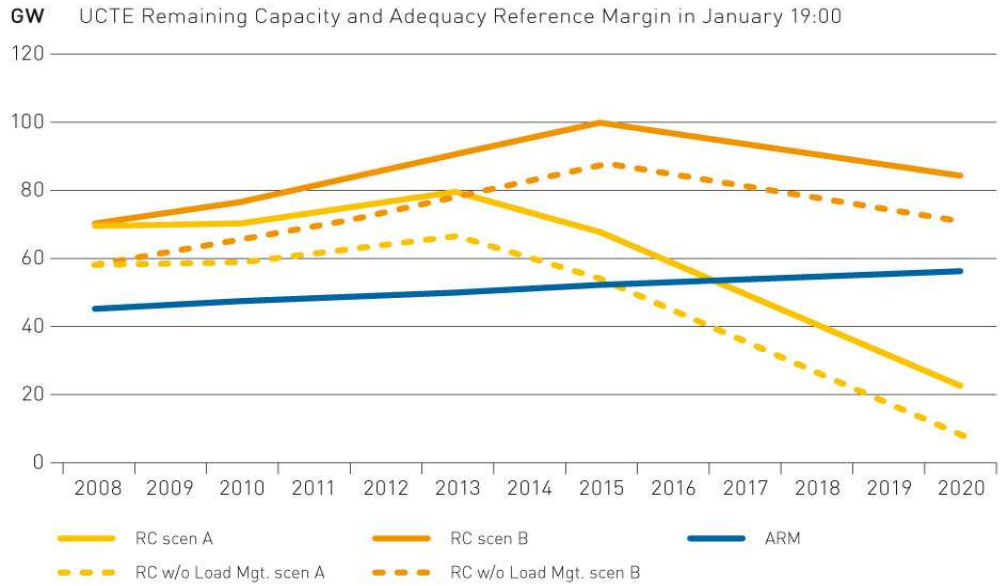
- Consumption growth is expected to slow down thanks to energy efficiency improvement measures.

- By 2015, the load growth rate is nearly 1.9%/year, up to 455 GW at January 19:00 reference time point 2015 (vs. 400 GW in 2008)

- After 2015, the load growth rate is about 1.6%/year, up to 490 GW at January 19:00 reference time point 2020.



Generation adequacy – UCTE, January



- Generation adequacy of the UCTE system should not be at risk up to 2015 in any generation scenario and at any reference point
- The need for further investment decisions in new generation capacities for 2020 represents about 50 GW.

  - This requirement should however be met, provided announcements regarding new generations projects (“Best estimate” scenario B) *are confirmed.*

Generation adequacy – UCTE, January

Evolutions of NGC, RAC, Load and RC over 2008 – 2020 period for scenarios A and B

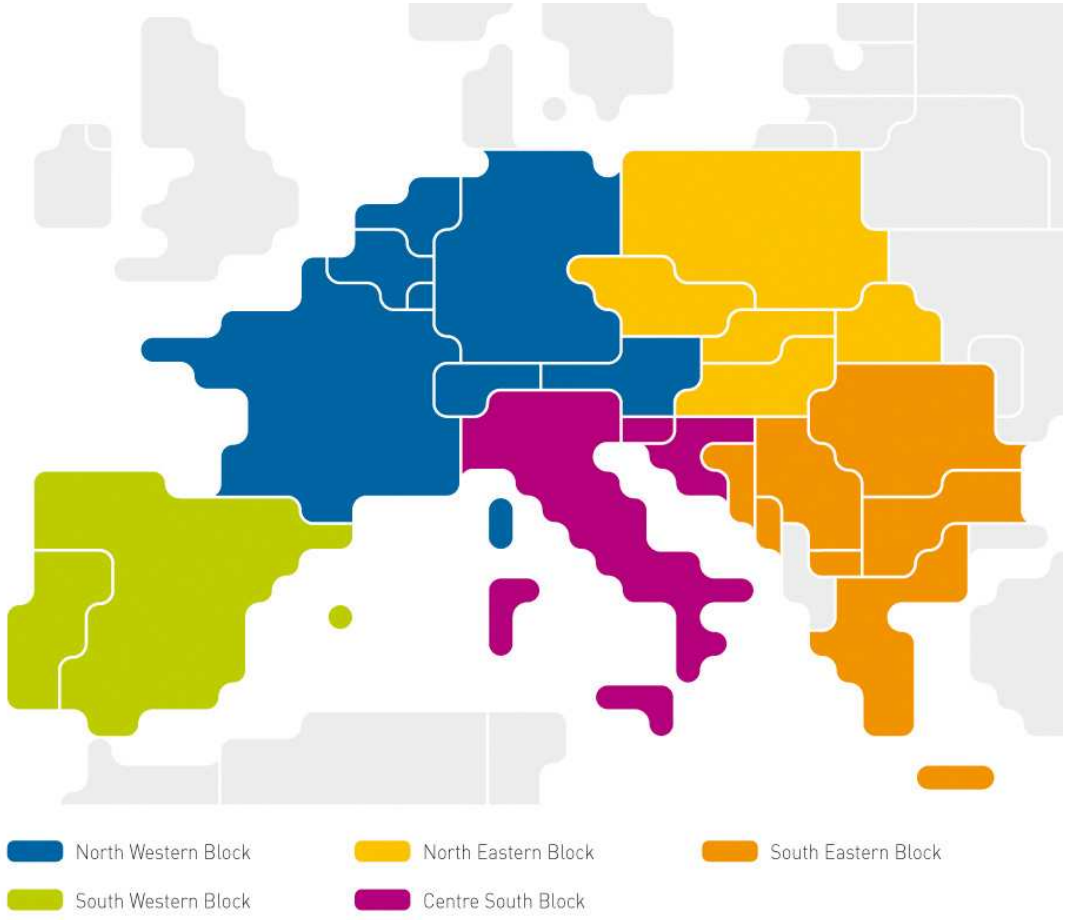
Scenario A, increase, January, 11:00	2008 - 2010	2010 - 2013	2013 - 2015	2015 - 2020
Net Generating Capacity	30.4	44.0	16.2	9.1
Reliably Available Capacity	16.7	29.5	4.3	-9.8
Load	16.8	20.6	16.2	36.5
Remaining Capacity	0.0	9.5	-11.3	-45.8

Scenario B increase, Januray, 11:00	2008 - 2010	2010 - 2013	2013 - 2015	2015 - 2020
Net Generating Capacity	39.1	52.4	40.3	46.7
Reliably Available Capacity	23.8	34.5	25.6	19.2
Load	16.9	20.8	16.3	36.5
Remaining Capacity	6.9	14.4	10.0	-16.7

“Conservative” Scenario A: UCTE system reliability is improving over 2008 – 2013 period. Investments firmly decided cannot face the expected decrease of available generation between 2015 and 2020.

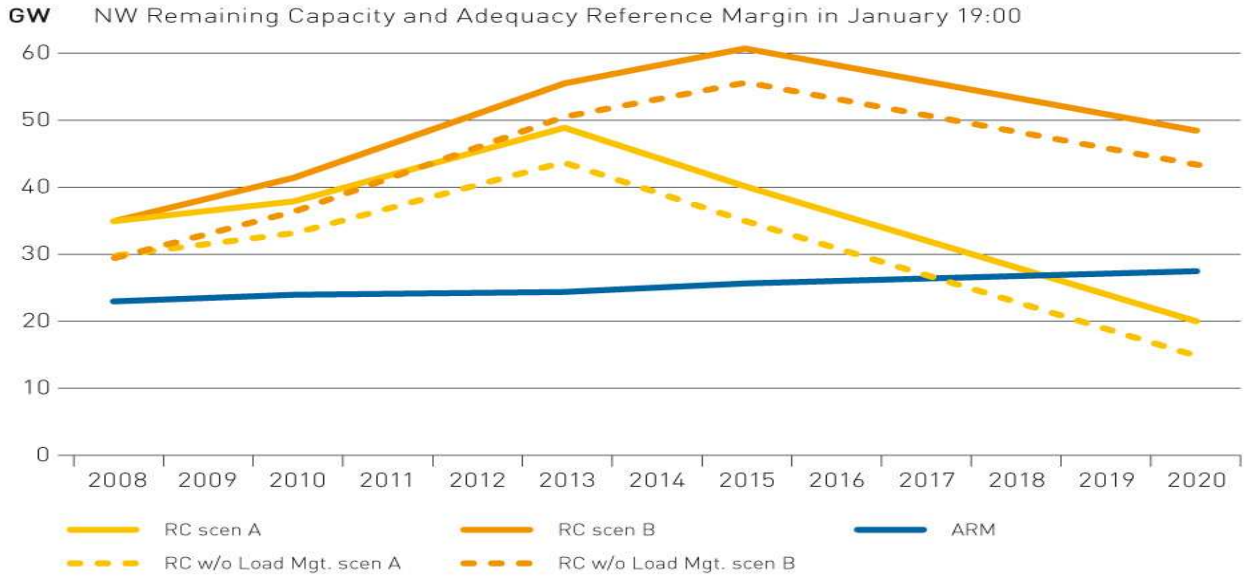
“Best estimate” Scenario B: UCTE system reliability is improving over 2008 – 2020 period.

Generation adequacy – Regional blocks approach



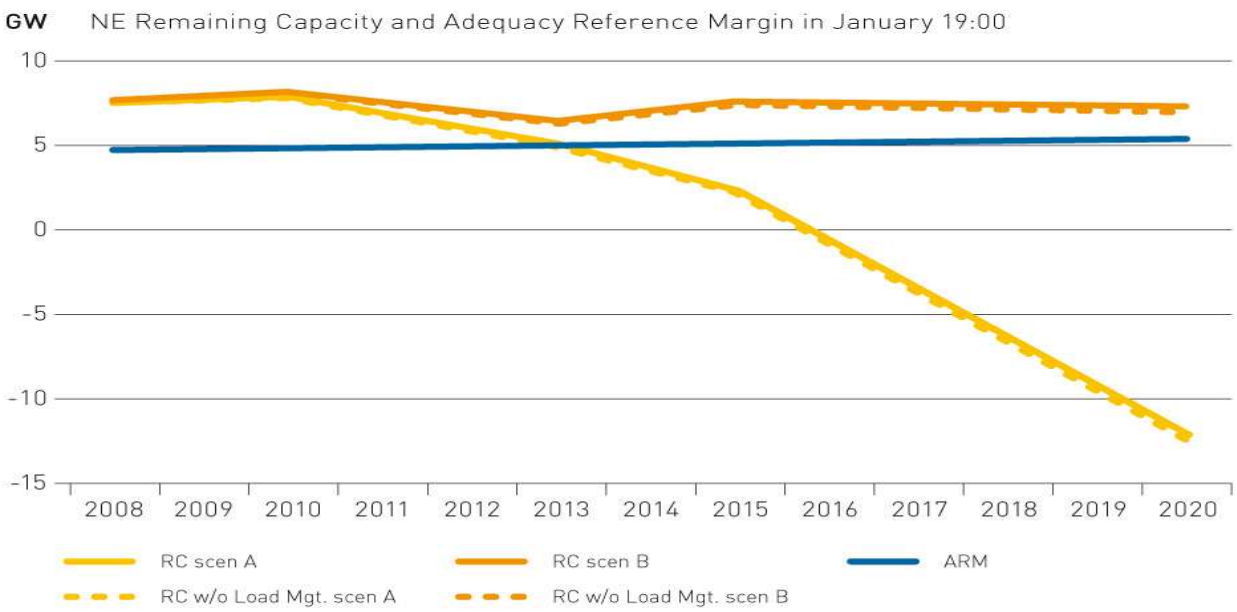
- 5 regional blocks are defined for a local adequacy analysis.

Generation adequacy – North Western UCTE



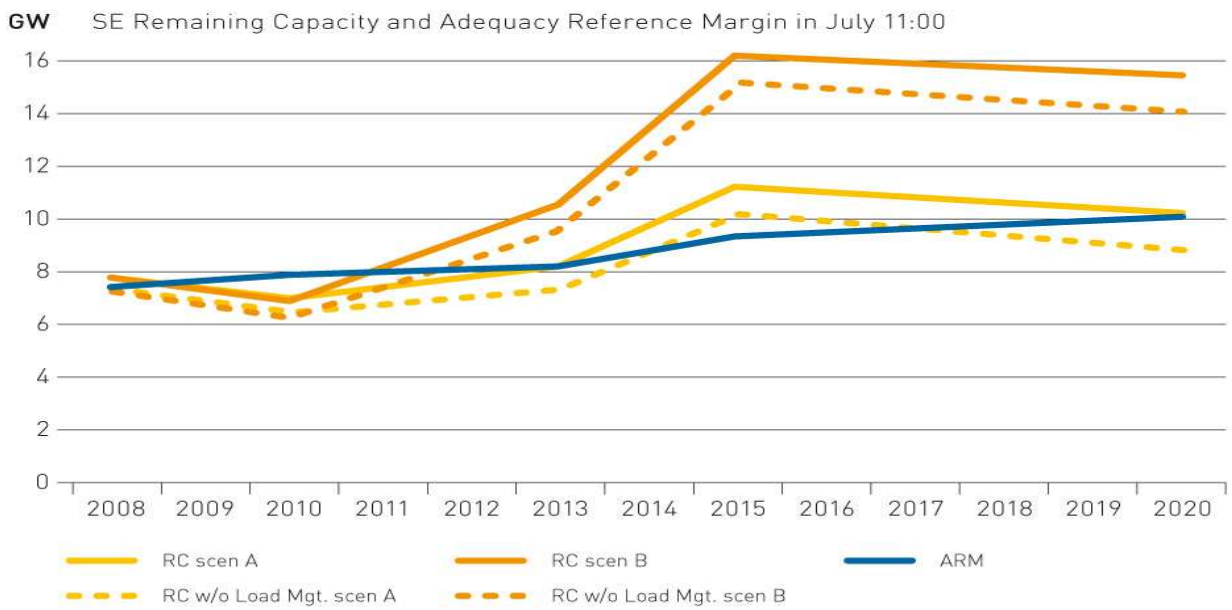
- "Conservative" scenario A: approx. 20 GW of NGC required in 2020 to keep 2008 margins
- "Best estimate" scenario B: adequacy is achieved up to 2020
  - Much higher generation capacity forecasts compared to the previous SAF report despite decommissioning
    (LCP directive, nuclear phase out in Germany and Belgium)
  - Increasing remaining capacity excess in the mid-term

Generation adequacy – North Eastern UCTE



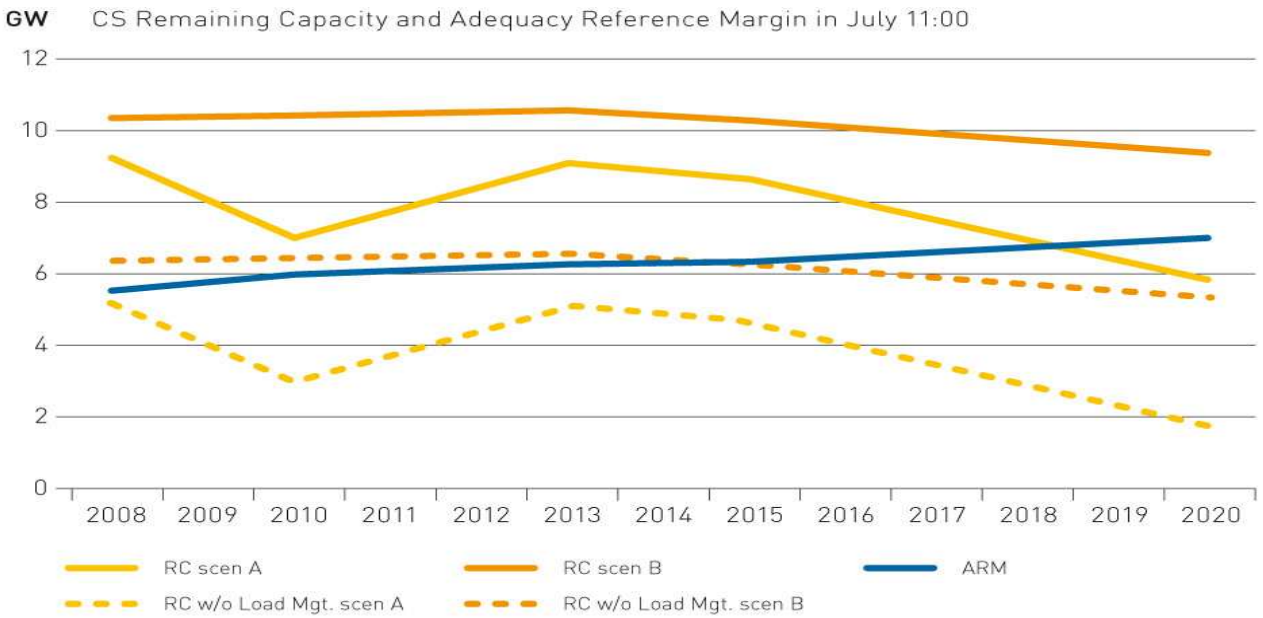
- "Conservative" scenario A: adequacy is achieved up to 2013;
  ca. 30 GW of NGC required in 2020 to keep 2008 margins
- "Best estimate" scenario B: adequacy is achieved up to 2020
  - Nuclear commissioning in Slovakia after 2015.

Generation adequacy – South Eastern UCTE



- "Conservative" scenario A: adequacy level stable but a minimum up to 2020
- "Best estimate" scenario B: adequacy is achieved up to 2020
  - Romania and Bulgaria should be the major sources of Remaining Capacity in the block.

Generation adequacy – Centre South UCTE

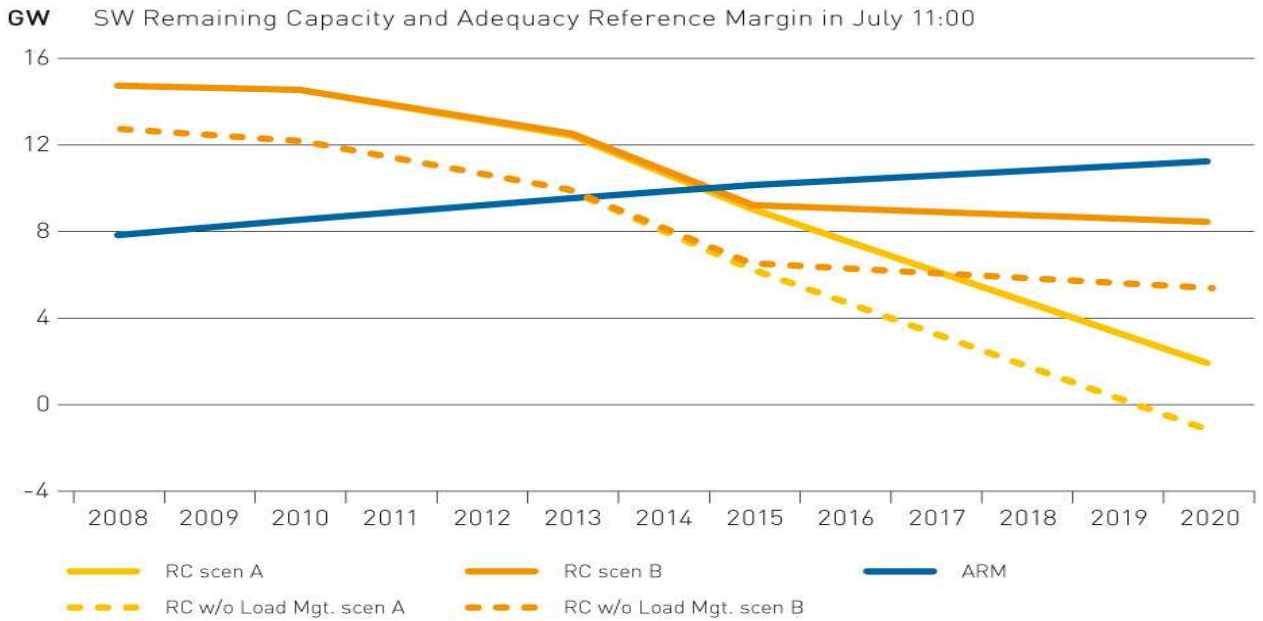


- "Conservative" scenario A: adequacy is achieved up to 2018, thanks to DSM (or imports)
- "Best estimate" scenario B: adequacy is achieved up to 2020, thanks to DSM (or imports)

  approx. 10 GW of NGC required in 2020 to keep 2008 margins

  - The block is likely to rely on load management (or imports) in some occasions to ensure adequacy

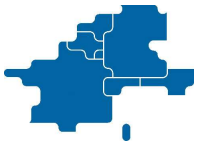
Generation adequacy – South Western UCTE



- "Conservative" scenario A: adequacy is achieved up to 2014
- "Best estimate" scenario B: ca. 5 GW of NGC required in 2020 to meet ARM requirements

  - Strong capacity increase in the mid-term compared to the previous SAF 2007-2020 report
  - Important RES share (higher non usable capacity).
  - Load is expected to grow at a rate of 3,7% a year, exceeding generating capacity increase.

Generation adequacy – comparison of regional blocks



Adequacy should be achieved and even increase in the mid-term.
20 GW of additional capacity must be confirmed to maintain adequacy in 2020 at the same level as in 2008.

Adequacy should be achieved in the mid-term.
30 GW of additional capacity must be confirmed to maintain adequacy in 2020 at the same level as in 2008.

Adequacy should be stable but minimum in the mid-term (slightly negative in 2010).
In 2020 adequacy is forecasted about 20 GW higher than in 2008.

Adequacy should be achieved in the mid-term with a minimum in 2010.
10 GW of additional capacity must be confirmed to maintain adequacy in 2020 at the same level as in 2008.

Adequacy should decrease in the mid term.
13 GW of additional capacity are required to meet the adequacy reference margin requirement in 2020

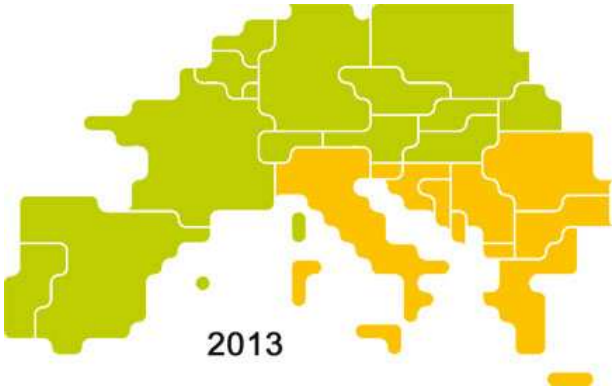
Generation adequacy – Evolution

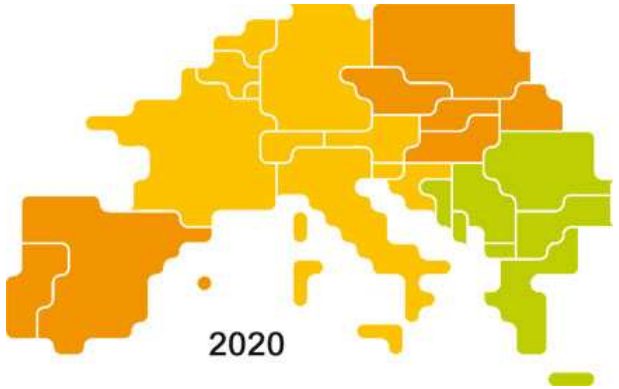
- In the next five years, generation adequacy requirements are met is the Northern and Western parts of UCTE, whereas the situation is more stressed, but not critical in the Southern parts.

- Later on, the picture should particularly enhance in the South-Eastern regional block with some major projects forecasted.

  Elsewhere, a regular decrease of remaining capacity is expected in the mid/long term, unless new investments interfere.

  In this respect, margins might deteriorate quicker in the North-Eastern and South-Western regional blocks, than in the North-Western and Centre-South regional blocks.



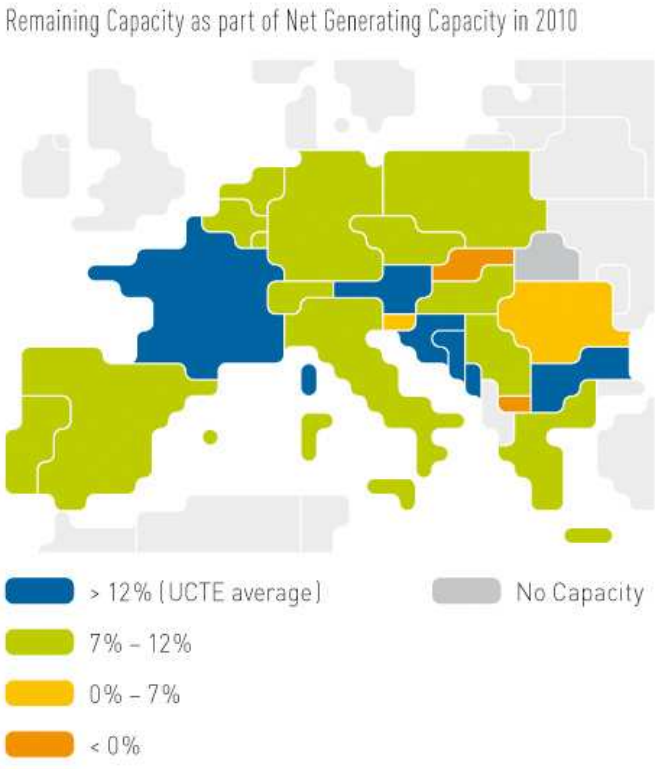


Remaining Capacity of national systems

- In 2010, Remaining Capacity is equivalent to 12% of the Net Generating Capacity

  - On average for the whole UCTE considering “Best estimate” scenario B.

  - In 2010 countries most likely to import at winter peak are FYROM, and Slovakia.



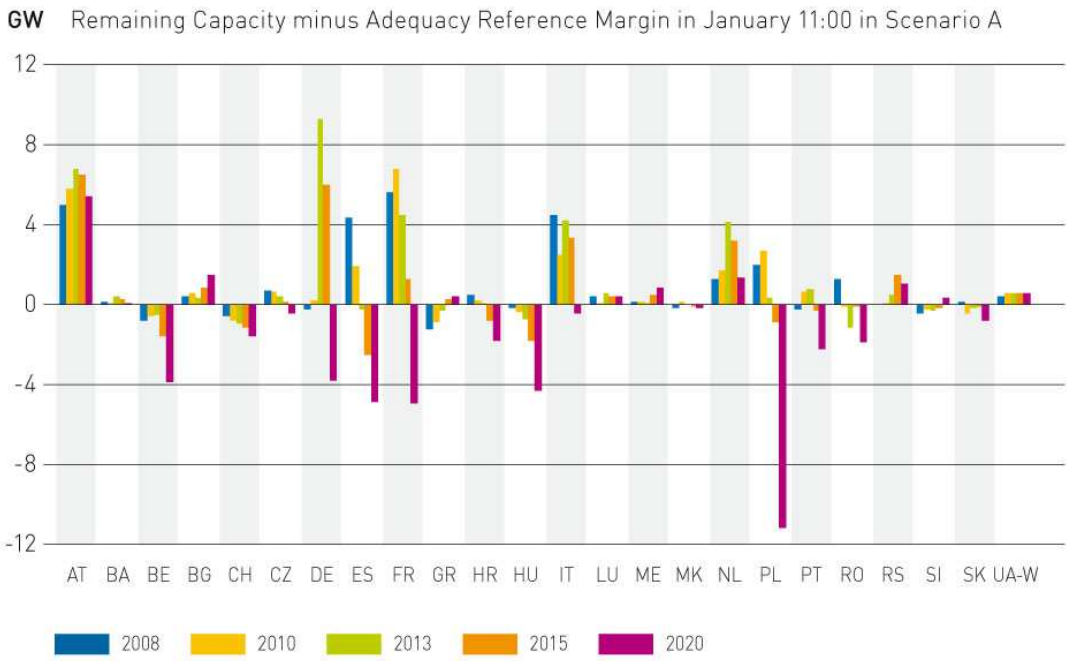
Generation adequacy – National systems, scenario A

- Indicative ARM in isolated situation is not met …

  … in 2010 in 1/3 of the countries

  … in 2015 in 1/2 of the countries

  … in 2020 in almost all countries
  (except Austria, Bulgaria, Greece, Luxembourg, Montenegro, Serbia, the NL, Slovenia, Western Ukraine)



- Sometimes ARM may be a stronger objective than the one used for national generating adequacy assessment.
- Compared to last year SAF study, the situation is quite stable.

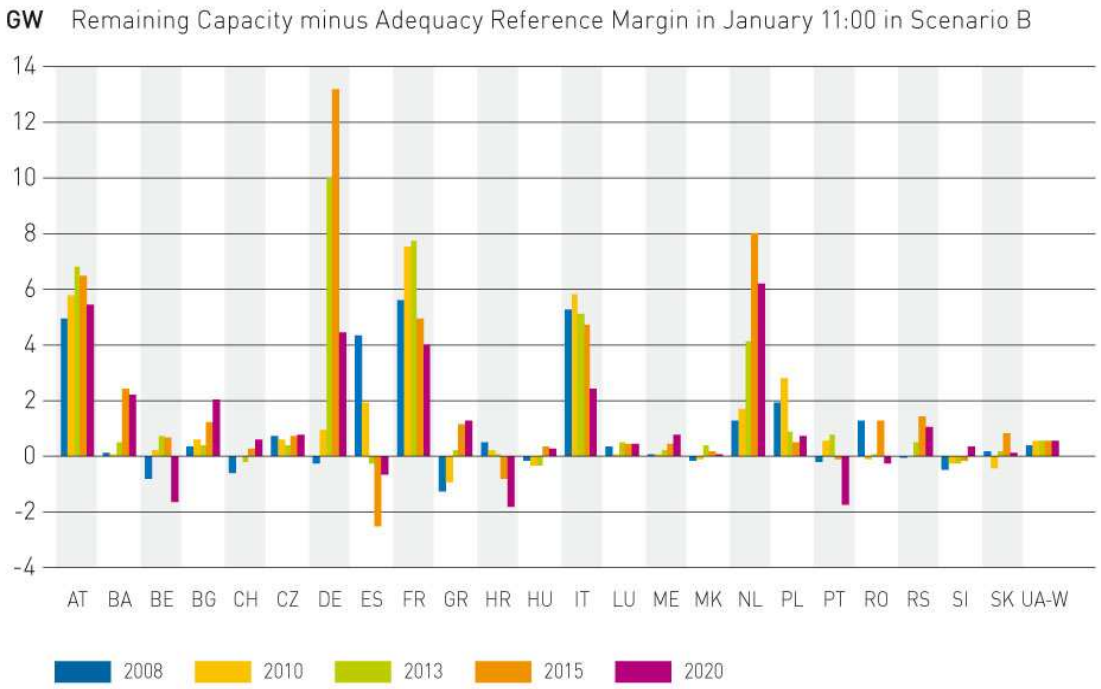
Generation adequacy – National systems, scenario B

- Indicative ARM in isolated situation is not met …

  … in 2010 only in 6 countries *(map)* Greece, Hungary, FYROM Romania, Slovenia and Slovakia

  … in 2015 only in 3 countries Spain, Croatia and Slovenia.

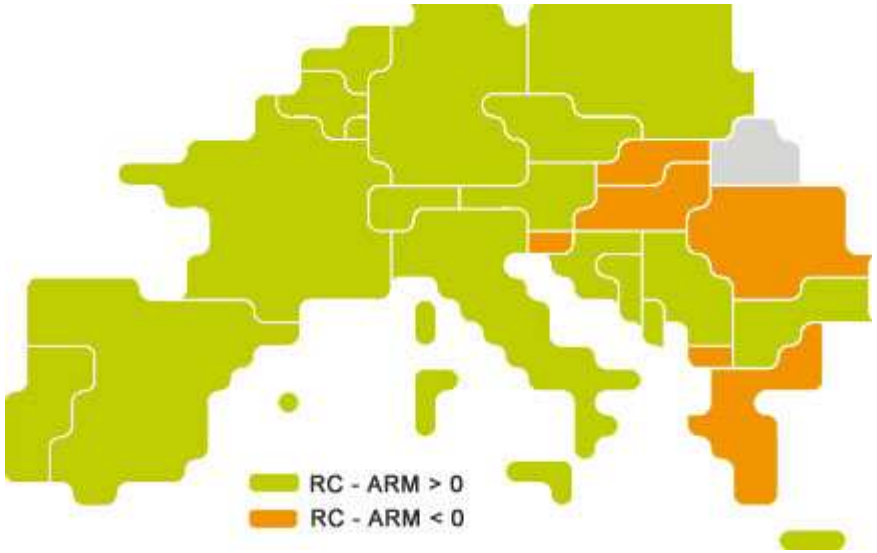
  … in 2020 in only 5 countries *(map)* Belgium, Spain, Croatia, Portugal, Romania.



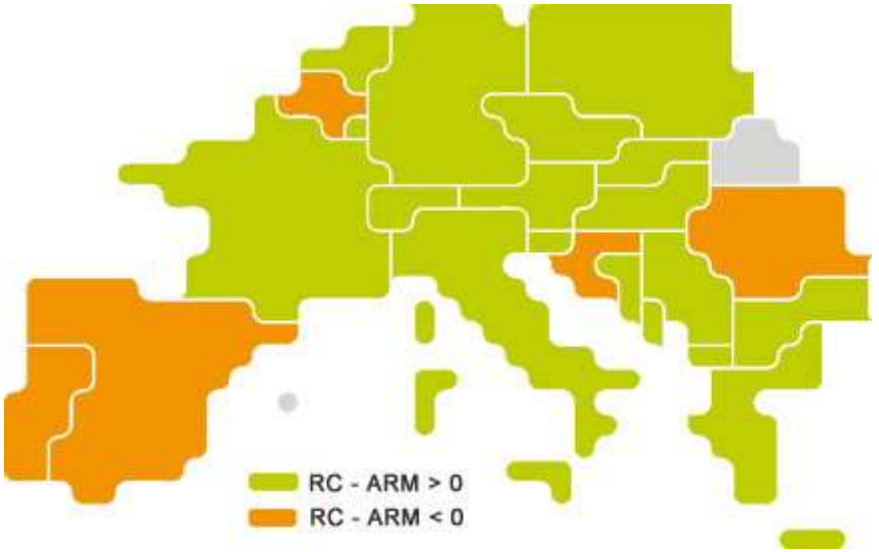
• Compared to last year SAF study, the situation is improving.

Generation adequacy – National systems, scenario B

Remaining Capacity minus Adequacy Reference Margin – Jan. 2010



Remaining Capacity minus Adequacy Reference Margin – Jan. 2020



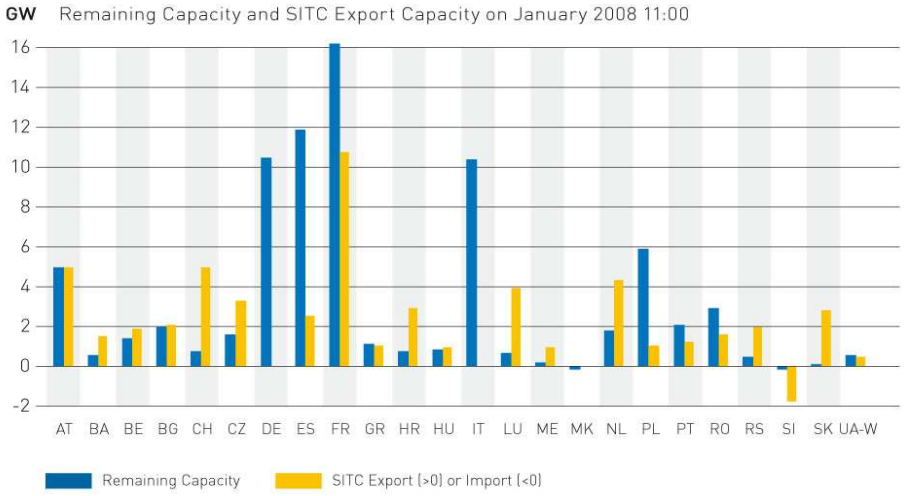
Definition of SITC

- The Simultaneous Interconnection Transmission Capacity (SITC) of a power system is the overall transmission capacity through its peripheral interconnection lines.
- SITC are assessed consistently with the UCTE Transmission Development Plans.
- The SITC export value is called Export Capacity and may differ from the SITC import value, called Import Capacity.

Gross Remaining Capacity versus SITC

- Remaining Capacity (RC) is compared to Simultaneous Interconnection Transmission capacity (SITC).
- Countries with positive Remaining Capacity are potential sources of support to others systems through interconnection lines.
- When Export Capacity is lower than a positive Remaining Capacity, it means that all the extra capacity cannot be exported under standard conditions.

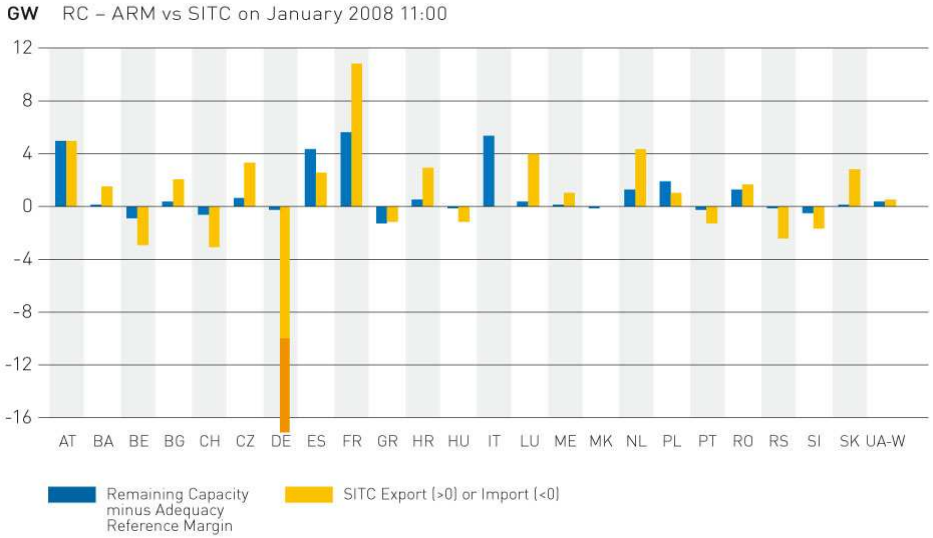
- In 2008, Spain, France, Italy, Poland, Portugal and Romania does not appear able to export all their extra RC under standard conditions.



Remaining Capacity excess versus SITC

- Remaining Capacity (RC) minus Adequacy Reference Margin (ARM) is compared to Simultaneous Interconnection Transmission capacity (SITC).
- A positive difference RC – ARM > 0 is extra capacity potentially exportable in most of the situations, and can be compared to simultaneous export capacity.
- A negative difference RC – ARM must be smaller than the simultaneous import capacity to ensure the National system's adequacy can be met with the support of its neighbours.

- In 2008, the situation appears constrained in Greece where the capacity likely to be imported exceeds the import capacity.



Conclusions

- **Generation adequacy of the UCTE system should not be at risk up to 2015 in any generation scenario and at any reference point**.

- Compared to the previous SAF 2007-2020 report, Remaining Capacity forecast appears much higher today, by more than 10 GW in Conservative scenario A. This is an illustration of the **steady investments in generating capacity decided and announced in most of the countries in the last few months**.

- After 2015, additional investments in generating capacity are required to maintain the level of adequacy at an appropriate level, reaching **50 GW of Net Generating Capacity by 2020**.

- **Future investments are however likely to be sufficient to maintain adequacy up to 2020 at the level of 2008**.

- **Transmission system bottlenecks may prevent to achieve fully this potential**: new investments are not located evenly over UCTE, and, because of its stochastic nature, the strong development of wind power can induce additional stress on mutual support.

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THANK YOU FOR YOUR ATTENTION

Appendix

Simultaneous Interconnection Transmission Capacity

- The Simultaneous Interconnection Transmission Capacity (SITC) of a power system is the overall transmission capacity through its peripheral interconnection lines. SITC are assessed consistently with the UCTE Transmission Development Plans.

  - *The SITC export value is called Export Capacity and may differ from the SITC import value, called Import Capacity.*

- RC > Export Capacity means that all the extra capacity can be exported in most of the situations.

- A positive difference RC – ARM > 0 is extra capacity potentially exportable in most of the situations, and can be compared to simultaneous export capacity.

- A negative difference RC – ARM must be smaller than the simultaneous import capacity to ensure the National system's adequacy can be met with the support of its neighbours in all situations.