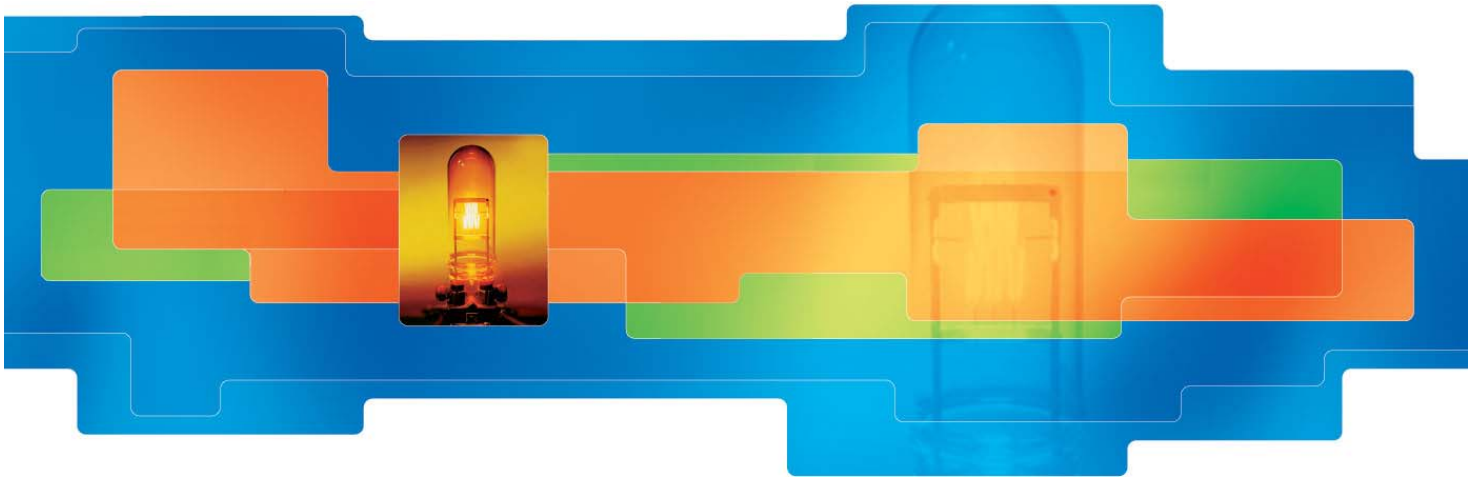

UCTE System Adequacy Forecast 2007-2020

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UCTE System Adequacy Forecast 2007-2020

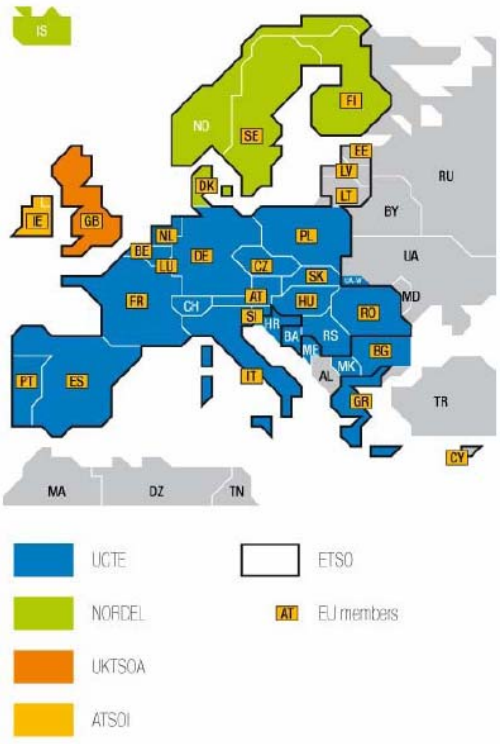
- Introduction
- Methodology
- Generation Adequacy
- Transmission System Adequacy
- Conclusions

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 the Netherlands to Romania and Greece.
- It aims to keep the quality and reliability of the UCTE system at high level.

UCTE

- 23 countries
- 450 Million people
- 625 GW of generation capacity
- 2500 TWh
  - 16% 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 Member States.

- The Directive requires to report on security of supply on a 15-year timescale.

- Security of supply, internal market achievement and climate change issues have taken a growing importance in the last years.
  - Through the publication of System Adequacy reports, UCTE contributes to these issues by releasing detailed data and analysis from TSOs expertise.

System Adequacy Forecast

- The System Adequacy Forecast aims at providing 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 on the main changes expected in the UCTE transmission grids, especially interconnections.

- It aims at providing 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 on the generation availability and on the load level.
    - Uncertainties result from planned and unplanned outages, availability of primary sources, weather conditions such as temperature, wind, water inflows.
  - Transmission adequacy enhances the analysis with the flexibility provided by interconnections and import/export flows.

Adequacy

- In the liberalised electricity 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

- In this framework it is necessary:
  - To check the short-term ability to cover the peak load relying on the existing generating assets, on the ones under construction or the ones 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.

UCTE System Adequacy Forecast 2007-2020

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- **Methodology**
- Generation Adequacy
- Transmission System Adequacy
- Conclusions

Methodology

- Adequacy forecast need to 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 through questionnaires and data collecting processes.
- The present report covers continental Europe, on the period 2007 – 2020.
- Extension to the whole European system is performed within ETSO.

Methodology

- Forecast deals with 2 scenarios to cover the uncertainties on the future generation capacity.
  - "Conservative" Scenario (A)
    - Hypothesis: 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)
    - Hypothesis: Considering further generation developments expected from national generation development plans, European directives, applications for grid connection…
    - Goal: To estimate the potential future developments induced by market signals and the adequate incentives for investments.

Methodology

- Forecast deals with 3 reference points:
  - 3rd Wednesdays of January, at 11:00;
  - 3rd Wednesdays of January, at 19:00;
    - closer to synchronous peak load.
  - 3rd Wednesdays of July, at 11:00.

- Load 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. Estimate the amount of reliably available generation at the reference time by reducing generating capacity for expected unavailability. 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 energy conditions (hydro, wind)…

4 steps to estimate adequacy

2. Estimate the amount of available generation which exceeds the expected load at reference point. 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 increase the Remaining Capacity.

4 steps to estimate adequacy

3. Define an indicative level of remaining capacity to be reached, considered as *sufficient* to provide reliable supply *at the peak load*. This level is called “Adequacy Reference Margin” and calculated as :

Margin against the 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*.
- *Sufficient* level estimation: high enough to limit the risk of shortfall at 1%, 2 to 5 days a year on average for UCTE members.
  - **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.

4 steps to estimate adequacy

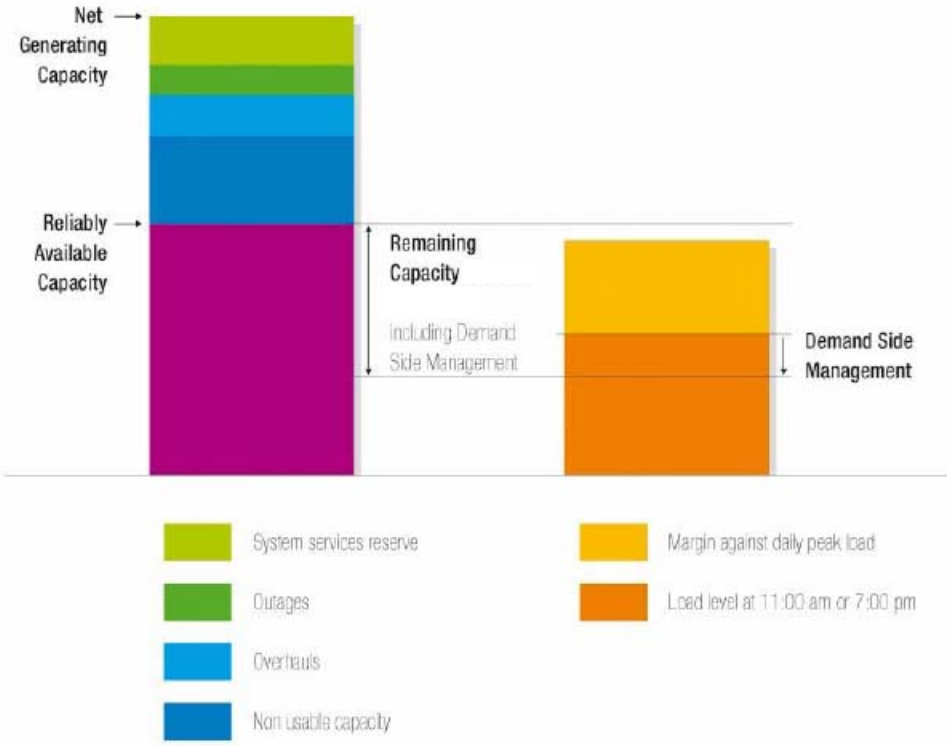
4. The synthetic feature is that to ensure the reliability of the system **Remaining Capacity must be higher than the Adequacy Reference Margin**

   RC ≥ ARM means that generation is available for exports in most of the situations

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

6.

Methodology



UCTE System Adequacy Forecast 2007-2020

- Introduction
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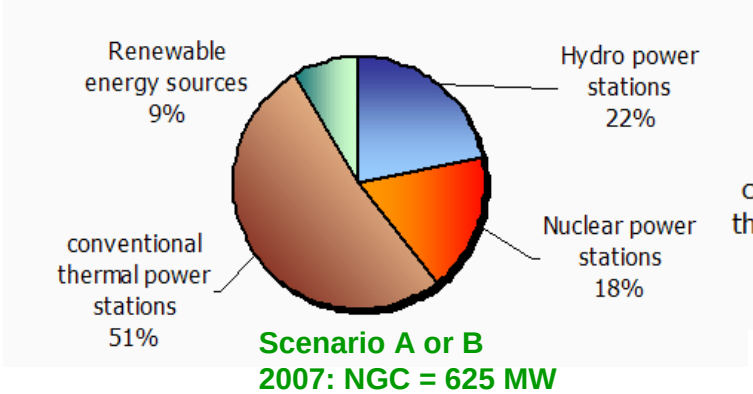
- **Generation Adequacy**
  - Whole UCTE System
  - Geographical Blocks
  - National Systems
- Transmission System Adequacy
- Conclusions

Generation Mix

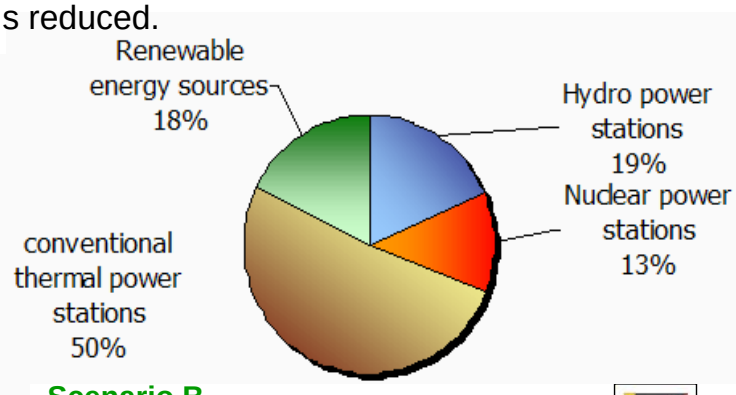
- From 2007 to 2015, Generating Capacity increases:

Generating Capacity Increase	*Scenario A*	*Scenario B*
Total	+80 GW	+128 GW
Renewable energy (incl. hydro)	+54 GW	+73 GW
Conventional thermal	+30 GW	+58 GW
Nuclear	-4 GW	-3 GW

- These trends lead to double the share of renewable in the UCTE mix, while fossil fuel remains stable and nuclear share is reduced.



Scenario A or B
2007: NGC = 625 MW



Scenario B
2015: NGC = 753 MW

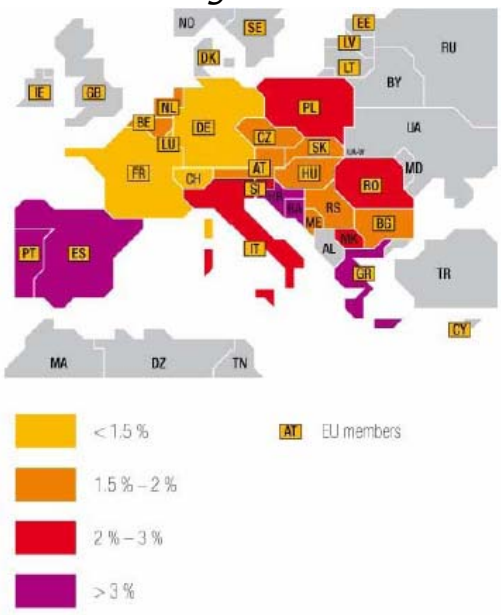
Reliably Available Capacity

- "Conservative" Scenario A
- While Net Generating Capacity is increasing by +80 GW in 2015, Reliably Available Capacity is increasing by +46 GW only.
- This is due to the important share of renewable in the new generating capacity, as the contribution of wind power capacity is quite low in terms of Reliably Available Capacity.
- "Best Estimates" Scenario B
- While Net Generating Capacity is increasing by +128 GW in 2015, Reliably Available Capacity is increasing by +79 GW only.
- In 2015, almost 170 GW out of the 753 GW of Net Generating Capacity is considered as non usable.

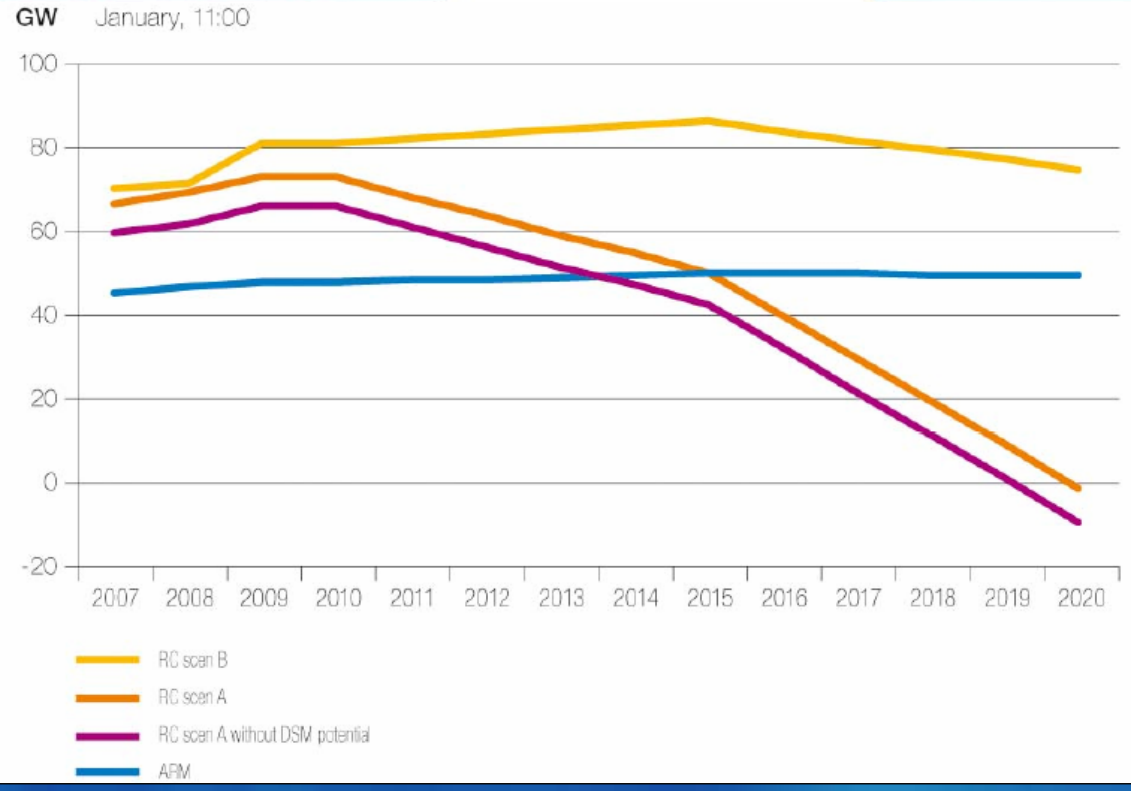
Consumption and Load

- The consumption growth is quite different from one area to the other, generally higher in the south and eastern part of UCTE.
- Consumption growth is expected to slow down in most of the countries, under the effect of energy efficiency improvement.
- The load at January 11:00 reference time points increases of +63 GW by 2015, corresponding to an annual average growth of nearly 2% a year.
- After 2015, load increases at a rate of 1,5% a year up to 480 GW in 2020.

Annual growth in 2010



Generation Adequacy - UCTE, January



Generation Adequacy - UCTE, Synthesis

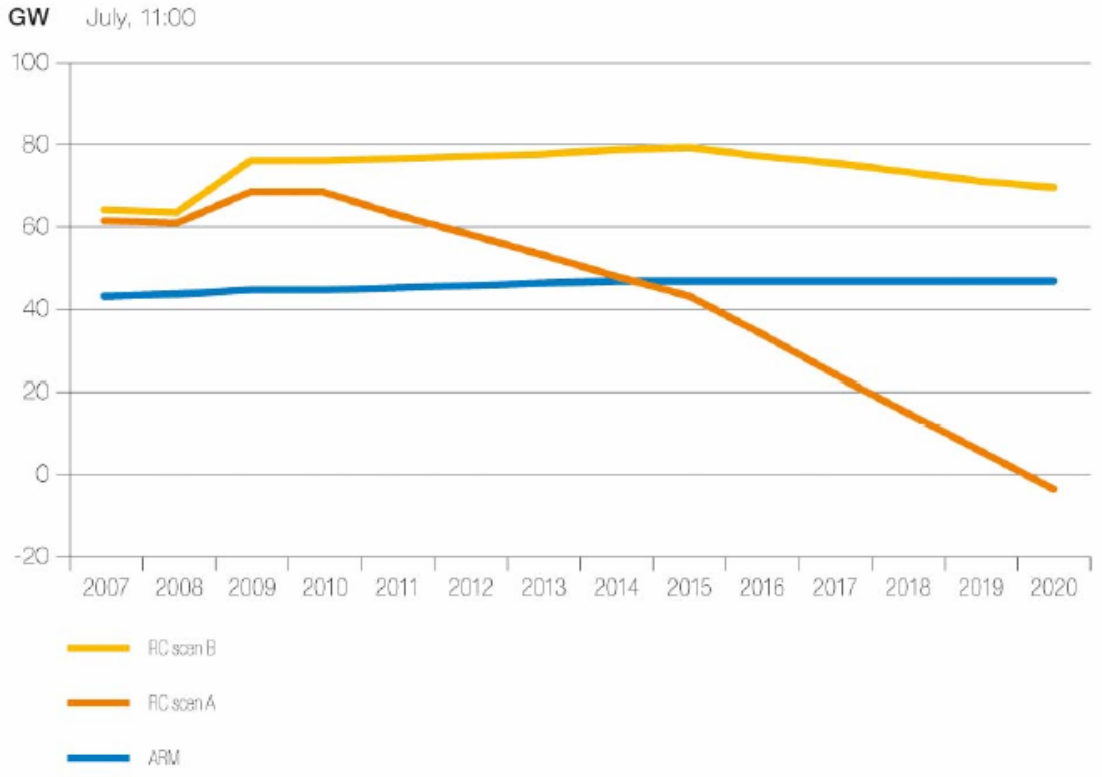
- "Conservative" Scenario A
  - Confirmed investment decisions seem sufficient, at UCTE level, to get a reasonable level of adequacy from now on to 2010.
  - Nevertheless, adequacy will be at risk by 2014-2015 if further investments are not decided in due time.
  - Furthermore, 50 GW of new generation capacities would be necessary to reach the adequacy criteria in 2020.

- "Best Estimate" Scenario B
  - Global adequacy would be ensured all over the 2007-2020 period, provided expected investments are actually realised.

Generation Adequacy - UCTE, Synthesis

- Security will be at risk if further 10 GW (RAC) investments are not confirmed by 2015.
- Security will be at risk if further 50 GW (RAC) commissioning is not performed from now on to 2020.
- The overall amount of commissioning to be performed in UCTE by 2020 reaches 175 GW to 200 GW:
  - Already expected new commissioning (Sc. A) : 70 GW
  - Expected decommissioning, to be compensated : 55 GW
  - Further capacity needed to reach adequacy in 2020 : 50 GW (RAC)
  - It represents 28% of the current NGC

Generation Adequacy - UCTE, July



Generation Adequacy - UCTE, 2007-2010

- "Conservative" Scenario A (January 2010, 11:00)
  - Net Generating Capacity increases of +45 GW up to 670 GW
    - **Renewable energy (mainly wind) accounts for +30 GW**
  - Reliably Available Capacity increases of +30 GW up to 475 GW
  - Load increases of +25 GW up to 410 GW with +2.1% in winter
  - Remaining Capacity increases of +5 GW up to 65 GW
  - UCTE system reliability is improving over the period : RC=ARM+18 GW
    - **UCTE system could face a cold wave –10°C below normal temperature while keeping 18 GW (or 18+7 GW) to face every actual national peaks and unfavourable availability.**
    - **Demand Side Management could reduce the load of 7 GW.**

- "Best Estimates" Scenario B (January 2010, 11:00)
  - NGC : +55 GW RAC : +35 GW RC : +11 GW
  - RC=ARM+25 GW

Generation Adequacy - UCTE, 2010-2015

- "Conservative" Scenario A (January 2015, 11:00)
  - Net Generating Capacity increases of +34 GW up to 703 GW
    - **Renewable Capacity: +24 GW (mainly wind) up to 101 GW**
    - **Nuclear Capacity start decreasing of –2 GW**
  - Reliably Available Capacity increases of +15 GW up to 490 GW
  - Load increases of +39 GW up to 448 GW with +1.8% in winter
  - Remaining Capacity decreases of –23 GW down to 42 GW
  - Investments firmly decided today are 8 GW short to achieve adequacy
    - **DSM potential of 7.4 GW is not enough to match the ARM**
  - It is still possible to confirm new investments

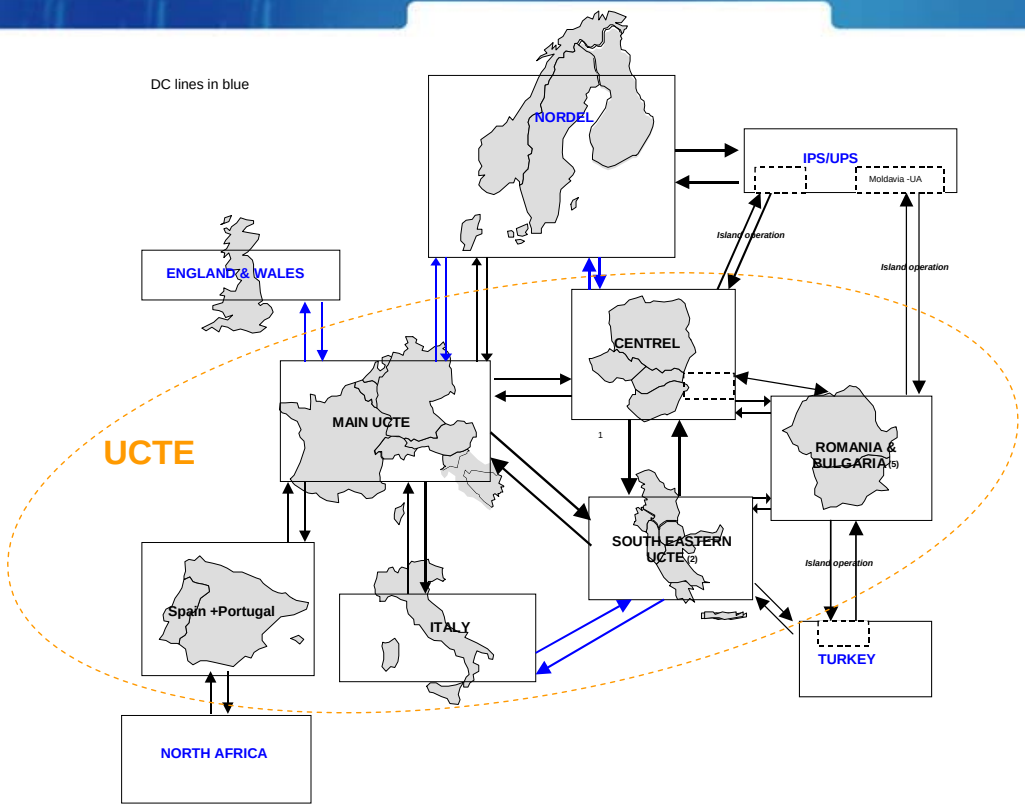
- Best Estimates" Scenario B (January 2015, 11:00)
  - NGC : +73 GW RAC : +44 GW RC : +5 GW
  - RC=ARM+26 GW

Generation Adequacy - UCTE, 2015-2020

- "Conservative" Scenario A (January 2020, 11:00)
  - Net Generating Capacity decreases of -4 GW up to 699 GW
    - **Renewable capacity: + 15 GW (mainly wind) up to 115 GW**
    - **Strong decrease of fossil fuel (-13 GW) and nuclear (-7 GW)**
  - Reliably Available Capacity decreases of -17 GW down to 473 GW
  - Load increases of +35 GW up to 483 GW with +1.5% in winter
  - Remaining Capacity decreases of -52 GW down to -10 GW
  - Investments firmly decided today are 58 MW short to maintain adequacy
    - **DSM potential of 7 GW is not enough to match the ARM**
  - It is still possible to confirm new investments

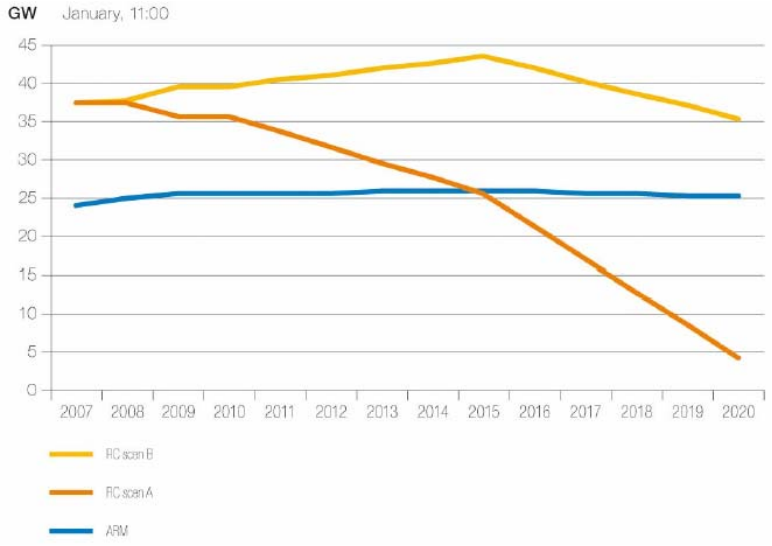
- "Best Estimates" Scenario B (January 2020, 11:00)
  - NGC : +49 GW RAC : + 23 GW RC : -12 GW
    - Around +70 GW additional fossil fuel capacity
  - RC=ARM+11 GW

Generation Adequacy - Geographical Blocks



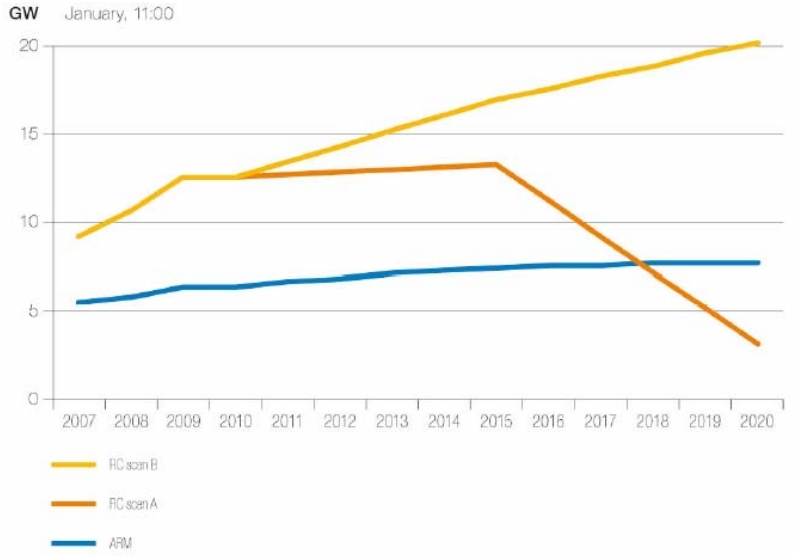
Generation Adequacy - Main UCTE Block

- From 2007 to 2010, adequacy is achieved.
- Adequacy is no longer ensured by 2015
  - Generating Capacity increase < Load growth.
  - Decommissioning
    - LCP Directive
    - Nuclear in Belgium and Germany
  - Commissioning
    - Nuclear in France
    - Fossil fuel in Belgium and Slovenia
    - Renewable in Germany
  - By 2020, +20 GW of additional capacity is required.
- Adequacy is achieved in Scenario B.



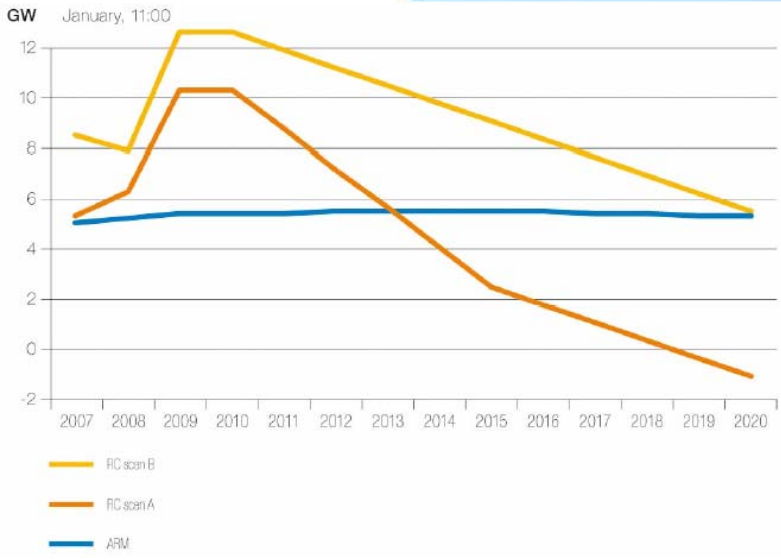
Generation Adequacy - Spain+Portugal

- From 2007 to 2010, adequacy is increasing.
- Adequacy is no longer ensured by 2017
  - Generating Capacity increase < Load growth
    - Load growth: 3.5%
  - Decommissioning
    - LCP Directive in Spain and Portugal
  - Commissioning
    - CCGT in Spain and Portugal
    - Wind farms in Spain and Portugal
  - By 2020, +5 GW of additional capacity is required
- Adequacy is achieved in Scenario B.



Generation Adequacy - Italy

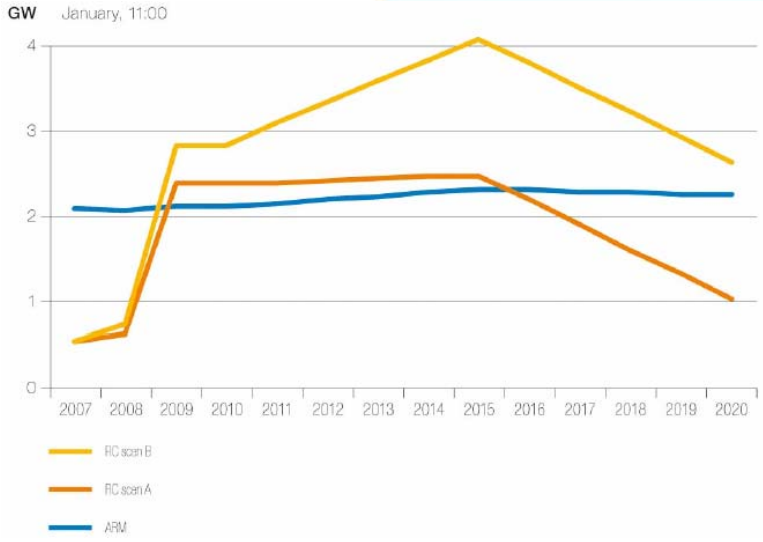
- From 2007 to 2010, adequacy is increasing.
  - Fossil fuel commissioning
- Adequacy is no longer ensured by 2013
  - From 2010, Generating Capacity increase < Load growth
  - Commissioning
    - Fossil fuel
    - Wind farms
  - By 2020, +7 GW of additional capacity is required



- Adequacy is achieved in Scenario B.

Generation Adequacy - South East. UCTE

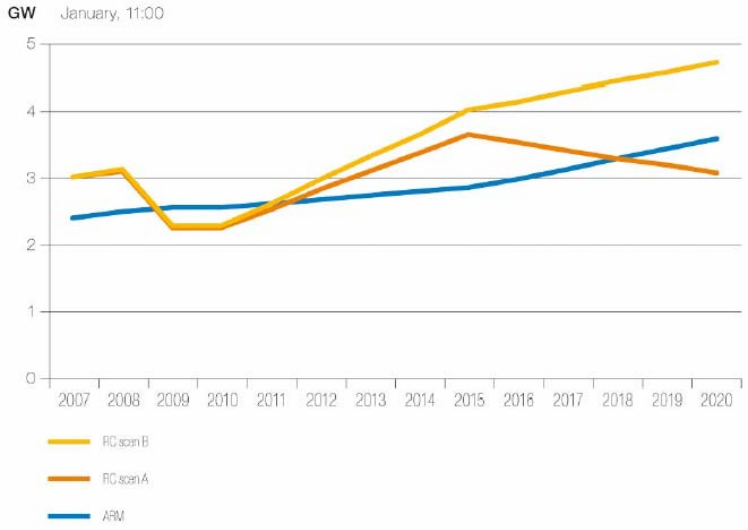
- From 2007 to 2010, adequacy is not achieved.
  - Adequacy rely on Imports
- From 2010 to 2015 Adequacy is just achieved
  - RC=ARM+0.5 GW
  - Commissioning
    - Gas units
    - Hydro units
    - Wind farms



- Adequacy is achieved from 2009 until the end of the study period in Scenario B

Generation Adequacy - Romania+Bulgaria

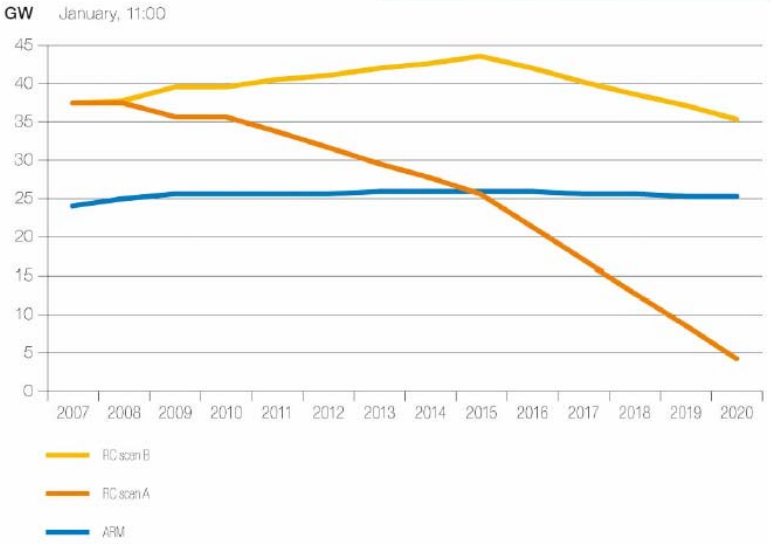
- From 2007 to 2010, adequacy is decreasing.
  - Generating capacity is decreasing
- Adequacy is achieved by 2012
  - Decommissioning
    - Nuclear plant, end 2006
    - Conventional thermal plants
  - Commissioning
    - Nuclear unit
    - Conventional thermal plants



- Adequacy is achieved by 2012 in Scenario B

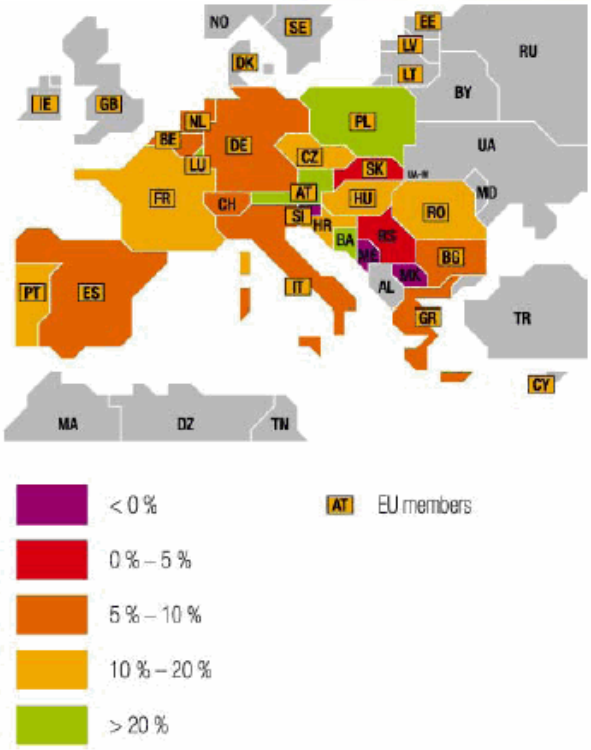
Generation Adequacy - CENTREL Block

- From 2007 to 2010 adequacy is achieved.
- Adequacy is no longer ensured by 2013
  - Generating Capacity decreases of –6% from 2010 to 2015
  - Decommissioning
    - Nuclear in Slovakia
    - LCP Directive
  - Commissioning
    - Nuclear in Slovakia
    - Lignite in Poland and Czech Republic
  - By 2020, +17 GW additional capacity is required.
- Adequacy is ensured in Scenario B.

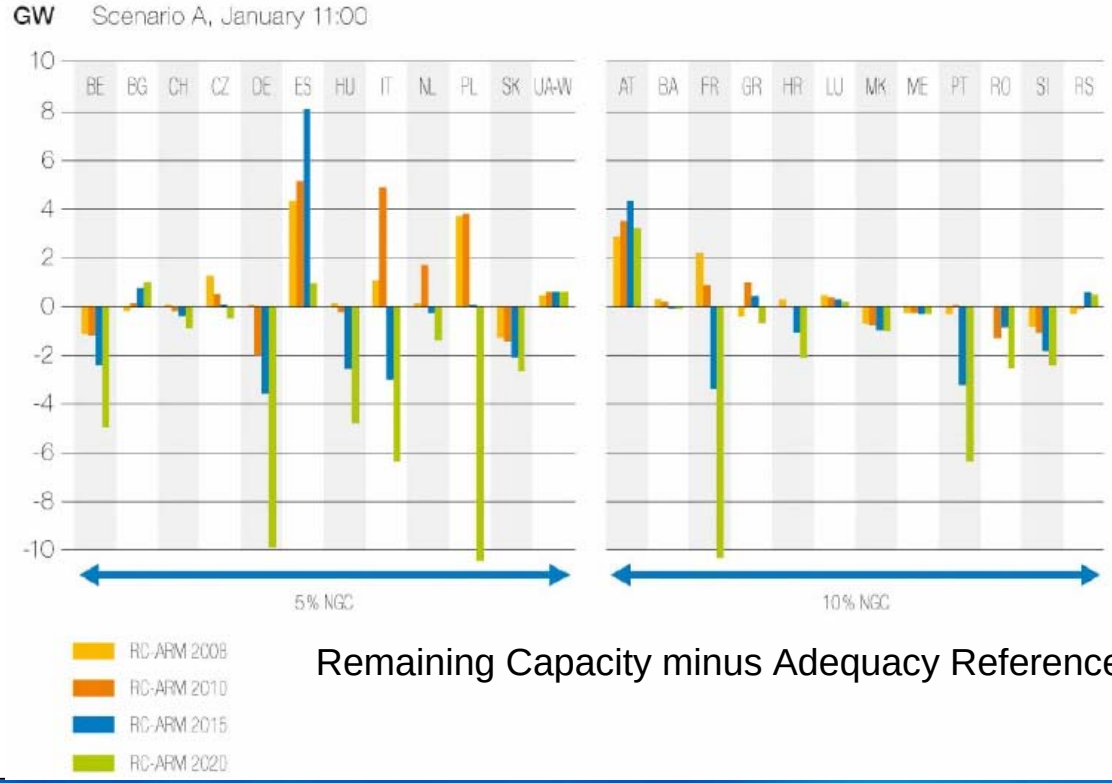


Generation Adequacy – National Systems

- State of Remaining Capacity in the UCTE countries in 2007,
- As a proportion of the Net Generating Capacity of each country.



Generation Adequacy – National Systems



Remaining Capacity minus Adequacy Reference Margin

Generation Adequacy – National Systems

- "Conservative" Scenario A

- In 2010, indicative ARM in isolated situation is not met in half of the UCTE countries.
  - Sometimes ARM may be a stronger objective than the one used for national generating adequacy assessment.

- In 2015, indicative ARM in isolated situation is not met in most of UCTE countries, which is not surprising as Scenario A is considered.

- In 2020, indicative ARM is only met in Austria, Bulgaria, Spain, Serbia, Western Ukraine and Luxembourg.

Generation Adequacy – National Systems

Generation Adequacy – National Systems

- "Best estimates" Scenario B

- In 2010, indicative ARM in isolated situation is not met in few of the UCTE countries:
  - Germany, Slovakia, Romania, Slovenia, Macedonia and Montenegro.

- In 2015, indicative ARM in isolated situation is met in most of UCTE countries, apart from:
  - Germany, Slovakia, Hungary, Romania and Macedonia.

- In 2020, indicative ARM is not met in:
  - Belgium, Germany, Slovakia, Hungary, Greece, Romania, Poland and Slovenia.

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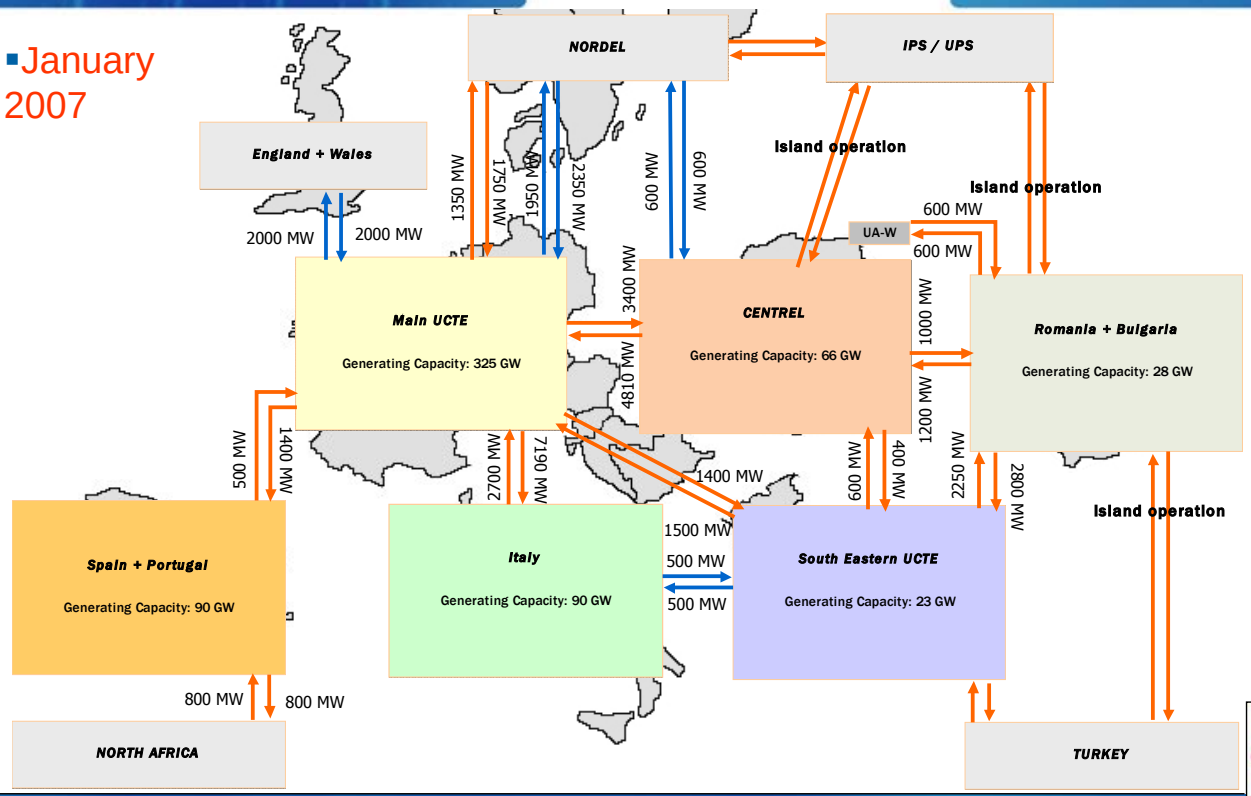
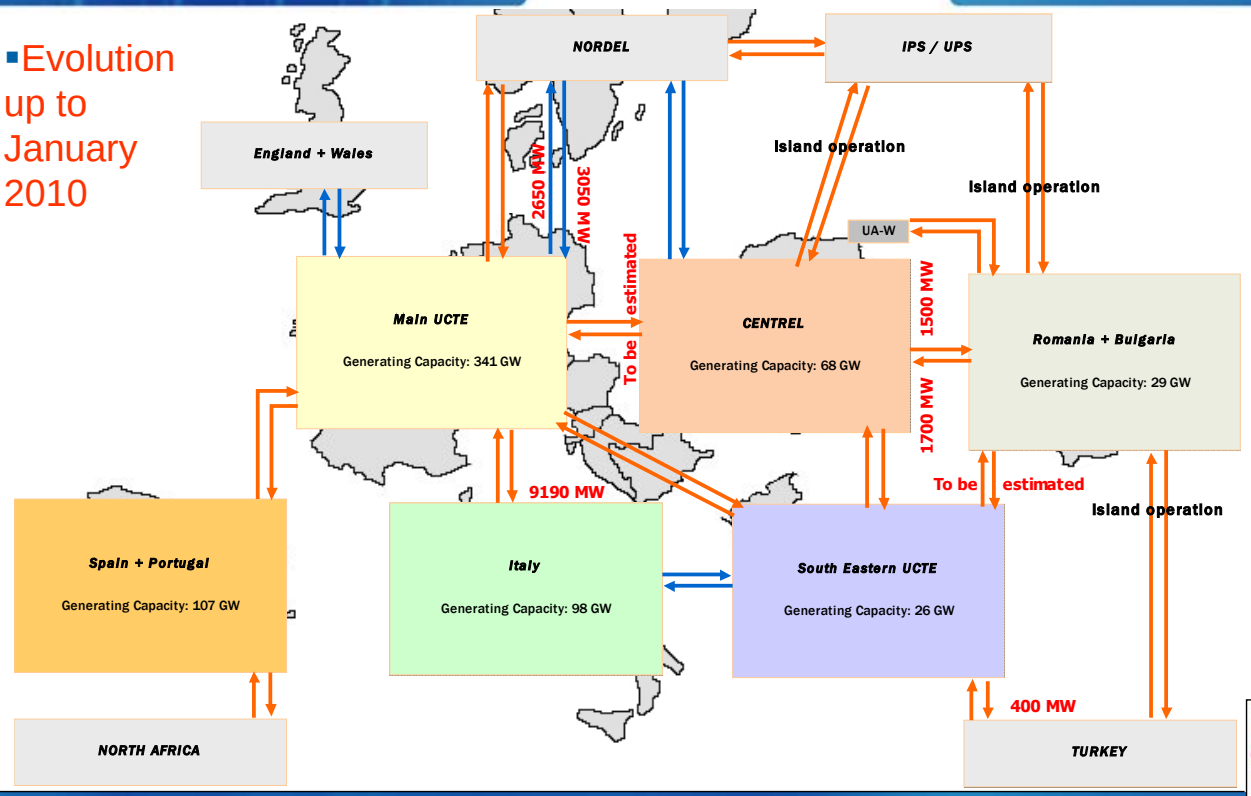
Transmission Adequacy - Geographical

- January 2007



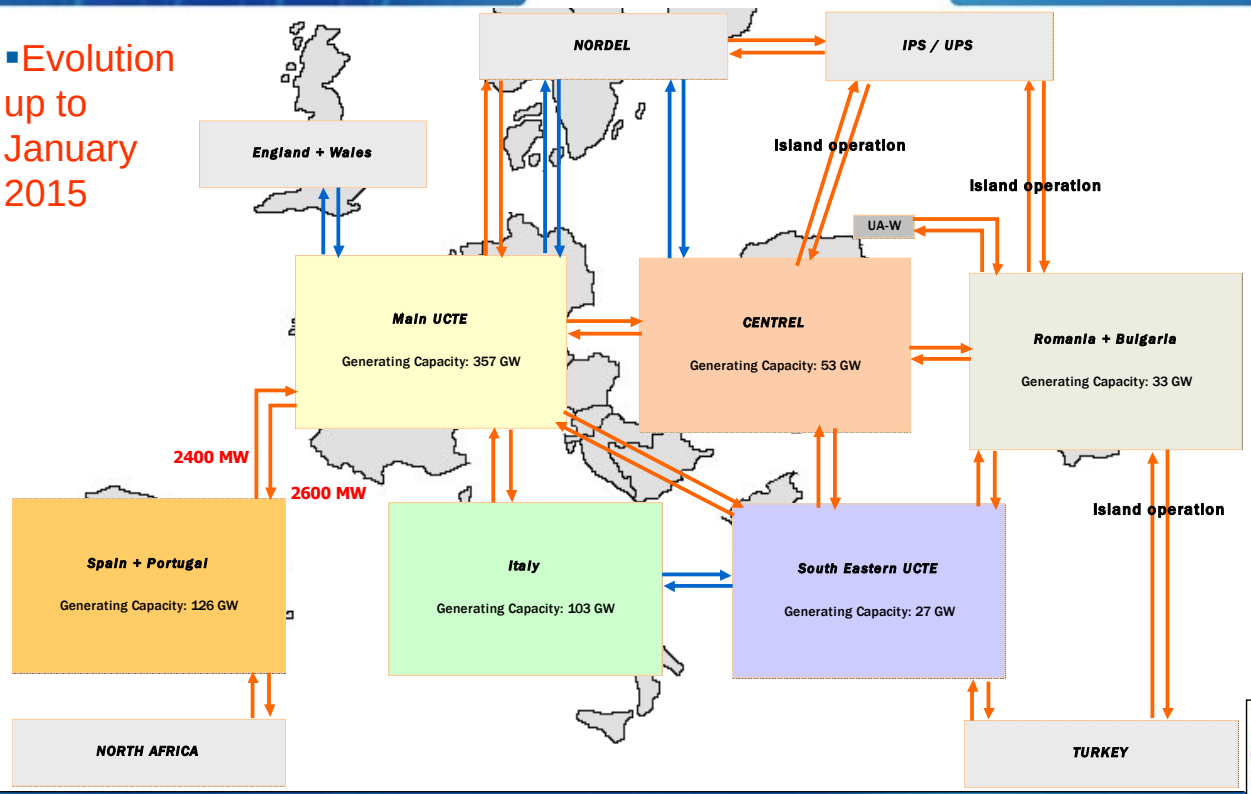
Transmission Adequacy - Geographical

- Evolution up to January 2010



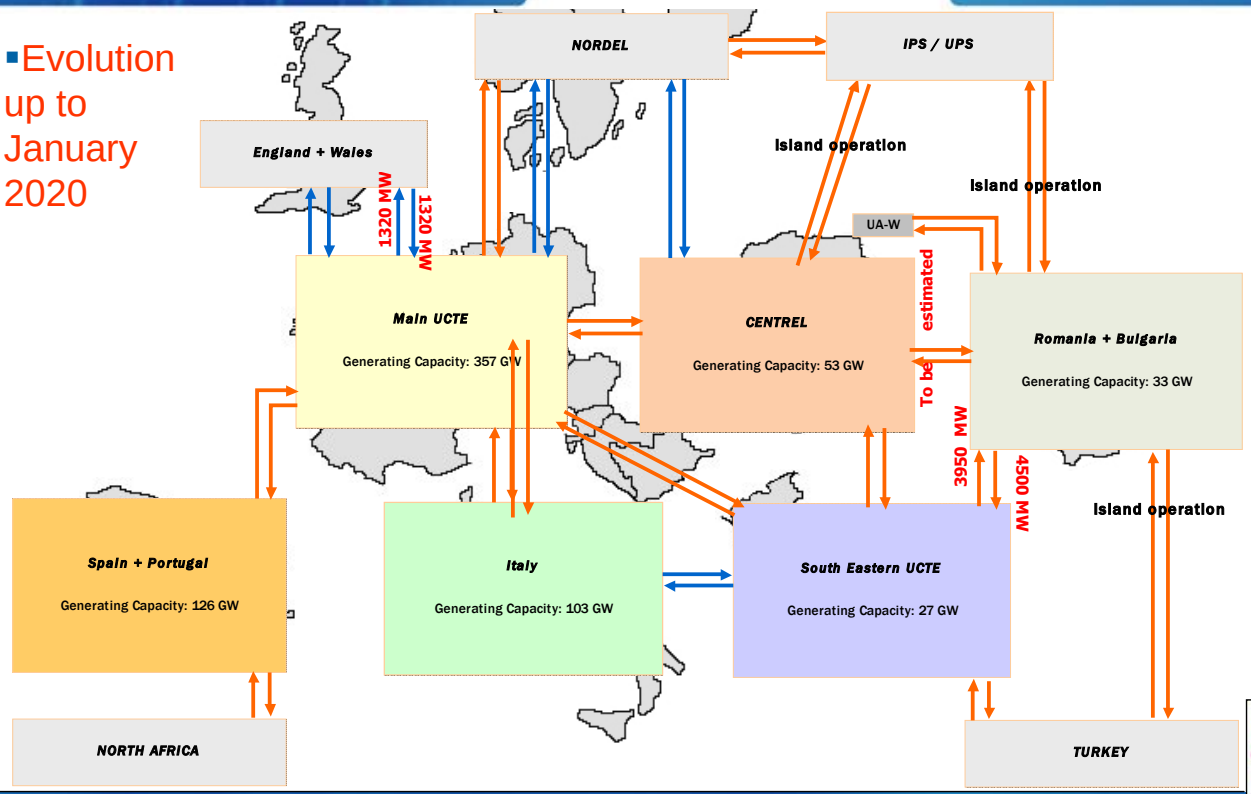
Transmission Adequacy - Geographical

- Evolution up to January 2015



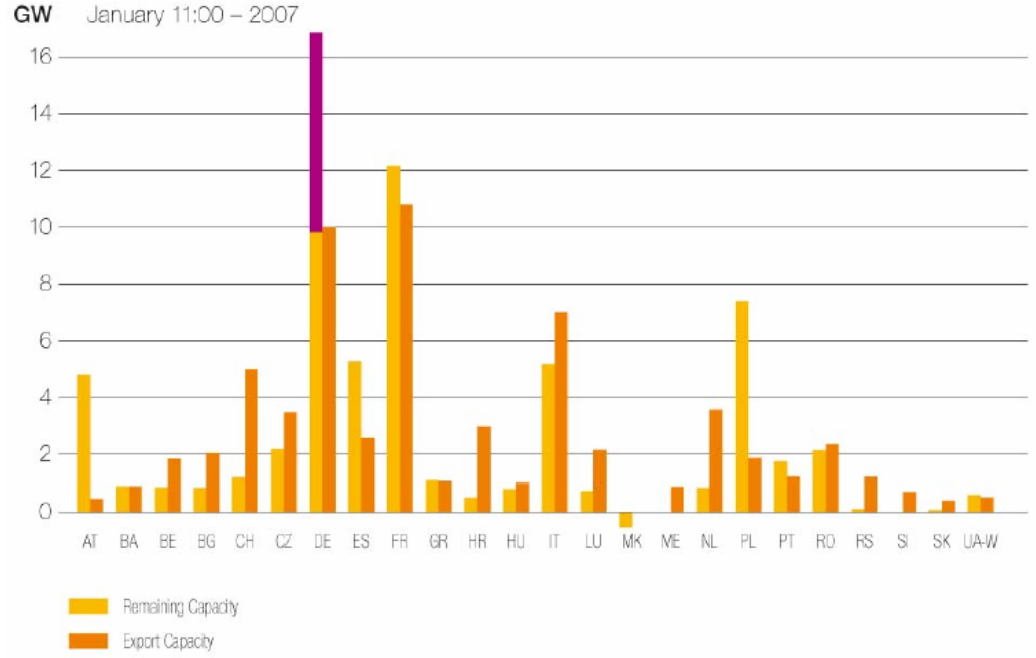
Transmission Adequacy - Geographical

- Evolution up to January 2020



Transmission Adequacy - National Systems

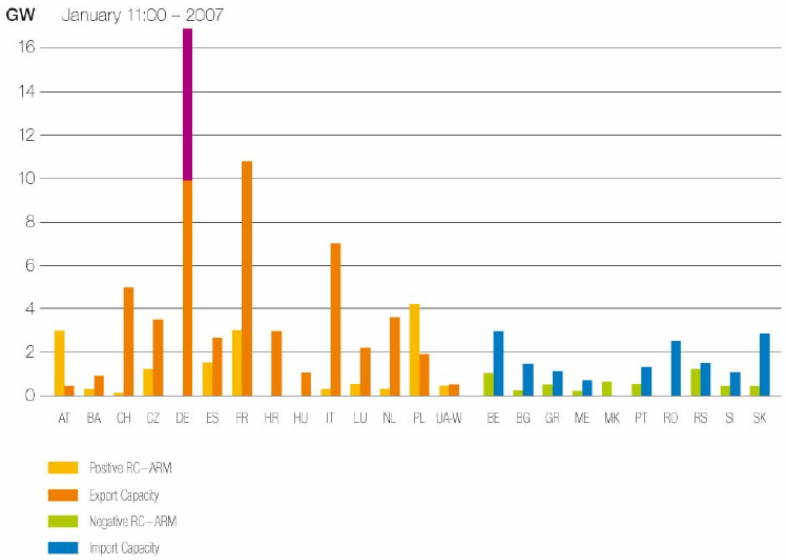
- Comparing Remaining Capacity to Transmission Capacities gives an overall view of potential congestions on interconnection lines.



Transmission Adequacy - National Systems

- Comparing RC – ARM to Transmission Capacities gives a view of potential exchange limitations under severe operation conditions:
  - If positive, RC – ARM is the capacity "Available for Export";
  - If negative, RC - ARM is the capacity "Likely to be Imported"

- If the RC-ARM is lower than the Import/Export related capacity, then congestions are likely to appear and to prevent generation adequacy to be satisfied through exchanges.



Transmission Adequacy - National Systems

- Overall, it appears that transmission capacities do not seem to be an obstacle to power balance achievement.
- The only limiting point concerns the export capacity of Poland and Austria, which is insufficient to enable exporting the generation available in these countries.
- But the important point is that no country likely to need to rely on imports when facing severe conditions seems to lack sufficient transmission capacity to do it.

UCTE System Adequacy Forecast 2007-2020

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- Transmission System Adequacy
- **Conclusions**

Conclusion

- Generation Adequacy is achieved over the 2007-2010 period, with a remaining capacity exceeding the adequacy reference margin by 15 GW.
  - This level is lower than what was expected according to the previous SAF report, but it remains sufficient to face unexpected events likely to affect the system.
- Generation adequacy decreases over the period 2010-2015 in scenario A, the remaining capacity reaching the level of ARM by 2014 (+ or - one year depending on DSM measures consideration).
  - This is quite consistent with previous SAF report, where this horizon was 2013.
- The first assessment carried out on the 2015-2020 period shows a rapid decrease of available generation capacity, so that the amount of further investments to be decided by 2020 reaches 50 GW.
- The overall amount of generation to be commissioned by 2020, including already decided investments and decommissioning compensation, would thus reach 175 to 200 GW.

Conclusion

- Nevertheless, adequacy needs a continuous monitoring especially in some areas :
  - South Eastern UCTE;
  - Main UCTE block.
- Transmission capacities seem sufficient on the point of view of adequacy achievement;
  - though they may be reinforced to enable more exchanges in the eastern part of UCTE and with Iberian peninsula.
- Having in mind that uncertainties affect these estimations :
  - In the short term lack of precise information;
  - In the medium term effects of CO2 trading and EU directive on large combustion plants on existing fossil fuel plants not completely included;
  - In the long term efficiency of market incentives for new investments still to be demonstrated.