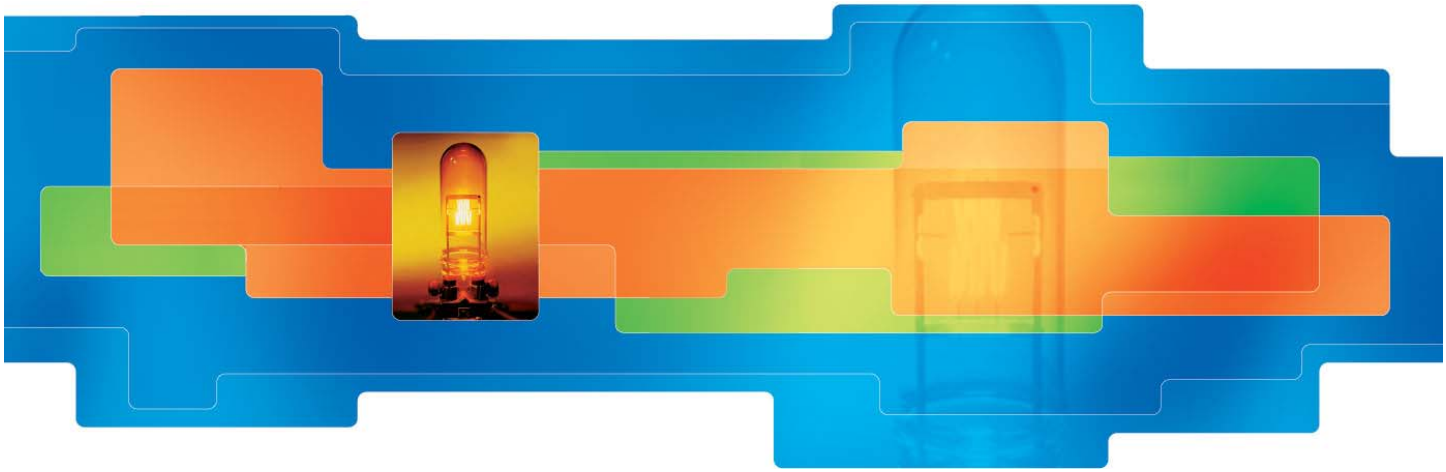

The UCTE System Adequacy Forecast 2005-2015

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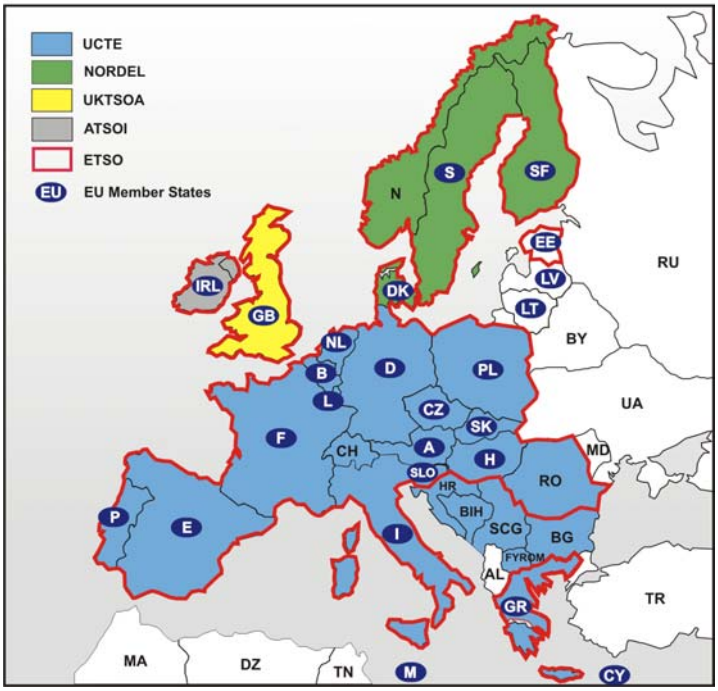
System Adequacy Forecast 2005-2015

- Introduction
- Methodology
- Main results
- Detailed analysis: geographical blocks
- Transmission system adequacy
- Conclusions

Introduction



UCTE Objectives

maintain the security of operation in the interconnected power system supply

22 countries
450 Million people
2300 TWh

Introduction

The UCTE System Adequacy Forecast aims at:

⇨ providing all European electricity market players with an overall view on system load evolution, as well as on the resources available to satisfy the system load, as an early input to investment decisions

⇨ providing all European electricity market players with an overview on the main changes expected in the UCTE transmission grids

⇨ providing TSOs which co-operate within UCTE with a prospective view of supply reliability developments throughout the network

Introduction

What is adequacy ?

⇨ Adequacy measures the **capability of the power system to supply the load** in all the steady states in which the power system may exist, considering standard conditions**.**

How to assess adequacy ?

⇨ **Generation adequacy** : verify the **capability of the available generation capacity to cover the peak load**, taking into account **uncertainties** on generation (resulting from planned and unplanned outages...) and on load levels (resulting from weather conditions….)

⇨ **System adequacy** : includes the **flexibilities provided by the interconnected network** (possibilities of import / export)

Methodology: role of system adequacy forecasts in the liberalised market

⇨ Most supply interruptions stem from the distribution network

⇨ But transmission disturbances or large-area power deficits can lead to interruptions with very high economic damages

⇨ Therefore forecasts are useful : these need to be international because reliability in the different countries is linked via transmission lines and trading

⇨ The UCTE system adequacy publications are the framework for assembling reliability data for the generation and transmission system for a large part of Europe

⇨ Since 2000, UCTE has made continuous efforts to adapt the system adequacy forecast to the new market environment and expectations

⇨ **the present report marks a new step of these improvements**

Main hypotheses (1)

- ⇨ **Extension of the forecast up to 2015 to provide earlier signals to the market**
- ⇨ **Introduction of two scenarios** in order to cover the higher uncertainties on future generation capacity at such time horizon
- ⇨ **Scenario (A) "Conservative"** : only new projects considered as "firm", estimated on the basis of data available to TSOs, are taken into account, as long as known decommissioning projects
- ⇨ **highlights potential unbalances without any new further investment decisions**
- ⇨ **Scenario (B) "Best Estimate" :** results from TSO's estimations of generation developments taking into account : national generation development plans, application of European Directives (renewables), applications for grid connection….

this scenario provides an estimation of potential future developments provided that market signals provide adequate incentives for investments

Main hypothesis (2)

Load

introduction of a new reference point to assess UCTE synchronous load :

- 3rd Wednesdays of January and July, at 11:00 (reference points)
- **3rd Wednesdays of January, at 19: 00** (closer to synchronous peak load)
- under normal climatic conditions

Other assumptions

⇨ **Long term export/import contracts** or participation in power plants out of the national territory not taken into account

⇨ **Interconnections** capabilities based on ETSO definitions and calculations

Methodology : assessing generation adequacy

Compare the capacity effectively available with ***a reasonable probability*** with the expected load at reference point

remaining capacity : RC = T + H + W - L - R

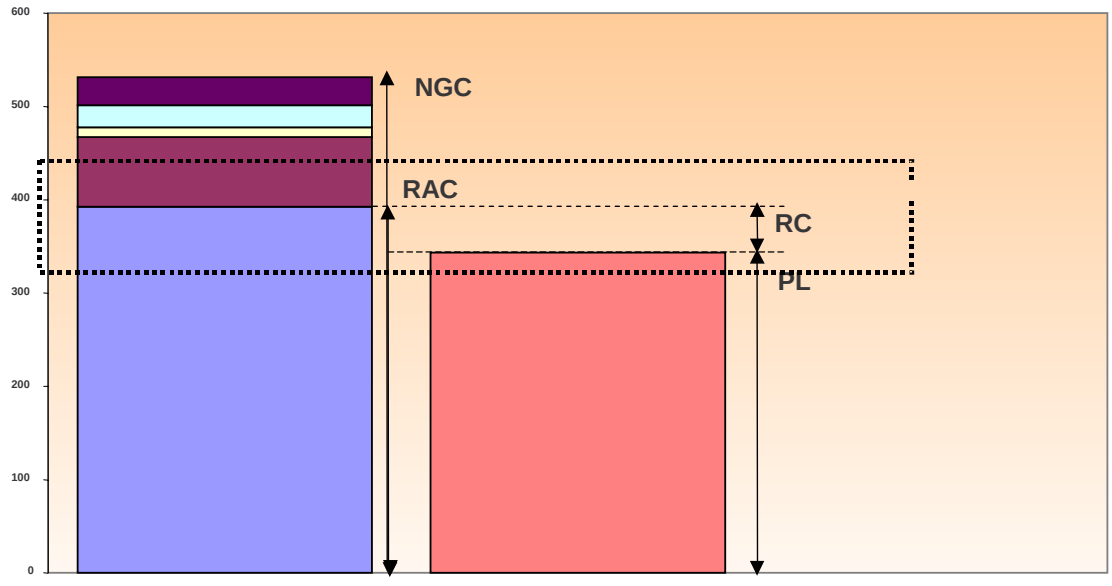
T, H, W : thermal, hydro, wind available generations
L : load
R : reserve for system services

Reasonable probability takes into account
- forecasted overhauls
- mean level of forced outages
- most probable energy conditions (hydro, wind)…

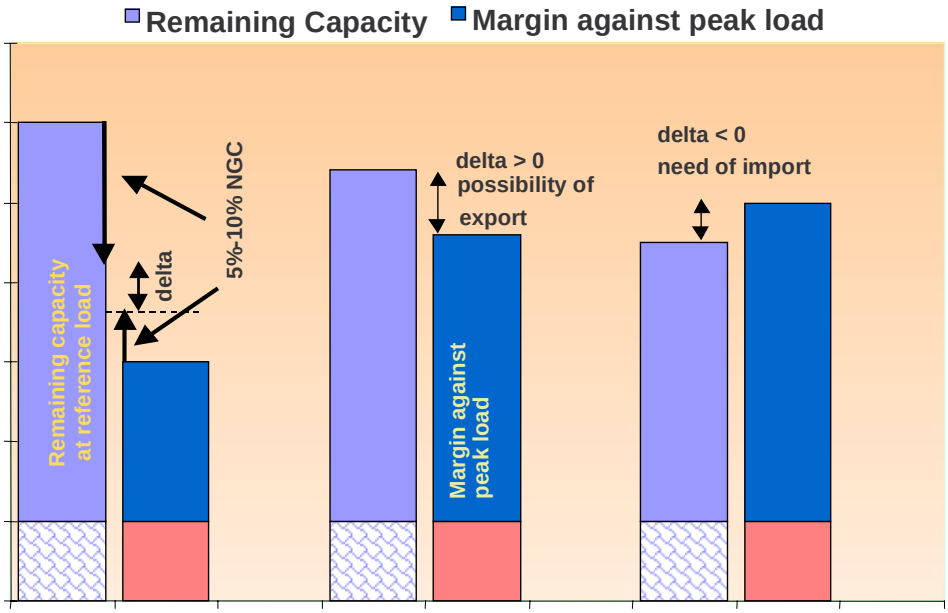
Adequacy reference margin (ARM) : level of RC considered as sufficient to provide a reliable supply

Methodology : components of the power balance

- Reliably available capacity
- Outages (thermal plants)
- Non usable capacity
- System services reserve
- Overhauls
- Peak load



Margin: possibility of export or need of import



- ✓ **Remaining capacity should be positive**
- ✓ **How much so ?**

=> depends on system (unit outage rates, load variability, unit sizes,...)

Methodology

Current indicative adequacy reference level :

Remaining Capacity at monthly peak load > 5% x Generation Capacity

Good overall index, allowing a reasonably low risk of shortfall for UCTE countries but :

- does not take into account the differences between systems : size of largest plants / size of the system, sensitivity to hydro or wind conditions, sensitivity of the load
  - ⇨ corresponds to a different probability of short fall for each country

⇨ **Refined Assessment for Generation Adequacy**

- based on evaluation of expectation, standard deviation and correlation for random variables
- consistent with country's generation structure

Proposed assessment for Generation Adequacy :

- Choice of a level of acceptable short fall risk (e.g. 1% risk = 2 to 5 days per year on average for UCTE)
- Defining the **needed Remaining Capacity** associated to the given level of risk

Methodology

Indicative adequacy reference level

Remaining capacity at peak load up to 5% of national generating capacity is still adaquate to limit the risk of shortfall at 1% :
• for UCTE as a whole and large areas
• for the following national systems :

Belgium, Germany, Italy, Netherlands, Switzerland, Czech and Slovak Republics, Hungary, Poland and Romania

Remaining capacity up to 10% of national generating capacity for systems more sensitive to random factors :

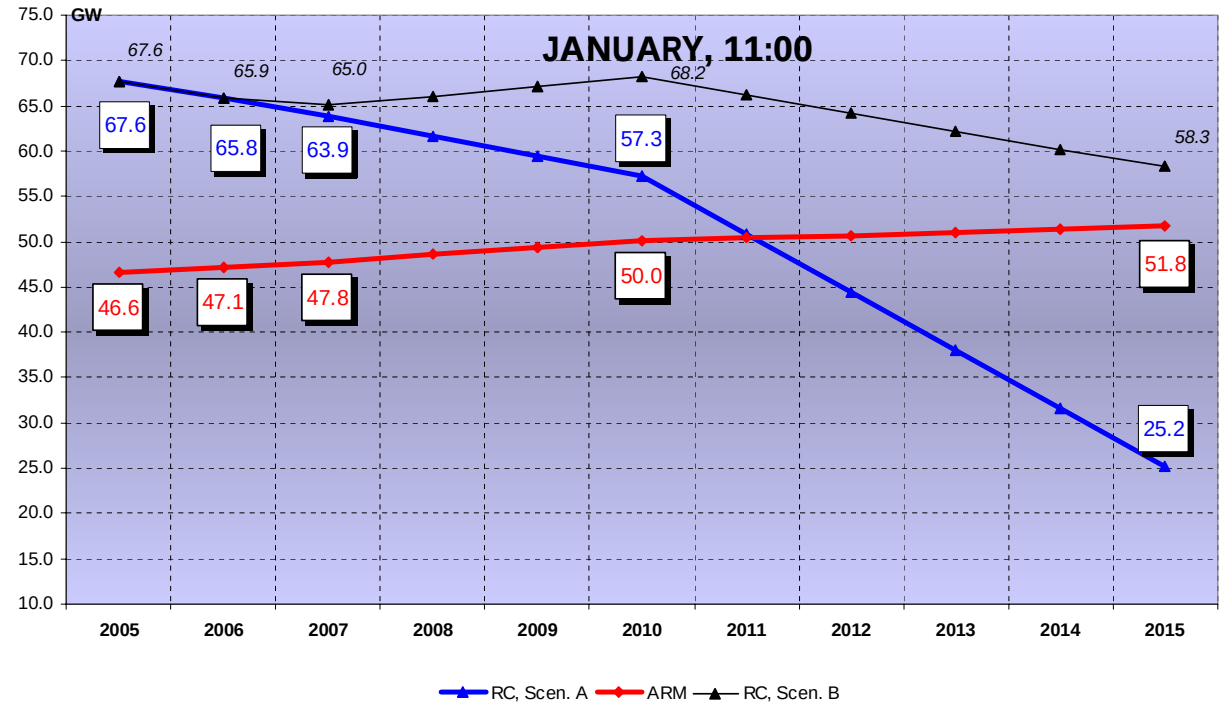
France, Greece, Spain, Slovenia, Croatia, SCG, Macedonia, Luxembourg, Austria, Portugal, Bosnia and Herzegovina

Generation adequacy : main results

* on January 1st 2002

- Whole UCTE system
  - period 2005 - 2007
  - period 2010 - 2015
- Detailed analysis by country
- Geographical blocks

Main results - Remaining Capacity January



Main results

* on January 1st 2002

⇨ security of supply of the UCTE system as a whole seems not to be at risk in 2005 - 2007

Scenario A

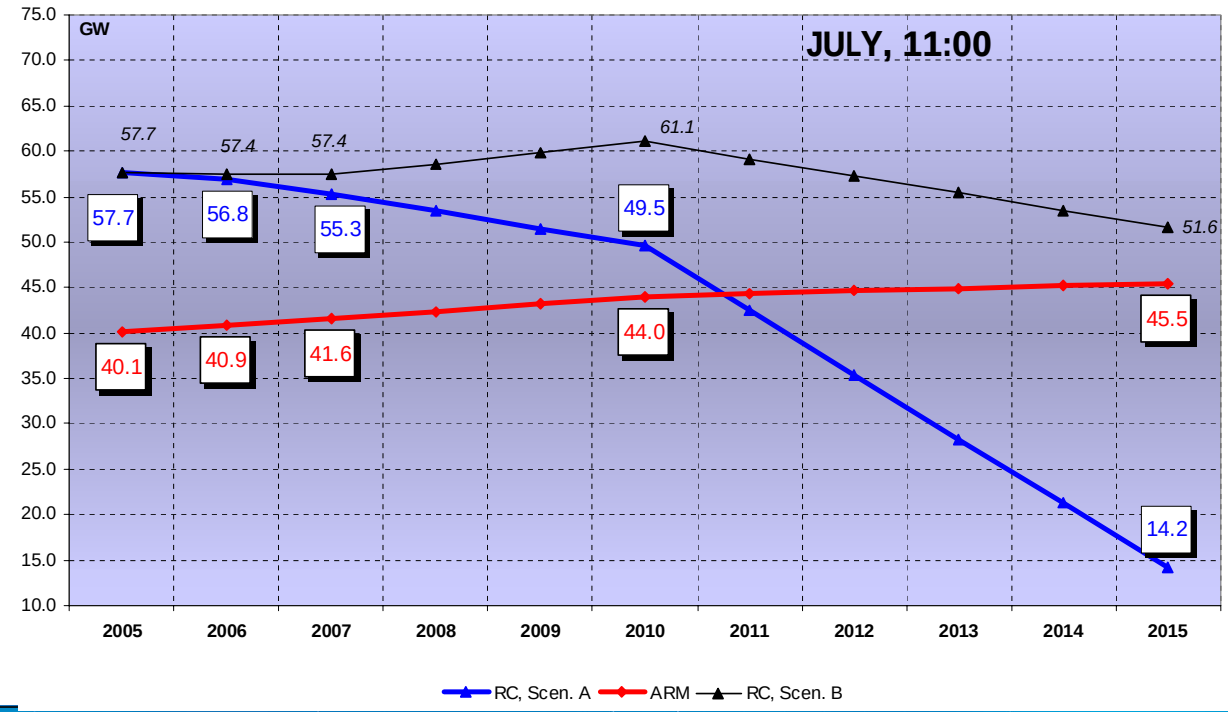
⇨ slight decrease of the security margin can be observed in 2007 and 2010

⇨ around 30 GW firm investments in generation would be necessary in 2015 to counterbalance the potential deficit

Scenario B

⇨ foreseen plans or projects should maintain adequate security of supply…. provided that proper investment incentives exist.

Main results - Remaining Capacity July



Main results - 2005 to 2007

⇨ **Installed capacity**

- increase of **20 GW** over the period from January 2005 and January 2007,
- **11 GW** from renewable energy sources (mainly wind)

⇨ **Reliably available Generation**

- only **+11 GW** from January 2005 to January 2007

⇨ **Load**

- annual average rate of increase of **2.0 % in winter (+2.2% in summer), + 15 GW over the period 2005-2007**

⇨ **Remaining Capacity**

- decreases from 2005 to 2007 (-4 GW in winter, -2 GW in summer)

In 2007, the overall Remaining Capacity for UCTE represents 10.5% in winter (9.2% at peak), 9.0% in Summer, of the total generating capacity

Adequacy Reference Margin index met

Main results - SCENARIO A - 2010 and 2015

⇨ **Installed capacity**

- from **2007** to **2010**

  increase of **25 GW** over the period / **+18 GW** for renewable energy sources (from 34 GW in 2005 to 49 GW in 2007)

- from **2010 to 2015**

  +19 GW (+24 GW from renewable and decrease of nuclear and fossil fuel)

⇨ **Reliably available Generation**

+13 GW 2007-2010 but only +1 GW 2010-2015

Load : annual average rate of increase of 1.7% until 2010, and 1.6% (1.8% in summer) on to 2015

Remaining capacity decreases from 2007 to 2010 (by 7 GW in winter, and 6 GW in summer) **it drops drastically to 25 GW (January) and 14 GW (July) in 2015**

Main results - Scenario B „Best Estimate“

* on January 1st 2002

✓**In Scenario B additional commissioning brings out**

- ✓ an extra capacity of **11 GW in 2010**, and **38 GW in 2015**
- ✓ mostly from fossil fuel energy sources
- ✓ out of which 90% can be considered as reliably available capacity

Effect on Remaining Capacity : + 11 GW in 2010, +33 GW in 2015

When Scenario B is taken into account, RC is improving until 2010, and accounts for 58 GW in January 2015, and 52 GW in July

Main results - 2010 and 2015

In 2010, the overall Remaining Capacity for UCTE represents 9% of the total generating capacity in January, and 7.7% in July.
In 2015 only 3.9% (winter) and 2.2% (summer)

Adequacy Reference Margin met in 2010, BUT NO MORE IN 2015

When assumptions from TSOs concerning commissioning are taken into account,
Remaining Capacity still represents 10.6% in winter (9.4% in summer) of Generating Capacity in 2010, and 8.4 % in winter 2015 (7.4% in summer 2015).
Under these hypothesis, Remaining Capacity matches the ARM from 2010 to 2015

Main results - 2005 to 2007

UCTE-Power Balance, 2005 – 2015 FORECASTS Results in GW

3rd Wednesday	2005			2006			2007		
	January		July	January		July	January		July
	11:00	19:00	11:00	11:00	19:00	11:00	11:00	19:00	11:00
Installed National generating capacity:									
Hydro power stations	133.0	133.0	133.0	133.1	133.1	133.1	133.6	133.6	133.8
Nuclear power stations	113.0	113.0	112.7	112.7	112.7	112.6	112.1	112.1	110.7
Fossil fuel power stations	305.8	305.8	307.3	310.2	310.2	312.5 *0.4*	315.4 *0.5*	315.4 *0.5*	318.2 *1.7*
Renewable energy sources	34.4	34.4	36.4	40.2 *0.1*	40.2 *0.1*	42.4 *0.1*	45.6 *0.7*	45.6 *0.7*	48.4 *0.7*
Not clearly identifiable energy sources	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.7
National generating capacity	**587.7**	**587.8**	**591.3**	**597.9** ***0.1***	**597.9** ***0.1***	**602.3** ***0.5***	**608.4** ***1.2***	**608.4** ***1.2***	**612.8** ***2.4***
Non-usable capacity	90.0	90.0	109.8	93.6	93.6	113.2	97.4	97.4	117.6 *0.1*
Of which, mothballed capacity	*12.0*	*12.0*	*12.8*	*12.1*	*12.1*	*12.1*	*11.7*	*11.6*	*11.6*
Maintenance and overhauls (fossil fuel power stations)	9.9	9.9	50.2	10.2	10.2	50.7	10.5	10.5	50.9 *0.1*
Outages (fossil fuel power stations)	17.6	17.6	16.6	18.4	18.4	17.1	18.3 *0.1*	18.3 *0.1*	17.0 *0.2*
system services reserve	31.2	31.0	30.4	31.5	31.5	30.7	31.9	31.9	31.0
Reliably available capacity	**439.1**	**439.2**	**384.2**	**444.2** ***0.1***	**444.2** ***0.1***	**390.7** ***0.5***	**450.3** ***1.2***	**450.3** ***1.1***	**396.2** ***2.1***
Load	**371.5**	**379.7**	**326.5**	**378.4**	**386.6**	**333.8**	**386.5**	**394.0**	**340.9**
margin against the daily peak load	17.2	8.5	10.5	17.2	9.0	10.8	17.4	8.7	10.9
Remaining capacity	**67.6**	**59.6**	**57.7**	**65.8** ***0.1***	**57.6** ***0.1***	**56.8** ***0.5***	**63.9** ***1.2***	**56.2** ***1.1***	**55.3** ***2.1***

In red : difference scenario B - scenario A

Main results - 2010 and 2015

UCTE-Power Balance, 2005 – 2015 FORECASTS **Results in GW**

3rd Wednesday	2010			2015		
	January		July	January		July
	11:00	19:00	11:00	11:00	19:00	11:00
Installed National generating capacity:						
	135.1	135.1	135.4	136.4	136.4	136.4
Hydro power stations	*0.3*	*0.3*	*0.3*	*1.8*	*1.8*	*2.0*
	110.0	110.0	110.0	105.5	105.5	105.5
Nuclear power stations				*0.8*	*0.8*	*0.8*
	323.3	323.3	327.3	321.8	321.8	321.8
Fossil fuel power stations	*8.0*	*8.0*	*8.6*	*27.2*	*27.2*	*30.5*
	63.2	63.2	67.1	87.1	87.1	89.9
Renewable energy sources	*2.6*	*2.6*	*2.7*	*8.1*	*8.1*	*9.4*
Not clearly identifiable energy sources	1.8	1.8	1.8	1.8	1.8	1.8
	633.4	**633.4**	**641.6**	**652.5**	**652.5**	**655.3**
National generating capacity	***10.9***	***10.9***	***11.6***	***38.0***	***38.0***	***42.7***
	136.6	136.6	198.6	152.9	152.9	215.2
Non-usable capacity	*0.1*	*0.1*	*0.4*	*4.5*	*4.5*	*5.0*
	33.0	32.8	32.3	34.5	34.5	34.0
system services reserve	*0.2*	*0.3*	*0.0*	*0.5*	*0.4*	*0.3*
	463.8	**463.9**	**410.7**	**465.0**	**465.0**	**406.1**
Reliably available capacity	***10.9***	***10.7***	***11.5***	***33.0***	***33.1***	***37.4***
Load	**406.5**	**414.9**	**361.1**	**439.8**	**447.8**	**391.9**
margin against the daily peak load	18.4	10.2	11.9	19.2	11.2	12.7
	57.3	**49.0**	**49.5**	**25.2**	**17.2**	**14.2**
Remaining capacity	***10.9***	***10.7***	***11.5***	***33.0***	***33.1***	***37.4***

In red : difference scenario B - scenario A

Detailed analysis by country

Remaining Capacity is compared to the Adequacy Reference Margin

Based on forecasts for 2005

⇨**Countries who need RC>5% NGC :**

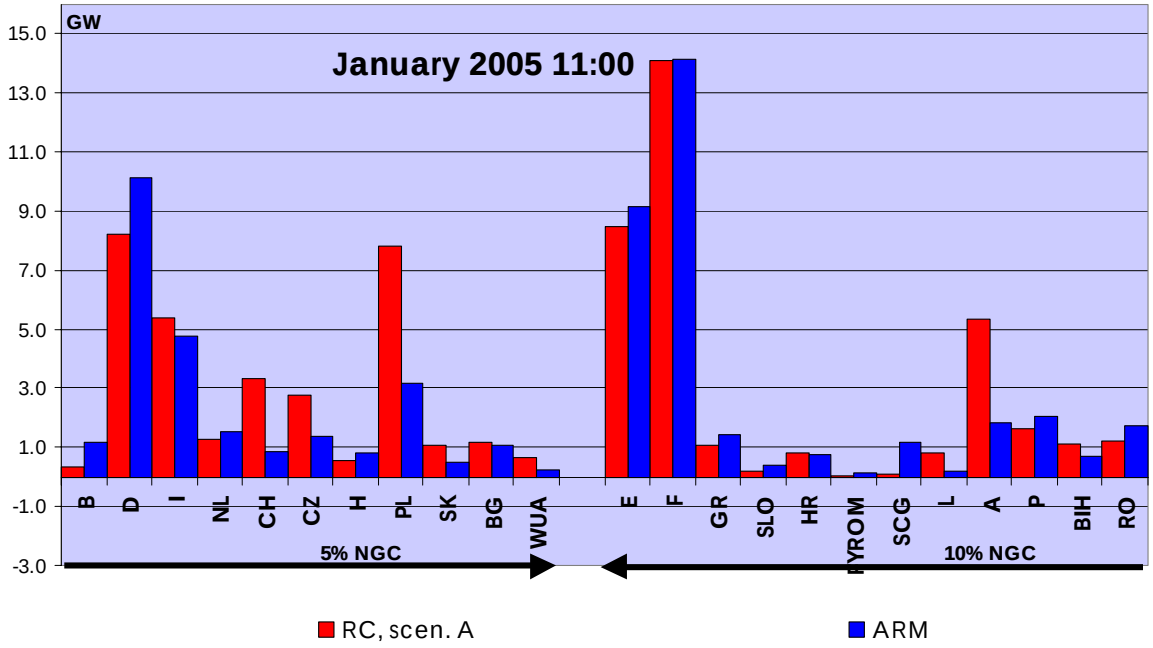
Criteria not respected for Germany, Hungary, and Belgium

⇨**Countries who need RC>10% NGC :**

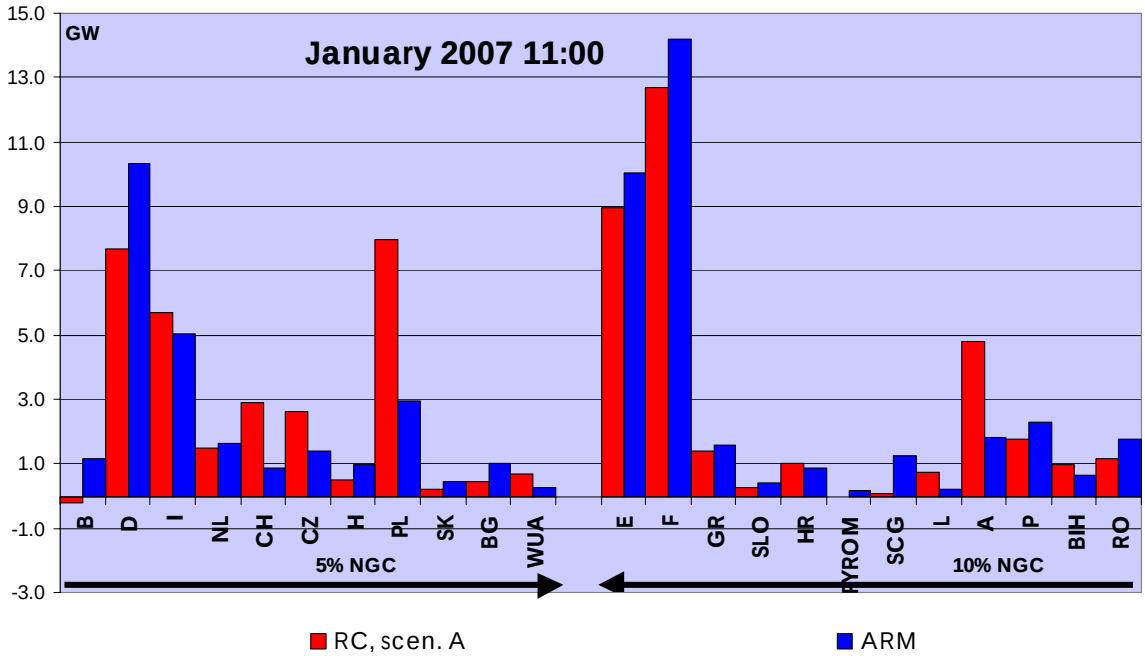
Criteria not respected for Spain, Greece, Slovenia, Macedonia, Serbia and Montenegro, Portugal and Romania

(see next slide)

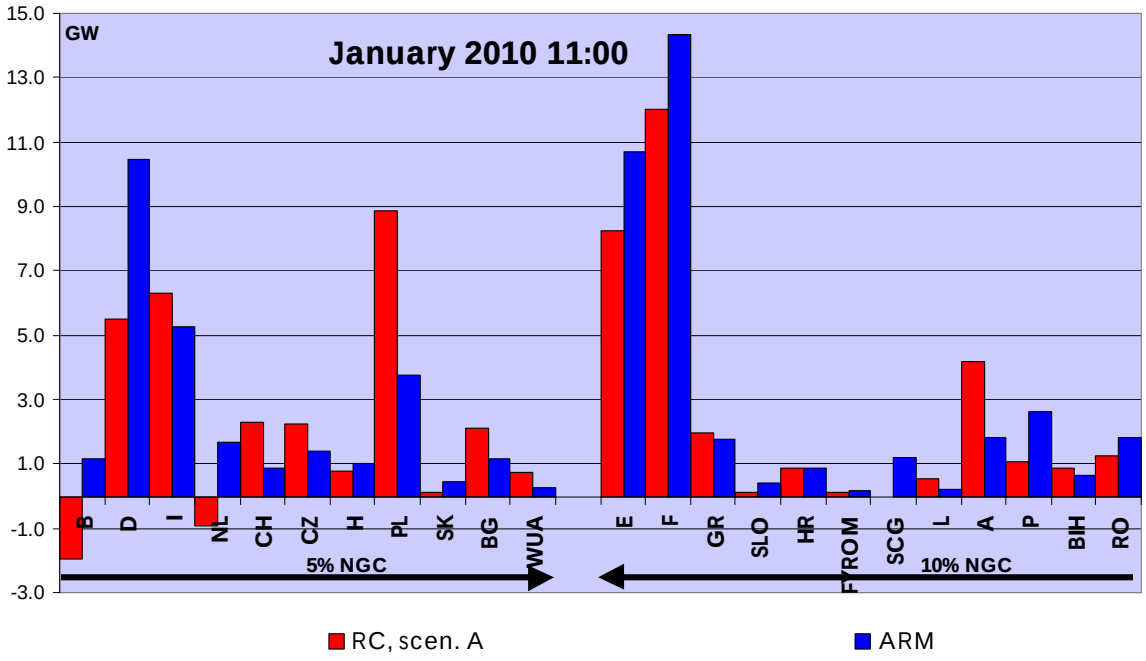
Remaining capacity / ARM - 2005



Remaining capacity / ARM - 2007

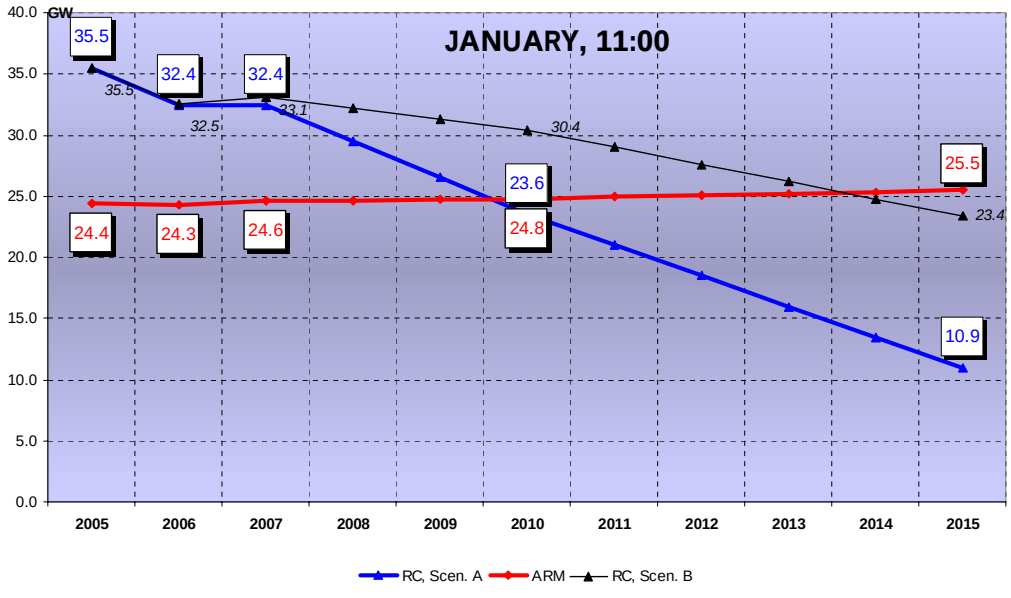


Remaining capacity / ARM - 2010



Detailed analysis: geographical blocks

- **Main UCTE block**



Detailed analysis: geographical blocks

- **Main UCTE block**

Remaining capacity is decreasing
over the period from 2005 to 2007 and further on

⇨ remaining capacity / generating capacity is :
11.2% in 2005, 10.0% in 2007, 10.7% in 2010, 3.2% in 2015 in winter

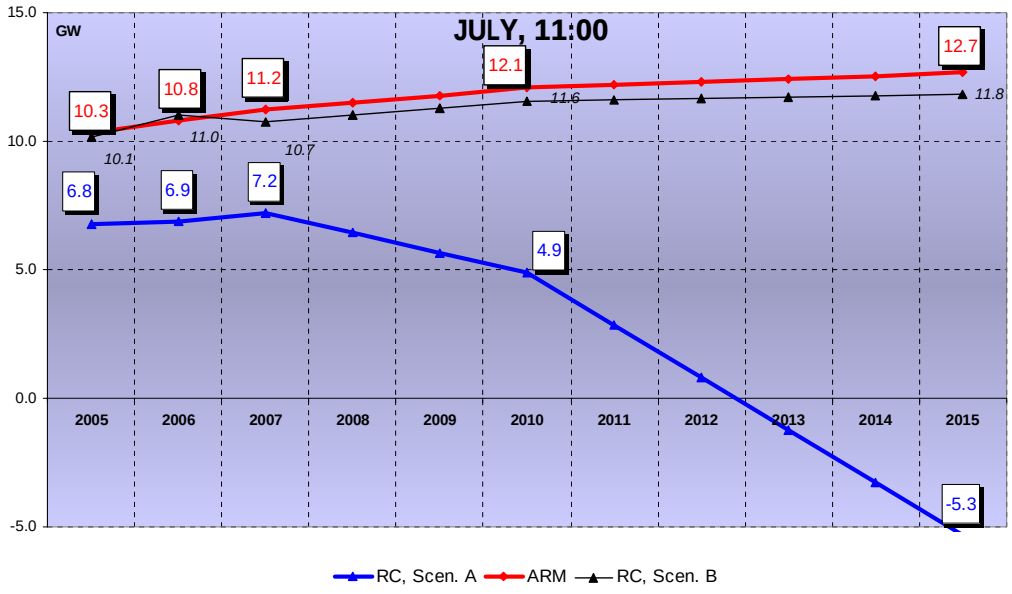
⇨ **this is sufficient to match the adequacy reference margin until 2007, but no more in 2010**

With hypothesis from scenario B, main UCTE may though match the index in 2015

This block could become a net importer in 2010
in unfavourable conditions if the investments foreseen are not realised

Detailed analysis: geographical blocks

- **Spain and Portugal**



Detailed analysis: geographical blocks

- **Spain and Portugal**

⇨ **Significant increase in generating capacity is expected both in Spain and Portugal, so as Remaining Capacity remains stable until 2010.**

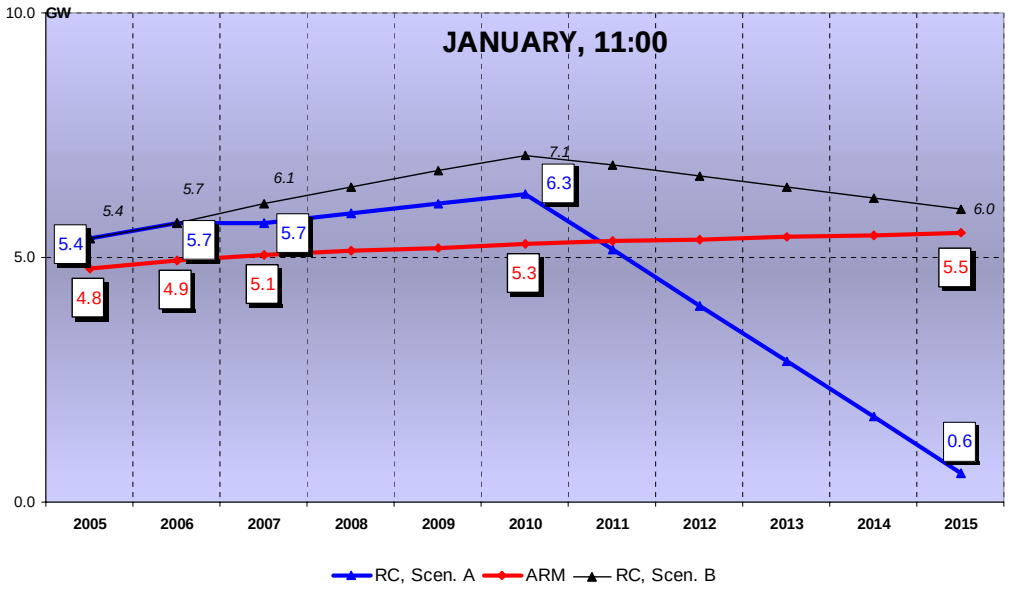
⇨ **Nevertheless, the reference margin (refering to 10%) is not met in summer (by 3 GW), and in winter in 2010.**

⇨ Even in scenario B, index would hardly be met in 2010.

Additional investments in generation and in interconnections are needed to ensure the reliability of this region

Detailed analysis: geographical blocks

- **Italy**



Detailed analysis: geographical blocks

* on January 1st 2002

- **Italy**

Given the expected development of generation, Remaining Capacity is stable from 2005 to 2007, and improving in 2010.

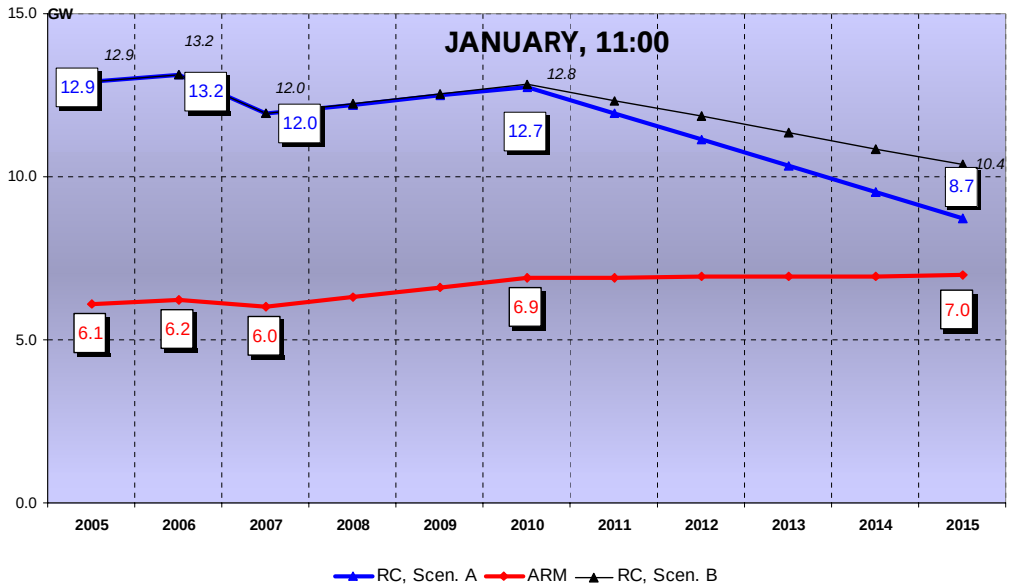
Under these conditions, the index is met over the period 2005-2010.

Extra commissioning will be necessary to provide a sufficient level of security in 2015

Detailed analysis: geographical blocks

* on January 1st 2002

- **Centrel**



Detailed analysis: geographical blocks

* on January 1st 2002

- **Centrel**

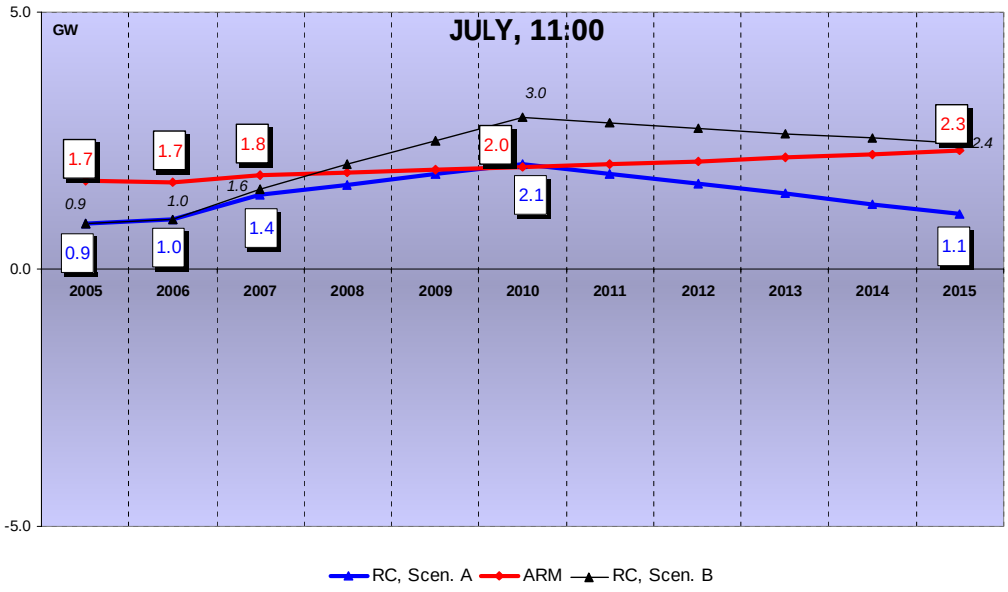
⇨ without extraordinary changes in both the generating capacity and the load, the **Centrel block reaches the reference margin** even considering the minimal scenario, with a remaining capacity of 19 % of the generating capacity in 2005, and still 12.5% in 2015

this block should remain a structural exporter
but uncertainties on the effects of the future environmental legislation

Detailed analysis: geographical blocks

* on January 1st 2002

- **South Eastern UCTE (Greece, SCG, FYROM)**



Detailed analysis: geographical blocks

* on January 1st 2002

- **South Eastern UCTE (Greece, SCG, FYROM)**

Increase in the generating capacity is almost enough to match the load growth

but remaining capacity is not sufficient to match adequacy reference margin

Interconnections will play a crucial role for security of supply

- **Romania and Bulgaria**

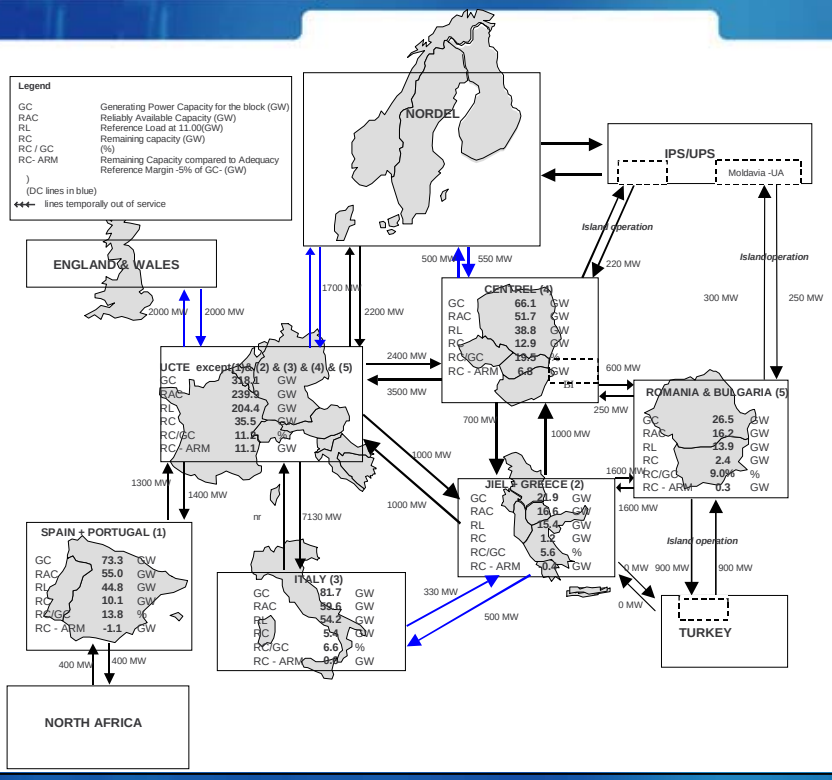
⇨ Remaining capacity decreases over the period 2005-2007, and improves from 2007 to 2015

The indicative reference margin is met over the period from 2005 to 2015, except in 2007

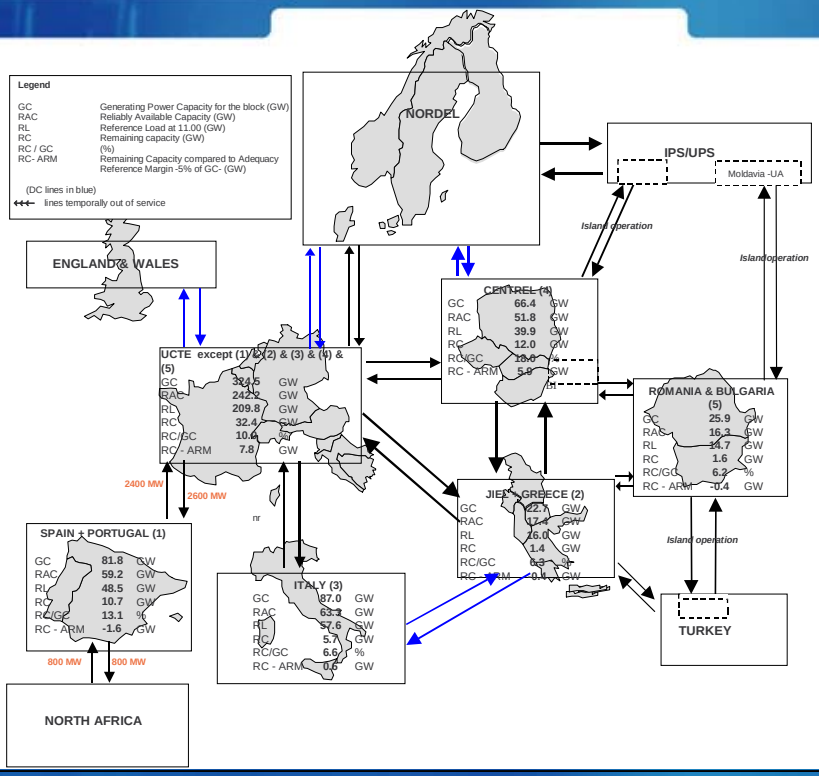
⇨ New commissioning, as expected in scenario B, would help to meet the index in 2007.

Geographical blocks January 2005 11:00

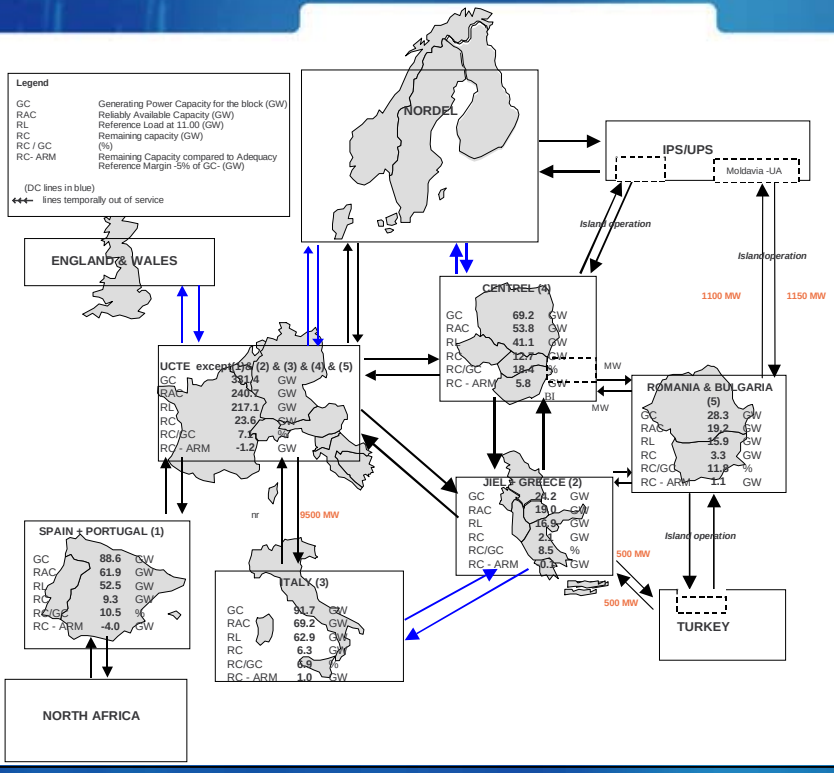
* on January 1st 2002



Geographical blocks January 2007 11:00



Geographical blocks January 2010 11:00



Transmission system adequacy

Developments on interconnection over the period 2005-2007

Line or equipment	Voltage level	Date	Cross-border
BALBOA – ALQUEVA line	400 kV	2004 - 2005	E -P
Avelgem – Avelin – Mastaing (second circuit)	400 kV	2005	B-F
Double AC tie-line Robbia – San Fiorano	400 kV	2005	CH -I
Stip-Cervena Mogila	400kV	2005	FYROM – BG
ESTRECHO-FARDIOUA (2nd CIRCUIT)	400 kV	2005	E - Morocco
Chooz – Jamiolle – Monceau	225/150 kV	2006	B Fr
PST Zandvliet + Kinrooi	400 kV	2006	B-NL
2nd line Slavotice - Durnrohr	400 kV	2006	CZ - A
Bitola-Lerin	400kV	2006	FYROM – GR
Vrutok-Bureli	220kV	2006	FYROM - AL
Line Meliti –Bitola 400 kV	400 kV	2006	FYROM - GR
Line Philippi – Turkey	400 kV	2006	GR -Turkey
OHL Nadab –Bekescsaba	400 kV	2007	RO -H
Single line Podgorica – Tirana	400 kV	2007	SCG - AL

Transmission system adequacy

Developments on interconnection over the period 2007-2010

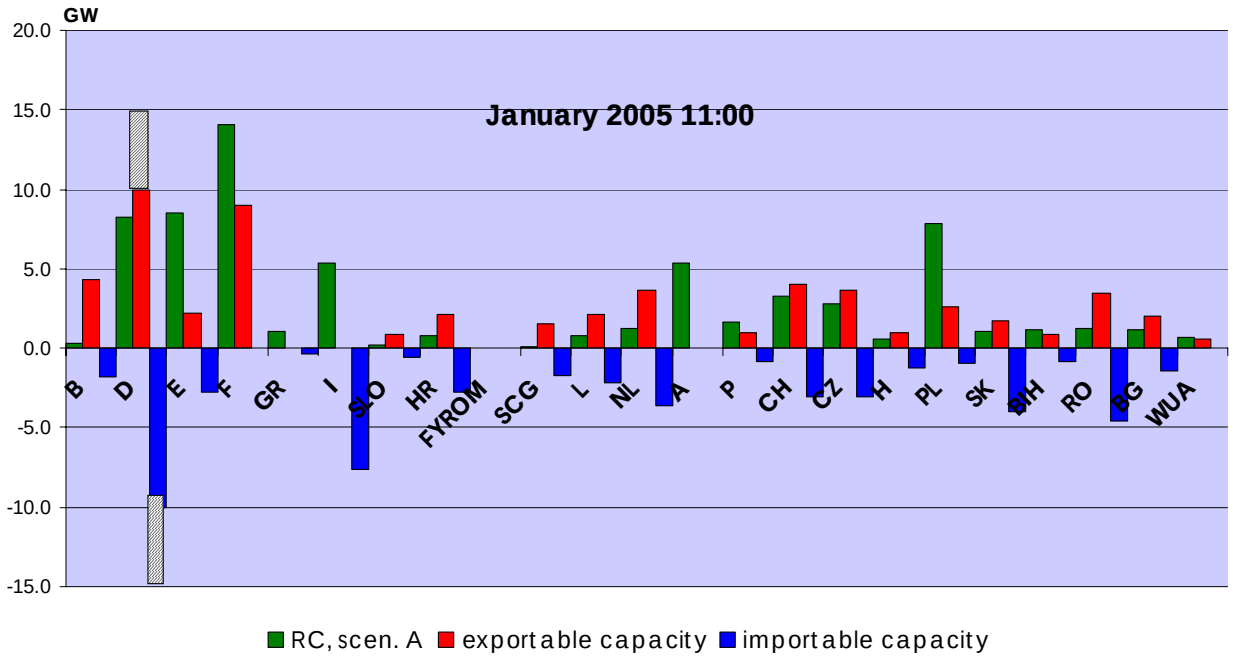
Line or equipment	Voltage level	Date	Cross-border
Single line Nis – Skopje	400 kV	2007	SCG - FYROM
Single line Mitrovica - Ugljevic	400 kV	2007	SCG - BA
France – Spain : eastern reinforcement	400 kV	2007	F -E
Nadab - Bekescsaba	400 kV	2007	H-HR
Line Ernestinovo - Pecs	400 kV	2007 - 2008	H-RO
Upgrade of line Audorf – Kasso -		2008	D - DK
Lienz – Cordigniano Line	400 kV	2008	A -I
OHL Suceava - Balti	400 kV	2009	RO - MD
Cirkovce – Pince Line	400 kV	2010	SLO - H
Single line	400 kV	2010	SCG - H
Line Valdigem – Douro Intal - Aldeadavilla	400 kV	2010	E - P
2x400 kV Okroglo - Udine	400 kV	2011	SLO - I
Bitola - Zemjak	400kV	2015	FYROM – AL
Upgrade of 400 kV line Isar – St Peter		>2010	D - A
PST Hagenwerder - Mikulowa		>2010	D - PL

Transmission system adequacy

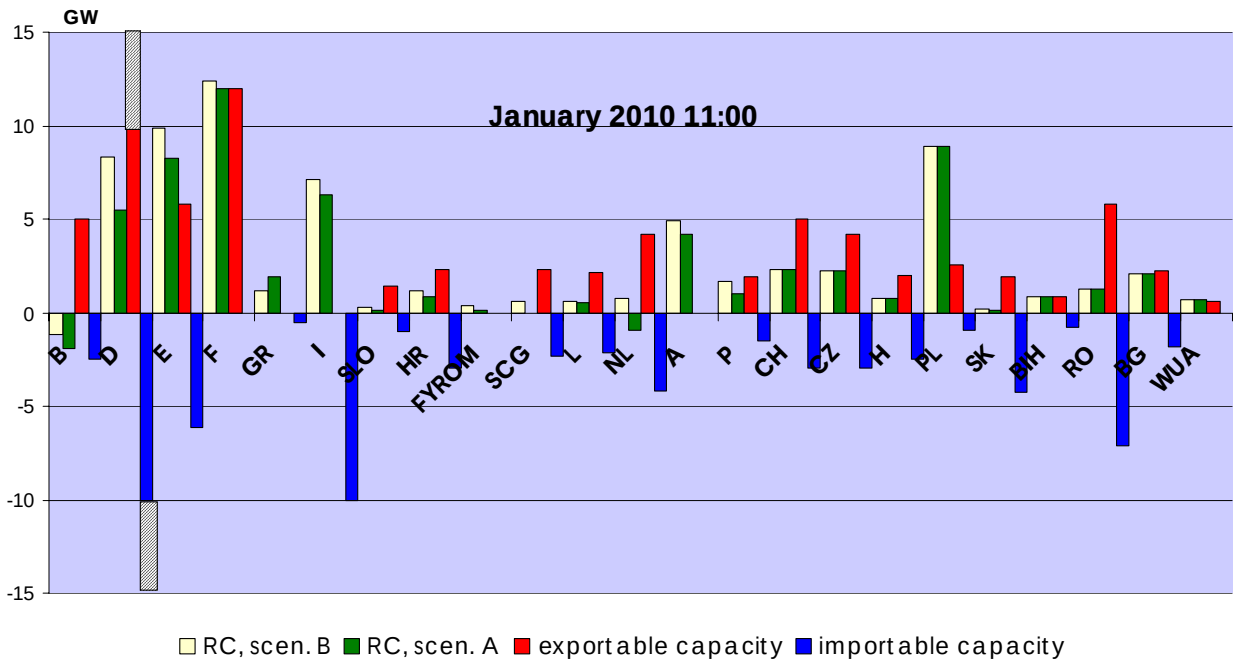
As far as regional blocks are concerned, noticeable increase of exchange capacities are expected according to developments on interconnections :

- between **main UCTE** and **Spain+Portugal** (+1200 MW in 2007)
- between **main UCTE** and **Italy** (+800 MW in 2008, +1600 MW in 2010)
- between **Spain + Portugal** and **Morocco** (+ 400 MW in 2007)
- between **JIEL +Greece** and **Turkey** (+500 MW in 2010)
- between **Centrel** and **main UCTE** (in 2007-2008)
- between **Centrel** and **Romania & Bulgaria** (in 2007)
- between **Romania & Bulgaria** and **IPS/UPS** (+1100 MW in 2009)

Contribution of the interconnection



Contribution of the interconnection



Contribution of the interconnection

Transfer capacities does not seem to be an obstacle to system security

Nevertheless, some particular situations are noticeable :

- the relatively low exchange capacities of Spain and Portugal in 2005 ; the situation improves in 2010 when exchange capacities are of the same order of magnitude as the remaining capacity

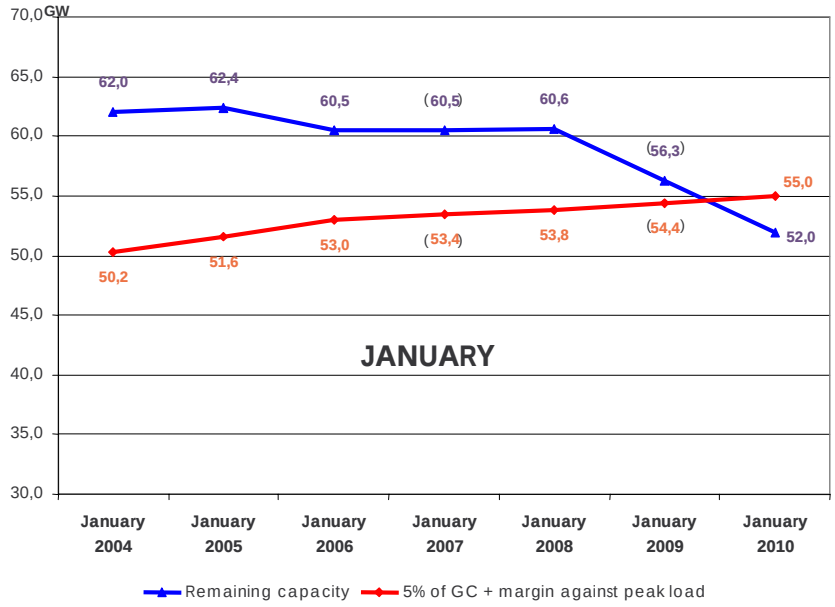
- remaining capacity in France higher than the exportable capacity in 2005 ; this value is however subject to large variations but the potential for exports can be limited at some periods. The exportable capacity seems to be more adequate in 2010 after the reinforcement towards Belgium and Spain are commissioned.

- exportable capacity seems to be lower than the export capabilities in Poland.

- In 2005 the ratio between the remaining capacity and the transmission capacity is balanced in Germany. On interconnections with the Netherlands, there currently exists congestion with regard to exports, and with regard to imports from North to East.

Conclusion : comparison with last year results

Figure 2 | Remaining capacity vs. 5% of NGC + margin against peak load - January



Conclusion : comparison with last year forecast

Comparison with previous year's forecast (SAF 2004-2010 for 2005, 2006 and 2010)

⇨**Generating capacity : Higher** by approx. 8 GW in 2005*, 2006, and 2010

* partly owing to changes in statistical classification of generation

⇨**Load :** updates lead to an increase of approx. 5 GW in the short term, but **trend is confirmed** in 2010 (+2 GW only)

⇨**Remaining capacity :** consequently **higher** by approx. 5 GW in winter (comparable in summer) in 2005 and 2006, and 4 GW in winter 2010, as compared to last year's forecasts

Mismatch between RC and ARM, expected in 2009-2010 in SAF 2003, is postponed to the period 2010-2011 in this year's forecasts

Conclusion

- Security of supply not at risk due to the adequacy of the system for the three coming years
- should be ensured in 2010 but still two major uncertainties
  - effects of CO2 trading and EU directive on large combustion plants on existing fossil fuel plants ;
  - market incentives for new investments

- Further developments

⇨ **UCTE collaborates within ETSO with other TSO associations (NORDEL, UKTSOA, ATSOI) in order to provide a comprehensive view on security of supply and adequacy at the EU scale => available in March**

Conclusion

- **Renewable Energy Sources**
- Increasing impact of renewable energy sources, mainly wind power, in the generation mix of the UCTE system
- This development brings new challenges to TSOs concerning
  - short term variations of power flows across the international transmission system and
  - the availability of balancing power.
- In the countries with high shares of wind power (especially Spain and Germany), significant development of the transmission network is necessary.

System Adequacy Forecast 2005-2015

- **Capacity data (Net values in GW – 3rd Wed at 11:00)**

1. Hydro power stations
2. Nuclear power stations
3. Fossil fuel power stations
4. Renewable energy sources (without hydro)
5. Not clearly identifiable energy sources
6. **National Generating capacity (=1+2+3+4+5)**
7. Non-usable capacity
8. Maintenance (thermal power stations)
9. Outages (thermal power stations)
10. System services reserve
11. **Reliably available capacity (=6-(7+8+9+10))**
12. **Load**
13. Margin against the daily peak load
14. **Remaining capacity (=11-12)**

Structure of the SAF Report 2005-2015

✓**Methodology**

✓**Generation Adequacy - Main results**

- ✓ Period 2005-2007
- ✓ 2010 / 2015
- ✓ Regional Analysis of the Remaining Capacity
- ✓Comparison with previous forecasts

✓**Transmission System Adequacy**

- ✓ Main developments on international interconnections
- ✓ Remaining Capacity / Transfer Capacity
- ✓ Maps with Power Balance Elements for Regional Blocks

✓**Detailed analysis of the Power Balance Elements**