May 2005

GENERATION ADEQUACY:

AN ASSESSMENT OF THE INTERCONNECTED EUROPEAN POWER SYSTEMS 2007-2015

(Prepared in co-operation with UCTE, NORDEL, UKTSOA, ATSOI)

ATSOI *UKTSOA* *NORDEL* *NORDEL*

Executive Summary

This report issued by the European Transmission System Operators Association (ETSO) sets out the results of a study of the European electricity market for the period to 2015. It considers the potential development of electricity demand and installed generation capacity in the European countries that are members of UCTE, NORDEL, UKTSOA and ATSOI. It does not include assessments of the systems of countries that are members of the European Community but have no interconnection with any of the above Associations. It assesses, on this basis, the extent to which generation capacity is adequate to meet demand in the short and longer term. Generation adequacy in its broadest sense is a necessary part of achieving security of supply for electricity, although, as is well recognised, is not sufficient to achieve this end on its own.

In the short term generation adequacy assessments have to be based on existing capacity and capacity that is either currently under construction or at an advanced stage of planning.

For the longer term however, the assessments reflect the extent to which new, additional generating capacity may be required to achieve generation adequacy rather than reflecting an inadequate level of capacity. In order to put these longer-term requirements in perspective, two scenarios are included in the analysis.

The first only includes new generation developments that are considered by the Transmission System Operators (TSOs) to be certain or almost certain of going ahead.

The second scenario includes the TSOs' best estimates of the level of future generation based on the information that they have available to them of generation schemes that may be only at a very early stage of development. In either case, in the liberalised European electricity market, the level of actual new generation capacity and, for that matter of plant closures, will depend primarily on market forces and on the efficiency of the European energy markets. It remains the case that even in this second scenario, a shortfall in generation in relation to the level required to meet the index of generation adequacy does not reflect an expectation of what, in the event, is likely to occur. Instead, it reflects the fact that on the basis of TSOs' knowledge, the amount of additional capacity above current plans that is likely to be required.

TSOs, while not being responsible for generation developments, are, nevertheless, best placed of all market actors to monitor and assess current trends and future developments. It is for this reason that ETSO has undertaken this analysis.

The estimates set out in the report build on the recently published assessments of generation adequacy produced by the Union for the Co-ordination of Transmission of Electricity (UCTE). This organisation covers the whole of the European synchronous system and the majority of electricity demand and generation capacity in Europe. However, the ETSO estimates also include analysis of Nordic Countries (including Finland, Sweden, Denmark and Norway), Great Britain and Ireland (both the Republic of Ireland and Northern Ireland).

Each of these latter three groupings is also a synchronous area and all four groupings are connected either directly or indirectly via Direct Current links (in addition there is a AC link between Western Denmark and UCTE). This means that energy can be and is traded between these synchronous areas and that generation adequacy and security of supply in these four areas are inter-dependent. This report therefore presents a more comprehensive picture than any of the reports of the individual areas of the European situation.

These assessments require the adoption of a methodology to translate the raw data concerning demand and generation capacity into estimates of generation adequacy. Approaches to this can differ. In order to ensure consistency and reflecting both the size of the UCTE and the long-standing history of UCTE in this area of analysis, this study has adopted the UCTE methodology.

The need to consider generation adequacy at a European level reflects, as has been mentioned above, the ability to trade energy between synchronous areas, between countries and between TSO control areas within countries.

Within synchronous areas, an imbalance between supply and demand for electricity will affect the system frequency across the whole area and can, if not remedied, lead to disconnection of demand and perhaps generation. Security of supply within a synchronous area is therefore closely related to generation adequacy within that area. It is also the case that with electricity being traded across DC interconnectors between synchronous areas in increasing quantities, the possibility to interrupt exports from one area to another due to inadequate generation being available in the exporting area will affect security of supply in the importing area. Even within synchronous areas, the capability of the transmission system is not unlimited so that insufficient generation in one part of a synchronous area cannot always be offset by surpluses in other areas.

For this reason the approach adopted in the generation adequacy study is to consider generation adequacy in each of the synchronous areas and the contribution that interconnections between synchronous areas can make to generation adequacy through providing assessments of potential imports and exports. However it has to be recognised that the provision of interconnection capacity with another area does not by itself give rise to increased generation adequacy, unless surplus generation is available in the exporting area. In addition, within the UCTE area, further sub-divisions are considered to reflect the fact that the transmission system capability between certain areas may affect the ability of generation in one part of UCTE to supply demand in another part.

Results

As indicated above the results of the analysis have to be considered in two parts, for the short term (2007) and for the medium longer-term (2010 and 2015). Information is collected for both winter and summer peaks but the analysis is focussed on winter except for the southern areas.
In the short-term generation capacity can only be increased as a result of plant commissioning that is either under construction now or is at a very advanced planning stage.
For 2010, and even more so for 2015, new projects can be brought forward in response to market trends.

For the short-term the following conclusions can be drawn:

- Margins as measured against UCTE methodology are tightest in Great Britain and in Ireland and are most robust in the UCTE Main Block and CENTREL, with all other areas showing adequate margins.
- Even in Great Britain, where the indicative Adequacy Reference Margin is not met, the potential availability of mothballed plant and for imports from the UCTE Main Block, where the margin is the highest in Europe through interconnections, means that the situation is expected to be satisfactory.
- In Ireland margins are low; imports from Great Britain or potentially from UCTE Main Block via the British system will help to assist in fulfilling generation capacity requirements

- In NORDEL, generation demand balance is satisfactory for a normal winter day. In a cold winter day corresponding to a probability once in ten years additional measures of about 3-4 GW are likely to be needed. Imports from Russia, CENTREL and from Main UCTE can contribute with 4200 MW if the generation adequacy of the exporting areas is sufficient to export. There is also a substantial potential for demand response in the Nordic countries.
- In UCTE main block despite a slight decrease from current levels, margins seem to remain adequate.
- In Spain and Portugal and in Italy, a significant increase of capacity allows a satisfactory balance in the short term to be reached.
- In South Eastern UCTE, margins remain below the reference adequacy level; imports will play an important role to ensure security of supply in this area.
- In Romania and Bulgaria margins are just below the reference level; imports from Centrel can provide additional capacity;
- CENTREL should remain a structural exporter in the short term.

For the longer term:

In scenario A:

- Margins are decreasing in most of the areas even after taking into account new projects considered certain or almost certain.
- For the whole European system, around 50 GW of new capacity is needed in 2015 in order to meet the required generation adequacy margin. This figure can be considered as a minimum due to the limited knowledge of the future plant decommissioning, especially those which could result from the implementation of new environmental legislation.

According to the TSO's best estimate scenario (scenario B), most of this capacity is expected to be commissioned in due time, provided that market mechanisms give proper incentives to invest. Nevertheless, under these assumptions Centrel and Bulgaria – Romania are the only surplus areas.

1 BACKGROUND

For a number of years the European TSO associations working at regional level i.e. UCTE, NORDEL, ATSOI and UKTSOA, have carried out power balance analysis and forecasts.

A number of TSOs or associations (UCTE, NORDEL, etc) have for a number of years produced generation plant demand forecasts at the national level to provide early warning signals to decision-makers concerning generation adequacy and more generally system reliability as well as to indicate business opportunities for the market players. Such forecasts; however have not been regularly performed at a European level and the compatibility with other national balances is not necessarily checked.

Such forecasts are also performed at national level, either by the TSO's, by Regulators or by State Agencies; however, such analysis is not regularly performed at a European level and the compatibility with other national balances is not necessarily checked.

Developments in the European energy market and changes in the overall European generation adequacy during recent years have considerably increased the interest in power balances in a broader European scale. Against this background, ETSO has decided that it would be useful to collate a European power balance for the counties that are interconnected, in close collaboration with the regional associations.

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2 METHODOLOGY FOR ASSESSMENT OF GENERATION ADEQUACY

The individual associations currently use a number of approaches but there is no common methodology within the European power system to assess generation adequacy i.e. to estimate if there is sufficient capacity to supply demand in the various member states.

In the main, two methods are used:

- a deterministic approach which indicates the total generation likely to be needed at peak load hours.
- a probabilistic approach, which takes into account the random character of the different terms of the power balance (load, unit availability, etc) and allows the calculation of the probability that the system may not be able to supply demand; the results are often characterized by a loss of load expectation (LOLE).

For most systems, the main risk is not having sufficient generation capacity to meet demand at time of peak and a power balance established at time of peak load is normally sufficient to give a good estimation of the generation adequacy.

The basic methodology of these exercises consists of comparing the installed generating capacity with the actual or forecast load, taking into account unavailable or unusable generation capacity resulting from fuel interruptions, forced outages, overhauls and reserves required in operational time frame.

The result of the analysis is a positive or negative balance, indicating whether a certain area or region has generating capacity that it could export without endangering its own reliability, or whether it needs to import power in order to ensure reliable supplies.

However, where there is a risk of a regional energy shortage (especially for systems depending on hydro conditions like the Nordel region), then specific calculations must to be performed in order to check if the available energy is sufficient to supply the yearly consumption.

ETSO has decided in the interests of efficiency to adopt the UCTE methodology for presenting the EU electricity industry position. The UCTE methodology is a deterministic approach focussed on power balance at time of peak load, which allows the assessment of the generation adequacy on the basis of the reserves available at this time; more precisely an indicative index has been defined – the adequacy reference margin (ARM) expressed as the ratio “ remaining capacity” over installed capacity, which corresponds to the level of reserves consistent with a 1% risk of not being able to cover the load while maintaining sufficient reserves for frequency control. Appendix 1 gives more details on the methodology used for the power balance.

It is important to point out however that due to significant differences among the different power systems in Europe (size, generation mix, structure of the load, level of interconnection but also level of accepted risk), it is very difficult if not impossible to define a common margin of spare generation capacity over and above peak demand to ensure that demand is met with an acceptable level of security.

Another important consideration is that liberalisation and competitive generation markets tend have, in a number of instances to have had a beneficial (a reducing) effect on the plant margin required to meet load for a given quality of supply and security standards although – this is not the case of every country. Plant margins that appeared satisfactory under centrally planned regimes could be considered by the markets as too high under liberalised market structures. For example in the case of GB, the experience has been that since liberalisation a lower plant margin of 20% is considered as comfortable for meeting peak load, compared to the 24% plant margin used prior to liberalisation. This reflects the improvement in the operational efficiency of generators, which is translated into higher plant availability and also the lower lead times between construction and commissioning of plant due to changes in technology choice, (largely investment in CCGTs).

Nevertheless within UCTE, a study taking into account the probabilistic characteristics of the individual systems had shown that a ratio of 5% to 10% of available capacity above demand (ARM) is sufficient for the power plant operator reserve requirements.

For larger areas where the average unit size is typically small compared to the system size a ratio of 5% is adequate.

In the NORDEL region the load sensitivity to temperature can represent an increase of about 5% of peak load between average temperature and the temperature with a probability of occurring once in ten years. On the other hand the unavailability of the hydro plants due to forced outages is very small compared to thermal plants and there are often possibilities to increase hydro generation during short peak hours. There is also a substantial potential for demand response.

Small, isolated or weakly interconnected systems also may need also larger reserves to enable the same security as in large area.

Appropriateness of using the UCTE Methodology

The UCTE methodology has historically been used for assessing generation adequacy in the operational time frame, of up to 3 years ahead. The aim of the UCTE exercise has been to consider whether in the light of generation plant available, that under construction, and forecast load developments, there was adequate generation capacity within each country, or block of countries within the synchronous area to meet peak demand. The usefulness of this exercise was to raise awareness of operational requirements within UCTE to provide mutual support particularly through use of interconnectors.

Recently UCTE has decided to extend the coverage of its generation adequacy report to 2015, which clearly covers the planning time horizon of the industry.

ETSO considered these exercises as useful and decided that it would be appropriate to undertake this work for all the EU power system.

Given that UCTE forms the largest synchronised area with the EU power system, ETSO decided to adopt the UCTE methodology and build on this existing material and provide similar analysis for Nordel, GB and Ireland.

Whilst ETSO considers it useful to identify the operational challenges for TSOs in the short term, it has considered carefully the benefits of extending the generation adequacy report beyond the short term, whilst still using the UCTE methodology, due to the difference of messages that can be delivered respectively from short term and long term results.

The UCTE methodology, in effect, considers plant margins in the face of holding plant capacity largely at its current levels, and allowing for that under construction or at an advanced stage of development such that it is almost certain to go ahead, and allowing for peak load to increase in line with trends. The longer the projection period the greater the expected plant shortages and therefore this should not be surprising. This however should not have the same messages as plant shortages in the short term and does not have the same implications for security of supply.

The main benefit for the extension to 2015 is to provide an appreciation of the amount of new generation investments required or demand side management initiatives that need to be developed to provide equivalent capacity relief.

Plant shortages against peak load or against what is considered as an adequate reference margin are opportunities for investment, which the market, if allowed to operate, should deliver.

ETSO Approach

The ETSO generation adequacy projections cover the years 2007 – 2010 - 2015 and consider for each year peak load situations for the months of January and July (except for Nordel, where the summer balance is not critical in the Nordel countries).

Because the analysis of the situation inside each regional organisation is basically the responsibility of the regional TSO associations, the present report focuses on the overall situation of the European power system and on the mutual assistance and trading opportunities that the regional blocks can provide to each other using interconnection capacities.

Because these longer term forecasts are subject to higher uncertainties, considering that today it takes only two to three years to build new power plants, TSOs' have **long term scenarios** whose aim is to give an evaluation of the range of uncertainties, and an evaluation of the risks concerning security of supply over the ten coming years.

Scenario A (Conservative); it only takes into account existing and new power plants whose commissioning can be considered as sure: plants under construction or whose investment decision is notified as firm to the TSOs.

This scenario shows the evolution of the potential imbalances if no further new investment decision were taken in the future. It enables the identification of the amount of investments that are necessary over the period to maintain a targeted standard of security of supply.

Scenario B ("best estimate scenario"): it takes into account future power plants whose commissioning can be considered as reasonably probable according to the information available to the TSO: commissioning resulting from governmental plans or objectives, concerning for example the development of renewable sources in accordance with the European legislation, or estimation of the future commissioning resulting from the requests for connection to the grid of from the information given by producers to the TSOs.

This scenario gives an estimate of potential future developments, provided that market signals give adequate incentives for investments. It should be stated at this stage that in the cases where the assessments for 2010 and 2015 fall short of the required generation adequacy margin, this should not be interpreted as a forecast of expected generation inadequacy. Instead, it reflects that, at present, there are currently insufficient generation projects identified by the TSOs to meet this margin.

3 MAIN RESULTS AND EVALUATION

Tables 1, 2 and 3 as well as Figures 1 to 6 summarise the results of this combined power balance forecast for the 3rd Wednesday in January and July of the years 2007 – 2010 - 2015; these figures are based on data collected mostly in summer 2004.

More detailed information on the situation of the different regional blocks and comments and conclusions are available in the reports published by the regional associations or by the individual TSO's (see references).

The main conclusions concerning the generation adequacy aspects are summarized below including some specific contributions made for the present exercise. This report focuses on the potential of interconnections to improve the security of supply.

3.1 MAIN TRENDS

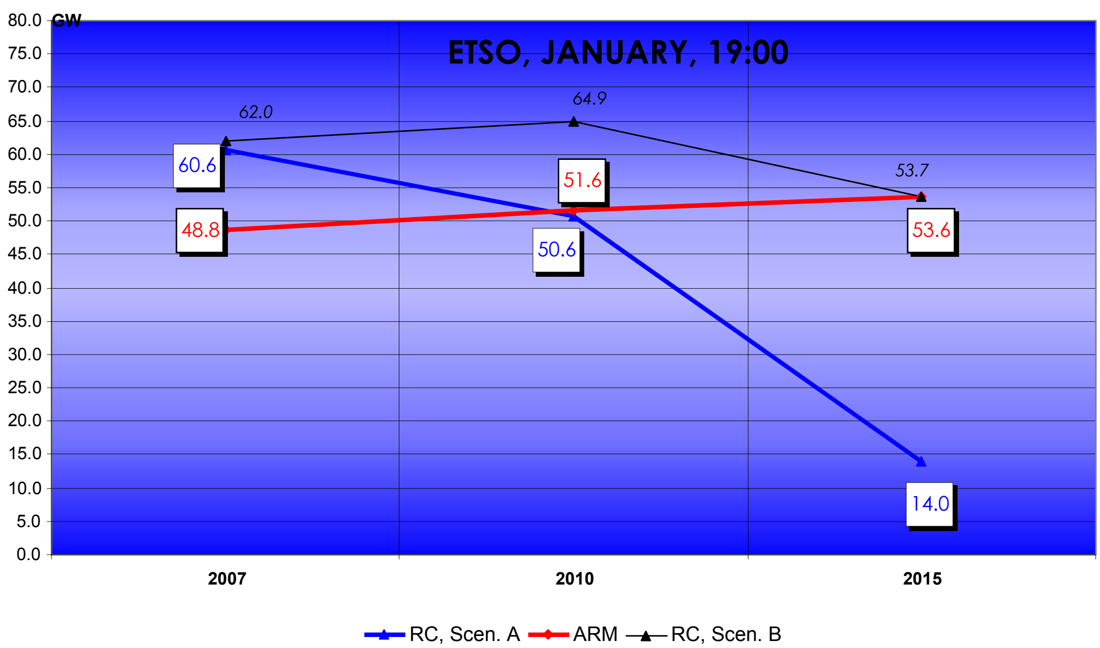
Continuing growth of electricity demand is expected over the period; the growth rates are moderate in the Northern part of the European system (1-2 % per year) and higher in the Southern part (3-4% per year). The synchronous winter peak load is expected to reach 535 GW in 2007 and 595 GW in 2015, i.e. a 60 GW increase over the period.

In the short term, as shown in the figure below, with an installed generation capacity of 785GW leading to a reliably available capacity of 595 GW at winter peak, generation adequacy is achieved across Europe, although exceptional weather conditions and high demand or exceptionally low generation availability can always test the system.

For the longer term, in Scenario A demand growth and plant closures will tend to reduce plant margins: up to 50 GW of new generating plant is likely to be required in Europe in 2015 in order to maintain the current adequacy level.

In addition CO_2 trading and the large combustion plant Directive could accelerate plant closures and increase actual requirements for new plant.

According to scenario B, investment plans estimated by TSO's, can contribute up to 40 GW.



3.2 UCTE MAIN BLOCK

Generation adequacy

2005-2007

From January 2005 to 2007, generating capacity increases by 6 GW (of which 5 GW comes from renewable energy sources), mainly in Germany. However as most of it comes from wind power plants, it contributes to an increase of only 2.1 GW of reliably available capacity.
The annual average growth for load is 1.3% in winter and 1.4% in summer over that period.

As a consequence, RC decreases from 33.6 GW in 2005 to 30.7 GW in 2007 **it is nevertheless enough to provide margins of 9GW above the estimated ARM.**

Considering the national ARM, however, it should be noted that the countries in the northern area (Belgium, the Netherlands, Germany and France) are not expected to meet the individual margins in winter over this period.

2010

The increase in generating capacity is 7 GW over the period 2007 to 2010, matching the load increase. Decommissioning in nuclear and fossil fuel power plants result in a decrease of reliably available capacity. RC is only 21.9 GW (reduction of 9 GW when compared to 2007) in winter 2010.

RC just meets ARM in winter. Without any additional investment, tight situations could be expected in cold weather conditions.

When scenario B is taken into account, it appears that extra commissioning foreseen by TSOs would enable the ARM to be met in 2010.

2015

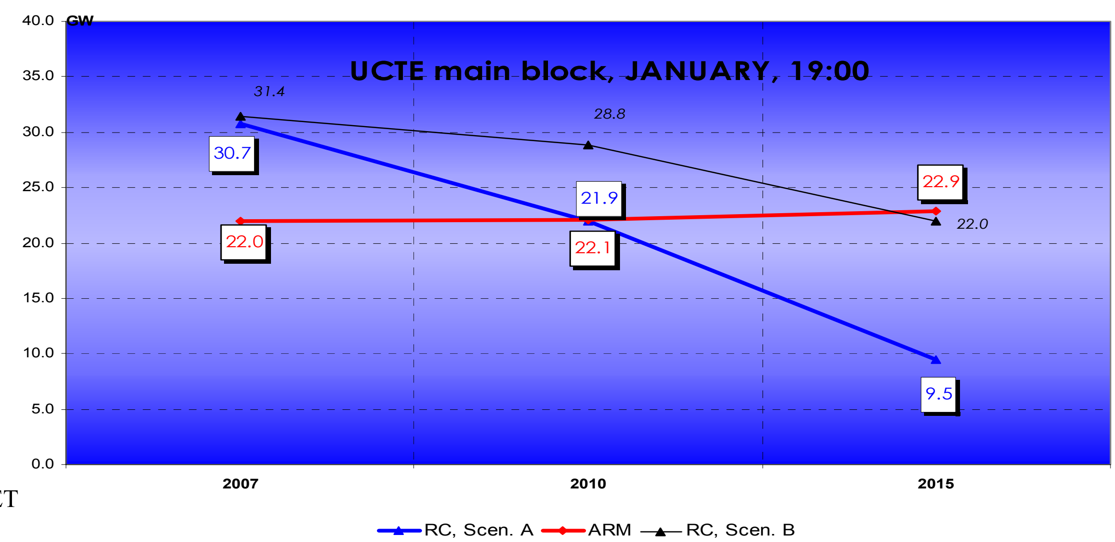
Projected commissioning are primarily from renewable energy sources. The remaining capacity drops significantly from 2010 to 2015: it is only 9.5 GW in winter, and 10.9 GW in summer.

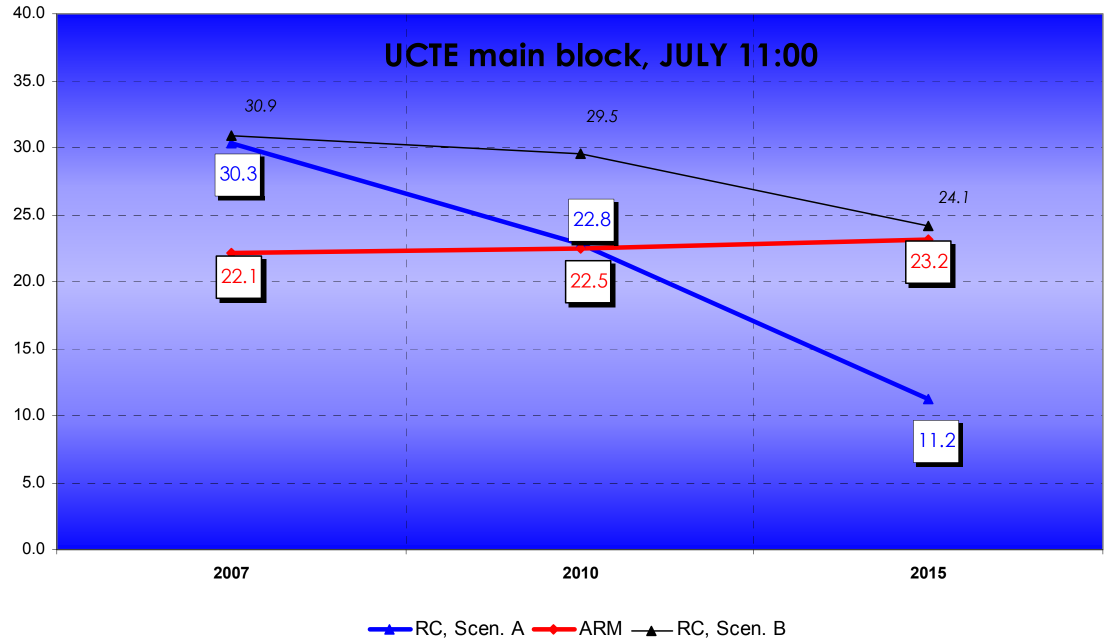
To meet the ARM in 2015, an additional 12 to 15 GW commissioning of reliably available capacity would be necessary in the main UCTE block.

Tight situations may occur on interconnections when it is necessary to use neighbouring generation to improve the balance in some countries.

The extra generation expected in scenario B is nearly sufficient to cover ARM in 2015 for this block (lack of approx. 1 GW in winter). The situation is very similar in summer: it mainly results from the planned outages that are scheduled in order to maintain the same level of adequacy all year long.

Remaining Capacity vs. ARM





Role of interconnections

This block plays a key role in the European power system due to its size and to its central geographical position.

Exports from this block are currently very important to secure the supply of the surrounding areas. This situation should be maintained till 2010, if the new plants expected in scenario B are confirmed.

In scenario A the export capacity would be more depending on operating and meteorological conditions; situations were imports would be necessary could arise in extreme circumstances.

3.3 CENTREL BLOCK

Generation Adequacy

<u>2005-2007</u>

No change in the generating capacity is expected in this block from 2005 to 2007, while load should increase by 3% over the period. Remaining Capacity remains almost stable until 2007.

ARM is met from 2005 to 2007.

Poland is the main provider of this comfortable margin; other countries also meet the ARM, except Hungary, which is slightly below the ARM.

<u>2010</u>

From 2007 to 2010 the commissioning of new fossil fuel power stations contributes in an increase of 2 GW for Reliably Available Capacity; given the lesser increase of load, Remaining Capacity improves again.

ARM is met in 2010 with a residual margin of approx. 5 GW.

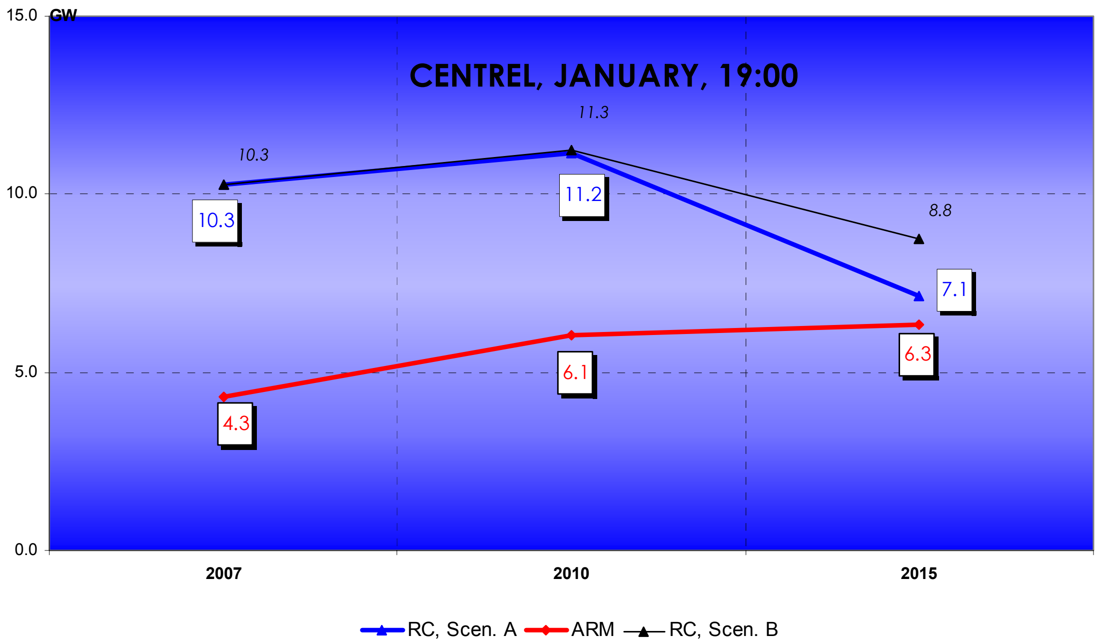
On the other hand the expected decommissioning of fossil plants due to new environmental requirements have not been taken into account in this year's forecast (as they are not available in summer 2004). Depending on their amount they can worsen the power balances in the region significantly, especially in Poland where the generation park is almost 100% coal based.

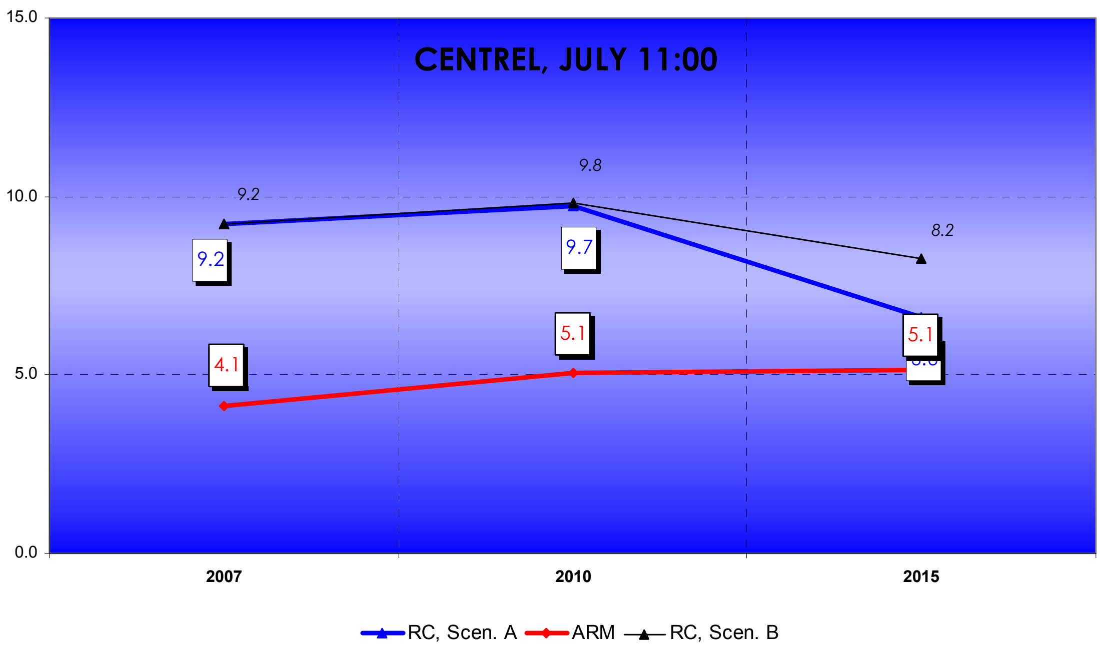
<u>2015</u>

2015 should not bring any additional capacity for the block, but the Remaining Capacity is such, that **the ARM is still met by approximately 2 GW in 2015.**

This is the case for Poland and Czech Republic; Slovakia and Hungary meet just the ARM.

Remaining Capacity vs. ARM





The interconnection capacities of CENTREL (approximately 6 to 7 GW) seem to be adequate compared to the remaining capacity.

CENTREL should be able to help surrounding areas whose situation at peak load appears to be less favourable; however predominant westward flow of electricity in the region causes congestion at the network interface with the UCTE main block throughout the year.

3.4 NORDEL

Generation Adequacy

The NORDEL figures refer to the sum of peak demand in separate countries in a normal winter day. The simultaneous peak demand is often some 1000 to 1500 MW lower than this.

In a normal winter day in Scenario A, the peak demand can be met without imports beyond 2010; in 2015 there is a risk that additional measures would be needed to maintain the balance. In Scenario B the peak demand can be met without import beyond 2015.

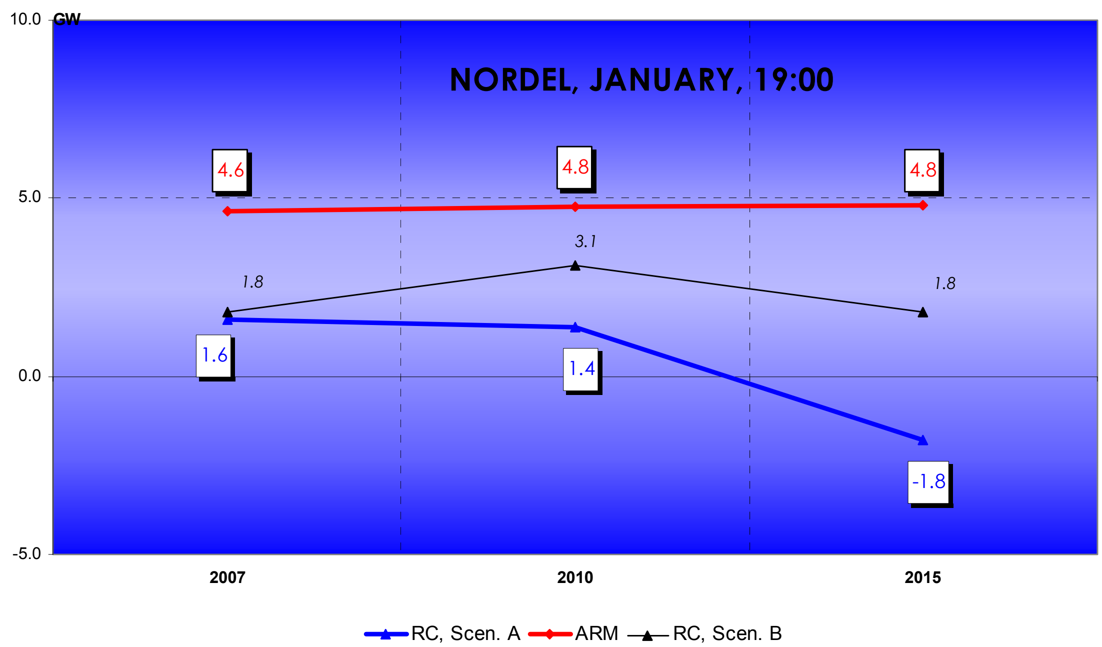
If the temperature corresponding to a day that can be statistically expected to occur once every 10 years is considered, the demand would be increased by some 5000 to 7000 MW in 2015 compared to the average temperature conditions

This means that an amount of about 3500-4500 MW (2007) up to 8000 MW (2015) will need to be covered by imports, demand response and new generation capacity in Scenario A.

In Scenario B the corresponding figures are about 3000-4000 MW (2010) both in 2007 and in 2015

The estimated investment plans contribute an additional 3500 MW to the peak load capability.

Remaining Capacity vs. ARM (Normal Temperature)



Role of interconnections

Interconnection capacity with the EU countries is 2600 MW (2007) increasing to 3700 MW (2010 and 2015) in Scenario A and, 2600 MW (2007) to 4300 MW (2015) in Scenario B.

The interconnection capacity with countries outside EU, i.e. with Russia, is 1600 MW during the whole period.

Imports are needed in peak load hours corresponding to the extreme 10-year winter temperature. The interconnection capacity is sufficient to cover the additional needs in all cases except in Scenario A in 2015.
Availability of imports depends on the simultaneous generation adequacy of the exporting countries and the market price differences.
In Poland (CENTREL) there is a surplus of generation capacity but because of transmission bottlenecks it cannot be used fully. In Germany the power balance is assessed to be tighter and the import possibility from Germany will be reduced in the coming years. In addition there is a potential correlation between cold periods in Nordel area and in Northern part of UCTE, which can lead to reduced availability of imports from UCTE.

New capacity or increased demand response are needed in the extreme 10 year winter in Scenario A.

3.5 Great Britain

Generation Adequacy:

Scenario A
The projected generating capacity presented in Table 2 reflects the plant that is currently available and that which is under construction, whilst taking into account all announced closures. It is a conservative view and does not try to capture plant that may be expected to be built as a result of the efficient operation of the market, to meet the required increments in capacity.

Scenario B
This scenario is not the best view as seen by the GB TSO but is a variant on Scenario A to capture that plant which is currently contracted with the TSO and which the TSO believes has a 95% chance of going ahead. It does not capture any other projects that are currently not contracted with the TSO but which are considered as likely to be built over the period to 2015, following the efficient working of the market.

Both generation scenarios A and B are compared to the best view growth in load expected on the transmission network. Any shortfall in plant capacity should not be taken to indicate security of supply problems for the system, but rather to show how much new capacity will be required to be built to bridge the increasing gap between existing plant capacity and that required to meet the growth in peak demand (GW) over time.

Table 2 shows the Conservative Generation Scenario A and Scenario B against the reference load on the third Wednesday in January at 19:00 Central European Time. As can be seen there is very little difference between the two for 2007.

Great Britain is projected to have sufficient capacity to meet the reference load in 2007 where the reference load is that expected to occur in Average Cold Spell conditions, defined in broad terms as a day when temperatures are zero degrees Celsius at noon across the country. At this level of demand there is still a remaining margin of some 2500 MW.

This margin is below the adequacy reference margin of 4400 MW, as defined by the UCTE methodology (5% of registered capacity plus the margin between peak load and reference load) but the GB TSO believe that it is adequate. Specifically, the gross plant margin in Great Britain, that is the ratio of “Installed Capacity” to “Peak Demand”, is projected to be in 2007 approximately 20%, excluding the capacity of the interconnector with the UCTE main block and approximately 23% if that capacity is included. Typically, a 20% figure is considered adequate for security of supply of the British system.

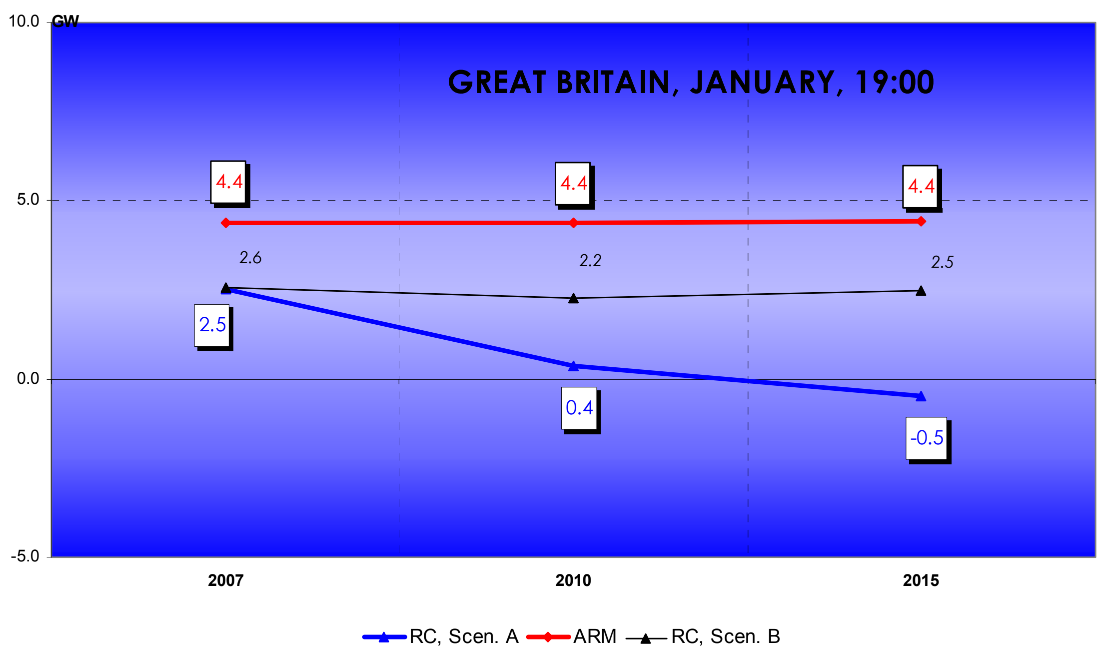
It is important, as mentioned above, not to misinterpret the projected shortfall in remaining capacity, and associate this with adverse impacts on the security of electricity supply either in the short term (2007) or in the longer term (2010 and 2015). For example, the projected shortfall against the adequacy reference margin in 2007 of some 1900 MW should be seen in the context of the potential level of imports that can be provided by the 2000 MW link with the UCTE main block.

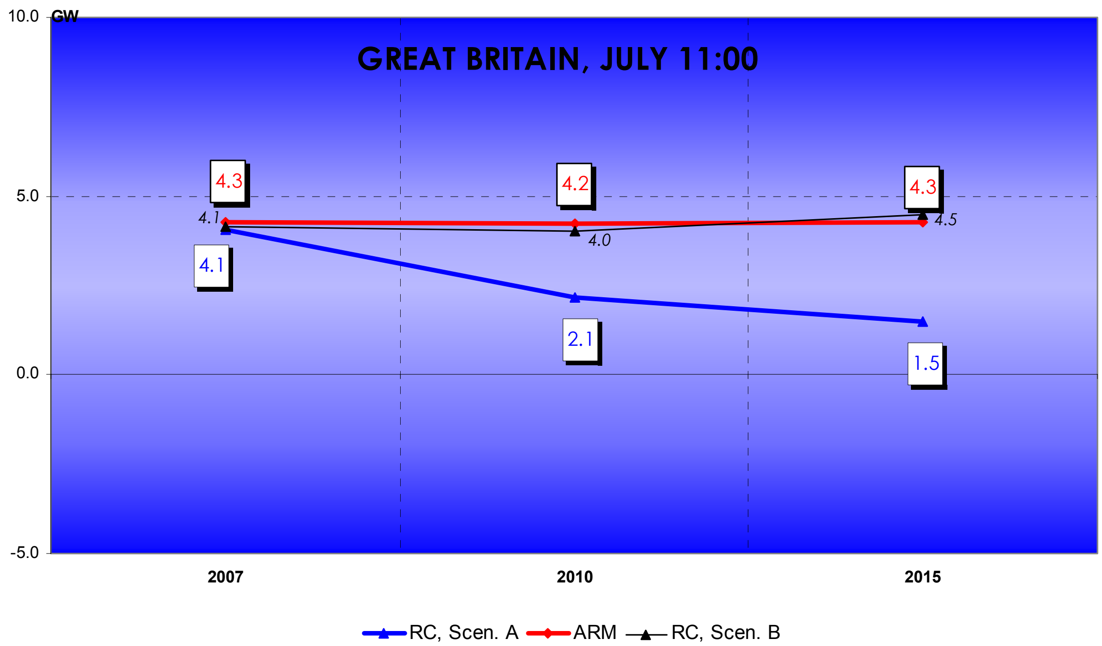
The UCTE main block itself is expected to have a surplus of some 8 GW relative to the Adequacy Reference Margin (ARM) in 2007 and some 30 GW in relation to the reference load. Seen in this context there is adequate capacity to meet peak demand in 2007.

For the longer term (2010 and 2015), the estimated shortfalls against the Adequacy Reference Margin (estimated on the basis of 5% of generating capacity) should not be interpreted as reflecting an expected shortage of capacity to meet demand but as an assessment of the amount of new capacity that is likely to be required to be installed over and above that already considered as relatively firm.

Given the limited assumptions concerning plant closures over this period, these assessments could be considered as a minimum in terms of new plant construction. However, the balance between new plant construction and plant closures will be a function of developments of market prices over this period.

Remaining Capacity vs. ARM





The GB-France Interconnector, which connects Great Britain and the UCTE Main Block, has a capacity of 2000 MW in both directions.

Flows of power across this link are very much a function of the price differential between Great Britain and Continental Europe. Restrictions on imports to the full capacity of the link, as a result of congestion within England, occur only under outage conditions on the England and Wales system. This occurs about 5% of the year and not usually at time of peak demand.
Hence it is expected that imports could be available to the full 2000MW level during system peak. The level actually provided will depend on relative market prices, which at peak time are likely to reflect partly the levels of generation adequacy in the two markets. The continuing levels of adequacy shown by this study for the UCTE Main Block would suggest that such capacity would be available at least until 2010.

Similarly exports to Ireland will depend on relative market prices and available capacity. The current export capacity of 450MW to Ireland needs to be taken into consideration in assessing the adequacy of imports from UCTE main block to meet demand in Great Britain.

3.6 Republic of Ireland – Northern Ireland

Generation adequacy

<u>Republic of Ireland:</u>

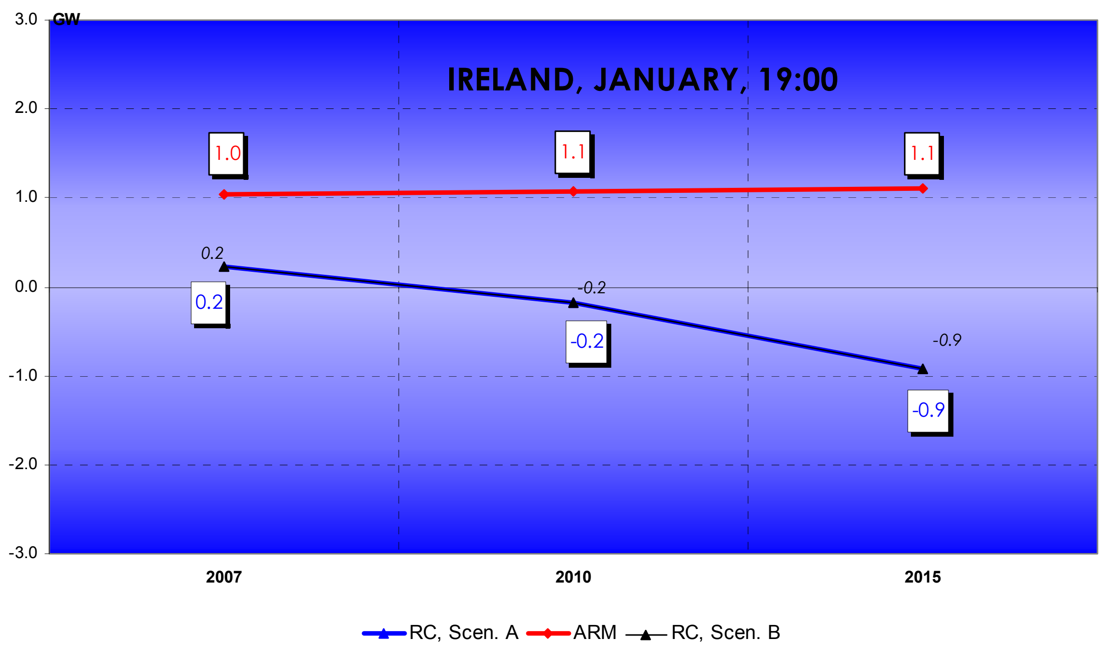
The plant demand position in the Republic of Ireland is tight, with a shortage of capacity to meet the reference level of peak demand in 2005 of about 260MW. This is significantly below that level that would be considered, according to UCTE methodology, as an Adequate Reference Margin of about 550 MW. Similarly a capacity shortage of about 260 MW is projected for 2007.

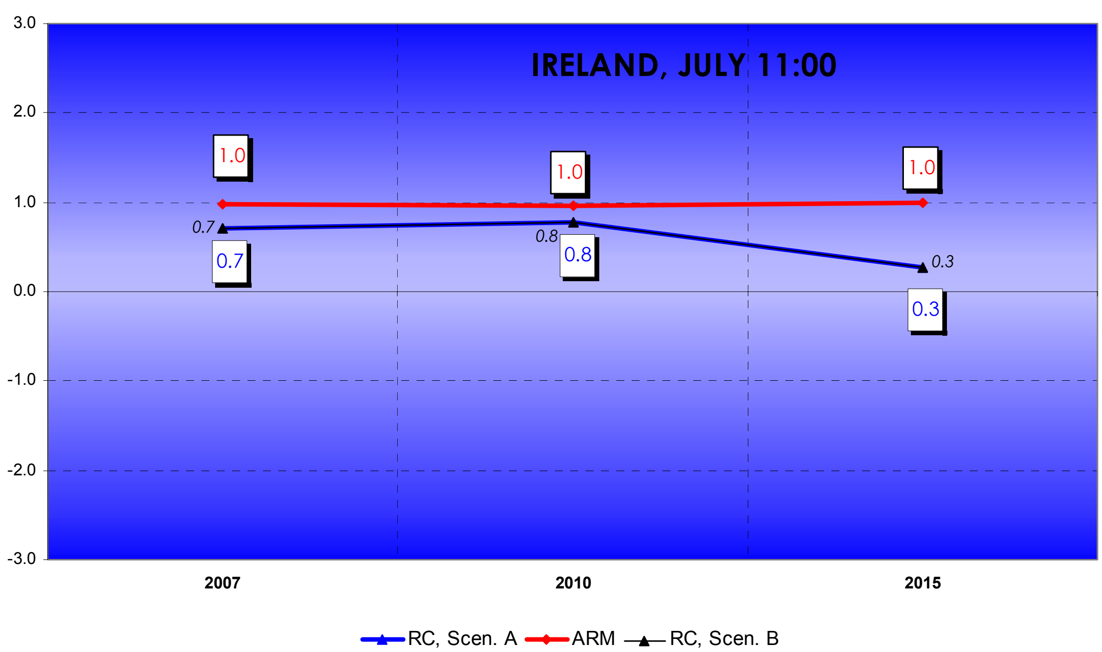
The reference peak load is expected to increase by about 1700 MW between 2005 and 2015 whilst reliable available capacity is expected to increase by about 900 MW. This suggests that without further generation developments, the Republic of Ireland will be faced with significant plant shortages of about 1500 MW against the Adequacy Reference Margin. Part of this shortage could be met from imports from Northern Ireland, with which it has an import capacity of 330 MW. However, as can be seen from below, Northern Ireland also faces tight plant margins.

Northern Ireland;

The plant margin position in Northern Ireland is also expected to be tight in 2005 when a shortage of about 150 MW is expected against peak demand and a shortage of about 200 MW is expected against the Adequacy Reference Margin. However relief can be expected from the 450 MW import capacity from Great Britain and indirectly via the British system from UCTE Main Block. The position is expected to improve in 2007 as some 360 MW of additional plant is commissioned against an expected growth in load of about 190 MW. Nevertheless according to the UCTE methodology margins are projected to still be insufficient by about 80 MW, and will remain tight at this level over the period to 2015..
Whilst there is an import capacity from GB (450 MW) which can provide relief against the projected national shortage of generating capacity this may not however be relied upon as this could be offset by an equivalent export capacity with the Republic of Ireland. (330 MW)

Remaining Capacity vs. ARM





3.7 SPAIN and PORTUGAL

Generation adequacy

2005-2007

Expected commissioning in the block contributes to an increase of generating capacity of 8 GW over the period. Renewable energy sources contribute to half of this increase. The increase in Reliably Available Capacity covers the load increase.

As a consequence, the ratio Remaining Capacity / Generating Capacity is maintained in 2007. **But the RC doesn't meet the ARM (related to 10% of generating capacity that reflects the sensitivity of this block to hydro and wind conditions) neither in winter nor in summer.**

2010

In scenario A from 2007 to 2010, the increase in generating capacity (+7 GW) relies to a large extent on the development of renewable energy sources, with a limited contribution to the increase in Reliably Available Capacity (+2.7 GW). **Remaining Capacity remains below the ARM in winter, and in summer.**

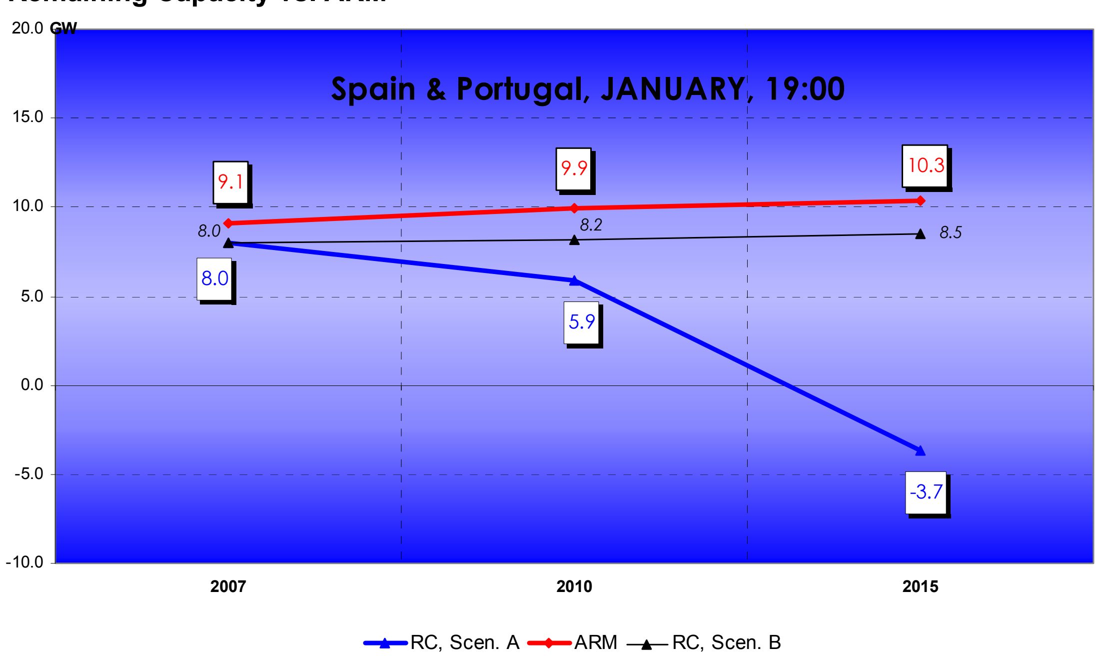
Scenario B shows that an additional 2.5 GW increase of the generating capacity can be reasonably expected which allows more adequate margins over the period to be restored.

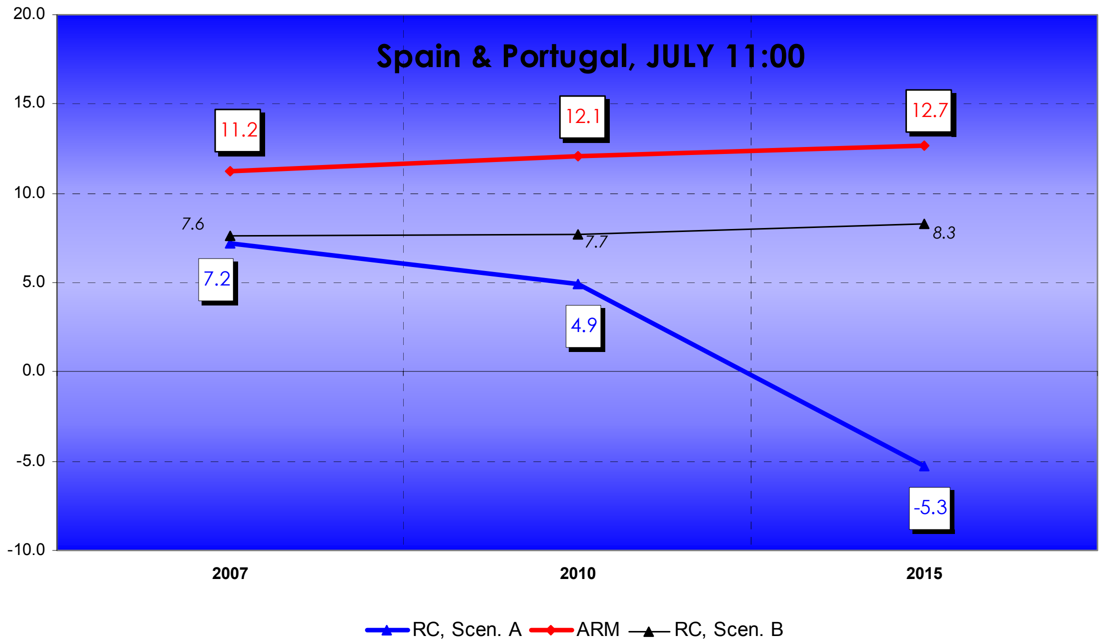
2015

In scenario A in 2015, new commissioning does not compensate for expected shut downs, and Reliably Available Capacity remains at its 2010 level. As a consequence, when load increase is annually 3.1% (winter peak load, 3.3% in summer), **Remaining Capacity falls to negative values in 2015**.

In Scenario B, new commissioning of plant not yet planned but expected to be put in place would maintain an adequate level of generation.

Remaining Capacity vs. ARM





Role of interconnections

Interconnection capacity represents only a small part of the installed generation capacity (1.4 GW with UCTE main block).

At the beginning of the period it is likely to be used for imports into Spain (considering the positive RC of UCTE main block). In 2010 both the systems (UCTE Main Block and Spain and Portugal) are just balanced at winter peak. Exchanges will depend on the conditions of each system.

3.8 ITALY

Generation adequacy

2005-2007

Generating capacity in Italy should increase by 6.5% (+5 GW) by 2007, mainly due to commissioning of fossil fuel power plants, with a high contribution to Reliably Available Capacity. This will contribute to improve Remaining Capacity over the period (+3.4 GW).

Under these circumstances, **ARM is met from 2005 to 2007**.

2010

The trend expected from 2005 to 2007 should be maintained until 2010, with a further increase of 6 GW of Reliably Available Capacity, due to commissioning in fossil fuel power plants. The increase in load is covered, and Remaining Capacity increases slightly from 2007 to 2010.

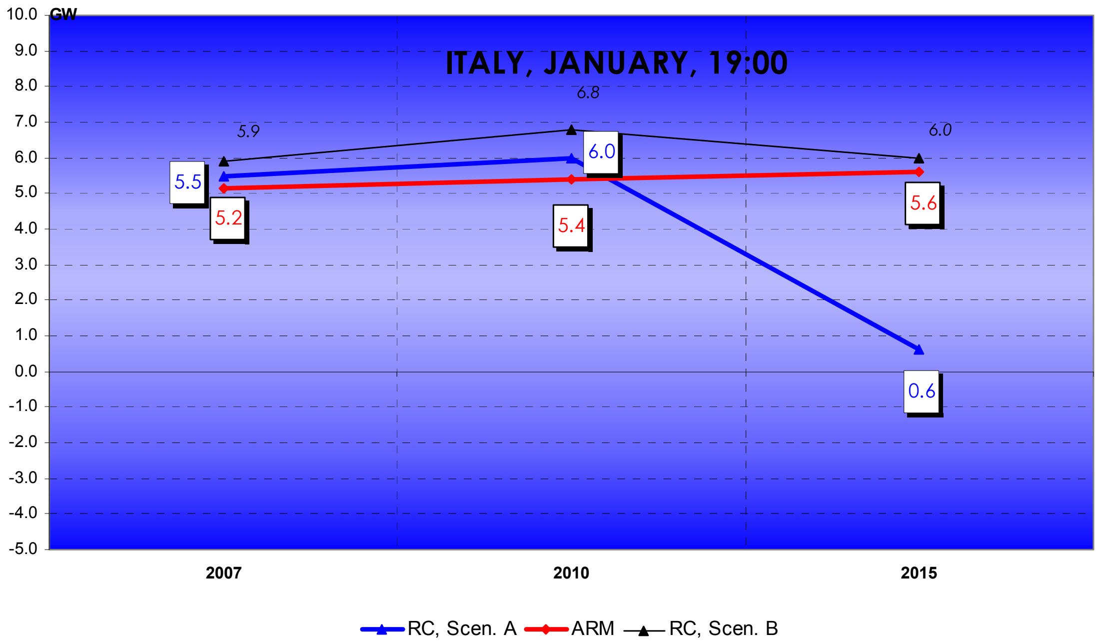
ARM is met in 2010, with an extra 3.5 GW margin in summer.

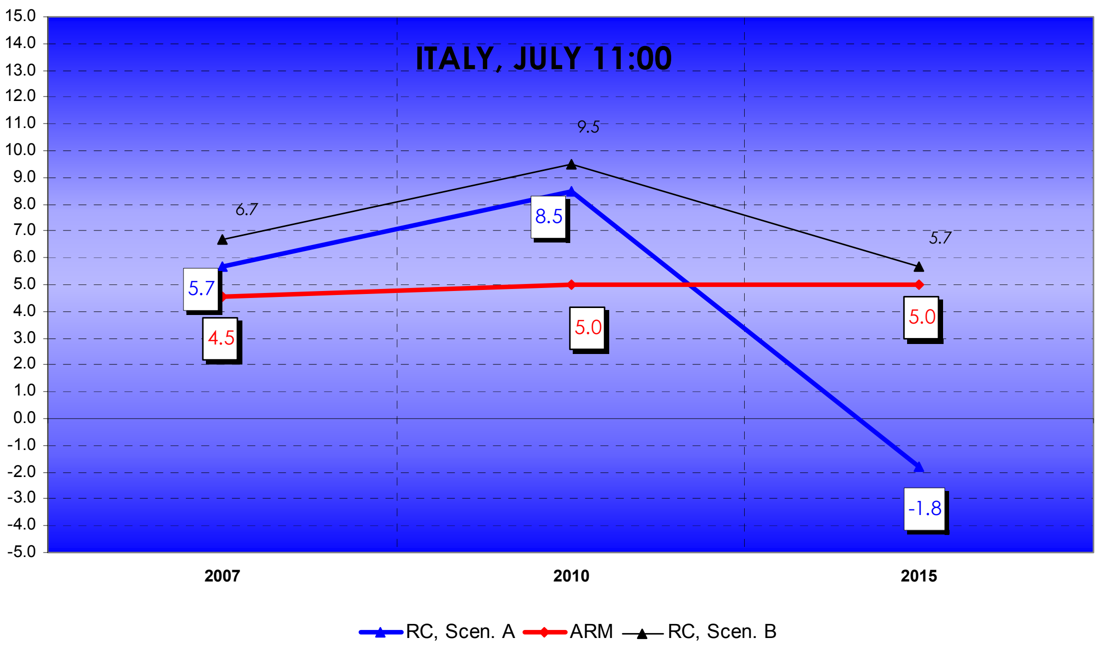
2015

Commissioning of new plants are expected to continue, with 3 GW from fossil fuel sources in 2015, and 1 GW from renewable energy sources. Nevertheless, it is not sufficient to cover load increase (+10 GW), and Remaining Capacity is drastically decreasing.

ARM is not met in 2015; extra Reliably Available Capacity of up to 7 GW is needed.

Remaining Capacity vs. ARM





Role of Interconnections

The expected import capacity (8 GW increasing to 9.5 GW) will provide additional security to the Italian system.

3.9 South Eastern UCTE

Generation Adequacy

2005-2007

In the conservative scenario, no significant increase in generating capacity is expected from 2005 to 2007. Remaining Capacity remains at very low levels.

ARM is not met from 2005 to 2007 in winter or in summer. The situation of the block is representative of each national case.

2010

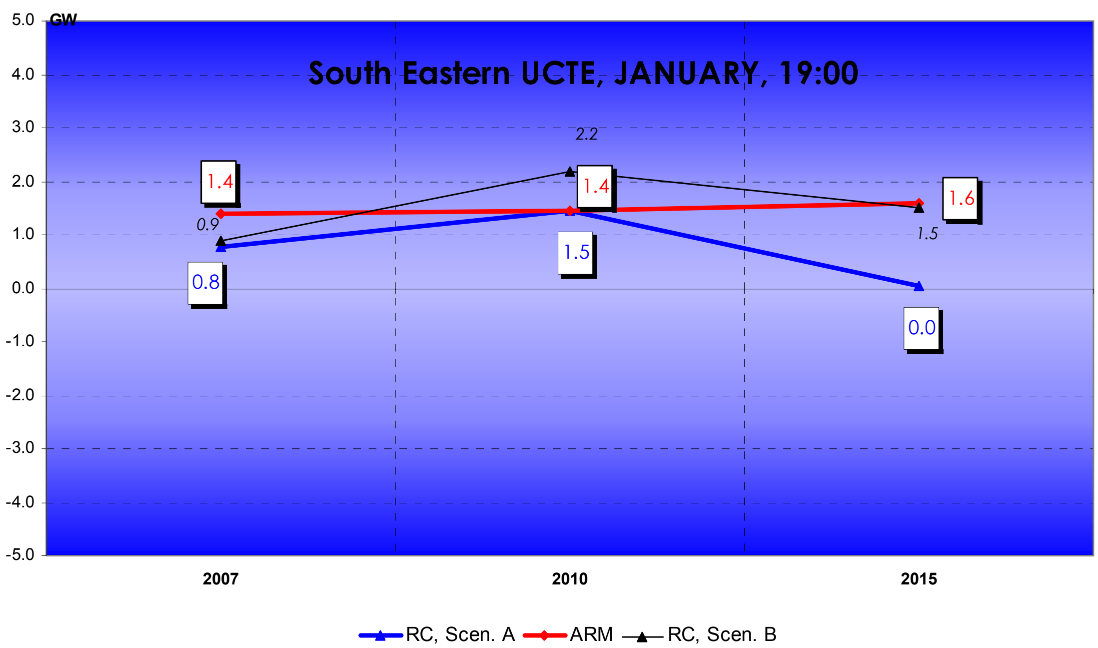
Generating Capacity developments are still expected to be very low, matching the increase in load, .

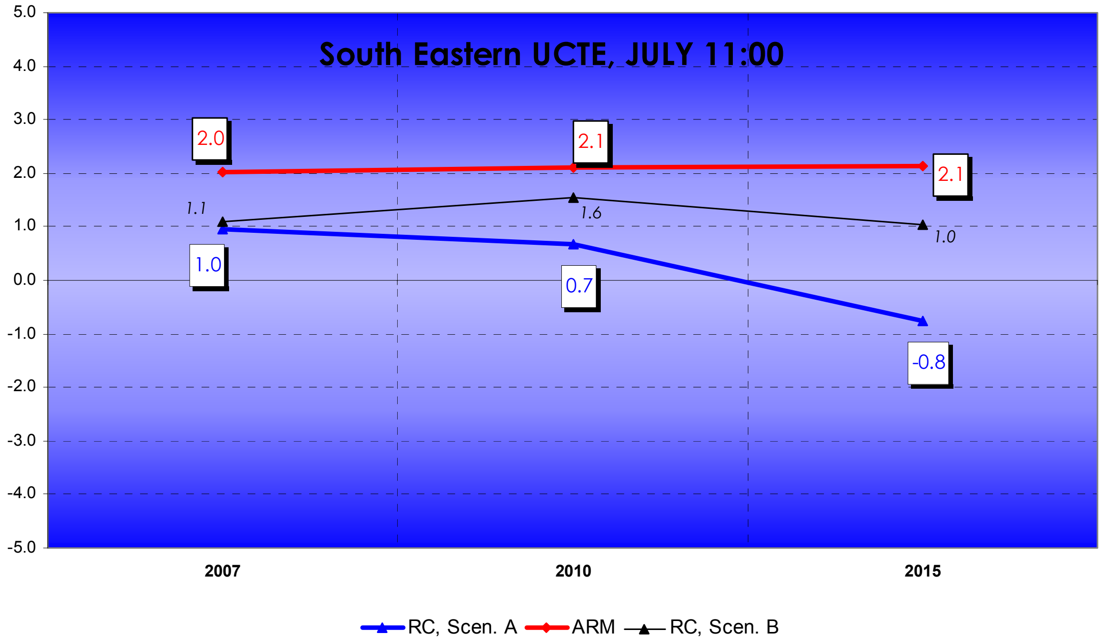
ARM is just met in 2010. RC is negative in summer in Greece.

2015

ARM is not met in 2015; additional Reliably Available Capacity of 1 to 2 GW is needed. RC in summer is negative.

Remaining Capacity vs. ARM





Role of interconnections

Interconnections will play a key role in ensuring security of supply.

Currently imports from Romania and Bulgaria, both of which have an existing export capability, help to balance the situation in the region.

The interconnection of this zone with CENTREL and UCTE main block also increases the possibility of imports. Therefore, the use of interconnection capacity will probably relieve this system and its security will not be compromised.

3.10 Romania & Bulgaria

<u>2005-2007</u>

Generating capacity is stable over the period. Owing to the load increase, Remaining Capacity is decreasing, and is just sufficient to meet the **ARM over the period.** This is the case for both Romania and Bulgaria.

<u>2010</u>

From 2007 to 2010 generating capacity is expected to increase by 2.5 GW and Remaining Capacity improves by 1.6 GW.

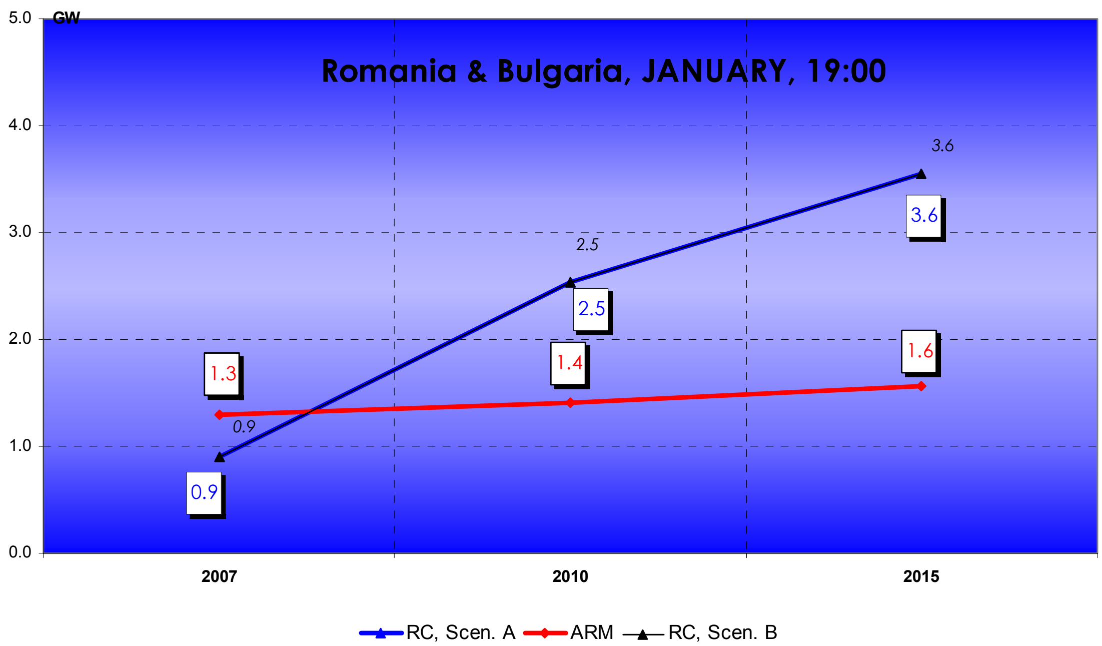
ARM is met in 2010 by 1 to 1.5 GW.

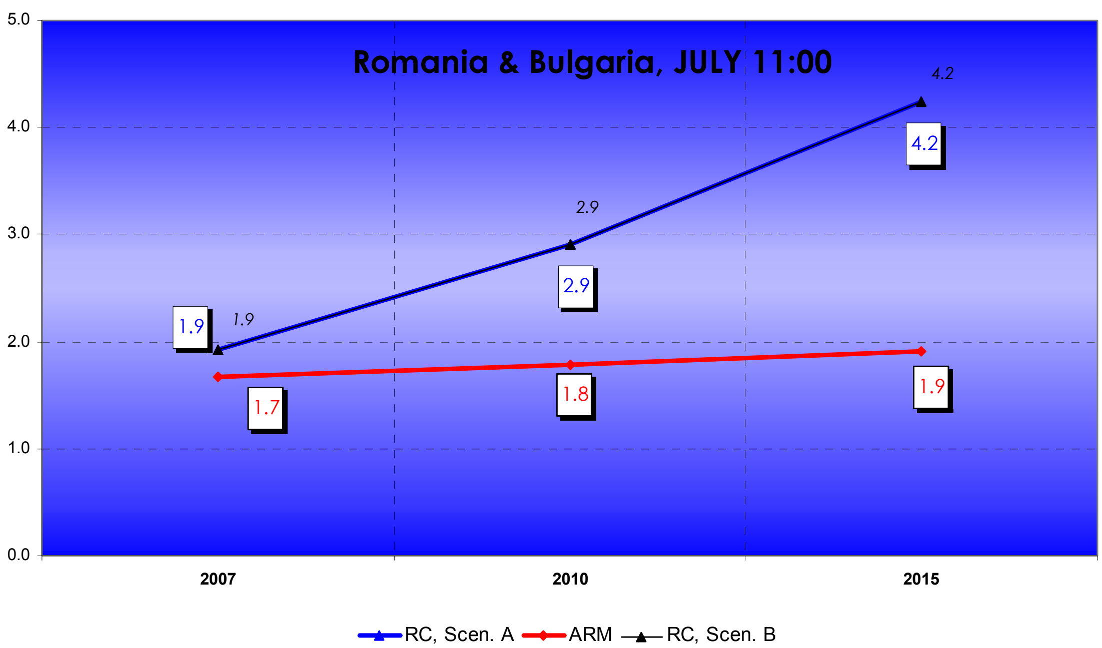
The situation improves particularly for Bulgaria.

<u>2015</u>

Commissioning of a nuclear power plants in Bulgaria results in an increase of Reliably Available Capacity, and as a consequence further improves Remaining Capacity.
The ARM is still met, by approx. 2 GW in 2015.

Remaining Capacity vs. ARM





Role of interconnections

This block is connected with South Eastern UCTE and Centrel. Additional links exists with Turkey and IPS/UPS.

Interconnection with South Eastern UCTE will provide further security to this block especially in summer. Interconnection with Centrel can provide additional capacity.

4 CONCLUSION

The study has set out a power balance forecast for the synchronously or asynchronously interconnected European power system in the years 2007- 2010 - 2015.

Generally speaking, an erosion of generation adequacy in the European power system can be observed with more areas depending on imports, and fewer able to commit to export capacity.

It is apparent that the European power system will be more sensitive to unusual weather situations, mainly in the winter period but possibly at other times of the year as was seen during this summer.

For the whole European system, around 50 GW of new capacity are needed in 2015 in order to maintain an adequate level of security of supply.
According to the TSO's best estimate scenario, this capacity should be brought in due time provided that market mechanisms give proper incentives to invest.

NORDEL should remain an exporter in periods of above average hydro inflow; but it will rely on imports in case of low hydro inflows or cold temperature.

UCTE main block, which represents a major part of the installed capacity in Europe, is facing a decrease in remaining capacity towards the defined level of 5% of installed capacity at peak load. The ability of UCTE main block to export to the importing surrounding areas could be limited in some cases e.g. low temperatures in the UCTE area.

However when analysing these results one must not forget the uncertainties in the data used for this exercise: in some countries some mothballed plant could be returned to service within a rather short time; on the other hand the decision to decommission older units can be taken very quickly.

Even if interconections will play an important role by allowing to compensate the effects of random factors which can affect the region, reasonable regional balance in the long term are the key for security of supply.

Web links

1. UCTE : www.ucte.org => SYSTEM ADEQUACY FORECAST 2005 – 2015
2. UK : www.nationalgrid.com => SEVEN YEAR STATEMENT
3. NORDEL : www.nordel.org => Power and energy balances today and three years ahead
4. IRELAND : www.eirgrid.ie => Generation adequacy statement 200X – 200X

Table 1	**European Generation Adequacy Forecast 2007 – 2015: global results (in GW) ETSO**					
		January				
		Sc A	**Sc B**	**Sc A**	**Sc B**
Installed National generating capacity – NGC	**2007**	785.1	786.7	n.a.	n.a.
	2010	812.5	828.5	n.a.	n.a.
	2015	833.5	879.7	n.a.	n.a.
Reliably Available capacity – GC	**2007**	594.5	595.9	n.a.	n.a.
	2010	608.9	623.2	n.a.	n.a.
	2015	610.0	649.5	n.a.	n.a.
Reference load	**2007**	533.9	533.9	n.a.	n.a.
	2010	558.3	558.3	n.a.	n.a.
	2015	596.1	595.9	n.a.	n.a.
Margin against the peak load - MPL	**2007**	9.5	9.5	n.a.	n.a.
	2010	11.0	11.0	n.a.	n.a.
	2015	12.0	12.0	n.a.	n.a.
Remaining capacity at reference load – RCRL	**2007**	60.6	62.0	n.a.	n.a.
	2010	50.6	64.9	n.a.	n.a.
	2015	14.0	53.7	n.a.	n.a.
Remaining capacity at peak load – RCP)	**2007**	51.1	52.5	n.a.	n.a.
	2010	39.6	53.9	n.a.	n.a.
	2015	2.0	41.7	n.a.	n.a.

Table 2	**European Generation Adequacy Forecast 2007 – 2015: global results (in GW) January Forecast**																		
		NORDEL		**GREAT BRITAIN**		**IRELAND**		**UCTE MAIN BLOCK**		**SPAIN + PORTUGAL (1)**		**SOUTH EASTERN UCTE (2)**		**ITALY (3)**		**CENTREL (4)**		**Romania Bulgaria (5)**	
		Sc A	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**ScB**	**ScA**	**ScB**	**ScA**	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**Sc B**
Installed National generating capacity – NGC	**2007**	92.4	92.6	75.3	75.5	9.0	9.0	324.5	325.1	81.8	81.8	22.7	22.7	87.0	87.5	66.4	66.4	25.9	25.9
	2010	95.2	98.2	74.7	76.7	9.3	9.3	331.4	337.7	88.6	90.8	24.2	25.1	91.7	93.0	69.2	69.3	28.3	28.3
	2015	96.4	101.3	75.1	78.4	9.5	9.5	339.4	355.4	90.8	103.9	24.9	26.6	96.0	101.5	69.9	71.6	31.4	31.4
Reliably Available capacity – GC	**2007**	72.7	72.9	64.9	65.0	6.6	6.6	242.1	242.8	59.2	59.2	17.5	17.6	63.3	63.7	51.8	51.8	16.3	16.3
	2010	74.3	76	63.8	65.6	6.8	6.8	240.7	247.5	61.9	64.1	19.2	19.9	69.2	70.0	53.8	53.9	19.2	19.2
	2015	74	77.4	64.0	66.9	7.1	7.1	236.5	249.0	61.0	73.2	19.8	21.3	73.0	78.4	53.0	54.6	21.7	21.7
Reference load	**2007**	71.1	71.1	62.4	62.4	6.4	6.4	211.4	211.4	51.2	51.2	16.7	16.7	57.8	57.8	41.6	41.6	15.4	15.4
	2010	72.9	72.9	63.4	63.4	7.0	7.0	218.7	218.7	55.9	55.9	17.7	17.7	63.2	63.2	42.7	42.7	16.7	16.7
	2015	75.8	75.6	64.5	64.5	8.0	8.0	227.0	227.0	64.6	64.6	19.8	19.8	72.4	72.4	45.8	45.8	18.2	18.2
Margin against the peak load – MPL	**2007**	0	0	0.6	0.6	0.1	0.1	5.7	5.7	0.9	0.9	0.3	0.3	0.8	0.8	1.0	1.0	0.0	0.0
	2010	0	0	0.6	0.6	0.1	0.1	5.5	5.5	1.1	1.1	0.2	0.2	0.8	0.8	2.6	2.6	0.0	0.0
	2015	0	0	0.7	0.7	0.2	0.2	5.9	5.9	1.3	1.3	0.4	0.4	0.8	0.8	2.8	2.8	0.0	0.0
Remaining capacity at reference load – RCRL	**2007**	1.6	1.8	2.5	2.6	0.2	0.2	30.7	31.4	8.0	8.0	0.8	0.9	5.5	5.9	10.3	10.3	0.9	0.9
	2010	1.4	3.1	0.4	2.2	-0.2	-0.2	21.9	28.8	5.9	8.2	1.5	2.2	6.0	6.8	11.2	11.3	2.5	2.5
	2015	-1.8	1.8	-0.5	2.5	-0.9	-0.9	9.5	22.0	-3.7	8.5	0.0	1.5	0.6	6.0	7.1	8.8	3.6	3.6
Remaining capacity at peak load – RCP)	**2007**	1.6	1.8	1.9	1.9	0.1	0.1	25.0	25.7	7.1	7.1	0.5	0.6	4.7	5.1	9.3	9.3	0.9	0.9
	2010	1.4	3.1	-0.3	1.6	-0.3	-0.3	16.4	23.3	4.9	7.1	1.2	2.0	5.2	6.0	8.6	8.7	2.5	2.5
	2015	-1.8	1.8	-1.1	1.8	-1.1	-1.1	3.6	16.1	-4.9	7.3	-0.3	1.2	-0.2	5.2	4.3	5.9	3.6	3.6
Simultaneous Importable capacity	**2007**	4.2		2.4	2.4	0.4		9.7		2.2		4.3		7.9		4.4		3.4	
	2010	4.6		2.4	3.0	0.4		11.3		3.4		4.8		9.5		4.4		4.3	
	2015	4.6		2.4	3.6	0.4		11.3		3.4		4.8		9.5		4.4		4.3	
Simultaneous exportable capacity	**2007**	3.8		2.4	2.4	0.4		16.4		1.8		4.6		-		5.3		3.1	
	2010	4.2		2.4	3.0	0.4		19.6		3.0		5.1		-		5.3		4.0	
	2015	4.2		2.4	3.6	0.4		19.6		3.0		5.1		-		5.3		4.0	

Table 3	European Generation Adequacy Forecast 2007 – 2015: global results (in GW) July Forecast																			
		NORDEL		**GREAT BRITAIN**		**IRELAND**		**UCTE MAIN BLOCK**		**SPAIN + PORTUGAL (1)**		**SOUTH EASTERN UCTE (2)**		**ITALY (3)**		**CENTREL (4)**		**Romania Bulgaria (5)**	
		Sc A	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**ScB**	**ScA**	**ScB**	**ScA**	**Sc B**	**Sc A**	**Sc B**	**Sc A**	**Sc B**
Installed National generating capacity – NGC	**2007**	n.a	n.a	75.3	75.5	9.4	9.4	324.6	325.3	83.3	83.7	22.9	22.9	88.8	90.1	67.0	67.0	26.2	26.2
	2010	n.a	n.a	74.7	76.7	9.3	9.3	333.5	339.9	89.7	92.5	24.2	25.1	96.0	97.3	70.0	70.1	28.3	28.3
	2015	n.a	n.a	75.1	78.4	9.5	9.5	340.7	356.7	91.8	106.6	24.9	27.0	96.0	104.1	70.4	72.2	31.4	31.4
Reliably Available capacity – GC	**2007**	n.a	n.a	52.9	53.0	5.8	5.8	207.2	207.8	55.3	55.7	15.8	15.9	63.4	64.4	41.2	41.2	13.2	13.2
	2010	n.a	n.a	51.8	53.6	6.4	6.4	206.8	213.5	57.3	60.1	16.9	17.8	71.6	72.6	42.7	42.8	15.3	15.3
	2015	n.a	n.a	52.0	54.9	6.7	6.7	201.2	214.1	56.3	69.9	17.8	19.6	71.0	78.5	41.8	43.4	18.1	18.1
Reference load	**2007**	n.a	n.a	48.9	48.9	5.1	5.1	176.9	176.9	48.1	48.1	14.8	14.8	57.7	57.7	32.0	32.0	11.3	11.3
	2010	n.a	n.a	49.6	49.6	5.7	5.7	184.0	184.0	52.4	52.4	16.3	16.3	63.1	63.1	33.0	33.0	12.4	12.4
	2015	n.a	n.a	50.5	50.5	6.4	6.4	189.9	189.9	61.6	61.6	18.5	18.5	72.8	72.8	35.2	35.2	13.8	13.8
Margin against the peak load – MPL	**2007**	n.a	n.a	0.5	0.5	0.0	0.0	5.9	5.9	2.9	2.9	0.9	0.9	0.1	0.1	0.8	0.8	0.4	0.4
	2010	n.a	n.a	0.5	0.5	0.0	0.0	5.8	5.8	3.1	3.1	0.9	0.9	0.2	0.2	1.6	1.6	0.4	0.4
	2015	n.a	n.a	0.5	0.5	0.0	0.0	6.2	6.2	3.5	3.5	0.9	0.9	0.2	0.2	1.6	1.6	0.3	0.3
Remaining capacity at reference load – RCRL	**2007**	n.a	n.a	4.1	4.1	0.7	0.7	30.3	30.9	7.2	7.6	1.0	1.1	5.7	6.7	9.2	9.2	1.9	1.9
	2010	n.a	n.a	2.1	4.0	0.8	0.8	22.8	29.5	4.9	7.7	0.7	1.6	8.5	9.5	9.7	9.8	2.9	2.9
	2015	n.a	n.a	1.5	4.5	0.3	0.3	11.2	24.1	-5.3	8.3	-0.8	1.0	-1.8	5.7	6.6	8.2	4.2	4.2
Remaining capacity at peak load – RCP)	**2007**	n.a	n.a	3.6	3.6	0.7	0.7	24.4	25.0	4.3	4.7	0.1	0.2	5.6	6.6	8.5	8.5	1.6	2.3
	2010	n.a	n.a	1.6	3.5	0.7	0.7	17.0	23.7	1.8	4.6	-0.2	0.7	8.3	9.3	8.2	8.3	2.5	3.3
	2015	n.a	n.a	1.0	4.0	0.2	0.2	5.1	18.0	-8.8	4.8	-1.7	0.1	-2.0	5.5	5.0	6.6	3.9	4.6
Simultaneous Importable capacity	**2007**	4.2		2.4	2.4	0.4		9.7		2.2		4.3		7.9		4.4		3.4	
	2010	4.6		2.4	3.0	0.4		11.3		3.4		4.8		9.5		4.4		4.3	
	2015	4.6		2.4	3.6	0.4		11.3		3.4		4.8		9.5		4.4		4.3	
Simultaneous exportable capacity	**2007**	3.8		2.4	2.4	0.4		16.4		1.8		4.6				5.3		3.1	
	2010	4.2		2.4	3.0	0.4		19.6		3.0		5.1				5.3		4.0	
	2015	4.2		2.4	3.6	0.4		19.6		3.0		5.1				5.3		4.0	

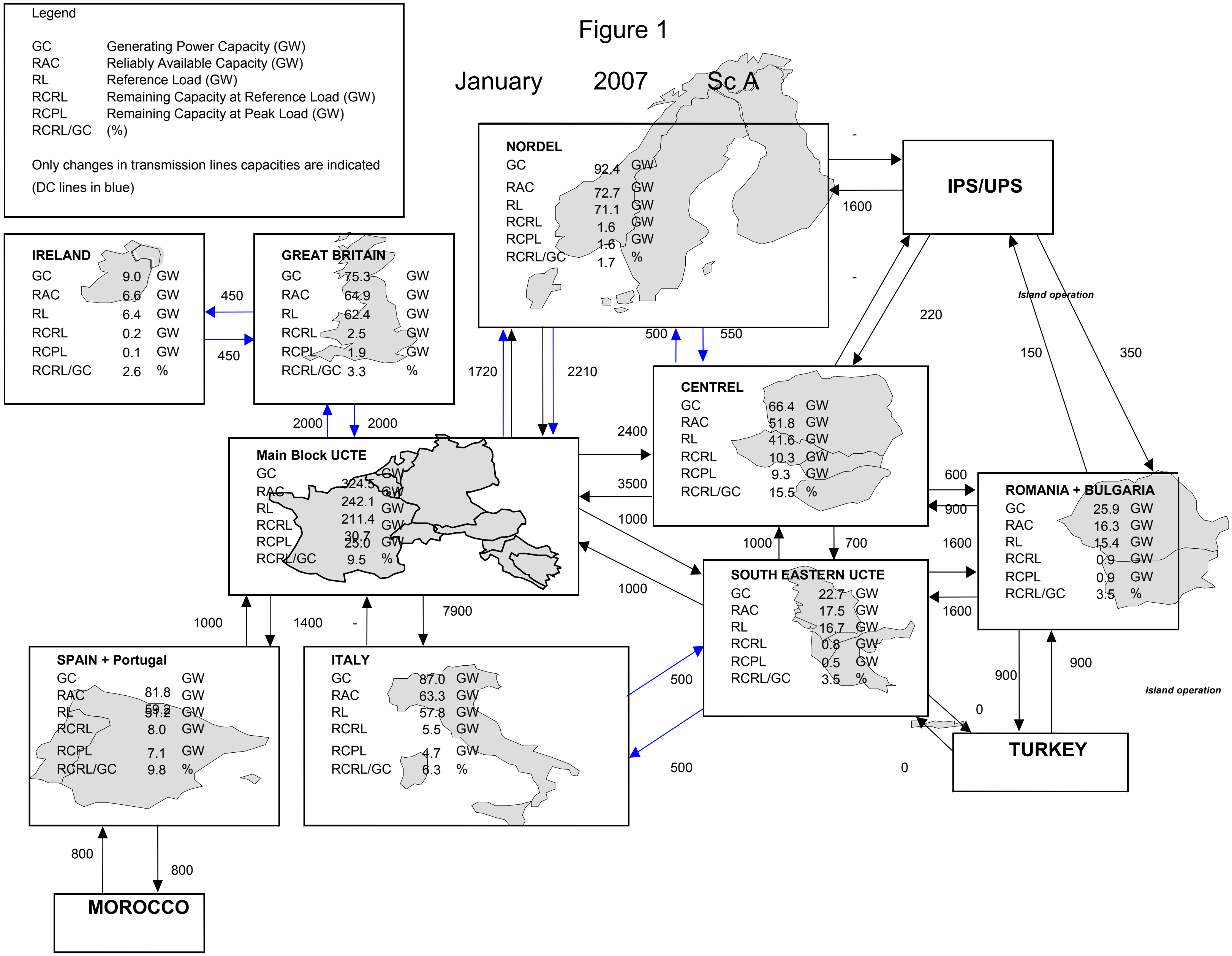
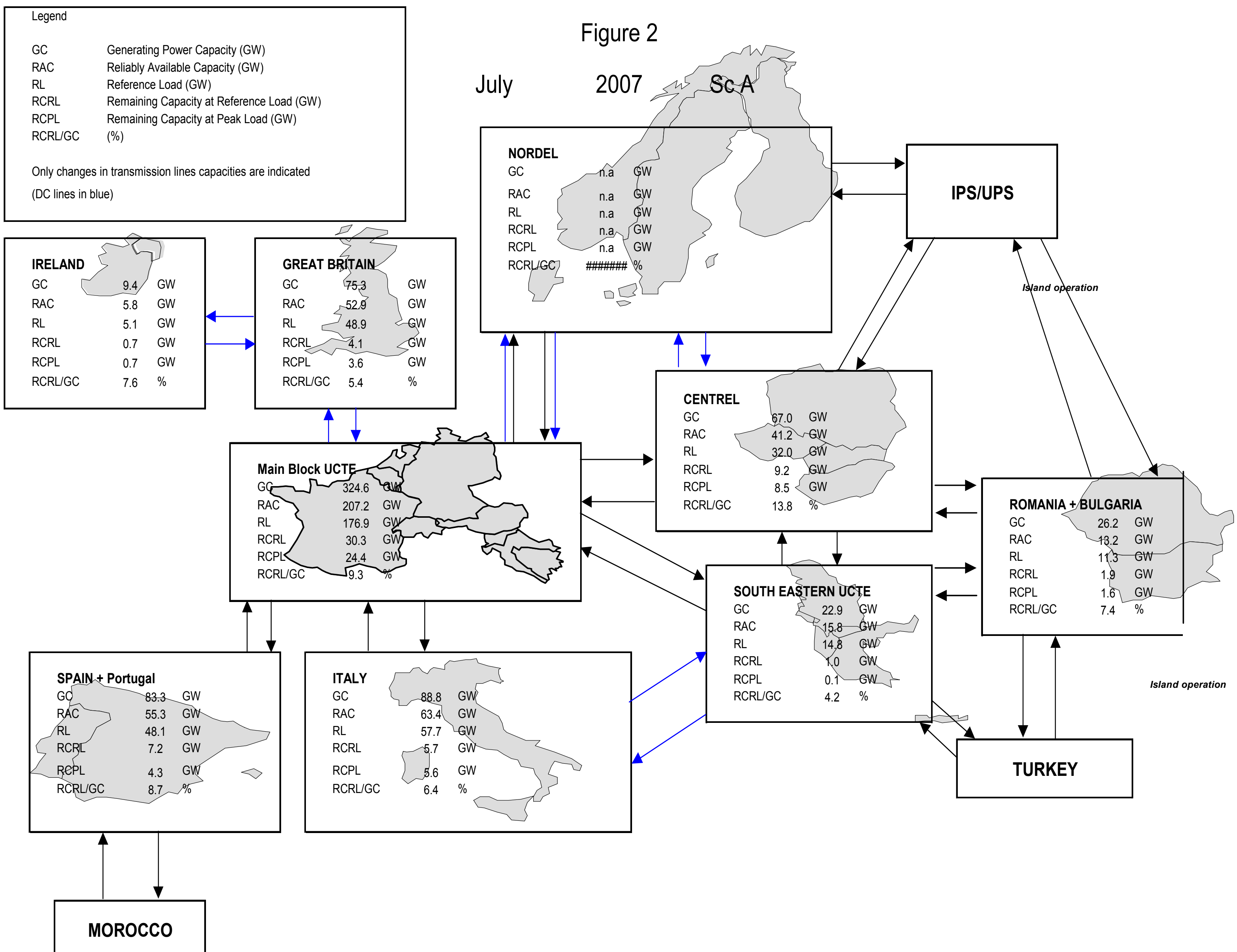


Figure 1
January 2007 Sc A
Legend
GC Generating Power Capacity (GW)
RAC Reliably Available Capacity (GW)
RL Reference Load (GW)
RCRL Remaining Capacity at Reference Load (GW)
RCPL Remaining Capacity at Peak Load (GW)
RCRL/GC (%)
Only changes in transmission lines capacities are indicated
(DC lines in blue)
NORDEL
GC 92.4 GW
RAC 72.7 GW
RL 71.1 GW
RCRL 1.6 GW
RCPL 1.6 GW
RCRL/GC 1.7 %
IPS/UPS
IRELAND
GC 9.0 GW
RAC 6.6 GW
RL 6.4 GW
RCRL 0.2 GW
RCPL 0.1 GW
RCRL/GC 2.6 %
GREAT BRITAIN
GC 75.3 GW
RAC 64.9 GW
RL 62.4 GW
RCRL 2.5 GW
RCPL 1.9 GW
RCRL/GC 3.3 %
CENTREL
GC 66.4 GW
RAC 51.8 GW
RL 41.6 GW
RCRL 10.3 GW
RCPL 9.3 GW
RCRL/GC 15.5 %
Main Block UCTE
GC 324.5 GW
RAC 242.1 GW
RL 211.4 GW
RCRL 30.7 GW
RCPL 25.0 GW
RCRL/GC 9.5 %
ROMANIA + BULGARIA
GC 25.9 GW
RAC 16.3 GW
RL 15.4 GW
RCRL 0.9 GW
RCPL 0.9 GW
RCRL/GC 3.5 %
SOUTH EASTERN UCTE
GC 22.7 GW
RAC 17.5 GW
RL 16.7 GW
RCRL 0.8 GW
RCPL 0.5 GW
RCRL/GC 3.5 %
SPAIN + Portugal
GC GW
RAC 81.8 GW
RL 59.2 GW
RCRL 8.0 GW
RCPL 7.1 GW
RCRL/GC 9.8 %
ITALY
GC 87.0 GW
RAC 63.3 GW
RL 57.8 GW
RCRL 5.5 GW
RCPL 4.7 GW
RCRL/GC 6.3 %
TURKEY
MOROCCO
Island operation
Island operation
450
450
2000
2000
1720
2210
500
550
1600
220
150
350
2400
3500
1000
1000
600
900
1000
700
1600
1600
900
900
0
0
500
500
1000
1400
7900
800
800


Legend
GC Generating Power Capacity (GW)
RAC Reliably Available Capacity (GW)
RL Reference Load (GW)
RCRL Remaining Capacity at Reference Load (GW)
RCPL Remaining Capacity at Peak Load (GW)
RCRL/GC (%)
Only changes in transmission lines capacities are indicated
(DC lines in blue)
Figure 2
July 2007 Sc A
NORDEL
GC n.a GW
RAC n.a GW
RL n.a GW
RCRL n.a GW
RCPL n.a GW
RCRL/GC ####### %
IPS/UPS
Island operation
IRELAND
GC 9.4 GW
RAC 5.8 GW
RL 5.1 GW
RCRL 0.7 GW
RCPL 0.7 GW
RCRL/GC 7.6 %
GREAT BRITAIN
GC 75.3 GW
RAC 52.9 GW
RL 48.9 GW
RCRL 4.1 GW
RCPL 3.6 GW
RCRL/GC 5.4 %
CENTREL
GC 67.0 GW
RAC 41.2 GW
RL 32.0 GW
RCRL 9.2 GW
RCPL 8.5 GW
RCRL/GC 13.8 %
Main Block UCTE
GC 324.6 GW
RAC 207.2 GW
RL 176.9 GW
RCRL 30.3 GW
RCPL 24.4 GW
RCRL/GC 9.3 %
ROMANIA + BULGARIA
GC 26.2 GW
RAC 13.2 GW
RL 11.3 GW
RCRL 1.9 GW
RCPL 1.6 GW
RCRL/GC 7.4 %
SOUTH EASTERN UCTE
GC 22.9 GW
RAC 15.8 GW
RL 14.8 GW
RCRL 1.0 GW
RCPL 0.1 GW
RCRL/GC 4.2 %
Island operation
SPAIN + Portugal
GC 83.3 GW
RAC 55.3 GW
RL 48.1 GW
RCRL 7.2 GW
RCPL 4.3 GW
RCRL/GC 8.7 %
ITALY
GC 88.8 GW
RAC 63.4 GW
RL 57.7 GW
RCRL 5.7 GW
RCPL 5.6 GW
RCRL/GC 6.4 %
TURKEY
MOROCCO

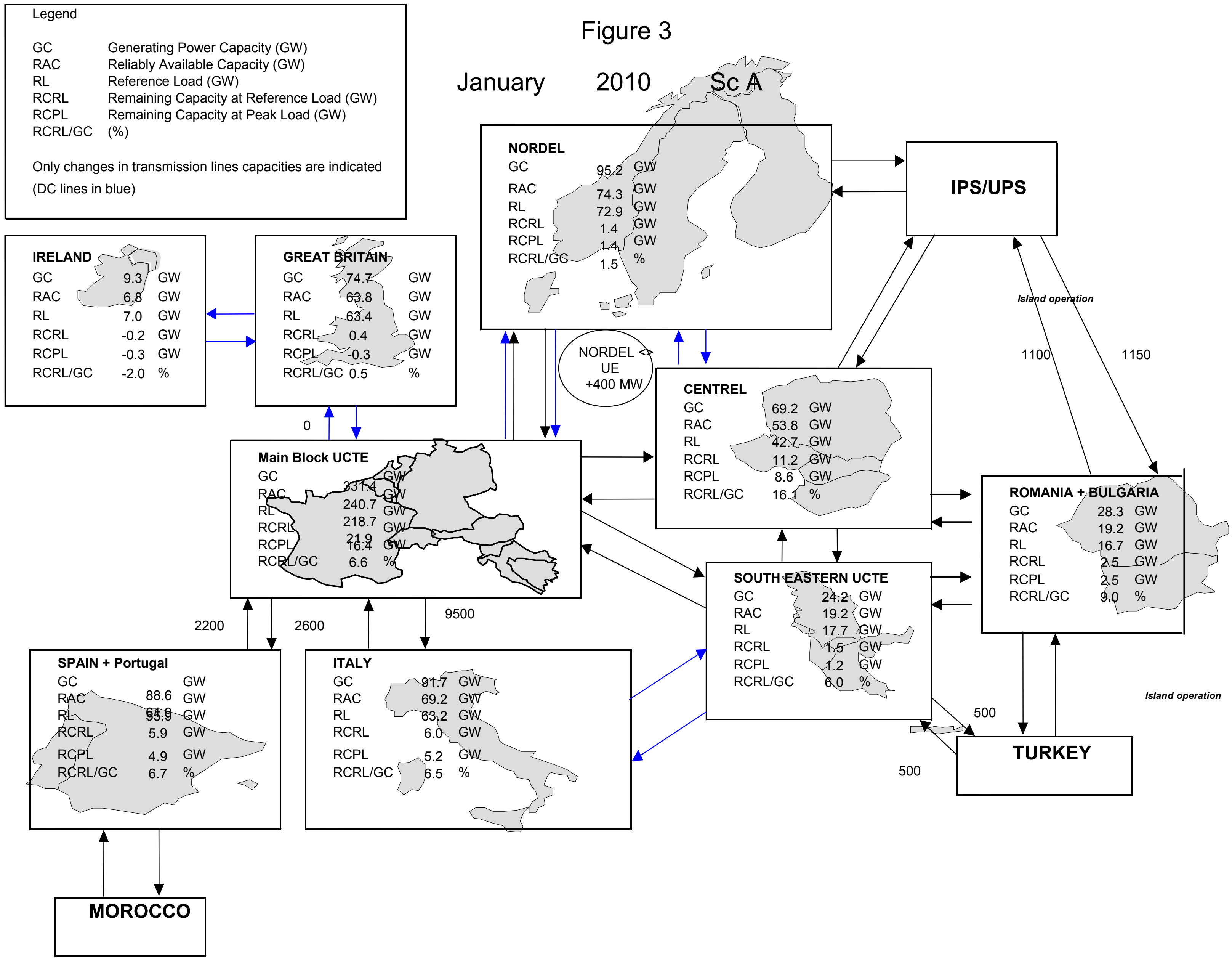
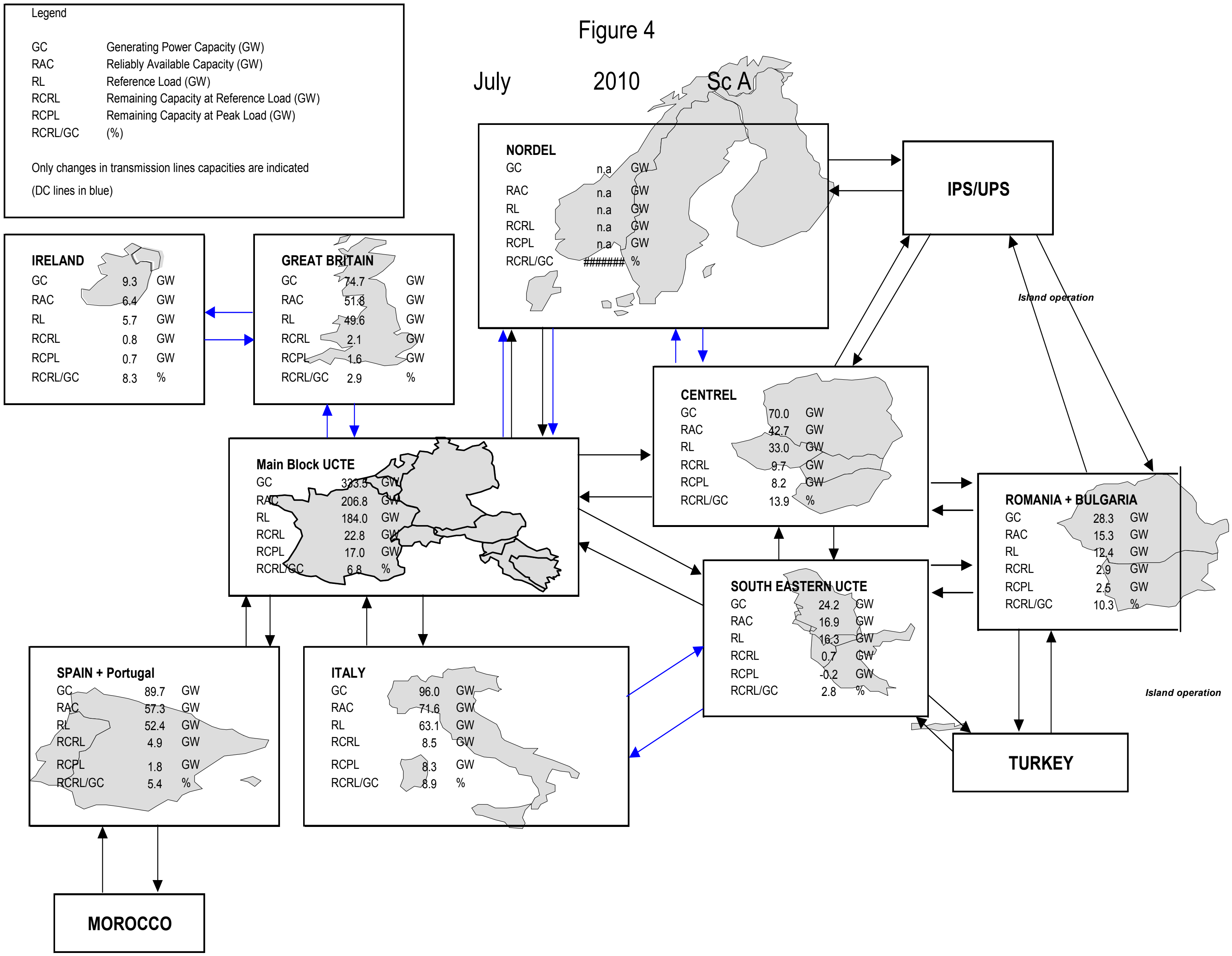


Figure 3
January 2010 Sc A
Legend
GC Generating Power Capacity (GW)
RAC Reliably Available Capacity (GW)
RL Reference Load (GW)
RCRL Remaining Capacity at Reference Load (GW)
RCPL Remaining Capacity at Peak Load (GW)
RCRL/GC (%)
Only changes in transmission lines capacities are indicated
(DC lines in blue)
IRELAND
GC 9.3 GW
RAC 6.8 GW
RL 7.0 GW
RCRL -0.2 GW
RCPL -0.3 GW
RCRL/GC -2.0 %
GREAT BRITAIN
GC 74.7 GW
RAC 63.8 GW
RL 63.4 GW
RCRL 0.4 GW
RCPL -0.3 GW
RCRL/GC 0.5 %
NORDEL
GC 95.2 GW
RAC 74.3 GW
RL 72.9 GW
RCRL 1.4 GW
RCPL 1.4 GW
RCRL/GC 1.5 %
IPS/UPS
NORDEL <> UE +400 MW
CENTREL
GC 69.2 GW
RAC 53.8 GW
RL 42.7 GW
RCRL 11.2 GW
RCPL 8.6 GW
RCRL/GC 16.1 %
Island operation
1100
1150
0
Main Block UCTE
GC 331.4 GW
RAC 240.7 GW
RL 218.7 GW
RCRL 21.9 GW
RCPL 16.4 GW
RCRL/GC 6.6 %
ROMANIA + BULGARIA
GC 28.3 GW
RAC 19.2 GW
RL 16.7 GW
RCRL 2.5 GW
RCPL 2.5 GW
RCRL/GC 9.0 %
SOUTH EASTERN UCTE
GC 24.2 GW
RAC 19.2 GW
RL 17.7 GW
RCRL 1.5 GW
RCPL 1.2 GW
RCRL/GC 6.0 %
2200
2600
9500
SPAIN + Portugal
GC 88.6 GW
RAC GW
RL 55.9 GW
RCRL 5.9 GW
RCPL 4.9 GW
RCRL/GC 6.7 %
ITALY
GC 91.7 GW
RAC 69.2 GW
RL 63.2 GW
RCRL 6.0 GW
RCPL 5.2 GW
RCRL/GC 6.5 %
Island operation
500
500
TURKEY
MOROCCO


Legend
GC Generating Power Capacity (GW)
RAC Reliably Available Capacity (GW)
RL Reference Load (GW)
RCRL Remaining Capacity at Reference Load (GW)
RCPL Remaining Capacity at Peak Load (GW)
RCRL/GC (%)
Only changes in transmission lines capacities are indicated
(DC lines in blue)
Figure 4
July 2010 Sc A
NORDEL
GC n.a GW
RAC n.a GW
RL n.a GW
RCRL n.a GW
RCPL n.a GW
RCRL/GC ####### %
IPS/UPS
Island operation
IRELAND
GC 9.3 GW
RAC 6.4 GW
RL 5.7 GW
RCRL 0.8 GW
RCPL 0.7 GW
RCRL/GC 8.3 %
GREAT BRITAIN
GC 74.7 GW
RAC 51.8 GW
RL 49.6 GW
RCRL 2.1 GW
RCPL 1.6 GW
RCRL/GC 2.9 %
CENTREL
GC 70.0 GW
RAC 42.7 GW
RL 33.0 GW
RCRL 9.7 GW
RCPL 8.2 GW
RCRL/GC 13.9 %
Main Block UCTE
GC 333.5 GW
RAC 206.8 GW
RL 184.0 GW
RCRL 22.8 GW
RCPL 17.0 GW
RCRL/GC 6.8 %
ROMANIA + BULGARIA
GC 28.3 GW
RAC 15.3 GW
RL 12.4 GW
RCRL 2.9 GW
RCPL 2.5 GW
RCRL/GC 10.3 %
SOUTH EASTERN UCTE
GC 24.2 GW
RAC 16.9 GW
RL 16.3 GW
RCRL 0.7 GW
RCPL -0.2 GW
RCRL/GC 2.8 %
Island operation
SPAIN + Portugal
GC 89.7 GW
RAC 57.3 GW
RL 52.4 GW
RCRL 4.9 GW
RCPL 1.8 GW
RCRL/GC 5.4 %
ITALY
GC 96.0 GW
RAC 71.6 GW
RL 63.1 GW
RCRL 8.5 GW
RCPL 8.3 GW
RCRL/GC 8.9 %
TURKEY
MOROCCO

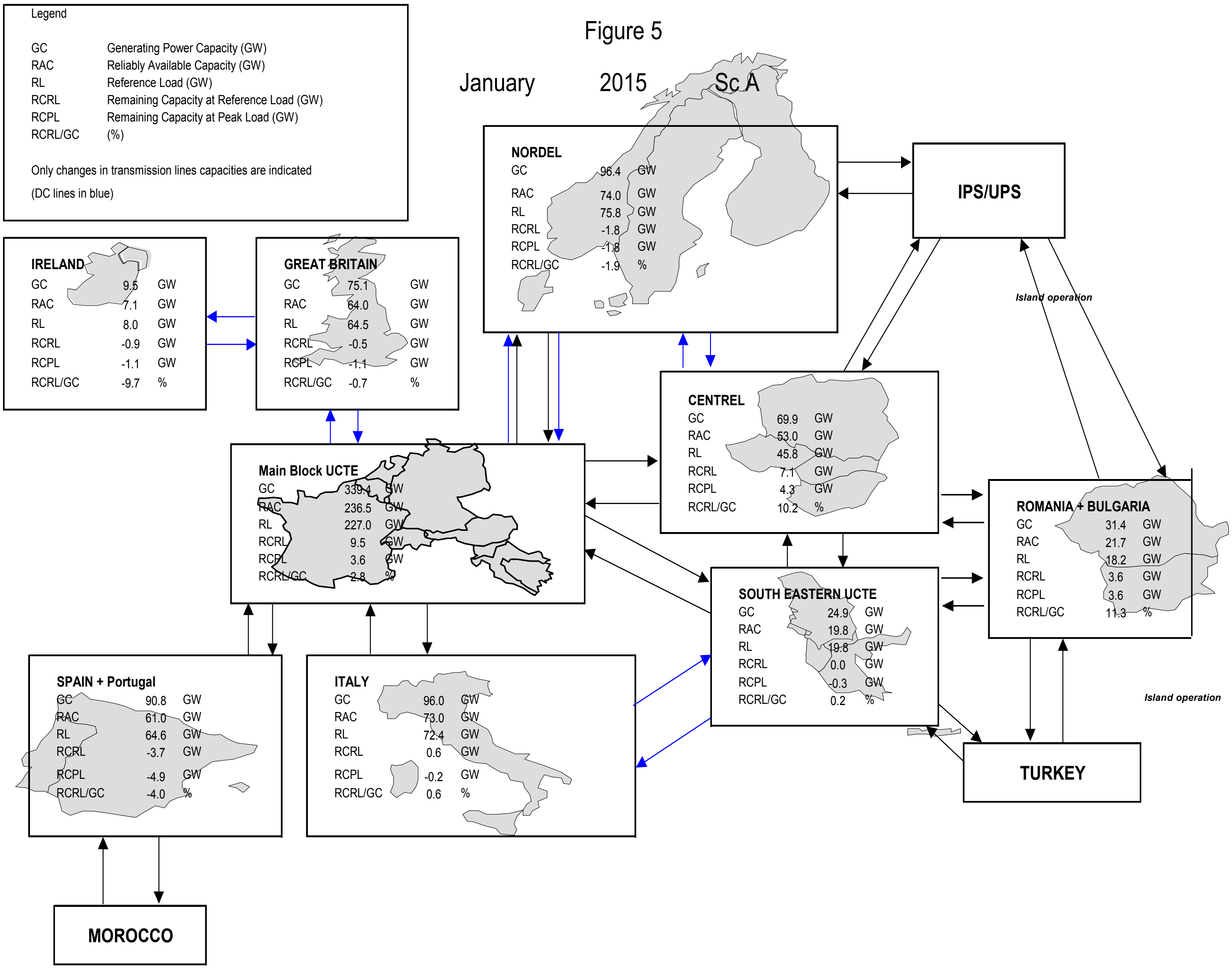
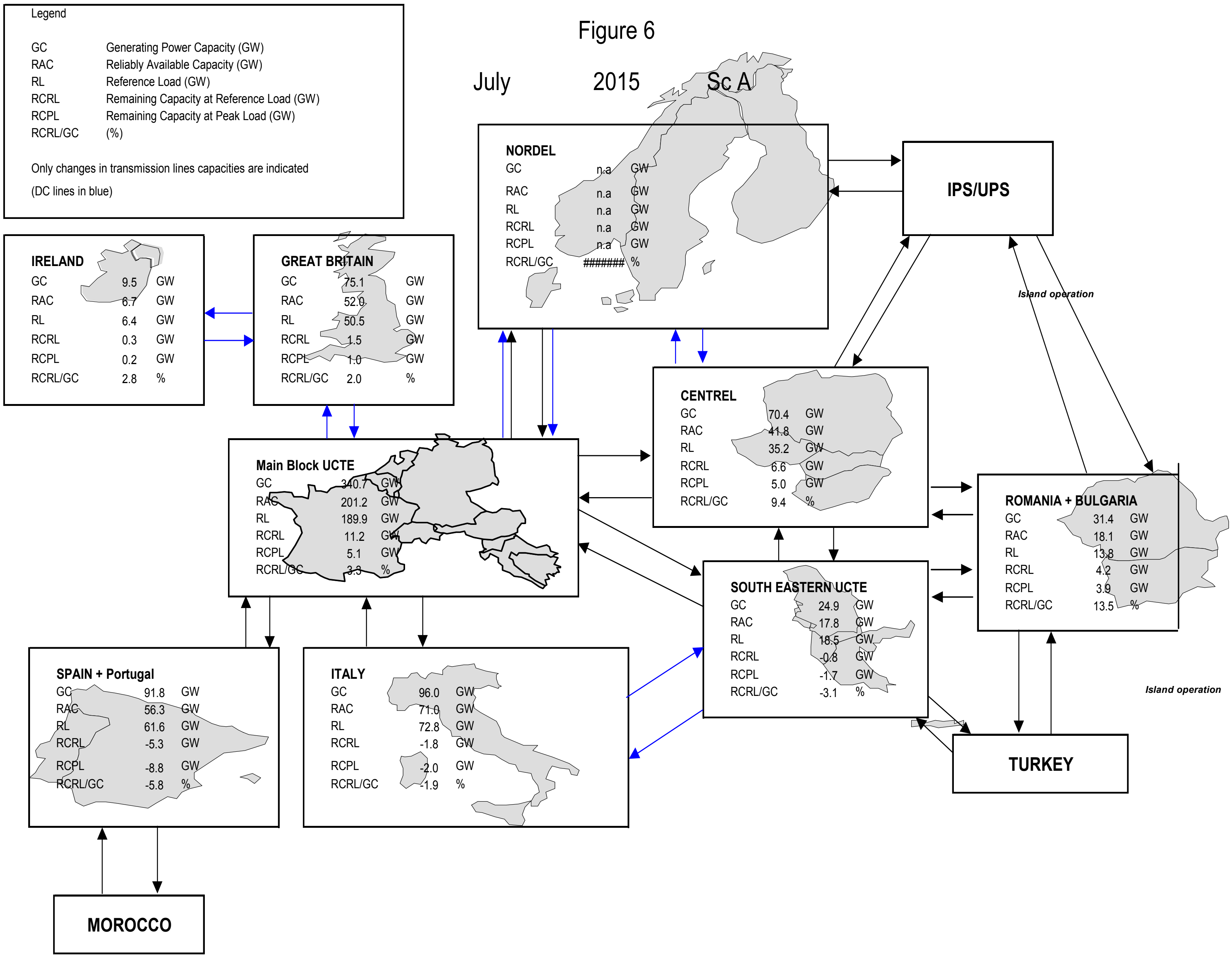


Figure 5
January 2015 Sc A
Legend
GC Generating Power Capacity (GW)
RAC Reliably Available Capacity (GW)
RL Reference Load (GW)
RCRL Remaining Capacity at Reference Load (GW)
RCPL Remaining Capacity at Peak Load (GW)
RCRL/GC (%)
Only changes in transmission lines capacities are indicated
(DC lines in blue)
NORDEL
GC 96.4 GW
RAC 74.0 GW
RL 75.8 GW
RCRL -1.8 GW
RCPL -1.8 GW
RCRL/GC -1.9 %
IPS/UPS
IRELAND
GC 9.5 GW
RAC 7.1 GW
RL 8.0 GW
RCRL -0.9 GW
RCPL -1.1 GW
RCRL/GC -9.7 %
GREAT BRITAIN
GC 75.1 GW
RAC 64.0 GW
RL 64.5 GW
RCRL -0.5 GW
RCPL -1.1 GW
RCRL/GC -0.7 %
Island operation
CENTREL
GC 69.9 GW
RAC 53.0 GW
RL 45.8 GW
RCRL 7.1 GW
RCPL 4.3 GW
RCRL/GC 10.2 %
Main Block UCTE
GC 339.4 GW
RAC 236.5 GW
RL 227.0 GW
RCRL 9.5 GW
RCPL 3.6 GW
RCRL/GC 2.8 %
ROMANIA + BULGARIA
GC 31.4 GW
RAC 21.7 GW
RL 18.2 GW
RCRL 3.6 GW
RCPL 3.6 GW
RCRL/GC 11.3 %
SOUTH EASTERN UCTE
GC 24.9 GW
RAC 19.8 GW
RL 19.8 GW
RCRL 0.0 GW
RCPL -0.3 GW
RCRL/GC 0.2 %
SPAIN + Portugal
GC 90.8 GW
RAC 61.0 GW
RL 64.6 GW
RCRL -3.7 GW
RCPL -4.9 GW
RCRL/GC -4.0 %
ITALY
GC 96.0 GW
RAC 73.0 GW
RL 72.4 GW
RCRL 0.6 GW
RCPL -0.2 GW
RCRL/GC 0.6 %
Island operation
TURKEY
MOROCCO


Legend
GC Generating Power Capacity (GW)
RAC Reliably Available Capacity (GW)
RL Reference Load (GW)
RCRL Remaining Capacity at Reference Load (GW)
RCPL Remaining Capacity at Peak Load (GW)
RCRL/GC (%)
Only changes in transmission lines capacities are indicated
(DC lines in blue)
Figure 6
July 2015 Sc A
NORDEL
GC n.a GW
RAC n.a GW
RL n.a GW
RCRL n.a GW
RCPL n.a GW
RCRL/GC ####### %
IPS/UPS
Island operation
IRELAND
GC 9.5 GW
RAC 6.7 GW
RL 6.4 GW
RCRL 0.3 GW
RCPL 0.2 GW
RCRL/GC 2.8 %
GREAT BRITAIN
GC 75.1 GW
RAC 52.0 GW
RL 50.5 GW
RCRL 1.5 GW
RCPL 1.0 GW
RCRL/GC 2.0 %
CENTREL
GC 70.4 GW
RAC 41.8 GW
RL 35.2 GW
RCRL 6.6 GW
RCPL 5.0 GW
RCRL/GC 9.4 %
Main Block UCTE
GC 340.7 GW
RAC 201.2 GW
RL 189.9 GW
RCRL 11.2 GW
RCPL 5.1 GW
RCRL/GC 3.3 %
ROMANIA + BULGARIA
GC 31.4 GW
RAC 18.1 GW
RL 13.8 GW
RCRL 4.2 GW
RCPL 3.9 GW
RCRL/GC 13.5 %
SOUTH EASTERN UCTE
GC 24.9 GW
RAC 17.8 GW
RL 18.5 GW
RCRL -0.8 GW
RCPL -1.7 GW
RCRL/GC -3.1 %
Island operation
SPAIN + Portugal
GC 91.8 GW
RAC 56.3 GW
RL 61.6 GW
RCRL -5.3 GW
RCPL -8.8 GW
RCRL/GC -5.8 %
ITALY
GC 96.0 GW
RAC 71.0 GW
RL 72.8 GW
RCRL -1.8 GW
RCPL -2.0 GW
RCRL/GC -1.9 %
TURKEY
MOROCCO

Appendix: Structure of the Power Balance

The power balance forecasts are based on the following items:

National Generating Capacity (NGC)

The national generating power capacity is the net maximum output capacity of electricity producers and of the power stations of industrial auto-producers of each country. It is divided into hydro power stations, nuclear power stations, conventional thermal power stations, renewable energy sources and power sources that cannot be clearly identified. Net maximum output capacities are used in the projections. Independent power producers and autoproducers are classified in the different categories as a function of their primary energy sources. For blocks, GC (Generating Capacity) is used instead of NGC.

Reliably Available Capacity (RAC)

The so-called “reliably available capacity” in UCTE methodology is obtained from the national generating power capacity after deducting non-usable capacity, estimated planned) overhauls and (forced) outages of thermal power stations as well as system services reserves; this is in fact the estimated available capacity in average operating conditions.

Based on TSO statistics regarding injections from different power plants, the TSO can estimate the part of the generating capacity which is not usable due to the above various reasons.

The so-called non-usable capacity may be due to lack of primary energy (for example wind energy), temporary limitations of capacity in hydroelectric power stations and multi-purpose installations (for example heat extraction in combined heat and power plants, water debit for irrigation), capacity of power stations in test operation whose commissioning date is uncertain, limitations due to transmission network congestion etc. Mothballed plant, which can be returned to service within a short time (from some months to one year or even longer), should be also deducted from the NGC; however in some cases the capacity of these mothballed plants is already deducted from the NGC.

In respect of outages, a multi-annual average value (expected value) is used in the forecast. With regard to above-average outages, adequate operating reserve may be scheduled by power plant operators (not the TSOs).

System services refer to capacities, which are required to ensure the short-term operation of the power system. They include power reserves necessary for frequency control, voltage control, restoration of supply and system management. System services reserves do not include long-term reserve capacities, which are not the responsibility of the TSOs but of the power plant operators. The latter long-term reserves are included in the Remaining Capacity (see below).

As a result, the RAC may represent only 70% of the NGC for some countries or group of countries. This apparently low level results mainly from the rather high level of non-usable capacity of hydro and wind power generation due to the uncertainties that affect the availability of their primary energy.

Reference Load (RL)

In order to get a consistent picture of the power balance across Europe it has been decided to collate load data against a common reference time. The load of each country (including transmission losses), , is recorded for at the reference time, 3rd Wednesday in January at 19:00 and 3rd Wednesday of July at 11:00 (this latter not available for NORDEL), without taking into account power exports. The projections of load are made under normal climatic conditions, e.g. outdoor temperatures corresponding to the multi-annual average, and normal development of economic activities are assumed in these forecasts.

Basing the power balance on such a common time seems to be preferable to basing it on each TSO´s peak load; due to the large geographical scale of the European system the regional peaks occur at different times and their summation would systematically over-estimates the common peak load of the larger system.

Margin to Peak Load (MPL)

When interpreting the load forecast and generation adequacy results, one needs to consider that the reference time may not correspond to the monthly peak load recorded in the different control areas.

To help quantify this effect, the difference between the peak at the reference time and the peak of the month is provided as additional information. Calculating the remaining capacity at the monthly peak gives a more reliable estimation of the generation adequacy for the isolated systems of some regions.

Because the peak load for a set of countries is calculated as the sum of the peaks of the individual countries, this leads to an overestimate of the peak load for the largest geographical blocks (or subsystems).

Remaining Capacity at Reference Load (RCRL)

The remaining capacity at the reference load is obtained from the expected available capacity minus the reference load. As explained, the reference load does not represent the peak load. This is an additional reason why the remaining capacity must not be interpreted as a surplus capacity.

Remaining Capacity at Peak Load (RCPL)

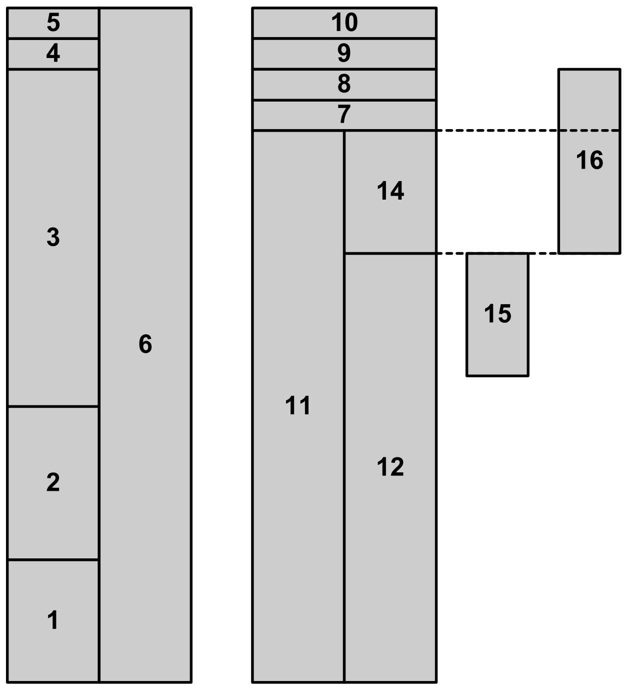
The remaining capacity at the peak load is obtained from the remaining capacity against reference load minus the margin to peak load. The remaining capacity at time of peak load provides a better indication of the adequacy of generation to meet load against a number of potential risks of loss of plant, abnormal weather and demand forecast errors. It also provides a more realistic estimate of the potential for exports;

Transfer Capacities

When establishing a statistic for such a large area as the interconnected European power system, one is clearly not only interested in the overall sums of installed capacity, load and remaining capacity, but also in the balances within large sub-systems. Such sub-systems can most easily be defined along the boundaries of the synchronously operated areas, i.e. UCTE, NORDEL, GB and Ireland. But also within UCTE additional sub-systems can be defined along the boundaries of relatively weakly interconnected or congested interfaces or different market organisations.

Since it is not possible to make reliable forecasts for the transfers between different control areas or countries, these cannot be used in the power balance. However, the potential effect of such transfers on the reliability of supply within each sub-system can be inferred from the net transfer capacities (NTCs) between the sub-systems. These NTC values are calculated at regular intervals by ETSO (www.etso-net.org).

Definitions of Power Balance Methodology



1. capacity of hydro power plants
2. capacity of nuclear power plants
3. capacity of conventional thermal power plants
4. capacity of renewable sources
5. capacity of not clearly identifiable sources
6. national generating capacity (= 1 + 2 + 3 + 4 + 5)
7. non-usable capacity
8. overhauls
9. outages
10. system services reserve
11. reliably available capacity (= 6 – 7 – 8 – 9 – 10)
12. reference load
13. margin against the monthly peak load (not shown in Figure)
14. remaining capacity excluding exchanges (= 11-12)
15. importable capacities (NTC)
16. exportable capacities (NTC)

Generation adequacy assessment

Generation adequacy assessment consists in investigating the ability of the generating units to match the system load evolution.

The approach used in this report is based on a comparison between the load and the generating capacity considered as "reliably available" for power plant operators (generating capacity after the deduction of various sources of unavailability - non-usable capacity, scheduled and unscheduled outages - and reserves required by TSOs for system services ; see figure hereafter).

The load corresponds to a common synchronous reference for the entire European network. The selected reference points are the third Wednesday of January at 19.00 and the third Wednesday of July at 11.00; the load forecast is based upon the assumption of normal climatic conditions.

In addition the difference between these reference loads and peak load is estimated for each geographical area.

The resulting balance, called "remaining capacity" (RC), can be interpreted as the capacity that the system needs to cover the difference between the peak load of each area and the load at the synchronous reference time, and, at the same time to cover demand variations (resulting for example from weather conditions) and longer term unplanned outages which the power plant operators are responsible to cover with additional reserves.

Developments have been performed by UCTE in order to estimate the level of RC necessary to provide a given level of security of supply taking into account the characteristics of every subsystem. A probabilistic approach has been used which allowed to define the statistical characteristics of the RC as the results of the probabilistic characteristics of each component : load and unavailability of generation.

Considering a level of risk for each national system corresponding to 1%, it results that for the UCTE system and some national systems, RC at peak load (RCPL) representing 5% of the national generating capacity is the condition to provide a reliable supply. For some other national systems, more sensitive to random factors (load variations or unavailability of generation), RCPL should represent around 10% of the national generating capacity.

This reference level of RCPL plus the difference between peak load and reference load (Margin to Peak Load – MPL) is called Adequacy Reference Margin (ARM).

Thus generation adequacy is assessed on the basis of the comparison between RC and ARM.

This method is applied to assess generation adequacy of the various geographical blocks ; the synchronous peak load of the blocks is estimated by the sum of the peak loads of the individual countries.

This approximation leads on one hand to an overestimation of the peak load for the largest geographical blocks and to a conservative view of the level of adequacy. On the other hand, considering the synchronous peak load of large size blocks leads to rely on the assumption that it is always possible to carry where needed the generating power available in a country in any other country of the block, whereas the capacities of the transmission system actually limit these possibilities.

The future trends in generation capacity are developed according to the assumptions underlying each scenario.

But when considering the results of these scenarios the following simplifications must be taken into account:

- because decommissioning decisions concerning generation units are often notified to TSOs with a short notice, the national generating capacity can be overestimated, especially on the medium long term,
- because cross-border exchanges forecasts are not taken into account in the power balance, the analysis considers neither long term contracts nor the participation in power plants located out of the national territory. However, these contracts can represent a significant and permanent contribution to satisfying the national load in some countries.