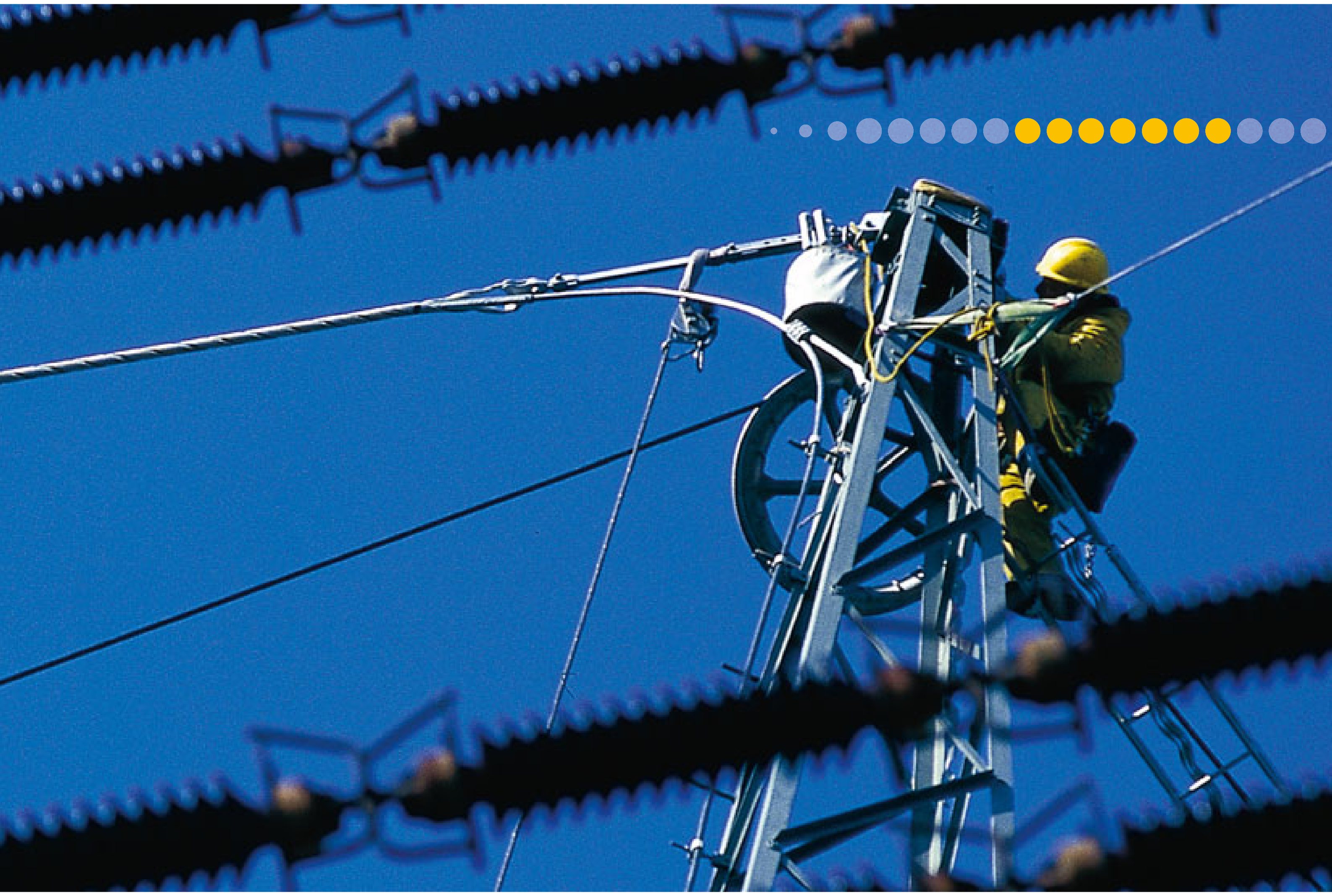

System Adequacy Methodology

union for the co-ordination of transmission of electricity

UCTE

UCTE SYSTEM ADEQUACY METHODOLOGY

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1 INTRODUCTION

1 INTRODUCTION

1.1 Purpose of this Document

This document aims at describing the data and the methodology for system adequacy analysis used by UCTE in its System Adequacy Retrospect reports and System Adequacy Forecast reports.

1.2 System Adequacy

System adequacy of a power system is a measure of the ability of a power system to supply the load in all the steady states in which the power system may exist considering standards conditions.

System adequacy is analysed through generation adequacy and transmission adequacy. General methodology used for system adequacy analysis is introduced in Chapter 2.

Generation adequacy of a power system is an assessment of the ability of the generation on the power system to match the consumption on the power system. The methodology for generation adequacy analysis is introduced in Chapter 3.1.

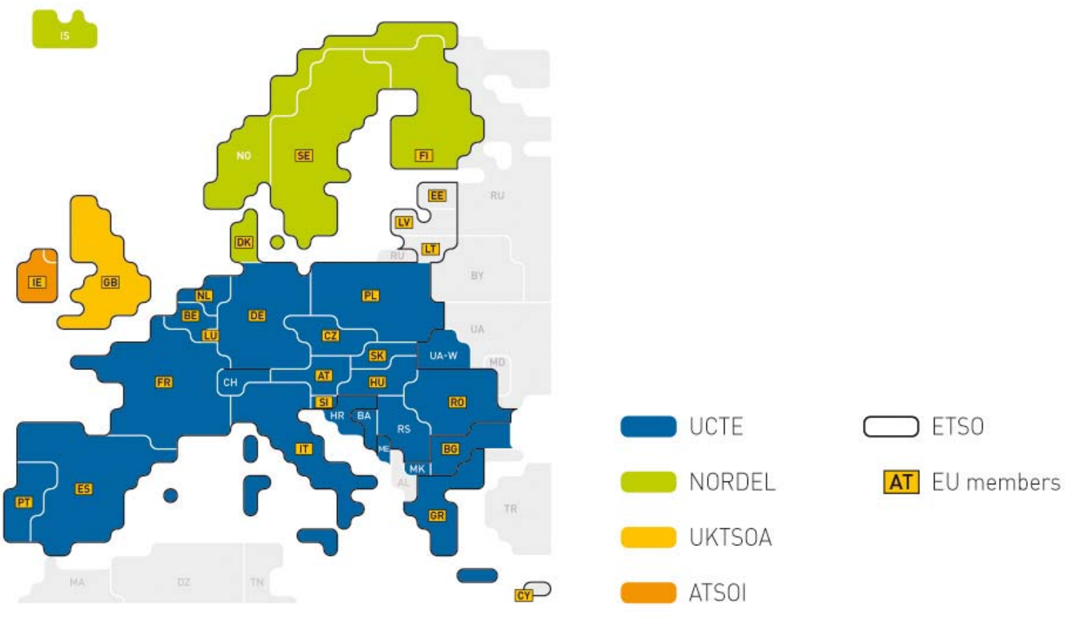
Transmission adequacy of a power system is an assessment of the ability of a power system to manage the flow resulting from the location of both consumption and generation. The methodology for transmission adequacy analysis is introduced in Chapter 3.2.

1.3 Geographical Perimeter

The perimeter of the system adequacy analysis performed by UCTE is made of all the countries of the UCTE members minus the Denmark West associated member Energynet.dk and plus the Ukraine West TSO Ukrenergo[1].

The differences between the UCTE perimeter and the actual geographical perimeter of the System Adequacy analysis are small enough to extend its results to the actual UCTE perimeter.

Figure 1 Map of UCTE Members



[1] Ukrenergo operates the UCTE interconnected grid around the town of Burshtyn in Western Ukraine.

Table 1 System Adequacy Geographical Perimeter

Abbreviation	Complete Country Name	National Correspondent
AT	Austria	VERBUND APG
BA	Bosnia-Herzegovina	ISO BiH
BE	Belgium	Elia
BG	Bulgaria	ESO EAD
CH	Switzerland	swissgrid
CZ	Czech Republic	CEPS
DE	Germany	VDN
ES	Spain	REE
FR	France	RTE
GR	Greece	HTSO/DESMIE
HR	Croatia	HEP-OPS
HU	Hungary	MAVIR ZRt.
IT	Italy	Terna S.p.A.
LU	Luxembourg	CEGEDEL Net S.A.
ME	Montenegro	EPCG
MK	Former Yugoslav Republic of Macedonia	MEPSO
NL	Netherlands	TENNET
PL	Poland	PSE-Operator SA
PT	Portugal	REN
RO	Romania	Transelectrica
RS	Serbia	JP EMS
SI	Slovenia	ELES
SK	Slovak Republic	SEPS
UA-W	Ukraine West	Ukrenergo

1.4 Time of Reference

Times in the studies are expressed in Central European Time (CET=UTC[2]+1) in winter and in Central European Summer Time (CEST=UTC+2) in summer.

1.5 National Representativeness

Every national correspondent company is in charge of collecting data aggregated for the whole country.

Yet, in some countries, the collected data do not cover the entire national system. It might be due to a limited access to data on the distribution network, to production units connected to private grids for own consumption, etc.

National Representativeness index is the estimation of the percentage of the national value the collected data are representative of.

Collected data are published as such[3] and are not extended to the estimated national values. Yet the collected data are representative enough for the results to be extended to the whole Geographical Perimeter of the system adequacy studies. Comparison between figures from

[2] UTC is the international designation for Universal Coordinated Time

[3] This convention may deviate from the one used in the statistical data publication.

consecutive reports must be carefully considered due to potential changes in the National Representativeness index.

As generation adequacy is based on the comparison of load and generation, National Representativeness of load data and generation data should be almost identical to make the generation adequacy assessment reliable.

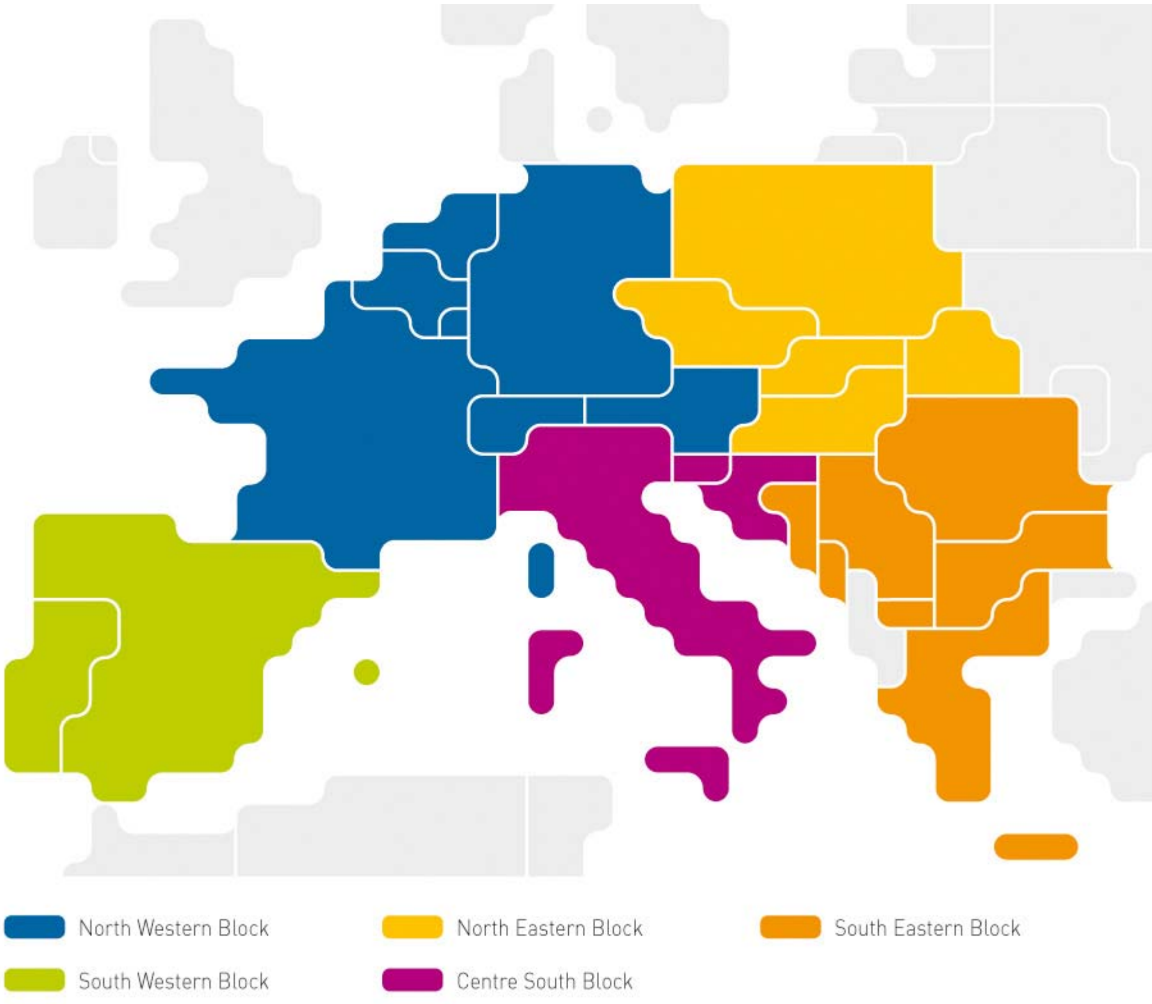
1.6 Aggregation Perimeters

System adequacy is analysed at 3 levels: individual countries, regional blocks and the whole UCTE.

The analysis at regional level completes the overall UCTE-wide picture by taking account of major limitations in power flows within the whole synchronous area.

Regional blocks[4] are defined according to the configuration of the transmission network and are introduced in the figure below.

Figure 2 Map of System Adequacy Regional Blocks



[4] North western Block used to be referred to as CENTREL Block. Slovenia and Croatia joined Italia in a Centre South Block from 2008.

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Generation adequacy of a power system is an assessment of the ability of the generation on the power system to match the consumption on the power system.

2.1 Power Balance

System adequacy analyses are based on power balance calculations at specific time points and on various perimeters.

2.2 Time Horizons

Forecast

A UCTE System Adequacy Forecast report is published at the beginning of each year (Y) with the following time horizons:

- Initial forecast on the year of publication (Y),
- Mid-term forecast on the year 5 years after the year of publication (Y+5), e.g. 2013 in the report published early 2008
- Long-term forecast on the rounded mid decades and decades following the publishing date, e.g. 2010, 2015 and 2020 in the report published early 2008.

Retrospect

A UCTE System Adequacy Retrospect report is published by the middle of every year (Y) with a retrospect of the year before the publishing date (Y-1).

Retrospect reports dedicated to one year (Y-1) may include monitoring of the evolutions of the various figures throughout the earlier years (Y-2, Y-3, etc.) when relevant.

Data regarding year Y-1 are still provisional in most countries when published in year Y. Indeed, the final official data are to be published many months later. For the same reason, data regarding year Y-2 sometimes differ from the data published in Y-1 because they have been updated in the meantime.

Comparison between figures of the same year from consecutive reports must be carefully considered due to updates in the data previously published but also due to changes in the national representativity.

2.3 Reference Points

Reference points are the dates and times power data are collected for.

Reference points are specified as characteristic as possible of the state of the UCTE power system over the study period.

Power data collected for each country are synchronous at each reference point and can thus be aggregated.

In order to compare the evolutions of the results similar reference points are specified for all time horizons and from one report to another.

Data collected for the hour H are the average value from the hour H-1 to the hour H.

Forecast

3 annual reference points are defined in the forecast reports:

- The 3rd Wednesday of January on the 11th hour (from 10:00 CET to 11:00 CET
- The 3rd Wednesday of January on the 19th hour (from 18:00 CET to 19:00 CET)
- The 3rd Wednesday of July on the 11th hour (from 10:00 CEST[5] to 11:00 CEST)

Power data used in the forecast power balance are hourly average estimated values.

Retrospect

A single monthly reference point is defined in the retrospect reports:

- The 3rd Wednesday of each month on the 11th hour (from 10:00 CEST to 11:00 CEST) in summer and (10:00 CET to 11:00 CET) in winter

As much as possible, power data used in the retrospect power balance are based on hourly average values of the actual metering at the every reference points.

2.4 Load

Load on a power system is the net consumption corresponding to the hourly average active power absorbed by all installations connected to the transmission grid or to the distribution grid, excluding the pumps of the pumped-storage stations.

"Net" means that the consumption of power plants' auxiliaries is excluded from the Load, but network losses are included in the Load.

Forecast

Load forecast is the best national estimate available to the TSOs, under normal climatic conditions. It is estimated according to technical, economical and political assumptions, especially on demography, economic growth and, energy efficiency policy.

Retrospect

Load is based on hourly average actual metering.

2.5 Load Management

Load Management[6] (LM) is the potential deliberate load reduction available at peak load to balance the system and ensure reliability.

Forecast

Load Management forecast is estimated according to the information available to each TSO.

Retrospect

Activated Load Management is reflected in the Load metering. Load Management is therefore not used in the generation adequacy retrospect assessment and no value is collected.

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[5] See Chapter 1.4

[6] Previously referred to as Demand Side Management Potential in the UCTE System Adequacy Forecast reports

2.6 Generation Forecast Scenarios

As long-term forecast is subject to a high level of uncertainty and considering that it can take two to three years only to build a new power plant, UCTE has developed 2 long-term generation scenarios to help assessing the range of uncertainty and evaluating the risk for the security of supply over the coming years.

Net Generating Capacity and the related primary energy sources breakdown as well as, unavailable capacity are build in every countries according to these 2 generation scenarios.

Conservative Scenario or Scenario A

This scenario takes into account the commissioning of new power plants considered as sure (power plants under construction before the data collection or whose investment decision has been notified as firm to the correspondent company) and the shutdown of power plants expected during the study period.

This scenario shows the evolution of the potential unbalances if no new investment decision were to be taken in the future. It makes possible to identify the investments necessary to maintain the expected security of supply over the forecast period.

Best Estimate Scenario or Scenario B

This scenario takes into account the generation capacity evolution described in scenario A as well as future power plants whose commissioning can be considered as reasonably credible according to the information available to the TSOs: commissioning resulting from governmental plans or objectives (regarding the development of renewable sources in accordance with the European legislation for instance), from the requests for connection to the grid or from the public information or from information provided to the TSOs by producers or would be producers.

This scenario gives an estimation of potential future developments, provided that market signals give adequate incentives for investments.

2.7 Net Generating Capacity

Net Generating Capacity (NGC) of a power station is the maximum electrical net active power it can produce continuously throughout a long period of operation in normal conditions.

- ”Net” means the difference between, on the one hand, the gross generating capacity of the alternator(s) and, on the other hand, the auxiliary equipments' load and the losses in the main transformers of the power station.
- For thermal plants “normal conditions” means average external conditions (weather, climate…) and full availability of fuels.
- For hydro and wind units, “normal conditions” refer to the usual maximum availability of primary energies, i.e. optimum water or wind conditions.

Net Generating Capacity of a country is the sum of the individual Net Generating Capacity of all power stations connected to either the transmission grid or to the distribution grid.

Power stations jointly operated with foreign partners are fully taken into account in the net generating capacity of the country where the power station is actually located. When a power station is located at the border of two countries, the share of each operator is reflected in the related national Net Generating Capacity.

Net Generating Capacity of each country is subdivided according to the following primary energy sources:

- Nuclear power;
- Fossil Fuels, subdivided into:
  - Lignite,
  - Hard Coal,
  - Gas,
  - Oil,
  - Mixed Fuels, comprises power plants which burn several fuels according to opportunity
  - Non Attributable Fossil Fuels, comprises power plants which, according to their fossil fuels do not correspond to or can not be categorised among the previously mentioned categories;
- Hydro power
  - Storage Hydro,
  - Run-of-River Hydro,
  - Pure Pumped-Storage Water[7];
  - Mixed Pumped-Storage Water, comprise pumped-storage water power plants with significant natural cumulative flow into the upper reservoir
- Renewable Energy Sources (other than hydro), subdivided into:
  - Wind,
  - Other RES, i.e. photovoltaic, geothermal, biomass, waste, etc.;
- Not Clearly Identifiable Sources comprises power plants which do not correspond to or cannot be categorised among the previously mentioned categories, according to the primary energy used.

2.8 Unavailable Capacity

Although a power station can theoretically generate its Net Generating Capacity, this is not actually the case for the several causes that are listed bellow.

Unavailable Capacity is the part of Net Generating Capacity that is not reliably available to power plant operators due to limitations of the output power of power plants.

Non-Usable Capacity

Aggregates reductions of the net generating capacities due to the following causes:

- Limitation due to intentional decision by the power plant operators
  - Power stations in mothball which may be re-commissioned if necessary
  - Power stations bound by local authorities which are not available for interconnected operation
  - Power stations under construction whose commissioning is scheduled for a certain date, but capacity is not firmly available because of delays or retrofitting

[7] The energy used by pumped-storage water plants to pumped the water into the storage facility as been provided by the power system. Therefore the pumped-storage water capacity cannot be considered as Renewable Energy Sources capacity.

- Power stations which are converted to other fuels or which are equipped subsequently with desulphurisation and de-nitrification plants
- Power stations in test operation

♦ Unintentional temporary limitation

- Power stations which output power cannot be fully injected due to transmission constraints
- Power station in multiple purpose installations where the electrical generating capacity is reduced in favour of other purposes such as heat extraction in combined heat and power plants for instance

♦ Limitation due to fuel constraints management

- Nuclear power stations in stretch-out operation
- Fossil fuel power stations
  - Power stations with interruptible fuel supply
  - Power stations with poor quality fuel, like unfit coal

♦ Limitation reflecting the average availability of the primary energy source

- Hydro power stations
  - Run-of-river power stations with usual seasonal low upstream water flow
  - Tidal power stations
  - Storage power stations subject to usual limitation such as limited reservoir capacity, power losses due to high water, loss of head height or limitation of the downstream water flow
- Wind power stations with seasonal lack of wind;
- Geothermal power stations,

♦ Limitation due to other external constraints

- Hydro power stations with water flow regulation for irrigation, navigation, tourism
- Power stations with output power limitation due to environmental constraints
- Power stations with output power limitation due to external thermal conditions

Maintenance and Overhauls

Aggregates scheduled and organised unavailability of generating capacity for regular inspection and maintenance, including recharging of fuel elements in nuclear power plants.

Should this information be unavailable to a TSO for some specific capacity, the related reduction due to maintenance and overhauls are included in the Non-Usable Capacity.

Outages

Forced unavailability of generating capacity, i.e. not scheduled and not included in Maintenance and Overhauls.

Should this information be unavailable to a TSO for some specific capacity, the related reduction due to outages is included in the Non-Usable Capacity.

System Services Reserve

Part of the Net Generating Capacity[8] required to compensate for real-time unbalances or to control the voltage, the frequency, etc. and which falls under the responsibility of TSOs to maintain system security from 1 hour ahead up to real time. It is made of:

- Primary Control Reserve (according to the definition in the UCTE Operational Handbook)
- Secondary Control Reserve (according to the definition in the UCTE Operational Handbook)
- The amount of Tertiary Reserve which can be activated within 1 hour and which is required by the TSO according to its operating rules.

System Services Reserve does not include longer-term reserve prior to 1 hour. This latter reserve is set up to face potential outages. Part of it is actually used to cover outages and counted in the Outages capacity. The rest is available and counted in the Remaining Capacity defined in Chapter 2.10.

System Services Reserve does not include the reserve which falls under the responsibility of market participants unless set up to complete the level of reserve required by UCTE rules.

Forecast

The amount of System Services Reserve is determined according to the operating rules of each TSO.

Retrospect

In the retrospect studies, System Services Reserve corresponds to the amount of reserve contracted and available to the TSO at the reference time.

2.9 Reliably Available Capacity

Reliably Available Capacity (RAC) on a power system is the difference between Net Generating Capacity and Unavailable Capacity.

Reliably Available Capacity is the part of Net Generating Capacity actually available to cover the load at a reference point.

2.10 Remaining Capacity

Remaining Capacity (RC) on a power system is the difference between Reliably Available Capacity and Load.

Remaining Capacity is the part of Net Generating Capacity left on the system to cover any unexpected load variation and unplanned outages at a Reference Point.

Remaining Capacity is illustrated on Figure 3 page 14.

The Remaining Capacity is not fully available to power plant operators as part of it is also necessary to system operators for security reasons. See System Services Reserve definition in Chapter 2.8.

Forecast

Forecast Remaining Capacity is also calculated including Load Management which increases the Remaining Capacity.

[8] Load reduction measures contributing to system services are excluded of System Services Reserve

Retrospect

Remaining Capacity should not be confused with the Surplus of available capacity defined by UCTE in its statistical data[9] and which does not include operational margin left to the system operators.

2.11 Exchanges

The Remaining Capacity may be altered to reflect the role physical flows on interconnections lines have on the power balance of each individual country and regional blocks.

Forecast

There is no forecast on physical exchanges. The potential role of physical exchanges is analysed by the comparison of Remaining Capacity with Simultaneous Interconnection Transmission Capacities introduced in Chapter 2.16.

Retrospect

Exchanges are the difference between the import and export physical flows on every interconnection lines[10] of a power system.

Physical flows are metered at the exact border or at a virtual metering point estimated from the actual one.

Positive Exchanges (imports > exports) increases the Remaining Capacity.

2.12 Margin Against Peak Load

To extend the results from a unique reference point to a whole analysed period, UCTE considers the Margin Against Peak Load.

Margin Against Peak Load is the difference between Load at the reference point and the peak load over the period the reference point is representative of.

Forecast

As reference points for the system adequacy forecast are seasonal, the related Margin Against peak Load must be seasonal too and is called Margin Against Seasonal Peak Load (MaSPL).

A Margin Against Seasonal Peak Load is then estimated for each reference point:

- 1 summer value defined as the difference between the Load at the summer reference point and the forecast summer peak load, where summer peak load is related to the summer season the reference point is part of;
- 2 winter values defined as the difference between Load at each winter reference point and the forecast winter peak load, where winter peak load is related to the winter season the reference point is part of.

Retrospect

As reference points in the System Adequacy Retrospect are monthly, the related Margin Against Peak Load must be monthly too and is called Margin Against Monthly Peak Load (MaMPL).

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[9] http://www.ucte.org/services/statisticalterms/capacity/

[10] Figures may differ with the ones reported by UCTE for statistic purposes which exclude distribution lines.

It is calculated as the difference between the actual monthly peak load metering and the Load metering at the monthly reference point.

2.13 Remaining Margin

Remaining Margin (RM) on a power system is the difference between Remaining Capacity and Margin Against Peak Load.

Remaining Margin is the part of Net Generating Capacity left on the system to cover any unexpected load variation and unplanned outages over the analysed period the Margin Against Peak Load is representative of.

Remaining Margin is illustrated in Figure 3 on page 14.

Forecast

Remaining Margin is assessed with Margin Against Seasonal Peak Load but without any forecast physical exchanges.

The potential role of physical exchanges is analysed by the comparison of Remaining Capacity with Simultaneous Interconnection Transmission Capacities introduced in Chapter 2.16.

Retrospect

Remaining Margin is calculated with Margin Against Monthly Peak Load and with or without Exchanges.

Figure 3 Remaining Capacity and Remaining Margin

2.14 Spare Capacity

Spare Capacity is the part of Net Generating Capacity that should be kept available at Reference Points to ensure the security of supply in most of the situations.

Spare Capacity is supposed to cover a 1% risk of shortfall on a power system i.e. to guarantee the operation on 99% of the situations.

Spare Capacity is estimated considering random fluctuations of Load (reflecting especially its climatic sensitivity) and of Reliably Available Capacity (reflecting especially thermal outages, hydro and wind conditions). Random fluctuations may be estimated using probabilistic approach or Gaussian law model and related standard deviation.

UCTE studies concluded that Spare Capacity could be characterised in each individual country as 5% or 10% of Net Generating Capacity, depending on the specific load variations and unavailability of generating units on each national power system.

Spare Capacity for a set of countries (regional blocks or whole UCTE) is expressed as 5% of Net Generating Capacity (see next Chapter).

2.15 Adequacy Reference Margin

Adequacy Reference Margin (ARM) is the part of Net Generating Capacity that should be kept available at all time to ensure the security of supply on the whole period each reference point is representative of.

Adequacy Reference Margin in an individual country is equal to Spare Capacity plus the related Margin Against Peak Load.

Adequacy Reference Margin in a set of countries (regional blocks or whole UCTE) is estimated as the sum of the two following terms:

- Sum of all individual Margin Against Peak Load values. As peak load are not synchronous in every countries, this sum is over estimating the actual Margin Against Peak Load of the set of countries.
- Spare Capacity of the set of countries, estimated as 5% of Net Generating Capacity of the set of countries. Spare Capacity of the set of countries is lower than the sum of all individual Spare Capacity values and compensates the above mentioned over estimation of Margin Against Peak Load.

2.16 Simultaneous Interconnection Transmission Capacities

Simultaneous Interconnection Transmission Capacity (SITC) of a power system is the overall transmission capacity through its peripheral interconnection lines within UCTE. SITC are calculated according to the UCTE Regional Transmission Plans.

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

Due to potential correlation between the transmission capacities on the adjoining borders of a country, it is not always possible to calculate the SITC of a country by simply adding the Net Transfer Capacity[11] (NTC) on all the borders of the country. A dedicated calculation is then performed by the TSOs.

SITC values are potentially different at every reference points on every time horizons.

[11] NTC is the maximum total exchange program between two adjacent control areas compatible with security standards applicable in all control areas of the synchronous area, and taking into account the technical uncertainties on future network conditions. See UCTE Operation Handbook http://www.ucte.org/publications/ophandbook/

3 ANALYSIS

3 ANALYSIS

3.1 Generation Adequacy

Generation adequacy is assessed for each individual countries, for each regional blocks identified within the UCTE system in Chapter 2.1, and for the whole UCTE.

Forecast

Generation Adequacy Forecast at Reference Point under Normal Conditions

Considering Remaining Capacity definition in Chapter 2.10, generation adequacy forecast on power system is assessed at the reference points with the Remaining Capacity value which is calculated under normal conditions.

When Remaining Capacity is positive, it means that some generating capacity is likely to be available on the power system under normal conditions.

When Remaining Capacity is negative, it means that the power system is likely to be short of generating capacity under normal conditions.

Seasonal Generation Adequacy Forecast in Most of the Situations

Generation adequacy forecast on power system is then seasonally extended by the comparison of the related Remaining Capacity and Adequacy Reference Margin.

Considering Spare Capacity definition in Chapter 2.14, any Remaining Capacity over Adequacy Reference Margin is likely to be available on a power system in 99% of the situations. On the other hand, when Remaining Capacity is lower than Adequacy Reference Margin, the power system is likely to be short of generating capacity in 1% of the situation.

Yet, there are uncertainties on the Spare Capacity assessment and the percentage figures mentioned before should not be taken for granted.

When Remaining Capacity is over or equal to Adequacy Reference Margin, it means that some generating capacity is likely to be available for export on the power system.

When Remaining Capacity is lower than Adequacy Reference Margin, it means that the power system is likely to have to rely on import flows when facing severe conditions.

When Remaining Capacity is lower than Adequacy Reference Margin, it must be interpreted as a potential deficit of generating capacity on the on the power system if no investment in additional generating units are decided from now on to the analysed time horizon.

Considering “Conservative” Scenario A introduced in Chapter 2.6, investment decisions may also consist in the confirmation of projects which have been publicised but not firmly engaged yet.

Considering “Best Estimate” Scenario B, additional firm investment decisions are necessary.

As the decommissioning date of the generating units is often notified to TSO at short notice, Net Generating Capacity can be overestimated and so can Remaining Capacity and generation adequacy.

Retrospect

Generation Adequacy Retrospect at Reference Point

Generation adequacy retrospect on power system is assessed at the reference points through the Remaining Capacity value.

When Remaining Capacity without Exchanges is positive, it means that the power system had enough internal generating capacity left to cover its Load; when negative, it means that the power system had to cover its Load with the help of imports.

As long as all individual Remaining Capacities with Exchanges are positive, it means that the power balance was achieved throughout UCTE.

Monthly Generation Adequacy Retrospect

Considering Remaining Margin definition introduced in Chapter 2.13, the generation adequacy retrospect assessment is then monthly extended.

When Remaining Margin without Exchanges is positive, it means that the power system had enough internal generating capacity left to cover its load at any time of the month.

When Remaining Margin without Exchanges is negative, it means that the power system might have to rely on imports to cover its monthly peak load.

The evolution of the annual minimum Remaining Margin throughout the years is a good indicator of the true evolution of the generation adequacy.

3.2 Transmission Adequacy

Transmission adequacy is assessed for each individual countries and regional blocks identified within the UCTE system in Chapter 2.1.

Further analysis on transmission adequacy will be available in the UCTE Regional Transmission Plans.

Forecast

Transmission adequacy forecast aim at identifying potential congestions and potential need for developments of interconnection lines. It does not aim at identifying the cross border flows that would be originated by market price differences resulting from differences in fuel mix between countries or regional blocks for instance.

Transmission Adequacy Forecast at Reference Point under Normal Conditions

Considering the Remaining Capacity definition in Chapter 2.10, generation adequacy forecast on power system is assessed at the reference points with the comparison of Remaining Capacity, calculated under normal conditions, and Simultaneous Interconnection Transmission Capacity.

It assesses the ability of a power system to transmit its own positive Remaining Capacity to its neighbouring power systems.

When Remaining Capacity is positive and lower than Export Capacity, it means that the generating capacity likely to be available on the power system can be exported *under normal conditions at reference point.*

When Remaining Capacity is negative and its absolute value is lower than Import Capacity, it means that all the necessary import flows to meet load can be imported *under normal conditions at reference point*.

Seasonal Transmission Adequacy Forecast in Most of the Situations

As explained in Chapter 3.1, when Remaining Capacity is over or equal to Adequacy Reference Margin, it means that some generating capacity is likely to be available for export in 99% of the situations. On the other hand, when Remaining Capacity is lower than Adequacy Reference Margin, it means that the power system is likely to have to rely on import flows in 1% of the situations.

It assess the ability of power system to meet its Adequacy Reference Margin with the necessary support of import flows from its neighbouring power systems or the ability of a power system to export its positive Remaining Margin to its neighbouring power systems, if necessary.

When Remaining Capacity minus Adequacy Reference Margin is positive and lower than Export Capacity, it means that all the generating capacity likely to be available on the power system can be exported *in most of the situations*.

When Remaining Capacity minus Adequacy Reference Margin is negative and its absolute value is lower Import Capacity, it means that all the necessary import flows to meet load can be imported *in most of the situations*.

Retrospect

Transmission Adequacy Retrospect Analysis

Transmission adequacy retrospect analysis look at the constraints on internal and interconnection lines with a direct impact on the Exchanges introduced in Chapter 2.11.

Transmission adequacy is therefore retrospectively analysed regarding 3 aspects:

- The main developments and upgrades on the UCTE network during the year with emphasis on commissioned lines or transmission devices with a significant impact on the interconnections and on congestions by increasing the NTC, by reducing or increasing constraints, by decreasing congestion costs, …)
- The main disturbances which have affected the transmission lines, collected by the UCTE TSO Forum organization and published on the Living Grid[12] section on the UCTE Web site,
- The congestions observed on the interconnection lines as and their criticality estimated by both countries on interconnection, according to a common index.

Congestions Retrospect Analysis[13]

There was a congestion on an interconnection border when access have not be granted to all the actors who requested it, i.e. when market players were eager to buy more capacity than on sale.

Therefore, congestions in the frame of System Adequacy Retrospect report are not necessary physical congestions but should be called commercial or contractual congestions.

Their causes are to be found not only in the limited technical capacity of the interconnection lines, but also in the allocation mechanisms of the Net Transfer Capacity which were applied.

In order to qualify precisely the congestion, the table below is been used to classify the occurrence of congestion for each border and on each direction, according to the season and the hour of the day.

Tableau 1 Interconnection Congestion Occurrence Classification

Season	**Hours**
Never (**N**)	Never (**N**)
Spring (**Sp**)	Varying (**V**)
Autumn (**Au**)	Peak hours (**P**)
Summer (**Su**)	Night hours (**Ni**)
Winter (**W**)	Day hours (**D**)

[12] See UCTE Living Grid http://www.ucte.org/services/livinggrid/

[13] This methodology is currently under revision by UCTE

All year (**AY**)	All day (**A**)

Methods for congestion management in each country are also specified.

More, for each border and on each direction, congestions are rated with an annual severity index. This index is the annual frequency of any congestion, expressed as a percentage. It is the ratio of the total time duration of all the congested periods during the analysed year by whole year duration.

Severity indexes are represented on a map with arrows described in the table bellow.

Tableau 2 Interconnection Congestion Severity Index Representation

Severity Index	Arrow's colour	Annual Frequency of Occurrence
n.a.	White	n.a.
0	Green	0%
1	Yellow	1-25%
2	Orange	26-50%
3	Red	51-75%
4	Purple	76%-99%
5	Black	100%

Severity indexes in the same direction may differ one both sides of a border means that maximum capacity allocation is more often reached on one side. Various reasons may explain this: existence of physical congestion on the internal network of the TSO may be one, as well as capacity allocation process which may differ. Next chapter provides national comments concerning these issues.

According to this rather ”commercial” definition of congestion, it is also possible to observe congestion simultaneously in both directions. When the maximum amount of capacity to be allocated is fully fixed ex-ante in both directions and there is neither export capacity nor import capacity left on sale, for instance. This is why the total of severity indexes in both directions may exceed 100% in some cases.

4 GLOSSARY OF TERMS

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Adequacy Reference Margin	Adequacy Reference Margin (ARM) is the part of Net Generating Capacity that should be kept available at all time to ensure the security of supply on the whole period each reference point is representative of. Adequacy Reference Margin in an individual country is equal to Spare Capacity plus the related Margin Against Peak Load.
Load Management	Load Management (LM) is the deliberate load reduction available at peak load to balance the system and ensure reliability should the system be stressed out.
Exchanges	Exchanges are the difference between the import and export physical flows on every interconnection lines of a power system.
Export Capacity	See Simultaneous Interconnection Transmission Capacities
Generation Adequacy	Generation adequacy of a power system is an assessment of the ability of the generation on the power system to match the consumption on the power system.
Import Capacity	See Simultaneous Interconnection Transmission Capacities
Load	Load on a power system is the net consumption corresponding to the hourly average active power absorbed by all installations connected to the transmission grid or to the distribution grid, excluding the pumps of the pumped-storage stations. “Net” means that the consumption of power plants‘ auxiliaries is excluded from the Load, but network losses are included in the Load.
Margin Against Peak Load	Margin Against Peak Load is the difference between the Load at the reference point and the peak load over the period the reference point is representative of. Margin Against Peak Load is used to extend analysis from a reference point to longer period the reference point is representative of.
National Representativeness	National Representativeness index is the estimated percentage of the national value the collected data are representative of.
Net Generating Capacity	Net Generating Capacity of a power station is the maximum electrical net active power it can produce continuously throughout a long period of operation in normal conditions, where: ♦ "net" means the difference between, on the one hand, the gross generating capacity of the alternator(s) and, on the other hand, the auxiliary equipments' load and the losses in the main transformers of the power station; ♦ for thermal plants “normal conditions” means average external conditions (weather, climate…) and full availability of fuels; ♦ for hydro and wind units, “normal conditions” refer to the usual maximum availability of primary energies, i.e. optimum water or wind conditions. Net Generating Capacity of a country is the sum of the individual

	Net Generating Capacity of all power stations connected to either the transmission grid or to the distribution grid.
Reference Points	Reference points are the few dates and times power data are collected for. Reference points are characteristic enough of the whole studied period to limit the data to be collected to the ones at the reference points.
Reliably Available Capacity	Reliably Available Capacity (RAC) on a power system is the difference between Net Generating Capacity and Unavailable Capacity. Reliably Available Capacity is the part of Net Generating Capacity actually available to cover the load at a reference point.
Remaining Capacity	Remaining Capacity on a power system is the difference between Reliably Available Capacity and Load. Remaining Capacity is the part of Net Generating Capacity left on the system to cover any unexpected load variation and unplanned outages at a Reference Point.
Remaining Margin	Remaining Margin on a power system is the difference between the Remaining Capacity and the Margin Against Peak Load. Remaining Margin is the part of the Net Generating Capacity left on the system to cover any unexpected load variation and unplanned outages over the period the Margin Against Peak Load is representative of.
Simultaneous Interconnection Transmission Capacities	Simultaneous Interconnection Transmission Capacity of a power system is the overall transmission capacity through its peripheral interconnection lines within UCTE. SITC are calculated according to the UCTE Transmission Development Plans. The SITC export value is called Export Capacity and may differ from the SITC import value, called Import Capacity.
Spare Capacity	Spare Capacity is the part of Net Generating Capacity that should be kept available at Reference Points to ensure the security of supply in most of the situations. Spare Capacity is supposed to cover a 1% risk of shortfall on a power system i.e. to guarantee the operation on 99% of the situations.
System Adequacy	System adequacy of a power system is a measure of the ability of a power system to supply the load in all the steady states in which the power system may exist considering standards conditions. System adequacy is analysed through generation adequacy and transmission adequacy.
Transmission Adequacy	Transmission adequacy of a power system is an assessment of the ability of a power system to manage the flow resulting from the location of consumption and generation.
Unavailable Capacity	Unavailable Capacity is the part of Net Generating Capacity that is not reliably available to power plant operators due to limitations of the output power of power plants.

5 DATA COLLECTION TABLES

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Forecast Table

National Power Data (positive net values in GW)		Time Horizon 3rd Wednesday January 11:00 am	January 7:00 pm	July 11:00 am
Net Generating Capacity per primary source				
1	Nuclear Power			
2	Fossil Fuels	0.0	0.0	0.0
2A	*of which, Lignite*			
2B	*of which, Hard Coal*			
2C	*of which, Gas*			
2D	*of which, Oil*			
2E	*of which, Mixed Fuels*			
2F	*of which, Non Attributable Fossil Fuels*			
3	Renewable Energy Sources (other than hydro)	0.0	0.0	0.0
3A	*of which, Wind*			
3B	*of which, Other RES*			
4	Hydro power			
4A	*of which , Storage Hydro*			
4B	*of which, Run-of-River Hydro*			
4C	*of which, Pure Pumped-Storage Water*			
4D	*of which, Mixed Pumped-Storage Water*			
5	Not Clearly Identifiable Energy Sources			
6	**Net Generating Capacity** (6=1+2+3+4+5)	**0.0**	**0.0**	**0.0**
Unavailable Capacity per type				
7	Non-Usable Capacity			
8	Maintenance and Overhauls			
9	Outages			
10	System Services Reserve			
11	**Unavailable Capacity** (11=7+8+9+10)	**0.0**	**0.0**	**0.0**
12	**Reliably Available Capacity** (12=6-11)	**0.0**	**0.0**	**0.0**
13	Load			
14	Load Management			
15	**Remaining Capacity** including DSM Potential (15=12-13+14)	**0.0**	**0.0**	**0.0**
16	Spare Capacity (e.g. 5-10% of NGC)			
17	Margin Against Seasonnal Peak Load			
18	**Adequacy Reference Margin** (18=16+17)	**0.0**	**0.0**	**0.0**
Simultaneous Interconnection Transmission Capacity				
19	Import Capacity			
20	Export Capacity			

Retrospect Table

National Power Data		January	February	March
Net Generating Capacity per primary source				
1	Nuclear Power			
2	Fossil Fuels	0.0	0.0	0.0
2A	*of which, Lignite*			
2B	*of which, Hard Coal*			
2C	*of which, Gas*			
2D	*of which, Oil*			
2E	*of which, Mixed Fuels*			
2F	*of which, Non Attributable Fossil Fuels*			
3	Renewable Energy Sources (other than hydro)	0.0	0.0	0.0
3A	*of which, Wind*			
3B	*of which, Other RES*			
4	Hydro power			
4A	*of which , Storage Hydro*			
4B	*of which, Run-of-River Hydro*			
4C	*of which, Pure Pumped-Storage Water*			
4D	*of which, Mixed Pumped-Storage Water*			
5	Not Clearly Identifiable Energy Sources			
6	**Net Generating Capacity** (6=1+2+3+4+5)	**0.0**	**0.0**	**0.0**
Unavailable Capacity per type				
7	Non-Usable Capacity			
8	Maintenance and Overhauls			
9	Outages			
10	System Services Reserve			
11	**Unavailable Capacity** (11=7+8+9+10)	**0.0**	**0.0**	**0.0**
12	**Reliably Available Capacity** (12=6-11)	**0.0**	**0.0**	**0.0**
13	Load			
15	**Remaining Capacity** (15=12-13)	**0.0**	**0.0**	**0.0**
16	Margin Against Monthly Peak Load			
17	**Remaining Margin** (17=15+16)	**0.0**	**0.0**	**0.0**
18	Physical Imports			
19	Physical Exports			
20	**Exchanges** (20=19-18)	**0.0**	**0.0**	**0.0**

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