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UCTE “Operational Statistics” Working Group

POWER BALANCE OF THE UCTE: scope, objective and structure

1. Scope and objective

The “Operational Statistics” Working Group prepares at regular intervals studies on the common power balance of the countries belonging to the UCTE, i. e. at the present time:

B	Belgium
D	Germany
E	Spain
F	France
GR	Greece
I	Italy
HR	Croatia
SI	Slovenia
BiH	Bosnia-Herzegovina
YU	Yugoslavia
FYROM	FYR of Macedonia
L	Luxembourg
NL	Netherlands
A	Austria
P	Portugal
CH	Switzerland
CZ	Czechia
H	Hungary
PL	Poland
SK	Slovakia

Though there are differences in the structure of electricity supply in the various countries, the very close co-operation between transmission system operators (TSOs) enables co-ordinated action to be pursued.

For most countries, the electricity supply is not analysed in total but only a part of it described by the “share in total supply” that often represents “public supply” (e. g. contrary to industrial auto-generation) or the energy flowing through the transmission network.

This may lead to differences with regard to official statistics of the various countries. On the other hand, the balances may also include non-synchronous parts of countries connected through HVDC links (such as Corsica, Sardinia) as well as networks of countries which are temporarily not in parallel with the remainder of the network (e. g. in Ex-Yugoslavia).

The compilation of the power balance serves the following objectives:

- It shall give an overall survey of the power demand and the components used to meet this demand in the control areas of TSOs co-operating in the UCTE.
- In the light of the deregulated European electricity market, it shall give an overview of these important aspects of supply reliability to all players in the market.
- Hence, the power balance meets part of the system responsibility of transmission system operators.

A power balance forecast is established in autumn of each year for the three following years for the typical winter and summer months which are January and July. With a view to clearly illustrating the evolution over the years, the past year is included in the balance with retrospective values and the current year with updated forecast values. At the end of each year, the effective development is analysed in a retrospective power balance and compared to the forecast. The results obtained form the basis for a validation and thus for the compilation of the next forecast.

Additional information about the situation in terms of the energy economy in the different countries is given in an energy balance published in the monthly statistics and in the Statistical Yearbooks of the UCTE.

2. Data of TSOs in the deregulated electricity market

Unbundling of energy utilities pursuant to the EU Electricity Directive which has been implemented by most EU countries in or before 1999, implies new requirements for statistics:

- Given the fact that the different power plant operators and the various trading organisations are competing with each other, they are frequently no longer prepared to furnish data on generation scheduling or on certain aspects of customer demand.
- Besides, each individual power plant operator or each individual trading organisation covering only part of a certain geographic market, it will hardly be possible for them, even if they closely co-operate, to compile power balances relating to geographic areas.
- As a general rule, Pools are considered as any other participants in the market. In some countries, however, Pools may be charged with particular tasks (e. g. supply of non-eligible customers). Such an obligation to supply often implies a close co-operation

between the Pool and the TSO, which can facilitate the information flow from the Pool to the TSO, e. g. in terms of reserves.

- The TSOs are not only responsible for a safe and reliable functioning of the total system, but with connection data, load forecasts and the schedules of system users they have also the data available required for the compilation of the power balance forecast and retrospect.
- Pursuant to their national Grid Codes or to the UCTE rules, TSOs are obliged to ensure the confidential treatment of information relating to transactions. Therefore, they can only use aggregate data for their statistics.
- Power balance forecasts and retrospects can be compiled by TSOs on the basis of data available to them.

Forecast data can be derived from values based on past experience or from supply connection data and schedules of system users. These data and statistics available to the system operator can be used as a basis for the most important components of the power balances, as described in chapters 3 and 4. Though the quality of data is reduced as against power balances established in the past by integrated power companies, it remains acceptable if estimated values are used (e. g. non-usable capacity, outages, overhauls). The most serious problems concerning the availability of data are encountered by TSOs with regard to reserves as well as imports and exports. As shown in sections 4.5 and 4.10, these difficulties can be solved to a large extent by giving the table a new structure (subdivision of reserves into a TSO part for system services and a power station operation reserve part; combination of the latter with the surplus available capacity; consideration of international Net Transfer Capacities as a substitute for reliable import and export values).

The necessary information for the compilation of power balance forecasts and retrospects is obtained by the TSOs from programme data and information of power plant operators or, where this is not possible for competition reasons, from estimated values.

3. General structure of the power balance

To allow simultaneous analyses of the capacity being operated in parallel at the same frequency in the various UCTE countries (reference capacity) and thus to prevent overestimation caused by adding-up non-synchronous capacities, the third Wednesday of each month at 11:00 a. m. central European time (CET) was selected as uniform reference moment for the balance.

As the power balances of the UCTE represent an instantaneous picture of the generation and load structures in the different countries, one cannot draw any conclusions on the energy situation without additional information on the quantitative covering of demand. The monthly statistics of the UCTE can serve as a basis for this evaluation. Moreover, it has to be noted that the possibilities of power transport depend on the respective network situation.

All power values are net values. In the forecast, they relate to average hydro conditions whose probability of being exceeded amounts to 50 %. Normal operation of reservoirs is assumed for the preceding months.

The study proceeds from the maximum output capacity of generating units and takes account of reductions in output due to

– non-usable capacity
– overhauls of thermal power plants
– outages of thermal power stations
– the reserves required for system services and reserves for power plant operation or the proportion required at the reference moment (reserve capacity to cover outages or increasing demand due to climate or economic conditions).

In the forecast the firmly available capacity calculated in this way is compared to the expected load at the reference moment.

In the retrospect the guaranteed capacity is compared to the effectively measured load at the reference moment.

As additional information, a margin with respect to the expected monthly maximum load is indicated in the forecast.

In the retrospect, the reference load is compared to the monthly reference load.

Hence results a theoretic remaining capacity that can be positive (capacity surplus or export potential) or negative (lack of capacity or need for imports).The remaining capacity is compared to the capacities that can be safely transported across the frontiers of the country concerned or of a group of countries.

The structure of the power balance is annexed in the form of a table. All countries indicate their data in this scheme so that summing up of these values leads to a common power balance of the UCTE region.

The most important results of the studies are periodically published in the UCTE reports. Apart from a summary of results, the data are represented in tables and diagrams and completed by comments describing also the particularities of the different countries or groups of countries.

4. Explanation of the terms used in the power balance

4.1 National generating and purchase power capacity (lines 1 to 6)

The national generating and purchase power capacity is the net maximum output capacity of energy utilities and of the power stations of industrial auto-producers of each country.

The net maximum electric capacities are obtained from the gross maximum electric capacities minus the electric station auxiliary power.

Power stations jointly operated with foreign partners are fully taken into account as national power capacity by that country where the power station is located.

If a power station is located at the frontier of two countries the share of each country is considered as national generating capacity.

The national generating and purchase power capacities are divided into hydro power stations, nuclear power stations, conventional thermal power stations, renewable energy sources and power sources that cannot be clearly identified.

Conventional thermal power stations also include gas turbines as well as industrial auto-producers and mining industry power stations which do not exclusively cover station auxiliary demand.

“Renewable energy sources” and “not clearly identifiable energy sources” comprise capacities which, as a function of the primary energy used, do not correspond to the categories of hydro power stations, nuclear power stations and conventional thermal power stations, and which can be used for public/general supply and can thus be transported across the distribution and/or transmission networks.

“Renewable energy sources” comprise the following primary energies:

1. wind energy
2. photovoltaics/solar energy
3. geothermal energy
4. energy from biomass and waste (e. g. biogas, damp gas, municipal waste, industrial waste, wood and waste of wood)

In certain cases (e. g. classification of refuse-fired power stations) a clear distinction must be ensured as against renewable energies and conventional thermal power stations by means of footnotes or the like.

Independent power producers and supplies of industry to the public/general network are classified in the different categories as a function of their primary energy sources. Supplies of industrial auto-producers to the public/general network are likewise classified according to the primary energy used. However, this differentiation will not always be possible. The total generating capacity results from the network connection data, also from those announced for new power stations in the future.

4.2 Non-usable capacity (line 7)

Part of the generating and purchase power capacity indicated in the statistics cannot be freely deployed, such as

– Capacity which cannot be utilised due to a temporary lack of primary energy, for instance
  - run-of-river power stations which, in the long mean, show low water supplies (hydraulic constraints) during certain seasons
  - tidal power stations
  - geothermal power stations
  - conventional thermal power stations with fuels that cannot be fully utilised, like unfit coal
  - oil- and gas-fired power stations with interruptible fuel supply
  - nuclear power stations in stretch-out operation
  - Lack of wind in wind power stations during certain seasons

– Capacity of hydro power stations which is subject to temporary limitations, such as
  - limited reservoir capacity, which does not allow the full power output to be developed over periods of heavy load

  - power losses due to high water
  - loss of head height
  - limitation of the flow downstream of the installation

– Capacity that cannot be transmitted because the necessary transmission capacity has not been scheduled (transmission constraints)
– Capacity in multiple purpose installations where electrical capacity is reduced in favour of other purposes, for example
  - heat extraction in combined heat and power plants
  - water debit for irrigation, navigation or tourism
– Power reduction caused by the cooling systems of power stations
– Capacity of power stations under construction whose commissioning is scheduled for a certain date, but capacity is not firmly available because of delays or retrofitting.
– Capacity from generating units which are converted to other fuels or which are equipped subsequently with desulphurisation and denitrification plants.
– Part of capacity from power stations in test operation which are supposed to be not usable or which were effectively not usable
– Capacity reduction due to ecological constraints
– Capacity in conservation which is commissioned only in emergency cases
– Capacity locally bound by municipal and regional utilities which is not usable for interconnected operation.

In some member countries, the volume of non-usable capacity is not exactly known; therefore, the values for the different types of power stations should be estimated on the basis of statistics.

The non-usable capacity, e. g. of hydro or wind power stations, is obtained by comparing the power stations' connection capacity with the statistics of supplies from these power stations. To obtain reliable values for the power balance forecast, the TSO must have the necessary expertise in terms of hydro or aero-generation to analyse these statistics.

4.3 Maintenance (thermal power stations) (line 8)

An estimation of scheduled overhauls, including recharging of fuel elements in nuclear power plants is given in the forecast. As described in chapter 2, capacities under Maintenance are obtained from the statistics on power station supplies. Above-average Maintenance capacities must be compensated through reserve capacities (see 4.5).

In the retrospect, the effective Maintenance capacities must be indicated for the reference moment. Therefore, every TSO is obliged to develop, in co-operation with power station operators, a procedure for the collection of the necessary data on Maintenance capacities.

As only one reference moment has been agreed-upon for each month, it may happen that the effective Maintenance programs are not reflected accurately for the whole period of time. Nevertheless, the aggregate sum for all UCTE countries provides sufficiently precise information.

Maintenance capacities are obtained, for instance, from the statistics about power station supplies.

4.4 Outages (thermal power stations) (line 9)

Concerning the expected multi-annual average of outages, an average value (expectation value) is given in the forecast. With regard to above-average outages, adequate operating reserve has to be scheduled (4.5).

The effective outages are indicated in the retrospect.

The value of outage capacities is obtained from the statistics on power station supplies.

4.5 System services reserve (line 10)

The definition and utilisation of power reserves differ from one country to the next. Nevertheless, the methodology agreed upon in this study for the total balance of the UCTE countries enables each country to take account of its own considerations in terms of power reserves.

The total reserve capacity required is intended to compensate for all possible differences in the power balance between the expected situation under normal conditions and the actual situation; it is thus intended to ensure a reliable and economic electricity supply. This reserve capacity is necessary

– because the maximum load may exceed the expected value due to
  - meteorological influences, e. g. air temperatures below long-term average, cloudy sky
  - structural and economic influences and changes in consumption habits
– because part of the generating capacity is lower than expected according to the forecast owing to
  - hydraulicity or availability of hydro power stations below the mean value
  - above-average capacity subject to overhauls in thermal units
  - above-average outages of generating units
  - unanticipated requirements in terms of environmental protection
  - outage of purchased power (industry and foreign partners).

The following distinctions are made as a function of access time and responsibility:

– seconds reserve for power-frequency control (primary and secondary control reserve) that is made available chiefly through the control band width of power stations operating under primary control *(responsibility of the TSO);*

– minutes reserve (warm reserve or spinning reserve) that is provided chiefly by storage stations, pumped-storage stations, gas turbines and by thermal power stations operating at less than full output *(responsibility of the TSO);*

– hours reserve (cold reserve or stand-by reserve) available in thermal power stations which have to be started for this purpose *(responsibility of the power plant operator).*

(see also “Rules concerning primary and secondary control of frequency and active power in the UCPTE”)

Seconds and minutes reserve is provided in the framework of the “frequency control” system service by those power plant operators that have implemented, in co-operation with the TSOs, the necessary technical measures and have been bound by the TSO by contract to provide this reserve, and are called upon to make it available. Hence, this reserve is well known to the TSO.

Hours reserve is provided by the power plant operators. Reserves are activated as a function of the contractual arrangements concluded between customers and power plant operators, independently to a large extent of TSOs.

The reserve capacity considered as indispensable by the countries for system operation or the reserve effectively available is indicated in the forecast and in the retrospect as reserve for system services.

This reserve is made available by the internal system equipment only; it does not cover any losses pertinent to the contractual relationship between power station/customer.

The power plant operation reserve (if not indicated in line 8 “Overhauls (thermal power stations)” or line 9 “Outages (thermal power stations)”) is given in line 14 as estimated value (see also 4.9).

The necessary additional reserve requires the most complex analysis. On one hand, the TSO controls primary, secondary and minutes reserve because, according to the national Grid Codes, he is responsible for the operational reserves which are of decisive importance for the security of system operation. But in addition, this reserve component of the power balance methodology implies also long-term reserves for which system users are responsible in most countries, and which can be freely traded. In countries where a central Pool exists, this may also fall in the ambit of the Pool. The corresponding reserve demand must therefore be determined on the basis of information obtained from the power plant operators (or from the Pool) or, if this is not possible for competitive reasons, it must be estimated. These estimations can be carried out by using, for instance, statistics on program deviations of generation schedules and information about programs on reserve injections.

Owing to the aforementioned difference in responsibilities, a distinction is made in the power balance between the system operator’s reserve for system services and the power plant operator’s reserve. The system services reserve falls under the responsibility of TSOs and is hence completely known to them. Its amount is determined mainly on the basis of UCTE rules.

The volume of reserves for power plant operation as well as information on overhauls, outages and non-usable capacity is of particular importance in terms of competition: Information from power plant operators can hardly be obtained, except in the case of a

central Pool. Therefore, the power plant operation reserve is integrated into the net power balance, i. e. the “remaining capacity”.

4.6 Guaranteed capacity (line 11)

The guaranteed capacity is obtained from the national generating and purchase power capacity after deducting all reductions in capacity and reserve capacities, i. e. non-usable capacity, overhauls and outages of thermal power stations as well as system services reserves. This capacity is firmly available to cover the load.

4.7 Load (line 12)

The load of each country, also called reference load, is recorded at the reference moment (3rd Wednesday of each month – 11:00 a. m., Central European Time) without taking account of power exports. It is measured at the high-voltage terminals of generator transformers and at substations. The sum of loads of the different member countries leads to the simultaneous aggregate load of the UCTE.

Normal climatic conditions, e. .g outdoor temperatures corresponding to the multi-annual average, and normal development of economic activities are assumed in the forecast.

In the retrospect, the load that was recorded at the reference moment has to be taken into account.

4.8 Margin as against the monthly peak load (line 13)

In general, the effective peak load of a month is higher than the load measured on the 3rd Wednesday of each month at 11:00 a. m. This difference between the load recorded at the reference moment and the monthly peak load is indicated as a margin. It is given only as an additional information about expected (according to the forecast) and effective (according to the retrospect) monthly peak loads; it does not influence the calculation of the internal surplus of available capacity (cf. 4.9).

In the forecast, the countries indicate the additional demand in capacity they expect beyond the reference load at the moment of peak load, assuming normal outdoor temperatures and normal economic development.

The effective deviation between the monthly peak load and the reference load is indicated in the retrospect.

In some member countries, the effective monthly peak load is not known, but only the peak loads recorded on the Wednesdays of the month concerned.

4.9 Remaining capacity (line 14)

The remaining capacity is obtained from the guaranteed capacity minus the reference load.

The positive remaining capacity constitutes an export potential that is guaranteed to a large extent because most reductions in capacity and possible load increases within each country (cf. 4.2 – 4.5) have already been taken into account for its determination in the power balance. But owing to the geographical extension of the UCTE network and possible transmission constraints it is not fully available at each point of the interconnected power system.

However, the power plant operation reserve is not included in the system services reserve. Therefore, it appears as part of the remaining capacity and of the export potential. The reserves intended to cover long-term power plant failures are not taken into consideration; the remaining capacity must therefore not be considered as a surplus capacity.

To obtain a realistic picture of the reliability of supply, of a possible surplus capacity or of the export potential, competent readers must carefully interpret the remaining capacity, taking account not only of imports and exports but also of possible strategies regarding power plant operation reserve and general reliability strategies of electricity traders with respect to their customers.

4.10 Guaranteed transportable capacities (lines 15 and 16)

It can be imagined that in some countries transfrontier electricity exchanges will assume such a large proportion (e. g. in conjunction with an international electricity exchange market) that short-term international purchases and supplies will become extremely important for the power balance. In this case, a power balance that takes only account of imports and exports announced long in advance and known from schedules would not provide significant information. This may give rise, for instance, to a negative available capacity that would not

reveal reliability problems but only the fact that large energy quantities are traded at short notice on international spot markets.

With a view to avoiding such situations, the TSOs concerned compile for each country a power balance leaving imports and exports out of account.

But already today, imports and exports reach considerable dimensions that are of decisive importance for the power balance and are likely to further increase in the future. Therefore, they must not be ignored in future power balances even though their estimation might be difficult. Thus, the surplus of available capacity within the UCTE will even gain in importance as the sum of all countries in the synchronous area.

These balances can be set up for the sum of UCTE countries and for groups of countries selected in accordance with technical network aspects (e. g. Iberian Peninsula, Italy, Balkans). This assumes that NTC values are available for interfaces between groups of countries and the remainder of UCTE. This possibility of interpretation of power balances, based on NTC values, will develop as a function of the evolution of relevant congestions in Europe as well as of the calculation and publication of NTC values.

4.11 Effective surplus of exchanges (line 17)

For the forecast, there is no sufficient information available about imports/exports. For the retrospect, effective values are known. Therefore, the tables of the retrospect comprise an additional line “effective surplus of exchanges”.

UCTE POWER BALANCE: FORECAST

	Country:						
	Power data (net values in GW)	**2001**		**2002**		**2003**	
		3rd Wednesday		**3rd Wednesday**		**3rd Wednesday**	
		January	**July**	**January**	**July**	**January**	**July**
	National generating and purchase power capacity:						
1	hydro power stations						
2	nuclear power stations						
3	conventional thermal power stations						
4	renewable energy sources						
5	not clearly identifiable energy sources						
6	**National generating and purchase power capacity (6=1+2+3+4+5)**						
7	non-usable capacity						
8	overhauls (thermal power stations)						
9	outages (thermal power stations)						
10	system services reserve						
11	**Guaranteed capacity (11=6-(7+8+9+10))**						
12	**Load**						
13	margin against the monthly peak load						
14	**Remaining capacity (14=11-12)**						
	Transportable capacities						
15	importable capacity						
16	exportable capacity						

UCTE POWER BALANCE: RETROSPECT

	Country:												
	Power data (net values in GW) ***3rd Wednesday***	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
	National generating and purchase power capacity:												
1	hydro power stations												
2	nuclear power stations												
3	conventional thermal power stations												
4	renewable energy sources												
5	not clearly identifiable energy sources												
6	**National generating and purchase power capacity (6=1+2+3+4+5)**												
7	non-usable capacity												
8	overhauls (thermal power stations)												
9	outages (thermal power stations)												
10	system services reserve												
11	**Guaranteed capacity (11=6-(7+8+9+10))**												
12	**Load**												
13	margin against the monthly peak load												
14	**Remaining capacity (14=11-12)**												
	Transportable capacities												
15	importable capacity												
16	exportable capacity												
17	Effective surplus of exchanges												