

## **Balance: physical data represented by frequency**

Electricity cannot be stored in large quantities and economically. At all times, therefore, a balance must be maintained between the amount of power injected into the grid (generation and imports) and the amount taken from it (consumption, exports and losses).

Frequency gives an accurate indication of this balance and, as such, is an essential piece of data for the successful operation of power grids. In Europe, frequency is set at 50Hertz (i.e. an oscillation of 50 cycles per second). In other words, our electricity alternates at 50 cycles per second.

A slight deviation from this reference value triggers automatism and prompts the system operator to take action:

- Frequency below 50Hertz indicates that more power is being consumed than generated and injected into the grid. In such cases, either generation must be increased or consumption must be reduced to re-establish the correct balance.<sup>1</sup>
- Frequency above 50Hertz indicates that more power is being generated than consumed. In such cases, generation must be reduced or consumption increased to re-establish the correct balance.

## **Balance: a responsibility shared between generators and the transmission system operator**

- **Security of supply** is primarily the responsibility of the authorities. Consequently, the Secretary of State for Energy determines the national equipment plan and has the power to take any measures necessary (e.g. preventing the shutdown of power plants).
- **Market players** (generators, suppliers, balance responsible parties) are responsible on the one hand for honouring their supply contracts with customers and on the other for ensuring a quarter-hourly balance between the energy they inject into the grid (including imports) and the consumption of their customers (including exports). They decide themselves whether this electricity comes from local generation, import or a combination of the two.
- **As a transmission system operator (TSO), Elia** allows market players access to its grid, including interconnections, and provides a range of services to maintain a constant balance between generation and consumption in the Belgian control area – the key to the successful operation of the European grid.

If demand outweighs supply, Elia can re-establish the correct balance:

- o by addressing supply and/or demand through supply contracts concluded with generators in Belgium and through interruptibility contracts concluded with industrial customers or aggregators (market players encompassing a large number of medium-size and small consumers), or through voluntary offers;

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<sup>1</sup> If imbalances are not remedied quickly, frequency continues to fall. Below approximately 49.8Hz, frequency exceeds 'normal' control parameters and exceptional measures are implemented by automatism. Below approximately 48.5Hz, the system is at major risk of collapse.

- by making emergency purchases from neighbouring TSOs, RTE in France and TenneT in the Netherlands<sup>2</sup>.

Commercial transactions involving the purchase and sale of electricity are made either under bilateral contracts between suppliers/generators and buyers, or on organised markets (exchanges). Broadly speaking, long-term supply contracts are concluded under bilateral transactions and short-term contracts are concluded on power exchanges.

In Belgium, the short-term electricity market is organised by Belpex. Thanks to the coupling measures established by system operators and power exchanges, Belgian market players are able to access an area covering France, the Netherlands, Germany, Luxembourg and, indirectly, Scandinavia: power purchase orders placed on Belpex can be fulfilled by sell orders placed on Belpex or exchanges in France, Germany and Scandinavia, provided import capacities within these systems and at the Belgian borders are sufficient.

Exchanges are subject to market rules (supply and demand), and available energy is sold to the highest-bidding players. In order for electricity to be sold to Belgian players, players on the Belgian market must pay the price determined by supply and demand.

## **Belgian import capacities**

Belgium is directly interconnected with the Netherlands via its northern border and with France via its southern border. A maximum of 3,500 MW can be imported commercially. From a contractual point of view, this capacity is split between the southern and northern borders and made available on the market annually, monthly and daily.

In practice, Belgium can import up to 3,500 MW (even if that power is only generated in the Netherlands) provided the bids of players on the Belgian market are competitive with those made by players on the German or French markets.

## **Increasing import capacity through new interconnections**

Improvements to existing interconnections (e.g. at the northern border) and plans for new connections (Nemo, an interconnection with the United Kingdom, and Alegro, a direct interconnection with Germany) are needed in order to increase Belgium's import capacity. These developments must be accompanied by investment to guarantee the stability of voltage control on the Belgian grid.

## **Simulation models**

Elia uses probabilistic models to perform risk analyses and simulations for security of supply. For all time frames and any given hour of the year, the models can be used to calculate the probability that consumption on the Belgian power system can be covered, taking into account import/export capacities (assuming

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<sup>2</sup> Purchases are made under short-term contracts in order to address exceptional incidents or situations. Prices and volumes under those contracts are not guaranteed, since ultimate responsibility for balancing commercial portfolios lies with market players.

market players are able to buy the energy they need from abroad to supply their customers).

Simulations serve as the main basis for the Secretary of State's equipment plan, published in late June.

Following the announcement regarding the extended unavailability of Doel 3 and Tihange 2, Elia performed simulations based on new hypotheses, namely:

- the unavailability of the Doel 3 and Tihange 2 reactors;
- keeping online some 1,000 MW of thermal generation capacity (the decommissioning of which was announced by generators in line with the the Secretary of State's decision).

The simulations showed that, based on the above assumptions:

- Belgium will become structurally dependent on imports during the winter peak in order to cover demand for electricity;
- the interconnection improvements made by Elia will enable the required energy (up to 3,500 MW) to be imported, provided that Belgian market players can find counterparties over the border and that the grids concerned have enough transmission capacity;
- margins for operating the Belgian electricity system will become increasingly tight and it will become essential that no further plants are shut down for a long period.

## **Winter Outlook**

The Winter Outlook is an estimate of electricity needs and the generation facilities available to meet them Europe-wide. It is carried out each winter (and a Summer Outlook is carried out each summer) by system operators in 34 interconnected countries. The findings are then compiled at European level by ENTSO-E. The relevant information is generally available by late November to early December.

If the Winter Outlook demonstrates a greater risk for Belgian market players attempting to find power outside Belgium during cold snaps (especially combined with periods involving low injection of wind power or solar energy), Elia could be required to take exceptional measures, namely:

- postponing preventive maintenance of its grid with a view to ensuring the maximum availability of all system components;
- requesting the postponement of maintenance on generation units;
- more extensive operational monitoring, in both forecasting mode and real time;
- pooling reserves with neighbouring TSOs RTE and TenneT and optimising border capacities;
- increasing requirements for flexibility and control of demand vis-à-vis market players.

## **Electricity shortages**

Shortages can be usually forecast. The Winter Outlook provides an early indication of sensitive periods at European level while the generation and

consumption forecasts communicated by suppliers allow Elia to identify any potential critical situations.

A shortage response procedure is regularly updated by Elia in consultation with the Federal Public Service (FPS) for Energy and the FPS Interior crisis centre.

### ***Limiting demand***

In the event of a **confirmed shortage, proactive demand limitation measures** can be decided on and rolled out by authorities; they are then implemented by the TSO:

- **Campaign to raise awareness** among individuals and businesses, relayed by the media (radio, TV, Internet, etc.): actions might include simple practices which can be applied at all times to reduce energy bills (turning off appliances left on standby, turning out lights in empty rooms, lowering thermostats by 1°C, etc.), shifting consumption to off-peak periods.
- **Reducing consumption for certain specific purposes** by businesses and institutions (temporary shutdown of air conditioning, refrigerators, public lighting, etc.) and for individuals (electric heaters, household appliances, and so on).

### ***Selective load shedding***

If, after exhausting all other possibilities, an imbalance between generation and consumption is confirmed, Elia will be required to roll out its **selective load-shedding plan**. This reduces the energy demand of a limited number of consumers for the amount of time necessary.

Load can be shed in blocks of 500 MW, spread geographically across the whole of Belgium in five zones accounting for 100 MW each: Northwest, Centre, Northeast, Southwest and Southeast. Load shedding is orchestrated by means of Elia high-voltage substations.

Legislation determines which types of customer are susceptible to outages in the first instance (rural areas), and which must have power as a matter of priority (Seveso companies, military zones, airports, etc.).

In the event of a **sudden interruption** such as a fall in frequency (see event of 4 November 2006 below), load is shed automatically by means of frequency relays in high-voltage substations. Based on needs and frequency variation, up to six blocks of 500 MW could be activated (totalling 3,000 MW).

In the event of a **shortage**, load is shed preventively, at peak times, based on the deficit to be covered. If such situations reoccur, blocks can be alternated ('staggered load shedding') so as to prevent the same consumers repeatedly experiencing outages.

## **Example of load shedding due to a sudden event: 4 November 2006**

On 4 November 2006, the decommissioning before schedule of a line overhanging water in order to let through a boat leaving its shipyard led to the overload and the successive tripping of high-voltage lines on the German grid.

The European synchronous grid subsequently split into three separate areas. The western section, including the Benelux, part of Germany, France, Switzerland, Italy, Spain and Portugal, experienced a significant generation deficit, with consumption far greater than generation in that part of the grid.

On the Belgian grid, two countermeasures were implemented:

- Quick-start generation units were immediately brought online to generate additional power.
- Some 800 MW of power (i.e. approximately 10% of the load, which totalled around 8,000 MW) was interrupted briefly, primarily affecting industrial customers and residential customers in rural areas.
- Identical measures were taken by all continental European countries affected by the situation.

The Elia grid thus demonstrated its capacity to react appropriately to a major disruption and normal service was resumed in under an hour.

For more information, please contact:

### Media:

Lise Mulpas	+32 2 546 73 75	+32 478 65 28 90
Axelle Pollet	+32 2 546 75 11	+32 475 84 38 91

[lise.mulpas@elia.be](mailto:lise.mulpas@elia.be)  
[axelle.pollet@elia.be](mailto:axelle.pollet@elia.be)