



## Stabilising grid voltage levels by generating or absorbing reactive energy

Voltage stability is essential to ensuring efficient operation of the high-voltage grid. Elia manages to maintain grid voltages at a suitable, stable level by using the services provided by producers that are connected to its grid. By generating or absorbing reactive energy, they contribute to controlling and stabilising the grid voltage. Producers with units providing these services supply Elia with a reactive power band that is dedicated to voltage control. A distinction is made between regulating production units and non-regulating production units. The former units provide primary and centralised control, the latter only centralised control. Primary control is provided automatically around the clock by units that are in operation, whereas centralised control is provided on an occasional basis at Elia's request. Elia pays the producers for these services.

### I. Voltage control: principles

#### I.1. Voltage and reactive energy

##### Why control voltage?

The transmission of electrical power is subject to one particular principle of good practice: the voltage level must be as high as possible while the current must be as low as possible, within the limits imposed by the grid. These conditions enable maximum power to be transmitted while minimising energy losses and safeguarding the production units from ageing prematurely. However, the limited insulation capacity of the relevant lines and cables means that it is essential that the voltage in the grid does not exceed a certain level. Elia is responsible for controlling voltage and relies on the assistance of the producers connected to its grid in order to do so.

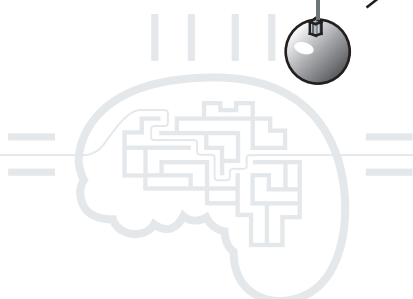
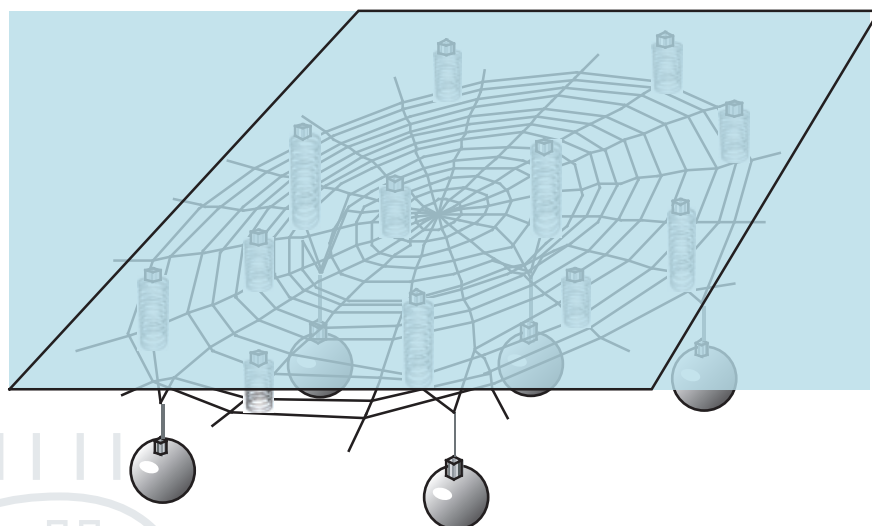
##### Stabilising voltage levels by managing reactive energy

Voltage fluctuations are inevitable due to the influence of:

- the fluctuations in power that are caused by the offtakes and injections that industrial activity in Belgium entails;
- electrical flows and topological changes in the grid.

The grid's reaction to such fluctuations is similar to a web, which must be supported by a flexible force (illustrated by the springs in the drawing below) so that it can withstand the tugging to which it is subjected. In Elia's meshed grid the springs represent reactive energy. As for the "balls" attached to the web, these symbolise various operations affecting the grid, such as injections, offtakes and foreign electrical flows.

Whereas the frequency in the grid is influenced by the behaviour of active energy, the voltage is affected by reactive energy. As active energy is very easy to transmit, frequency can be managed at national and European levels. Since reactive energy is harder to transmit, voltage has to be managed more locally. This means that the production units that take part in controlling voltage have to be strategically located.



Elia needs reactive energy to maintain its grid and stabilise the grid voltage.

This energy is partially supplied by producers: in line with the voltage level measured in the grid, production units stabilise the voltage by absorbing or generating reactive energy. This service, supplying reactive energy to Elia, is governed by a voltage control contract between Elia and the producer concerned.

In addition to managing the reactive energy supplied by the producers, Elia makes use of a number of means of its own to stabilise grid voltage, such as manual or automatic control of transformers or management of the park of capacitor banks in the Elia grid.

## **I.2. Essential technical features**

Elia ensures that the facilities taking part in voltage control are able to supply or absorb enough reactive power to meet the requirements stipulated in the contract between Elia and the producer. To meet these requirements, the production units must have certain technical features that vary depending on whether the unit is a controlling production unit or a non-controlling production unit.

## **I.3. Controlling production units and non-controlling production units**

The federal Grid Code defines these units as follows:

"Any controlling production unit must be able, on first request by the system operator, to adapt – automatically and without delay – its supply of reactive power in the event of slow voltage fluctuations (over a period of minutes) and quick voltage fluctuations (over a period of a fraction of a second)" (Article 69);

"Any non-regulating production unit must be able to adapt its supply of reactive power to the requirements of the grid (at the very least via commutation of its reactive power production between two levels agreed between the system operator and the grid user concerned)" (Article 70).

## **I.4. Selection based on location and price**

After organising a call for tenders, Elia chooses suppliers of the voltage control service based on price and also on the location of the production units within the high-voltage grid.

# **II. Primary control and centralised control**

There are two types of voltage control: primary control and centralised control. Controlling production units are actively involved in primary and centralised voltage control whereas non-controlling units are only actively involved in centralised control.

## **II.1. Primary control**

Primary voltage control takes place around the clock at production units that are in operation. If these units (via their terminals) detect a voltage fluctuation, they immediately and automatically make the appropriate adjustments to their reactive-energy production. The units use, for example, voltage regulators that can perform a correction within a matter of just a few seconds. Only controlling production units are able to provide primary control.

## **II.2. Centralised control**

Centralised voltage control is activated following communication between the operators at Elia's control centre and the operators of the production unit via which the voltage control service is to be provided to Elia.

Unlike primary control, which is automatic, centralised control is provided by the producer at Elia's request. Elia provides centralised voltage control by making use of a control band specified in the contract.

## **II.3. Band reserved for voltage control**

The regulating and non-regulating production units that take part in voltage control supply Elia with a regulation band that is reserved for generating or absorbing reactive power. Reactive power is used to restore the voltage to an acceptable level if there is any voltage fluctuation. The regulation operation is carried out by adjusting the instructions given to the production units.

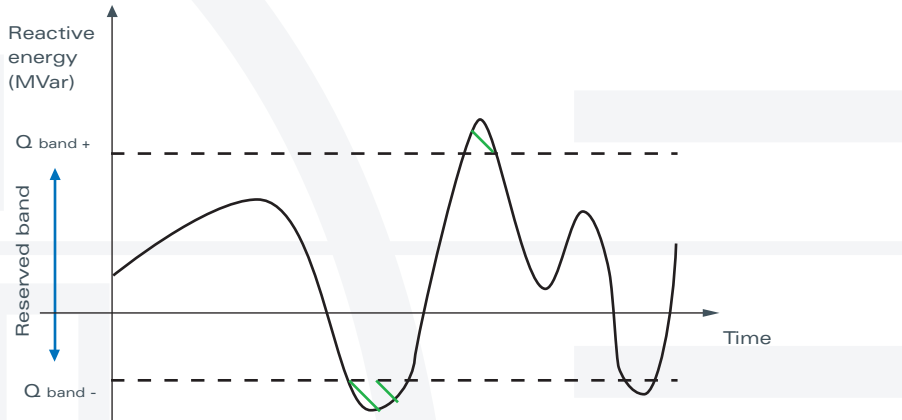
The contract stipulates the band in which the production unit is able to absorb or generate reactive energy:  $[Q_{band-}; Q_{band+}]$ . The  $[0, Q_{band+}]$  portion of the band represents generation of reactive power whereas the  $[Q_{band-}; 0]$  portion of the band represents absorption of reactive power.

In the case of primary control, reactive energy is activated automatically, within the bounds of the band that is provided by the producer.


In the case of centralised control, Elia asks the producer to activate reactive energy upwards or downwards, depending on the band specified in the contract. Elia will ask for production of reactive energy equal to the upper level of the band ( $Q_{band+}$ ) and absorption of reactive energy equal to the lower level of the band ( $Q_{band-}$ ).

Elia may also ask for activation outside the band, as long as this does not compromise the production unit's security. In any case, Elia will only rarely ask for activation of reactive power outside the band for the non-controlling units.

Use of the band for a regulating production unit




 Activation outside the reserve

 Reactive power activated automatically by the production unit depending on the voltage observed

Use of the band for a non-regulating unit



 Reactive power activated at Elia's request

### III. Remuneration for voltage control

Elia pays the producers for the reserved control bands based on:

- a unit price;
- the volume contracted in Mvar;
- the length of use.

Elia will check that the unit is in operation and is able to generate reactive energy.

In the event that absorptions or injections either requested by Elia (centralised control) or observed by Elia (primary control) go outside the contractual limits of the [Qband-; Qband+] band, Elia pays the producer for the actual volumes absorbed or generated an amount in €/MVAh.

### IV. Voltage control: benefits for the producer

The producer derives various benefits from supplying Elia with these voltage control services:

- the payment provided by Elia allows the producer to cover the costs of its voltage control services. The appropriate equipment (voltage detector, automatic or manual regulators, etc.) is built in to most thermal and nuclear production units;
- by taking part in voltage control, producers contribute to ensuring grid voltage stability: an essential precondition for efficient operation of their production processes. This allows them to improve the reliability of their facilities and increase their service life.

### V. Legal and contractual basis

Under the federal Grid Code, the transmission system operator has to control the voltage of its system (Article 257). The Grid Code also makes reference to the purchase procedure and the contractual provisions that the system operator has to observe to acquire these services. Elia organises calls for tenders to ensure sufficient regulation band availability for voltage control.

The Grid Codes stipulate that any production unit with a nominal capacity of 25 MW or more is a regulating unit.

Voltage control services are governed by contracts of at least one year signed by Elia and the producer. These contracts set the amount of the payment due from Elia.

## Voltage control in 5 key points

- As the electricity transmission system operator in Belgium, Elia has to stabilise the voltage in its grid.
- Elia may stabilise its grid voltage by activating reactive energy in production units that are connected to its grid.
- The reactive energy may be activated by the production units automatically (primary control) or at Elia's request (centralised control).
- Producers are paid for providing the voltage control service and for activating reactive energy if it has not been reserved in advance.
- Producers with units that have a capacity of over 25 MW have to take part in primary control of the Belgian grid voltage.

