

The European Association of Transmission System Operators for Europe (ENTSO-E) published an updated information on an event from 8 January, when the synchronous area of continental Europe was separated into two parts due to outages of several transmission network elements in a very short time.

This update presents the key findings of detailed analyses, which have a preliminary character subject to new facts, which will emerge in the still ongoing investigation. The analyzed sequence of events concludes that the initial event was the tripping of a 400 kV busbar coupler in the substation Ernestinovo (Croatia) by overcurrent protection at 14:04 CET. This resulted in a decoupling of the two busbars in the Ernestinovo substation, which in turn separated North-West and South-East electricity flows in this substation. North-West bound lines which remained connected to one busbar, connect Ernestinovo to Zerjavinec (Croatia) and Pecs (Hungary), while South-East bound lines which remained connected to another busbar, connect Ernestinovo to Ugljevik (Bosnia and Herzegovina) and Sremska Mitrovica (Serbia).

The separation of flows in the Ernestinovo substation, lead to the shifting of electric power flows to neighboring lines which were subsequently overloaded. Soon after, the line Subotica - Novi Sad (Serbia) tripped due to overcurrent protection. This was followed by the further tripping of lines due to distance protection, leading eventually to the system separation into two parts at 14:05 CET.

The system separation resulted in a deficit of power (approximately - 6.3 GW) in the North-West area and a surplus of power (approximately + 6.3 GW) in the South-East area, resulting in turn in a frequency decrease in the North-West area and a frequency increase in the South-East area.

At approximately 14:05 CET, the frequency in the North-West area initially decreased to a value of 49.74 Hz within a period of around 15 seconds before quickly reaching a steady state value of approximately 49.84 Hz. At the same time, the frequency in the South-East area initially increased up to 50.6 Hz before settling at a steady state frequency between 50.2 Hz and 50.3 Hz.

Due to the low frequency in the North-West area, contracted interruptible services in France and Italy (in total around 1.7 GW) were disconnected in order to reduce the frequency deviation. These services are provided by large customers who are contracted by the respective Transmission System Operators (TSOs) to be disconnected if frequency drops under a certain threshold. In addition, 420 MW and 60 MW of supportive power were automatically activated from the Nordic and Great Britain synchronous areas respectively. These countermeasures ensured that already at 14:09 CET the frequency deviation from the nominal value of 50 Hz was reduced to around 0.1 Hz in the North-West area.

In order to reduce the high frequency in the South-East area, automatic and manual countermeasures were activated, including the reduction of generation output. As a

consequence, the frequency in the South-East area returned to 50.2 Hz at 14:29 CET and remained within control limits (49.8 and 50.2 Hz) until the resynchronization of the two separated areas took place at 15:07 CET.

Between 14:30 CET and 15:06 CET the frequency in the South-East area was fluctuating between 49.9 Hz and 50.2 Hz due to the rather small size of the South-East area where also several production units were disconnected. During this period, the frequency in the North-West area fluctuated far less and remained close to the nominal value, due to the rather large size of the North-West area. This frequency behavior is a subject of further detailed investigation.

The automatic response and the coordinated actions taken by the TSOs in Continental Europe ensured that the situation was quickly restored close to normal operation. The contracted interruptible services in Italy and in France were reconnected at 14:47 CET and 14:48 CET respectively prior to the resynchronization of the North-West and South-East areas at 15:08 CET.