How the European power system almost collapsed in January

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At the beginning of the year, we were closest to the disintegration of the European electricity network in several years, when the continental network split into two unsynchronized parts on January 8th at 14:05. The European System Operators Association (ENTSO-E) analyzed the incident and found that the problems started in Croatia and then spread in a cascade. Fortunately, they fixed the problem in one hour and ensured synchronization of both parts of the network.

The European continental network covers virtually the whole of continental Europe, except for the Baltic States, Belarus, Ukraine and Moldova, as well as Turkey, Morocco, Algeria and Tunisia. This makes it one of the largest synchronized systems in the world. This means that the frequency of the electrical voltage is synchronized across the entire network that is physically connected.

The source of the problems is a 400-kV busbar coupler in the Ernestinovo distribution and transformer station (RTP) in Croatia near Osijek in the east of the country, which was disconnected by the current protection on January 8th at 14:04:25. As a result, the two busbar systems were no longer connected and synchronized, separating the northwest and southeast streams in the RTP. The north-western flows to Žerjavinac (Croatia) and Pecs (Hungary) were connected to one collection system, and the south-western to Sremska Mitrovica (Serbia) and Ugljevik (Bosnia) to another. This caused changes in physical flows through the network, which 23 seconds later triggered the disconnection of the connection Subotica - Novi Sad due to congestion. This triggered additional disconnections due to remote protection, which further split the system into two parts 20 seconds later. The European electricity grid was suddenly divided into a north-western part and a south-eastern part, and the border went through Croatia, northern Serbia and Romania.

This, of course, immediately affected the balance sheets. There was a deficit of 6.3 GW of power in the north-western part of the network, and a surplus in the south-eastern part, because the physical flows before the distribution were just like that. As a result, our network frequency dropped from 50 Hz to 49.74 Hz, and in the southern part of the network it rose to 50.6 Hz. The control brought these values to a more tolerable 49.84 Hz and 50.25 Hz in a few seconds. This is still a big problem - let us remember the problems three years ago, when the frequency dropped to 49.996 Hz due to uncompensated consumption in Kosovo and last year's incident. Less than an hour later, at 15.07, both parts of the network managed to synchronize and connect.

Capturing a frequency that deviates from 50 Hz when current consumption and production are no longer aligned occurs with multiple levels of regulation. The frequency changes because the excess (or lack) of energy flows from the kinetic energy of the turbines - this needs to be compensated. In Slovenia, 2 percent of the rated power of all production capacities must be available for primary regulation, which is switched on within two seconds after the 20 mHz deviation. ENTSO-E requires around 15 MW of reserve for primary regulation from Slovenia, but we have three times as much. Within 30 seconds, the automatic process of secondary regulation offered by some production facilities begins. Later, after 15 minutes, if the disturbance is not eliminated, tertiary regulation follows, when the used power reserve is replaced manually. This also includes reducing consumption or disconnecting large consumers if they participate in tertiary regulation.

This happened on January 8th. Due to the hour-long deviation, 1.7 GW of large consumers with tertiary regulation contracts were disconnected in France and Italy. They received an additional 420 MW and 60 MW from the UK and Scandinavia (these systems are connected to the mainland by direct current, so they are not synchronized, but can provide power). This raised the frequency from 49.8 to 49.9 Hz. On the other hand, they had to disconnect 975 MW of production capacity in Turkey in the southeast, dropping the frequency to 50.2 Hz. As this part of the network was significantly smaller and other sources were disconnected, the frequency fluctuated between 49.9 and 50.2 Hz during this time.

The splitting of the network into smaller parts is a very serious incident that can end in major electrical eclipses. Finally, on November 4, 2006, such a case caused an eclipse of more than 15 million customers that lasted two hours. At that time, the network was divided into three parts, and the reason was the planned shutdown of the German transmission line, to which the distributors did not adapt properly. The incident had political consequences and was, for example, the reason for the introduction of the European Awareness System (EAS) platform.

In conclusion, I think that it is important to ensure the stability of the transmission network and to ensure the stability of the production and distribution of electricity. We are building new transmission lines and optimization of existing ones, we are connecting new production units, and we are also building new storage capacities. As a result, the security of the network will be improved and the risk of its disruption will be reduced. However, there is still a lot to do, and the new security measures are also necessary. The development of new smart grids is also an important part of this process.

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