

Reading Report 1

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0.1 Summary

What was formerly known as the UCTE, now known as the Synchronous Grid of Continental Europe, is a grid of one frequency that supplies power for the populations of many different European countries. In 2006, a disturbance in the UCTE occurred in Germany. Subsequently, many high voltage lines were affected, causing major outages in several nearby countries.

To allow large ships passage on a river, a 380kV double line had to be de-energized for safety precautions, which is standard. A large ship had requested passage through this river in Germany. The request for this de-energization was received many days prior to the date of the ship's travel. This should have allowed plenty of time for thorough simulation calculations of the impact of opening these lines and redistributing load.

Unfortunately the simulation did not consider the entire situation, and when the lines were opened, some of the other lines that the load was transferred onto had their limits exceeded. This caused protection equipment to trip, resulting in a cascade reaction and power outages all over Europe. Frequencies in a previously synchronized area became asynchronous and ranged from 49.7 to 51.4 Hz.

0.2 What Worked

Though the cascading outage was a rather large issue, there were some aspects of the situation that were handled well. One step that was taken and should be taken again next time there is a similar situation is the inter-TSO (transmission system operator) communication prior to the lines being opened. E.ON Netz communicated with nearby TSOs RWE Transportnetz and TenneT, exchanging information about the opening of the lines. Though there was not enough discussion and planning to stop the blackouts from happening, it was a good idea to have inter-TSO planning for a situation like this.

Another important point to consider when performing another line de-energization in the future is to ensure that there are active power reserves in case it is needed. During this incident, there were active power reserves, as is required. This was a good thing and this should always be the case. Unfortunately in this situation, the reserves were not sufficient enough to correct the power imbalance, but it was still good that this rule was being followed. In most cases, the minimum 3,000 MW reserve would likely be plenty to fix an imbalance.

One more response to a major outage that was well exemplified in this situation was automatic load-shedding. Many of the countries that were impacted by this outage had automatic load-shedding systems that did trigger properly, causing a total load shed of about 16,000 MW. Automatic load-shedding helps with frequency re-balance.

0.3 What Needs Improvement

The main reason that the incident occurred was that the "N-1 security rule" was violated. The N-1 security rule is the idea that in a grid network, if a component fails while maximum possible transmission and load are occurring, there should not be any wavering in the network's security. It is called N-1 because the grid must be able to remain operational with no changes with the presence of one contingency event. With any more than one contingency event simultaneously, the expectation is no longer that the grid should remain operational with no changes - likely, some load must be shed.

The party responsible for opening the 380kV double line, E.ON Netz, only calculates N-1 security at the discretion of their grid control center. In the case of the double line open, the TSO did not perform the calculations. Many TSOs do not perform regular real-time security analyses, E.ON Netz being one of them. At the time, the UCTE Operation Handbook required that "TSOs monitor at any time the N-1 criterion for their own system." Though many argue that this is interpretable in different ways, it appears that E.ON Netz did not meet requirements.

At the time of the incident, there was no Europe-wide operational or legal framework. Standardized frameworks help to reduce the number of outages as well as reduce the amount of time to resolve outages when they do occur. If there had been a more clear set of standards as to when to perform N-1 security calculations, the issues with opening the lines could have been foreseen. Constant, up-to-date information exchange between different TSOs and distribution system operators (DSOs) about generators would also help, as N-1 security calculations would not be useful if they are simulated on an inaccurate model of the actual system.

Even with the lack of clear standards and calculations, however, the extent of the damage could have been reduced. Firstly, the reaction to the initial alarms of safety limits being reached was not decisive enough. E.ON Netz didn't use the information that the nearby TSOs had given them during remediation of the initial warning alarms, so the decision to couple busbars at a nearby substation to quell the alarms actually worsened the situation and caused the blackouts. A different reaction to the initial alarms could have prevented this cascade.

Finally, the behaviour of and communication about generators must be discussed as something to improve as well. TSOs at the time especially lacked control and data for 'decentralized' generation units. Many TSOs don't know when these units will automatically trip and disconnect and then later reconnect to the grid. Generation units that tripped due to under-frequency once the frequency became unsynchronized only served to worsen levels of imbalance of the power supply and demand.

Overall, the situation was not handled properly from beginning to end, but it did expose flaws in the UCTE system of standards, coordination, and regulation. In reality, the coordination of such expansive systems that are controlled and operated by many separate entities will always be difficult. For the most part, nothing happens until it happens - it is hard to predict when there will be a critical gap in communication

or a shortfall in standards. Though hopefully in the future this exact situation will not transpire in this way again, it would not be surprising if something entirely different but equally widespread were to occur, due to the nature of largescale operations handled by multiple parties.