WHITE PAPER

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Network stability

TELE is a solutions partner for all issues related to monitoring grid stability, peak load management, and automated handling of "rolling blackouts."

Large-scale failures of power grids in Europa and the USA in recent years have drawn attention to the stability of electricity grids. In 2003, a power outage occurred across a large area of the northeast of the USA, as well as parts of Canada. The failure was the result of market fragmentation and a lack of investment after deregulation of the power market. Decades-old networks with poor maintenance can no longer bear the constantly increasing load. Another blackout occurred through a fault in a substation of the US energy supplier Florida Power & Light in the US state of Florida. As a result, the energy supply in the Miami area broke down and over 3 million people were without power. Due to a malfunction in a 500 kilovolt line between California and Arizona in 2011, there was a blackout in which 1.4 million households or 5.7 million people were affected in California, Arizona, and in the north of Mexico. However, Europe has had its share of power supply incidents too. Due to strong fluctuations through the failure of multiple power stations in Turkey's power grid in spring 2015, the grid connection with Europe was interrupted. As a result, 80 of the 81 provinces in the country could no longer be supplied with power. 76 million people remained without power for 9 hours.
These incidents show that the worldwide power supply isn't as stable as we would like, not least due to the expansion of renewable energy supplies and the transport of power over long distances.

Why it is difficult to keep the network stable

Current energy supply is based on the interaction of a large number of very different producers that are connected across wide geographical distances through a line grid. The main problem is the change of the generating structure. Nowadays, many producers of renewable energy (wind, water, and photovoltaic systems) do not supply in a consumption-oriented way, but only when their resources are available. The challenge is then to adjust the consumption to the production. Also the reserves of controllable production capacities have to be adjusted. A constant balancing act must take place. It is also necessary that the participants have a flawless technical interaction. If this is not guaranteed, even small breakdowns can lead to large-scale network collapses.

Various factors

The stability of electrical grids is determined by a multitude of parameters. If the line between the producer and the network is short, the connection is termed as rigid. This contributes to increasing the stability. If, however, the power is transported over large distances, as is so often the case today, the stability is weak.
Also, the maximum output that a producer can deliver is limited. In the event of an overload he can fall out of lockstep, i.e., he is no longer running in sync with the rest of the grid. Such a disruption of the grid takes place, for example, if lines are switched off. A voltage drop also has a similar effect.

Disastrous cascade
The most common cause of blackouts though is the failure of connecting lines. Here, two effects add up that affect the stability. On the one hand the connection is weakened due to the line between producer and consumer. This reduces the resetting forces that maintain synchronous operation. And, on the other hand, a one-sided reduction of the transport capacity leads to a shift in loads. Points that were originally supplied with power from two sides are only supplied from one side after the loss of a line. That lowers the voltage. But consumers feeding of the grid at this time continue with the same performance, which causes the current to rise and results in a further reduction of the voltage and so a disastrous cascade of instability is created.
Lowering the voltage also negatively affects power stations. Power stations need a lot of power and must be supplied via auxiliary systems in order to work, which are also supplied via the grid. If the voltage drops impermissibly, the protection system automatically disengages the power station from the grid. Through the idling or switch-off of a power station there is in turn less power available for consumers, which can lead to a snowballing breakdown of a grid.

Rolling blackout
Rolling blackouts are an emergency measure to prevent wide-spread power outages. In such cases, the power supplier switches off parts of the power grid for a time, until enough energy is available in the grid again to ensure continuous operation. Rolling blackouts are the order of the day in developing countries, but must also be implemented sporadically in North America to prevent grid breakdowns.
So, for example, Texas experienced rolling blackouts in 2006 and 2011 with shutdowns between 20 minutes and eight hours, after 50 power stations had to be switched off. Canada had to fight rolling blackouts most recently in 2014 in Newfoundland and Labrador. At the time, due to extremely low winter temperatures, a lot of energy was consumed and at the

same time a blizzard caused a fire in a substation. That led to a shutdown of a power station and also to a rolling blackout.
In 2012, the power supplier Albertas was instructed to carry out a rolling blackout as six power stations had failed during a heat wave and the power supply could no longer be ensured. In both Canadian cases the regional power outages lasted up to an hour.

Protection systems – prevent blackouts, control rolling blackouts
What can we do? On the one hand protection systems that help prevent power outages are needed. And, on the other hand, monitoring solutions can ensure that rolling blackouts can be controlled according to emergency plans defined in advance, automated, and therefore can be safely handled so that downstream systems are not damaged. That is especially important for companies where power cuts can cause the breakdown of plants, resulting in high costs and safety concerns.
TELE is a solutions partner for all grid stability issues and, together with customers and system partners, can develop and produce solutions for both producers as well as consumers.

Grid and system protection – supplier side separation
Grid and system protection is switched between a decentralized energy producer, such as a photovoltaic system, for example, and the grid of the public energy supply company (EVU) and continuously checks the grid quality. If the voltage or frequency in the public grid rises or falls beyond permissible limits, the small power station is immediately decoupled. Now the grid operator can ensure that the grid is stable again. Only then can small power stations be connected again.
In this way, unintentional, isolated operation that is dangerous for maintenance personnel is prevented. The corresponding parameters for this separation process are standardized differently in different countries. TELE has brought grid and system protection to the market that can be freely configured in the field and thus can be individually adapted to your requirements. To prevent misuse, password protection or a sealing of the device is possible at the official delivery point. For the first time, operation in single as well as three-phase grids is possible through simple switching. The new grid and system protection from TELE is suitable for medium and low voltages.

NSO – Consumer-side separation and automated control
TELE's NSO disconnects consumers in a controlled manner as soon as the grid becomes unstable. Two scenarios are possible: Either the grid operator sends a signal in the event of grid problems, or the NSO can also itself directly measure if the grid is unstable, when, for instance, the fre-

quency drops impermissibly. Only once the grid is stable again will the NSO automatically connect the consumer back into the grid.
In this way, it can be precisely defined in an emergency plan which consumers and in what order, how long they can be taken out of the grid, and when they should be reconnected. At a meat processing company, for example, it could look like this: the EVU reports grid problems. Up to now the company had to manually disconnect and reconnect refrigerated warehouses to relieve the grid. With the TELE NSO, on the other hand, it is possible to disconnect the system automatically and remotely as well as time-controlled from the grid or also connect it back into the grid. Additionally, the corresponding data can be read and made further use of via a communication module on various devices, such as industrial PCs and cellphones.

Avoid feed
If it is desirable to principally avoid feeding into a grid, the G2BM load monitor from TELE is used. It works via effective power recording, optionally in single and 3-phase grids, with an adjustable threshold value and separately adjustable start-up bridging and trigger delay. If you use underload monitoring, the device switches off if the consumption falls below a certain threshold value. If negative energy is consumed, i.e. fed in, it is also switched off. With this configuration, a certain positive consumption always remains, as the minimum positive switching threshold (e.g. 5 %) must be considered.

Peak load management
Energy usage that is as even as possible during the course of the day has high savings potential for the energy supplier and prevents grid failures. With the Eco8, TELE offers a switching device that minimizes load peaks via a consumption trend calculation. To do this, it switches different consumers across 8 isolated relay outputs (expansion up to 64 consumers possible) off and back on as soon as the adjustable target value for control mode is exceeded. The duration is variably adjustable according to the specifications of the EVU and can also be limited by the momentary value.
Load peaks can be minimized by shifting the energy supply from certain consumers to times with less supply. This is especially suited to consumer that have the capacity of being able to store energy in form of heat (cold), pressure, level (filling level), etc. in rechargeable batteries, such as refrigerated warehouses, for example. The Eco8 determines the consumption with a defined period of time that is determined by the EVU. To do this, it independently synchronizes itself either with the synchronous pulses coming the EVU counter or the internal real-time clock. Via the switchable

consumers, Eco8 keeps the consumption within a defined output. For communication and control, the device features a bus interface and an internal data logger that records the most important consumption data of the last two months. Additionally, a time switch is built into the device for time control.

Compensating short-term interruptions
Short interruptions in the grid can lead to undefined conditions in control cabinets. To prevent this from happening, the V2UF grid wipeout detector from TELE ensures continuous voltage monitoring, detects grid wipe-outs/short interruptions of at least 10 ms, and guarantees a safe switch off/on of downstream consumers. In this way, the device prevents components in the control cabinet reacting to short interruptions with undefined states and produces a reset pulse for a controlled restart after a power failure.