Measurement concept for an autarkic emergency operation of a community power grid

MOTIVATION & AIM

The Bordesholm public utilities are planning a project to implement the autarchic emergency operation of the power grid.
This is a pioneering project, as for the first time in Germany there will be an emergency power supply for a small town by battery storage.
The advantage of an autarchic emergency operation is that the community can continue to be supplied with electricity from renewable energy in the event of a power failure.
For this purpose, a measuring technique must also be used which takes over the monitoring of the power grid.

The power supply comes from a transformed medium voltage of 20 kV of the upstream grid. In the event of a power failure, the section switch disconnects the contact to the upstream grid at the same time as the starting current of the battery storage. In the power grid are two biogas power plants stationed. They contribute to power generation and this can be used to recharge the battery.

The measuring points are in front of and behind the synchronous section switch, at the biogas plants and in three AC- Converters on the photovoltaic systems.

The measuring process includes the following steps:

1st switching into island operation.
Transient and voltage dips can occur here. A transient is a settling process or a section in a signal,
which are caused by switching operations in electrical circuits or by electrostatic discharges.
The duration is in the nano and microsecond range. Voltage drops can also occur.
In the event of a voltage drop, the voltage is zero within a short time interval.

2nd maintaining in isolated operation
Here, the balance between power generation and consumption must be maintained in order to avoid overloading.
For this purpose, the RMS values of the isolated network state must be measured permanently.

The 3rd and last point is the measurement for the duration of synchronization and switching action.

When the power failure has been rectified, you can switch back on again.
Here the frequencies of the upstream network and the island network are adjusted to each other until they run synchronously. Then the synchronous section switch switches on. At this time the transient overvoltages are also measured.

MEASURING REQUIREMENTS

As we have a medium voltage network, voltage transformers are required at the measuring points, which transmit the medium voltage of 20 kV proportional to a low voltage of 400V. One Voltage transforme is used per phase.

For a complete measurement 6 channels are necessary. 2 channels per phase for current and voltage. In total we have 3 phases.

However, in order to be able to measure with high resolution, such a network analyzer should achieve approximately 500 measurements per period.

Fiber optic cables are installed for data transmission. This makes it possible to reach up to 500k kBits per second. This fast data rate is also useful for the measuring instruments. Since the signal is transmitted via fiber optic cable as a light signal, it is necessary to convert the light signal into an electrical signal. A signal converter must be used for this purpose. In order to perform the measurement centrally, the measuring device must be remote controllable via ethernet.

DATA TRANSMISSION

The Data Transmission can be calculate as an estimate:

Assessment per measurement: 16 Bits = 2 Byte

Transmission speed

2 Byte* 500 *50Hz * 6 channels = 300kB/s

(2 byte multiplied by 500 measured values per period multiplied by 50 hearts (mains frequency) multiplied by 6 channels per measuring device, results in 300 kb per second.)

For 10 seconds measuring we need 3 MB Data memory.

DATA PROCESSING & DISPLAY

The measuring system is controlled by a computer with suitable software in the control center. The measuring system must be able to calculate and display the active, reactive and apparent power. All measurement data are merged here and displayed on the computer.

It is possible to display a time course of voltage, current, active power, reactive power and apparent power.

An event list with time stamp and values is also required. The maximum values would also be relevant, for example as bar graphs.

REQUIRED MATERIALS

For an overall System we need 6 measuring instruments and 12 voltage transformers,

a fiber optic connection for fast data transmission,
an available computer with data memory,
a suitable software for data processing, display and control of the system

and possibly a mobile measuring device.

MY RECOMMENDATION

My recommendation is the PQ DA Smart from A-Eberle as it measures with a very high resolution of 800 values per period. The software is included free of charge. The PQI DA smart has no display, but can be read out and controlled by a computer. In price it lies in a favorable comparison to the other measuring instruments. As the software is free, it saves again the costs.

I chose the Sineax A230 to perform inverter measurements on the PV systems. A power measurement must be carried out on the inverter. The meter has large numeric displays for active reactive and apparent power, which is ideal for inverter measurements. It is also possible to read and control it centrally on this measuring device.