GridBox – Open real-time distribution grid control system

A holistic Smart Grid Approach

Project overview

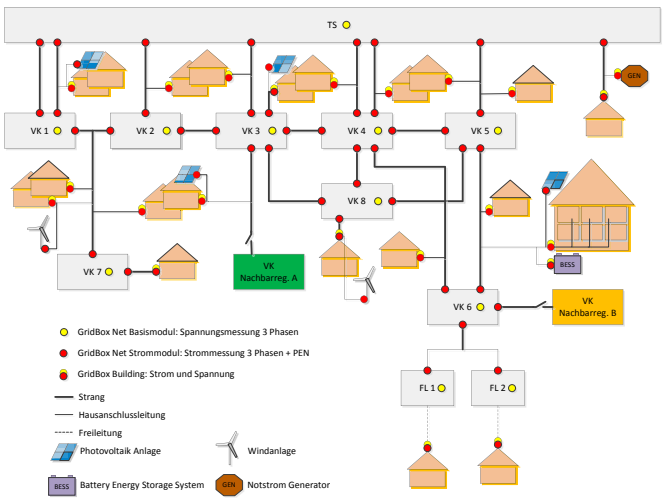
- Smart grid demonstration project
- Two test regions on MV / LV grid levels:
  - One urban region, community of Zurich
  - One rural region, canton of Berne
- Main project focus:
  1) Grid stability by high accuracy measurement and real-time control
  2) Secure integration of renewable energy infeeds, battery and prosumer household storage connected to distribution grids
  3) Business cases in future energy grids

Vision

GridBox proposes a novel grid management system which provides solutions to the new energy system requirements for handling the growing infeed of distributed electricity generators (PV, wind, CHP, biomass), the increased flexibility of active electricity consumption and the use of distributed storage. The distribution grids will be exposed to different power load levels and daily usage patterns, voltage levels will vary a lot and will always not decrease towards the end of the radial segments as in the past. GridBox provides a strongly coordinated, distributed, low cost, small form factor solution for guaranteeing a secure operation of the distribution grid while at the same time allowing (local) market participation also for prosumers, i.e. consumers with their own electricity generation and storage. GridBox is adaptable and open to new grid technology and business models.

Main Technology

At the core of the GridBox concept is a highly distributed network of real-time measurement devices. All nodes within this network communicate real-time grid status information in a hierarchical manner. The grid state is continuously measured and modeled, so that appropriate control of relevant parameters is possible. The GridBox platform aims at integration of any type of power generation, consumer, storage and intelligent building technology and offers a flexible framework for grid optimizing algorithms.



Project milestones and timeline

- September 2013: Project start, Hardware/Software development
- July 2014: Pre-Rollout, Proof-of-concept of platform
- December 2014: Development finished, Algorithms simulated
- March 2015: Rollout of roughly 200 devices finished, begin of full system operation
- March 2016: Technology verification finished

Key elements

Distributed communicating sensor-/actor nodes connected to the distribution grid

The GridBox as the basic element of the concept is the measurement point for the grid state as well as the interface to influence the operation and the stability of relevant actors and parameters. Thus the GridBox as the local physical presence of the grid management system is implemented both at strategic points in the distribution network (grid levels MV - LV) as well as directly with the electricity producers and consumers. A communication network between the individual nodes (GridBoxes) allows the expansion of a limited local view towards a complete system picture and an integrated, strongly coordinated approach to the optimization and control of the grid state.

Real-time measurement and model-based detection of grid state

The information gathered from the distributed grid is imported into a model of the physical power system to determine the complete system state of a grid section. This enables the detection of erroneous measurements and allows the determination of critical grid model parameters at non-measurable locations.

Monitoring and control of power producers and consumers

On the basis of stability criteria and the computed model state, grid bottlenecks and hot spots are determined in real time. Based on these insights, flexible prosumers are controlled in such a way that a secure grid state can be maintained at any time.

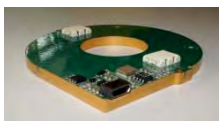
Robustness due to principle of locality

The calculation of the system state and the rationale needed for effective controls are contained in the grid boxes connected to the grid. This basic functionality is therefore not dependent on a central monitoring and control infrastructure. This allows for maximum autonomy and independence of each power supply and keeps the communication reaction times short.

By monitoring and controlling local information the manageability of data security is improved and the processing complexity of data is reduced. In particular, the localization of the prosumer control (Demand Response) reduces the overall optimization problem to a region as a manageable sub-problem.

Holistic approach, open platform

The technological basis of GridBox allows further system functionality such as offline grid optimization based on an extended data basis, power quality measurements, topology detection without a-priori information, islanding detection and virtual power plant operation. GridBox provides an open platform for smart grid applications. Open interfaces allow extensions and an easy integration of third-party systems.


GridBox hardware, small form factor Rogovsky coil, data module

Project partners

The following organizations are members of the GridBox consortium:

BKW Energie AG, Bern, Switzerland
ewz (Elektrizitätswerk der Stadt Zürich), Zürich, Switzerland
Supercomputing Systems AG, Zürich, Switzerland
Bacher Energie AG, Baden, Switzerland

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