Energy
National Research Programmes 70 and 71

Project

Software-based real-time grid control

Intermittent Widespread Energy Sources in Distribution Networks

Intermittent Widespread Energy Sources in Distribution Networks

Besides fundamentally altering power production, the energy transition places new demands on the transmission and distribution of electricity. Researchers at the EPFL in Lausanne have demonstrated how the power grid can learn to manage large amounts of green electricity.

When power consumers also become power producers, the stabilisation of the grid turns into a difficult task. *Source: Shutterstock/city100*

At a glance

- Researchers at the EPFL in Lausanne have developed a system to gear the power grid for the fluctuating production of electricity from solar and wind energy.
- An EPFL building demonstrates how inertial loads can be used to counterbalance such power fluctuations.
- This new system allows for self-regulation of local grid areas and concurrently contributes to the stability of the entire power grid.

Renewable energies are a central pillar of the federal government's Energy Strategy 2050. For example, by 2050, photovoltaics should cover 20 % of the total power consumption. But can the existing power grid cope with such a massive input from the sun, wind and other renewable resources? Electricity production from these resources is inconstant, and the grid is not designed to handle the expected large fluctuations. In future, if the grid is not adapted, this could lead to power peaks that can overload the lines and jeopardize the stability of the electricity supply.

In two interconnected projects, researchers at the EPFL have developed a system that exploits the potential of the so-called "smart grid" to stabilize the power network. The theoretical principles and the software required to control all complex sub-networks in real time were developed in one of these projects. Using an EPFL building, the other project demonstrated how the inertia of heating and cooling systems can be used to buffer power fluctuations.

Exploiting virtual storage

The combination of the results of these two projects exemplifies how a future power grid could function. Virtual storage systems play a central role in this strategy. The EPFL building mentioned above is an example of such a system. It makes use of the physical phenomenon by which the room temperature of a building reacts very slowly to the input or removal of heat. This means that within short time intervals the temperature can be increased or decreased at will, without this being immediately noticeable in the building. The heat storage capacity of the EPFL building thus helps counterbalance the variable working load and the fluctuating power production of the building's own photovoltaic system. By doing so, the researchers were able to better control and calculate the power consumption of a sector of the EPFL campus.

A scalable principle

Another key result of this two-part research project is the finding that a system that works for a single building can, in principle, also be applied to the entire Swiss power grid. The control system developed by the EPFL researchers conceals the complexity of the power-producing and -consuming devices under a generic surface, which means that the entire building functions like a single device. The same control system can be used to combine several such buildings into a single unit, which in turn can be steered together with other units. The system is therefore scalable.

A new concept for network stability

The EPFL system described here is not the first to use inertial loads such as heat supply to stabilise the network. Similar approaches have already been investigated, for example, in a project developed by IBM Research and the large-scale distributor Migros, in which a cold-storage warehouse served as a buffer. However, the EPFL system is the first to function in real time, the reaction time being less than one second. Thanks to this approach, the different parts of the power grid not only function reliably, but also help stabilise the rest of the grid. The technical term for this system is “ancillary services”. These are provided by a given subsection for the entire power grid.

However, this concept is difficult to implement in the current setting of regulations and incentives. Quite the opposite: small electricity producers and consumers rely on the efficiency of the power grid for dependable electricity transmission. According to the investigators, incentives need to be created so that all producers and consumers, including the small ones, are willing to contribute to the stability of the grid. This can be achieved by increasing the cost related to the usage of the grid and by encouraging rather than hindering ancillary services. This course of action decentralises not only power production but also responsibility for the stability of the grid.

Produkte aus diesem Projekt

- COMMELEC: Enabling a large-scale integration of renewables into legacy grid infrastructures
  Date of publication: 01.01.18
- Control by Commelec
  Date of publication: 01.01.18
- Pilotage automatique des réseaux de distribution en temps réel
  Date of publication: 01.01.18
- A composable method for real-time control of active distribution networks with explicit power set points. Part I: Framework
  Date of publication: 01.01.18
- Real-Time Control Framework for Active Distribution Networks Theoretical Definition and Experimental Validation
  Date of publication: 01.01.18
- Real-Time Operation of Microgrids
  Date of publication: 01.01.18

Contact & Team

Prof. Jean-Yves Le Boudec
EPFL IC IINFCOM LCA2
Route Cantonale
INF 016 Station 14
1015 Lausanne

+41 21 693 66 31
jean-yves.leboudec@epfl.ch

Jean-Yves Le Boudec
responsible for the project

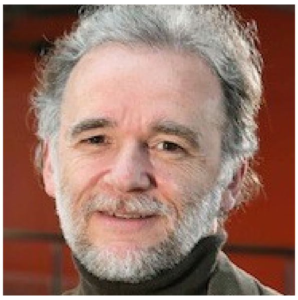
Niek Johannes Bouman

Drazen Dujic

Luca Fabietti

Colin Jones

Andreas Kettner



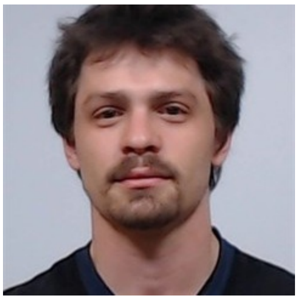
François Marechal

Maaz Mohiuddin

Mario Paolone

Wajeb Saab

Enrica Scolari



Paul Stadler

Eleni Stai

Yan-Kim Tran

Cong Wang

Connected projects

Real-time control of power flows

Being Able to Give in is a Strength, Even in the Power Grid

Demand and storage in electricity networks

Making Sure the Power Grid Does Not Go Out of Synch

All information provided on these pages corresponds to the status of knowledge as of 24.05.2019.