Virtual Energy Storage Network based on Residential Heating Systems

Tiko Energy Solutions AG

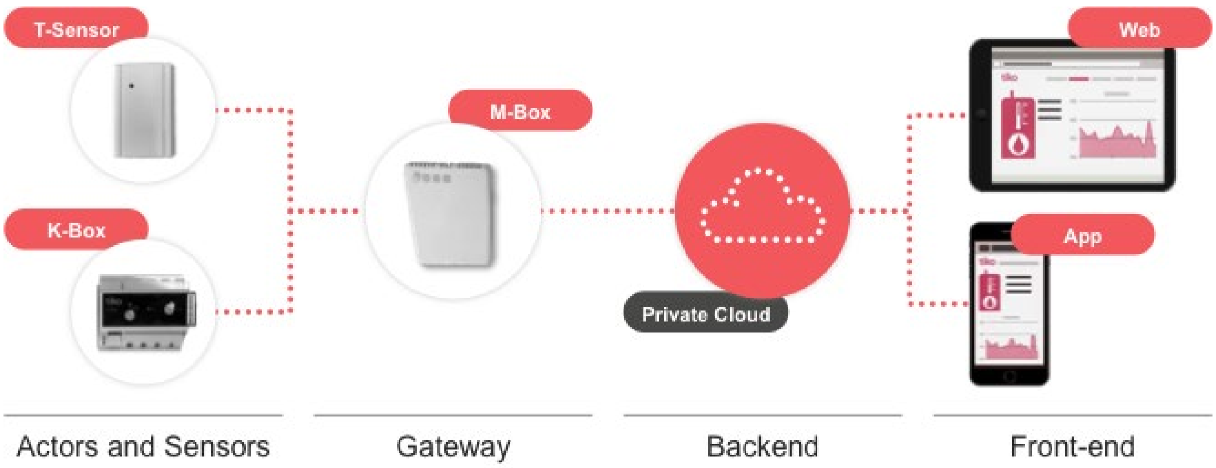

Figure 1: tiko system overview [1]

Summary of IoT case

To ensure stability of power grids, the energy supply and demand must be balanced. Traditionally, the demand for electricity was assumed to be unchangeable and production-side balancing was applied to the system. With the increase of fluctuating renewable energy sources, electricity production itself is becoming difficult to control. To enable a reliable power grid operation with fluctuating supply, flexibilization of the demand side must be achieved. Due to the high inertia of the thermal energy demand in the buildings sector, the demands are well suited for load side flexibilization if they are covered by heat pumps or other forms of electrical heating.

The company tiko Energy Solutions AG started with the development of its ancillary service business in 2012 and entered the market with its solution in 2014. In 2017, tiko's virtual power plant already included over 10,000 electrically based heating systems throughout Switzerland. More than half of these installations are heat pumps. The remaining installations are made up of direct electric heaters, night storage heaters and hot water boilers. In 2017, tiko managed a total capacity of up to 50 MW in Switzerland [1]. tiko offers the grid operator both primary control quality (frequency stability) and secondary control quality (balancing between planned power and actual power in the grid). Since 2017, tiko has been expanding its market internationally and has established a customer base in several countries in the EU [2].

The tiko system can be divided into 4 parts (see Figure 1). As actors and sensors, two devices are connected directly to the heating system. The “K-box” measures the power consumption and at the same time serves as a control switch using a relay. The T-sensor is used to ensure comfort, so that the room or water temperature does not drop out of the desired temperature range due to a switch action. Both devices communicate within the house power line carrier (PLC) with the “M-box” (gateway). The “M-box” collects all data and communicates via 3G/4G network with the private cloud (backend) of tiko. All processing work is performed on the cloud server. This backend system collects all information about the connected devices and combines it with additional information such as local weather forecasts, past consumption patterns and estimation of the current state of the devices. Based upon this information and employing proprietary algorithms, the system determines the removal or addition of the individual loads to achieve the necessary balance throughout the entire system. On the private user side, customers can monitor and manage their own energy consumption via a webpage or app (frontend). This enables them to make better use of their energy-saving potential.

Apart from comfort limits, switching limits have also been implemented. Especially for heat pumps, frequent switching on and off can lead to a performance loss and increased wear of the equipment. The switching limits were developed by tiko in cooperation with leading HP vendors. Figure 2 shows an example of an air/water heat pump being switched off for 52 minutes by the tiko system. The typical heat pump in the tiko system is switched less than five times per day on average.

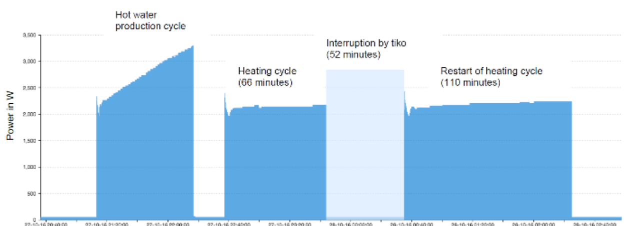

Figure 2: heat pump cycle interrupted by tiko control [1]

The market experience of tiko shows that a pooling of heat pumps and other electrical heating devices in a virtual power plant is economically viable. Due to the large number of devices connected, the on/off control system is the only economical solution. An individual control of parameters is regarded to be too expensive and complex without much increase in the benefits. Due to the high transparency provided to the private users, it was possible to identify incorrectly configured heat pumps and to improve their efficiency with new parameters set by the customer.

Result

- Ancillary services based on residential heating devices can be provided economically.
- The key elements for a successful solution are:
  - Simple and cost-efficient hardware
  - Secure and reliable communication
  - Efficient handling of big amounts of data
  - Simple and efficient control algorithms
  - Value proposition for all involved parties

FACTS ABOUT THE IOT CASE

IoT catagory: HP pooling, power grid services

Heat supply capacity: Up to 50 MW

Heat source: Multiple sources covered

Analysis method: Big data analysis, control engineering

Modelling requirements: Data driven model further detail n.A.

Data required: Power consumption, weather forecast, user behaviour, user profile, power prices, grid operator demands

Data interface: Local Power Line Communcation, GSM (3G/4G) to backend (Cloud) and frontend (App, Webpage)

Transmission protocol for data: TCP-IP, Modbus RTU, Modbus TCP, Power Line Communicaton

Quality-of-Service: Real-time (online control)

Technology Readiness Level: TRL 9

Link to webpage: www.tiko.energy

References

[1] M. Geidl, B. Arnoux, T. Plaisted, and Dufour Stéphane, “A fully operational virtual energy storage network providing flexibility for the power system,” in Proceedings of the 12th IEA Heat Pump Conference, Rotterdam, 2017.

[2] Energy Management System & Virtual Power Plant - tiko Energy, Online Available: https://tiko.energy/ (accessed: Nov. 28. 2022).