ENHANCED SMART METER INFRASTRUCTURE FOR EVENT-DRIVEN TARIFFS TO CONTROL FLEXIBILTY IN GERMANY

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Overview

The German government has set itself the goal of achieving a climate-neutral electricity sector by 2035 [1]. In addition, 25 – 32 million fully electric vehicles and 14,3 million heat pumps are expected to be operational by 2037 [2]. The massive expansion of fluctuating renewable energy producers required for this, coupled with the simultaneous elimination of controllable fossil fuel power plants, leads to high volatility in the electricity supply and thus to strongly fluctuating prices on the electricity market. However, the new household-related electricity consumers (heat pumps, electric vehicles and home battery storage) also offer very high flexibility potential for the electricity system: they can be intelligently shifted in terms of their time of use without any loss of comfort. Smart meters in combination with home energy management systems (HEMS) and intelligent electricity tariffs are the key technology for activating this flexibility. We will present a newly developed event-driven tariff that incentivises consumers to shift their electricity consumption in a market- and grid-serving matter. We will also present the prototype of the enhanced smart meter infrastructure and the required signalling between the involved stakeholders and devices.

Methods

For obtaining our results, we used a variety of different methods: We conducted expert surveys with more than one dozen electricity vendors regarding the market potential of dynamic and event-driven tariffs. Various tariff concepts have been simulated with historic and contemporary market data. The prototype of the enhanced smart meter infrastructure has been developed and tested by our project partner EMH Metering, one of five certified manufacturers of smart meter gateways in Germany. The combination of event-driven tariffs, smart meters, HEMS and flexible devices (charging station, battery, AC) has first been tested as hardware-in-the-loop in our labs and then validated in our e-mobility field lab. The event-driven tariff is currently being used in a field-study with selected customers of a utility company in the south-west of Germany.

Results

In our workshop-contribution we will first give a brief summary of the relevant initiatives to digitalize the distribution network: The mandatory smart meter rollout [4], the obligation to offer dynamic/flexible tariffs and the mandatory control of large consumption devices (e.g. heat pumps, batteries, wallboxes) by the DSO. The combination of these initiatives provides the basis for a grid- and market serving behaviour based on financial incentives.

A key role for the financially driven control of flexibilities has the dynamic tariff. Such a tariff mirrors the prices of the wholesale market on the energy exchange and provides a financial incentive to consume in times of high renewable energy production. However, according to a qualitative expert survey conducted by the authors, dynamic tariffs, have many disadvantages: high price volatility and hence a high financial risk for electricity venders and consumers, high complexity for transparency and billing due to 1/4h-metering values [5]. We will introduce a concept for an event-driven tariff minimizing the drawbacks of dynamic tariffs, but still incentivizing the household for market-serving and grid serving shifts of their electricity consumption.

In its basic version, the tariff concept includes three tariff levels. Per default, the base tariff level (middle tariff level) applies to the customer. If contractually agreed thresholds of the wholesale price are exceeded, the supplier triggers a corresponding tariff event and the change to the then applicable tariff level (cap tariff level or floor tariff level). The basis for such a tariff level change is always the wholsale exchange price.

To implement the three-step tariff, an enhanced smart metering infrastructure is necessary. There is complex signaling between the respective actors - electricity vendor or external market participants (aEMP), the gateway administrator (GWA) and Smart Meter Gateway - to transmit the tariff information.

The main focus of our contribution is a description of the technical implementation of such an enhanced Smart Metering infrastructure. In principle, two network interfaces are available within the smart meter gateway for the communicative connection. One is the wide area network (WAN) for the connection of active external market participants (aEMP) and the gateway administrator (GWA) and the other is the home area network (HAN) for the connection of controllable devices. For the proposed tariff concept, the devices are controlled via the Home Energy Management System (HEMS), which is connected to the SMGW via the TLS-Proxy-Function. Figure 1 illustrates the logical communication interfaces between SMGW and HEMS as well as the type of data transmission.

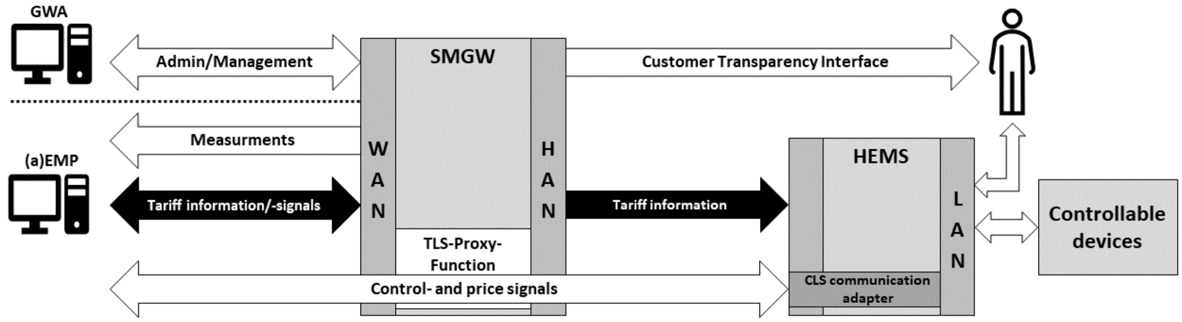

Fig. 1: Logical communication interfaces between SMGW and HEMS.

As can be seen from the description of the tariff concept, the events for a tariff level change in the WAN are triggered by the energy supplier. For this purpose, the tariff information on which the tariff levels are based is transferred to the GWA by the supplier (in the role of the aEMP). This information contains the requests for tariff level switch and should be transferred the day before (publication of day-ahead prices). The GWA stores the tariff information in the respective registers of the SMGW. The respective tariff levels then apply for the following day. The tariff information can then be transferred in the HAN to the HEMS for a price-optimized control.

Conclusions

The results we will present are based on the project "KEMAL", conducted by EMH Metering (one of five certified manufacturers of smart meter gateways in Germany), elenia institute (Technical University Braunschweig) and Biberach University of Applied Sciences. It is funded by the German Ministry for Economic Affairs and Climate Protection under grant no. 03EI6064A/B/C.

The prototype of the enhanced smart meter infrastructure is currently being tested in the e-mobility field laboratory at Biberach University of Applied Sciences. The event-driven tariff is currently being evaluated in a field-study with selected customers of a utility company in the south-west of Germany. Our tariff concept in combination with the enhanced smart meter infrastructure solves many of the drawbacks of current tariffs. We therefore expect, that the new version of the technical requirements for smart meter gateways [6] of the German legislator will include the capability to process tariff events as mandatory requirement for all smart meter Gateways in Germany.

References

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