Subscribe | Past Issues | Tr

View this email in your browser

carpe DIEM Newsletter

Demonstration sites

Kreis Ostholstein as a case study

Presentations of carpeDIEM

Interreg article about carpeDIEM

We represented carpeDIEM at the Grünstromevent

Robert Brehm gave a talk at the KES-AMSTA conference on the algorithms underlying the carpeDIEM optimization process.

New Persons

Hendrik Saβ started his Master project within carpeDIEM at SDU.

Events

The following two events are organized by us.

- September 5, 2017 360º Workshop for carpeDIEM, Flensburg

- October 4-5, 2017 100% Climate Neutrality Conference with Session dedicated to Intelligent Energy Systems

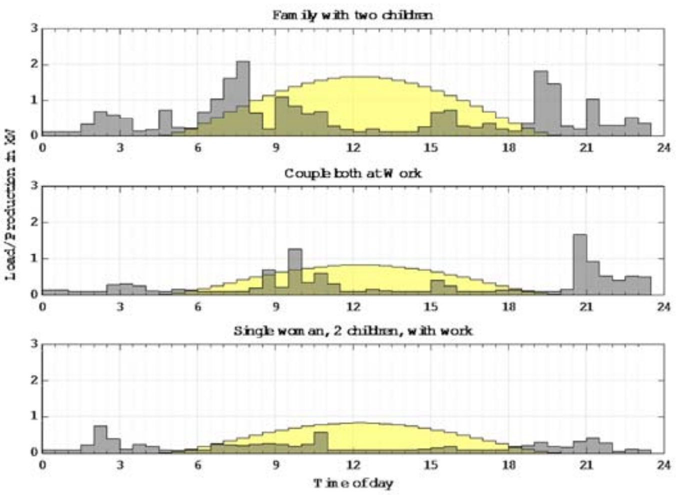
Find more interesting events on our homepage

This project is supported by the European Fund for Regional Development.
Dette projekt finansieres af midler fra Den Europæiske Fond for Regionaludvikling.
Dieses Projekt wird gefördert mit Mitteln des Europäischen Fonds für regionale Entwicklung.

Presentation of an algorithm for coordinated Charging/Discharging of Batteries in a residential Microgrid at the KES-AMSTA conference

The KES-AMSTA (Agent and Multi-Agent Systems: Technologies and Applications) conference is an international scientific conference for research in the field of agent and multi-agent systems. Agents and multi-agent systems are related to a modern software paradigm which has long been recognized as a promising technology for constructing autonomous, complex and intelligent systems, also for decentralized distributed energy management for Smart-Grid applications.Robert Brehm presented a distributed, decentralized method for coordinated scheduling of charge/discharge intervals of storage capacities in a microgrid that is integrated in a utility grid. This multi-agent based algorithm has been developed within the carpeDIEM project. The decentralized algorithm is based on a consensus scheme and solves an

optimization problem with the objective to minimize, by use of storage capacities, the power flow over a transformer substation between the utility grid and the microgrid. The algorithm works purely decentralized and on the basis of a multi-agent system, which means the optimal solution is found only by information exchange of interacting appliances. It is shown that when using this coordinated scheduling algorithm, load profile flattening (peak-shaving) for the utility grid is achieved. Additionally, mutual charge/discharge between batteries which are interconnected in the same grid (behind the same transformer substation) is prevented. The effect of coordinated scheduling and the resulting prevention of mutual charge/discharge is shown in the simulation below.



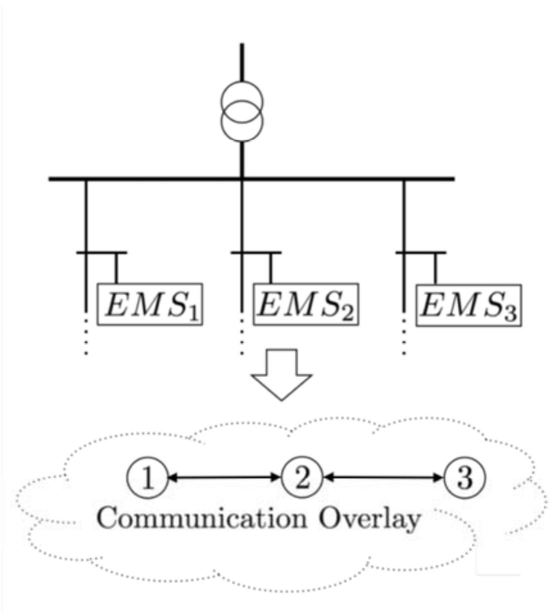
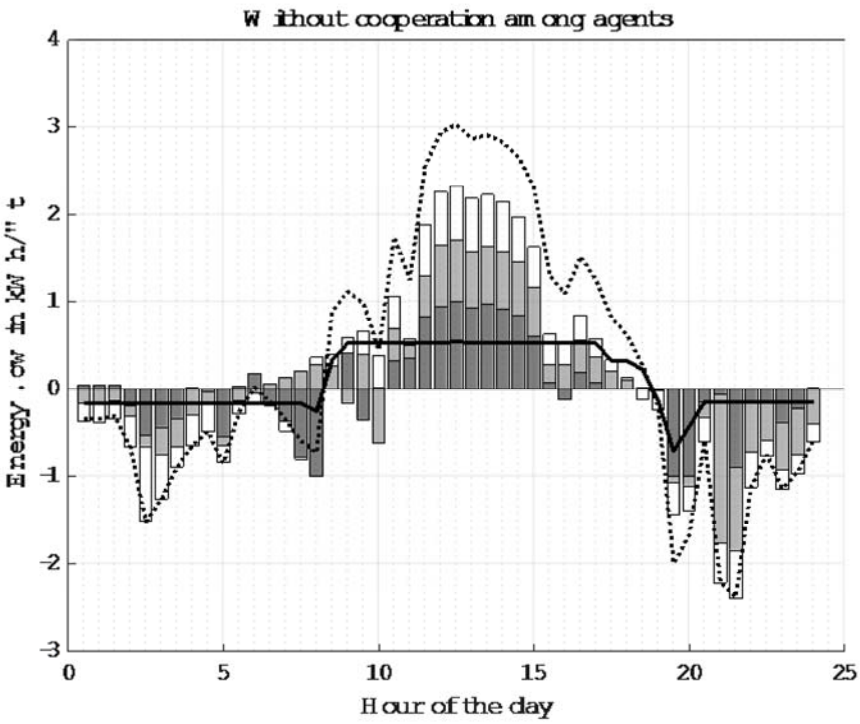


Fig.1 Three different user types underlying the simulation.

To illustrate the concept of coordinated scheduling, a scenario of three different residential households has been simulated. Figure 1a shows the simulated load (grey) and local PeakVoltage production profiles (yellow) for different households (upper image) connected on the same LowVoltage grid (lower image). These are operated by three individual agents, which iteratively exchange information via an overlay communication network (lower image). It is assumed that these households are equipped with PeakVoltage panel installations and local battery capacities with individual different limited charge and discharge currents and limited storage capacity and that they are connected on the same LowVoltage grid. Each household's agent is able to control, in each household: the energy flow in and out of the battery and iteratively exchange this information with neighboring agents. All agents will thus converge to a consensus for each time interval, so that either all batteries are charged at a time, or discharged and mutual charging/discharging is prevented.



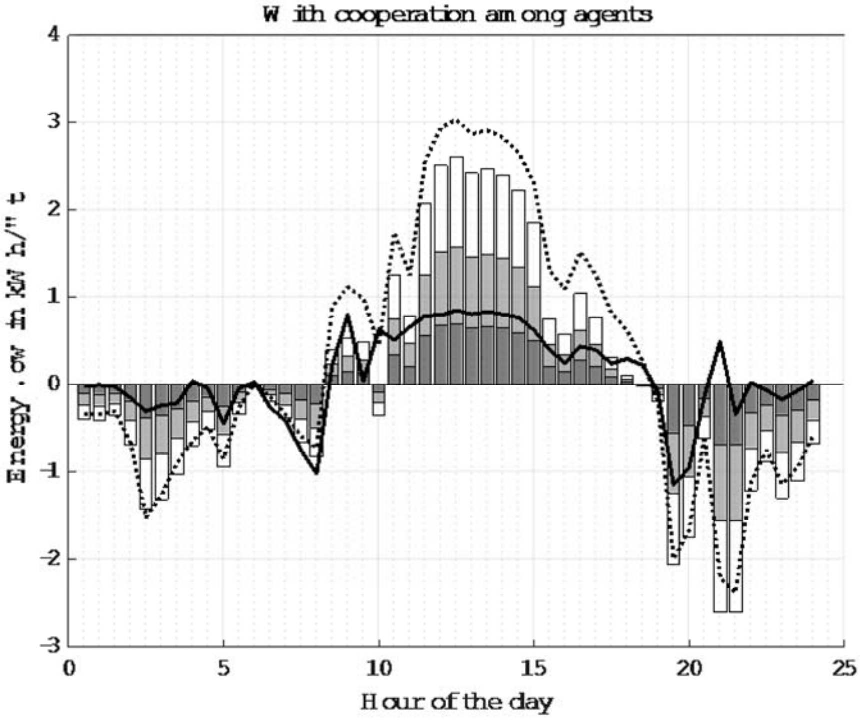


Fig. 2 Results of the simulation.

The results obtained are presented in Figure 2. This shows the optimal battery power flow over the scheduling time horizon as a stacked bar graph for each battery as cooperatively agreed among the EMS agents using the coordinated scheduling algorithm. Each different colored (grey-scale) bar represents an individual battery controlled by an agent. A downward pointing bar, symbolizes battery discharging while and an upward pointing bar symbolizes battery charging. Further shown in Figure 2 is the original grid load profile (sum over all loads) as a dashed line and the residual grid profile as a solid black line after coordinated (upper chart) and non-coordinated scheduling (lower chart), respectively. The results as shown in the upper chart of Figure 2 can be compared with the lower chart of Figure 2, which shows the data for the same load and production profile simulation. However, in contrast to the coordinated multi-agent scheduling, in the upper chart each agent solves the given optimisation problem without cooperation among agents. The results obtained in these simulations demonstrate a significant reduction in magnitude of the grid load profile, thus the feed-in peaks around noon as well as the peak loads in the

morning and evening are smoothed. This is evident for both simulation scenarios. However, there is a significant difference between the two scenarios. In contrast to the results obtained with a coordinated scheduling algorithm, when optimising individually only, charge and discharge intervals between the different nodes are not coordinated. Cases are present where at in the same time intervall, a battery at a particular node charges whereas a battery at a different node discharges, so mutual charging/discharging occurs. This can be seen specifically between 6:00 and 10:00 o'clock and others in Figure 2 (upper chart).

In progress is currently an extended scheme in which an overlying supervisory authority agent can dictate a set-point for the utilization of the batteries inside the virtual microgrid so that the amount of peak shaving can be influenced. Additionally a predefined profile can be dictated by a supervisory agent (such as an energy distributor) and so that the EMS agents cooperatively optimise towards that profile. This then reflects a least-squares function approximation, with the objective of minimising the difference between the given profile (function) and the profile provided by the VMG.

Hendrik Sass is an international guest researcher from Lübeck, who moved to Denmark in April. His work is part of an active exchange program and a cooperative arrangement within the carpeDIEM project between the University of Applied Sciences in Lübeck and the Mads Clausen Institute.

In order to control and optimize the energy flow within an energy transmission and distribution system, the responsible energy management system (EMS) must know the energy consumption of its consumers. This information must be available before the EMS can make any control decisions. Such data is often not given and must be acquired. Often the behavior of loads and consumer changes over time. Therefore, the system must be able to measure and learn the behavior of consumers, connected to an EMS. This is exactly what Hendrik will address in his work.

His goal is the design and development of a custom energy management hardware for the carpeDIEM project. The system will be capable of measuring and controlling connected loads, like electric vehicle charge stations or other electrical appliances. The system will be able to learn the electrical behavior of such connected devices and create a prognosis of its energy consumption. This is done by the use of machine learning techniques. The acquired data can then be used as a forecast to make reliable scheduling algorithms for control decisions within the EMS.
Besides the creation of the hardware, his written final Master thesis will focus on the implementation of different machine learning algorithms on a processing system (ARM) and the development of a hardware solution in a field programmable gate array (FPGA). It is expected, that the hardware solution will outperform the machine learning software of the processing system such that it can react faster to dynamic changes within the system. His thesis will investigate how much the performance increase is, in case of a distributed energy management system, and if its advantages justifies the higher complexity and cost of a FPGA supported system.

Conception and evaluation of intelligent charge stations for coordinated charging of electrical vehicles for the district administration of the Kreis Ostholstein

The district administration of the Kreis Ostholstein in Germany considers changing its business car fleet to electrical cars. One of the problems the district administration is facing is, that the transformer substation, which would feed the charge stations for the electrical cars, has only a limited capacity left to add extra loads. To add charge points for electrical vehicles to the substation, the transformer substation would need to be reinforced. The energy supplier and distributor which own the transformer substation would charge an extra fee for the reinforcement. Within the carpeDIEM project it will be investigated if it is

possible to add extra charge points without reinforcement of the substation. In this scenario an intelligent energy management system schedules the charging of the electrical vehicles so that the maximum capacity of the transformer substation is not exceeded, thus the reinforcement of the transformer substation would not be needed. This is an economical benefit since the fee for the transformer reinforcement would be saved. In addition this demonstrates how to efficiently use the existing grid infrastructure by more intelligent energy management without grid reinforcement.
CarpeDIEM will then identify the issues related to simultaneous charging of a complete electrical vehicle fleet, such as peak loads and will simulate scenarios for intelligent coordinated charging of the car fleet in order to smoothen the load profile over the transformer substation, so that capacity limits are not exceeded and the transformer substation reinforcement can be avoided. This will be done based on use profiles of the current car fleet (anonymous driver logbooks).
