Zurich University of Applied Sciences

zhaw School of Engineering
IEFE Institute of Energy Systems and Fluid Engineering

CLEAN ENERGY MINISTERIAL

ISGAN INTERNATIONAL SMART GRID ACTION NETWORK

Flexibility Utilisation of Municipalities to Optimally Use the Electricity Grid

L. Rüegg[1], R. Hiltebrand[1], A. Obusevs[1], A. Mächler[1], P. Korba[1]
[1] Zürich University of Applied Sciences, Switzerland

Motivation

Electrifying the energy system with heat pumps and electric vehicles is a strategy of many countries to reduce CO2 emissions. Large electrification, however, poses several new challenges for the electricity system, particularly in combination with a simultaneous substitution of nuclear power plants by volatile renewables such as photovoltaics. The increasing consumption of electricity and the growing number of installed photovoltaic systems are pushing the existing electrical grid to its limits. Today's grid must be expanded with smart controllers and their components regulated. For this purpose, an understanding of flexible participants such as boilers, heat pumps and electric vehicles, and new production facilities such as photovoltaic systems must be built up. The aim of this poster is to present municipality flexibility potential and the proposed energy scheduler for flexible loads shifting to the optimal place, considering defined restrictions. The results are used to calculate the new parameters for the locally installed model predictive controllers (MPCs), which control appliances according to the scheduler setpoints, to optimally utilise flexibilities for peak shaving.

Overall Control Concept

The grid structure dealt with in this work includes not only the different grid levels, but also the communication of the consumers with controllers. Until now, the municipality under investigation has worked with MPCs as well as smart meters. These communicate and control the corresponding flexibility directly through data from the transformer station. In this way, the load curve is continuously adjusted according to the given situation. However, this procedure does not allow any control by the grid operator (DSO). With the Energy Scheduler, a higher-level calculation of the loads for the municipal grid is to be carried out. An overview is shown in Figure 1. By taking into account past load data and weather forecasts an overall load profile for the next 24 hours is generated by using the Energy Model [1]. This overall profile of the municipality is then given to the energy scheduler where its loads are being scheduled, considering shifting limitations and consumer preferences and the optimised profile parameterised. These parameters are transmitted to the local MPC and control units of the respective flexibility.

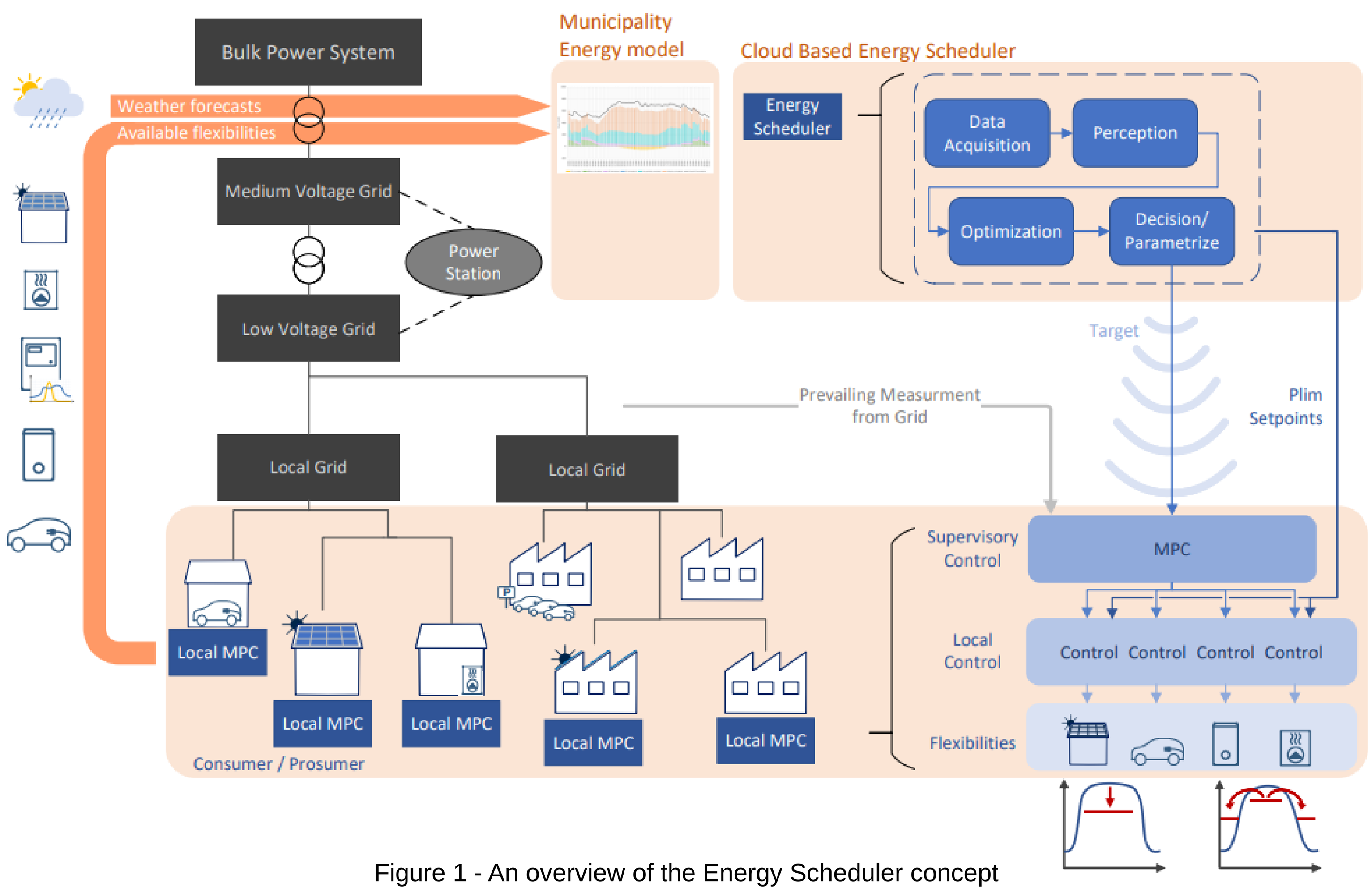

Figure 1 - An overview of the Energy Scheduler concept

The target is transferred to the MPC, where the MPC follows the scheduled grid loading while considering substation measurements during the day. At the same time, a Plim is passed to the corresponding control units of the flexibility (EV, boiler or HP). This means with a sunny weather forecast, a high PV production can be expected. Thus, more flexibilities can be shifted to the daytime. In case of bad weather forecasts, the parameters can be adjusted accordingly, and the loads being kept as flat as possible in advance by activating them predominantly during the night.

Scenarios Contents

For a realistic scenario development with a focus on the municipality, the Energy Perspective 2050+ is taken as a basis, considering ZERO Basis, business as usual (BAU) and a so-called potential, or POT (fully exhausted potential), scenarios are offered.

	2020	2050 ZERO	2050 BAU	2050 POT
Amount:	35	2586	2290	4960
Energy: [GWh]	0.16	10.57	9.36	20.27

	2020	2050 ZERO	2050 BAU	2050 POT
Increase:		15.27x	5.20x	24.43x
Energy: [GWh]	1.41	21.58	7.34	34.51

	2020	2050 ZERO	2050 BAU	2050 POT
Increase:		3.08x	1.59x	3.68x
Energy: [MWh]	7.36	22.66	11.69	27.11

	2020	2050 ZERO	2050 BAU	2050 POT
Increase:		0.71x	0.82x	0.75x
Power: [GW]	22.71	15.90	18.55	16.95

Figure 2 - Three scenarios for the municipality are based on the Energy Perspectives 2050+ [2]

Results:

In Figure 3 three load profiles for the ZERO Winter and Summer scenario are shown: Initial load profile with considered scenario and HP/EV/PV grow, optimally shifted loads (no constraints, theoretically possible) and shifted loads considering constraints.

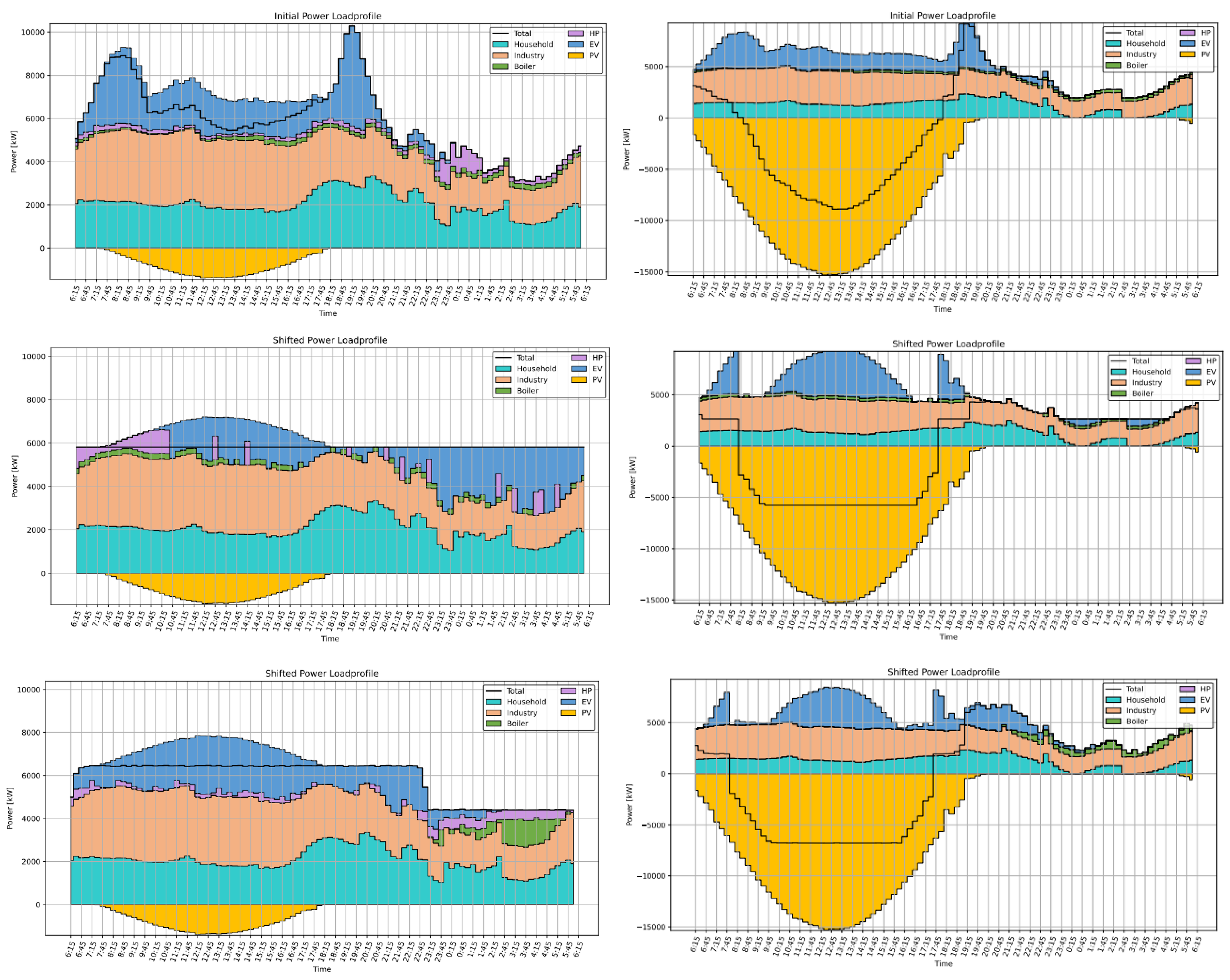

Figure 3 - Visualisation of the ZERO Winter (left) and Summer (right) scenario load profiles (initial, optimal and constrained)

Conclusion

The results of this study demonstrate, how the Energy Scheduler can handle three possible future scenarios, based on recent data from the SFOE. The data clearly indicate that it is important to handle the increasing consumption of electrical energy with demand-side management and utilize available flexibility. It was possible to shift the loads during the day to achieve a reduction of costs in the future scenarios for winter and summer with sunny weather, between 22% and 46.1%. Furthermore, for the alternative scenario, that is representing a growth of flexibility in the recent infrastructure of the municipality for two different weather situations, it was possible to decrease the costs between 7.7% and 10.5%.

References

[1] L. Rüegg, R. Hiltebrand, A. Obushevs, P. Korba "Energy Model for Municipality Flexibility Investigation" 2022 IEEE 63rd RTUCON
[2] Swiss Federal Office of Energy (SFOE), "Energieperspektiven 2050+, Kurzbericht," Swiss Federal Office of Energy (SFOE), Bern, 2020.