Disaggregation of household load profiles

Motivation and research question

The expansion of renewable energies triggers problems in today’s energy system, which cause increasing demand for flexibility. Demand Side Management (DSM) supports the integration of renewable energy sources into the energy system. To examine the DSM potential for relevant household appliances (here: dishwasher, washing machine, dryer) precisely, their characteristics, i.e. load profile, time and frequency of uses, have to be determined. Past research usually tried to identify well-known home appliances with measured load profiles in unknown load profiles [1]. Since this is not practicable for a large number of households, a new approach is developed to determine the appliances’ existence and characteristics only based on the household’s power consumption.

Methods

The evaluations use electrical load data of 565 German households with a temporal resolution of one minute [2,3]. The load profile of a regularly operated appliance is identified by clustering relevant intervals which are extracted from the full year’s data. The correlation coefficient is applied as metric for clustering. Figure 1 shows an exemplary cluster.

In order to assign these resulting clusters to appliance types, five properties are defined to describe the appliances’ characteristics numerically. Their values are determined based on measured data from different manufacturers as well as varying programs. As a consequence, the properties result in a range of values, whereby at least one property is disjoint for two appliance types. It occurs that more than one cluster is assigned to a certain appliance, which takes into account that various programs might be used. Finally, these allocated load profiles are used to determine the time of uses of the household’s appliances.

Results and Conclusions

Figure 2 shows a heat map of recognized dishwasher uses for all analyzed households. The heat map covers a whole year (August 1, 2014 –July 31, 2015). Each column represents a calendar week (CW) and includes 168 (=7·24 h) cells, which contain the recognized starts for all appliances during the interval. The normalized scaling marks the cell with the maximum number of detected uses white; hours with no uses are painted black.

On working days, dishwashers are mainly operated in the evening, whereas on weekends the uses are distributed more equally over the whole day. The figure shows that dishwashers are most frequently used in...
winter. The uses during days like Christmas (CW 52) or holidays differ from the corresponding days for the rest of the year.

![Figure 2: Heat Map for dishwasher uses](image)

These plausible results demonstrate the correctness of the developed approach. Using properties to assign unknown load profiles to household appliances is a suitable method if the summed electrical load is the only available information. Besides the depicted user behavior (cf. Figure 2) also the duration and power consumption for the determined appliances’ load profiles match literature values [4,5].

References