Hoog Dalem

Introduction

Hoog Dalem, an all electric residential area in the Netherlands, is a USEF demonstration project. Its purpose is to test different end user propositions related to PV and batteries. The two main propositions are:

- Sun in my House: surplus generated solar energy is stored in a battery to be used at times when demand for energy is greater than energy generated.
- Night by Day: batteries are charged during low tariff hours. The energy stored is used during high tariff hours.

As well as using batteries for in-home optimization, it is also possible to use them to avoid overloading of the distribution grid. USEF processes are used to achieve this and this paper provides insight into how these work.

USEF process steps

In Hoog Dalem, flexibility is provided to the DSO only. The aggregator collects demand and generation forecasts for individual households and uses these to create a *D-prognosis* which is sent to the DSO. The DSO checks whether the D-prognosis fits within the grid constraints. Where it doesn't, the DSO requests flexibility from the aggregator who, as far as he is able, offers this. After the DSO has accepted the flexibility offer, the aggregator provides a new D-prognosis which includes it.

Remarks on flexibility in Hoog Dalem

The use of batteries to provide flexibility differs for each proposition. The 'Sun in my House' batteries are only considered as a shiftable load, with a constant load of 750 Watts during nine PTUs. It is assumed that each battery is discharged at the start of a new day. The 'Night by Day' batteries are considered to behave as a shiftable generator with comparable characteristics. Each battery is assumed to be fully loaded at 6:00 AM each morning.

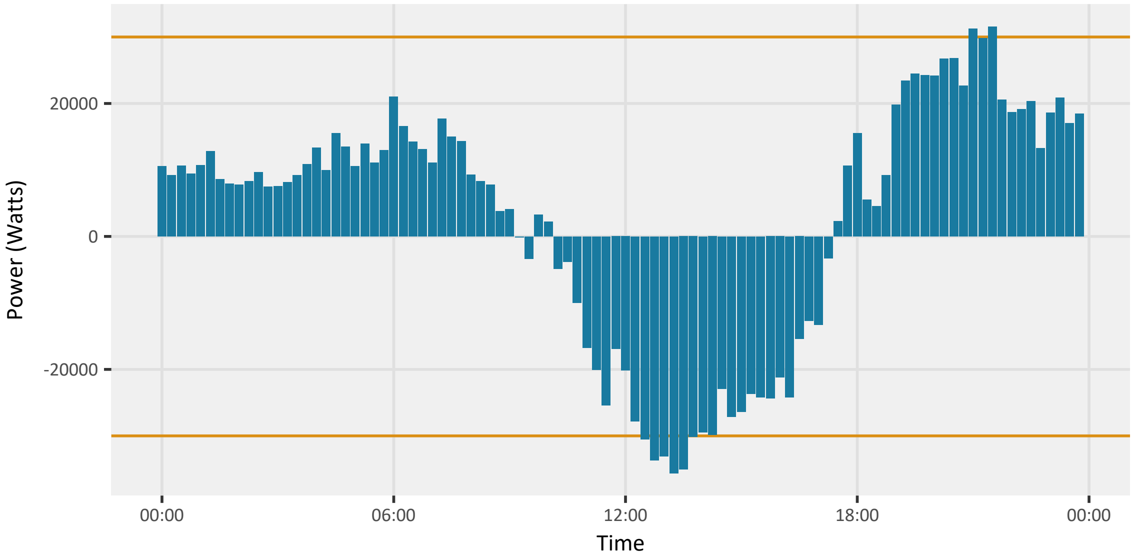
While we recognize that using the batteries this way is sub-optimal, the simplification is a necessary part of meeting the demonstration objective which is to show how USEF works. In future experiments, the batteries will be used in a more efficient way.

The forecasted energy is based on two components, the uncontrolled load and the forecasted PV generation. The uncontrollable load is calculated by taking the means of the previous three weekdays of seven reference households. PV generation is forecasted using the data of PVGIS (http://re.jrc.ec.europa.eu/pvgis/) and prognosed sky coverage.

USEF step by step

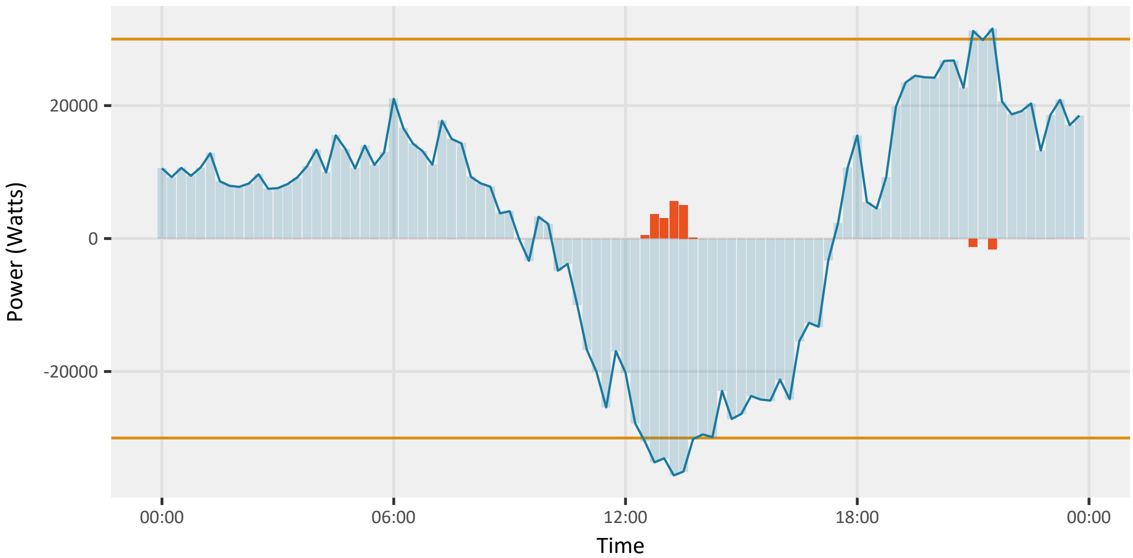
In the remainder of this paper, each process step will be discussed. The starting point is that the grid capacity is limited to +/- 30 kW. The data used for the plots are the actual values for 8 September 2016. In each new plot, the bars of previous plots are faded, except for the limits.

First D-prognosis



The plot above shows the initial D-prognosis sent by the aggregator in blue. This includes the forecasted demand and generation of all houses assuming in-home optimization only.

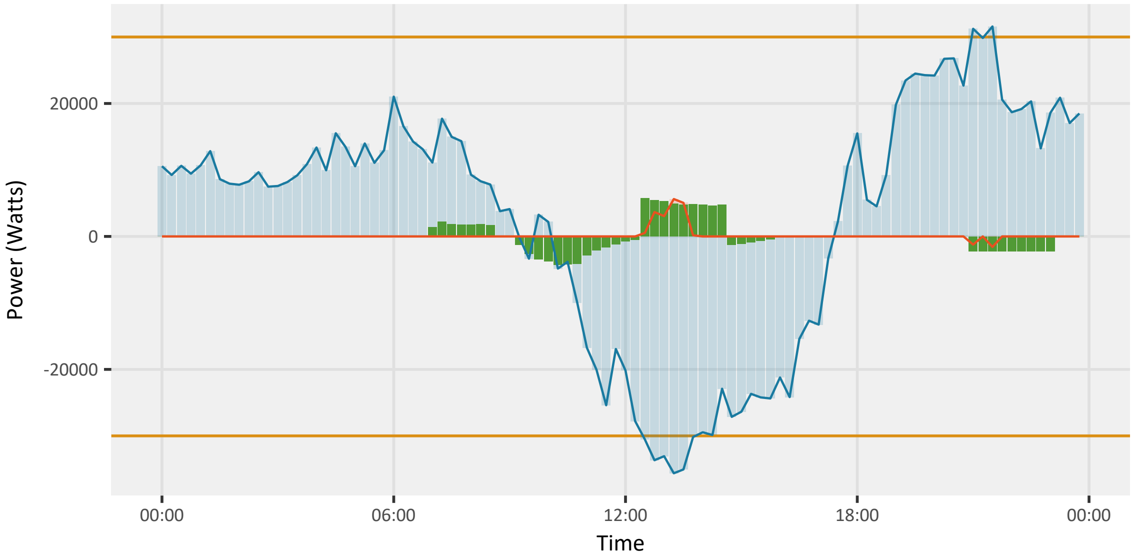
FlexRequest



Between 12:30 and 13:45, generation causes too much feed in and at both 21:00 and 21:30, consumption is too high. Both situations will cause an overload if no measures are taken so the DSO requests flexibility using a *FlexRequest* to reduce the load on the grid. The amount of flexibility needed is depicted in red[1].

[1] A FlexRequest also contains information about tha available capacity. This is not shown in the figure

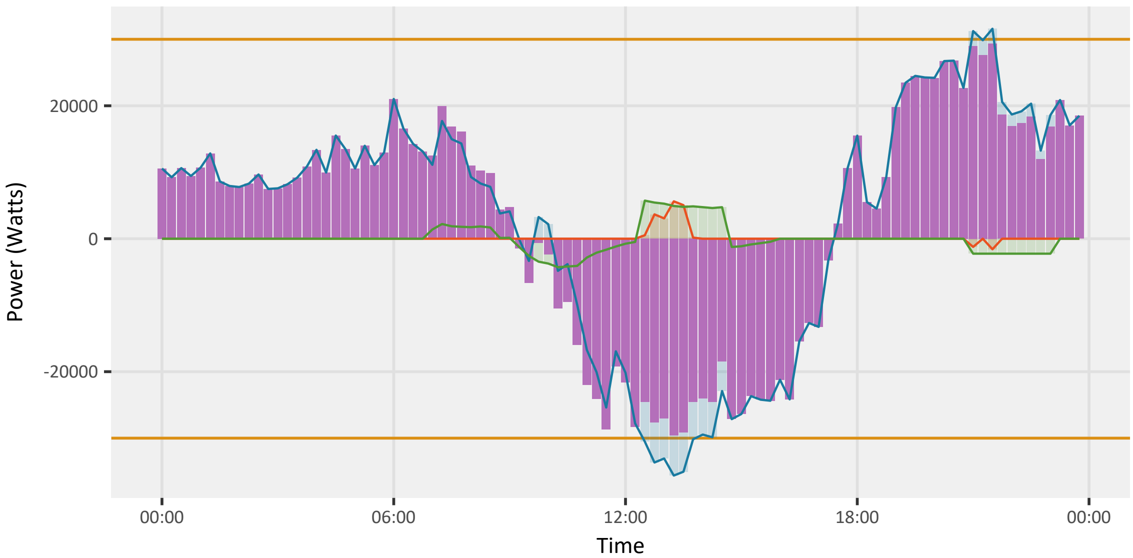
FlexOffer



The *FlexOffer* created by the aggregator includes both the flexibility requested by the DSO and the effect of the aggregator providing this flexibility. Lowering the peak between 12:30 and 13:45 causes an increase in feed-in during the PTUs preceding this period because, in the initial prognosis, the batteries were loaded during this period[2]. Shifting the batteries implies an increase of generation at the PTUs when the batteries were initially charged. The flexibility offered to solve the overload at 21:00 and 21:30 has a similar impact in the morning.

At the Hoog Dalem implementation, every FlexOffer made by the aggregator is automatically ordered by the DSO regardless of price or fit. FlexOffers may be accepted despite not offering enough flexibility and resulting in additional FlexRequests which cannot be fulfilled. This is an acknowledged project-specific limitation. The gate closure check—included in the USEF processes—ensures that this process step will lead to a final result.

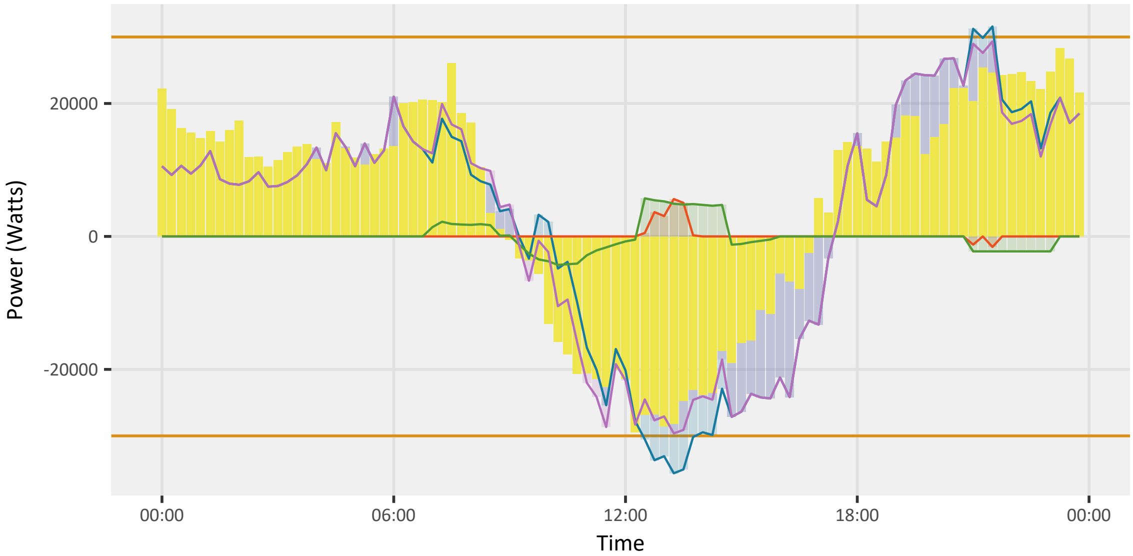
Final D-prognosis



The flexibility offered by the aggregator results in a final D-prognosis.

[2]The minimal increase during the PTUs following the period where flexibility is needed is due to the algorithm used by the aggregator. This assumes that each battery is charged with 750 Watts unless the surplus of energy generated is lower. The result is a lower than expected FlexOffer causing the minimal effect in the following PTUs.

Actual



The actual values differs from the prognosed values. Although the difference between actual values and the values in the final D-prognosis are substantial for certain PTUs, the offered flexibility can be realized by the aggregator, even although the algorithms used by the aggregator are very basic.

Conclusion

Batteries can aid the avoidance of grid congestion where they are controlled on a district level by an aggregator. The USEF processes enable communication about the amount of flexibility needed between aggregator and DSO[3]. It is proven that the process steps result in a final prognosis where flexibility helps to avoid (forecasted) congestion.

The results show a substantial difference between the final forecast and actual measurements. This is mainly caused by USEF's heavy reliance on forecasts which, in this project, are limited to a small number of reference households. This situation would clearly be improved in larger volume real-life implementations..

[3] And between aggregator and BRP—this is however not part of the Hoog Dalem demonstration project.