Domestic Battery Power Management Strategies to Maximize the Profitability and Support the Network

This code contains three different management strategies for the residential behind the meter batteries (BESS) in order to maximize the customer's profitability and enhance the network performance. The three algorithms are briefly explained as:

1- Conventional Rule-Based Algorithm (CRBA): This is the conventional method of (dis)charging the BESS according to upper and lower thresholds that maximizes the customers profitability only through maximizing the PV self-consumption.
2- Proposed Day-Ahead Scheduling Algorithm (PDSA): This is an optimization-based algorithm aims to optimize the electricity bill and load variance using the WORHP solver. Optimizing the load variance supports the network through flattening the household net profile.
3- Proposed Rule-Based Algorithm (PRBA): This is a rule-based algorithm that does not require any optimizer however, it optimizes the electricity bill and load variance according to a set of inputs.

In order to run the code, the required inputs are detailed as follows:

- The household profiles should be entered in any data resolution in the file (data.m) in the following format:

Demand (kW) (first column)	PV (kW) (second column)	EV (kW) (third column)

  - These data can be copied directly from excel/CSV file.

- Use BESSMA.m, to run the code. The inputs for the main program (BESSMA.m) are described in the following table:

Main Inputs	
`SaveR`	To save the data in excel sheet: 1 will save in Results.xls, other values will not.
`Prog`	Selects the required algorithm. 1 for CRBA, 2 for PDSA, and 3 for PRBA
`DataRes`	Data resolution in minutes (10 for 10 minutes, 30 for 30 minutes, 60 for 1 hour)
BESS Inputs	
`BESS`	Actual Capacity [kWh]
`DOD`	Depth of discharge in fraction (0 to 1)
`SOCMAX`	Maximum state of charge (0 to 1)
`BESSP`	Maximum rating of the BESS [kW]
`RE`	BESS System efficiency = BESS Efficiency * Inverter/Charger Efficiency
Time of use tariff inputs (The algorithms are developed for the double tariff rates of UK)	
`HR`	High rate value (day rate) [p/kWh]
`LR`	Low rate value (night rate) [p/kWh]
`TLS`	Start hour of night rate
`TLE`	End hour of night rate
`EX`	Export tariff rate in [p/kWh]
Network Details to calculate the losses and household voltage	
`VT`	Network Transformer voltage [V]
`PF`	Power factor
`R`	Resistance from the transformer to the household [Ohm]
`X`	Reactance from the transformer to the household [Ohm]
`EX`	Export tariff rate [p/kWh]
Program 1 (CRBA) Inputs	
`PTHD`	Upper threshold for discharging [kW]
`PTHC`	Lower threshold for charging [kW]
Program 3 (PRBA) Inputs	
`EVS`	EV charger rating [kW]
`AVGD`	Average daily consumption [kWh]
`Season`	The PV seasons (1 for high PV season / summer, 0 for low PV season / winter)
`PTHDn`	Normal upper threshold for discharging [kW]
`EVA`	Average EV charging hours
`EVC`	Electric vehicle status, if the EV will be charged next day EVC=1, otherwise, EVC=0
`FPV`	Forecasted PV daily generation
`PVL`	Forecasted of number of PV hours calculated from the start time of PV (`PVS`) and the end time of PV (`PVe`)

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- To use the PDSA, the WORHP solver require to be installed in your machine. You can download the solver and request the License from this Link: https://worhp.de/. After the installation completes according to the WORHP guide, please copy the license file (worhp.lic) to this folder or add it to the directory via MATLAB.
- More details on the work implemented in this code will be available soon through a published paper.
- The main code content is obscured in the file (MAINCODE.p). After publication, this code will be revealed as an open source.
- This code can be used to generate the power dispatch of residential batteries (with any specifications) to minimize the household's electricity bill for any time period (single day to multiple years). The output is the net demand and electricity bill with and without the battery, in addition to the battery power dispatch, state of charge and degradation.

- If you will use this code in the production of a publication, please cite the following papers:

  A. If you used any part of this code, please cite this paper:

  [1]. A. A. R. Mohamed, R. J. Best, X. Liu, and D. J. Morrow, 'Domestic Battery Power Management Strategies to Maximize the Profitability and Support the Network', p. 5. (**The exact Proceedings will be added soon**)

  B. If you used the optimization-based algorithm (PDSA), please cite the following paper in addition to paper number [1]:

  [2]. C. Büskens and D. Wassel, 'The esa nlp solver worhp', in Modeling and optimization in space engineering, Springer, 2012, pp. 85–110.

  C. If you used the BESS degradation results, please cite the following paper in addition to paper number [1]:

  [3]. B. Xu, A. Oudalov, A. Ulbig, G. Andersson and D. S. Kirschen, "Modeling of Lithium-Ion Battery Degradation for Cell Life Assessment," in IEEE Transactions on Smart Grid, vol. 9, no. 2, pp. 1131-1140, March 2018, doi: 10.1109/TSG.2016.2578950.

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