FEVER | Future Electric Vehicle Energy networks supporting Renewables

UKRI Engineering and Physical Sciences Research Council

FEVER Planning and Operation

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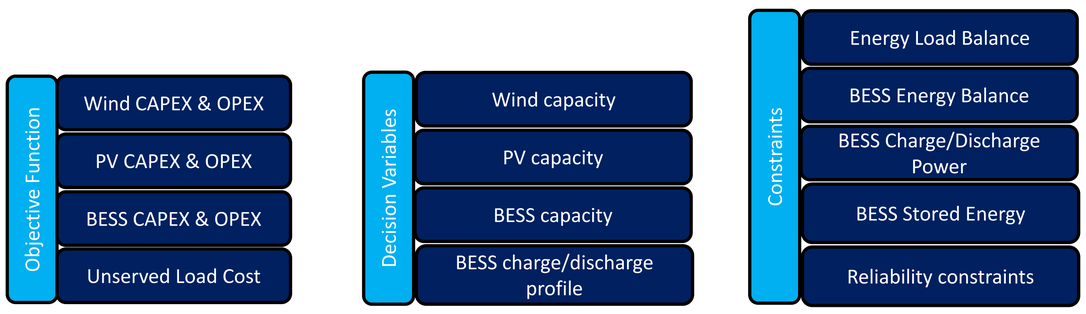
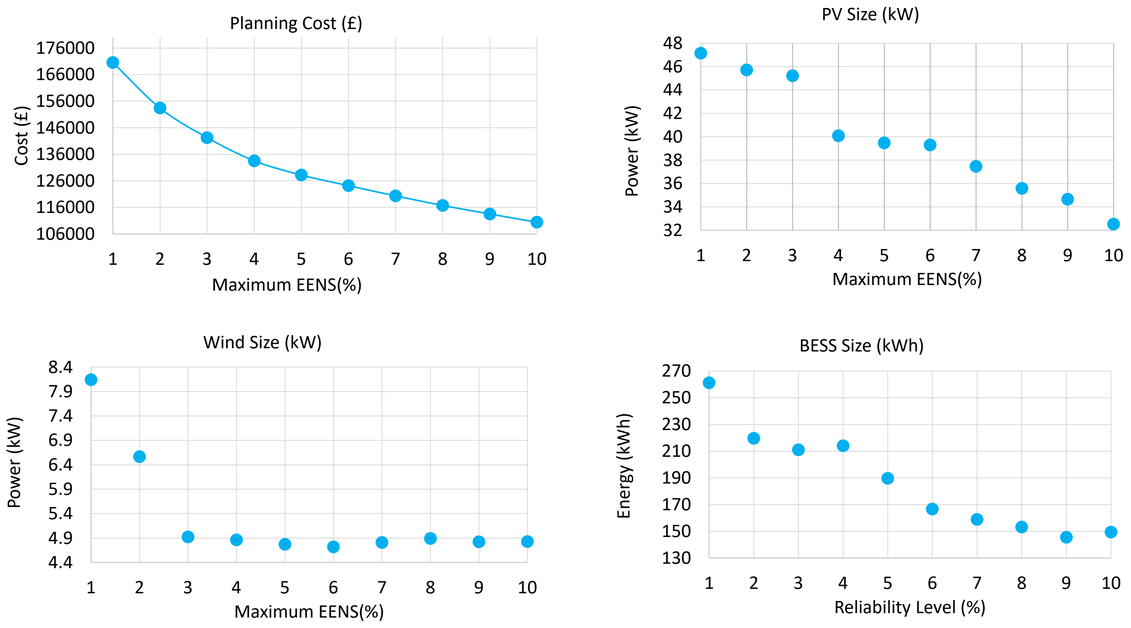
Planning

- Marwell Zoo is a possible site for the first demonstration of this project
- The planning stage of the program is formulated as a mixed integer linear programming (MILP) problem
- The objective function is based on minimizing the CAPEX and OPEX of the system
- The main constraints of the system are composed of the system load balance and reliability limitation
- The planning problem is solved in the PYOMO environment using the GUROBI solver.

➢ Main structure of the planning optimization problem



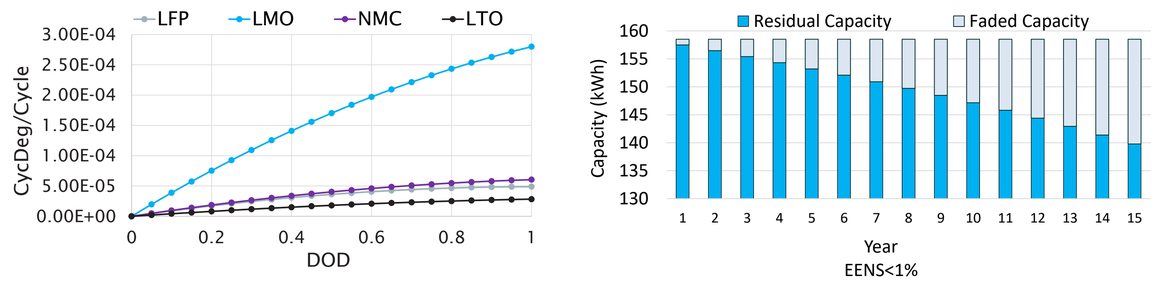
➢ Considering reliability indices in planning problem



Battery Degradation

Incorporating cycle and calendar aging for a more accurate estimation of the BESS size.

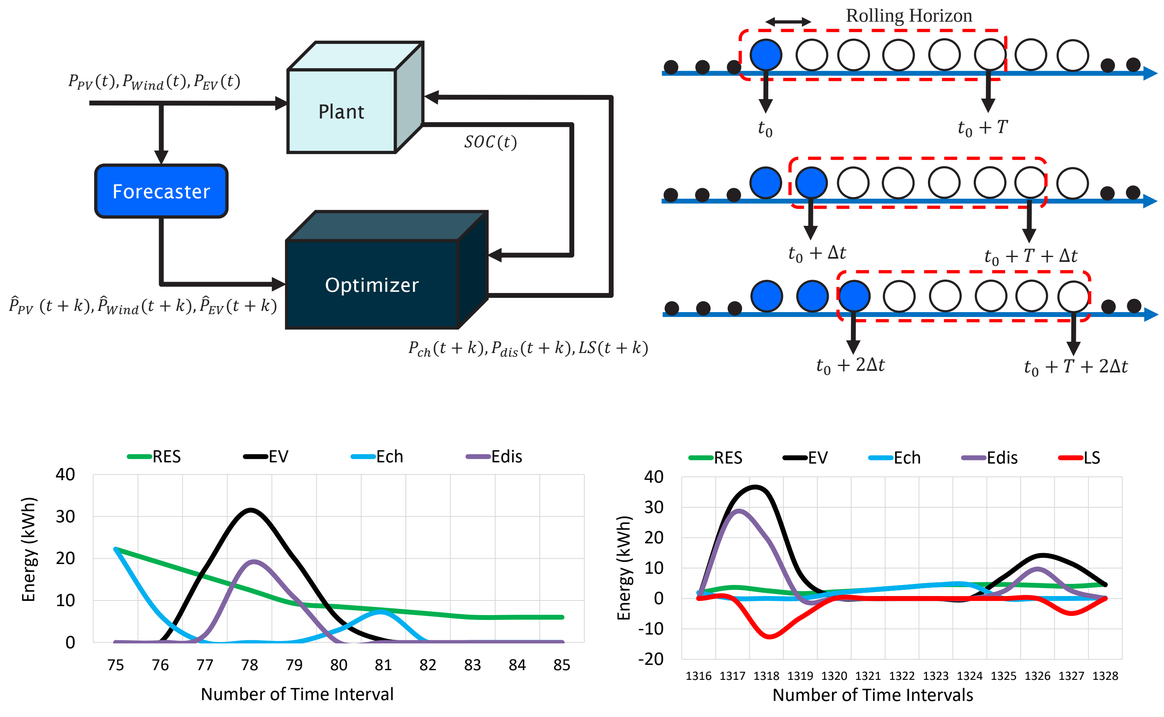
➢ **Cycle and calendar aging**



Energy Management System

- Rule based energy management: This approach is based on maintaining the load balance according to converter and BESS constraints
- Predictive optimizer: This method solves an optimization problem for a rolling horizon
- The outputs of the EMS specify the charge/discharge profile of the BESS in addition to the amount of load that is managed.

➢ Predictive optimizer for EMS



Conclusions

✓Cost reduces as expected energy not supplied (EENS) increases: £170,561 for an EENS of 1%, this cost decreases to £107,747 for accepting an EENS of 10%.

✓Increasing the power ratings of wind and PV, the BESS will be less active which results in lower capacity fade.

✓Two energy management schemes are studied. While the rule based scheme leads to a 461 kWh unmet load, the load curtailment for the predictive optimizer is 382 kWh. The improved performance of the predictive optimizer is due to using a rolling horizon.

Next Steps

- Developing forecasting models for wind power generation and PV power generation.
- Developing a system for estimating the charging power for each EV station according to various parameters
- Model based estimation the battery SOC SOC.

References

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- Sayfutdinov, T., Patsios, C., Vorobev, P., et al, ’Degradation and operation-aware framework for the optimal siting, sizing, and technology selection of battery storage’, IEEE Trans. Sustain. Energy, 2020, 11, (4), pp.2130-39.
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