Energy Demand and the Potential for Renewable Energy on the Isle of Iona

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Background

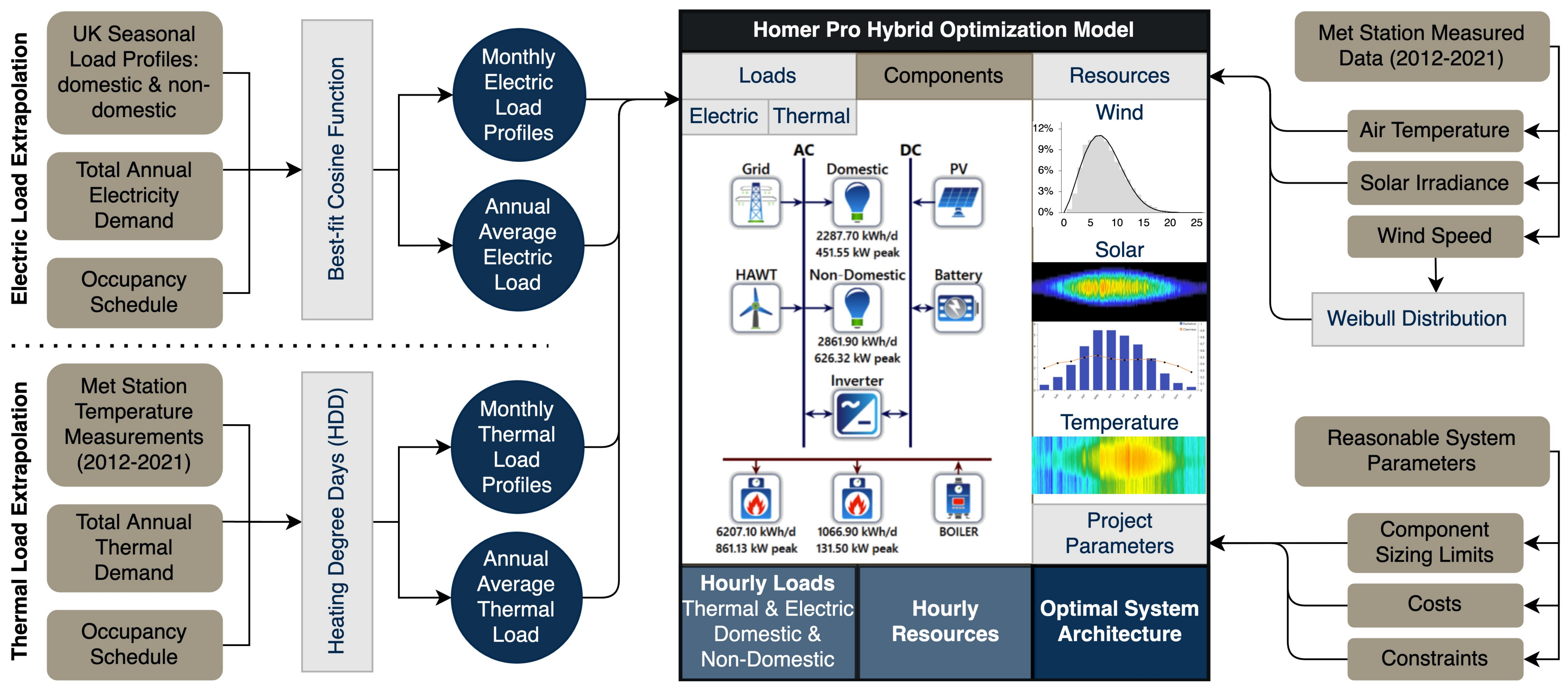
Producing reliable energy load profiles is essential in distributed energy planning [1]. However, energy data at the district level is often sparce, necessitating extrapolation for which accuracy has a direct effect on the efficiency and cost of a system being planned [2]. Accurately determining loads is especially important for sizing components of distributed smart energy systems to ensure apt system balances [3].

Thus, we develop a top-down model for creating domestic and non-domestic thermal and electric load profiles from very little input data and apply it to the the small Scottish Isle of Iona. The modelled loads, alongside renewable resource data, are then input into a hybrid optimization model to determine the potential for renewable energy and offer an optimal system architecture.

Objectives

1. Conduct a comprehensive survey of Iona's energy system and present available renewable resources.
2. Create a model to extrapolate thermal and electric loads for two different sectors using very limited top-level energy consumption data.
3. Propose components to increase Iona's system reliability, whilst decreasing emissions and prevalent fuel poverty [4].
4. Run a hybrid optimization model on the proposed system to determine its optimal architecture.
5. Evaluate effectiveness of the present extrapolation method.

Methodology



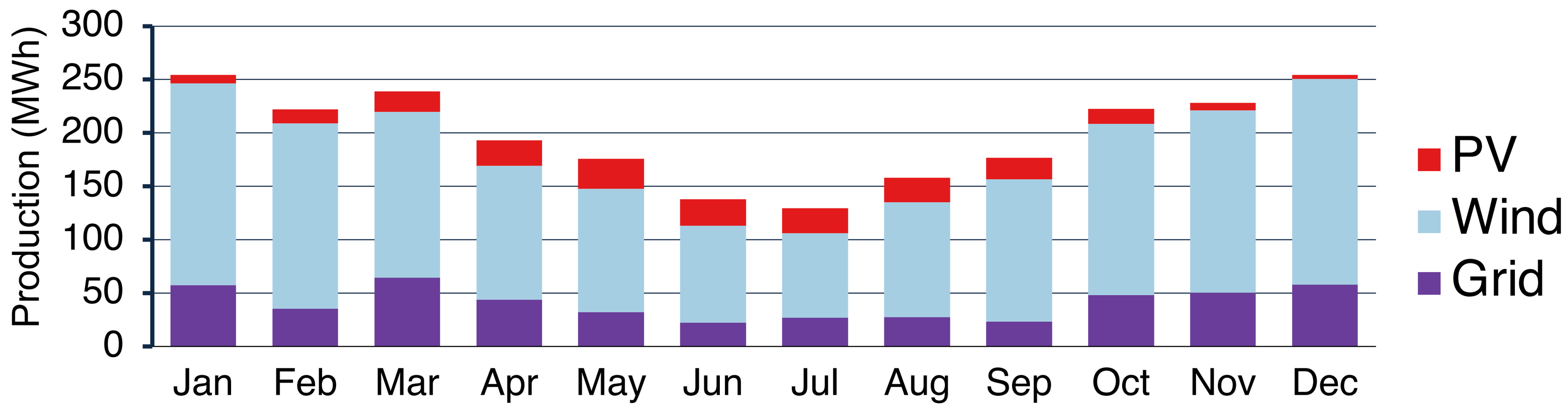
Results

Winning system architecture for Iona using the extrapolated load profiles and input resources from the nearby Tiree met station:

PROPOSED SYSTEM + + + + +

+ 217 kW of PV generation capacity
+ 400 kW of wind generation capacity
+ 453 kWh of battery capacity (lead acid)

Would reduce operating costs from £673k to £366k per year, with a £1.82M capital investment and simple payback of 5.5 years.



Conclusions

Our load model shows promising results, although being limited by the quality of input data for Iona. Thermal load outputs are likely accurate, being based on hourly input data. Electric loads are prone to errors, as the seasonal input data is too general. Modelling accuracy improves with higher-quality input data.

From a technical and resources perspective, Iona shows good potential for renewable energy development. However, planning restrictions are presently a major limiting factor.

Further Work

To quantify the accuracy of our models they need to be applied to systems where hourly loads can be measured and compared to the model results. Additionally, accuracy could be improved by considering the effect of temperature on electric heating loads.

References

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