

# Evaluating Energy Use at Two Passive House Plus Dwellings in the UK

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## Introduction

### Domestic Energy Use and Passive House Plus

This paper presents findings from one-year energy use data (May 2020 – April 2021) of two Passive House Plus dwellings, 'Lark Rise' (ID 5535) and 'Brambles' (ID 6613), to understand the contribution of such houses to grid decarbonisation, since 30% of the UK's annual final energy use is domestic usage [BEIS, 2020].

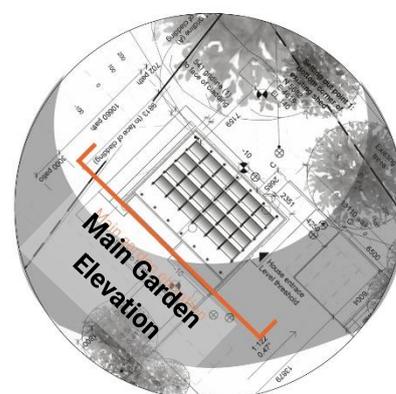
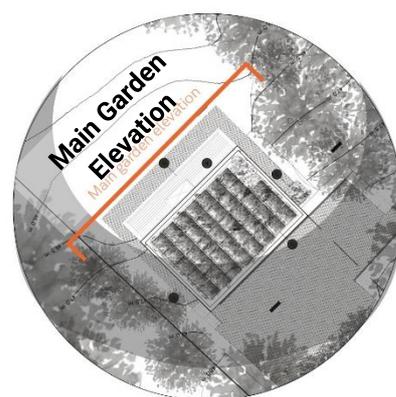
Lark Rise has been in use since 2015 while Brambles, since early 2020. Both houses have a Tesla Powerwall home battery, which provides energy use data (PV generation, final energy use, Powerwall storage and exports/ imports to and from the grid) via the Tesla Powerwall mobile phone app.

## Results & Conclusions

### Lessons Going Forth

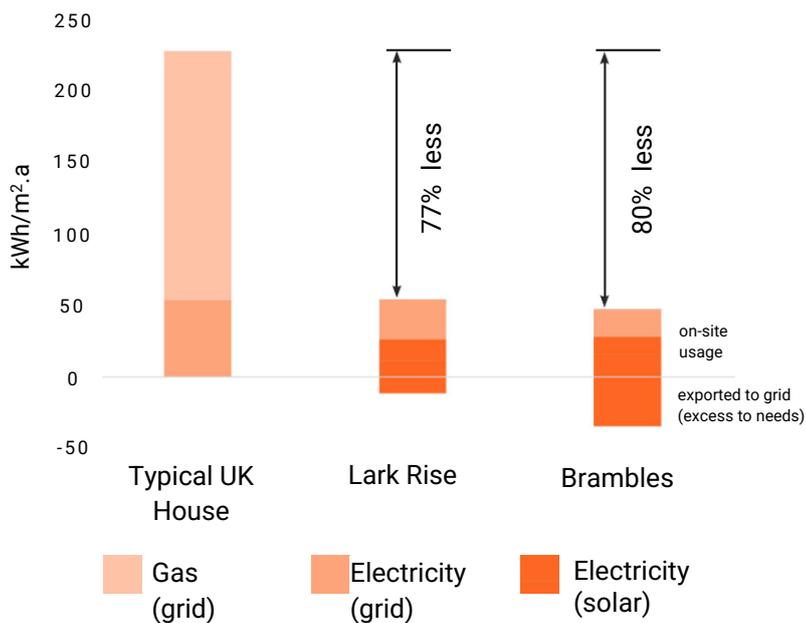
Whilst the monitoring study is ongoing, the following findings have been made:

- 1) Though occupants of both homes are able to meet about 88% of their energy requirements from a rooftop solar array and Powerwall in the summer, this extent of autarky is not possible in winter due to insufficient sunshine hours and intensity of solar radiation in relation to the higher energy demand due to heating and lighting. Energy self-sufficiency is better in summer than in winter.
- 2) However, compared to a typical dwelling in the UK, the two Passive House Plus (with battery) dwellings studied can offer annual average energy savings of 80% while maintaining high levels of comfort (Figure 2).

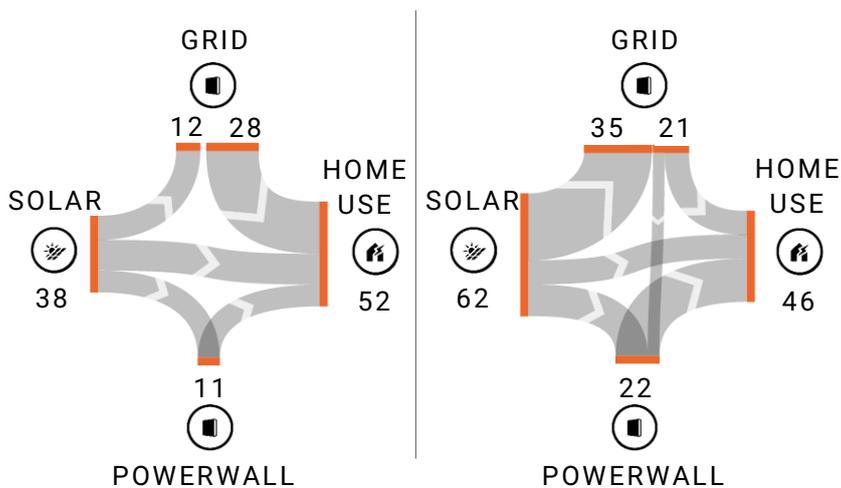


**Figure 1: Roof plan of Lark Rise, 175 m<sup>2</sup> (above) and Brambles, 150 m<sup>2</sup> (below), with the sun path indicated in light grey.**

**Brambles' southwest facing garden elevation allows it to receive more sunlight (solar heat gains and lighting) in winter, reducing its final energy demand for heating and lighting.**



**Figure 2: Lark Rise Energy Imports and Exports as compared to a 'typical' UK home [data from BEIS, 2020]**



**Figure 3: Annual energy flows at Lark Rise (L) and Brambles (R); Brambles generated more PV energy and exported 1/3<sup>rd</sup> of it to the grid.**

3) Brambles has better overall performance – with 40% higher annual PV generation and 25% lower energy demand than Lark Rise (Figure 3) - due to a favourably-orientated south-west facing garden elevation which admits more sunlight and solar heat gains in winter (Figure 1), less overshadowing on the PV array from surrounding trees and occupant behaviour which demonstrated a match between on-site renewable energy supply and demand. Thus, it has a significant net export to the grid.

4) At Brambles, the self-consumption ratio was 70%; without battery it would only be 28%. The Tesla Powerwall augments the houses' energy autarky by storing PV energy surpluses for night-time use, helping to reduce the houses' evening grid loads. If applied at scale, this would significantly abate the pressure of peak demand on the National Grid.

5) The Tesla-Octopus Energy Plan allows Brambles to source its energy 100% renewably, demonstrating the efficacy of a decarbonised community grid.

This study offers promising results for the future of new-build Passive House Plus dwellings and the hope is that more buildings will be built to a) reduce energy demand by design and b) to reduce operational carbon by sourcing energy demand renewably, with a demand-supply match, so that existing energy infrastructures do not require substantial upgrades.

## References

[BEIS, 2020] BEIS, 2020. ECUK: Consumption data tables (Excel) [Online]. London: Department for Business, Energy & Industrial Strategy. Available from: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/928354/2020\\_consumption\\_tables\\_-\\_web\\_copy.xlsx](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/928354/2020_consumption_tables_-_web_copy.xlsx) [Accessed 26 May 2021].

## Short Summary

The annual energy usage data of two British Passive House Plus dwellings with battery has shown that whilst there are improvements needed in winter energy autarky, the houses consume 80% less energy than the typical UK home and offer potential for community-based 100% renewable energy tariffs.

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