INFRARED HEATING AND SOLAR PANEL TRIAL

CASE STUDY REPORT

Redrow undertook a 12-month research project between February 2022 and March 2023. The research project was designed to better understand the feasibility of adopting technology to:

- Deliver Redrow's drive towards fossil fuel free homes,
- Provide a better product and more efficiency home for our customers,
- Align with future carbon reduction requirements in building regulations,
- Support Redrow's target to be net-zero carbon.

A trial was undertaken to test the claimed benefits of an Infrared heating system with solar panels provided by supplier Wondrwall. The system provided a gas-free heating and energy system which used IR panel heating supported by PV, battery storage and AI home automation under real life conditions. The trail also aimed to assess the customer experience and to better understand the potential adoption of the technology in future Redrow house designs.

The project was conducted in partnership with the supplier Wondrwall who are a provider of a complete gas-free energy and home automation system. It uses AI and mobile phone accessibility to predict homeowner behaviour which in turn manages the homes heating, lighting, and hot water accordingly. Wondrwall indicated that the system was expected to achieve fuel savings of between 33% and 50%, with accompanying emission reductions.

Wondrwall technology was installed in an Oxford Lifestyle Home (Wondrwall home), with a Standard Oxford House type (Control home) used as a control for comparison. The Wondrwall home was installed with infrared ceiling heating panels and an intelligent hot water system which work in conjunction with solar PV and a battery storage solution along with new home automation software. The control home was installed with a standard gas combination boiler with Wondrwall home automation. Both occupying families were made up of 2 adults and 2 children of school age. The two properties were neighbouring Redrow homes at Langley Grange, Scissett, Yorkshire. The homes were built to Part L 2013 building regulations.

Figure 1: Ceiling Installation of IR panels

Results of the trial: Energy consumption

The Wondrwall home used net 4921 kWh of energy in total, compared to the control home, which used 9933 kWh of energy. Net energy consumption for the year was 50% lower for the Wonderwall house. CO_2 emissions were reduced from 1870kgCO_2 to 602kgCO_2, a reduction of 68%. The energy costs were reduced by 55%, from £1893 to £851[1].

The Wondrwall home generated solar electricity from the 10 panel PV array, generating 3.4kWp. This generated 2861 kWh of electricity, which contributed £838 of the cost savings, along with generating 998kWh that was exported to the grid, generating a small revenue of £43 over the 12 months period. Additionally, 392 kWh of off-peak electricity was purchased for battery storage and use during peak hours. This generated a saving of £864 compared to purchasing the electricity at full peak costs.

Table 1: Comparison between Control home and Wondrwall home

	Control Home	Wondrwall Home	Comparison	% reduction
Net Energy Consumption	9933 kWh	4921 kWh	- 5012 kWh	-50.5%
Net CO2 Emissions	1870 kgCO2	602 kgCO2	- 1268 kgCO2	-67.8%
Energy Bill	£1893	£851	- £1042	-55.0%

The Wondrwall technology installed into the home provided an accurate record of the energy consumption and provided a customer energy-use profile over the 12-month trial. This identified that heating was the biggest consumer of energy within the home (40.8%), with lighting & appliances the second biggest consumer (34.4%) and then hot water at 24.8%.

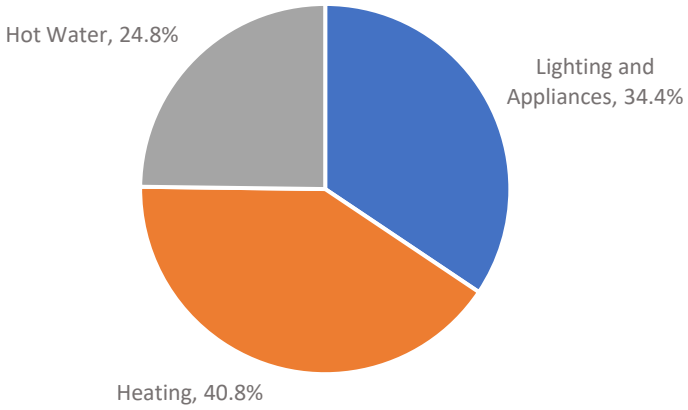


Figure 2: Energy use profile of the Wondrwall home

Summary of the customer experience research.

Wondrwall homeowners were satisfied with the Wondrwall system, especially the PV and battery solution which led to lower cost bills. They also liked the comfort of the IR ceiling panel heating system and home automation. The control homeowners did not get the benefits from the PV and battery storage and there were issues with connecting the home automation systems with their existing heating and hot water systems. Both homeowners also noted issues with the smart light switches (buzzing white noises) and the control home has since had them removed. A more detailed customer response to the Wondrwall experience is provided in Appendix C.

[1] Prices quoted are actual costs at the time of the project.

Results of the research project

The project demonstrated that the technology provided through the Wondrwall system achieved reductions in energy consumption along with subsequence reductions in carbon emissions and running costs. Customer experience was good for those in the Wondrwall home, who benefitted from the full system.

The running cost benefits were driven by the PV installation and storage of off-peak electricity in the battery storage. During May to August, the Wondrwall home generated more energy than consumed, with a revenue generated from an export tariff. These costs efficiencies resulted in the full Wondrwall system delivering a payback within 6 to 7 years.

The project identified that the SAP calculations (at time of the trial) did not allow for the inclusion of efficiency benefits from all the features of Wondrwall. For example, SAP did not include calculations for the home automation benefits and occupancy and zonal heating. This meant that any comparison of the SAP ratings between the Wondrwall and Control home would not recognise all the energy efficiency benefits that were identified through this trial. SAP calculations did however account for the benefit of PV and battery storage.

Figure 3: Photograph showing PV installation.

The project also provided useful data for subsequent work to assess the benefits of ASHP installation, as the data from the Control home was used to compare against a similar Oxford house type installed with an ASHP. This was essential data for Redrow's policy on ASHPs, further details of which can be found at https://www.redrow.co.uk/energy-efficiency/eco-electric.

Conclusion

The study has been valuable in developing Redrow's understanding of the installation of new technology, both from a customer experience and from a technical and build perspective.

The overall conclusion from the project is that the primary energy cost and carbon reduction benefits from the Wondrwall installation were delivered by PV and battery storage. Although customer feedback from the trial was positive, the IR panel heaters themselves did not reduce running costs to the same extent as the PV and battery storage. In comparison to gas, the running costs are high. The home automation also did not bring about as significant benefits as the PV and battery storage, and because of issues with some of the technology it was not considered as beneficial by both sets of customers.

The results of the trial demonstrated that the greatest cost reduction for customers came from the installation of the battery storage, and the purchasing of off-peak electricity; £864 compared to £838 from the PV panels (excluding the feed in tariff revenue). Given that the purchasing cost of batteries in this instance is lower than the cost of PV, the battery storage system as a standalone system would deliver a quicker payback. Using a standalone battery system would deliver these benefits to customers' energy bills but would not in itself reduce carbon emissions from the home, which is central to the government's objectives of the Future Homes Standards.

Figure 4: Photograph of Wondrwall Battery Storage solution

The cost saving benefits are an attractive offer to customers to reduce monthly utilities bills. The customer could choose to make investment into PV and battery solutions paid for by additional lending and would deliver an immediate energy cost benefit. Especially when energy costs are high, this is a valuable benefit to customer's monthly outgoings.

Figure 5: PV installation on Oxford House Design Roof

The current Future Homes Standard consultation presents two options for future requirements, one of which would include PV installation on all houses (high efficiency solar PV panels covering equivalent of 40% of ground floor area). For an Oxford house type, this would equate to 16 panels, compared to the 10 installed in this trial. Therefore, if the government selects this option, it's likely that this would require significant changes to Redrow's roof designs to facilitate the additional PV suggested. A different design could allow more panels to be added to the roof, however this would require a redesign of the roof and room layout, with impacts on customer experience as well as the wider aesthetic impact on the individual home, the wider street scene and plotting

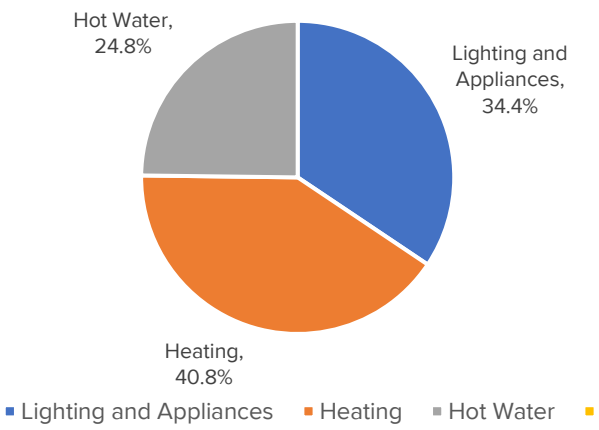
considerations for the development at large. Such considerations need to be taken into account when considering additional PV, as well as the impact on capital installation costs. The other option being consulted on would require a 75% reduction in carbon emissions compared to 2013 energy efficiency requirements, which our design with ASHPs currently achieve.

One of the additional benefits to Redrow of completing the project, as well as developing a greater understanding of the technology implementation and customer benefits, is to support the wider industry understanding of new housebuilding technology. As well as publishing this summary report on the findings, the results have been passed to the Future Homes Hub to increase the knowledge and intelligence around future design options, and measures that can be taken to improve efficiency and reduce costs and carbon emissions.

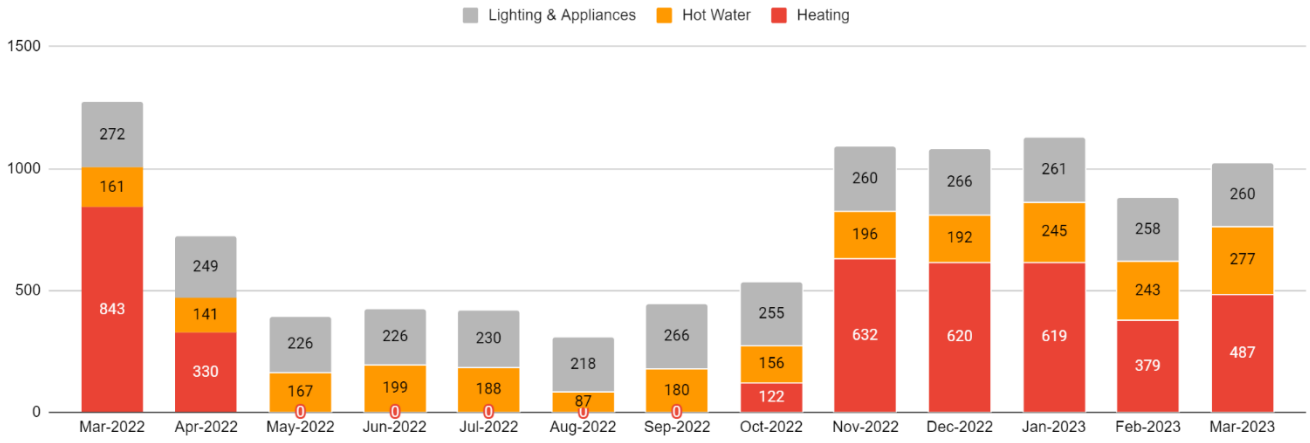
APPENDIX A: ENERGY CONSUMPTION RESULTS OF WONDRWALL HOUSE

Energy consumption | April/2022 to March/2023 Inclusive

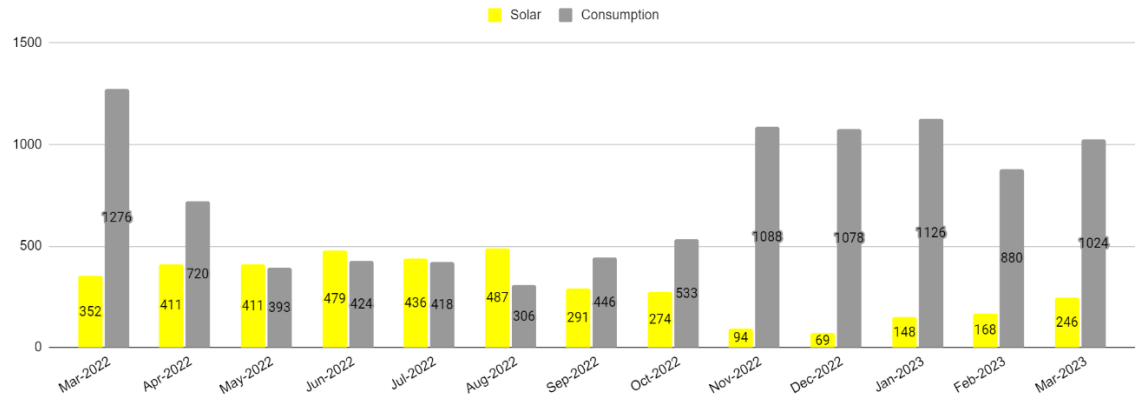
- Wondrwall technology installed offered an accurate record of the energy consumption profile was established over the 12-month trial.
- Heating was the biggest consumer of energy within the home (40.8%)
- Lighting & appliances the second biggest consumer (34.4%). This is not reflected in SAP / EPC reports and unaffected by fabric improvements.
- Hot water consumes 24.8% of the household energy Use of integrated heat pump cylinder or heat pumps will reduce energy consumption for hot water.



Energy Consumption Breakdown | By Month (kWh)

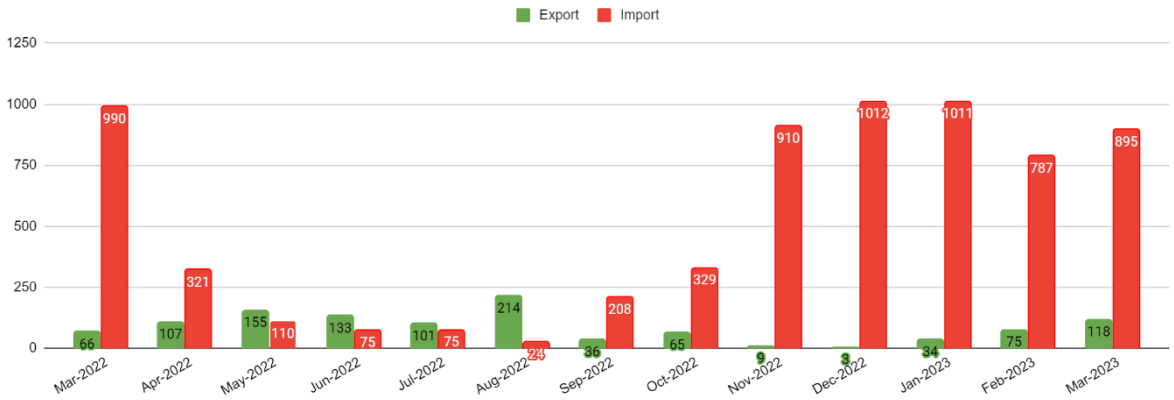


Energy Generation versus Consumption | By Month



- Homes were net-zero energy consumption from May to August.
- December lowest month for generation and highest for consumption but still solar provided over 6% of energy (free).

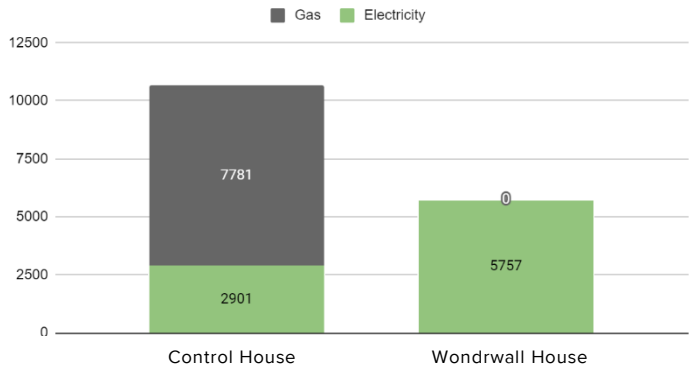
Energy Import versus Export | By Month



- Participation in National Grid Saving Sessions in January, February and March increased exports but decreased energy costs (and reduced grid load).

APPENDIX B: WONDRWALL VERSUS CONTROL HOUSE RESULTS

Energy Import| April/2022 to March/2023 Inclusive



- The Control house imported twice as much energy as the Wondrwall house (gas & electricity).
- However, the Wondrwall house imported twice as much electricity as the Control house because it runs on 100% electricity.

Key Metrics:

- Net energy consumption 50% lower.
- CO2 emissions 32.2% lower.
- Energy bills 45% lower.
- Energy bills do not include Government support or Domestic flexibility credit so actual bills lower.

Key Metrics (April 22 : March 23)	**Control House**	**Wondrwall House**
Net Energy Consumption	9933 KWH	4921 KWH
Net CO2 Emissions	1870 KG	602 KG
Energy Bill	£1893	£851

APPENDIX C: LIVING IN THE WONDRWALL HOUSE

The Wondrwall home at Langley Grange in Scissett is lived in by two adults and two children. They've moved from a big old house in nearby Clayton West to a very modern Oxford Lifestyle, which gives them three double bedrooms, each with its own bathroom.

They moved into their new home in February 2022 and, have been astounded by how low their bills have been during the summer months.

The new homeowner explained: "During the summer months (from May to August) our bills have averaged less than £20 per month. We haven't experienced a full winter here yet, but we know we will be paying a lot less than many households, and we feel very fortunate for that."

A comparison with their old property isn't really fair, as it was much bigger, built in the 1600s, and didn't enjoy the modern standards of insulation, air tightness and double glazing of a new Redrow home; but their average monthly energy bills there were around £140 per month combined for gas and electric; plus £1,000 per year for wood for the two wood burners they used as they had no central heating downstairs.

The homeowners weren't particularly looking to live a more sustainable lifestyle – it was the house and the location they wanted – but, now settled, they've both become much more conscious about the environment and the impact they have on it, reporting that "Being more energy efficient and taking part in the trial has made us much more mindful. We tell everyone – friends, family, colleagues – about our experience and how beneficial it is. It's exciting to be part of a trial that will influence how people live going forward."

They say the house's intelligent living system is unintrusive and that once they adjusted to the changes it's been like living in any other homes. Any monitoring via Redrow and Wondrwall is going on in the background via an app, so they don't even think about it. "We've had a few teething problems, like some 'white noise' from the light switches and sometimes the automatic light sensors can be too sensitive or not sensitive enough. However, the service from Wondrwall to sort anything out has been excellent – they treat us like VIPs,"