Net Zero Energy Demand Homes

Lessons Learned Report #2

13 December 2023

FRASERS PROPERTY AUSTRALIA

Artist impression, indicative only

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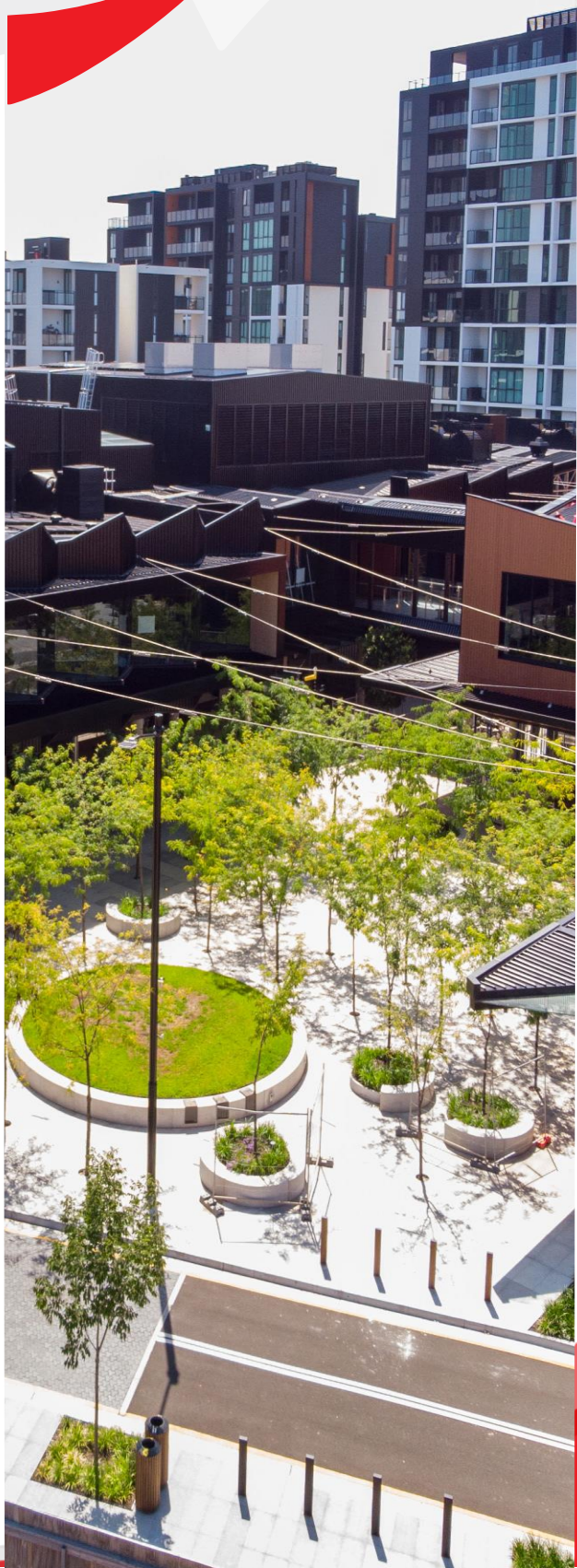

Purpose

The purpose of this document is to provide the second update to the Australian Renewable Energy Agency (ARENA) and the industry regarding lessons learned to date on the Net Zero Energy Demand (NZED) Homes project at Ed.Square, Frasers Property Australia's masterplanned community in Edmondson Park, NSW.

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ARENA Acknowledgement and Disclaimer

This project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program.

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ARENA Summary

Table 1. Project details

ACTIVITY TITLE	NET ZERO ENERGY DEMAND HOMES
Reference	Lessons Learned Report #1
Reporting Period	December 2019 – November 2021
Contract Number	2019/ARP045
Recipient Name	Frasers Property Australia
Partners	Real Utilities
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Date of Submission	**13 December 2023**

Executive Summary

Frasers Property Australia was approached by the Australian Renewable Energy Agency (ARENA) to participate in a study of the cost and energy efficiency of Net Zero Energy Demand (NZED) homes at Ed.Square, with the objective of understanding the potential and pathway to deliver these homes on a larger scale.

The Frasers Property and ARENA partnership will deliver 51 all-electric medium density homes in a range of sizes and designs as part of Frasers Property's Ed.Square masterplanned community in Edmondson Park, NSW.

This report summarises the key learnings to date from the NZED homes project since our first milestone report. The project is in progress and will be completed in 2025.

Construction of the NZED homes commenced in October 2021. The lessons learned to date focus on the activities associated with:

- Design compliance of the solar boosted hot water system and visual impact
- Construction program for geothermal air conditioning system
- Indoor environmental quality monitoring strategy

Future lessons learned

Additional learning from the construction, handover and monitoring will be provided in the next lessons learned report.

Construction of the 51 NZED homes commenced in October 2021 and are forecast for completion in September 2023. After residents settlements, a two-year study period will commence which will compare the homes at Ed.Square against a business-as-usual development in terms of energy efficiency, energy costs and more.

The data captured in this study will provide valuable new insights into the cost, efficiency, and effectiveness of new sustainable housing technology to help identify the optimum path for its widespread application.

Project Summary

In October 2020, Frasers Property Australia and the Australian Renewable Energy Agency (ARENA) announced a $1.42 million project that will deliver 51 Net Zero Energy Demand (NZED) homes at Ed.Square, Frasers Property's masterplanned community in Edmondson Park, in south-west Sydney.

The project aims to create homes that will feature technology which, over the course of a 12-month period, will produce on average more energy than they consume.

The project, with an initial commitment of $708,910 in funding from ARENA, aims to expand the knowledge and understanding of renewable energy technology so that these innovations can be refined and developed to elevate the energy performance of Australian housing.

The 51 medium density homes are a mix of one, two, three and four-bedroom designs of up to three storeys and have been branded Balanced Energy Homes, or BE.Homes. The homes will integrate a suite of renewable energy, electrification and energy efficiency measures including 4 kW of solar photovoltaic panels (PV) per dwelling, ground source heat pump space conditioning, induction cooktops, electric boosted solar hot water, low-e glazed windows, LED lighting and roof insulation.

All appliances will be electric with no gas connected, delivering ongoing connection savings to residents, and supporting increased utilisation of the electricity network.

Once the homes are complete and occupied by residents, a two-year study period will commence which will compare the homes at Ed.Square against a business-as-usual development in terms of energy efficiency, energy costs and more. The data captured will provide valuable new insights into the cost, efficiency, and effectiveness of new sustainable housing technology to help understand the opportunity for its widespread application

The homes will aim to demonstrate net zero energy demand by:

1. Excluding all gas infrastructure, replaced instead with electric infrastructure;
2. Maximising energy efficiency through on-site renewable technology and efficient systems design; and
3. Increasing customer awareness through targeted marketing and education on operating NZED homes efficiently.

As part of the NZED Homes project, Frasers Property has committed to:

1. Developing 51 NZED homes including:
    a. 4kW of solar PV per dwelling
    b. Ground source heat pump system space conditioning for all two and three-bedroom dwellings (representing 43 dwellings)
    c. Induction cooktops
    d. Electric boosted solar hot water
    e. Low-e glazed windows
    f. R6.0 roof insulation
    g. Master switch
    h. LED lighting
    i. Vertical shade screens where necessary
    j. Confirmation of air tightness through blower door testing

2. Provide all residents with access to an embedded energy network, installed and operated by Real Utilities, Frasers Property Australia's wholly-owned carbon neutral licensed energy retailer.
3. Undertake project, budget, and consultant management.
4. Complete construction of homes with agreed technology.
5. Report on delivery in line with the Frasers Property & ARENA agreement.
6. Calculate the overall economic benefits to the developer, residents, and energy retailer.
7. Create specific, targeted marketing collateral to support the uptake of NZED homes by customers and utilise collateral to increase their education on the benefits of living in a NZED home.

Lessons Learned: Electric boosted solar hot water – orientation and visibility from the street

Category

Technical / Regulatory / Safety

Objective

The key objectives of the NZED homes are:

- Exclude the use of gas infrastructure and replace with electrical infrastructure
- Maximise the efficiency of the homes in terms of hot water systems and design
- Deliver the technology in built form

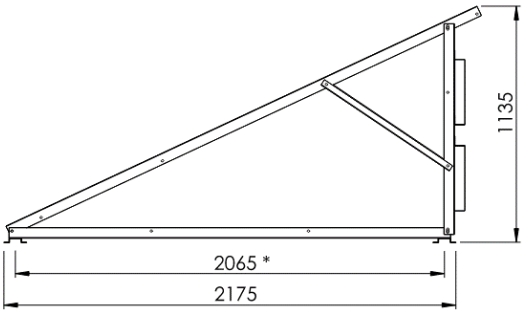
To meet these objectives, the NZED homes were designed to include the use of electric boosted solar hot water units, whilst ensuring that the homes' architectural facades were not negatively impacted. It was also important to provide access to the serviceable plant on the roof, should any works or maintenance need to be undertaken.

Detail

When initial designs were created to incorporate solar hot water units, the requirements associated with compliant design weren't fully accounted for.

The original design considered architectural outcomes, with the wing of each of the solar units facing each other. Whilst this design was compliant to class 1 buildings (single residential homes) and verified by the manufacturer to work to capacity, it was not compliant with class 2 buildings (Multi-residential / apartments). To ensure it was compliant with class 2 buildings, the solar units needed to be orientated to 45 degrees true north. This change in positioning, coupled with the manufacturer's requirement to have the solar units elevated to the optimal angle, made the solar units visible at street level.

Figure 1. Solar hot water units on a rooftop.



Side Dimensions - Kits RF180CC12A, RFCC3302A, RF330CCT03A

Note : all dimensions in millimetres (mm)

Figure 2. Solar panel framing dimensions.

Implications for future projects

Future projects that incorporate solar panels and solar hot water will require specialist input from a solar designer from concept design stage. Given the visual impact of the equipment's from adjacent homes, the solar designer and architect should assess and coordinate rooftop design to allow for angles, orientation, total loads (weights and power), and location of the water tank. Standard specifications from top three manufacturers can be used to inform the assessment and allow flexibility in the procurement process. This will ensure that compliance and design outcomes are achieved by taking into consideration all aspects of the whole roof plant design.

Conclusion

Whilst solar hot water is a great way of achieving the objectives of the NZED homes, the size of the solar units required on the roof does have an impact on the architectural design of the homes. Unless all outcomes and possible challenges are considered early on in the planning and design process, the home's architectural façade may not meet initial design expectations.

Lessons Learned: Additional program duration for geothermal air conditioning ground bores

Category

Procurement / program

Objective

To provide additional requirements to the NZED homes compared to standard home design:

- Geothermal air conditioning

Detail

Most of the additional requirements for NZED homes are higher specification in materials or change of materials which have little to no impact on program duration. However, with the introduction of geothermal air conditioning, a program's start on-site has to commence significantly earlier – in terms of procurement and the installation of the geothermal bore holes. Civil works would usually be the first trade to commence on-site, followed by services. However, with the inclusion of geothermal air conditioning, a platform to working levels is required that allows the drilling rigs to commence on-site for installation of the bore holes. Each bore hole takes approximately 1-2 days to complete, including boring of the hole, installing the loop and completing the grout filling. This adds approximately 40 days to the program per block before the usual contract works commence. This may be even further extended if inclement weather is encountered.

The cost implications to a project for an additional 1-2 months of preliminaries needs to also be taken into consideration when assessing the financial viability of the system. On this particular project, program lenght has increased by 5 to 10% due to geothermal drilling, it has impacted the project overall cost by ~1%.

No grant funding available for this technology at the time of the project.

Implications to future projects

The implementation of geothermal air conditioning requires very early upfront procurement to ensure impacts to the program are controlled and time on-site is well co-ordinated. Early program input from the geothermal contractor is crucial to ensuring correct and achievable time frames, along with having measurable deliverables that allow for accurate program tracking. The additional cost of the additional project preliminaries must also be considered in the financial feasibility study.

The cost of additional prelims is driven by the need to start physical works onsite earlier to allow for the geothermal boring. Traditionally construction works typically has a soft start with procurement and design undertaken in an office, whereas with Geothermal you have an extra two days of work per unit. This includes the physical boring undertaken at the commencement of works on site. This intern introduces additional site prelims and a longer duration of works on site.

Conclusion

There is limited availability of geothermal contractors in the market and as a result it is important to engage with them early to understand their capacity to deliver works to the program as there are often no alternatives. Furthermore it is important to factor in their access to manpower/ skilled personnel to undertake the works and also their access to appropriate machinery and equipment.

In conclusion, engagement with the contractors early is vital to establish the feasibility of Geothermal air conditioning technologies in terms of preliminary costs, and to forecast the project budget appropriately. Further to this, the feasibility of scaling this technology across future projects is ultimately dictated by the size of the contractor pool who have the required capabilities in the local market.

Lessons Learned: Indoor environmental quality monitoring

Category

Technical / Risk

Objective

One of the key objectives of the NZED homes project is to measure and assess the air quality benefits of the technology installed homes, especially with the transition to all electric equipment. To meet this objective, indoor environmental quality sensors have been installed in the NZED homes and in non-NZED homes delivered within Ed Square masterplanned community for comparison. The non-NZED homes represent business as usual practices, including gas equipment for cooking and hot water production.

Detail

Indoor environmental quality will be measured in the 51 NZED homes, and in 10 ‘business-as-usual’ homes located in other stages within the same masterplanned community. The business-as-usual homes have gas for cooking and hot water production, energy efficient fixtures and a lower NatHERS rating.

The indoor environmental sensors are installed in each of the selected homes in an easily accessible location and away from operable windows. The devices are measuring the following parameters:

- Humidity (%)
- Total VOCs (ppb)
- Ambient light level (Lux)
- Temperature (°C)
- Carbon dioxide (ppm)
- Particulate Matter PM2.5 (µ/m3)
- Ambient noise level (dBA)

Indoor environmental quality sensors selection

The sensors were selected based on the parameters measured, the aesthetic of the sensors, the connectivity options and that the data is accessible via a safe, centralised platform. The same devices were installed throughout the site to facilitate data management and ensure a robust comparison. The selected product was then tested in the sales office prior to procurement for the homes.

Sensor locations

The sensors are located in the main living area, away from the kitchen and from the operable windows in order to reduce the interference with daily activities and external air quality.

Connectivity

The sensors are connected to a gateway device via cellular connectivity. The data is then collected in a secure online platform.

Implications for future projects and conclusion

At the time of procurement, there were little indoor air quality sensors meeting the project needs available in Australia and an overseas manufacturer was preferred. The market has now changed, and more products are available directly in Australia. Local procurement opportunities will therefore be assessed on future projects.

The data collection has been disrupted with some sensors being disconnected following a power outage. The sensors are not accessible remotely and need to be re-activated on-site. The connectivity resilience and engagement with residents will be assessed further on future projects to reduce data gaps. With the study being conducted across many homes, the impact and risk of data gaps in the overall assessment is mitigated. This strategy will be recommended for future studies as well.

On future projects Frasers Property Australia will also consider sharing the data with the residents as an education tool.

Next steps

The construction of the NZED homes at Ed.Square are forecast for completion in September 2023. Frasers Property Australia anticipate further lessons will be learned which will influence future projects and highlight new pathways for the potential broader adoption of these homes in the mass market.

The next lessons learned report will be published in December 2023 and will include learnings from the construction, handover and monitoring of the NZED homes.

The final knowledge sharing report will be published in 2025 after a two-year period of monitoring of the homes during operation. The performance of NZED homes will then be compared with other homes within the Ed.Square development to quantify the benefit of the features of the NZED homes.

Possible topics that may be covered in the final knowledge sharing report include:

- Technical and commercial analysis of the installed features.
- Contractor insights into the physical delivery and maintenance of NZED homes, including embedded energy networks.
- Customer insights on their experience in the homes and satisfaction with the transition to all-electric.
- Increased insights into effective marketing and sales functions for NZED homes.

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