Net Zero Energy Demand Homes

Lessons Learned Report #3

29 February 2024

FRASERS PROPERTY AUSTRALIA

Artist impression, indicative only

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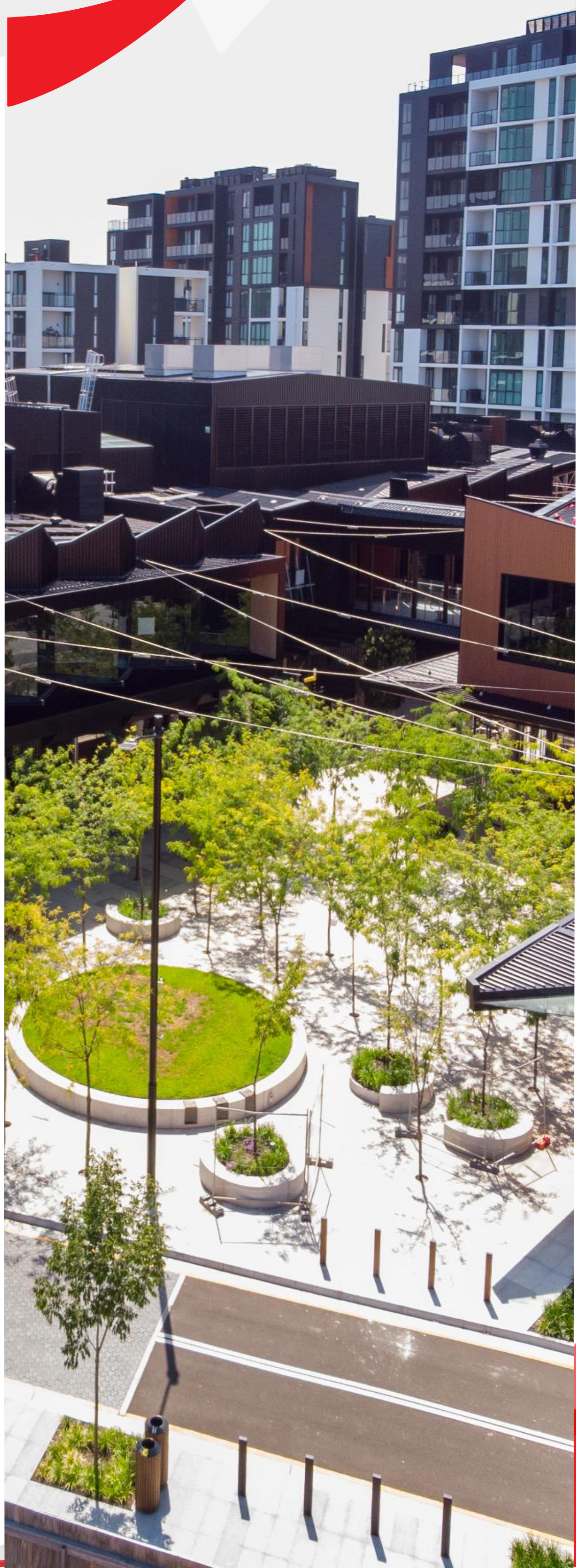

Purpose

The purpose of this document is to provide the third 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[1] Lessons Learned Report #2[2]
Reporting Period	November 2021 – February 2024
Contract Number	2019/ARP045
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1 https://arena.gov.au/knowledge-bank/net-zero-energy-demand-homes-lessons-learnt-1/
2 https://arena.gov.au/knowledge-bank/frasers-property-net-zero-energy-demand-homes-lessons-learned-report-2/

Executive Summary

This report summarises the key learnings to date from the Net Zero Energy Demand Homes (NZED) project since our second Lessons Learned Report in June 2023 as required by ARENA in granting an extension. The project is in progress and will be completed in 2025.

Construction of the NZED homes commenced in October 2021 and practical completion was reached in December 2023. Settlements were finalised in January 2024. This report captures lessons learned since the 30 June 2023 Lessons Learned report was finalised, and focuses on the following topics:

- Increasing the number of solar panels and equipment on the roof of town homes requires additional considerations to be made around the spatial design and the ability to access the space safely.
- Applicability of solar-boosted hot water technologies on smaller home typologies. The One Bedroom Ground Floor Town Home typologies may benefit from alternatives such as instantaneous electric systems.
- Developing a monitoring strategy involves multiple business functions beyond the development team. This includes customer care, legal, IT and sustainability teams.

Future lessons learned

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

Construction of the 51 NZED homes commenced in October 2021 with Block F South achieving practical completion in September 2023, followed by Block E South in December 2023. Settlements across both blocks were staggered and occurred between September 2023 and January 2024, marking the commencement of a two-year study period which will compare the NZED homes against a base case of 10 'business-as-usual' (BAU) homes within the Ed Square development. The study will allow quantitative data (such as energy efficiency, operational costs, indoor air quality, occupant comfort) and qualitative data (surveys with occupants) to be monitored and compared across the NZED and BAU homes.

The data captured in this study will provide valuable new insights into the cost, efficiency, effectiveness and lived experience of new sustainable housing technologies. It will also help identify opportunities and challenges relating to the scalability and widespread adoption of technologies that support Net Zero Energy outcomes for the residential sector.

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 are electric with no gas connection, delivering ongoing savings to residents, and supporting increased utilisation of the electricity network.

A two-year study period commenced upon settlement of the homes. The study will compare the NZED 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-, three- and four-bedroom dwellings (representing 39 dwellings when excluding 1 bedroom homes)
    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: Safety In Design associated with additional plant on the roof of Three Storey Homes

Category

Technical / Regulatory / Safety

Objective

The key objectives of the NZED homes are:

- Exclude the use of gas infrastructure and replace with electrical infrastructure.
- Maximising the homes efficiency through on-site renewable technology and efficient system design
- Deliver built form construction and technology

Detail

In meeting the objectives of the agreement, the NZED homes were designed to include solar, electric-boosted domestic hot water (DHW) systems and photovoltaic panels (PV). The DHW system was specifically chosen for its ability to be located on the roof, enabling it to free up valuable space in the private open space and common areas where this equipment would typically be situated. This avoided negative impacts on the architectural facades and open space areas both in terms of spatial constraints and aesthetics.

Due to the location of the PV and DHW systems, it was important to provide safe access to the system on the roof during the construction and operational phase of the buildings. A parameter was set by the team to keep a clear zone around the live edge of the roof. Setting all roof plant back from the live edge by 1.5 metres allowed safe access to be provided for ongoing maintenance without the need of a substantial parapet or safety rail.

The design commenced by placing the solar electric boosted DHW units directly above where each unit's bathroom is located to optimise the pipe run. The PV panels were then located around the DHW units. Care was taken to locate and orientate the PV panels to maximise solar access and avoid overshadowing by the DHW units. It was challenging to strike a balance between providing safe roof access for maintenance and trying to achieve the optimal performance outcomes of the PV and DHW systems. This was made harder by multiple level changes in the roof design that required additional clearance for access steps and ladders. Maximising the number of PV panels on the roof was therefore a challenge for the project team due to the spatial constraints of equipment and safety access.

Figure 1. Aerial roof plan

Implications for future projects

Due to the challenges faced around optimising the performance of equipment and provision of safe roof access, early design coordination is vital.

An understanding of the performance requirements of each type of system in insolation is helpful to prioritise the location of each piece of equipment across the roof. The safe access to the roof was the initial driving point of the roof layout, followed by the location of the DHW units as they needed to be located above bathrooms. The PV panels offered more flexibility and could therefore be arranged to accommodate these constraints.

Alternative spatial solutions may be sought to enable additional equipment to be located on the roof, however these should be explored in the early design phase as they may have cost, construction and aesthetic implications – such as including significant parapets (circa 1m in height) to the perimeter of the roof.

Conclusion

Where development teams are looking to achieve spatial efficiencies by opting for roof mounted systems, up-front coordination is paramount to ensure that the spatial arrangement and performance of equipment is optimised as well as safe access is achieved for ongoing maintenance.

Where possible, create the circa 1.5m (or alternative agreed) setback around the roof perimeter at design stage for safe roof access where no parapet of significance (circa 1m) exists. Where the 1.5m is not available, more detailed safety/maintenance systems are required and should be considered at design stage.

It is beneficial to arrange more flexible systems such PV panels around equipment that is more constrained to a specific location, such as DHW systems. Care should be taken to ensure that Solar PV panels have optimal solar access and are not overshadowed.

Lessons Learned: Applicability of Electric-Boosted Solar Domestic Hot Water systems in different home typologies

Category

Procurement / Technical / Safety

Objective

Improve commercial viability of NZED home upgrades by acknowledging home type differences and a tailoring of response and specification for each home type.

As noted earlier the key objectives of the NZED homes include:

- Exclude the use of gas infrastructure and replace with electrical infrastructure
- Maximising the homes efficiency through on-site renewable technology and efficient system design
- Deliver built form construction and technology

Detail

In the early design stages of the NZED homes, Frasers committed to specifying Electric Boosted Solar Hot Water systems as part of the original agreement with ARENA. The project could have benefitted from further investigations into alternative DHW systems that may have been more appropriate to the various home typologies.

The homes are a-typical as they are three storeys with a separate one-bedroom apartment located on ground floor. This typology is more reflective of a Class 2 (Apartment) than a Class 1 (single dwelling) building and presented the following challenges:

- Dead-leg[3] issues were created due to the substantial pipe-work distance between the roof-mounted Electric-Boosted Solar DHW system and the one-bedroom apartment on ground floor.
- The cost of the system was higher than more conventional electric DHW systems.
- Spatial constraints and maintenance access challenges created by co-locating other services on the roof such as PV panels.
- Applicability of an Electric-Boosted Solar DHW system to a small one-bedroom apartment with substantially lower demand compared to 2, 3 and 4-bedroom homes.

Given the above issues, the team believes that greater investigation could have gone into alternatives particularly for the one-bedroom homes where relative energy savings may have been better overcome with the commitment to alternative technologies such as heat pump or electric instantaneous hot water units. If there was shown to be an energy demand differential in an alternative DHW system (i.e. electric instantaneous) this could be offset by installing additional solar panels in the space made available by removing the Solar Boosted Electric Hot Water Units from the roof. Alternatively, the design team could explore ways to facilitate heat-pump infrastructure into the design.

[3] A section of a piping system that has been altered or capped such that water can no longer flow through.

Implications to future projects

Investigate alternatives/upgrades and home specifications with a greater acknowledgement of housing type (size and location). In this instance the NZED homes were made up of multiple home types (1 to 4 bedroom typologies in various configurations) within a strata complex with no site flexibility. Most upgrades were applied to all homes simultaneously during early modelling investigations.

This additional nuance to early investigations and commitment would lead to more commercially sustainable and practical outcomes.

Conclusion

For projects which include a variety of housing types, investigations should consider each home typology before committing to standardised specification upgrades, even within a common strata block. Spatial constraints, pipe-work distance, unit cost, maintenance access and anticipated hot water usage demand of the home all need to be considered.

For example, in the case of this project, the ground floor one-bedroom apartment may have benefitted from an instantaneous electric system which could have been easily concealed within a cupboard, supported by additional PV (with no additional spatial requirements) and would have been significantly more cost effective than the Electric Boosted Solar Hot Water system.

Lessons Learned: Developing a monitoring strategy that involves multiple business functions

Category

Technical / Risk

Objective

One of the objectives of the project was to collect two years of consistent operational data to compare performance of the NZED homes against the business-as-usual (BAU) homes. This consists of collecting energy data and indoor environmental quality data across all 61 homes in an efficient and effective manner.

Detail

To date, the procurement and installation of two types of monitoring technologies has been completed. The energy data will be collected by Wattwatchers devices installed directly into the switchboard of each home and will provide a comprehensive breakdown of energy consumption across multiple circuits of the home including cooking, space heating and cooling, domestic hot water heating and general plug loads. The Indoor Environmental Quality (IEQ) data will be collected via AWAIR Omni devices which monitor Temperature (°C), Carbon Dioxide levels (CO_2), Relative Humidity (%), Particulate matter (PM2.5), Volatile Organic Compounds (VOC ppm) as well as background noise (dB) and daylight levels (Lux).

Monitoring devices were installed and activated prior to settlements taking place. Each contract of sale included clauses which outlined the requirement for participation in the ARENA study. This stipulated that purchasers would be required to allow monitoring of energy and IEQ data of the home over the course of a 2-year period.

Several challenges have been encountered with the monitoring process to date. These include:

1. **Monitoring periods being linked to settlement dates in Contract of Sale**

   Due to the size of the development, there were several stages of delivery for the precinct participating in the ARENA study. This resulted in a staggered settlement program. Block D South settlements occurred earlier in the program (October 2021) whereas Block E South was the final portion to complete settlements over 2 years later (December 2023). This resulted in monitoring periods not overlapping. As part of the ARENA agreement, a minimum of 1 year of data is required to overlap across all homes.

   To resolve this, the team will need to investigate how to extend the agreements with owners to ensure that there is sufficient overlap in data to satisfy the study.

Block	Contract start date (Settlement)	Contract end date (2-year period)	Contract variation (extension required)	Overlapping data (1 year min)
D North	Mar 2023	Mar 2025	+1 Year	Yes
D South	Oct 2021	Oct 2023	+2 years	Yes
E South	Dec 2023	Dec 2025	N/A	Yes
F South	Sep 2023	Sep 2025	N/A	Yes

2. Collaboration between different business functions

To resolve the monitoring period overlap, coordination and collaboration between various functions within the business is needed as follows:

- Development team:
  - Providing the settlement dates
  - Coordinate contracts with owners
  - Establishing appropriate customer incentive in collaboration with customer care team
- Sustainability team:
  - Reviewing monitoring process to ensure 1 year of overlapping data is achievable
  - Briefing customer care team in preparation for customer communication
- Legal team:
  - Legal support and review of contract variations
- Customer care team:
  - Input into customer incentives
  - Communication with customers
- IT team
  - Technical trouble shooting support for the monitoring devices and connectivity between router and gateway equipment
  - Management of individual access to monitoring platforms

3. Monitoring device connectivity

A review of the AWAIR platform reveals that 13 devices across the project are currently inactive. This equates to approximately 80% of all AWAIR devices currently being active and receiving data. The earlier homes delivered in Block D have the largest gaps in data, with only four devices collecting data since settlements occurred. Data on these devices is only available from March 2023.

Similarly, a review of the Wattwatchers platform revealed that approximately 70% of devices are currently active and receiving data consistently. Historical records show that only three devices have a full 2 years' worth of data available.

Possible reasons for inactive status include:

- Disruptions to power supply (e.g. power cut or switch board re-boot)
- Connection interferences* (between device and gateway and/or router)
- Device interference from occupants* (occupants turning device off in home)

*for AWAIR monitors only

To resolve this issue, the project team will need to refine the monitoring strategy to include the following:

- A device log to track connectivity status
- An action plan to conduct a regular and thorough review of connectivity status of all devices
- A troubleshooting process to reconnect devices
- Monthly meetings to manage disconnected devices (including sustainability, development, IT and customer care teams as needed)
- Clear articulation of responsibilities and chain of custody when managing data

Implications for future projects

On future projects that involve monitoring, contracts with the owners should reflect the nuances of the project delivery timelines and allow flexibility to postpone the start time for the monitoring period until all homes have reached settlement. It is important, however, to acknowledge the difficulty in the Sales process as purchasers are always after certainty. The other alternative would be to have extended the term of monitoring under the original contract to circa three years to facilitate program movement. This would help avoid the need for any contract variations.

A monitoring strategy should be developed in the early stages of the project – ideally prior to the installation of any monitoring devices. This should identify all relevant business functions who may need to provide support and input on the strategy including development, sustainability, IT, customer care, legal and construction management teams. Ideally, a workshop should be held with these teams to brainstorm any potential challenges that may occur and gain insights from each specialty area. This would be beneficial to ensure all areas are covered, and a robust plan can be drafted to manage any issues in a proactive manner.

Conclusion

The team has had to remain agile in order to meet the requirements of the original agreement with ARENA in terms of the overlapping monitoring period. Challenges were created due to the agreement being based on a specific settlement program and assumption that data collection would be consistent across all homes. The reality of construction delays, due to supply chain disruptions and covid, over the project delivery program has hindered the ability to obtain a whole years' worth of overlapping data across all homes to date. Further to this, connectivity issues with the monitoring devices were unforeseen and challenging to manage due to the need for onsite technical troubleshooting and in depth, regular reviews of the platforms to identify disconnected devices. A longer monitoring program is recommended on future projects seeking to obtain occupational data.

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