

Case Study: Narara Ecovillage



Photo courtesy of Narara Ecovillage Co-operative

Narara Ecovillage is a unique community development that will use smart technology to deliver a carbon-neutral village

Narara Ecovillage's vision, mission and aim:

The vision is for an **environmentally**, **socially** and **economically** sustainable world.

The **mission** is to create a sustainable ecovillage as a demonstration of this vision.

The **aim** is to research, design and build an ecovillage at Narara, blending the principles of ecological, economic and social sustainability.

Summary

Narara Ecovillage has established a smart grid including their own renewable energy generation, as part of their mission to create a sustainable ecovillage. In this case study you will find a description of the Narara Ecovillage, guidance on navigating technical and regulatory challenges in community-led smart energy projects, and key outcomes of the project.

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This case study was prepared as part of the NSW Government Clean Energy Knowledge Sharing Initiative. This case study, and additional case studies and resources on innovative clean energy projects, can be found at: energy.nsw.gov.au/ksiprojects.

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The Narara Ecovillage

Narara Ecovillage is a 64-hectare property located on the Central Coast of NSW, originally used as an agricultural research station. The site is now the home of a unique community development that will use smart technology to deliver a carbon-neutral village. The village is designed to cater for rooftop and ground-mounted solar photovoltaics (PV) and will use an environmentally friendly 'smart grid' control system. This system will balance the community's energy generation, consumption and storage, while using a two-way transformer to connect to the NSW grid.

The Ecovillage is currently designed to support 60 homes, and there are plans to expand to around 150 homes in the future. The Ecovillage also has its own waste water treatment plant.

The Narara Ecovillage shows how a housing development can be carbon neutral, and how the electricity grid can cope with high levels of renewable energy generation in suburban developments. Both of these features are part of the reason that the project has attracted funding from the Australian Renewable Energy Agency (ARENA). The project will collect data and develop resources to be used by other community groups or developments.

"Providing a clean, reliable supply of power from renewable sources is a primary concern of the project. Projects like ours represent a paradigm shift in the way communities can manage energy use themselves, generating and storing energy on site and minimising the use of the national grid. Our long-term goal is to generate more energy than we need and to offer our surplus to Central Coast residents at a competitive price."

John Talbot, Narara Ecovillage, Project Director

Key features of the Narara Ecovillage

The Smart Grid

A smart grid is an electrical network that incorporates local or distributed electricity generation controlled by smart technology. Smart grids allow high penetration of renewable energy generation and can improve energy affordability, reliability, convenience and resilience as well as provide environmental and community benefits.

The Narara smart grid will include at least 471 kilowatts (kW) of **residential solar PV**, 196 kW of **centralised solar PV**, at least 460 kilowatt hours (kWh) of **energy storage**, and integrated **demand-side management and control systems**. For comparison, a typical new suburban home might feature 3-5 kW of solar PV and 7-10 kWh of battery energy storage.

High penetrations of solar PV on the grid can mean that on some days, systems automatically shut down to avoid over-voltage and power quality issues. One of the main features of the Narara solution is its **link to the NSW grid**. The system actively regulates the power quality and voltage to integrate the high-density solar generation with the local grid.

This is made possible by a transformer, nicknamed "Priscilla", which allows the smart grid to manage when the energy is used directly on site, shared among different homes and buildings, stored in batteries, or exported to be sold to customers outside of the smart grid. This transformer, along with other smart technology, factors in weather conditions and time of day to predict the amount of energy that will be available from solar panels and the energy that will be required by the community, to determine whether to automatically move energy between buildings or import or export energy from the NSW grid. The same type of smart transformer has been used in Europe to create 100% solar suburbs.

The homes

Homes in the Narara Ecovillage will incorporate passive solar design, thermal mass, energy efficiency, and incentives to minimise the use of energy-intensive mechanical heating and cooling to help manage peak demand in summer and winter. All new buildings will need to conform to the village building standard, which includes a 7-star energy efficiency rating.

Each home will feature solar panels and access to storage, a solar-powered water system, and access to an electric car charging station. Homes will also monitor energy use, and will be able to use smart technology, including smart thermostats and smart plugs, to make sure energy is used sustainably. The resident will be able to monitor and control many aspects of their home energy system.

In focus: integrating into the existing electricity grid

Narara Ecovillage secured exemptions from the Australian Energy Regulator to operate a private network embedded within the national grid and sell electricity to residents. When private networks such as shopping centres and retirement villages do this, they typically recover energy costs by rolling them into fixed charges such as rent. Narara Ecovillage did not

consider that this approach would incentivise energy efficiency so instead created a separate electricity retailing entity, Narara Ecovillage Power (NEV Power Pty Ltd ABN [51 611 577 103](#)), to allow customers to be separately metered and billed.

The high levels of solar generation at Narara meant that voltage levels at the grid connection point would sometimes have been outside the permitted limits. This is usually solved by providing multiple transformers dotted around the development, but Narara Ecovillage opted for the less obtrusive and more cost-effective smart grid transformer.

This choice created new challenges. A typical private network would be a low-voltage electricity customer, meaning that the transformer providing power to the ecovillage would sit on Ausgrid's side of the private network boundary. However, the smart transformer had to be ordered from Europe and was not pre-approved by Ausgrid, a process that would have taken over a year. Instead, the team opted to become a high-voltage customer so that the transformer would sit on Narara's side of the private network boundary. This decision in turn created additional design challenges and infrastructure costs.

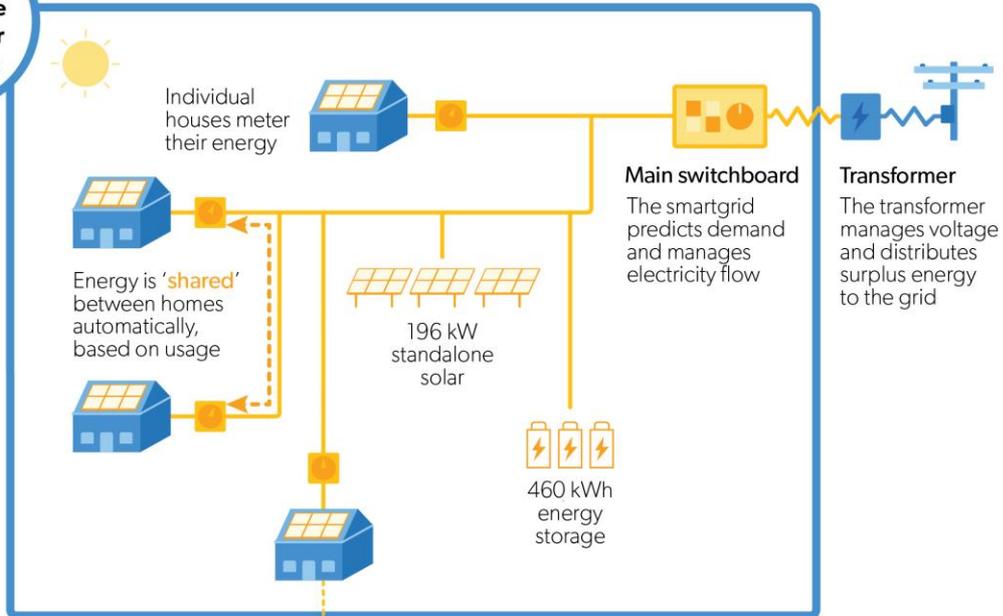
Overcoming challenges

Challenges	Solutions
Technological challenges in linking to the NSW grid – load constraints and variable power quality	<ul style="list-style-type: none">o The smart grid transformer – the transformer regulates voltage and power quality
Funding – a high capital outlay for infrastructure could not be completely met by the community	<ul style="list-style-type: none">o Multi-sourced support – federal, state and co-operative member funding provided essential capital to enable the project
Complexity in linking to the NSW grid –NSW network service provider, Ausgrid, does not yet have the structures in place to easily approve this type of system	<ul style="list-style-type: none">o Project management – continuous engagement with Ausgrid was required to navigate the additional approval steps
National regulations – work with the Australian Energy Regulator to be able run the microgrid and sell electricity to residents	<ul style="list-style-type: none">o Project management – a process was established to apply for and receive a Network Service provider exemption and Retailer exemption licence from the Australian Energy Regulator.

Narara: creating a low-emission lifestyle

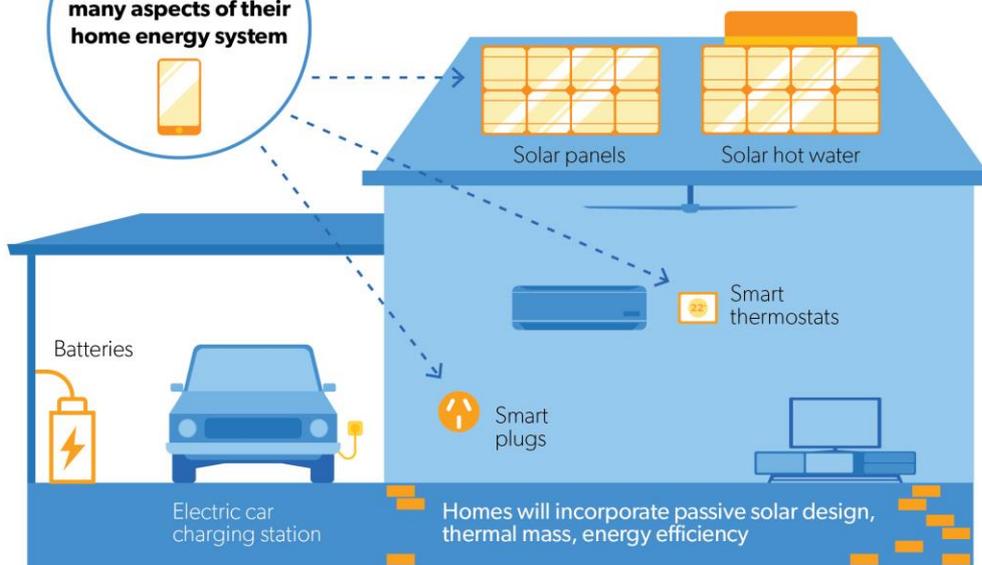
Creating, capturing, and controlling **solar energy**

100% renewable energy for all homes



Residents can monitor and control many aspects of their home energy system

Optimising energy use within the home



"The Narara Ecovillage is happening at a time of great change in the national electricity scene, particularly concerning the rules around embedded private networks and smart grids. To create the system in a changing landscape, the solution was to design something robust and simple."

Simon Evans, Director at Beast Solutions, Energy system design and consulting

Findings for future community-led smart energy projects

The project team learned many lessons by encountering and overcoming several challenges.

1. System selection

In hindsight, the choice to use the smart grid transformer may have created greater challenges than the alternatives. While any solution would have come with 'first mover' problems, it might have been possible to arrive at a cheaper and simpler system. Using alternative voltage regulating devices such as STATCOM units, for example, would have had a similar initial cost and approval delay, but no need for infrastructure upgrades to cope with a high-voltage gateway. Regardless of the solution, starting the network service provider's approval processes much earlier would also have taken pressure off the project.

2. Time management

Sometimes, yielding to early time pressures can cost time later in the process. Various important decisions were postponed until they became urgent, at times not leaving sufficient time for careful consideration. As a result, coordination between contractors and

designers suffered. The project results have been good, but the team would adopt a more tightly coordinated design approach next time, to allow definitive decisions to be locked in at an earlier stage.

3. Decision-making

The Narara Ecovillage Cooperative is self-governed, following principles of 'dynamic governance' (aka 'sociocracy'), an established collective decision-making system that allows all members to contribute to important decisions. During the development of the smart grid, the members of the cooperative held workshops, meetings and investigations of options at key milestones. This ensured that the decision-making process was followed to members' satisfaction but sometimes lengthened project timeframes. For example, a decision on the location of the waste water treatment plant was delayed by over a month while new options were costed.

4. Working with contractors

The Narara Ecovillage team would take more time and effort to educate contractors and sub-consultants. While many of the individual design elements were not new, contractors and sub-consultants found it difficult to integrate their services into the wider vision and sometimes struggled over the differences between Narara and a business-as-usual project.

5. Budgeting

The Narara Ecovillage Cooperative is grateful for the support of ARENA. Next time, however, the team would spend more time and effort at an early stage to narrow down options and conduct robust feasibility and cost-benefit studies, so that funding could be secured earlier without necessarily relying on ARENA for support.

Key players and roles

- **The community and the Narara Ecovillage Cooperative** provided the ideas, drive and commitment to envision and develop an inclusive community, based on sustainable technologies. They also invested in the construction of the smart grid and other community infrastructure, as well as the construction of their own homes.
- **The NSW Government Office of Environment & Heritage** provided \$70,000 as part of a wider funding commitment to support the development of community-owned clean energy projects across New South Wales.
- **The Australian Renewable Energy Agency** provided \$1,158,000 (31% of the total cost of the smart grid) as part of their investment in projects to accelerate Australia's shift to renewable energy, and later provided another \$660,000 to enable the smart grid transformer and its associated infrastructure.

- **Beast Solutions** provided in-depth feasibility studies and developed designs and specifications for the smart grid, elicited government funding and support and navigated approval requirements.

"Without [ARENA] funding, a network on this scale and level of sophistication would not have been possible. While we're brazenly claiming to be Australia's smartest community-owned grid right now, we will be delighted to pass on the mantle when other communities develop even more efficient systems based on our learnings."

Lyndall Parris, Narara Ecovillage founder



Photo courtesy of Narara Ecovillage Co-operative

Benefits of the Narara Ecovillage project

The Narara Ecovillage demonstrates how to combine existing technology to achieve carbon neutrality. Community title developments offer opportunities to pool solar and storage resources. The Narara smart grid design features a combination of home-based and pooled generation and storage resources, which points the way for community groups, retirement villages and other single-title developments to invest in renewable technology.

The outcomes of the project include:

- a carbon-neutral ecovillage
- a model for further deployment of smart grid and smart home solutions in community projects, including methodology and smart grid specifications
- a model for seamless grid interaction using a high level of local renewable generation
- a new business model for operation, maintenance and billing
- significant data on the interaction of the microgrid with the network service provider
- significant data on social impacts and resident behaviour
- the use of local resources, equipment and contractors to encourage on-site industry and job creation
- information and resources for investors, industry bodies, policy makers and regulators, industry and community energy groups.

What next for smart grid projects

Groups of individuals with a strong vision can often be first movers during this time of rapid technological, regulatory and political change

in the energy sphere. Since Narara Ecovillage was first conceived, there has been much discussion about smart grids, microgrids and embedded networks, but still very few real projects that directly benefit communities. In December 2017, Narara Ecovillage hosted around 50 delegates, representing 19 countries, from the 13th International Symposium on Microgrids (hosted by CSIRO). Presentations and tours were followed by much informal discussion at this important global knowledge-sharing event.

There is now a strong tide in the industry, pulling towards greater ease of integrating smart grid technologies, greater clarity in regulations and rules, and greater awareness and acceptance among electricity network service providers, developers and finance providers. By riding this tide, and by using the lessons learned by the Narara Cooperative, new smart grid and microgrid developments will be faster and easier.

Where can I find out more?

This case study was prepared by Beast Solutions in collaboration with Narara Ecovillage Cooperative Ltd, as part of the NSW Government's Clean Energy Knowledge Sharing Initiative.

Additional case studies and resources on innovative clean energy projects can be found at:

energy.nsw.gov.au/ksiprojects

For more about Narara Ecovillage, see nararaecovillage.com