flex'talk

Seed Project

ASSESSMENT, FINDINGS AND RECOMMENDATIONS

Seeding the Future of Smart Energy: trialling smart home technology installation and connectivity to inform scalable deployment in Kiwi homes.

Electricity Engineers' Association

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

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This report is intended to provide insights from the FlexTalk pilot trial of OpenADR on the suitability of OpenADR for the New Zealand electricity industry. It is not a substitute for specialist engineering advice.

If there is uncertainty on what technical or legislative requirements should apply in any situation, specialist advice, including legal advice, should be sought. This report is the outcome of the combined efforts and inputs of the authors and contributors. Any statements, opinions or conclusions in this report are not to be taken as attributable or assumed attributable to the Electricity Engineers' Association, the Energy Efficiency and Conservation Authority, or any individual wider project participant.

Examples and case studies in this report are included to assist understanding of OpenADR and demand flexibility common communication protocols. The examples or case studies are not a comprehensive statement of matters to be considered, nor steps to be taken, to comply with any statutory obligations pertaining to the subject matter of this report but they do illustrate how the electricity distribution sector has applied in practice OpenADR and the issues for consideration.

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Contents

SOLAR HOME EV WIND CHARGE

Foreword

Aotearoa New Zealand's transition to a renewable energy future presents both challenges and opportunities. One of the greatest strengths of our industry is its ability to share, collaborate and innovate in the pursuit of solutions to complex problems. FlexTalk is a perfect example of this mindset.

From the outset, the Electricity Engineers' Association (EEA) and the Energy Efficiency and Conservation Authority (EECA) recognised FlexTalk as an opportunity to strengthen government and industry collaboration, taking a proactive approach to future system design. Demand flexibility, also known as distributed flexibility, will be essential to ensuring a secure, reliable and resilient electricity system, while optimising infrastructure investment and integrating more renewable energy. International experience shows that increased adoption of demand flexibility brings great benefits but also unique challenges.

This latest FlexTalk project builds on the foundations established by earlier trials, continuing the critical work of developing an approach for enabling demand flexibility in New Zealand. Through FlexTalk, the EEA, EECA and industry sponsors are working together to address a key challenge: how to unlock the potential of demand flexibility to benefit consumers, networks and the wider energy system.

This project has reinforced that standardised communication protocols, system interoperability, and consumer engagement are essential to the effective scaling of demand flexibility solutions. If we want this nation's businesses, homes and flexibility providers to actively manage their electricity use in response to real-time conditions, they need the right tools and incentives, and the confidence to participate.

LOOKING AHEAD

New Zealand has a strong foundation to create a more flexible and responsive electricity system but realising its full potential will require coordinated effort across regulators, network operators, retailers, technology providers, and consumers. To enable widespread adoption of demand flexibility, we must address several key challenges:

» Establishing clear market signals and regulatory frameworks that incentivise participation.

» Ensuring interoperability and standardisation of demand-side technologies to enable seamless integration across the energy system.

» Scaling successful pilot projects into fully operational market solutions, driving meaningful impact.

By aligning policy settings, industry collaboration and consumer engagement, demand flexibility can become a fundamental pillar of New Zealand's transition to a low-carbon, resilient, and consumer-driven energy future.

Collaboration has been key to the progress we have made to date; it remains essential as we move forward. The insights from the work delivered under the FlexTalk banner are guiding us forward. However, more work is needed, more investment is required and more opportunities must be explored.

Having completed this latest piece of work, we are now planning the next exciting phase of FlexTalk where we expand our reach and scale-up our in-home trials. We invite you to join us in this exciting work and help our nation seize the value demand flexibility can offer us all.

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Chief Executive, EECA

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SECTION ONE

Executive Summary

The FlexTalk Seed Project, a collaboration between the EEA and EECA, was designed to explore and test, at small scale, the practical application of installing and signalling smart devices to enable demand flexibility in New Zealand.

It builds upon the foundational work of the original FlexTalk project, the Demand Flexibility Common Communications Protocol Project (2024), which examined open communication protocols used between flexibility suppliers and end use devices in consumer homes.

The primary objective of the seed project was to assess the practicalities around installing and signalling smart devices in consumer homes, to provide initial insights that could 'seed' the way for larger scale trials. The project is called seed for this reason, it enables us to learn by doing and test before scaling.

OBJECTIVES AND APPROACH

The project aimed to:

1. Identify and evaluate selected technologies for their suitability for demand flexibility
2. Identify components for project planning, including the cost, installation complexity
3. Provide insights to inform future FlexTalk projects and smart device installation best practice
4. Provide guidance and the inputs into smart device installation best practice.

Over five months, the project installed smart devices including home energy management systems (HEMS) and hot water and air conditioning monitoring and control devices, in 10 homes, before testing interoperability, sending signals to control the devices remotely and gathering participant feedback.

FINDINGS AND KEY INSIGHTS

TECHNOLOGY PERFORMANCE	All devices tested successfully responded to signals and provided reliable control over hot water and air conditioning loads.
INSTALLATION & CONNECTIVITY	Electricians found the Shelly and Intesis products relatively straightforward to install. Connectivity through direct message queuing telemetry transfer (MQTT) was more stable and scalable than manufacturer cloud-dependent solutions.
CUSTOMER EXPERIENCE	None of the seven respondents perceived any change in their hotwater or airconditioning experience during the demand flexibility events. One participant highlighted the additional value in the customer mobile application which also enabled remote control of their smart device.
SIGNALLING EFFECTIVENESS	Signals successfully adjusted device behaviour although variations arose due to customer intervention and appliance status at the time of signalling.
SCALABILITY CONSIDERATIONS	The project highlights that to scale demand flexibility solutions effectively, there is a need for standardised communication protocols, interoperability between systems and improved consumer engagement.

1

RECOMMENDATIONS FOR SCALING DEPLOYMENT AND CONSUMER ADOPTION

To ensure further success of product and integration trials and consumer adoption of new product trials and consumer adoption of new demand flexibility technologies and systems, the following key actions are recommended.

1. Streamlining installation

Develop pre-installation assessments, provide standardised installer training and create pre-configured smart device kits.

2. Enhancing device connectivity

Prioritise direct device connections over cloud-reliant solutions and continue evaluating cost-effective HEMS solutions (due to the benefits of a single connection point for aggregators).

3. Improving consumer engagement

Develop intuitive dashboards for monitoring energy usage, introduce opt-out participation settings and offer incentives for consumer involvement.

4. Future-proofing demand flexibility

Advocate for industry-wide interoperability standards, expand trials to include solar, battery storage and electric vehicle (EV) charging, and collaborate with policymakers to refine regulatory frameworks.

The FlexTalk Seed Project confirms the feasibility of demand flexibility in New Zealand, with minimal household disruption. To scale deployment and drive consumer adoption, the focus must now shift to implementing these recommendations. Advancing these actions will be key to building a scalable, consumer-centric system that supports a resilient, electrified future.

SECTION TWO

Introduction

2.1 WHAT IS DEMAND FLEXIBILITY?

Demand flexibility refers to the ability of residential and industrial consumers to adjust their electricity consumption in response to price signals, incentives or system needs. This can be achieved through smart technologies, automation or behavioural changes. It enables better alignment between electricity supply and demand; reducing peak loads and improving system stability. It also supports the integration of more renewable energy sources into the electricity mix.

2.2 GLOBAL AND LOCAL DRIVERS FOR DEMAND FLEXIBILITY

Around the world, demand flexibility is emerging as a critical tool in modern electricity systems. Factors driving this shift are outlined below.

» **Renewable energy integration:** as the integration of variable generation sources like wind and solar increase, flexible demand helps match consumption with generation patterns.

» **Electrification of transport and heating:** the rise of electric vehicles (EVs), heat pumps and electric process heating creates new electricity demand that must be managed to avoid stressing the grid.

» **Grid congestion and peak demand challenges:** managing peak loads through demand flexibility reduces the need for network upgrades and lowers wholesale market prices.

» **Decentralised energy resources:** the proliferation of in-home smart devices, batteries and distributed generation allows consumers to participate actively in the energy system.

2.3 WHY DEMAND FLEXIBILITY MATTERS FOR NEW ZEALAND

As New Zealand moves towards a future powered almost entirely by renewable energy, the way people use electricity needs to evolve. Demand flexibility gives consumers the ability to shift or adjust their energy use in response to price signals, incentives or grid needs and is becoming an essential tool to ensure a secure, affordable and sustainable energy future.

With more wind and solar coming online, the challenge isn't just generating enough electricity but making sure it's used at the best possible time. Unlike hydro and geothermal, which provide steady output, wind and solar generation is intermittent and fluctuates depending on the weather. By shifting electricity use to when the wind is blowing or the sun is shining, demand flexibility helps make the most of New Zealand's abundant renewable resources, including intermittent resources, and reduces reliance on fossil-fuel generation.

At the same time, New Zealand's electricity demand is set to grow with the increasing electrification of transport, heating and industry. EVs, for example, could significantly add to peak electricity demand if consumers all charge their vehicles at the same time. Likewise, the shift away from fossil fuels in industrial heating will require careful management to prevent unnecessary strain on the grid. Demand flexibility enables the integration of new load smoothly, reducing the risk of congestion and keeping network costs under control.

Demand flexibility also strengthens resilience. As extreme weather events become more frequent, a more responsive and adaptable electricity system can help prevent disruptions. It also reduces, or can delay, the need for network upgrades and new generation and their associated costs.

2.4 THE CONSUMER'S ROLE AND THE RISE OF HOME ENERGY MANAGEMENT SYSTEMS

A crucial enabler of demand flexibility is the consumer. While the electricity system has traditionally been a one-way supply chain where power is generated, transmitted, and consumed passively, this dynamic is shifting. Consumers are becoming active participants, with new opportunities to manage their energy use, lower their costs and contribute to a more efficient grid.

HEMS are emerging as a key technology to help consumers take advantage of demand flexibility. These smart systems allow households to automate and optimise their energy use based on real-time data, electricity pricing and grid conditions. HEMS can coordinate appliances like hot water heaters, EV chargers, heat pumps and batteries to ensure energy is used efficiently, minimising costs while maximising comfort.

For example, a HEMS can automatically schedule an EV to charge when electricity prices are low or when solar generation is high. It can also heat or cool a home when renewable energy is abundant, reducing reliance on electricity during peak hours. With increasing integration of solar panels and home batteries, these systems can help households store excess energy and use it when it's most valuable, either for their own needs or by exporting it back to the grid.

HEMS can also provide consumers with access to demand flexibility markets. As the electricity system evolves, consumers will have the ability to participate in programmes where they are rewarded for shifting their energy use in ways that support the grid. This could include:

- time-of-use pricing, automatically adjusting energy consumption based on lower off-peak prices;
- demand-response programs, opting-in to reduce energy use during peak periods in exchange for financial incentives, or
- virtual power plants, aggregating household batteries, solar and flexible appliances to provide services to the grid, allowing consumers to sell their flexibility like a power station would.

2.5 CONSUMER VALUE: EXISTING AND FUTURE POTENTIAL

The value proposition for consumers participating in demand flexibility programmes extends beyond cost savings to include greater visibility, automation, and control over their energy use.

Consumers engaging with demand flexibility can already benefit from:

- reduced energy bills by shifting load away from peak pricing periods;
- enhanced visibility and control through energy management applications and automation, and
- seamless demand flexibility with no noticeable impact on household comfort.

Looking ahead, consumers could unlock even greater value by leveraging:

- battery storage and solar optimisation, scheduling power consumption based on real-time pricing and self-generation;
- EV charging flexibility, charging when grid demand is low or renewable supply is high;
- grid services participation, earning incentives for allowing networks to optimise household loads.

With the right incentives, automation tools, and consumer education, demand flexibility can transition from a technical feature to a widely adopted consumer energy management solution, delivering both individual and system-wide benefits.

2.6 FROM CONCEPT TO IMPLEMENTATION: THE ROLE OF FLEXTALK

While the benefits of demand flexibility are clear, the practical challenges of enabling widespread participation remain.

Consumers, technology providers, and industry stakeholders all have a part to play in making demand flexibility work. This requires clear communication between consumers and their end-use devices, flexibility suppliers and networks to ensure that flexibility services can be delivered seamlessly and effectively. Standardised communication protocols and interoperable systems are essential, allowing for scalable, efficient and consumer-friendly solutions.

However, regulatory barriers also pose challenges to large-scale implementation. Existing technical regulations in New Zealand often reference outdated or incomplete standards, creating compliance and integration difficulties. For example, in New Zealand the Low Voltage (LV) network protection settings and inverter response requirements vary across distribution networks. While AS/NZS 4777.2:2020 specifies updated inverter settings for voltage and frequency response, some network operators still reference older versions or apply custom grid codes that differ from the standard. This inconsistency can lead to conflicting requirements for manufacturers and installers, causing challenges in ensuring uniform compliance across networks. As a result, distributed energy resources (DER) such as solar PV and battery inverters may respond differently to grid disturbances depending on the region, reducing the overall effectiveness of coordinated demand flexibility and grid stability efforts. Aligning network connection standards with the latest AS/NZS 4777.2 provisions would help create a more harmonised and efficient approach to DER integration in New Zealand.

This is where FlexTalk comes in. FlexTalk is an industry initiative designed to bridge the gap between theory and real-world application. It aims to develop, test and implement the communication, coordination and control mechanisms necessary for effective demand-side participation in New Zealand. FlexTalk works to ensure that demand flexibility solutions are not only technically feasible but also supported by clear, consistent regulatory frameworks.

FlexTalk's first project, the Demand Flexibility Common Communication Protocols Project, tested and documented New Zealand-specific communication between electricity distribution businesses and flexibility suppliers. The work covered in this report, builds on the knowledge gained from the previous trial to test open communication protocols and signal transmission between flexibility suppliers and smart devices in consumer homes. This knowledge provides New Zealand-specific documentation of device signalling and control functionality, including signals to turn devices on, off, up, and down.

By addressing both technical and regulatory barriers, FlexTalk plays a critical role in accelerating the adoption of demand flexibility and ensuring that consumers, networks, and technology providers can participate effectively in New Zealand's evolving electricity system.

SECTION THREE

Objectives, approach and methodologies

3.1 DELIVERY PARTNERS

Delivery partners were essential to the success of the project. Cortexo led the technical aspects, providing the OpenADR (R)[1] platform and ensuring seamless connectivity and communication with the installed smart devices.

Ivory Egg played a crucial role in product selection, electrician training and the installation and commissioning process. They provided expert advice on the chosen products and signalling approaches, ensuring a positive experience for participating homeowners.

3.2 OBJECTIVES OF THE SEED PROJECT

The project conducted a small-scale practical deployment to facilitate learning through hands-on experience. It installed selected HEMS and in-home smart devices to control the behaviour of both hot water systems and heat pumps in 10 consumer homes. Some devices were also installed in a test environment.

The objectives of the project are outlined below.

1. **Identify potential technologies and standards**
   - Explore potential technologies and standards, and identify potential delivery partners for future FlexTalk projects.
   - Test global standards needed for flexibility with a focus on communication protocols standards, data standards and cybersecurity standards.
   - Critique solutions tested to identify opportunities and limitations on New Zealand's low-voltage electricity networks.
2. **Identify components for project planning**
   - Determine the costs to retrofit connectivity and interoperability to consumer devices and their installation.
   - Assess timing, risks and potential industry co-funding associated with scaling the FlexTalk Seed project.
3. **Provide a starting point for FlexTalk future projects to scale**
   - Provide smart device options and scenarios.
4. **Provide guidance and the inputs into smart device installation best practice**
   - Inform the connectivity and interoperability requirements for electricians and technology installers.

1 OpenADR and the OpenADR Logo are trademarks owned by OpenADR Alliance.

3.3 DELIVERY APPROACH

The project was designed to be nimble, delivered over five months and split into the following six phases with ongoing research at all stages.

FIGURE 1: PROJECT PHASES

IDENTIFY	ON-BOARD	INSTALL	IMPLEMENT	SIGNAL/TEST	DOCUMENT LEARNINGS
What devices should be included in the seed project.	Establish agreements with identified delivery partner(s) and onboard customers (10x electricians).	Retrofit connectivity to existing devices in homes and install HEMS to enable interoperability.	Develop/code virtual top node (VTN) graphical user interface for signalling requirements and implement required reporting. Implement software to signal smart devices.	Send signal to device and assess its ability to respond.	Capture findings on smart device installations, the technical ease and barriers and the experience of project participants from a technical, device and participation in demand flexibility point of view.

RESEARCH

Conduct wider research to inform scaling-up additional projects, including gaining knowledge on system and device-level technology to enable interoperability.

3.4 PRODUCT SELECTION

The selection of products focused on identifying global and reputable brands that enabled hot water cylinders (HWC) and air conditioning (AC) monitoring and control. The following table identifies the products or smart technology selected, their purpose and rationale for selection.

TABLE 1: PRODUCT SELECTION RATIONALE

BUNDLE	PRODUCT NAME	PRODUCT PURPOSE	WHY WAS PRODUCT SELECTED?
1	Shelly Plus 1PM	HWC control	» Chosen as a leading and respected solution in New Zealand and global markets. » Combines high functionality, reliability, open protocol support and low cost.
	Shelly Add On	HWC temperature input module for	
	Shelly DS18B20-3M	HWC temperature probes two used)	
	Shelly EM+50	HWC and AC power measurement	
	Shelly Pro EM-50	HWC power measurement	
2	Intesis AC Cloud gateway	AC control and feedback	» Chosen as a proven multi-brand wired AC control solution. Reliable two-way control and feedback from AC units, offering superior control and feedback accuracy compared to infrared solutions. » IR used only when a consumer's AC unit lacked a wired control option.
Used with 5/10 Shelly installations	Teltonica RUT241	Cellular modem	
3	Universal Devices' EisyADR	HEMS	» Potential as a low-cost, scalable HEMS solution with an onboard OpenADR virtual end node (VEN). » It's an established and proven solution in other markets such as the U.S (further discussion is in *Section 4 Product Technical Analysis* below).
	Universal Devices' ZMatter USB	Enable ZWave, ZIgbee and Matter communication	
	Universal Devices' OpenADR Production Certificate	Enable Open ADR VEN functionality	
4	SkyCentrics' EcoPort with one year cellular service	EcoPort HWC controller	» A leading and widely used gateway for controlling Ecoport devices, particularly in markets like the USA. » Supports OpenADR 2.0 protocol and API communication with Ecoport devices.
5	XXter Controller with BREEAMS reporting	HEMS / BMS	» Chosen as a building management system (BMS) suitable for larger residential, commercial or public buildings. » Relatively low cost and support for key open protocols relevant to energy management (KNX, Modbus, BACnet, and OCPP).

3

FIGURE 2: HOTWATER CONTROL AND MONITORING PRODUCTS

Shelly Plus 1pm and Shelly Add-on for hotwater monitoring and control (temperature probe not pictured)

Ecoport gateway (white) and simulator (black) for hotwater control

FIGURE 3: HEATPUMP CONTROL AND MONITORING

Intesis (wired) AC cloud gateway for airconditioning monitoring and control

Intesis (infrared) AC cloud gateway for air conditioning control and feedback

FIGURE 4: HOME ENERGY MANAGEMENT SYSTEMS

XXter HEMS/BMS

Universal Device HEMS

Homey Pro HEMS

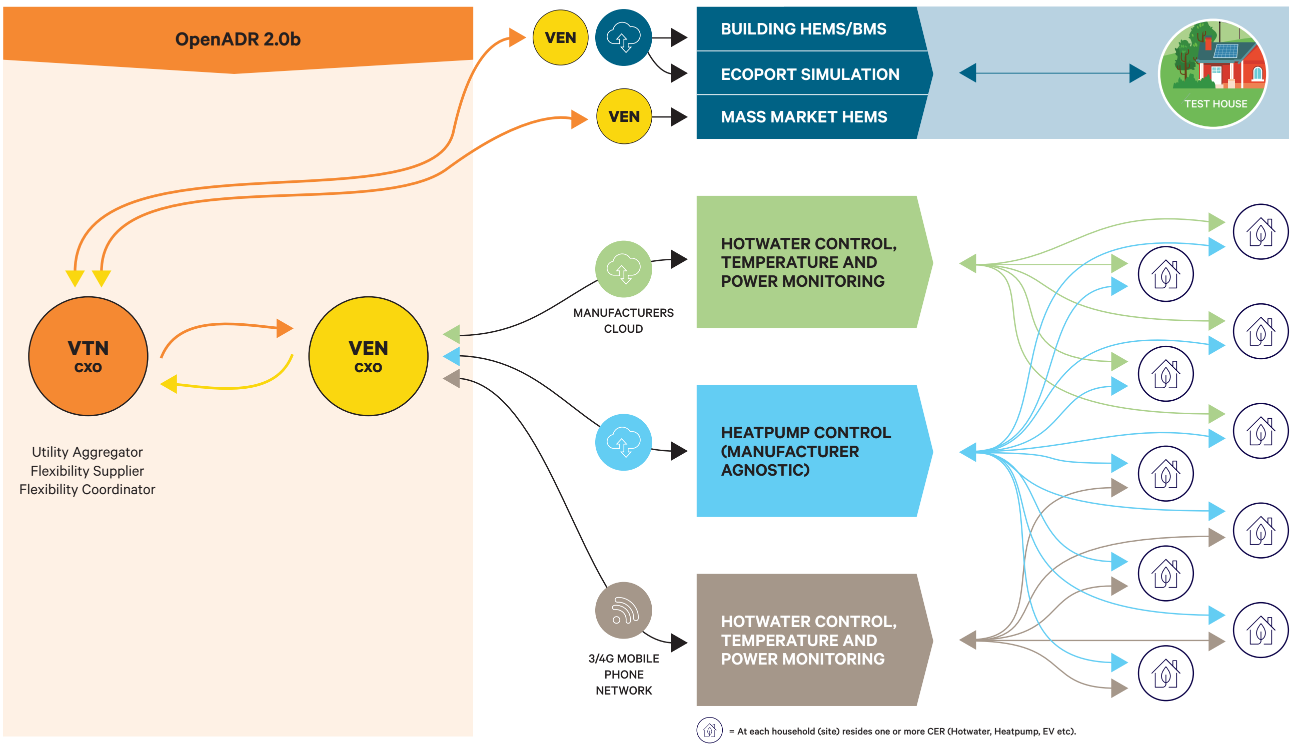
3.5 CONNECTION METHODS

The project explored various connection methods of the devices to the OpenADR virtual top node (VTN)/virtual end node (VEN) to assess the opportunities and limitations of each approach. These methods included:

1. Hot water control and temperature monitoring connecting both through the manufacturer's cloud and directly to the device
2. Heat pump control and feedback connecting via an AC manufacturer-agnostic cloud services
3. Energy consumption monitoring for hot water and heat pumps connecting both through the manufacturer's cloud and directly to the device
4. HEMS, testing both an entry-level HEMS and a combined HEMS/BMS solution, and
5. EcoPort (CTA-2045) control, utilising VEN to VTN interface for communication.

Figure 5 outlines the equipment and connection methods used in the project.

FIGURE 5: SEED PROJECT ARCHITECTURE – CONNECTION METHODS OF DEVICES



3.6 CUSTOMERS AND LOCATION

Ten electricians, geographically spread across the country (see *Figure 6*), participated in the project as both installers and customers. Ivory Egg recruited these electricians and provided them with the necessary equipment.

Five of the electricians also received an additional Teletonica product to enable cellular connectivity, allowing the project to test an alternative connection method.

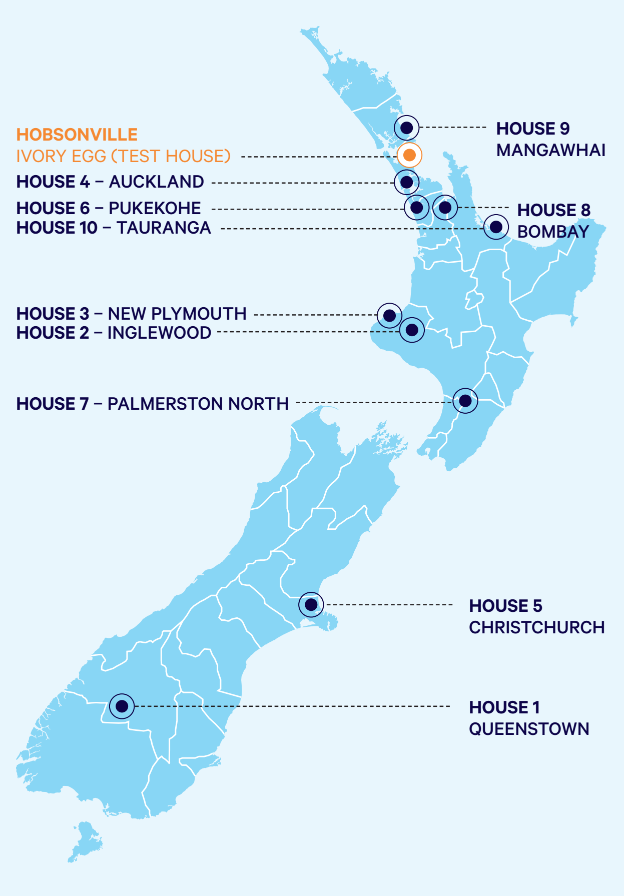
Cellular connections can be crucial in scenarios where wifi is unavailable or unreliable; where increased security is required as cellular networks generally have stronger security protocols compared to wifi; in remote areas with limited broadband infrastructure, or where backup connectivity is desirable.

By testing cellular connectivity, the project aimed to explore its potential as a viable alternative or complement to wifi particularly in situations where wifi may not be suitable or available.

A dedicated test house was also set up at Ivory Egg's showroom in West Auckland. This allowed for learning on new and unfamiliar technology and focused testing of the Ecoport and HEMS units in a controlled environment. The Ecoport and HEMS solutions were new to the project team.

The test house provided a dedicated space for hands-on learning and troubleshooting, allowing the team to experiment with different connection methods and configurations. In delivering a controlled environment, it also allowed for more precise experimentation and minimised the risk of disrupting homeowners or impacting their daily routines.

FIGURE 6: CUSTOMER AND TEST HOUSE LOCATIONS



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3.7 INSTALLATION APPROACH

Participants were briefed on the project and technology during the recruitment process. After onboarding, they received a bundle of smart devices to install in their homes, along with tailored installation and commissioning instructions. Ivory Egg created two versions of these process guides: one for installations using wifi and one for cellular connections.

These guides included written instructions and visual aids to help participants identify the hardware components and utilise third-party applications for installation and commissioning*. The guides provided step-by-step instructions to ensure safe and correct installation of the devices.

Only nine participants completed installation within the desired timeframe therefore only nine homes were part of the signal testing phase.

** Process documentation can be provided upon request.*

3.8 SIGNAL DESIGN AND TESTING

The signalling phase of the project ran for three weeks from December 2024. The project used a VEN to simulate a group of sites and send simple signals based on the OpenADR 2.0A specification.

These signals, of 0, 1, 2, or 3, triggered predefined control actions on the end devices.

» Signal 0: No change to the device.

» Signals 1-3: Triggered specific control actions, with increasing levels corresponding to more significant adjustments.

TABLE 2: SIMPLE SIGNAL MAPPING

LEVEL	INTERNAL STATE	SHELLY CLOUD / DIRECT STRATEGY	INTESIS STRATEGY (WHERE INSTALLED)
0	NORMAL_DEMAND	All device relays turned ON	No action
1	REDUCED_DEMAND_LOW	Hot water DISABLED	No action
2	REDUCED_DEMAND_MEDIUM	Hot water DISABLED	Heat pump on and in cool mode: increase temp set point by 2 degrees Heat pump on and in heat mode: decrease temp set point by 2 degrees Otherwise: no action
3	REDUCED_DEMAND_HIGH	Hot water DISABLED	Turn off heat pump

For example, a level 2 signal sent to an Intesis-connected heat pump operating in heating mode would decrease the temperature setpoint by 2 degrees. This aimed to optimise the heat pump's efficiency and reduce power consumption.

The specific mapping of signals to control actions is detailed in the following section.

3.9 PARTICIPANT EXPERIENCE AND ASSESSMENT

Two surveys were conducted during the project to gather feedback from participants. The first, an installation survey, focused on the electricians' experience installing the Shelly and Intesis devices, gathering data on the time, cost and effort required.

The second, a participant experience survey, aimed to understand participants' awareness of device adjustments made during the signalling phase and to gather insights into their experiences with signalling and its impact on appliance behaviour in their homes.

SECTION FOUR

Results and discussion

The project's primary goal was to evaluate the scalability of various smart home technologies by assessing the ease of installation, connection and control. Key objectives included determining installation costs and timelines, evaluating technical complexity, identifying best practices and establishing a foundation for scaling future projects.

This initial exploration provided valuable insights into the complexities involved and generated key learnings for future scaling efforts.

Additionally, the project conducted preliminary investigations into the potential for these technologies to enable flexibility services. Further research into device logic, consumer tolerance and participation incentives will be crucial to realising the full potential of these services.

This key outlines the project's core objectives. Within each results section, the specific objectives addressed by that focus area are highlighted:

OBJECTIVES KEY

- **Identify potential technologies and standards**
- **Identify components for project planning**
- **Provide a starting point for scaling DF projects**
- **Provide guidance and input to smart device installation best practice**

4.1 PRODUCT TECHNICAL ANALYSIS

- **Identify potential technologies and standards**
- **Identify components for project planning**
- **Provide a starting point for scaling DF projects**

A product analysis (see *Table 3* below) reveals that all devices tested, except one, are scalable. Connection, installation and communication with these devices presented no significant technical challenges. However, there were learnings throughout on the ease of connection and various security nuances to the specific device types.

The Universal Devices unit, chosen for its inbuilt certified OpenADR 2.0b VEN, demonstrated simple and reliable OpenADR communication. However, commissioning it with New Zealand's current hot water and AC control products was complex and time-consuming, making it unsuitable for immediate large-scale deployment. Recent updates supporting Shelly and Matter devices may improve commissioning; if so, it could become a viable future solution.

The project also began researching whether the use of a HEMS unit is a better option for the consumer, rather than individual direct connections to each device. It found that the use of a HEMS has several advantages. It acts as a single point of connection to the outside world that can make data visible and receive signals. As every home has different requirements for energy management, the HEMS allows for local rules and logic to be set for each home. If communication with external services is lost, the HEMS can still provide optimal energy management services in the home.

Without a HEMS, the logic for each home would need to be provided at the remote service and any loss of communication would result in devices being unable to optimise energy use or provide the services they were installed for. Please note installation times and costs were recorded during a learning phase and are discussed in 4.3.1 below, and do not represent expected figures for a scaled solution. We anticipate lower costs and improved efficiency with product cost reductions and streamlined installations.

TABLE 3: PRODUCT ANALYSIS AND SCALING RECOMMENDATION

BUNDLE	NAME	PURPOSE	COST (ESTIMATE NZD)	CONNECTION METHOD	RECOMMENDED FOR SCALING
1	Shelly Plus 1PM	HWC control	$36	Wifi	Y
	Shelly Add On	HWC temperature input module for	$29	Connected to Shelly Plus 1PM	Y
	Shelly DS18B20-3M	HWC temperature probes (two used)	$13	Connected to Shelly Add On	Y
	Shelly EM+50	HWC and AC power measurement	$105	Wifi	Y
	Shelly Pro EM-50	HWC power measurement	$158	Wifi	Y
Used with 5/10 of Shelly installations	Teltonica RUT241	Cellular modem	$249	Wifi and cellular	Y
2	Intesis' AC Cloud gateway	AC control and feedback	$484	Wifi	Y
3	Universal Devices' EisyADR	HEMS	$851	Wifi	N
	Universal Devices' ZMatter USB	Enable ZWave, ZIgbee and Matter communication	$275	Connected to EisyADR	N
	Universal Devices' OpenADR Production Certificate	Enable Open ADR VEN functionality	$155	na	N
4	SkyCentrics EcoPort with one- year cellular service	EcoPort HWC controller	$584	Cellular	Y
5	XXter Controller with BREEAMS reporting	HEMS / BMS	$5,364	IP	Y

KEY
- Recommended for scaling
- Not recommended for scaling

4

4.2 PRODUCT CONNECTION ANALYSIS

Provide a starting point for scaling DF projects

The project evaluated various product connection methods, each with its own opportunities and limitations. Four methods were used: via a manufacturer's cloud service; via a manufacturer-agnostic cloud service; directly via the mobile phone network, and directly to a 'within device' VEN.

Connecting through a manufacturer's cloud service, while simple, carries risks like manufacturer dependence, pricing changes and potential outages. Similarly, relying on a manufacturer-agnostic cloud service introduces third-party dependencies.

Direct connection to devices via a mobile network offers independence from manufacturer clouds while retaining consumer access to device-specific apps.

Lastly, utilising built-in OpenADR VENs within devices like HEMS and Ecoports allows for standardised, potentially more robust communication with an OpenADR VTN (such as the Cortexo VTN used in this trial).

4.3 PRODUCT INSTALLATION ANALYSIS

Identify components for project planning

Provide guidance and input to smart device installation best practice

Project participants were surveyed after installing the devices in their homes and provided feedback on their experiences on a rating scale of 1-5 with 1 being easiest and 5 being hardest. Installers were also asked about the suitability of the process guides provided and where efficiencies could be made on the installation process.

FIGURE 7: INSTALLATION PHOTOS

Shelly device installation in House 8

Shelly Temperature probe installed on outlet pipe in House 10

XXter HEMS/BMS , DIN mounted in distribution board – Ivory Egg Test house

4.3.1 – EASE AND COST OF INSTALLATIONS

Shelly devices were used for hot water control and averaged a difficulty rating of 2 out of 5 taking an average of three hours to install, including documentation review. This indicates a relatively straightforward process.

Air conditioning monitoring and control installations using Intesis products also averaged a 2 out of 5 complexity rating and a two-hour installation time, suggesting a similar level of ease when it came to installation.

The cellular connection setup was rated 1 out of 5 and was considered trivial by participants. They consistently highlighted the thoroughness of the installation documentation provided by Ivory Egg.

The universal device was rated a 5 for difficulty. Connection and communication to the building using Open ADR was simple, fast and reliable. However, commissioning it to control the hot water heating and AC control products which are currently available in New Zealand was relatively complicated and time consuming. For this reason, as tested, it is not recommended for delivery at scale in New Zealand at this time. On publication of this report it was announced that the Universal Device would support a wider range of products available in New Zealand such as Shelly and Matter devices. If the commissioning process with these newly supported devices is simpler and faster, it may be a viable solution for delivery at scale in New Zealand in the future.

The Ecoport device was rated a 1 in terms of difficulty; easy and quick to install.

The Xxter controller, the HEMS/BMS solution trialled, was rated a 2 in terms of difficulty and would take approximately three hours to install. It was noted that installation time would depend on the size of project; the larger the project and the more controllable loads, the longer installation would take.

Several electricians encountered challenges during installation, highlighting that the existing infrastructure of a home can impact the complexity of the process.

» **Inaccurate temperature readings.** One electrician noted that a non-copper inlet pipe on their hot water cylinder hindered accurate temperature readings, emphasising the importance of considering pipe material when using temperature probes.
» **Extensive rewiring.** One electrician faced multiple issues, including an undersized supply cable, inaccessible pipes requiring under-house access, separate meter and distribution board locations and outdated wiring on an asbestos board. These issues necessitated significant rewiring and upgrades.
» **Installation location.** An outdoor hot water cylinder location required IP-rated installation for weather protection.
» **Wifi signal.** One electrician experienced initial difficulties with wifi signal strength, requiring troubleshooting to resolve.

These examples reinforce that installation challenges often stem from the existing electrical setup and infrastructure of older homes, rather than complexities with the new smart home equipment itself.

Table 5 presents average installation costs for each product, based on an electrician installer experience survey. These costs include both device cost and labour. Given that these figures were collected during a learning phase, they do not reflect expected costs for a scaled solution. We anticipate lower costs and improved efficiency through product cost reductions and streamlined installations.

As one electrician summarised,

"A standard setup like you would find in a new build would be a breeze to install, while old bungalows present far more of a challenge".

TABLE 4: PRODUCT INSTALLATION ANALYSIS – TIME AND COMPLEXITY						
	HOT WATER PRODUCTS (SHELLEY)	AIR CONDITIONING PRODUCTS (INTESIS)	CELLULAR CONNECTION	UNIVERSAL DEVICE (HEMS)	SKYCENTRIC ECOPORT	XXTER CONTROLLER WITH BREEAMS REPORTING
Average install time (hours)	3	2	0.6	8	1	3
Average difficulty rating	2	2	1	5	1	2

(1 easy – 5 difficult).

Please keep in mind that the installation costs presented in the following analysis reflect a trial setting. We anticipate significant cost reductions when these smart devices are rolled out at scale with standardised installation kits.

TABLE 5: PRODUCT INSTALLATION AVERAGE COST					
	HWC / AC INSTALLATION WITH WIFI CONNECTION	HWC / AC INSTALLATION WITH CELLULAR CONNECTION	UNIVERSAL DEVICE (HEMS)	SKYCENTRIC ECOPORT	XXTER CONTROLLER WITH BREEAMS REPORTING
Average cost of install (Includes labour and devices, excludes travel cost)	$1,563	$1,689	$2,081	$684	$5,664

4

For survey results see Appendix B – Installation survey results.

4.3.2 – PROCESS INSTALLATION GUIDANCE

To guide the installation process, Ivory Egg developed comprehensive instructions tailored to each electrician's connection type (wifi or cellular). These provided visual aids and step-by-step guidance to ensure the safe and correct installation of all devices. Feedback was sought and all survey respondents stated that the Ivory Egg process documentation was clear and easy to follow.

The installation surveys identified two key areas for improving the efficiency of installation.

1. Providing comprehensive material kits. Providing electricians with all necessary installation materials, including supplementary items like cable ties and mount boxes, will streamline the process and eliminate delays caused by sourcing additional components.
2. Enhanced guides. Incorporating more specific guidance on product placement within the installation instructions will benefit electricians with less experience with these specific devices. For example, specifying the optimal location for the EM hot water clamp and Shelly 1PM devices for those not familiar with Shelly installations would be beneficial.

Overall, the feedback indicates that installing the selected smart devices is generally straightforward and efficient except for the Universal Devices' unit. Adequate training, support and the provision of all necessary components are key factors for successful installation.

"If we were installing the hot water control equipment regularly it would be handy to have a pre-designed and built box with all control equipment that just intercepts the hot water switch wire to the cylinder". HOUSE 10

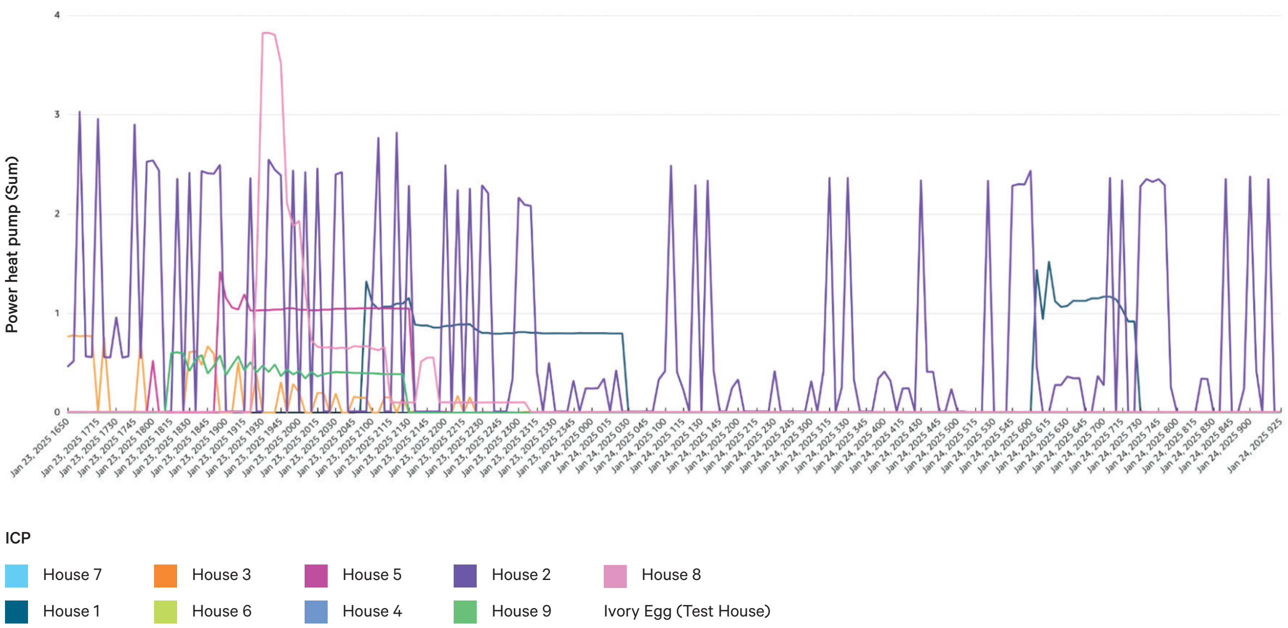
4.4 MONITORING DEVICES AND REPORTING

- Identify potential technologies and standards
- Provide a starting point for scaling DF projects

Data was sent from the VEN to the VTN every five minutes, reporting all variables being tracked at that five-minute point. Data was displayed on a dashboard page, providing a summary of specific site information.

The chart below shows the heat pump power usage data for all ICPs displayed in the three VENs, over a selected period. Depending on the signal type, the event would either turn the power off (signal type 3) or adjust the set point by 2 degrees (signal type 2).

FIGURE 8: HEAT PUMP USAGE BY ICP



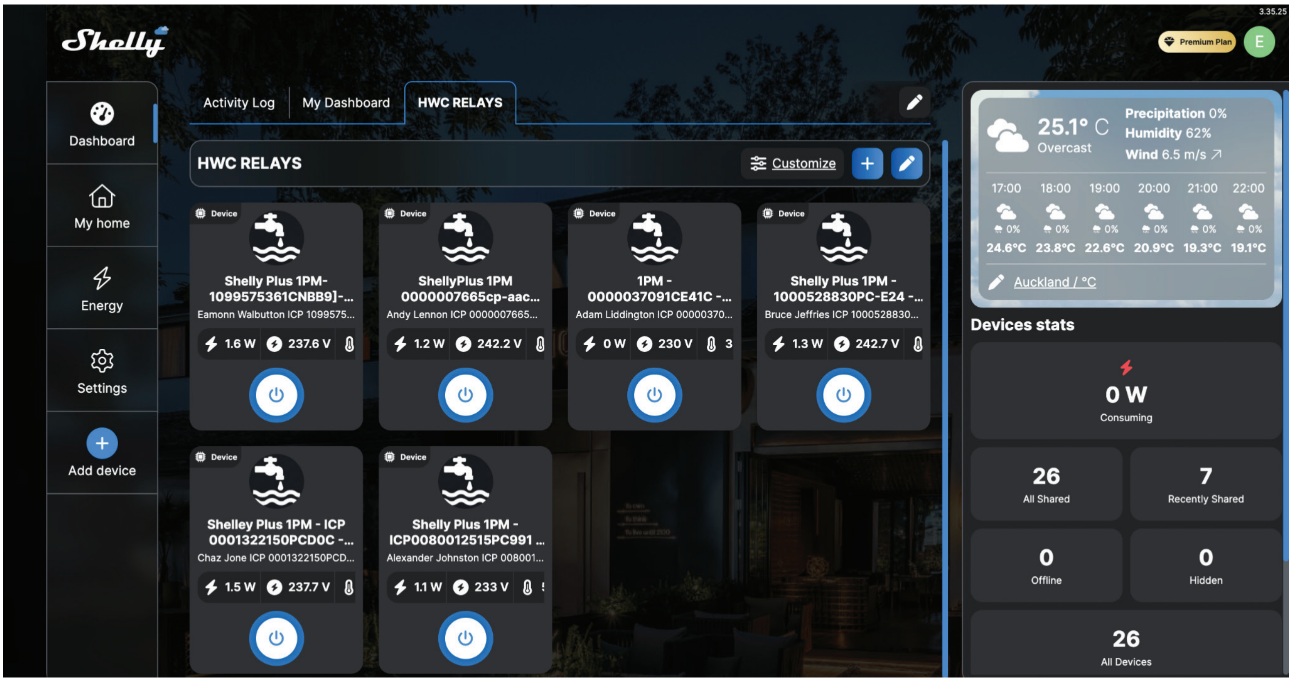
For hot water cylinders, the action of the power relay could be separately monitored by the hot water control manufacturer's cloud service as shown in the Shelly Hot Water Control (HWC) Relay dashboard below. For the trial, although the VEN showed the state of the hot water element's power consumption, it was important to independently confirm that hot water returned to 'on' after the event's end time.

Staff monitored the HEMS events in the test house, noting the operation of the targeted lighting, HVAC system and hot water cylinder.

Participants could access the manufacturers' hot water and heat pump control apps for their own devices to gain real-time information and, if necessary, override external signals sent via the VTN.

Monitoring the HEMS and EcoPort devices was done via the VTN, reporting that the event was 'opted-in' and that the test house staff observed the behaviour of the physical devices.

FIGURE 9: SHELLY DASHBOARD



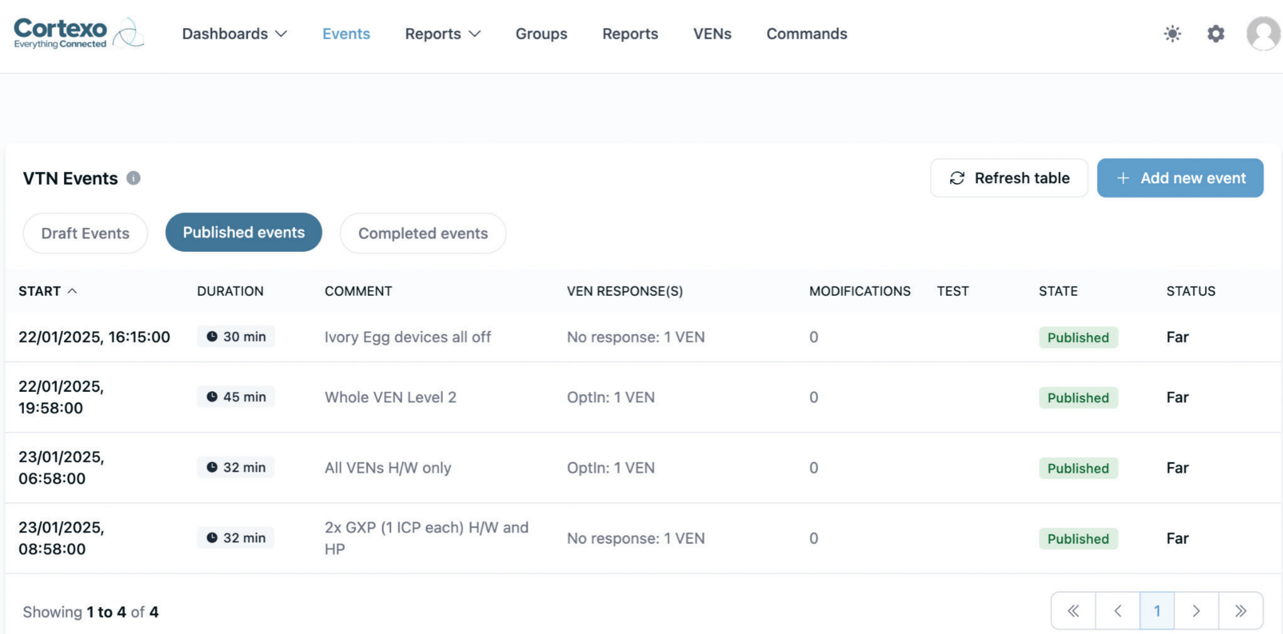
Hot Water Control (HWC) Relay Dashboard showing Shelly products connected via the Shelly application interface for products located in electricians (customer) homes.

4.5 EVENT DISPATCH

- ☑ Identify potential technologies and standards
- ☑ Provide a starting point for scaling DF projects

Devices were dispatched, or controlled, via OpenADR commands from a VTN simulating a utility or large aggregator, to a single VEN simulating a grouping of sites. Events were preset and let run. The VTN event panel and logging system have all the event details. See *Figure 10* below depicting the VTN events screen.

FIGURE 10: VTN EVENTS SCREEN



START	DURATION	COMMENT	VEN RESPONSE(S)	MODIFICATIONS	TEST	STATE	STATUS
22/01/2025, 16:15:00	30 min	Ivory Egg devices all off	No response: 1 VEN	0		Published	Far
22/01/2025, 19:58:00	45 min	Whole VEN Level 2	OptIn: 1 VEN	0		Published	Far
23/01/2025, 06:58:00	32 min	All VENs H/W only	OptIn: 1 VEN	0		Published	Far
23/01/2025, 08:58:00	32 min	2x GXP (1 ICP each) H/W and HP	No response: 1 VEN	0		Published	Far

Signalling took place over a two-week period, and various ‘targets’ were tested. Targets refer to the fact that a VEN could have just one flexibility asset associated with it, for example a household via a HEMS unit, or multiple targets such as several ICPs within a grid exit point, or several grid exit points within a zone substation. These target names, geographical areas or specific ICPs were pre-agreed targets and included in the signals sent between the VTN and VEN so that the VEN knew which flexibility asset(s) it needed to instruct.

There were 17 events targeting a combination of devices. All but one event were actioned as expected. The one failure (event 11) was an event incorrectly set up in the VTN that failed to be sent. All other event messages were sent but the result depended entirely on whether the targeted device was in use or not. For example, the heat pump was often not on, or the hot water element was not heating.

As the purpose of this project was focused on the installation and suitability of devices, events were initially limited to ensuring as little interference with the home as possible. As confidence in the operation of hot water control grew, the final few tests were done during the morning and evening peak when it was likely that hot water heating was occurring and therefore the home would be impacted.

4

It is worth noting that one participant configured their own device behaviour schedule within the Shelly application, which interfered with the remote-control signals. This highlights the importance of considering user customisation and potential conflicts when designing and deploying demand flexibility programs.

All events were recorded on a project event spreadsheet per *Table 6* below.

TABLE 6: SIGNAL EVENT LOG

TARGET	TEST NUMBER	SIGNAL DATE	SIGNAL TIME	SIGNAL TYPE	EXPECTED BEHAVIOUR
1 ICP	1	17-Jan-25	1615-1645	Simple Level 2	HW off HP increase 2 degrees
1 ICP	2	18-Jan-25	1215-1245	Simple Level 2	HW off HP increase 2 degrees
Whole VEN (7 ICPs)	3	20-Jan-25	1040-1110	Simple Level 2	HW off HP +/- 2 degrees if operating
Whole VEN (7 ICPs)	4	20-Jan-25	2000-2030	Simple Level 2	HW off HP +/- 2 degrees if operating
2 ICPs	5	22-Jan-25	1435-1515	Simple Level 2	HW off HP +/- 2 degrees if operating
Whole VEN (7 ICPs)	6	22-Jan-25	1958-2043	Simple Level 2	HW off HP +/- 2 degrees if operating
Whole VEN (7 ICPs)	7	23-Jan-25	0658-0730	Simple Level 2	HW off HP +/- 2 degrees if operating
2 ICPs	8	23-Jan-25	0858-0930	Simple Level 2	HW off HP +/- 2 degrees if operating
HEMS (Skycentrics)	9	23-Jan-25	1330-1430	Simple Level 3	HW off, lights off, HVAC change setting
HEMS (Universal)	10	23-Jan-25	1405-1505	Simple Level 3	VEN opt-In
All VENS & HEMS	11	23-Jan-25	1930-2100	Simple Level 2	HW off, lights off, HVAC change setting
HEMS (Skycentrics)	12	24-Jan-25	0507-0637	Simple Level 3	HW off, lights off, HVAC change setting
Whole VEN (7 ICPs)	13	24-Jan-25	0600-0730	Simple Level 2	HW off HP +/- 2 degrees if operating
Ecoport	14	28-Jan-25	1445-1500	Simple Level 3	Ecoport Event signal received
HEMS	15	29-Jan-25	0515-0715	Simple Level 3	HW off
2 ICPs	16	29-Jan-25	1900-2030	Simple Level 2	2x HW 1x HP
2 ICPs	17	30-Jan-25	0615-0715	Simple Level 2	2x HW 1x HP

KEY

HW = hot water; HP = heat pump; HVAC – Heating, ventilation and air conditioning

Available data was reviewed before and during events to observe whether the requested state change occurred. In most cases, the hot water or heat pump was already off.

It was confirmed through the manufacturer's independent monitoring system that the control system switched the hot water relay and returned to 'on' after the event, even though the hot water thermostat may have kept the element off because the water was at temperature. Control via the Shelly Cloud was found to be slower to action than direct control of the Shelly hot water control relay via the 4G mobile phone network. The ICPs connected via the Shelly Cloud are House 5, House 10 and House 8.

4.5.1 – EXAMPLE: EVENT FOUR

Event four occurred on 20 January 2025, between the time of 20:00 and 20:30, and signalled all ICPs the instruction of Simple Level 2. The following outlines what was observed in both hot water and heat pump behaviour.

Hot water

The data below shows hot water power consumption in kilowatts (kW) with the event period highlighted in yellow.

The data shows some hot water systems were heating in the five-minute period before the event. When the event started, the control relays were turned off for all cylinders. Three ICPs were slow in actioning the signal as they were connected via the Shelly Cloud. Also note that the monitoring relays measure a residual 'noise' (2-4 Watts of power).

TABLE 7: EVENT FOUR – HOTWATER POWER CONSUMPTION (KW)

CONSUMPTION KW							
DATE/TIME	HOUSE 7	HOUSE 1	HOUSE 3	HOUSE 5	HOUSE 2	HOUSE 10	HOUSE 8
20/01/2025 19:40:00	0.003	0	0	0.003	2.004	0	3.258
20/01/2025 19:45:00	0.002	0	0	3.309	2.023	0	3.256
20/01/2025 19:50:00	0.003	0	0	3.354	0	0	3.256
20/01/2025 19:55:00	0.003	0	0	3.354	2.044	0	3.25
20/01/2025 20:00:00	0.001	0	0	3.334	0	4.074	3.264
20/01/2025 20:05:00	0.001	0	0.001	0	0	0	0.001
20/01/2025 20:10:00	0	0	0.001	0	0	0	0.001
20/01/2025 20:15:00	0	0	0.001	0	0	0	0.001
20/01/2025 20:20:00	0	0	0.001	0	0	0	0.002
20/01/2025 20:25:00	0.001	0	0.001	0	0	0	0.001
20/01/2025 20:30:00	0.003	0	0	0	2.185	0	0.002
20/01/2025 20:35:00	1.807	0	0	3.466	2.03	4.155	0.003
20/01/2025 20:40:00	1.808	0	0	3.354	0	4.055	0.004
20/01/2025 20:45:00	1.798	0	1.219	3.238	0	4.055	0.003
20/01/2025 20:50:00	0.003	0	1.219	3.288	0	4.049	0.003

Heat pumps

We were able to remotely control the heat pump's power (on/off) and temperature setpoint settings. To prioritise customer comfort, we opted only to make temperature adjustments when the heat pump was actively in heating or cooling mode.

Heat pump set points were changed in the event period based on the following criteria:

- has up-to-date set point, power-enabled and mode data values (i.e. they are present);
- power is on, and
- current mode must either be 'heat' or 'cool'.

The testing period for heat pump control largely coincided with the summer holiday period, resulting in limited regular use of heat pumps, some customers were away from residence (on holiday). Consequently, the observed impact of set point changes was minimal. It's expected that across all seasons, particularly during winter months when heat pumps are used more consistently, these set point adjustments would yield more significant energy reduction.

Observations are outlined below covering seven ICPs over three set time periods. The yellow shows the event start time for all ICPs with heat pump control operating. As the set point is only checked and changed once at the start of the event, it is only the start time that has been highlighted in yellow. Note that in the five minutes before the event and at the event start time, only one heat pump was operating as indicated by the shading in the 'on/off' column. The set point was changed from the recorded 27 degrees at 19:55 to 29 degrees at 20:00 in accordance with the rules set in the Intesis simple signal strategy in the table above; Signal type 2, heat pump on in 'cool' mode.

At 20:05 the heat pump was switched off.

TABLE 8: EVENT FOUR – HEAT PUMP POWER CONSUMPTION (KW)

DATE_TIME	ICP	POWER	SET POINT	TEMP	MODE	ON/OFF
2025-01-20 19:55:00	House 7	0.002	18	25	cool	0
2025-01-20 19:55:00	House 1	0	27	25	cool	1
2025-01-20 19:55:00	House 3	0.003	21	23	cool	0
2025-01-20 19:55:00	House 5	0.003	21	3276.8	heat	0
2025-01-20 19:55:00	House 2	0.002	18	23	heat	0
2025-01-20 19:55:00	House 10	0				
2025-01-20 19:55:00	House 8	0.006	20	28	cool	0
2025-01-20 20:00:00	House 7	0.002	18	24	cool	0
2025-01-20 20:00:00	House 1	0	29	25	cool	1
2025-01-20 20:00:00	House 3	0.003	21	22	cool	0
2025-01-20 20:00:00	House 5	0.003	21	3276.8	heat	0
2025-01-20 20:00:00	House 2	0.002	18	23	heat	0
2025-01-20 20:00:00	House 10	0				
2025-01-20 20:00:00	House 8	0.005	20	28	cool	0
2025-01-20 20:05:00	House 7	0.002	18	24	cool	0
2025-01-20 20:05:00	House 1	0.003	22	25	auto	0
2025-01-20 20:05:00	House 3	0	21	22	cool	0
2025-01-20 20:05:00	House 5	0.003	21	3276.8	heat	0
2025-01-20 20:05:00	House 2	0	18	23	heat	0
2025-01-20 20:05:00	House 10	0				
2025-01-20 20:05:00	House 8	0.006	20	28	cool	0

4.6 END USER SURVEY INSIGHTS

Provide a starting point for scaling DF projects

At the conclusion of the signalling phase, participants were asked if they were aware that signalling was happening, or if signalling a device to change its behaviour had any impact on their comfort, quality or experience.

A 77% response rate (7/9) was achieved and feedback indicates a high level of tolerance for remote device control. There were no reported negative impacts on participants when either hot water or air temperature were altered and no reported change to customers' routines during the trial.

One customer began using the Intesis app for controlling their heat pump, stating it was "far more convenient and easier to use than the remote it (the heat pump) came with. I now turn my AC on before coming home from work and can turn it off from bed".

For full survey results see *Appendix C – Customer participation survey results*.

SECTION FIVE

Findings and recommendations

Key findings from the trial highlight selected product performance, installation ease, customer experience and demand flexibility signalling. The project offers recommendations for scaling deployment, potential insights for future trials to test load shifting and consumer engagement and the future potential of consumer energy resources in optimising energy use.

These insights lay the groundwork for larger-scale trials, refining technology, streamlining implementation and maximising benefits for both consumers and the grid.

5.1 KEY FINDINGS ON PRODUCTS AND INSTALLATION PROCESS

This project aimed to evaluate the ease of installing, connecting, and signalling various smart devices. Its primary focus was to identify which products are viable for large-scale deployment, and to assess the challenges associated with their installation and operation.

Findings indicate that while demand flexibility technology is promising, some refinements in device selection, installation guidance and consumer engagement will be required for scaling. Further to this, the existing infrastructure of homes, including the location of hot water cylinders and the condition of electrical wiring, must be carefully considered and included in installer training material.

A summary of key findings is below.

Product performance

Most smart devices performed as expected, demonstrating high reliability in hot water and air conditioning control. However, the Universal Devices' HEMS unit was deemed unsuitable for scaled deployment due to its commissioning complexity with New Zealand hotwater heating and AC control products. The XXter HEMS was identified as a viable solution for scaling, offering BMS capabilities. Further research during the trial also highlighted the Homey Pro HEMS as a desirable option for future scaling.

Ease of installation

The Shelly and Intesis products were generally reported as easy to install by electricians participating in the project. In contrast, the Universal Devices' HEMS unit was rated as significantly more difficult to install. Installation challenges were also encountered due to variations in existing home infrastructure, including the physical location of hot water cylinders and the configuration of electrical wiring.

Connectivity considerations

Direct connectivity via wifi and MQTT worked well, and could mitigate future risks that may arise from reliance on manufacturer cloud services.

Customer experience

No participants reported discomfort or inconvenience due to load shifting. One found additional value in remote control features (e.g. controlling heat pumps via an app).

Signalling reliability

While most signals successfully adjusted device behaviour, some inconsistencies were observed due to one customer setting up their own schedule in the device app thereby overriding external signals and appliance availability (if heat pump was "off" during event).

5.2 KEY FINDINGS ON SIGNALLING AND CUSTOMER EXPERIENCE

One objective of the project was to test the ability to signal smart devices to load shift without affecting customer comfort or behaviour. The trial provided initial insights into how load management strategies might impact real-world households.

A summary of key findings is below.

Successful load shifting

The project confirmed that hot water heating and air conditioning loads could be adjusted without affecting the customer's experience.

Minimal customer awareness of load control

Survey data revealed that six out of seven respondents were unaware of any changes to their energy use.

Positive customer feedback

There were no adverse customer reactions to remote signalling and all participants were positive about their involvement in the signalling phase of project. One participant actively engaged with new control features for their heat pump, suggesting the potential for value-add to consumers through better interfaces and access to their device data.

Variability in load response

Events revealed some variability in load response due to a couple of factors, including one customer setting up their own device schedule which overrode external signalling. The status of the device at the time of signalling also impacted whether a change to device behaviour was made.

These findings provide an initial indication that demand flexibility can be effectively integrated into consumer energy management with minimal disruption. Future efforts should seek to replicate this trial on a more significant scale to see if results can also be replicated while also focusing on fine-tuning the event logic, improving customer interfaces and expanding consumer awareness initiatives.

5.3 PROJECT LIMITATIONS AND ADDRESSABLE CHALLENGES

While this project demonstrated promising results, it was limited in scale, with 10 homes participating and only nine homes completing the trial. This small-scale deployment introduced several constraints.

Limited data sample

The small number of participants limits the ability to draw broad conclusions about the experiences and outcomes across diverse households and user behaviours. This limitation should be considered when interpreting the findings. Furthermore, one participant was unable to complete the installation within the project's timeframe, preventing them from participating in the signalling phase.

Technology scaling challenges

While all devices that performed well were deemed suitable for scaling, it should be noted that there are many more devices available on the market that have not yet been tested.

Consumer engagement insights

The trial involved electricians as participants, which is unlikely to reflect the experience of a general consumer base.

Seasonal variability

The project's implementation during the summer months may have affected the observed effectiveness of demand flexibility related to air conditioning units. Many participants were away or had their heat pumps turned off during the signalling phase, potentially limiting the ability to assess the full potential of demand response adjustments for these systems.

Steps to address these limitations

» **Expand trial participation.** Future phases should include a broader mix of households to assess demand flexibility across different demographics and usage patterns.

» **Improve data collection.** Enhancing monitoring and analytics will provide deeper insights into device performance and consumer engagement.

» **Refine consumer communication.** Developing tailored messaging and engagement strategies will ensure broader consumer participation and understanding.

» **Engage with regulators.** Work closely with industry stakeholders and regulatory bodies to develop updated guidelines and policies that facilitate demand flexibility adoption.

Installer experience limitations

The electricians participating in the trial were learning about and using the devices for the first time. This likely impacted installation time and cost. They selected and installed miscellaneous hardware independently, which informed the design of our optimised installation kits for future trials. Furthermore, they wired components on-site for the first time, and followed initial installation and commissioning instructions. This learning curve affected efficiency. At scale, installers will benefit from:

» Familiarity with the products

» Optimised, pre-selected installation kits

» Pre-wired and partially preconfigured kits

» Improved training and streamlined documentation.

We expect these factors will dramatically reduce installation time and costs in future deployments.

Product cost limitations

The upfront cost of the devices used in the trial remains relatively high, partly due to low production volumes and early-stage market conditions. However, as the market develops, increased competition, economies of scale, and improved supply chains are expected to drive costs down

5.4 RECOMMENDATIONS FOR SCALING DEPLOYMENT

For demand flexibility to be successfully deployed at scale, industry stakeholders must address installation efficiency, device connectivity, consumer engagement and regulatory alignment. The following recommendations outline key actions needed to support large-scale rollout.

1. **Optimising the installation processes**
   - Develop pre-installation checklists to assess site conditions (e.g. wiring, wifi strength)
   - Package pre-configured kits for streamlined deployment
   - Provide standardised installer training to ensure efficiency and consistency.
2. **Enhancing connectivity and control**
   - Prioritise direct device connections (e.g. MQTT) over cloud-dependent solutions
   - Use HEMS-based control to simplify device interactions and improve visibility
   - Continue evaluating alternative cost-effective and scalable HEMS solutions.
3. **Improving consumer experience and awareness**
   - Develop user-friendly dashboards to provide transparency on energy usage and savings
   - Introduce consumer opt-in or preference settings for personalised flexibility participation
   - Explore incentives, such as dynamic pricing benefits, to encourage consumer engagement.
4. **Future-proofing demand flexibility**
   - Advocate for interoperability standards to ensure flexibility across different platforms
   - Expand trials to include solar, battery storage, and EV charging
   - Engage with policymakers to align regulatory settings and support demand flexibility market structures.

5.5 CONCLUSION

The insights gained from this project provide a pathway for the delivery of larger-scale in-home trials of the use of smart devices in delivering demand flexibility.

It is only through the implementation of such trials and the learnings that come from them, that demand flexibility can become a mainstream solution for optimising household energy use while supporting a more sustainable, resilient, and efficient electricity grid.

SECTION SIX

Appendix

APPENDIX A – GLOSSARY OF TERMS AND ACRONYMS

Aggregators	See Flexibility suppliers.
BMS	Building management system.
Consumer	An electricity user.
Customer	An individual participating in our project whose premises, equipment, or generation are connected via interoperable devices.
Flexibility suppliers	An entity providing flexibility to perform a service for an electricity participant. A flexibility supplier may act as an aggregator of load. A load aggregator is an entity contracting with one or more consumers and dealing with the electricity otherwise required by those consumers in any way, including putting in place agreements under which those consumers voluntarily change their consumption level, so the entity can offer the combined increase or reduction in the interruptible load of all those consumers as collective demand, either in the wholesale electricity market or under any other bilateral agreement or contract.
HEMS	Home energy management system. Smart systems that allow users to automate and optimise their energy use based on real-time data, electricity pricing and grid conditions.
HWC	Hot water cylinder.
IoT	Internet of Things. A network of physical devices that are equipped with sensors, software, and other technologies that allow them to communicate with other devices and systems over the internet.
Interoperability	The ability of equipment, systems, apps or products from different suppliers to operate together in a coordinated way.
MQTT	Message queuing telemetry transport. A lightweight messaging protocol for use in cases where clients need a small code footprint and are connected to unreliable networks or networks with limited bandwidth resources. It is primarily used for machine-to-machine communication or Internet of Things types of connections.
Smart devices	An electronic device, generally connected to other devices or networks via different wireless protocols that can operate to some extent interactively and autonomously.
VEN	Virtual end node. Typically, a client end device that accepts a signal from a server.
VTN	Virtual top node. Typically, a server that transmits OpenADR signals to end devices or other intermediate servers.

APPENDIX B – INSTALLATION SURVEY RESULTS

Please keep in mind that the installation costs presented in the following analysis reflect a trial setting. We anticipate significant cost reductions when these smart devices are rolled out at scale with standardised installation kits.

TABLE 9: INSTALLATION SURVEY RESULTS

HOUSE #	PRODUCT	INSTALL TIME (HOURS)	INSTALL RATING (ELECTRICIAN)	SUMMARY NOTES COMMENTARY PROVIDED BY ELECTRICIANS	TOTAL COST OF INSTALLATION (EXCL TRAVEL TIME)
House 1	Shelly	1	3	Add extra details to process documents / training material for Shelly products – such as hot water clamp in switchboard after hot water fuse. Read the process instructions and you should have no issue.	$1,168
	Intesis	1	3	–	
House 2	Shelly	1	1	Very clear and easy to follow process documentation	$1,797
	Intesis	1	1	–	
	Teltonica	10 mins	1	Very easy setup – plug and play	
House 3	Shelly	4	4	The provided equipment was relatively easy to install. However, the existing wiring and plumbing infrastructure presented significant challenges. The hot water cylinder's supply cable was too small and needed replacement, and the location of the intake/outtake pipes required a difficult crawl space installation. Additionally, the outdated electrical setup (separate meter board and distribution board, old rewireable fuse, asbestos board) necessitated upgrading the wiring and installing a new MCB for easier current clamp reader installation. The primary installation difficulties stemmed from the pre-existing conditions, not the new equipment itself. Suggest check HWC cabling and pipe setup before starting install. A standard setup like you would find in a new build would be a breeze to install, while old bungalows prevent far more of a challenge.	$1,787
	Intesis	2	1	Product suppliers instructions clear and easy to follow, but manufacturers' instructions difficult to follow.	
	Teltonica	15 mins	1	Doesn't get much easier. Screw the antennae on and plug it in.	
House 4	Did not complete survey feedback at time of publication of this report				
House 5	Shelly	4	3	Physical Installation was straightforward. Commissioning and connection was challenging – HWC outdoors, needed wifi update to mesh system. Troubleshooting required for connection of the EM devices and the PLus 1pm. Had to play around with wifi, bluetooth eventually worked. Possible user error	$1,438
	Intesis	2	3	With the AC Intesis device, it would not connect to my wifi, and then, al by itself without any clear feedback on the app, would connect itself to my wifi. I did not realise this was all that needed to happen as the App did not give feedback, it just said it was connecting, even though it was already connected. I lost some hair here. It then would not let me share the set up via the website which required Cortexo intervention Some of this could be put down to the user (me), but i feel that some of it is the APP, or the devices	

HOUSE #	PRODUCT	INSTALL TIME (HOURS)	INSTALL RATING (ELECTRICIAN)	SUMMARY NOTES COMMENTARY PROVIDED BY ELECTRICIANS	TOTAL COST OF INSTALLATION (EXCL TRAVEL TIME)
House 6	Shelly	4	3	Was a bit hard having a old house with no din rail switchboard and with the ac unit jumped off a random circuit. Make sure device is back to the board, or bring ip boxes to store the units.	$1,687
	Intesis	4	3	Old house presented challenges	
	Teltonica	30 mins	1	–	
House 7	Shelly	3	2	Experienced issue getting the first unit to connect, Resolved with Ivory Egg support team	$1,487
	Intesis	1	3	–	
	Teltonica	5 mins	1	–	
House 8	Shelly	3	1	Just a note that incoming water inlet pipe isn't copper so we cant get a very accurate reading on the temperature for the time being.	$1,408
	Intesis	1	1	–	
House 9	Shelly	4	2	–	$2,237
	Intesis	30 mins	2	–	
House 10	Shelly	4	2	A purpose-built control box, mounted near the hot water cylinder and simplifying wiring (existing supply in, pre-wired output to cylinder), is a desirable solution. This would centralize all equipment in one accessible and well-ventilated location.	$1,687
	Intesis	1	2	Every AC is fed differently. Either dedicated circuit back to board or fed from a power outlet. Mine was fed from a power outlet, so the CT is large to fit into the power outlet it is fed from. I installed the CT in a mounting block behind the power outlet.	
	Teltonica	2	2	–	
Ivory Egg (NZ) Limited	Universal Device (HEMs)	8	5	Difficult to commission due to hotwater heating and AC control products which are currently available in New Zealand.	$2,081
	SkyCentric EcoPort	1	1		$684
	Xxter Controller with BREEAMS reporting	3	2	Some initial development work required. Note the larger the project and the more controllable loads, the longer it will take.	$5,664

APPENDIX C – CUSTOMER PARTICIPATION SURVEY RESULTS

Question 1: Did you notice any changes in the temperature or comfort of your household hot water during the signalling phase of the FlexTalk seed trial?

Yes – 1 No – 6

Question 2: What changes were noted in relation to your household hot water?

Survey comments provided: House 1 – My hot water was hotter – I was asked to turn my hot water temp setting water up at the beginning of the trial so this didn't surprise me.

Question 3: Has the trial impacted your day-to-day routine with using hot water in anyway?

Yes – 0 No – 7

Question 4: How has the trial impacted your day to day routine in relation to your household's hot water?

No – 7

Question 5: Did you notice any change in your air quality or comfort during the signalling phase of the FlexTalk seed trial?

Yes – 0 No – 7

Questions 6: Has the trial impacted your day-to-day routine with using your heat pump in anyway?

NA

Question 7: What changes were noted with air quality or comfort?

Yes – 1 No – 6

Question 8: How has the trial impacted your day-to-day routine in relation to your household's heat pump?

Survey comments provided: House 5 – I use it more often as the app is far more convenient and easier to use than the remote it came with. I now turn my AC on before coming home from work and can turn it off from bed.

Question 9: Are there any other comments you would like to make about your experience involved as a participant (consumer) in the FlexTalk Seed trial?

Survey comments provided: House 1 – The front end of shelly app is a bit clunky. If you hover over the graphs the readout covers the whole graph – and the graphs are a bit average anyway, you can't combine all the HWC information on one page, you have to go to the temp and on off page separately to the power usage page. When you try to go back from some parts of the shelly app it can close the app if you use the phone's back arrow.

The intesis front end is a bit simple. It's either tiny on the front page or so big that you have to scroll if you click into it – surely there is a middle ground with one full page of control.

Also, my heat pump works well so I am struggling with being told that it's a problem with my heat pump that no ambient temperature can be shown. If my heat pump could not tell what the ambient temperature was it would throw codes and not regulate the room temperature correctly – which it does to a decent standard. And the intesis app definitely knows there is an ambient temperature sensor as it showed a fault code on the app when I unplugged the sensor.

House 2 – While we didn't notice any change in our hot water over the trial I did see the battery on the solar system being used at night. If there is to be more testing, could the site having solar and battery's be considered so as to optimise this.

House 4 – Thought the ac cloud was easy to set up and made turning the air conditioner on when away from home nice and easy.

House 5 – From a consumer's view point there was no issues and I wasn't affected at all.

House 6 – Never noticed any impact from installed devices and did not impact my usage at all.

Electricity Engineers' Association

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