STANDARDS NEW ZEALAND
TE MANA TAUTIKANGA O AOTEAROA®

SNZ PAS 6012:2022

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STANDARDS NEW ZEALAND
PUBLICLY AVAILABLE SPECIFICATION

Smart home guidelines

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

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TECHNICAL ADVISORY GROUP REPRESENTATION

This publicly available specification was prepared by the P6012 Smart Home Technical Advisory Group (TAG). The membership of the TAG was approved by the New Zealand Standards Executive.

The TAG consisted of representatives of the following nominating organisations:

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Electricity Engineers' Association (EEA)
Energy Efficiency and Conservation Authority (EECA)
Lighting Council New Zealand (LCNZ)
Property Council New Zealand (PCNZ)
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Sustainable Electricity Association of New Zealand (SEANZ)
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REFERENCED DOCUMENTS

Reference is made in this document to the following:

New Zealand standards

SNZ PAS 6011	Electric vehicle (EV) chargers for residential use

Joint Australian/New Zealand standards

AS/NZS 4417	Regulatory compliance mark for electrical and electronic equipment
Part 2	Specific requirements for particular regulatory applications
AS/NZS 4777	Grid connection of energy systems via inverters
Part 1	Installation requirements
Part 2	Inverter requirements
AS/NZS 5341	LED lamps – Test methods – Energy and functional performance
AS/NZS 60598	Luminaires
Part 1 + A2	General requirements and tests

International standards

IEC 62746	Systems interface between customer energy management system and the power management system
Part 10-1	Open automated demand response
IEEE 2030	Smart grid interoperability for energy technology
Part 5	Standard for smart energy profile application protocol[1]
ISO/IEC 17050	Conformity assessment – Supplier's declaration of conformity
Part 1	General requirements

North American standards

ANSI/IES TM-21	Projecting long-term luminous, photon, and radiant flux maintenance of LED light sources
ANSI/IES LM-79	Approved method: Optical and electrical measurements of solid-state lighting products

[1] This United States Institute of Electrical and Electronics Engineers (IEEE) standard defines an application profile that provides an interface between the smart grid and users. It defines the mechanisms for exchanging application messages, the exact messages exchanged including error messages, and the security features used to protect the application messages. This standard focuses on a variety of possible architectures and usage models, including direct communications between an electricity distribution business (EDB) and consumers and prosumers, or between an EDB and flexibility provider (FP).

ANSI/IES LM-80	Approved method: Measuring luminous flux and color maintenance of LED packages, arrays, and modules
ANSI/IES LM-84	Approved method: Measuring luminous flux and color maintenance of LED lamps, light engines, and luminaires

Other publications

International Commission on Illumination (CIE). *CIE S 017/E International lighting vocabulary*. 2nd ed. Vienna: CIE, 2020.

OpenADR Alliance. *Open automated demand response (OpenADR) communication standards protocol development 2.0.* San Ramon, California: OpenADR Alliance, 2019.

Rozite, V. *Intelligent efficiency. A case study of barriers and solutions – Smart homes*. Connected Devices Alliance (CDA), 2018.

New Zealand legislation

Consumer Guarantees Act 1993

Energy Efficiency (Energy Using Products) Amendment Regulations 2020

Electricity Industry Act 2010

Electricity Industry (Levy of Industry Participants) Regulations 2010

Electricity Industry Participation Code 2010

Electricity (Safety) Regulations 2010

Privacy Act 2020

Radiocommunications Regulations (Radio Standards) Notice 2016

Websites

www.legislation.govt.nz

LATEST REVISIONS

The users of this PAS should ensure that their copies of the above-mentioned New Zealand standards are the latest revisions. Amendments to referenced New Zealand and joint Australian/New Zealand standards can be found on www.standards.govt.nz.

REVIEW OF STANDARDS

Suggestions for improvement of this specification will be welcomed. They should be sent to the National Manager, Standards New Zealand, PO Box 1473, Wellington 6140.

FOREWORD

This document has been prepared as guidance and is published as a publicly available specification (PAS).

The International Organization for Standardization (ISO) categorises publicly available specifications as documents that are not national standards, but which are produced by a national standards body to respond to a particular market need. PAS represent either consensus in an organisation or industry, or consensus of the experts within a specific working group.

ISO sets the maximum elapsed time before systemic review of a PAS as 3 years. In the case of rapidly evolving technologies and ongoing updates to international standards, it is generally accepted that the first review should occur within 18 to 24 months of the initial publication date. Additionally, ISO states the maximum life of a PAS is 6 years, by which time it should be converted to a standard. If the PAS is not converted to a standard by the end of this period, it should be withdrawn.

This PAS is expected to be used by government agencies, such as the Energy Efficiency and Conservation Authority (EECA), and energy services retailers. It provides advice and support for the development of smart home technologies and demand response and flexibility guidance. It could also be used by consumers when they are selecting new smart home devices or retrofitting existing devices with smart capability.

Why should you care about transitioning to a smart home?

We're seeing a shift in how the world uses energy to decarbonise global economies in an attempt to mitigate the impacts of climate change.

This global transition is creating greater demand on the national grid, by putting pressure on existing electricity infrastructure and the availability of supply. As such, we are now seeing a move toward more intermittent forms of renewable generation, and new fuels that can be converted to electricity.

The uptake in electric vehicles (EVs) is growing and many primary industry players are decarbonising their industrial processes by transitioning from a reliance on fossil-based fuels as a source of energy, to on-site renewable energy generation.

However, the situation is challenging as the transition is more complicated than simply adding generating capacity. Renewable electricity generation investment is expensive and can take many years to come online. Ultimately, the consumer pays (it's estimated that the cost amounts to about 60% of consumers' power bills). However, by limiting demand on the grid and networks, downward pressure on this cost can be applied.

Consumers can significantly contribute to decarbonisation by making appropriate purchasing and management decisions that assist the electricity industry in deferring significant infrastructure costs.

Smart homes technology can help consumers use electricity more efficiently by linking consumption and generation into the electricity industry through grid and network system operations and generation capability.

A smart home isn't a dwelling but a network of electrical appliances within that dwelling. With little or no input from the owner, smart home technology can control hot water cylinders, heat pumps, appliances, solar panels and batteries, lighting, and electric vehicles so that they either use less electricity or use electricity when demand on networks and generators is lower. Importantly, this control needn't be expensive.

This guideline explains what a smart home is, how it works, and what you can do. The elegant simplicity of a smart home is to 'set and forget'.

Publicly Available Specification

Becoming smart home-ready

1 GENERAL

1.1 Introduction

1.1.1 Overview

Where to start? This is the question most consumers looking to start their smart home journey will ask.

The first step is to conduct an assessment (see Appendix A). Your answers will give you a snapshot of where you stand. Then you can consider steps towards lowering your energy costs with smart technology.

It doesn't matter whether you rent or own – the process of setting up a smart home is the same because it focuses on technology, not the building itself. Also, bear in mind that as well as reducing your energy costs, a smart home can ensure that appliances and other electrical devices last longer as a result of being used more efficiently and less often.

Your smart home journey can begin with just one appliance connected (in the next 2 or 3 years) to a flexibility provider (FP).[2] In return for a cost benefit, the FP will tell the appliance to either switch off (if it's not in use) or turn down when there is a constraint in the supply system (see Figure 1). This will allow the electricity that you are not using at that moment to be used by someone else, or even avoid new generation from starting.

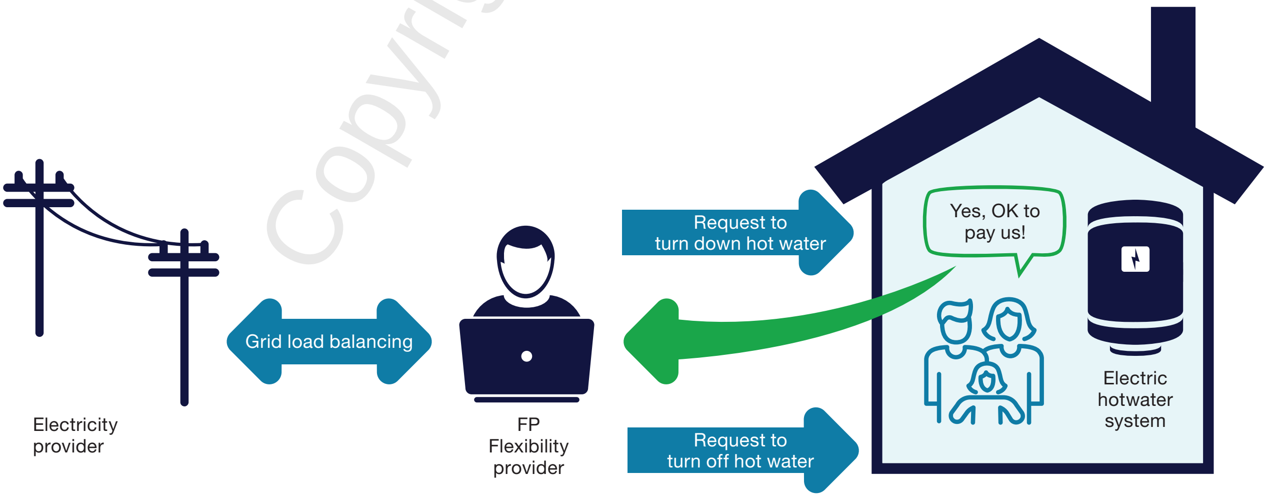

Figure 1 – Grid load balancing

2 The commercial establishment of flexibility providers (FP) is still in its regulatory infancy, though EECA suggests this is likely to occur in the next 2 or 3 years. An FP could be a local electrical distribution business, electricity retailer, or even a third-party supplier.

However, rather than just looking at one appliance, we suggest you start with your total home electricity costs. The average consumer's electricity use can generally be divided into three areas. Hot water accounts for a third, heating and cooling your home accounts for another third, and everything else (cooking, lighting, cleaning, and so on) accounts for the final third (see Figure 2). It makes sense, therefore, to focus on the bulk of your consumption: hot water and space heating/cooling.

1.1.2 Hot water

A larger hot water cylinder enables greater periods between charges, while wrapping it in insulation helps retain heat for longer.

Also consider installing a smart thermostat (you'll need an electrician to fit it) to map your use and turn your cylinder off or down at times when hot water isn't typically used. A smart thermostat can also react to FP signals (for example, if the electrical distribution business needs to shed load) in return for providing financial reward (perhaps a payment or credit on your next power bill) provided you are on a 'time of use' (TOU) plan.

Heating water only when you need it can save a significant amount of electricity.

If you wanted to shower at a time you normally wouldn't, you could temporarily override the system using a bypass switch (provided the FP has not turned the cylinder off temporarily). Using the bypass switch would, however, preclude you from receiving the benefit of providing flexible load at that time.

1.1.3 Heating and cooling

If you bought your air conditioner (heat pump) in the past 10 years, there is a very good chance it is already 'response capable'. Most residential heat pump units rarely run at more than 75% capacity; above this, they can be noisy, and higher fan-speed settings can create a lot of draft through greater air movement, making things uncomfortable.

Your FP could remotely alter the set point of the heat pump to reduce the compressor's electricity consumption. This could cause your premises to be temporarily warmer or cooler than usual, but you could receive a lower supply cost in return for your flexibility. As before, the system could be configured for you to override the restrictions.

1.1.4 Electric vehicles

Focusing on just your hot water cylinder and heat pump can significantly reduce your electricity bill, but a smart home really shows exceptional value for electric vehicle (EV) owners. A 'smart' EV charger will always charge at the best available price – this could include charging your vehicle from your solar photovoltaic (PV) panels and an energy storage system, if you have them.

1.1.5 HEMS

A fully functional smart home can also include a home energy management system (HEMS) that ties all the smart appliances together into a network. This uses algorithms to optimise electricity consumption.

The great advantage of a smart home is that any residence can gain access to the savings available by teaming up with an FP. Please join us on the journey to reducing our country's energy use while keeping your electricity bills as low as possible. In doing so, you will be helping yourself and the environment while contributing to decarbonisation.

Figure 2 – Understanding your total home energy costs

1.2 Scope

1.2.1 General

This PAS sets out good practice guidance for smart homes and home energy management systems (HEMS), and refers to:

(a) Safety requirements for which WorkSafe is the regulator;

(b) Advice concerning the energy efficiency transmission of electricity from the grid to a consumer's appliance;

(c) Government procurement rules.

1.2.2 Inclusions

(a) Section 1 introduces the concept of the smart home and explains the terminology used in this PAS.

(b) Section 2 describes what a smart home is and the core elements thereof. It introduces concepts such as 'demand response' and 'flexibility' and explains some of the defining technological features.

(c) Section 3 provides a smart home technology overview. It covers the subject of interoperability and why this is important, as well as distributed generation, data capture, and cyber security.

(d) Section 4 explains the relationship between a smart electricity network and a smart home containing smart appliances that are controlled by a home energy management system.

(e) Appendix A is designed to prepare the homeowner for becoming 'smart grid-ready'. It includes a preliminary assessment and provides guidance on the steps to reach each successive level.

(f) Appendix B is a technical specification guide and prerequisite for suppliers and installers of HEMS-related equipment, appliances, and supporting devices who wish to participate in government-related incentive schemes that encourage homeowners to use energy efficient technologies that can interface with smart grid networks.

1.2.3 Exclusions

This PAS does not apply to homes that are not connected to a network, either directly or indirectly. It also does not apply to smart grids, distribution system operators, and so on. However, these electricity ecosystem components will use the functionality in smart appliances, HEMS, and smart homes to obtain demand response and flexibility.

1.3 Objectives

This PAS is intended to guide electricity consumers, appliance retailers, and suppliers of smart home equipment and services in adopting good practice. It is designed to contain all relevant general smart home information, as well as point readers to more detailed information.

1.4 Interpretation

For the purposes of this PAS, the word 'shall' refers to requirements that are essential for compliance with this specification, whereas the word 'should' refers to practices that are advised or recommended.

1.5 Definitions

For the purposes of these guidelines, the following definitions shall apply:

Adaptive lighting — Lighting that responds to circumstances or predefined conditions while maintaining the lighting quality within the specified requirements for these circumstances or conditions. The requirements can focus on different aspects, such as energy efficiency, dynamic user needs, visual task, or ambience. The terms 'smart lighting' and 'intelligent lighting' are sometimes used with a similar meaning

Algorithm — A set of instructions for solving a problem or accomplishing a task. One example is a recipe, which consists of specific instructions for preparing a dish. Every computerised device uses algorithms to perform its functions in the form of hardware- or software-based routines

Alternating current (AC) — An electric current that reverses direction at regular intervals. In New Zealand, alternating current is delivered across the entire low-voltage residential electrical network at 230 V (volts) +/- 6% variance

Ampere (amp) — A unit of electric current

Application programming interface (API)	A set of definitions and protocols for building and integrating application software
Automation	Integration of diverse electrical devices and energy-consuming equipment, allowing automatic control in accordance with selected settings or in response to data from sensors
Battery	A device or system that stores energy in one form or another, allowing electricity to be produced when required. Storage can be within a number of different means, including but not limited to electric fields, chemical changes, or pressure
Bluetooth	Wireless technology standard for exchanging data over short distances NOTE – 'Bluetooth' is a trademark owned by the Bluetooth Special Interest Group.
Charging	Re-energising a battery unit with electricity
Circadian rhythm	For humans, this is the biological rhythm over 24 hours
Cloud computing	Using a network of remote servers hosted on the Internet to store, manage, and process data instead of using a local server or a personal computer
Connectivity	The capability of a device to receive and react to external signals
Direct current (DC)	An electric current of constant direction. This distinguishes it from alternating current (AC)
Demand response (DR)	'Demand response' (or 'demand-side response') refers to consumers or their appliances adjusting their electricity consumption during periods of peak demand, when electricity is scarce or electricity networks are congested, in response to time-based financial incentives. Demand response can consist of interrupting demand for a short duration or adjusting the intensity of demand for a certain amount of time by reducing or shifting loads or storing energy
Distributed energy resources (DER)	Electricity supply or demand resources (for example, solar PV, home battery units) or load that can be controlled within customer premises
Digitalisation	The application of information communication technologies across the economy, including the energy sector, to achieve desired outcomes such as improved safety, efficiency, and productivity

Electricity	Electrical energy
Electricity distribution businesses (EDB)	Publicly or privately owned companies that distribute electricity (generated from a variety of sources and transmitted across the national grid) through the electricity distribution network. More than 50 businesses across New Zealand play their part in this process
Electricity market	A market where generators sell their electricity into a pool, and retailers or purchasers buy electricity for resale or self-consumption. There are prescribed rules that set out the structure, price discovery, security, and integrity of the electricity market
Electric vehicle (EV)	A vehicle whose powertrain includes both a battery (which can be recharged via an external power source) and an electric motor. Charging is through either a plug-in charger or stationary or dynamic conductive or inductive power transfer
Flexibility	The ability of connected residential devices (or networks of devices) to communicate with each other and determine the 'least cost' combination of demand to optimise energy use
Flexibility (in electrical systems)	The capability of an electricity system to respond to upward or downward changes in the supply–demand balance in a cost-effective manner over a period ranging from a few minutes to several hours
Flexibility provider (FP)	A service provider that manages electrical energy demand (consumption) or export (generation) on behalf of a group of customers, and offers on-call or planned demand reduction services to the electricity market, grid owner, or networks
Frequency	Frequency is the rate, in seconds, at which a current changes direction. It is measured in hertz (Hz), an international unit of measure, whereby 1 Hz is equal to one cycle of alternating current (AC) electricity per second. For New Zealand, electrical alternating current is delivered at 50 cycles per second (50 Hz)
Home energy management system (HEMS)	A smart home system consisting of a network of devices that can be controlled via one hub or interface. A HEMS can encompass multiple services or be dedicated to a single service category (for example, a smart lighting system or a smart security system). Smart home technologies encompass appliances, systems, and other supporting or enabling technologies

Human-centric	Describes an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors, ergonomics, and usability knowledge and techniques. This approach enhances effectiveness and efficiency, improves human wellbeing, user satisfaction, accessibility and sustainability, and counteracts possible adverse effects of use on human health, safety and performance
IFTTT (if this, then that)	IFTTT allows you to do more with over 700 different apps and services, including Twitter, Dropbox, Evernote, Fitbit, Amazon Alexa, and Google Assistant. This brings services together into applets (automations that allow you to do things that your apps and devices can't do on their own)
Incentives	Incentives are normally government initiatives used to help shift a technology-based market in a desired direction. In the case of smart home appliances and electric vehicles, they can encourage a change in consumer purchasing behaviour over a relatively short time. These incentives often come in the form of grants or some other initiative that would, for example, assist a government in meeting its international climate change obligations
Integrative lighting	Lighting integrating both visual and non-visual effects and producing physiological and/or psychological benefits for humans NOTE – The term 'human-centric lighting' is used with a similar meaning.
Interoperability	The capability of different electricity networks, smart devices or smart device systems to connect and exchange data or instructions seamlessly
Internet of Things (IoT)	A system of interrelated computing devices, mechanical and digital machines, or objects that have unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction
Kilowatt hour (kWh)	A unit of energy equivalent to the energy transferred or expended in one hour by one kilowatt of power. An example is shown on your electricity invoice, where electricity consumption (over a given period) for all home appliances and devices is measured in kilowatt hours

Learning algorithm	A process or method used to extract patterns from data collection (for example, from sensors and controls) to identify and adapt appropriate solutions or applications for a device or system. An example is a 'smart' thermostat fitted to an electric hot water cylinder that maps usage patterns by volume and time of day
Light emitting diode (LED)	A solid-state device, emitting incoherent optical radiation when excited by an electric current
Lithium-ion battery	The technology that is currently standard in electric vehicle and home battery systems and which offers good energy density, power, and fast-charging ability
Luminaire	Apparatus which distributes, filters or transforms the light transmitted from at least one source of optical radiation. With the exception of the sources themselves, all the parts necessary for fixing and protecting the sources are counted, including a means for connecting to the power supply and circuit auxiliaries, where necessary
Nominal voltage	The value assigned to a system or circuit of a given voltage class for the purpose of convenient designation. The actual voltage can vary above or below this value. In New Zealand, the nominal low-voltage setting is 230 V +/- 6% measured typically at the property boundary
OpenADR	Open Automated Demand Response (OpenADR 2.0) is an open access, highly secure, two-way information exchange model and global smart grid standard.[3] OpenADR 2.0 standardises the message format used for demand response, flexibility, and distributed energy resource (for example, solar PV and home battery system) management so that signals can be exchanged in a uniform and interoperable fashion among network providers, FPs, HEMS, and 'smart' residential devices
Open interface	A public technical standard for connecting hardware to hardware and software to software
Plug-and-play	Describes software or smart home devices that are intended to work perfectly when first used or connected, without reconfiguration or adjustment by the user
Power	Rate of generating, conveying or consuming work or energy, including electricity (electrical energy)
Prosumer	A consumer with a small-scale, distributed electricity generation facility, which gives them the choice to produce at least some of their electricity needs and potentially sell the excess back to the grid

[3] See IEC 62746-10-1.

Real time A state where information is available simultaneously with an event, or immediately after collection

Sensor A device which detects or measures some type of input from the physical environment (for example, daylight, temperature, motion or pressure)

Smart grid An electricity network that enables the two-way flow of electricity. It employs communication technology to transfer real-time information that generators and end-use devices can respond to.

A smart grid can:

(a) Better facilitate the connection and operation of electrical load and generators;

(b) Increase the economic efficiency of electricity networks and generation, maintaining a cap on prices;

(c) Allow consumers to play a part in optimising the electricity system's operation;

(d) Provide consumers with greater information and options for how they use their electricity supply;

(e) Significantly reduce the environmental impact of the whole electricity supply system;

(f) Maintain and improve electricity system reliability, quality, and security of supply

Smart home A residence with a network of smart devices that can react to external signals from electricity retailers or flexibility providers. Smart home devices and networks operate using open communication protocols such as OpenADR 2.0 that enable consumer devices to communicate with any suitably configured flexibility provider (FP)

Smart home device A device that can connect to a communications network (directly or through a hub or central interface) and be controlled remotely or set to be controlled automatically based on user preferences and sensor inputs. Smart home devices include (but are not limited to) demand response-enabled devices

Smart meter A meter that records electricity consumption in intervals of an hour or less and communicates that information at least daily to the electricity provider for monitoring and billing purposes. This type of advanced metering infrastructure differs from traditional automatic meter reading in that it enables two-way communication between the meter and the central system. Smart meter functionality includes remote reading, support for advanced pricing plans and payment systems, and remote disablement and enablement of electricity supply

Standardisation

The implementation and development of technical standards based on the consensus of different parties that include industry, interest groups, standards organisations, and governments. Standardisation helps maximise compatibility, interoperability, safety, and repeatability

Standby mode

Mode in which the light source or other devices are switched off while still connected to a live power supply

Standby power

Electrical power consumed by a device in standby mode

Supplier declaration of conformity (SDoC)

An SDoC or 'supplier declaration of conformity' is a documented procedure recognised internationally whereby the supplier or manufacturer tests the product to the applicable technical regulations (for that country or region), then documents and labels the product before it is placed in the market.

Each SDoC:

(a) Is uniquely identified;

(b) Fully and uniquely identifies the article;

(c) Identifies the requirements the declaration attests to;

(d) Contains a statement that it complies with the relevant standard or other safety requirement;

(e) Identifies the basis for the declaration – for example, any testing or conformity assessment and who did the testing or assessment;

(f) Identifies the person making the declaration and their authority for doing so; and

(g) Is signed and dated by that person

NOTE – For more information on SDoCs specific to smart homes, see 2.8.

Time of use (TOU)

Describes a pricing methodology where various prices apply during day, week, or month periods. The methodology provides a financial incentive for consumers to defer discretionary electricity consumption from high price periods to low price periods, thereby reducing electricity demand on networks and generators

Vehicle-to-grid (V2G)

Describes a system whereby a smart home EV charger facilitates the flow of energy to and from an EV, thereby allowing it to act as a rechargeable energy source (battery). When an EV is connected to a V2G charger at home or work, charge from the EV can be used either as a power boost back into the grid network or as a cheaper power source for the residence when electricity prices are at their peak. V2G systems will eventually be able to power homes (V2H) during power outages

Vehicle-to-infrastructure (V2I)	Describes a communication model that allows vehicles to share information with the components that support a country's highway system. V2I essentially uses dedicated short-range communication (DSRC) frequencies to transfer data
WPA2 (Wi-Fi Protected Access 2)	WPA2 is the second generation of the Wi-Fi Protected Access wireless security protocol. Like its predecessor, WPA2 was designed to secure and protect Wi-Fi networks
WPS (Wi-Fi Protected Setup)	A feature supplied with many routers. It is designed to make the process of connecting to a secure wireless network from a computer or other device easier
Zigbee	A wireless technology developed as a global open standard to address the unique needs of low-cost, low-power, wireless IoT networks. The Zigbee standard operates on the IEEE 802.15. 4 physical radio specification in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz
Z-Wave	A secure, wireless mesh network that enables users to control their devices wirelessly by using controllers, key fobs, smart phones, tablets or computers to send commands to a hub, which then routes the commands to the destination devices

1.6 Abbreviations

Abbreviations have the following meanings:

A	Ampere
AC	Alternating current
ACOP	Annual coefficient of performance
API	Application programming interface
BC	Bayonet cap
BEV	Battery electric vehicle
BMS	Battery management system
CoC	Certificate of conformity
DC	Direct current
DER	Distributed energy resource
DG	Distributed generation
DR/DF	Demand response/flexibility

DSRC	Dedicated short-range communications
E3	Equipment Energy Efficiency Programme
EA	Electricity Authority
EDB	Electrical distribution business, also known as an electricity network
EECA	Energy Efficiency and Conservation Authority
EMC	Electromagnetic compatibility
ERL	Energy rating label
ES	Edison screw
ESR	Electricity (Safety) Regulations 2010
EV	Electric vehicle
FP	Flexibility provider
GWh	Gigawatt hour
GWP	Global warming potential
HEMS	Home energy management system
HHR	Half-hour metering
Hz	Hertz
IESANZ	Illuminating Engineering Society of Australia and New Zealand
IFTTT	If this, then that
kW	Kilowatt
kWh	Kilowatt hour
LAN	Local area network
LED	Light-emitting diode
mA	Milliamperes
MEPL	Mandatory Energy Performance Labelling
MEPS	Minimum Energy Performance Standards
MHz	Megahertz
mm	Millimetre
Mt	Million tonnes

MW	Megawatt
OCP	Open communication protocol
OCPP	Open charge point protocol
PAS	Publicly available specification
PJ	Petajoules
PV	Photovoltaic
RAPS	Remote area power supplies
RCD	Residual current device
SDoC	Supplier declaration of conformity
SSDG	Small-scale distributed generation
TOU	Time of use
V	Nominal voltage
V2G	Vehicle-to-grid
V2H	Vehicle-to-home
V2I	Vehicle-to-infrastructure
WKH	Warmer Kiwi Homes

2 WHAT IS A SMART HOME?

2.1 General

Smart homes are dwellings that can use less electricity with little or no input from residents.[4] They use a combination of appliances, sensors, and control signals to operate as normal, but do so more cost effectively. They can provide energy savings and reduce electricity bills while helping to avoid network over-investment. 'Set and forget' smart energy management can give consumers the means to reduce their outgoings and do their bit for the environment.

Figure 3 – Smart homes provide services such as lighting, cooling, and heating

Smart homes use self-learning and algorithms to adapt to user needs and electricity supply patterns while providing services such as lighting, cooling, and heating when needed (see Figure 3). Fully functional smart homes automatically reduce grid-purchased electricity consumption whenever possible. When smart homes have home-generated renewables such as solar PV and energy storage (for example, home battery systems) or EVs, less energy needs to be purchased. When smart homes are connected to the network, they can provide value in terms of management of peak demand, better supply-and-demand balance, and lower electricity bills.

[4] Source reference: *Intelligent efficiency. A case study of barriers and solutions.*

The energy savings of a smart home will depend on a range of factors, including:

(a) How many devices in the home have smart capability or can be retrofitted to be 'smart capable';

(b) How much electricity the devices use in different power modes;

(c) The level of automation (genuine smart homes prioritise energy efficiency, with the algorithms doing all the 'thinking');

(d) User behaviour. All smart home systems can be overridden by consumers, who could choose to revert to historical behaviours instead of letting the smart home system optimise electricity consumption to reduce costs. Consumer requirements are the highest priority, so being able to override the system is important, but doing so will reduce the amount of energy available to save.

For example, a smart home can optimise efficiency and reduce cost while charging an electric vehicle. Most consumers plug their EV in at home in the evening. If the charger is 'smart', it will determine when charging is going to cost the least while still ensuring the vehicle is fully charged and ready for use in the morning.

A smart home is a dwelling that has a system (with at least one device) that is network connected and can be automated or controlled remotely. It enables the control and automation of lighting, space and water heating, ventilation, air conditioning, home energy-generating or storage devices (for example, solar PV or home batteries), as well as home appliances such as clothes washers and dryers. Smart homes operate using open communication protocols that enable all devices to communicate with and connect to FPs. Open communication protocols also ensure that consumers can switch FPs easily.

Smart homes can deliver a range of benefits to households, including:

(e) Managing energy (energy efficiency);

(f) Managing electricity consumption to minimise use and cost;

(g) Managing demand response and flexibility (contributing to reducing demand on the grid for financial reward);

(h) Maximising self-consumption of any electricity generation within the smart home, as well as storage and delivery to the grid (from solar PV, home battery systems and EVs);

(i) Managing security;

(j) Enhancing comfort;

(k) Managing a household (for example, automatic reordering of groceries);

(l) Specialised services such as wellness or health management monitoring;

(m) Assisted living.

2.2 Smart home core elements

The appliances, electrical devices, and system or systems will vary depending on the household's needs and change as equipment is removed from or added to the system. Fully integrated smart home systems typically consist of sensors and switches connected to a hub (sometimes called a gateway or HEMS) from which the system is controlled with a user interface – for example, a wall-mounted terminal, mobile phone, or computer that requires an Internet cloud service (see Figure 4).

Figure 4 – A simple smart home

Smart home energy management technologies include smart thermostats (for water heating or controlling air temperatures), smart plugs (to retrofit connectivity to existing appliances), connected lightbulbs or smart lighting systems, smart appliances, energy-use displays, and smart home management systems, as well as energy generation and storage devices.

Technologies can make smart homes integrated and active participants in the energy system. In Figure 5, the smart home receives part of its energy requirement from the grid, uses in-home renewable energy generation and energy storage to lower its demand for grid electricity and associated costs, and optimises energy consumption by enabling smart appliances to run automatically at appropriate times.

It can also sell excess electricity back to the grid and provide demand response services to further lower its energy expenses or generate revenue. This delivers more benefits to the household in terms of a broader set of energy management options and is a better return on investment. It contributes to the energy system by supporting network stability, reducing the need for additional large-scale generation capacity, and increasing the use of renewable energy.

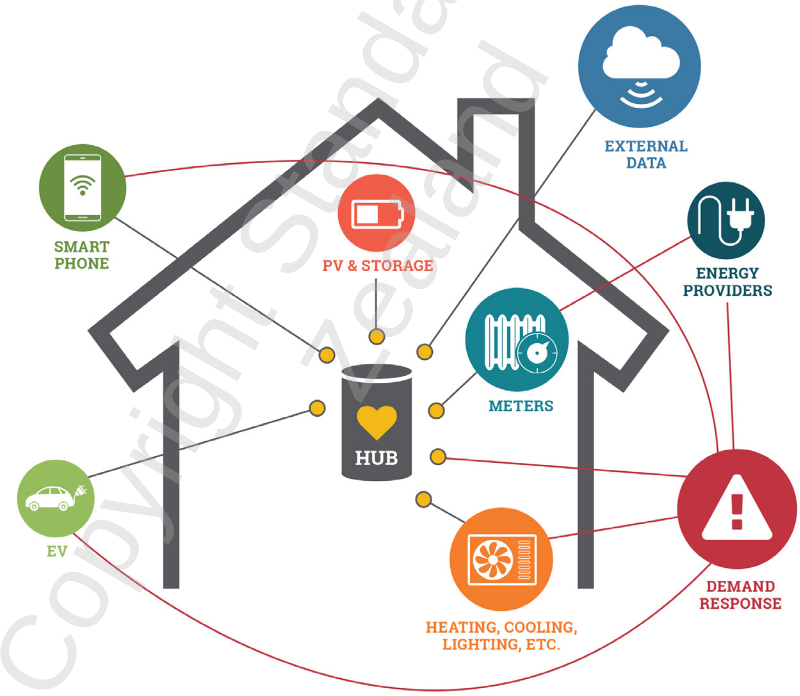

Figure 5 – A complex smart home as part of the wider energy system

Current trends include integration of voice control, artificial intelligence, and machine-to-machine learning. These technologies will make it easier for users to interact with their devices and systems and enable devices and systems to better adapt to household behaviour and needs.

Of particular interest are developments in energy awareness which enable the energy use data of individual devices to be made available by the devices themselves. This can open up opportunities for new energy efficiency actions, as well as new ways of measuring energy use.

2.3 Understanding demand response and flexibility

2.3.1 Demand response

With 'demand response', the end user changes their demand by either increasing consumption, turning on appliances, or decreasing demand by turning appliances off or down to assist in balancing generation and demand.

Demand response entails a consumer changing their electricity demand at times of either high or low system load. Typically, demand response is indicated through price signals, such as high prices for electricity or use of a network. In return for assisting the electricity supply system's management, consumers can get a reduction in their electricity price.

Distributed energy resources (DERs) comprise any equipment connected to the electricity supply that can provide demand response by varying their electricity consumption or production. Examples include solar PV systems, home battery systems, EVs connected to smart and two-way chargers, and smart appliances.

2.3.2 Flexibility

'Flexibility' means the devices in a smart home working together as a network to reduce electricity demand and reduce household electricity costs. For example, in a fully integrated smart home, a HEMS will decide what to do with excess PV generation. It could be stored in a battery unit, used to charge the hot water cylinder or EV, consumed by appliances operating in the home, or exported to the network. The HEMS will be monitoring signals from the FP to establish where the best value for the smart home lies. Flexibility describes the ability of the smart home to calculate and decide on the best course of action.

So, what are the benefits? Homeowners could:

(a) Earn money for switching off selected electrical equipment at times of high electricity demand or price, and for being available to switch off to reduce electrical load quickly if there's an unplanned major grid event;

(b) Reduce costs by being paid to shift their energy use;

(c) Make a meaningful contribution to New Zealand's energy transition.

2.3.3 Energy savings potential and other energy system benefits

The New Zealand electricity supply system of the near future will include increased consumer choice and reward for responding to a demand request.

New Zealand electricity systems are designed to meet peak demand. In other words, it's assumed that a household or business will operate at its highest consumption level (peak) at all times. Without knowing when demand is likely to be lower in high-demand periods, electricity networks and generators have to ensure that enough electricity is available to meet the peak at all times. This means there is usually surplus network capacity, with generation capacity in reserve.

Demand response and flexibility (DR/DF) open up a communication line between a household or business and an electricity provider. The provider asks the household or business if electricity demand can be reduced; if the answer is yes, the provider can reduce the amount of electricity in network capacity or standby generation that it has set aside for the household or business. For example, if a commercial EV is parked up (and fully charged) overnight and not needed until the following morning, the electricity account holder can make this 'demand' available to retailers, distributors, or FPs to use elsewhere on the network.

All of this happens automatically, with signals and algorithms.

2.4 Typical smart home technology features

Smart technologies often include advanced features such as sensors, controllers, software, touchscreens, displays, and cameras. Sometimes these advanced capabilities and features make it more difficult and costly to install, configure, operate, and maintain the equipment. This may result in either increased effort or cost for the homeowner.

Care should be taken in selecting appropriate equipment. You'll need to balance advanced capabilities and complexity so that technologies can provide the intended services without requiring significant technical expertise to install, configure, and operate.

Where possible, choose 'plug and play' devices with streamlined or automated installation and configuration, as well as predictive maintenance features.

2.5 Smart home technology overview

2.5.1 General

Fully integrated networks include automated management systems (known as home energy management systems or HEMS), which enable residential consumers to have greater control over their energy use and costs. HEMS technology ranges from programmable or communicating devices through to full autonomous control of all discretionary energy generation and consumption.

The level of complexity chosen often reflects how 'hands on' a consumer wishes to be regarding their household energy management.

2.5.2 Enhancing security of supply

Smart home consumers can assist with security of supply by reducing consumption (through energy efficiency and by changing their habits) and enabling flexible load or additional reserve generation on-call. They can also purchase appliances with 'smart' attributes and sign up to pricing plans that provide cost signals.

2.5.3 Current smart home technology uptake

Figure 6 and Figure 7 provide a snapshot of energy savings for residential appliances sold in New Zealand with DR-enabled technology. These appliances are covered by minimum energy performance standards (MEPS) and minimum energy performance labelling (MEPL) under the Equipment Energy Efficiency (E3) programme.

MEPS help prevent low-quality and poor-efficiency appliances being imported into New Zealand, while MEPL 'star ratings' can be seen on certain appliances in stores.

The appliance MEPS/MEPL programme has been running in New Zealand for more than 20 years and has saved consumers 70 PJ (petajoules) of electricity. This is equivalent to about 4.5 years of output by the Manapouri hydro scheme ($5 billion) and 2.7 Mt of avoided carbon dioxide (CO_2) production. (See Figure 6 and Figure 7.)

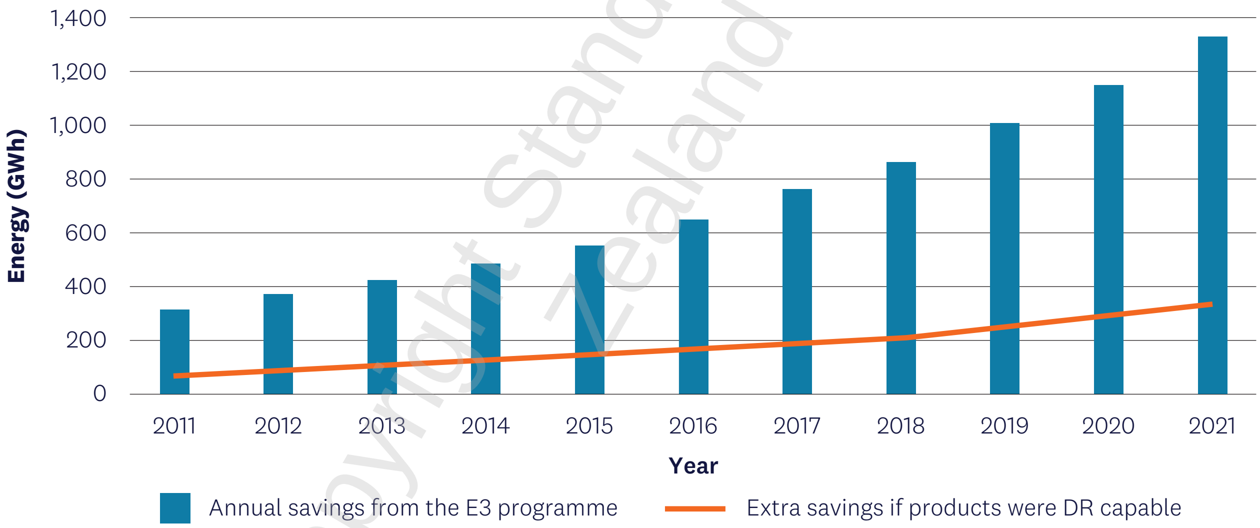

Figure 6 – Realised energy savings and with DR enabled

However, with the exception of some heat pump (air conditioner) models, the overwhelming majority of appliances installed in New Zealand homes are not 'smart'. This is changing as smart appliances become available and consumers choose to buy them.

Retrofitting 'smartness' is a low-cost option, but will not necessarily be as effective as a smart appliance itself. Also, retrofitting won't always be successful. For example, turning off a retrofitted dryer mid-cycle could reset the programme instead of pausing it.

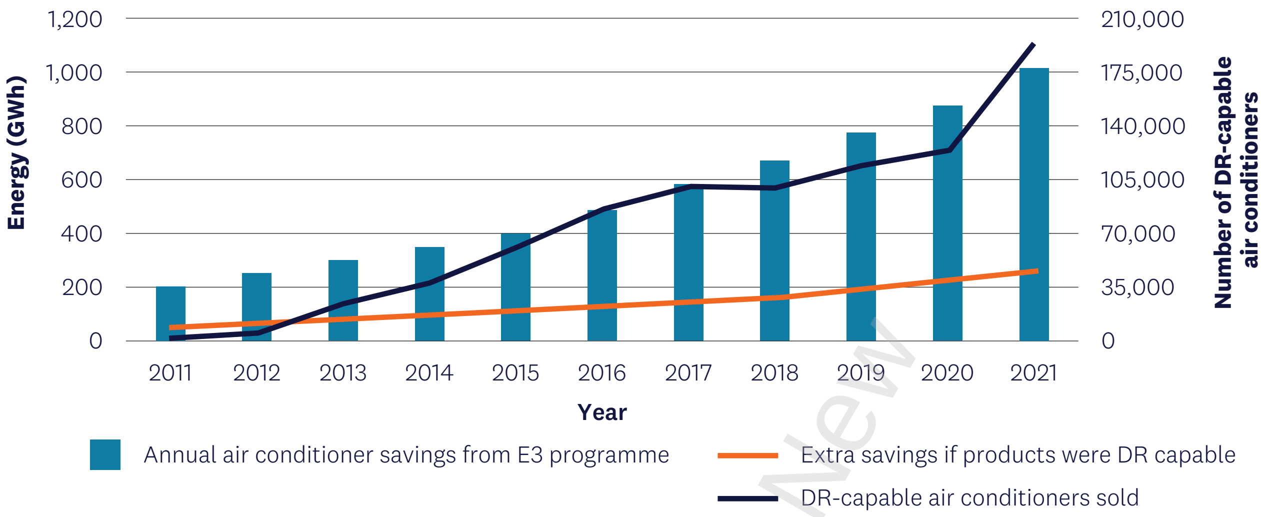

Figure 7 – Realised heat pump/air conditioning units' energy savings with DR enabled (including sales data)

2.5.4 Connectivity

Connectivity is the ability of a smart device to receive and act on an external flexibility provider's signal. This could be a signal to turn on the hot water cylinder or EV charger (based on an electricity price and supply trigger or perhaps surplus electricity from the solar generation).

Connectivity is the key to the door of flexible demand, enabling electricity networks to manage demand on their network, and giving consumers the opportunity to reduce their electricity bills. But remember that with most flexible demand systems, consumers can override a flexible demand signal. This just means that no inconvenience occurs if it doesn't suit a customer's needs at that moment.

Open communication protocols (OCPs) have been internationally recognised as fundamental to creating a fully flexible demand system. They are being installed in most major economies globally. OCPs are necessary to ensure that electricity suppliers can ‘see’ and control a flexible load. In practice, this could entail slowing down or speeding up the charging rate of an EV depending on overall demand on the network.

Similarly, OCPs are necessary to ensure consumers don’t get ‘locked in’ to a sole FP supply contract. Customers need to be able to switch FP whenever they want (much as they can change electricity suppliers now). OCPs ensure demand flexible loads are both visible and controllable to all electricity suppliers to avoid over-investment in network infrastructure.

2.5.5 HEMS interoperability and why it is crucial

There is a multitude of appliances that a customer could want to connect to a HEMS. However, many older appliances are not smart and cannot be fully remotely controlled as their connectivity is restricted to using a smart plug to give them a remote ‘on/off’ signal.

When purchasing new smart home equipment, customers should consider the equipment’s ‘interoperability’ – the ability to communicate with an FP, as well as with other devices in a smart home system.

Understanding what constitutes the smart home energy management system (Figure 8) will help you navigate this journey.

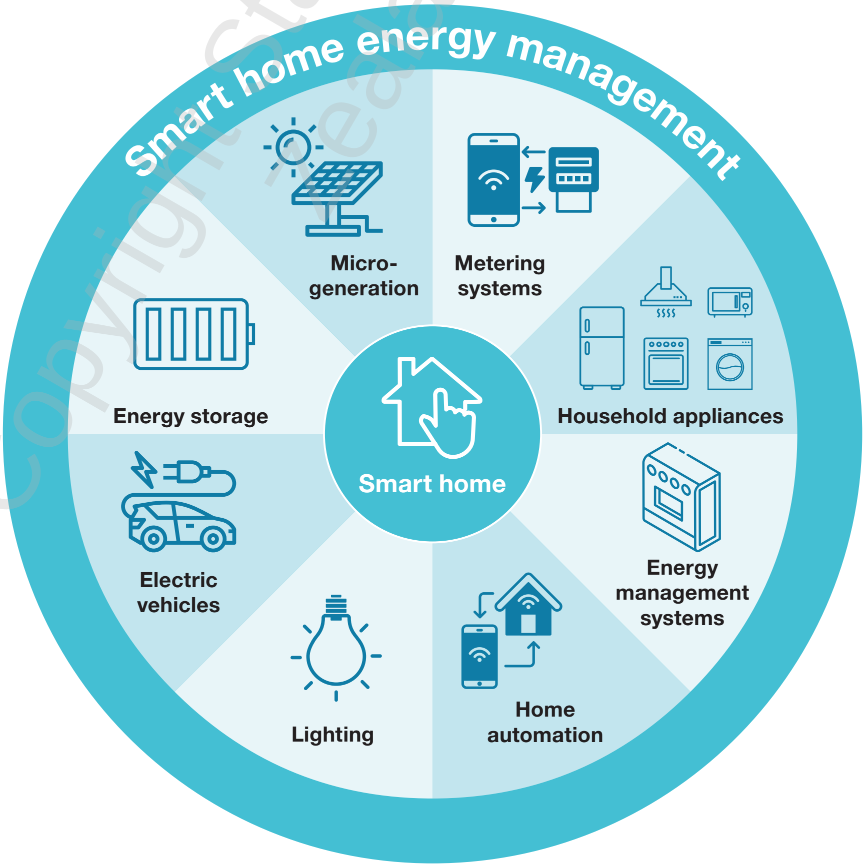

Figure 8 – Constituents of consumer-orientated smart energy

For example, in a fully integrated smart home, it could be more cost effective to charge an EV rather than export surplus electricity generated by solar panels to the network.

In another example, when electricity prices are high, it could be more cost effective to use power that has been stored in the home battery system to run the household, then recharge the battery from the network electricity supply when prices fall.

Interoperability begins and ends with the selection of appropriate smart appliances. Failure to pay attention to this critical element means that an appliance could be limited in its use for smart home purposes.

2.5.6 Smart appliances

Smart appliances are appliances with functionality that can enable flexibility.

In New Zealand, residential air conditioning units (heat pumps) must be capable of demand responsiveness. More than 830,000 such units have been sold in New Zealand since 2012, making them an obvious choice for consumers wanting to participate in FP programmes.

Similarly, retrofitting a smart thermostat to an electric water heater is another easy demand response target.

But it doesn't end there. EV chargers, lighting systems, and larger appliances that can consume significant amounts of electricity can also be attractive for demand response and flexibility programmes. Newer technologies such as heat pump water heaters are also efficient and can feature connectivity. All of these appliances can be controlled by a HEMS.

The selection of an appliance is critical, not just for its energy efficiency, but also for its potential future use in demand and flexibility programmes. Purchasers should consider the interoperability and communication options of the appliance that they are purchasing to ensure the maximum benefit over the life of the appliance.

In the future, smart appliances will be labelled to ensure consumers can identify such appliances at point of sale. The label below (Figure 9) is an example of the one used on heat pumps in Germany.

Figure 9 – Sample voluntary smart appliance label

In New Zealand, a version of this type of label is under development. In the interim, customers should ask their appliance retailer or supplier directly about the smart readiness of a specific model when deciding whether to buy it.

2.5.7 Energy rating labels

The energy rating label (ERL) – a mandatory 'comparative energy' label seen on certain appliances – provides product energy performance information at the point of sale. The star rating (from 1 to 10) helps consumers compare different models. The expectation is that an appliance with many stars will be more energy efficient than an appliance with fewer stars. The ERL also includes the appliance's expected annual energy consumption and running costs under specific conditions. (See Figure 10.)

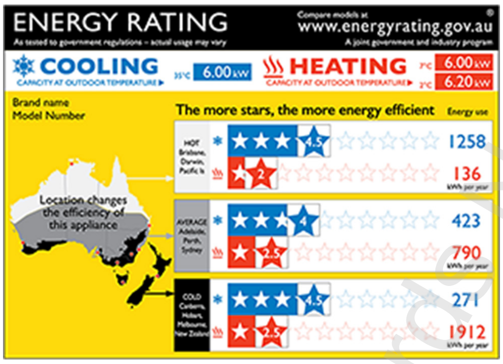

Figure 10 – An energy rating label

To improve the energy efficiency of products sold in New Zealand, ERLs:

(a) Allow consumers to consider the energy efficiency of certain appliances that they are looking to purchase;

(b) Encourage manufacturers and suppliers to compete on efficiency.

The primary market issue that ERLs are designed to address is information. 'Information failure' occurs when consumers have inaccurate, incomplete or ambiguous information. Selecting an appliance on the basis of price without considering life-cycle-running-costs (which, over the lifetime of an appliance, can be much greater than the purchase price) is an example of information failure.

Without an ERL, it can be hard to find information about running costs, making it difficult to compare similar products. Additionally, increased demand for more-efficient products sends manufacturers a signal to create more-efficient products.

2.5.8 EV chargers (including V2H and V2G)

EV chargers can provide flexibility by delaying charging or reducing the rate of charge. As EVs have large storage batteries (and use increasingly large chargers), and are usually stationed in garages overnight, residential EV chargers are valuable sources of flexibility to the system operator, networks, generators, retailers, and FPs.

In the future, smart EV chargers could offer power quality support by sensing and reacting autonomously to network voltage and frequency. Also, the type of charger will be critical for participation in flexibility programmes. Minimum requirements could include interoperability and communication so that the charge rate is able to be in-home and remotely controlled or delayed. The use of Open Charge Point Protocol (OCPP) ensures EV owners can pick the best flexibility programme to participate in and retain the ability to switch FP at will.

'V2H' and 'V2G' are terms that describe two-way charging of EVs. EVs have large on-board batteries that could, in the future, be used as electricity sources in smart homes. This means that the battery could be used to provide flexibility or an alternate supply of electricity at times when either the price is high or there is a constraint on the electricity network.

Where V2H or V2G is contemplated, customers should:

(a) Engage with their electricity retailer at an early stage to ascertain the network's requirements to allow EV charger inverters to generate electricity directly or indirectly into their network;

NOTE – There are application requirements set out on electricity retailers' websites.

(b) Purchase equipment with remote communication capability to future-proof their investment. Remote communication capability could include a HEMS to manage both the charge and the discharge of the EV battery electricity into the house at the most economic times.

2.5.9 Smart lighting

Residential smart lighting consists of energy-efficient LED luminaires (including retrofitted LED lamps) with network communication and remote-control capability. Smart lighting also offers home hospitality and entertainment opportunities with creative lighting for interior and exterior ambience.

Retrofitted LED replacement lamps (ES and BC lamp caps) offer economy and user convenience as part of a gradual transition to LED technology, but they do not always deliver an integrated 'systems' application approach. So what solution is right for you?

An entry-level residential smart lighting installation typically involves some form of adaptive technology such as wireless or automated dimming control and/or motion sensors that switch luminaires off if nobody is present. Adaptive lighting technology primarily focuses on energy efficiency, dynamic user needs, visual task, or ambience.

A more advanced residential smart lighting system could combine both adaptive and integrative technologies. Integrative lighting considers both visual and non-visual effects to provide physiological and/or psychological benefits. Integrative lighting is also referred to as 'human-centric lighting' and often involves manipulating light by adjusting the correlated colour temperature or following a circadian rhythm.

Advancements in the residential smart lighting sector mean that previously expensive and complex technologies such as integrative or human-centric lighting are more accessible than ever for homeowners looking for features beyond simple wireless control and convenience.

Some smart lighting systems can also provide an additional security layer with features such as simulated occupancy. If the occupants are not home, the lighting can be programmed to turn on and off in different rooms to make it look as though the occupants are home.

The ability for lighting to provide demand reduction services can be limited due to the relatively small loads involved and the functional requirement for light during typical peak periods. To find out more, discuss your specific lighting needs with an IESANZ-certified lighting designer or registered lighting practitioner.

2.5.10 Water heating

Some traditional New Zealand electric water heaters are already under the control of the network owner using non-HEMS technology (usually a ripple-control relay).

Modern ripple-control systems can respond autonomously to stabilise the grid. In exchange for giving electricity providers that control, customers could get a discounted electricity price.

However, ripple control is a simple on/off signal and does not provide the full functionality of a demand-flexible system. A hot water cylinder fitted with a smart thermostat and gateway for communication learns the hot water usage pattern of the cylinder to identify the best times for minimising electricity consumption. Advanced control also ensures that a supplier has the option to reduce the supply rather than turn the cylinder completely off.

Smart thermostats and gateway devices are readily able to be retrofitted to existing hot water cylinders. However, if a customer is contemplating changes to the existing control of electric water heating, they should engage with their FP or electricity distributor and retailer at an early stage.

2.5.11 Space heating and cooling

Remote control of heating and cooling can serve as a valuable asset for flexibility and reduce customer electricity costs.

Provided that remote communication capability is available on the air conditioner unit, or through an integrated HEMS system, an FP can change the demand of the heating or cooling device. This might involve limiting total output to 75% (as most air conditioner units operate below this level).

Smart room thermostats can be used to control energy use, increase thermal comfort, and pre-heat or pre-cool residences. For instance, in conjunction with a HEMS, a customer could make the decision to pre-heat their premises using surplus electricity from the PV on their premises, rather than inject that surplus electricity from their solar PV or battery system into a network and realise a lower economic benefit.

2.5.12 Smart electricity pricing plans

Standard electricity retailer and distributor pricing plans could provide incentives for smart home owners to change when they use electricity.

Electricity retailers and networks can provide information on pricing plans that could benefit consumers who are able to change the time that they use electricity. If your retailer cannot provide you with details on time-of-use pricing plans, approach other retailers and the network that your premises is connected to.

2.6 Distributed generation

2.6.1 Overview

Distributed generation (DG) refers to equipment that can generate electricity that is connected directly or indirectly to an electricity network, or to a consumer installation that is connected to an electricity network. It does not include:

(a) Generation equipment that is connected to the transmission grid;

(b) Generation equipment that is connected for the purpose of maintaining or restoring the provision of electricity, to part or all of a distributor's network as a result of:

  (i) a planned distribution network outage

  (ii) an unplanned distribution network outage

  (iii) when the distribution network capacity would otherwise be exceeded on part, or all of the distribution network

  (iv) generation equipment that is only momentarily synchronised with the distribution network for the purpose of switching operations to start or stop the generating plant.

DG systems often incorporate storage batteries, which act as flexible in-home energy storage and provide a controllable energy source. A battery integrated with a wind and/or solar PV installation provides, within its capacity limit, a valuable local energy buffer that can time-shift when the solar-sourced energy is released from the small-scale distributed generation (SSDG) system from a low-cost period to a high-cost period.

Unless they are installed in accordance with the network's requirements, SSDGs connected to low-voltage residential networks can cause problems related to electrical voltage (measured in volts), current (amperes or amps), and frequency (Hertz or cycles per second).

Before purchasing distributed generation equipment, check the regulatory requirements. Also ask the distributor about the connection requirements. It will not always be possible to connect the generation, or the capacity of the generation, that you wish to connect.

If you intend to install electricity generation that can inject into a network, obtain the network's consent (check its website for details). There may also be local council consents that are required, so also check with your local council. The network can impose conditions on the maximum electricity that can be injected into their network. The network can also require the distributed generation to stop generating at times when the network voltage is at or near its statutory maximum.

The time of day that electricity is produced by wind turbines will not necessarily be when a domestic customer uses the most electricity, in which case a reasonable proportion of electricity could be injected into the network. Changing the time of use of electricity to times when wind turbines are generating electricity, or alternatively storing that electricity for use later, can enable greater renewable energy use and lower electricity purchasing costs, as well as a degree of self-sufficiency.

Figure 11 illustrates the main components and connections of a typical residential small-scale installation (wind or solar PV, or both). The generation output connects through a DC/AC power inverter to the consumer's switchboard and directly supplies the household appliances. Any instantaneous power imbalance (either over or under) between the generation output and the household appliance demands flows through the electricity meter to or from the distribution network.

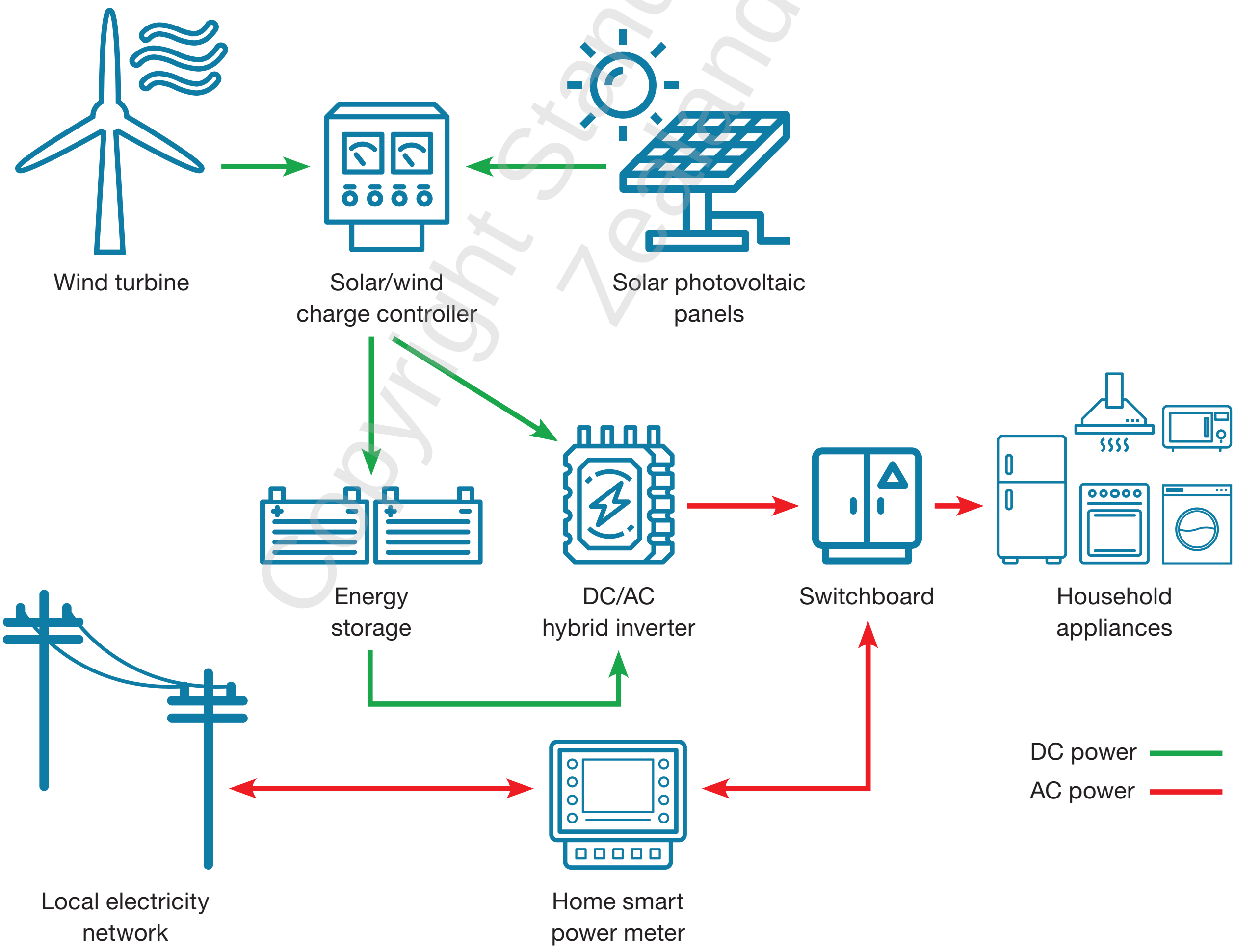

Figure 11 – Main components of a typical small-scale installation (wind or solar PV, or both)

Distributed generation can take many different forms. The most common forms include, but are not limited, to:

(c) Solar (photovoltaics);

(d) Wind turbines;

(e) Micro-hydro systems;

(f) Batteries (energy storage).

2.6.2 Solar (photovoltaics)

Solar (photovoltaic) panels convert solar energy into electricity. The electricity produced by panels on a residential building can either be consumed within the residence (self-consumption), stored in batteries, or exported into the electricity network and sold to the customer's retailer.

The disadvantage is that electricity is produced only when the sun shines and, even then it is variable, depending on the intensity of the sunshine.

2.6.3 Wind turbines

Wind turbines convert air pressure into electricity.

One disadvantage is that considerable blade area and wind speed are required to generate electricity. Another is that some blades create noise, requiring the turbine to be located away from populated areas. Other disadvantages include the need for laminar air flow for optimum output and reduced stress on the mechanical components. Also, a small wind turbine could need a resource consent if it exceeds the relevant council's height rules, as well as a building consent for the support structure.

Lastly, wind turbines only generate energy when there is sufficient wind, and wind cannot be guaranteed. Wind can, however, be used to supplement solar or micro-hydro generation and charge batteries.

2.6.4 Micro-hydro systems

A micro-hydro system converts water pressure into electricity. Water pressure can be obtained through height (where the flow of water is above the micro-hydro equipment) or can be 'run of river' (where a stream within a water course provides sufficient pressure). It can also be used to supplement solar or wind generation, and charge batteries.

The disadvantage is that considerable flow of water is required to generate electricity. A reliable water supply is needed to guarantee availability of electricity. Additionally, micro-hydro installations will most likely need resource consent for any infrastructure in the waterway and the diversion of water.

2.6.5 Batteries (energy storage)

Batteries can store low-cost or surplus electricity on the consumer's premises for later use (for example, when grid-delivered electricity is expensive). A HEMS should enable customers to:

(a) Store surplus electricity in batteries;

(b) Control EV chargers;

(c) Allow the battery charge/controller to be used as discretionary load that could be shed remotely when networks are congested;

(d) Allow the battery charge/controller to be either used to support network power quality or contracted to a virtual power plant or FP, in return for some form of financial incentive, as mentioned earlier.

2.7 Data capture and cyber security

2.7.1 General

This is one of the most important aspects of the entire smart home. Any shortcoming in one device can expose the other devices or indeed any other computing platform, such as a laptop or mobile phone, to cyber-attack, data theft, or data loss.

When choosing an appliance, think about its ongoing viability as well as:

(a) Local LAN connectivity (Wi-Fi/Bluetooth);

(b) Security updates;

(c) Application programming interfaces (APIs), protocols or methods for devices from disparate manufacturers to exchange data and interoperate;

(d) Cloud-to-cloud data sharing (data stewardship, data centre location, and so on).

2.7.2 Local LAN connectivity

This is typically through a Wi-Fi connection or ethernet cable to the home router. In some cases, manufacturers could use a 'bridge' or 'hub' that connects through Bluetooth, or to the home router and translates to other field protocols such as Zigbee or ZWave.

In all cases, use up-to-date, secure encryption such as WPA2 (Wired Equivalent Privacy, version 2), WPS (Wi-Fi Protected Setup) or other suitably secure encryption standards that are supported.

Also, choose suitably unique and complex passwords.

2.7.3 Security updates

Ideally, manufacturers would be clear about the frequency and lifetime of security updates of their appliances and other electrical devices so that the consumer can make an informed purchasing decision. Appliances would also, ideally, have an opt-in automatic update facility or alert that an update is available.

2.7.4 APIs and data exchange protocols

Application programming interfaces (APIs) are software interfaces that provide a clearly documented method of exchanging data and command and control signals to and from individual smart home systems. These APIs should also support up-to-date security as a basic function of messaging data exchange. Selecting products that support easily recognised vendor agnostic protocols (such as 'Matter') or have published open APIs is the easiest way to ensure that the widest number of vendor-to-vendor devices can interoperate in a secure and safe manner.

2.7.5 Cloud-to-cloud data sharing

Increasingly, vendors (cloud service operators) are providing higher-level features and functionality via vendor-owned servers or 'clouds'. As a part of this, customer data often needs to be stored and shared with other vendors, or third parties to provide additional features.

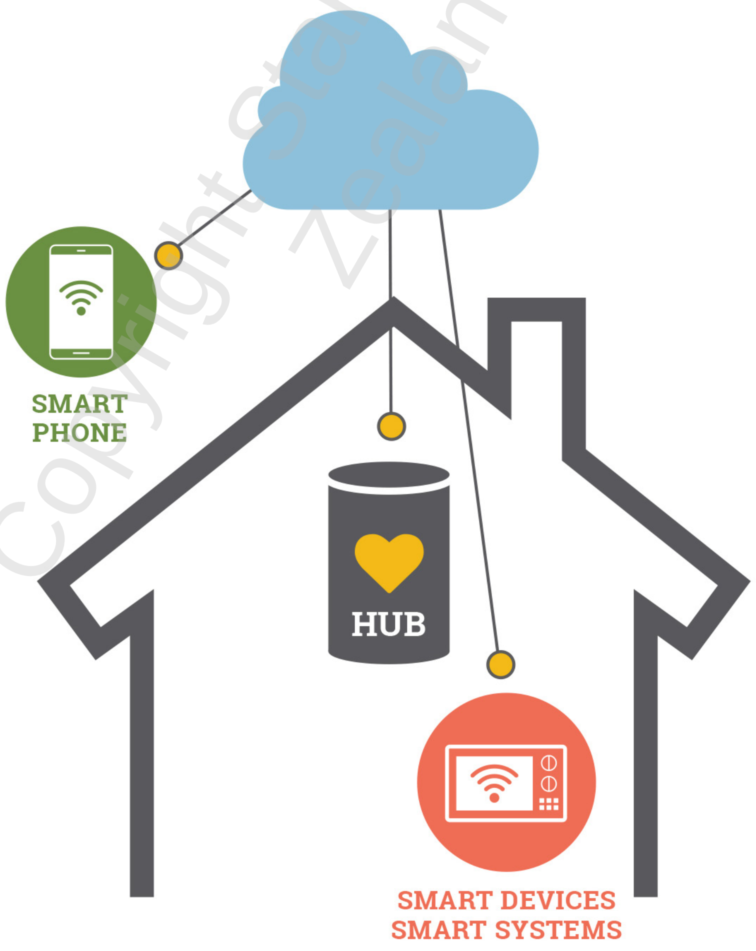

Figure 12 – Cloud-to-cloud data sharing

An example would be the use of a common IFTTT (if this, then that) Internet service to connect a home motion sensor and camera to an Internet-based video recording service. The smart homeowner should carefully consider the data stewardship, security track record, and in some cases, where the servers are located.

Privacy laws can vary greatly from the smart home location and the processing and data storage location of the vendor's server.

Flexibility providers must comply with all relevant enactments. That includes a clear understanding of data privacy if you are working with data about people. The Privacy Act 2020 provides rules that you must comply with when collecting and using the data. For more information about compliance obligations, go to https://www.data.govt.nz/toolkit/privacy-and-security/data-privacy/.

2.8 Smart home SDoC conformity

For smart homes in New Zealand there are typically two types or categories that an SDoC covers:

(a) Basic product functionality and safety;

(b) Radio spectrum compliance.

Electrically, the requirement for a medium-risk declared article is found under Regulation 83 of the Electricity (Safety) Regulations. It states that a product shall not be sold or offered for sale, unless the supplier (being the New Zealand manufacturer or importer) has made an SDoC in respect of the article.

The New Zealand Radiocommunications Compliance Notice 2020 describes the different levels of conformity for products, including the level of testing and documentation as well as product labelling requirements. It also describes the declaration of conformity (SDoC) requirements. Typically, electromagnetic compliance (EMC) ensures that products are immune to the required level of interference and do not cause interference. In a smart home this is particularly important where disparate components or systems are expected to work together seamlessly.

NOTE –

(1) Refer to the internationally agreed format for SDoCs, as specified in the standard ISO/IEC 17050-1.

(2) For an overview of conformity assessment, see ISO's attestations of conformity at www.iso.org.

(3) For an example about the use of SDoCs for electrical safety compliance, see WorkSafe's supplier declaration of conformity at www.worksafe.govt.nz.

3 UNDERSTANDING SMART HOME AND SMART GRID INTEROPERABILITY

3.1 General

The terms 'smart home', 'smart appliance', 'HEMS', and 'smart grid' mean different things, yet they are all related and, technically, none works optimally without the others.

Smart homes can use less energy, or reduce energy costs, or both, with little or no input from residents. Smart homes use a combination of appliances, sensors, and control signals to operate as normal, albeit more efficiently, and can help prevent network and generation overinvestment (which all consumers ultimately pay for). In a fully automated smart home, a home energy management system (HEMS) manages the purchase cost of electricity and ensures that there is sufficient capacity to run smart appliances, making optimal use of any distributed generation and battery storage.

Although smart homes can stand alone, their use is optimised when smart appliances are integrated with smart grids and FPs, which balance grid load (demand response), through a HEMS.

3.2 What is a smart appliance?

A smart appliance can be either programmed to run at certain times (low-cost times) or remotely controlled through an external signal or HEMS. It could also act autonomously based on inputs from sensors – for instance, if the refrigerator has been controlled 'off', but the temperature exceeds a set point, the refrigerator could 'decide' to run, regardless of the external control signal.

Although smart appliances can stand alone and react to external signals from FPs, they work optimally when integrated with a HEMS.

3.3 What is a HEMS?

A HEMS provides supervisory control of smart appliances (including EV chargers) and distributed generation, controls the environment within a premises, and integrates with external systems such as smart grids and FPs.

A HEMS can operate on its own, but the greatest benefit to consumers will be when there is a market demand for demand reduction services. When those markets develop, there could be multiple parties that interact with a HEMS – for instance, a network could interact with HEMS for the control of capacity and voltage on their network, an electricity retailer could interact with a HEMS to manage its electricity market purchasing costs, and an FP or aggregator could interact with a HEMS to manage virtual power plants, provide reserves, or contract ancillary services within the network.

The HEMS could also have rules programmed into it, such as temperature settings or when appliances are to operate (for example, within a specific price range).

3.4 What is a smart grid?

A smart grid is a network that intelligently monitors and manages the transport of electricity from all generation sources to meet consumers' varying electricity demands. It can automatically switch electricity around faults, isolate sections of the network, and control power quality and electricity demand.

While a smart grid can stand alone and just manage aspects of a network, in order to control electricity demand there needs to be remote communication, pricing incentives, and equipment to control.

A smart grid works optimally when it is integrated with HEMS or communicating directly with smart appliances. This is where residential demand and generation can be sourced for demand response or flexibility programmes to manage the network.

Smart grids provide a platform for networks to manage increasing demand requirements, aging infrastructure, and infrastructure investment. They can help achieve a more secure and sustainable energy future as more decarbonised load is added to networks. They can defer infrastructure investment, which can save costs being applied to consumers, as ultimately consumers pay for infrastructure investment and operation.

3.5 Data capture and smart metering

About 90% of New Zealand residences have remote communicating smart meters installed.[5] These meters record electricity use down to a granular level of usually 30 minutes, but many can operate to as low as 1 minute. This granular measurement combined with remote communication is invaluable for assessing customer cost efficiency. It enables customers to purchase electricity through smart pricing plans that provide incentives to purchase energy-efficient and HEMS-compatible appliances and equipment.

Customers can request their metering data from their electricity retailers. This data can be used by HEMS suppliers (and others) to determine the extent of cost savings available to customers by analysing economic pricing plans, consumption pattern changes, and services such as demand response or flexibility that the customer could provide.

The process and rules for customers requesting their metering data are set out in Part 11 of the Electricity Industry Participation Code 2010 (Code). If your premises has a smart meter fitted and your retailer will not provide either you or your agent with your metering data, you should refer the matter to the Electricity Authority.

Metering equipment providers (MEPs) collect and collate metering data from smart meters. Smart meters could, in the future, be used as data-collection points, or MEPs could read smart appliances directly in the same manner that they read smart meters. This functionality could become part of the electricity market, should multiple trader relationships develop as a method of electricity market settlement.

[5] To see a metering snapshot, go to https://www.emi.ea.govt.nz/Retail/Reports/AWNGPD.

3.6 Demand response and flexibility

'Demand response and flexibility' refers to reduction in electricity demand at the time the network experiences a constraint or there is a generation shortfall. The response is usually reactionary but can also be planned.

Flexibility is a way of managing the safety and security of electrical networks and available generation without increasing the physical network capacity. That is, demand response enables the more efficient use of network and generation assets.

3.7 Network demand response and flexibility

Electricity networks have finite capacities for the amount of electricity they can convey. The maximum capability of any section of a network depends on its design. As the required capacity increases, so does the network's capital cost.

As the economy decarbonises, the electrical load connected to networks is increasing. Network owners could increase overall capacity by investing significant sums of money in developing and enhancing their networks. These costs would ultimately be passed to customers in the form of increased network charges.

There are, however, alternatives – for example, lowering the demand or increasing the generation on a section of network instead of increasing the network's overall capacity. This is loosely called 'non-network alternatives' as commercial arrangements are used instead of more infrastructure. The impact of increased demand placed on a section of network can be reduced by deferring discretionary electricity consumption or turning on electricity generation during high periods of network demand.

Network demand response and flexibility can minimise the cost of electricity connection to customers by making more efficient use of existing assets.

3.8 Electricity generation demand response

Some renewable generation does not have fuel storage associated with it and tends to be intermittent in nature (for example, wind, solar, and some hydro). Electricity generators powered by these fuel forms can only generate when fuel is available. Intermittent electricity generation can stop and start unexpectedly, meaning electricity cannot be relied on to be available 100% of the time, unless some form of fuel storage is included.

Reducing electricity consumption at the time that intermittent generation stops or decreases and increasing consumption when the generation starts reduces reliance on what is called 'reserves' in the electricity market.

Reserves are 'instantaneous generation' which occur when electricity consumption exceeds available generation at any time. Providing reserves is costly and ties up fast-acting generation to operate in a standby mode. The more uncontrolled intermittent generation that connects to networks, the more reserve generation that could be necessary to maintain electricity quality and reliability throughout the country.

Demand response in the form of flexible demand enables more intermittent generation to be connected without increasing the need for reserve generation (instead of generation being called to meet demand, demand can be shed).

Better-managed electricity demand can reduce electricity consumption, minimising the impact of any shortfall in generation, and keep downward pressure on the electricity cost to customers.

3.9 Pricing incentives

A key pricing incentive is time of use (TOU) pricing, where energy prices vary based on the time of day. There is usually a three-tier TOU pricing schedule, with peak, shoulder, and off-peak periods. This gives consumers pricing choice and rewards those who shift load from peak periods.

Demand response and flexibility can be mandated (for example, through regulation). It could also be a condition for connection to a network, self-imposed by a consumer to manage the demand within their premises, or a pricing incentive whereby a customer receives a financial benefit to provide discretionary load.

A typical example is residential electric water heating where the customer receives a lower network charge in return for allowing the distributor to control when the hot water cylinder can consume electricity.

Pricing incentives can take many different forms. An event payment, for example, could be when a customer actually responds to a request to reduce demand. A planned incentive, meanwhile, could be in the form of a pricing plan, where all electricity supply is discounted. Such plans can be dynamic or fixed.

3.10 Smart home demand response and flexibility

Smart appliances or groups of smart appliances can use a HEMS to integrate with network demand response and generation demand response. Depending on the HEMS and smart appliances, the HEMS could react to either external price, internal premises electricity demand, or remote control by an FP.

A properly selected and configured HEMS can become an integral part of New Zealand's decarbonisation goal, as discretionary load can be used to tolerate greater amounts of intermittent renewable generation and manage network demands without compromising electricity quality or availability. However, a properly selected and configured HEMS is key. The market for non-network alternatives and generation response is still developing but will eventually be required.

As well as minimising the cost of delivered electricity, smart home demand response and flexibility can enable a customer to be more self-sufficient, provided they have invested in suitable appliances and in a fully integrated residence.

3.11 Distributed generation

Distributed generation (DG) generally refers to electricity generation that is connected directly or indirectly to a distributor's network and can inject electricity into that network.

DG encompasses a range of technologies and scales. Small-scale systems (less than 10 kW) such as solar photovoltaic modules (solar PV), batteries, small wind turbines, and micro-hydro schemes typically provide electricity sources for businesses, homes or farms that could also be connected to a local distribution network. Larger DG schemes can have capacity of up to several tens of megawatts (MW).

For customers that generate electricity, there's benefit in storing as much of the generated electricity as they can. Batteries can store electricity produced at times of low household consumption and release that electricity at times of high consumption when the DG is not operating, thereby reducing demand on the network and the amount of electricity purchased.

A HEMS can help an electricity distribution business (EDB) manage its network by automatically making sure that electricity consumption or generation does not add to the network's peak load stress while also optimising the use of electricity that is generated within the customer's premises.

If you wish to install DG, you must make an application to the network owner that your premises is connected to. Your network owner or DG supplier can help with this process.

3.12 Electricity distribution business connectivity and communication requirements

Connectivity and communication requirements to allow interoperability of customer premises equipment with electricity distributor systems are still being developed. Customers should contact their electricity distributor to determine the communication and participation requirements and ensure that their equipment will be compatible with the network's load control programme both now and in the future.

NOTE – Network pricing plan options could be tied to open communications capability, pricing incentives, or a requirement for the customer to carry out the control locally. To achieve the maximum benefits, the equipment needs to be compatible.

3.13 Installation anti-islanding

3.13.1 Overview

The three types of islanding that can electrically occur are:

(a) Remote area power supplies (RAPS) – islanded electrical installations:

(b) Distributed generation islanding;

(c) Self-sufficient islanding.

3.13.2 Remote area power supplies (RAPS) – Islanded electrical installations

These installations contain their own generation and can sometimes have battery storage. They are not connected, directly or indirectly, to a network at any time, but are entirely self-sufficient ('standalone').

RAPS installations can benefit from smart home technology or HEMS as the electricity demand can be controlled or rationed to within the capability of the generation and/or battery storage. This can minimise the capital outlay and operating costs associated with RAPS.

3.13.3 Distributed generation islanding

These installations contain their own generation and can sometimes have storage. They are not designed to stand alone (they normally need to be grid-tied), but are connected, directly or indirectly, to a network. An example is a solar PV system that requires a live network connection to operate. If there's a network failure, the generation should automatically turn off (this is a required safety precaution). With these connections, distributed generation supplements, rather than replaces, the electricity supply.

Such installations can benefit from smart home technology as the electricity demand can be controlled or rationed to within the availability and capability of the generation and/or storage, making the best use of self-consumed generation.

As the distributed generation is grid-tied and any surplus generation can inject into the network, there is a risk that electricity could be injected when the installation is disconnected from the network. This could be a potentially lethal situation. As a result, there are strong anti-islanding provisions within legislation. Your equipment supplier should ensure that the devices that you purchase comply with the relevant legislation and requirements.

3.13.4 Self-sufficient islanding

These installations contain their own generation, and possibly storage, and have enough capacity to be self-sufficient most of the time.

Usually, the installation is directly or indirectly connected to a network, but when the network fails, the installation can be isolated from the network so that it operates as a RAPS. Where more than one installation is connected, the installations form their own network (a micro-grid).

Installations such as these can benefit from smart home technology or HEMS as the electricity demand can be controlled or rationed to within the availability and capability of the generation and/or storage, making the best use of self-consumed generation.

4 THE TRANSITION FROM CONSUMER TO PROSUMER

4.1 General

In the energy transition, the consumer's role is changing.

Consumers were once passive users of electricity, but their decisions when purchasing appliances or distributed generation now impact the entire electricity supply system. When consumers install distributed generation along with smart appliances, they are integrating the operation of their premises with the electricity market. Such consumers are 'prosumers' because they both produce and consume electricity.

Consumers can significantly contribute to decarbonisation by making appropriate purchasing and management decisions that help the system operator, distributors, and generators to stabilise networks and the grid without requiring significant infrastructure costs.

New technology can connect consumer load such as the management of their distributed energy resources, (EVs, PV, heat pumps, batteries and so on) to the operation of the electricity supply system, where a value can be established for controlling consumer equipment, thus deferring cost from networks and generators.

Consumers can now choose to produce part or all of their electricity. They can also choose to export and sell their surplus. The transactional nature of the electricity market has already changed, with new business models emerging that could bring further benefits to consumers.

Any person can now choose to generate electricity and sell their surplus, providing there is network capacity to do so, and in the future could be able to offer demand reduction services to networks, retailers, and FPs.

4.2 What is the electricity market?

The purpose of the electricity market is to ensure that electricity generators and buyers are allocated their correct share of electricity generation or consumption, that security of supply issues are managed, that pricing uses a fair process, and that the electricity market is competitive, efficient, and reliable.

The New Zealand deregulated electricity market started its operation with partial deregulation on 1 October 1996. From that date, any consumer with half-hour (HHR) metering was able to purchase electricity from any retailer that agreed to supply it. From 1 April 1999, full retail competition commenced and all customers in New Zealand that had a connection to the grid or a network were able to choose their electricity retailer.

The electricity market is a mandatory gross pool. All generation injected into the grid or networks must be ultimately sold to the clearing manager and all consumption conveyed by the grid or networks must ultimately be purchased from the clearing manager.

Clearing manager sales and purchases are settled monthly at the final spot-price prevailing at the time at each individual point of connection to the grid that a customer is electrically connected to. This is referred to as 'wholesale market sales and purchases'.

Unlike metering in most other international electricity markets, metering in New Zealand is a competitive activity. Metering equipment providers compete on price, service, and functionality to provide metering services. Accurate measurement of electricity conveyed through a connection to the grid or network is key to a competitive and efficient electricity market.

The New Zealand electricity market is complex as there are many interactions between participants, between participants and the electricity market, and between participants and the Electricity Authority. Most smart home owners will not need to interact directly with the electricity market, but will instead interact through other participants such as retailers or FPs.

It should be noted that some customers are connected to private networks rather than the grid or a public network. These customers do not have a choice of retailer and will not necessarily be able to take advantage of smart home functionality. If you do not know what type of network you are connected to, ask your electricity retailer.

4.3 Regulating the electricity market

The electricity market is regulated by an independent Crown entity, the Electricity Authority. The Electricity Authority was established on 1 November 2010 under the Electricity Industry Act 2010. It develops, sets, enforces, and administers market rules (the Code) and monitors the market's performance.

The Act sets out who must comply with the Code and defines them as 'participants'. Anyone who generates electricity that can be injected into a network or the grid, retails electricity, acts as an FP, interacts with the electricity market, or is responsible for owning, operating or maintaining meters is a participant as defined in the Act and must comply with the requirements set out in the Code. Failure to comply with the Code is a serious issue and can result in punitive measures and prosecutions.

The Authority is funded through appropriations approved by Parliament each financial year (1 July to 30 June of each year). The Government is reimbursed for the cost of funding the Authority appropriations through a levy on industry participants. This levy is collected from generators, purchasers, and distributors (including the grid owner) in accordance with detailed formulae set out in the Electricity Industry (Levy of Industry Participants) Regulations 2010 (Levy Regulations).

NOTE – Further consumer-facing information is available on the Electricity Authority's website.[6]

[6] Select the 'Consumers' tab at https://www.ea.govt.nz/.

There are other regulators besides the Electricity Authority that regulate activities or equipment that could affect smart homes. They include:

(a) The Energy Efficiency and Conservation Authority (EECA), which regulates energy efficiency of appliances under the Energy Efficiency (Energy Using Products) Regulations;

(b) WorkSafe – Energy Safety, which is responsible for monitoring and enforcing the safe supply and use of electricity under the Electricity (Safety) Regulations. This includes generation, networks, installations and appliances;

(c) The Commerce Commission, which under product safety and consumer information standards regulates the non-electricity market components of the grid and networks and enforces the Consumer Guarantees Act (CGA).

4.4 Participation compliance requirements

Most premises with smart appliances (including networks of appliances controlled by a HEMS) will not become trading participants, but instead will contract with FPs who have the economic scale to meet the complex electricity market requirements.

There are, however, compliance requirements for smart home owners and operators.

(a) When considering the connection of any form of electricity generation that could be able to export from the premises, the owner of the premises must follow the processes set out in Part 6 of the Electricity Industry Participation Code.[7] Either the network owner that a premises is connecting to or the consumer's retailer can assist with this process. Network owners could place limitations on electricity generation that is connected to its network.

(b) Installations, appliances, and fittings must comply with the relevant requirements of the Electricity (Safety) Regulations.

(c) Equipment and appliances purchased in or imported into New Zealand must meet all the relevant enactments and standards including those specified under EECA regulations.

4.5 Prosumers

'Prosumers' are customers who both generate and consume electricity.

Residential customers are increasingly installing small, distributed generation (DG) units (for example, solar PV) in or on their homes along with home battery units. Typically, prosumers buy electricity from and sell electricity to electricity retailers or FPs. Retailers themselves buy and sell larger quantities of electricity from the electricity market.

Prosumers with DG units typically obtain a degree of self-sufficiency from renewable energy sources and can reduce electricity costs, provided self-consumption is carefully controlled to maximise benefits.

7 For more information on Part 6 of the Electricity Industry Participation Code 2010, go to: https://www.ea.govt.nz/code-and-compliance/the-code/.

When purchasing electricity from a retailer, consumers buy not just the electrical energy itself but also the additional costs of conveying the electricity to the consumers' premises and metering, settlement, and invoicing. These costs amount to about 60% of the invoice. Electricity that is generated within a consumer's premises can be consumed at no additional cost by the consumer, and surplus electricity can be exported into the connecting network. Retailers will usually purchase any surplus electricity generated, but the price that is given for electricity is the 'energy cost' only (about 40%). This is much lower than the cost of buying electricity due to the additional conveyance costs.

4.6 Prosumer participation

HEMS technology can help consumers maximise the benefits of self-generated electricity by automatically scheduling electricity consumption for when that electricity would otherwise be exported into the connecting network. A HEMS could also be able to reduce the purchasing cost of electricity by either managing consumption more efficiently or controlling appliances to operate only when electricity is at the most advantageous price.

Many distributors offer 'time of use' pricing plans with different network prices at different times of the day. The more demand on the network, the higher the network price will be, signalling to consumers that demand should be reduced during those periods.

Typically, peak price occurs between 7 am and 9 am and 5 pm and 11 pm, particularly during the winter weekday period. By automatically moving discretionary electricity consumption out of these hours into adjacent lower-cost periods, prosumers and consumers can save on the purchase price of electricity through the potential deferment of infrastructure spend.

Electricity retailers and networks can provide information on pricing plans that could benefit consumers who are able to change the time that they use electricity. If your retailer cannot give you details on TOU pricing plans, approach other retailers and the network that your premises is connected to.

For more information, see Appendix A.

APPENDIX A – HOUSEHOLD SMART HOME READINESS

A1 General

To become 'smart home ready', you'll need to consider three things:

(a) The way you currently use technology in your home;

(b) How open you are to adopting new technology; and

(c) How important energy efficiency is to you.

To help clarify your thoughts, take the quiz below.

A2 Assessment scoring

There are 15 questions in total. Each question has up to five possible answers. Choose only ONE answer.

In the left-hand column of the assessment table simply circle which answer best describes your current situation, then use the right-hand column to write in your score from the values listed in the table below.

Answer	Score
a	4
b	3
c	2
d	1
e	0

A3 Understanding your total score

Once you have completed the preliminary assessment, total your score. That score will sit within a certain range. The score range is designed to identify the extent of your household preparedness and readiness to engage in starting your smart home journey.

NOTE – For a full explanation of the score range, see A5.

Remember, it takes just one smart appliance to start the journey. We are confident that once you see the potential savings (without having to change your lifestyle), then 'setting and forgetting' other appliances in your home will appear very attractive.

A4 Preliminary assessment

	Question	Score
1	**Are you on the electricity grid or off-grid?**	
a	I am purely off-grid on my own form of energy generation (distributed energy resources) through a fully integrated energy storage (batteries) and control system.	
b	I can switch (when necessary) between either because I have adequate energy storage capacity and distributed energy resources to support most of my daily power needs.	
c	I am reliant on the grid for most of my energy needs, though I do have photovoltaic (PV) panels to help reduce my hot water energy consumption.	
d	I am totally reliant on the grid for all of my energy needs.	
2	**Is your home Internet enabled?**	
a	I have a satellite connection.	
b	I have a fibre connection.	
c	I am connected via copper cable.	
d	I use my mobile to connect via Wi-Fi.	
e	I have no connection at all.	
3	**Do you consider yourself to be Internet savvy?**	
a	Yes, I have a good grasp of the 'Internet of Things' and the interoperability of smart appliances and other devices in the home.	
b	Yes, I have a reasonable understanding of the Internet and the general interoperability of smart appliances and other devices in the home.	
c	Despite regularly interfacing with the Internet and having a handful of potentially smart devices, I don't really understand how the Internet can help improve my energy efficiency.	
d	I engage with the Internet primarily for entertainment purposes and that's about it. I have no idea about its relationship to smart appliances or devices in the home.	
e	I am not Internet savvy at all.	
4	**How would you describe yourself relative to the adoption of technology in your home?**	
a	An adopter of the very latest in innovative technology, well before the local market catches on.	
b	An early adopter of technology, maybe the first in my neighbourhood, community or town.	
c	I am part of the early majority; I know maybe a handful of people with this technology.	
d	I prefer to sit back and let the market mature before I dive in.	
e	I eventually take on new technology, usually because I cannot get an exact replacement or spare parts for my existing electrical equipment.	
5	**Do you know how to work the electrical appliances and devices in your home?**	
a	I know how to use all my appliances and devices.	
b	I have a good general understanding of most of my appliances and devices.	
c	I have a basic understanding of my appliances and devices.	
d	I have little or no understanding of my appliances and devices.	
e	I ask someone else to show me how things work.	

	Question	Score
6	**What type of user is your household?**	
a	Low energy user.	
b	Low to medium energy user.	
c	Medium to high energy user.	
d	High energy user.	
e	I don’t care.	
7	**Are you ‘energy conscious’?**	
a	Yes, very.	
b	Most of the time.	
c	Occasionally, especially when I get a large power bill.	
d	I don’t consciously think about it.	
e	I don’t care.	
8	**Are you satisfied with your current energy use?**	
a	Yes. I have a good understanding of my energy usage and my power bills fall within my expectations.	
b	Definitely not. I have analysed my power usage to get to the bottom of why my power bill fluctuates so much, and I am taking action.	
c	Not really. My appliances use a lot of energy, but I don’t know what to do about it.	
d	I know that my appliances use a lot of energy, but I don’t consciously think about it. I just accept that I use a lot of electricity.	
e	I know I use a lot of energy, but I cannot do anything about it as I am a renter.	
9	**How often do you analyse your home energy usage?**	
a	Monthly.	
b	Every 6 months.	
c	Yearly.	
d	When my electricity bill comes in.	
e	I don’t.	
10	**How often do you actively shop around for the best power prices?**	
a	Seasonally.	
b	Every 6 months.	
c	Yearly.	
d	Only when I am not sure that I am receiving reasonable value and service from my electricity provider.	
e	I don’t shop around.	

	Question	Score
11	**Are you a producer, consumer, or prosumer (both producer and consumer) of electricity at home?**	
a	I am a prosumer and I generate more than 50% of my energy on-site.	
b	I am a prosumer and I generate about 20% to 40% of my energy on-site.	
c	I am a prosumer and I generate about 10% to 15% of my energy on-site.	
d	I am strictly an 'on-grid' consumer of electricity.	
e	I don't know.	
12	**How do you track your energy usage?**	
a	Through a smartphone or computer app.	
b	Through my monthly online account.	
c	By reviewing my power bill when it arrives in the post.	
d	I don't. I just pay the bill.	
13	**Do you compare your home's energy consumption against others in your street, neighbourhood, town, or with your friends?**	
a	Yes, regularly.	
b	Occasionally.	
c	Rarely.	
d	Never.	
e	I don't care.	
14	**How do you control the appliances and devices in your home?**	
a	A standalone home energy management system (HEMS) does all the work.	
b	A basic HEMS controls some equipment, such as lighting and home entertainment.	
c	I switch most appliances and devices on and off manually, but I also use timers.	
d	I switch all appliances and devices on and off manually in response to off-peak electricity pricing plans (for example day/night).	
e	I switch all appliances and devices on and off manually, as I see fit.	
15	**Do you prefer to use high-energy-consuming appliances (for example, washing machines, clothes dryers, and heaters) during off-peak times when electricity prices are cheapest?**	
a	Always.	
b	Regularly.	
c	Occasionally.	
d	Rarely.	
e	I don't care when I use them.	
	Total	

A5 Understanding your score

Range	Your level	Assessment
0 – 13	**Entry** Level 1	You're probably using and paying far too much for your electricity. There's a lot to learn about energy efficiency, so turn to A6 for some tips on how to increase your knowledge and improve your situation.
14 – 25	**Traditional home** Level 2	The main issue for you is that you don't really know how to lower your energy use. You are probably using and paying too much for your electricity. See A6 for ways to improve your situation.
26 – 38	**Piecemeal automation** Level 3	You know a bit about technology interoperability and its relationship with energy efficiency. You are doing your best to address high consumption but would benefit from a greater understanding (professional advice, perhaps) of how to maximise efficiency and the advantages of becoming a prosumer. See A6 for ways to improve your situation.
39 – 60	**Full integration** Level 4	You have a good understanding of technology interoperability and its relationship with energy efficiency. Your home probably has LED lights, as well as smart appliances and distributed energy resources such as solar PV or an EV (maybe both). However, your HEMS is most likely a hybrid or standalone system, which means it can't communicate with the local electricity network, so you are missing out on prosumer benefits such as supply, flexibility, and the potential financial incentives that support these platforms. See A6 for ways to improve your situation.
Aspirational	**Ambient and invisible integration** Level 5	You have a comprehensive understanding of smart technology's role in an energy-efficient home environment. This is reflected in seamless interoperability of distributed energy resources, appliances, and other devices in the home, together with potential for a secure real-time data communication between a local FP and your fully integrated HEMS. For many people, this level is aspirational, but it is achievable within a reasonable time Zand will pay dividends in years to come. See A6 for further information on becoming smart grid enabled.

A6 Practical guidance for becoming smart grid ready

When it comes to energy efficiency, households are at different points in terms of technology and budget. Ideally in the next 12 to 18 months, you'd revisit the preliminary questions to see where you are, then take another look at what you need to do to get to the next level.

Your level	Guidance
Entry Level 1	Start tracking your energy bills so that you can compare what is happening month to month. Once you have a better understanding of how much you are paying, assess how you typically use energy within the home, paying attention to which appliances consume a lot of energy. Then ask, 'Could I use less energy without affecting my lifestyle by moving the times I operate some of my appliances to a time when electricity is charged at a lower rate?' If the answer is 'yes', congratulations! You are on the way to reducing your power bill. While you are assessing your appliance use, also check the energy rating labels (how many stars each appliance has). More stars mean the appliance uses less energy. EECA has information and advice about the energy efficiency of your appliances. Visit www.eeca.govt.nz or call 0800 358 676 for free advice. Consumer (0800 266 786) also provides advice on appliances and other devices by comparing their performance in laboratory tests. Now that you understand the key areas of energy use within your home based upon your lifestyle, it is time to ensure you are being charged the best rates relative to your requirements. Powerswitch is useful for comparing different electricity retailers' TOU rates. Visit powerswitch.org.nz, call 0800 266 786, or email info@powerswitch.org.nz.
Traditional home Level 2	Identify where you're using the most energy and determine how much you are paying for it. Assess how you typically use energy, paying close attention to which appliances consume a lot. Also review your current TOU profile. To start, concentrate on one or two areas that use a lot of energy. Consider what you need to do to create greater energy efficiencies. With lighting, for example, you could replace traditional lamps with LEDs for immediate savings. Look at TOU for your dishwasher, dryer, and space heaters. Think about replacing traditional electric heaters with heat pump technology and perhaps get a registered electrician to retrofit your electric hot water cylinder with a smart thermostat that is 'communication capable'. Accept that it will be almost impossible to participate in a smart grid network future unless your home is Internet enabled. Internet service providers (ISPs) and mobile phone companies can help you address your specific Internet needs. If you are not yet connected, now is the time.

Your level	Guidance
Piecemeal automation Level 3	Some of your devices could already be operating through a mobile app or enhanced automation platform (for example, Apple HomeKit, Amazon Alexa, Google Home or Google Assistant). However, these platforms do not make your home smart-grid-enabled. Rather, they tend to be standalone or hybrid-type systems that will need to be able to freely exchange data and control through your local network provider or FP. To determine which system is best for you, ask a HEMS specialist or contact your local service provider to recommend a supplier whose equipment is compatible with their network communication protocols. Consider installing distributed generation. This may come down to budget, but as a future participant in the energy market (supply and flexibility), you should in the first instance look to either wind turbines or solar (PV) panels, or both, as well as an energy storage system that will meet a large part of your immediate home energy needs and allow you to engage with a future FP. This progressive transition moves you from an electricity consumer to a prosumer. For more information and professional advice on distributed generation, contact a Sustainable Energy Association of New Zealand member through www.seanz.org.nz.
Full integration Level 4	Most of your appliances have a high level of energy efficiency and contain built-in modules with the capacity to communicate either through a HEMS platform or externally. The key here is to ensure they are able to freely exchange data and control through your local network provider, or a future FP. If this is not the case, you might be able to retrofit communication modules. Either way, consult your local HEMS specialist to ensure appropriate alignment with local network communication protocol requirements. From a distributed generation perspective, it is likely that you already have wind turbines or solar (PV) panels, or both, in conjunction with an energy storage system that not only meets a large slice of your immediate home energy needs, but will also allow you to engage with a future FP. Distributed generation includes electric vehicles (EVs). If you have or are considering purchasing an EV, ensure that the smart charger is capable of communicating with the local electricity provider or future FP. For more information on residential EV smart charging installations, download our free guide, SNZ PAS 6011 *Electric vehicle (EV) chargers for residential use*, contact EECA on 0800 358 676 or ask a registered electrician to ensure that your smart charger is installed correctly.
Ambient and invisible integration Level 5	You are already enjoying the benefits of a fully integrated and digitally controlled home environment, which is reflected in the seamless interoperability of distributed energy resources, appliances and other devices. Once contracts are in place, your HEMS automation system will be ready to interact with a smart grid network at any time so that you can reap the rewards of living in a truly flexible, energy-exchanging home.

A7 Other preliminary considerations

It's important that the technology you invest in **now** is appropriate for a smart home environment future. To ensure FPs provide the level of cyber security necessary to maintain the integrity of your home's systems and ensure that issues are appropriately addressed to maintain operational integrity (for example, issues could involve electrically controlled medical equipment or devices), then they will need to be registered with the Electricity Authority.

Questions to ask when you're buying a smart device

As a consumer or prosumer, ask retailers about the smart readiness of any appliance you are considering buying. If they cannot answer the following questions, find a retailer that can, or engage directly with the manufacturer or importer.

(a) Does the device feature connectivity? (In other words, can it receive and react to external signals to turn off or reduce load?)

(b) If the device does feature connectivity, what communication protocol does it use? (Smart devices use open communication protocols such as OpenADR v.2.)

(c) Is the device genuinely 'smart'? ('Smart' doesn't mean you can use your cell phone to turn it on or off. Rather, 'smart' means that the device is designed for interoperability and can communicate with an FP and other home devices in a HEMS network.)

(d) Do software updates happen automatically? (In order to keep your home cyber secure, Internet security protocols could change over time. You should ensure that, at a minimum, this occurs via a message, but it is easier if the changes are fully automated.)

(e) Is the smart device proprietary? (Some manufacturers will try selling you their equipment exclusively to lock you into a 'whole of home' solution. This could mean you cannot switch FPs at will.)

(f) What is the appliance's star rating? (The star rating label shows the appliance's energy efficiency information and how it compares to similar appliances. Don't use price as the only factor when purchasing an appliance because the lifetime running costs will dwarf the difference in price at the point of sale.)

Questions to ask when you're choosing an FP

(g) Is the FP a registered company? Is it a registered participant with the Electricity Authority?

(h) Does the FP have an agreement that sets out the terms and conditions and benefits?

(i) Does the agreement specify certain electricity retailers only?

(j) What are the benefits and are they 'on event'[8] or is there a standing access fee?

(k) Can the FP integrate with my appliances and equipment, or will other equipment be needed? If additional equipment is necessary, does the FP supply it? If I have to buy it, is it proprietary to that FP only?

8 Events are extracted from web services, user activities, system log, database, and so on.

(l) Is the communication secure? (In other words, is communication encrypted to protect my privacy?)

(m) Will the control exerted on consumption or generation impact my comfort or lifestyle?

(n) How do I contact the FP if the service contracted for does not operate (for example, there is no hot water or the EV won't charge)?

(o) What is the process if I purchase new or replacement appliances?

NOTE – If you are medically dependent, as set out in the consumer care guidelines, ensure that the FP is aware.

A8 Buying new or retrofitting?

Consumers and prosumers need to assess their home for connectivity in the first instance.

A smart home is a network of appliances that work together to minimise your energy consumption and are connected to an external FP to obtain the best available electricity price.

If you are just beginning your smart home journey, retrofitting can be a low-cost option to get you started. Then, when an appliance needs replacing or upgrading, buy a genuine smart device. A smart device will integrate seamlessly into your smart home network.

In the future, to make them easier to identify, smart devices will be labelled at the point of sale. In the interim, do your research, ask questions of the retailer or supplier, and take advice from suitably qualified experts (your electrician can be a valuable resource). Always remember that government agencies such as the following can provide you with advice and information:

(a) The Energy Efficiency and Conservation Authority (EECA) provides smart device advice;

(b) The Electricity Authority (EA) regulates the electricity market and ensures that consumers and prosumers have access to advice on how to connect to the network and minimise electricity costs;

(c) The electrical safety regulator WorkSafe – Energy Safety monitors and enforces compliance with safety requirements for New Zealand homes and appliances.

APPENDIX B – TECHNICAL SPECIFICATIONS

B1 General

This section describes the recommended minimum performance of products that should be used within a smart home system. It also provides guidance for equipment suppliers to help ensure they meet their existing compliance regulation obligations, understand any potential future obligations, and are aware of the typical specification levels EECA would assess for any future incentive programmes.

B2 Air conditioners/heat pumps

The energy performance level of most residential heat pumps/air conditioning units sold in New Zealand is covered in the Energy Efficiency (Energy Using Products) Amendment Regulations 2020, which are a mandatory requirement under New Zealand law.

For simple reference, an energy rating label (ERL) is provided at the point of sale so that consumers can quickly assess the energy performance and consumption level by climate zone. In Figure B1, New Zealand is in the 'cold' (black) zone.

To minimise the amount of electricity used to heat or cool your home, choose the highest performing unit within your budget, where possible.

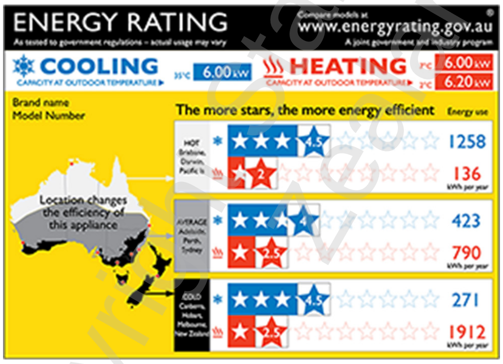

Figure B1 – An ERL showing New Zealand in the 'cold' zone

Between 2012 and 2021, the vast majority of heat pumps (also known as air conditioning units) sold in New Zealand had connectivity included or could be made demand-responsive with a simple upgrade. Email the supplier to find out what you'll need to make your model suitable for a demand flexibility programme.

Where possible, units should be configured to operate using open communication protocols such as OpenADR and IEEE 2030.5. This will ensure that consumers are not locked into proprietary solutions where only the supplier-provided system can be used.

B3 Dishwashers, clothes washers, and clothes dryers

The energy performance levels of most whiteware units sold in New Zealand are covered in the Energy Efficiency (Energy Using Products) Amendment Regulations.

To minimise the amount of electricity used in your whiteware appliances, use the energy rating label to select the highest performing unit to suit your budget.

EECA has also developed the Efficient Appliance Calculator[9] to enable online users to compare appliances and easily identify the most efficient product.

B4 Electric hot water systems

The energy performance levels of most electric hot water cylinders sold in New Zealand are covered in the Energy Efficiency (Energy Using Products) Amendment Regulations.

Hot water accounts for around one third of all residential electricity costs, so selecting the most efficient unit possible will help reduce the amount of energy your household pays for.

Very few traditional hot water cylinders provide connectivity, so a smart thermostat will more than likely be needed to connect to a flexibility provider. Smart thermostats are relatively 'low cost'; a qualified installer or electrician can probably provide one. Ensure all safety requirements are addressed when arranging to have a smart thermostat retrofitted to your cylinder and consult the manufacturer or supplier for advice and guidance.

Many newer hot water technologies (such as heat pump water heaters or hydronic units) are very energy efficient, with built-in connectivity. If you are considering buying a new system, make sure you select a 'smart' device.

Irrespective if for retrofit or new technology, select technology that can operate using open communication protocols (such as OpenADR or IEEE 2030.5) to maximise the flexibility of your device and ensure you can switch flexibility providers to suit your circumstances.

B5 Distributed energy resource systems

To enable direct current (DC) output to be converted to alternating current (AC), home battery systems and solar PV panels are paired with inverters. They (home batteries, solar PV panels, and inverters) are broadly referred to as distributed energy resources (DER) and should be considered at the same time as they form a system.

Neither home batteries, solar PV panels or inverters are regulated for energy efficiency in New Zealand, but there is e-regulation on safety and grid connectivity.

9 https://genless.govt.nz/for-everyone/at-home/choose-good-appliances/efficient-appliance-calculator/.

Inverters are regulated under Part 6 of the Electricity Industry Participation Code 'Connection of distributed generation', which specifies requirements to be connected to the grid. For inverters of 10 kW or less, refer to:

(a) AS/NZS 4777.1 *Grid connection of energy systems via inverters – Part 1: Installation requirements*; and

(b) AS/NZS 4777.2 *Grid connection of energy systems via inverters – Part 2: Inverter requirements*.

Each electricity distribution business (EDB) has an approved list of inverters that can be used in its network. Always work closely with your device provider and your electricity supplier to ensure safe and suitable technology is selected.

Most DER-supplied technology in New Zealand will have the ability to communicate and react to external signals. Ensuring open communication protocols can be used with your DER devices is critical to realising interoperability and maximising the return on your investment.

B6 Solar PV panels

Solar panels' cell efficiency can be quite low, but more efficient panels generate more energy per m^2. Solar panel manufacturers are graded under a 3-tier system, where tier 1 is considered the best. Consult your technology and electricity provider to ensure your PV system operates at the most efficient level and that all safety and grid connection requirements are met.

B7 EV chargers

EECA is consulting with industry on the efficiency and connectivity requirements of EV chargers.

It's anticipated that EVs will eventually be the largest electricity-consuming devices attached to home networks, so it is imperative that all safety requirements are met. Before buying a 'smart' EV charger, consult a suitably qualified installer and your electricity provider.

In the future, chargers are likely to be regulated for efficiency and connectivity, in addition to the current safety requirements. In the interim, EECA has provided a residential PAS (SNZ PAS 6011:2021 *Electric vehicle (EV) chargers for residential use*) to help buyers make informed EV charger choices.

B8 LED lamp specification

LED lighting is not currently regulated for energy efficiency.

The following specification is provided as a general guide for efficient LED lighting. In terms of a smart home, LEDs are best placed as part of a smart residential lighting system (see 2.5.9).

Attribute	Product criteria
LED lamp	A60 or similar
Brightness	60 W equivalent (± 800 lumens) or, 100 W equivalent (± 1400–1600 lumens)
Colour rendering index (Ra)	Minimum 80
Lighting source efficacy levels	Minimum 80 lumens/watt
Lifetime	L_{70}/B_{50} (70% of original lamp light output and 50% failure of the test population) at 15,000 hours

NOTES

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