Victorian Energy Upgrades Proposed Activity

Smart Thermostats Issues Paper

VICTORIA State Government | Environment, Land, Water and Planning

Author
This document has been prepared by the Department of Environment, Land, Water and Planning.

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Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

Accessibility

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Overview

About the Victorian Energy Upgrades (VEU) program

The Victorian Energy Upgrades (VEU) program is established under the *Victorian Energy Efficiency Target Act 2007* to help Victoria reduce its greenhouse gas emissions, reduce the use of electricity and gas and invest in industries that provide energy demand management technology and services. The program provides subsidies for residential and business consumers to reduce their energy use by upgrading appliances, processes or buildings.

The VEU program works by creating financial incentives for households and businesses to undertake energy saving activities. When accredited businesses (known as accredited providers) undertake eligible energy efficiency improvements in homes or businesses, they create Victorian Energy Efficiency Certificates (VEECs). Each VEEC represents one tonne of greenhouse gas emissions saved over the lifetime of the activity or product installed. VEECs can then be sold to energy retailers who must meet an emission savings target each year based on their annual electricity and gas sales.

The VEU program includes energy saving activities for both households and businesses. Activities currently available for households in the program include lighting upgrades, installation of shower roses, upgrades to hot water systems, space heating and cooling upgrades, and building shell upgrades such as weather sealing.

Purpose of the smart thermostat issues paper

The Department of Environment, Land, Water and Planning (the department) is looking at expanding the range of energy efficiency upgrades (activities) available under the VEU program and seeking feedback from stakeholders on four potential new activities, including;

- upgrades to the refrigeration equipment of cold rooms
- installation of Energy Management Information Systems (EMIS) in commercial buildings
- upgrades to install lagging (or insulation) on pipework for gas systems
- the installation of smart thermostats for residential heating and cooling systems.

The purpose of this document is to set out options to introduce the installation of smart thermostats for residential customers as an activity in the VEU program, and to seek the views of interested stakeholders.

Have your say

Stakeholders can submit their feedback on the four potential new activities using the **new activities consultation response template and/or the survey**, both available on the Engage Victoria website https://engage.vic.gov.au/victorian-energy-upgrades-new-activities-consultation. Please submit your feedback to the questions in the smart thermostats issues paper by completing the new activities consultation response template and/or the survey and uploading your submission to the Engage Victoria website. Feedback from stakeholder submissions will be used to guide creation and implementation of the new VEU activities.

Submissions can also be emailed to energy.upgrades@delwp.vic.gov.au or sent as a hard copy submission to: *Victorian Energy Upgrades, Department of Environment, Land, Water and Planning, PO Box 500, East Melbourne, VIC 8002*. If you make a submission by email or post, please ensure to state whether the department can publish your submission.

This consultation will close on 5 February 2021.

Introduction

Smart home technology

Smart home technology are devices (including smart lights, smart security cameras and smart thermostats) that are connected to a communications network (and therefore 'smart') and allow consumers to monitor and control their home environment from their smartphone or other networked devices. Smart home technology provides ways for consumers to manage their home and can lead to improved convenience, connectivity and control, and increased comfort. Some of these smart home technologies offer the opportunity to optimise the operation of energy-consuming systems in the home. These devices can also lead to better energy management and behaviour change by providing insight into energy usage (**Figure 1**).

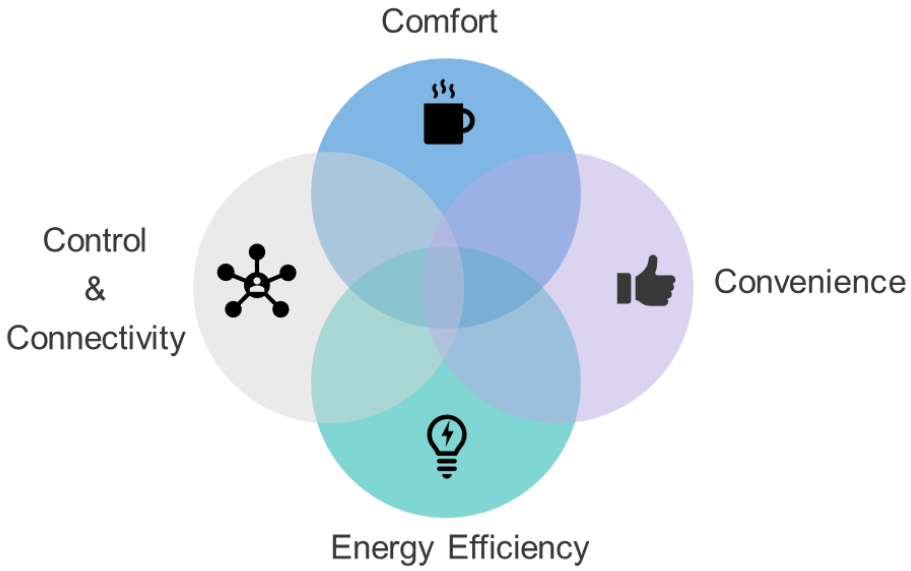


Figure 1 – Consumer benefits of smart home technology

The American Council for an Energy Efficient Economy (ACEEE) estimates that residential sector energy savings could reach as much as 17 per cent if households adopt smart home technology for their major energy end uses – space conditioning, water heating, lighting, kitchen and laundry appliances.[1] In addition, as smart home technologies are connected to communication networks, they can also make consumers integrated and active participants within the energy system.

Demand response involves consumers voluntarily lowering their energy usage for a period of time by automated control or behavioural response. When consumers consent to third parties such as utilities or distributors communicating with smart home technologies to provide demand response, congestion on electricity distribution networks during times of peak electricity demand can be reduced. In some cases, this can mean the need to invest in electricity distribution network capacity can also be deferred or avoided altogether.

1. American Council for an Energy-Efficient Economy, 2018, Energy Impacts of Smart Home Technology.

Smart thermostats

Residential homes with heating and cooling systems (ducted or non-ducted) typically have a pre-existing thermostat. These consist of either:

- a non-programmable thermostat where temperature can be adjusted according to preference
- a programmable thermostat where a user can setup on/off schedules and temperature schedules (some programmable thermostats may be Wi-Fi enabled).

The use of thermostats can greatly impact on heating and cooling efficiency, however, research suggests that homeowners generally do not use programmable thermostats or find programmable thermostats difficult to operate which can lead to higher utility bills.[2] It is estimated that for each degree of additional heating or cooling, energy consumption increases by 5 to 10 per cent.

Smart thermostats are a type of smart home technology which allows users to operate their heating and/or cooling equipment by a smartphone connected to either a cellular or Wi-Fi network. Smart thermostats can be battery operated or hardwired into the heating and cooling equipment. Ducted systems can connect using the existing thermostat wired connection. Split systems use standalone units installed in a location where infra-red signals can be received by the air conditioning unit.

Smart thermostats can be used to directly control equipment and may provide recommendations to householders on their smart phone about their energy usage.

Smart thermostats can provide consumers with the benefits of increased convenience, comfort and control over their heating and cooling system. Smart thermostat also offer various features designed to reduce heating and cooling costs through behavioural and non-behaviour responses (**Table 1**). Behavioural responses can produce energy savings if the user responds to information provided by the thermostat. Non-behavioural responses are hardware related, where the thermostat automatically adjusts its operation to save energy.

Table 1 - Behavioural and non-behavioural responses of smart thermostats

Behavioural Responses	Non-Behavioural Responses
• Interaction through smartphone applications	• Machine learning to optimise schedules based on user behaviour/building thermal capacity
• Provision of intuitive user interface	• Geofencing[3], on-board and or sensor-based occupancy sensing
• Provision of feedback on energy use	• Scheduling and temperature setbacks[4]
• Integration with other smart home devices	• Ability to obtain external temperature readings
	• Detection of system problems

The features present on smart thermostats vary between products. Common energy saving features among smart thermostat products are shown in **Figure 2**.

2. Peffer et al (2011) 'How people use thermostats in homes: A review', Building and Environment.
3. Geofencing involves linking a smartphone to the smart thermostat. Home occupancy can be detected based on the smartphones location.
4. Temperature setbacks are used to reduce how often a heating or cooling system operates. This is achieved by allowing the temperature in a home to drift to a lower (heating mode) or higher (cooling mode) temperature.

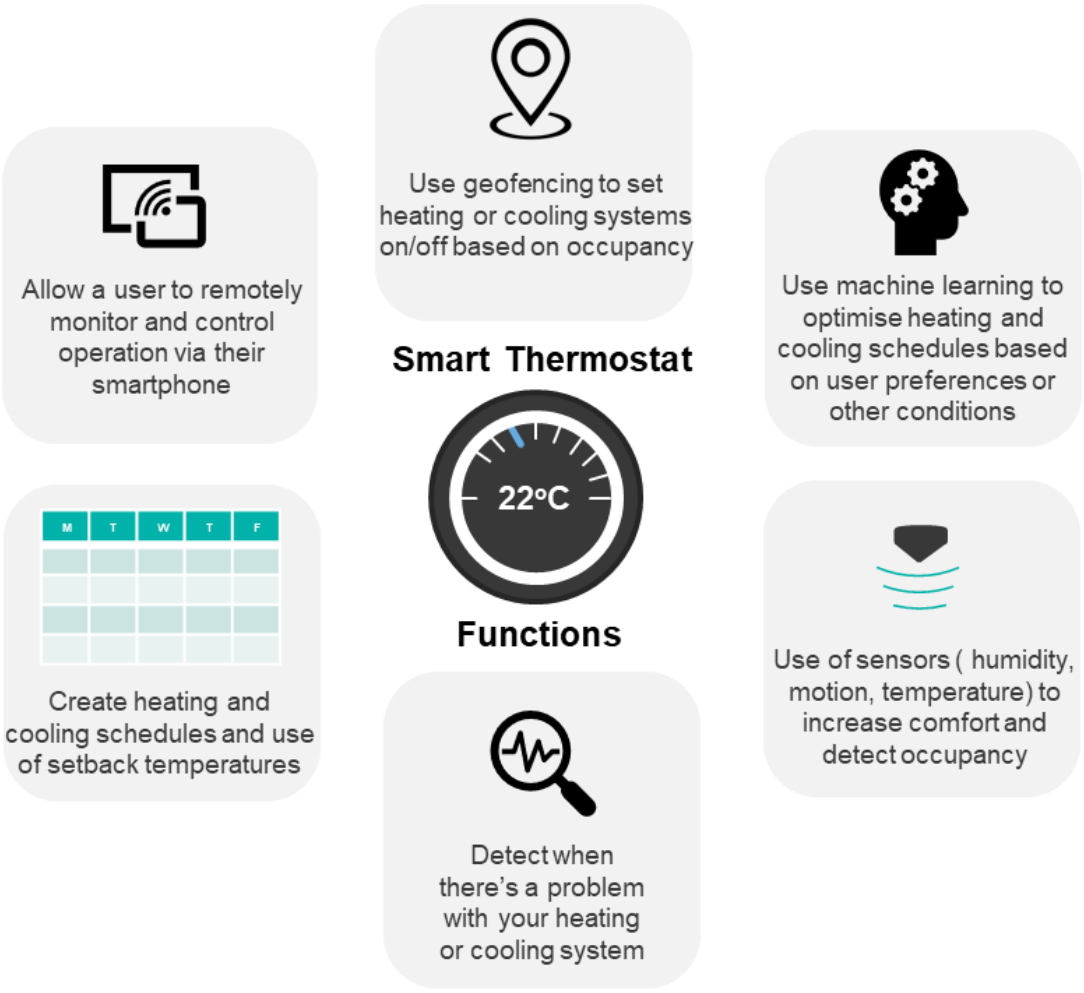


Figure 2 – Energy saving features of smart thermostats

Potential market and benefits

The market for smart thermostats has developed significantly overseas. Approximately 11 per cent of single-family homes in the US have invested in a smart thermostat, with some regions experiencing faster adoption of the technology than others. The Energy Star program run by the U.S. Environmental Protection Agency and U.S Department of Energy has specified energy efficiency criteria for smart thermostats (referred to as 'connected thermostats') which has attached a value to this technology for consumers. Several utilities in the US have also adopted smart thermostats in demand-side management programs to meet demand response and energy efficiency goals. Programs include Commonwealth Edison's (ComEd), smart thermostat rebate[5], Pacific Gas and Electricity Company's (PG&E) smart thermostat rebate[6] and Southern California Edison's smart energy program.[7] The smart thermostat market has also progressed in Europe, with over 20 million installed by 2019.[8] By 2025, over 63 per cent of North American and 41 per cent of European homes are forecast to have smart thermostats installed.[9]

The rise in smart thermostats in both Europe and America has led to a higher level of market maturity. Manufacturers have designed smart thermostats which are compatible with centralised space heating and cooling systems, including forced air furnaces and centralised air conditioning systems.

Smart thermostats have seen minimal market penetration in Australia to date. Installation compatibility issues with common heating and cooling systems have acted as a significant barrier to market development. Smart thermostats have also not been compatible with split system air conditioners. These factors have prevented technology providers from entering the Australian market.

Recently however, smart thermostat vendors have emerged in the Australian market with products suitable for installing with common heating and cooling systems including ducted gas heaters, ducted reverse cycle air conditioners and split system air conditioners. Products have received online promotion by retailers, telecommunication companies and energy utilities as part of a 'smart home'. These products typically retail for between $150-$400, including installation. Variations in price are commonly driven by product and installation costs. For split system air conditioners, smart thermostats are paired via an infra-red connection and are simple to install. For ducted systems, products are hardwired and require a licensed tradesperson to be installed.

The estimated stock of space heating and cooling equipment (predominantly split system air conditioners, ducted gas, and ducted reverse cycle air conditioners) in Victoria is in excess of 3 million units (**Table 2**). This coupled with the current low penetration rates of smart thermostats presents a large pool of opportunity for installation.[10] Additionally, there is supporting evidence of a growing consumer awareness of smart thermostats and an intention to purchase this type of smart home technology.[11]

Table 2 - Estimate numbers of space heating and cooling systems in Victoria[12]

Space Heating/Cooling Equipment	Estimated No. of Units
Split system air conditioners	~2,080,000
Ducted gas heaters	~1,140,000
Ducted reverse cycle air conditioners	~198,000

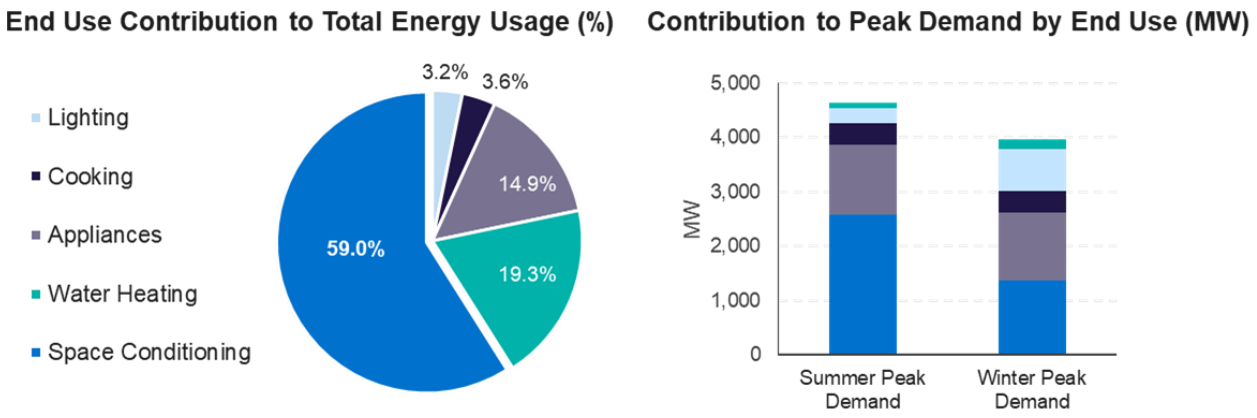
Almost 60 per cent of residential energy use in Victoria is used for space conditioning (**Figure 3 - left**). Although energy use is typically dominated by heating due to Victoria's climate, the rising use of split system air conditioners for cooling also contributes toward periods of summer peak demand (**Figure 3 - right**).

5. Commonwealth Edison, Smart Thermostat Rebates - https://www.comed.com/WaysToSave/ForYourHome/Pages/SmartThermostatRebates.aspx
6. Pacific Gas and Electricity Company, Smart Thermostat Rebate - https://www.pge.com/en_US/residential/save-energy-money/savings-solutions-and-rebates/rebates-by-product/smart-thermostats/smart-thermostats.page
7. Southern California Edison, Smart Energy Program - https://pages.email.sce.com/scesmartbonus/
8. Statista Research Department (2018), 'Houses with smart thermostat in the European Union (EU) 2014-2020.
9. Frost & Sullivan (2019) 'Global Smart Thermostats Markets, Forecast to 2025'.
10. Existing thermostats may use proprietary software which can reduce compatibility with smart thermostats, reducing the pool of opportunity
11. Essential Research, (2019) 'Energy Consumers Australia, Energy Consumer Sentiment Survey 2019'.
12. Data from Residential Baseline Study for Australia (2000-2030). https://www.energyrating.gov.au/document/2015-data-tables-residential-baseline-study-australia-2000-%E2%80%93-2030

Periods of peak demand can cause increases in wholesale market spot prices, and where the electricity network is augmented to accommodate demand, can increase network costs. These costs are passed on to a consumer's final energy bill.

By using their energy saving features, smart thermostats can improve the efficiency of heating and cooling for Victorian consumers[13], reducing the amount of energy used for space conditioning. In addition, as smart thermostats have communications capability (typically via Wi-Fi), they also offer the opportunity for customers to participate in demand response programs. Where a customer enrols in a third-party or utility led demand response program, smart thermostats can be used to increase or decrease air conditioning temperatures during periods of peak demand, which can reduce peak demand and provide relief to the grid.

Figure 3 – End use per cent contribution to total energy usage for Victorian households (left) and end use contribution to summer and winter peak demand in Victoria (right)[14]



Consultation questions:

1. Do you think there is a potential market for smart thermostat activities in Victorian homes?
    a. *Yes / No*
    b. Please explain your response.
2. Should the activity be available to residential premises only?
    a. *Yes / No*
    b. Please specify other sectors or types of premises that you think would benefit from this activity.

13 In addition to other service benefits such as of increased convenience, comfort and control over their heating and cooling system.

14. Data from Residential Baseline Study for Australia (2000-2030). https://www.energyrating.gov.au/document/2015-data-tables-residential-baseline-study-australia-2000-%E2%80%93-2030

Smart thermostats as a potential VEU activity

Overview

A smart thermostat activity in the VEU program would involve the installation of the smart thermostat product and connection to an appropriate heating and/or cooling system. This may involve retrofitting a thermostat to an existing split system air conditioner, ducted gas heater or ducted reverse cycle air conditioner.

The installation of a smart thermostat would lead to the creation of VEECs by the accredited provider. The amount of VEECs may vary depending on the space heating/cooling system that it is installed on. The accredited provider can sell these VEECs and create financial incentives which can be shared between them, suppliers and householders.

Creating an activity involves clearly defining what the product is, how energy savings are calculated, and the installations requirements that need to be met. These factors will be discussed in the following sections.

Smart thermostats in energy efficiency programs

Attempts at classifying smart thermostat eligibility for use in energy efficiency programs has been based on device features. Restrictive definitions of the term smart thermostat refer to models with advanced features (such as heat pump auxiliary heat control and optimisation[15], machine learning-based scheduling[16] and built in occupancy sensors).[17] Other definitions capture models that have all the features of programmable thermostats and connected thermostats (thermostats with Wi-Fi capabilities) but also have geofencing or occupancy sensing and offer the capability for demand response. These differences in classification can result in significantly different qualified products in energy efficiency programs.

Research from the US market distinguishes between smart thermostats and 'advanced' smart thermostats based on the energy saving features present on the device (**Table 3**).

Table 3 - Features of smart and advanced smart thermostats

Feature	Smart Thermostat	'Advanced' Smart Thermostat
Wi-Fi Connectivity	✓	✓
Intuitive user interface	✓	✓
Online dashboard that gives remote access	✓	✓
Occupancy sensing (on board, external sensors or geofencing)	✓	✓ (on-board)
Demand response capabilities	✓	✓
Machine learning (algorithms to learn occupant behaviours)	✗	✓
Sensing of external temperature for heat pump optimisation	✗	✓

15. Heat pump optimisation involves optimising compressor runtimes based on weather forecasts.

16 Machine learning means the thermostat has self-learning algorithms and can adjust the thermostats operation based on factors such as weather and occupant schedules.

17 On-board occupancy sensing incorporates movement sensors into the thermostat itself that detect movement in the room the thermostat is located.

Some utility led energy saving programs in the US require thermostats to have 'advanced' smart thermostat features before being eligible for participation.[18] The Energy Star program uses a classification system which resembles the smart thermostat features listed above, excluding occupancy sensing. The program has certified over 56 different smart thermostat products to date. To be eligible to obtain the Energy Star rating, products are required to meet the following key product criteria[19]:

- work as a basic thermostat in absence of connectivity to the service provider
- provide the ability to set a schedule
- give residents some form of feedback about the energy consequence of their settings
- provide information about HVAC (heating, ventilation and air conditioning) energy use, such as monthly run time
- meet temperature accuracy and standby power criteria
- provide the ability to work with utility programs for demand response.

The number of smart thermostats products available in Australia is significantly smaller than the US market, and the department is considering adopting similar product specifications to the Energy Star program criteria. These specifications will need to be adjusted to suit an evolving smart thermostat market in Australia.

Smart thermostats and demand response

As smart thermostats are the most common approach to air conditioner demand response in the US, the Energy Star program has also published criteria for smart thermostat demand response capability. This includes:

- the thermostat having a communication link that facilitates the use of open standards
- an interface specification or application programming interface to enable demand response functionality
- the ability for consumers to override a demand response signal
- a summary description of the product and/or associated service provider's demand response capabilities/services.

The Energy Star program specifies several open standards that the thermostat can adopt. However, these standards are not currently applicable in Australia where frameworks for demand response are evolving. The standard AS4755 'Smart Demand Response Capabilities for Selected Appliances' proposes a technical standards framework for air conditioners, electric storage water heaters (resistive), devices controlling swimming pool pump units and electric vehicle charger/discharger controllers. Smart thermostats are not covered by the proposed AS4755 standard. Part of the reason for this is because they rely on a signal being sent from the smart thermostat to the air conditioning unit to reduce or increase the temperature which reduces energy usage, as opposed to delivering the measurable load reduction under the various demand response modes (DRMs) outlined in AS4755.

In the absence of technical standards for demand response capability, the VEU program is considering what the relevant requirements for smart thermostats should be, for example:

- the smart thermostat has Wi-Fi capability
- provision of a statement evidencing demand response capability which provides information on:
  - demand response functionality provided by the device
  - any common standards or open source protocols used by the device
  - evidence of any past participation in demand response programs.

18. Bonneville Power Administration: Residential Smart Thermostat Qualified Product List.
19. Energy Star Program Requirements for Smart Thermostats - https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf

Potential VEU smart thermostat criteria

A potential set of smart thermostat criteria for stakeholder feedback is listed in **Table 4**. Noting that criteria 1, is for ducted systems only where the smart thermostat is hardwired.

Table 4 – Potential VEU Smart Thermostat Criteria

Criteria No.	Description
Product Requirements	
1.	For ducted systems where the smart thermostat is hardwired – in the absence of connectivity to a networked device (such as a smartphone), allows a consumer to: a. View the room temperature b. View and adjust the set temperature c. Switch between off, heating and cooling.
2.	Provide the ability for consumers to set and modify a heating/cooling schedule for a space.
3.	Provide feedback to occupants about the energy impact of their choice of settings.
4.	Provide the ability for consumers to access information relevant to their energy consumption, e.g. system run time.
5.	The product shall be capable of collecting the following data, including where noted, to the indicated resolution and accuracy: a. Unique thermostat ID b. Controlled equipment type c. Hourly average conditioned space temperature (reported to nearest 1°C)[20] d. Hourly average heating set point temperature (reported to nearest 1°C)[21] e. Hourly average cooling set point temperature (reported to nearest 1°C)[22].
6.	Provide the ability for consumer to use geofencing to reduce energy use.
7.	Static Temperature Accuracy < +/- 0.5°C.
8.	Network Standby Average Power Consumption < 3.0 W.
9.	Time to enter network standby after user interaction < 5 minutes.
10.	If battery powered, uses a battery that has a rated lifetime of at least 3 years when operating under normal circumstances.
11.	Uses for its communications with the sensing apparatus and any display device, an encrypted communication protocol.
12.	Uses for its communications with the heating and cooling system and the smart thermostat, an encrypted communication protocol.
13.	The customer is able to permanently erase all information held by the product.

20. Energy Star criteria are listed to the nearest 0.5°F.
21. Energy Star criteria are listed to the nearest 1°F.
22. Energy Star criteria are listed to the nearest 1°F.

Criteria No.	Description
14.	Any other data privacy requirements specified by the department.
Demand Response Requirements	
15.	Wi-Fi connectivity.
16.	Demand Response Capability Statement which contains information on: - any common standards or open source protocols used by the device which can be utilised by a remote agent or aggregator - evidence of past participation in demand response programs.

Consultation questions:

3. Are there VEU smart thermostat eligibility criteria that should be modified, removed or added?
    a. *Yes / No*
    b. Please explain your response.
    c. Do you have any other feedback on the proposed VEU smart thermostat eligibility criteria? *Yes / No*
    d. If yes, what is your feedback?
4. Should products that wish to be registered under the program provide a demand response capability statement?
    a. *Yes / No*
    b. Please explain your response.
    c. What other additional information should be provided?
5. Are there any other technical demand response requirements the department should consider for smart thermostats?
    a. *Yes / No*
    b. Please explain your response.

Energy savings and VEEC incentives

Field studies for smart thermostats have demonstrated savings between 5-10 per cent for heating and 8-16 per cent for cooling, relative to a pre-existing manual or programmable thermostat.[23] Literature reviews on the energy savings potential for smart thermostats report on average of 8-15 per cent reduction in HVAC usage.[24] These are typically based on results from product manufacturers, or through evaluation of utility led programs. However, results between studies are variable, and trials of the energy efficiency of these products have not been conducted within Australia.

It can be difficult to draw conclusions from studies due to variations in the smart thermostats tested (i.e. different energy saving features) in addition to differences in climate, study design and customer demographics. The Energy Star program has reduced this uncertainty by only certifying products that have verified energy savings based on field data collected from over 1,000 homes. For a smart thermostat to pass the measurement and verification process for the Energy Star program, there must be an annual per cent run time reduction (or mean reduction in energy use) of 8 per cent or more in heating and 10 per cent or more in cooling.

The number of VEECs that an activity can create depends on the amount of greenhouse gas emissions reduction the activity will cause. A deemed energy savings method is used to estimate the typical emissions savings for an activity. Based on the reported energy savings for smart thermostats, the department is considering a deemed value of 8-10 per cent yearly energy savings for heating and cooling energy usage based on a conservative estimate from the range of results that have been achieved. Total energy savings and therefore avoided emissions will also require consideration of the product lifetime and persistence of savings for both ducted (fixed products) and non-ducted (non-fixed products) systems. The department may also consider limiting the number of smart thermostats to one per household.

Incentives for Demand Response

As smart thermostats can provide energy efficiency and benefits to consumers through reducing demand on the electricity network, where devices are rolled out as part of a demand response program, the VEU program may consider giving additional VEECs to these devices.

Consultation questions:

6. Is there any data available on the energy savings from smart thermostats in Victoria or Australia that you know of and can share with the department?
    a. *Yes / No*
    b. What is that data?
7. What are other considerations the department should make in the deeming method for smart thermostats?

23. Urban, (2016) 'Energy Savings from Five Home Automation Technologies: A Scoping Study of Technical Potential'.
24. American Council for an Energy-Efficient Economy, 2018, Energy Impacts of Smart Home Technology.

Implementation

A register of approved products would be developed for the smart thermostat activity. Smart thermostats would be approved by the Essential Services Commission only if the product meets the technical specifications developed by the VEU program.

To create a VEEC in the VEU program, a person or business must become an accredited provider. While accredited providers do not necessarily carry out all facets of a VEU activity (for example, they may subcontract installation or act as an aggregator of activities), they are responsible for the correct creation of VEECs in compliance with the Victorian Energy Efficiency Target Act and Regulations and requirements of the Essential Services Commission.

It is expected that accredited providers will need to use appropriately qualified and trained installers to complete VEU smart thermostat activities. As accredited providers are responsible for making sure all their sub-contractors are appropriately licensed and trained, they may need to develop and implement training programs or have these delivered by other training organisations. All smart thermostat installations would have to meet the installations requirements administered by the Essential Services Commission in order to create VEECs. For smart thermostats which require modification to any electrical circuit, a tradesperson may be required. For smart thermostats which do not require modification to any electrical circuit, installers will be required to be appropriately trained on the functionality and limitations of the smart thermostats they are installing.

Consultation questions:

8. Are there technical installation requirements that you think are necessary?
    a. *Yes / No*
    b. Please explain your response.
    c. What do you think the technical challenges are that might prevent uptake of the activity?

Skills and training requirements

It is expected there will be enough currently active professionals to support undertaking the proposed VEU smart thermostat activity. Stakeholders are encouraged to provide relevant feedback on industry or installer capacity or capability risks and opportunities.

Consultation questions:

9. Are there any skills or training considerations for the proposed activity?
    a. *Yes / No*
    b. If yes, please provide further information.

Submissions

Summary of consultation questions

1. Do you think there is a potential market for smart thermostat activities in Victorian homes?
    a. Yes/No
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    a. Yes/No
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Have your say

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Submissions can also be emailed to energy.upgrades@delwp.vic.gov.au or sent as a hard copy submission to: *Victorian Energy Upgrades, Department of Environment, Land, Water and Planning, PO Box 500, East Melbourne, VIC 8002*. If you make a submission by email or post, please ensure to state whether the department can publish your submission.

Next steps

Key milestones in the introduction of the smart thermostat activity into the VEU program are:

• Open stakeholder consultation on the proposed activity	18 December 2020
• **Close stakeholder consultation on the proposed activity**	**5 February 2021**
• Response to stakeholder consultation on the proposed activity	March 2021
• Consultation on Regulations and Specifications for proposed activity	Second half 2021
• Finalise Regulations and Specifications	Second half 2021
• Smart thermostat activity introduced into the VEU program	Second half 2021