MONASH University

EMERGING TECHNOLOGIES RESEARCH LAB

FUTURE HOME DEMAND:

ANTICIPATING ENERGY AND EVERYDAY LIFE TRENDS ACROSS THREE VICTORIAN NETWORKS

EXECUTIVE SUMMARY

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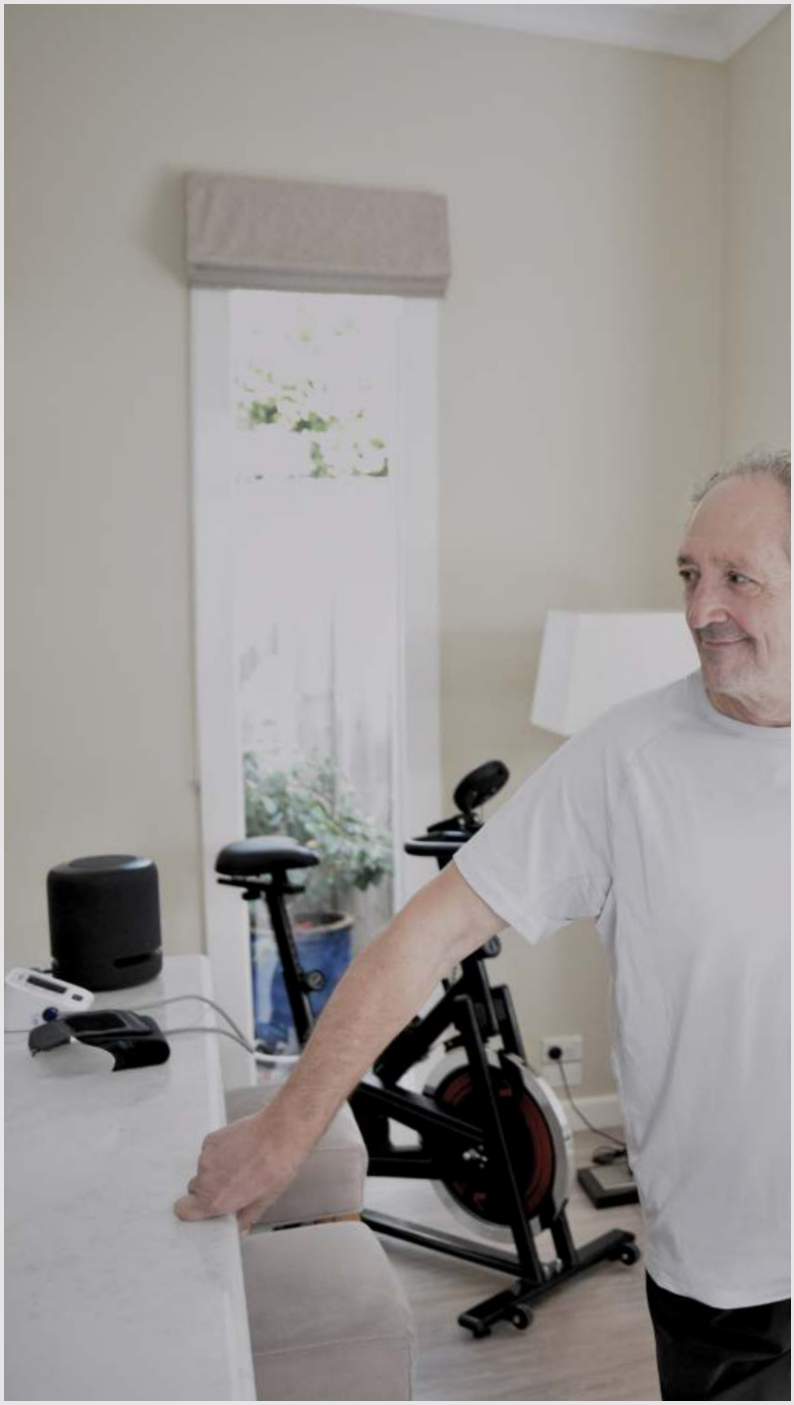
Dr. Kari Dahlgren
Dr. Hannah Korsmeyer
Dr. Fareed Kaviani
Dr. Rex Martin
Professor Yolande Strengers
Professor Sarah Pink

monash.edu/mada/emergingtechlab
monash.edu/digital-energy-futures



The Future Home Demand Report presents the findings of a multi-staged research project with 36 households across the three distribution businesses: CitiPower, United Energy and Powercor, as well as a survey with 1,325 responses from their customers.

This research builds on the methodology and process developed through the Digital Energy Futures Project (DEF), a partnership between Monash University, The Australian Research Council, Energy Consumers Australia, Ausgrid and AusNet Services. The research methodology was tailored to capture the most critical and relevant issues to CitiPower, United Energy and Powercor households and their energy futures, as well as draw on background research already conducted as part of DEF.

This report identifies 51 emerging digital energy future trends in everyday household life, and foresights for energy futures which capture the values, concerns and designs of CitiPower, United Energy and Powercor households about emerging digital and energy technologies.

The report also provides implications for energy forecasting, including demand management opportunities, and possible peak scenarios for consideration in energy planning.

CITY AND INNER-SUBURBS

CitiPower
Powercor
United Energy

OUTER SUBURBS

United Energy
Powercor

RURAL AREAS

Powercor

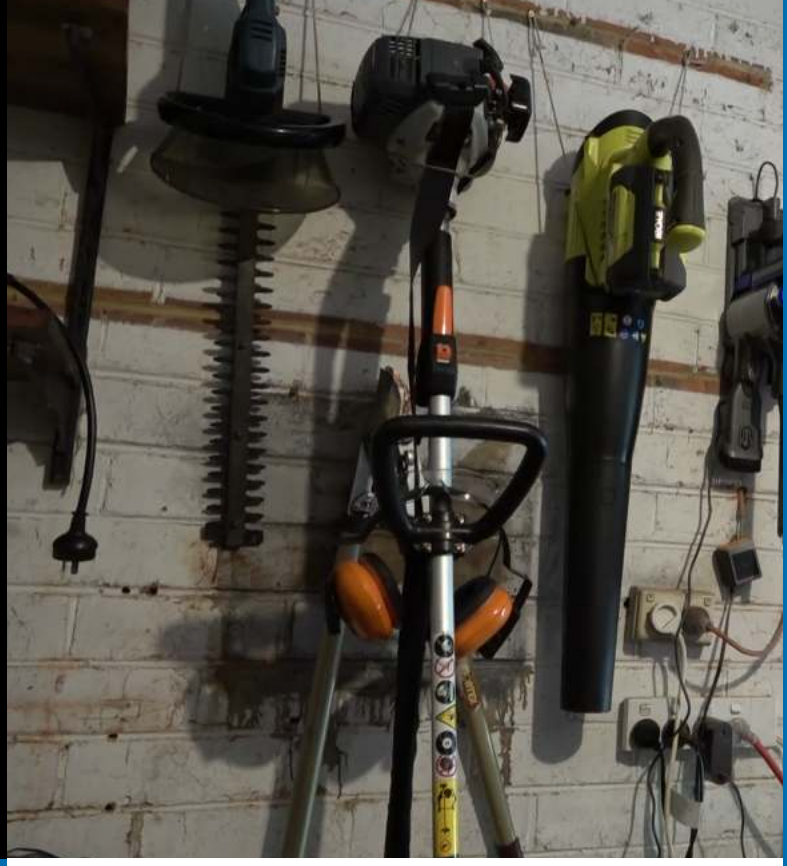
SEACHANGE AND HOLIDAY DESTINATIONS

United Energy
Powercor

Icons are used throughout to represent trends and foresights that are particularly relevant for consumer groupings within and between distribution businesses.

EMERGING TRENDS

Fifty-one emerging digital energy trends were uncovered through in-depth qualitative research with 36 households. The trends are organised across nine practice domains, which represent the major areas in domestic life where energy demand occurs or which are facing significant future change.



01

Mobility and charging

Electric vehicles will present new opportunities as well as new challenges for the electricity grid. Understanding how and when people will charge their electric vehicles is crucial for network planning. This research reveals that it is crucial to understand EVs within a larger set of mobility options and challenges, as well as in the context of existing understandings about battery charging, preparing for contingencies and in relation to automation and control.

Trend 1: Electric vehicles are increasingly desirable for a variety of reasons

Trend 2: Electric vehicles are increasingly envisioned as part of a mix of transport options

Trend 3: Electric vehicle charging continues to take place at home primarily

Trend 4: Access to charging facilities will continue to affect EV purchases

Trend 5: Maintaining control over charging continues to be a priority over relying on automation

Trend 6: Vehicle-to-grid technology is increasingly appealing as a household energy back-up

Trend 7: Charging routines and priorities continue to be important and influential

Trend 8: Interchangeable batteries are accelerating the electrification of garden and power tools

02

Caring at home

Caring is a central and crucial aspect of household life, and one in which emerging technologies are playing an increasingly important role. Households envision technology continuing to support them in caring for themselves and other members of the household, including pets. Energy used for caring is increasing and inflexible due to its importance for providing health, safety and comfort.

Trend 1: Pets are increasingly seen as family members with their own non-negotiable energy needs

Trend 2: Occasional hosting of guests is increasingly important in household decision-making

Trend 3: Caring increasingly requires being prepared for unforeseen circumstances

Trend 4: Self-care is increasingly important and connected to physical and mental health

Trend 5: More at-home care is increasing energy demand and limiting load flexibility

03

Cooking and eating

The gradual electrification of cooking is seeing a growing number of small appliances in kitchens, creating unclear outcomes for future demand. Refrigeration and freezer capacity is also expanding due to household trends around preparing for the unexpected, as well as increasing the lifestyle, recreational and hosting capacities of the home.

Trend 1: Continuing proliferation of small electric cooking devices

Trend 2: Household electrification is beginning in the kitchen, but occurring gradually

Trend 3: The size and use of fridges and freezers is increasing

04

Smarthome and automation

Interest in smart home technologies is relatively limited, gendered and often viewed as adding unnecessary complexity to the household. Despite the increasing prevalence of digital voice assistants, they are rarely used for broader household automation and many remain sceptical of increasing the automation of their homes. This will limit the role of automation in energy management.

Trend 1: Interest in smart home technology and automation continues to be relatively low overall

Trend 2: Smart home technology is continually and creatively adapted to suit the particular needs of each household

Trend 3: Smart home technology acceptance and use continues to be highly gendered

Trend 4: Smart home and energy management technology is increasingly frustrating when the initial installer is no longer resident in the home

Trend 5: Smart home technology is increasing the frustration of electricity outages

Trend 6: Automation is increasing household complexity, leading some to reject it

Trend 7: Households continue to desire 'final say' and the ability to easily override automation

05

Recreation and play

As a result of the ongoing COVID-19 pandemic and increased cost-of-living pressures, households are spending more time at home. Consequently, there is greater focus on household comfort, as well as investments in home improvements and digital devices that provide further opportunities for entertainment and recreation. This is an anticipated growth area for electricity demand.

Trend 1: Expanding expectations for the home are encouraging increasingly luxurious upgrades (by people's own standards)

Trend 2: Multiplication of screens and increasing simultaneous use of devices

Trend 3: Gaming is an increasingly common form of entertainment

Trend 4: Electric vehicles are increasingly used for recreation

Trend 5: Increasing technology-use for exercise at home

06

Working and studying from home

The COVID-19 pandemic saw many working and studying from home. People purchased new digital technologies and adapted their homes to accommodate these new working arrangements. Even as lockdowns have ended, many continue working from home in a hybrid manner that typically involves working remotely two to three days per week. Post-lockdown schools have returned to in-person learning. However, more hybrid forms of learning continue, particularly at the tertiary level.

Trend 1: Working from home continues in a hybrid model

Trend 2: The home is changing to respond to increased working and studying from home

Trend 3: Working and study at home is increasing household computer needs

Trend 4: Working from home increasingly facilitates afternoon load shifting

Trend 5: The particularities of working from home are increasingly important in generating heating and cooling needs

07

Healthy indoor air and thermal comfort

Household comfort is expanding beyond heating and cooling to include a growing interest in managing air quality in the home, including protecting the home and its occupants from bushfire smoke, allergens, mould and unpleasant odours. This means that the management of household air is becoming a household priority linked to health and safety, making it increasingly essential and therefore less flexible.

Trend 1: More rooms and spaces in (and on the edges of) the home are being heated and cooled

Trend 2: Increasing concerns about indoor air quality

Trend 3: Households increasingly looking to technology such as air purifiers and dehumidifiers to manage air quality

Trend 4: Growing interest in improving indoor air quality through both increasing and decreasing natural ventilation

Trend 5: Increasing interest in improving indoor air quality through the electrification of gas cooking

Trend 6: Increasing interest in improving indoor air quality through electrification of wood fired heating

08

Cleaning, showering and laundering

Maintaining cleanliness is considered essential for household health and well-being. While emerging energy and digital technologies present new possibilities, many households have strong routines and preferences around maintaining cleanliness and hygiene. Therefore these practices may be inflexible and the availability of hot water for such practices is considered necessary.

Trend 1: Showering continues to be embedded in other routines, and is increasingly important for maintaining structure for the day

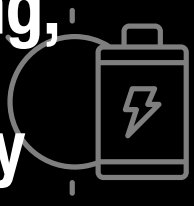
Trend 2: Concerns with air quality are encouraging dryer use

Trend 3: Continued mismatch between energy management and household cleaning priorities

Trend 4: Inherited cleaning advice continues to affect appliance usage

09

Making, saving, sharing, and storing energy



Households have considerable interest in the opportunities that new energy technologies give them to engage in the transitioning energy system, especially opportunities to contribute to decarbonisation and to resourcefully share solar energy. However, many household activities remain inflexible and some resist the adoption of smart technologies for energy management, preferring instead to maintain more hands-on control.

Trend 1: Interest in smart home technology is a precursor to energy technology interest

Trend 2: Households continue to show little knowledge of or engagement with their tariff

Trend 3: Solar self-consumption is increasingly appealing to households

Trend 4: People increasingly interested in sharing and resourcefully using renewable energy

Trend 5: Increasing solar-self consumption is motivated by a desire to be resourceful

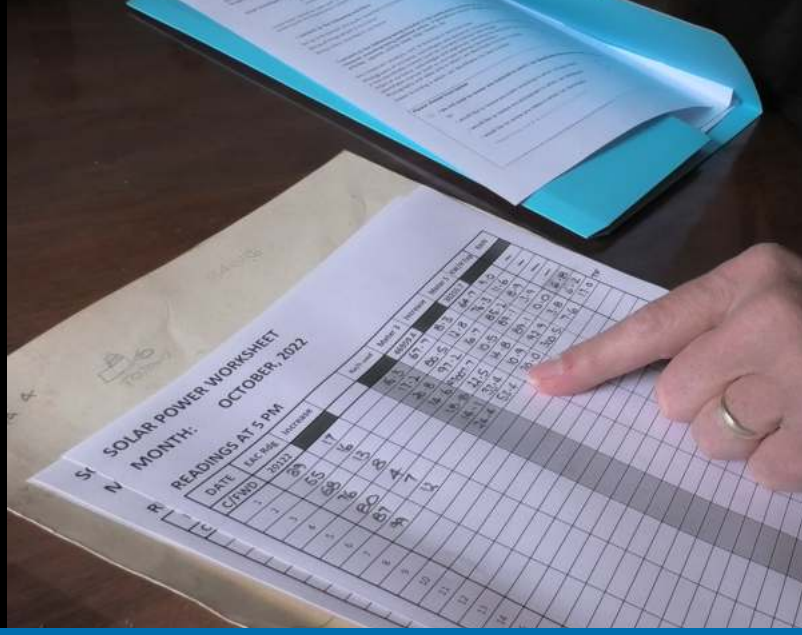
Trend 6: Responding to demand management is increasingly not motivated by financial incentives alone

Trend 7: Demand management to increase demand is creating greater confusion for households

Trend 8: Differential access to CER is accelerating inequitable participation in the energy transition

SURVEY FINDINGS

In-depth qualitative research with the 36 households informed the development of a survey with 1,325 CitiPower, United Energy and Powercor customers which explored the relevance and impact of emerging trends.

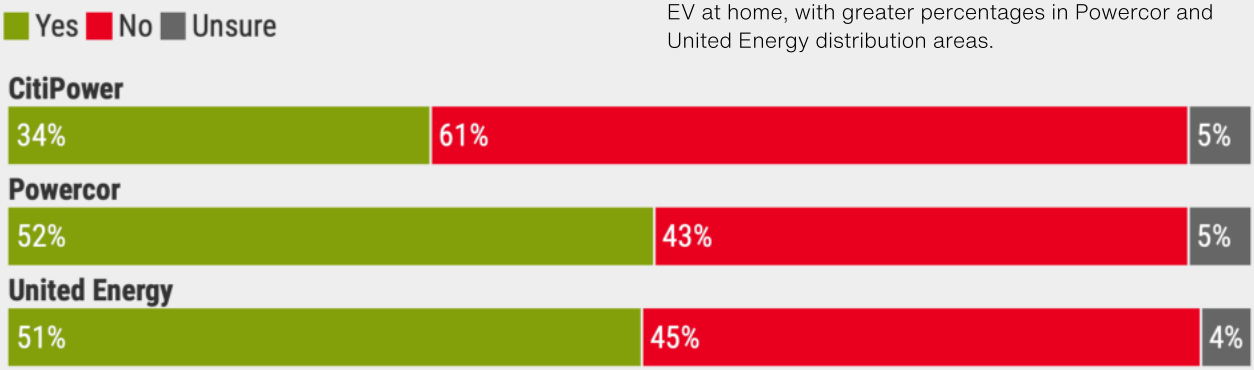


Charging and mobility

Do you currently have a place where you could (or already) charge an electric vehicle?

3.4% of survey respondents currently have an EV or plug-in hybrid vehicle, but 26.7% of respondents intend to purchase one in the next five years.

77 % of survey respondents with or intending to purchase an EV in the next 5 years (n=399), do or would charge their EV at home, with greater percentages in Powercor and United Energy distribution areas.

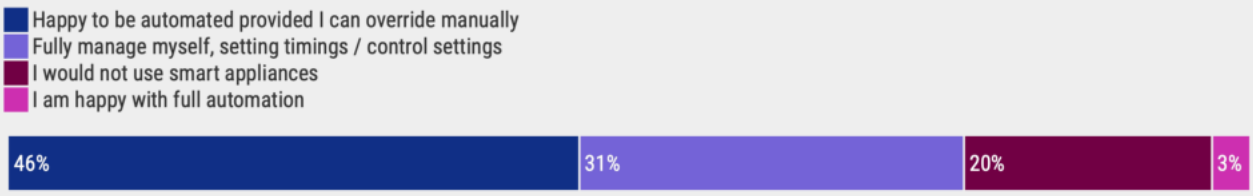


Future Home Demand Survey, Question 42.
All households (n=1325) grouped by provider: Powercor (n=477), CitiPower (n=439), United Energy (n=409). Row % displayed.

Smarthome and automation

Which of the following ways of using smart appliances would you prefer in your home?

Only 3% of survey respondents are happy for smart appliances to be fully automated, whereas 46% of respondents wanted the ability to override automated settings, another 31% want to set the timings or control the settings and 20% want no smart appliances.

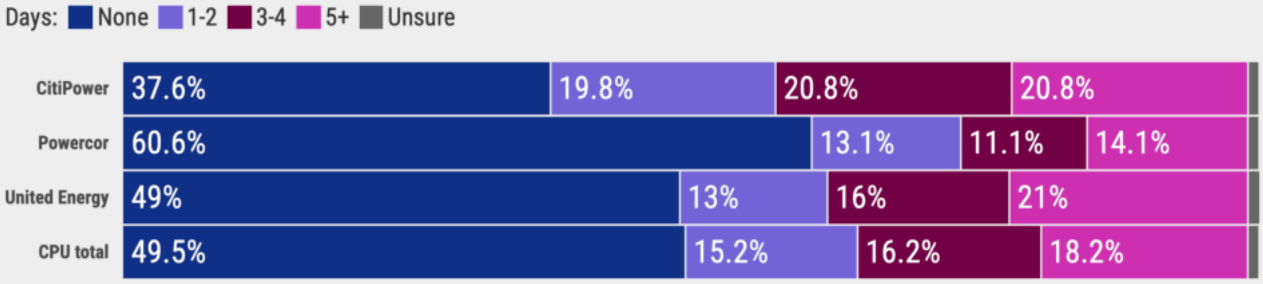


Future Home Demand Survey, Question 18.
Baseline: All households (n=1325)

Working and studying from home

In a usual week, how many days per week is your home occupied by someone 'working from home' (staying home while doing paid work)?

49.5% of all respondents do paid work from home at least one day per week. This is highest in the CitiPower network.

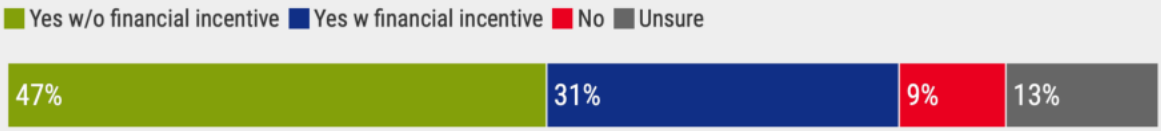


Future Home Demand Survey, Question 6.
All households (n=1325) grouped by provider: Powercor (n=477), CitiPower (n=439), United Energy (n=409). Row % displayed

Making, saving, sharing, and storing energy

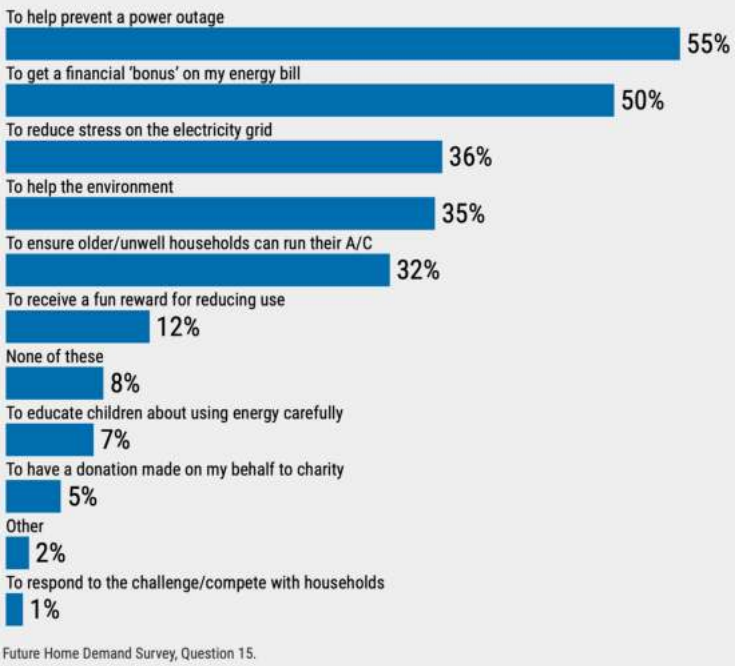
If, during a very hot period, there was such a campaign asking people to reduce their energy use, would you be willing to reduce your energy use?

47% of survey respondents said that they would respond to a demand management program to reduce their energy usage *even without a financial incentive.*



Future Home Demand Survey, Question 16.
All households (n=1325)

During times of high demand, people said they would reduce their energy for the following reasons:



Future Home Demand Survey, Question 15.

52.3% of survey respondents ranked "comfort, health and safety" as their first and primary household value, followed by "affordability and cost-effectiveness" (24%) and then "sustainability" (8%).

Implications for Energy and Forecasting

A workshop with CPU forecasters helped to refine the relevance of the research findings to develop the most relevant implications for forecasting. The workshop led to a focus on insights for EVs and charging practices, demand management opportunities and future peak scenarios.

(For energy and forecasting implications of the other eight practice domains, see full report.)

Mobility and Charging:

Implications for energy and forecasting are ranked via their likely material impact, with **red** representing high impact, **orange** representing medium impact, and **green** representing low impact.

Reasons for purchasing an EV reflect varied priorities in relation to charging EVs which will affect charging patterns, acceptance of automated charging and price responsiveness.

Acceptance of smart charging of EVs may be high, but people will want to maintain the option to override or control settings themselves, which may create peaks such as in advance of public holidays, storms, heatwaves and bushfire risk days, etc.

While cost savings and using renewable energy are the main preferences for charging EVs, high levels of convenience charging and preferences to keep EV batteries fully charged also exist, and may have significant material impact with higher EV uptake in the near future.

Rural area households are likely to maintain an ICE vehicle, even as they begin to adopt EVs. Although facing greater distances required for essential travel, they may be more willing to automate charging due to having the ICE backup.

The strong preference for at-home charging may lead to particular geographies of EV purchases, in relation to off-street parking access that may run counter to current assumptions about high income areas and EV adoption. There may be lower EV adoption than expected in high income areas without off-street parking in the city and inner suburbs. Further analysis by suburb is recommended to better target local EV uptake projections.

Demand Management Opportunities

This research has identified opportunities that exist for engaging or intervening into the emerging trends in each practice domain to better align practices with needs of the electricity grid.

Mobility and Charging: 

- Ensure householders understand and are able to maintain control over charging incentives and programs, including those which are automated.
- Target household routines and beliefs around charging existing battery-powered devices (phones, powertools, stick vacuums) as a means of both familiarising households with battery care, and ways of shifting charging in connection with demand and supply peaks. If properly guided, these capacities could aid future demand management of larger batteries, including household batteries or those in EVs.

Caring at Home: 

- Develop initiatives that meaningfully engage with the challenges and realities of caring for people, pets and home, which often depend on consuming energy (e.g. air conditioning).
- Partner with health authorities, community groups and other trusted organisations like the RSPCA to develop and promote initiatives which focus on low-energy or lower peak demand ways of providing care.

Cooking and Eating: 

- The continued popularity of refrigeration for non-perishable beverages (e.g. a beer fridge) offers an opportunity to target demand management messaging at this discretionary and often seasonal load.
- Promote energy efficiency information for the growing range of electric kitchen appliances, and encourage use of appliances with smart or timer delay functions to help consume daytime solar generation and flatten evening peak demand.

Smart Home and Automation:

- Offer a range of manual and high-tech ways for householders to engage with both the opportunities and challenges presented by automation and smart home technologies.
- Increase householders' acceptance of smart tech or direct load control by better explaining why such interventions are necessary, or through programs that offer cheap or free energy.

Recreation and Play:

- Energy is an important facilitator of recreation and play, which is increasingly taking place in people's homes and in more energy-intensive ways that often entail further forms of energy consumption, such as heating and cooling. Encourage households to (re)engage with recreation outside the home during peak periods or peak events, including through incentives to visit cinemas, playgrounds, shopping centres or pools.
- Promote 'log out and switch off' messages that encourage recreation and play devices to be switched off or powered down when not in use, beginning by targeting energy-intensive activities or devices including high-end gaming computers, spa baths, home saunas or additional screens.

Working and Studying at Home:

- The normalisation of working and studying from home offers opportunities to promote self-consumption of solar energy generated during the day. Increased solar self-consumption would provide a benefit both to consumers (through lower energy costs) and energy networks (via reduced needs to upgrade infrastructure).
- Working and studying from home is associated with higher heating and cooling demand, including through daytime occupation of the home's edges (spaces like garages, offices or studios). There is scope to promote lower-consumption forms of comfort while working and studying from home; examples include information campaigns or incentives that support the use of low-energy devices like fans and heated blankets, encouraging improved insulation, or promoting zoned heating and cooling.

Healthy Indoor Air and Thermal Comfort:

- Promote less-energy intensive heating and cooling by encouraging low-consumption adaptations that heat/cool the person as a first step towards improving comfort, rather than heating/cooling space. Examples could include changing clothing, consuming warming/cooling beverages and food, and using fans or hot water bottles to improve comfort.
- The electrification of services like gas cooking and wood heating offer opportunities to avoid or mitigate associated energy consumption through increased needs for air purification.

Cleaning, Showering and Laundering:

- Messaging around shifting controlled load hot water to afternoon heating should account for the importance of showering and bathing in relation to other important routines, such as preparing children for bed. In order to maintain the general acceptance of controlled load hot water, communications should use accessible terminology, and directly respond to householders' concerns (such as those around a general lack of hot water or a reduced morning hot water service).

There is also scope to frame hot water as a form of (thermal) storage, thereby illustrating to householders the wider importance of shifting controlled load hot water.

- Worsening air quality, extended periods of poor weather or intensifying standards of cleanliness may contribute to high-consumption forms of washing and drying; messaging could reassert the continued effectiveness of lower-consumption forms of cleaning, such as using a cold wash cycle or hanging clothes up to dry.

Making, Saving, Sharing, Shifting and Storing Energy:

- Demand management programs need to engage householders beyond financial terms, as people show interest in participating in managing energy for a wide variety of reasons, including out of generosity, from a sense of community, or through a desire to be resourceful.
- The high uptake of CER – which is occurring at the same time as working and studying from home are both being normalised and facilitated by new technologies – represents an opportunity to encourage greater self-consumption of solar power. Promoting the use of self-generated energy need not follow conventional demand management paths into automation or targeted messaging about peak times, but could instead draw on the existing strategies, capacities and desires people draw on to make the most of their solar generation.

Future Peak Scenarios

The analysis of all research findings identified nine possible emerging peaks with the potential to impact network businesses from 2030 onwards, if demand response opportunities are not implemented.

Holiday Hosting Peak

During the holiday season, increased convenience charging of EVs alongside high and inflexible energy demand creates localised peaks in areas popular with holidaymakers.

Storm Charging Peak

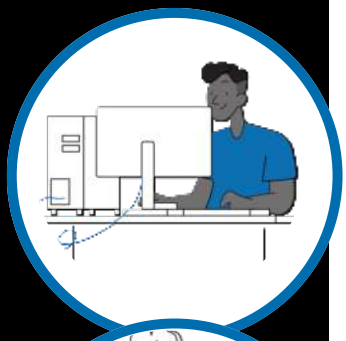
Prior to forecasted storms, home batteries and electric vehicles automatically respond to storm warnings to maintain their charge, and households charge up other mobile battery powered devices to prepare in case of a power outage.

Major Event Peak

Growing expectations for the home and new digital technologies increase the energy needs of entertaining, which create significant demand peaks during major sporting or cultural events.

Automation Override Peak

Smart home devices with automated settings are increasingly common, however rather than being set to respond to energy signals, the smart devices exacerbate evening peaks by privileging comfort and convenience.



School Holiday Peak

Staying at home with more technology and comfort during winter school holidays creates new peaks on cold overcast days.

Friday Work From Home Peak

Increased working from home on Friday, alongside EV charging in preparation for the weekend, creates demand peaks on Friday.

Thunderstorm Asthma Peak

Serious health and air quality concerns during asthma thunderstorms encourage closing up the home, running A/C and air purification which coincide with reduced solar production.

Bushfire Peak

Increasingly common bushfires create prolonged smoky conditions, limiting solar production while people stay home and increase their energy use to create safe and healthy air at home.

Diversifying demand troughs

More CER alongside changes in household practices and increasingly efficient appliances increase the frequency and intensity of demand troughs.

Foresights for Energy Futures

As part of the household research, participants were asked to imagine how their current routines might shift in different future scenarios. These are the key implications for demand management and energy forecasting that come from research participant's reactions to the possible future scenario presented below.

Solar Smoothing Future

Different demand management programs should offer specific suggestions and guidance and directly target flexible practices such as when to run the dishwasher and do the laundry rather than asking for general load shifting. Messaging can also target the opportunities offered by increased working from home to accomplish these chores in the middle of the day even without smart or automated appliances.

All Electric Future

Cooking will be increasingly electric in the near future. However, this is likely to be an inflexible practice, and therefore highly likely to add to evening peak demand unless offset by increased efficiency and smaller appliances. Forecasters should prepare for potential increased load from electric cooking. Electric heating is more flexible and likely to be a slower transition, which will first happen in new builds, such as in new estate and high growth areas in outer suburbs.

Afternoon Hot Water Future

It is crucial that any messaging around shifting the time of heating hot water be carefully explained, and households be informed that any changes would not impact on the availability of hot water for existing showering and bathing routines.

Extreme Weather Future

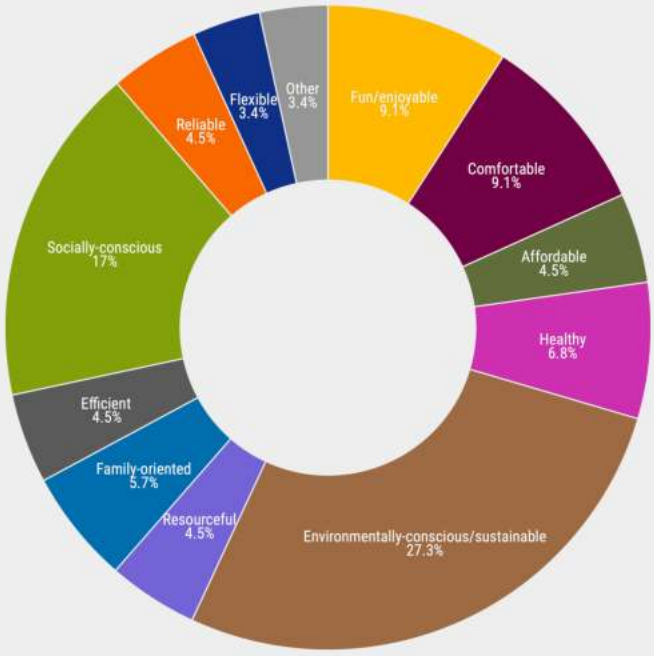
Increasing summer temperatures and extreme weather events may create significant changes to household routines in the future. Energy forecasting should incorporate climate projections into more than supply forecasts and recognise that demand is also likely to be significantly affected by a changing climate.

Vehicle-to-Grid Future

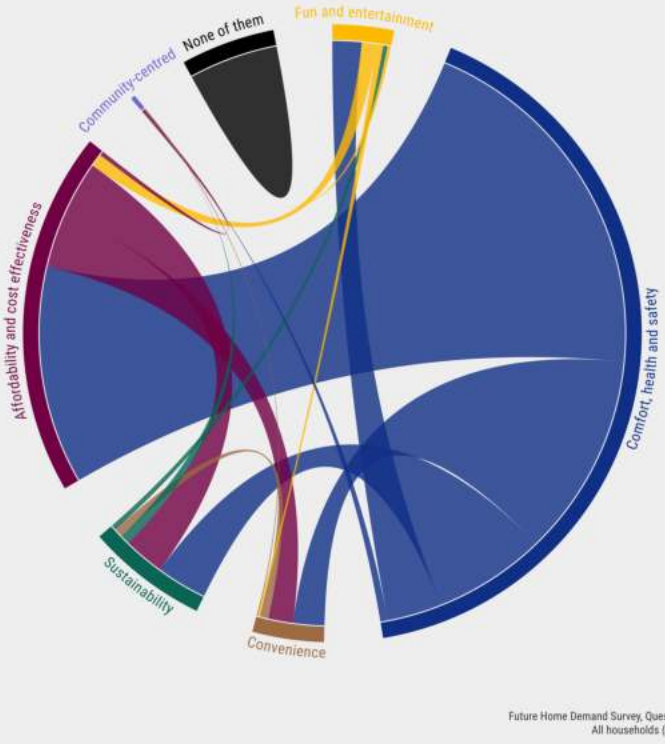
V2G was highly appealing to households, as this technology becomes more widely available it is likely to increase uptake of EVs, including in rural areas where the appeal of the EV as a backup battery is high. This may create unexpected patterns of high EV uptake in rural areas . However, people are hesitant about direct load control of EV charging, even more so as the importance of the vehicle becomes both about mobility as well as the home's back up battery. This is likely to limit the ability of V2G technology to serve energy management objectives of balancing the grid and may create new charging peaks (see Storm Charging Peak).

Household Values and Values-Based Demand Management Designs

As part of the design activity stage of the research visit, households were asked to choose a few key values that are important to their household. Survey respondents were also asked to rank a set of values in order of importance for their household.



Distribution of household values identified in household research.



Graph representing the flow from survey respondents' first selection to their second.

"Comfort, health and safety" was most respondents' primary household value (52.3%) in survey results, with affordability and cost-effectiveness the second most common primary value (31.7%).

These findings on key household values and priorities have important implications for demand management and forecasting including:

- A continuing focus on cost-reflective pricing or financial rewards and penalties will likely undermine demand management potential in CPU's customer base, particularly if economic measures are perceived to compromise comfort, health and safety.

- "Sustainability" and appeals to the environmental benefits of demand management are powerful, but they must similarly account for the importance of values like comfort, health, safety and affordability.

- Values commonly overlap; for example comfort, health and safety are directly linked to a better environment for many, evidenced in the rise of greater concerns about air quality in the context of bushfires and health concerns (see **Healthy Indoor Air and Thermal Comfort Trend 2**).

- Comfort, health and safety values also include concerns with community health and safety, as evidenced by survey responses on why people would respond to demand management, which emphasised preventing outages in the community and protecting vulnerable customers (see **Making, Saving, Sharing and Storing Energy Trend 6**).

- The prevalence of values around being socially conscious in the household research reflect this complexity, and represent opportunities to frame demand management in ways that appeal to these varied values.

Values-Based Demand Management Designs

With their key values in mind, participants were asked to design demand management programs or technologies using a card game technique. The designed objects and services reflect household desires and aspirations for energy management, ways that energy management can better align with their existing priorities and values, and household desires for future and more diverse engagement with the energy sector.

Participants designed:

Appliance-specific, real-time data and notifications
Some want the option to get real-time feedback on detailed household energy consumption via notifications including which appliances are using the most energy as well as the source of their energy to encourage greater use of renewable energy.

Ambient feedback
Some wanted ambient notifications about their energy (e.g. a chime or glowing lamp placed in the home). This was envisioned to encourage making energy management a shared responsibility with other members of the household (such as children and those less interested in energy management and traditional data), and created a more intuitive way to understand the relationship between household practices and energy consumption.

Digital and energy technology integration services
People sought solutions to the everyday challenges of trying to integrate smart and energy technology, such as services where a knowledgeable person comes to the home to install, educate and help manage technologies and energy efficiency in the house.

Advocacy services
People envisioned advocacy to be a form of service or community initiative that would help them to manage their energy and participate in the transitioning energy system, such as advocacy services which enable renters to access CER.

New energy technologies and technology services
People imagined alternative energy resources like mobile or rentable batteries that would enable more diverse forms of participation, while also avoiding the high upfront costs associated with current CER.

Smart devices for remote control
When participants imagined smart technologies, they were largely intended to increase remote control over appliances, such as via an app. They did not imagine full automation or third party management of devices.

Place-based, built environment and renewables initiatives
Deep knowledge of place and weather patterns influences what solutions householders design for their homes in particular environments, such as building design improvements to improve energy efficiency or particular forms of renewable energy.

Community initiatives
People want their energy practices to be more integrated with their local place and saw the dual possibilities to encourage community building while addressing energy challenges. Energy was commonly viewed as a shared resource and energy management included communal initiatives like shared swimming pools and shared meals.

Sharing solar abundance
People are very interested in sharing the energy they produce via CER, especially excess solar PV production that they cannot self-consume. Not wanting to waste solar energy motivated many who would prefer donating or sharing their excess solar production.

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FOR THE FULL REPORT VISIT:

Future Home Demand: Anticipating energy and everyday life trends across three Victorian networks

https://www.monash.edu/emerging-tech-research-lab/research/projects/future-home-demand-anticipating-energy-and-everyday-life-trends-across-three-victorian-networks

Authors
Dr Kari Dahlgren
Dr Hannah Korsmeyer
Dr Fareed Kaviani
Dr Rex Martin
Professor Yolande Strengers
Professor Sarah Pink

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Caulfield East VIC 3145

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