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DIGITAL ENERGY FUTURES

FORESIGHTS FOR FUTURE LIVING

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A partnership between:

DIGITAL ENERGY FUTURES

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Views and opinions

The views expressed herein are those of the authors and are not necessarily those of the Australian Government or Australian Research Council, project partners, or Advisory Committee members.

A partnership between:

MONASH University | Ausgrid | AusNet services | ENERGY CONSUMERS AUSTRALIA

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INTRODUCTION

INTRODUCTION

This report presents two key advances in social science-led qualitative foresighting for the energy industry.

New **foresighting concepts**, which use tested theory and research about social and technological futures to revise assumptions about future consumers.

New **foresights** designed to address three key areas of focus at the intersection of energy futures, and emerging automated systems and technologies:

- Electric vehicles and battery charging in local neighbourhoods (near futures, 2027)
- Comfort, care, and safety in the home and the rise of emerging air technologies (near futures, 2025-2030)
- The reconfiguration of routines and load shifting in response to extreme weather (far futures, 2050)

The report is the outcome of the fourth stage of the Digital Energy Futures project. It is based on the findings of 10 design ethnographic futures workshops with 42 people and ethnographic research with 72 households across Victoria and New South Wales, Australia.

The ethnographic research is also supplemented by consumer survey data and several analyses of energy and digital technology industry reports.

GLOSSARY OF TERMS

Autonomous Vehicle (AV)	Any vehicle (including cars, buses, shuttles and trucks) that can drive largely without human intervention through technology that allows it to sense its environment and navigate through it.
Central Business District (CBD)	
Consumer Energy Resources (CER)	A new term (which some argue should be used in place of DER) used to refer to energy technologies that consumers add to their lives, such as solar PV panels, home batteries, and electric vehicles.
Distributed Energy Resources (DER)	A common term (which is now sometimes superceded by CER) used to refer to energy technologies such as solar PV panels, home batteries, and electric vehicles.
Digital Voice Assistant (DVA)	A device or operating system which responds to voice commands and can perform tasks, often embedded into smart speakers or phones (e.g. Amazon Alexa, Apple's Siri and Google Home).
Demand management program	Programs that seek to alter consumers' energy demand and/or usage (e.g. battery storage and discharge) during specific time periods to manage peak electricity demand or to support grid stability, efficiency and/or sustainability of the energy system.
Drones	An uncrewed aircraft that is guided remotely or can fly autonomously.
Energy Consumer Behaviour Survey (ECBS)	Developed and delivered by Energy Consumers Australia using insights from the Digital Energy Futures project.
Energy Consumer Sentiment Survey (ECSS)	Developed and delivered by Energy Consumers Australia.
Electric Vehicle (EV)	Any vehicle, usually an automobile, that uses an electric motor for propulsion (including hybrids).

Forecasting	To predict or anticipate the most likely/probable future or trend and estimate their uncertainties.
Foresights	Knowledge developed about the future.
Futures	The plurality of possible and imagined future worlds or the plurality within any given future.
Human-Computer-Interaction (HCI)	Multidisciplinary field of research in the design and use of interfaces between people and computers.
HVAC	Heating, Ventilation and Air Conditioning.
Internet of Things (IoT)	A network of computing devices which can exchange data, embedded in everyday artefacts and connected by the Internet.
Load shifting/ smoothing	A load management technique involving moving electricity demand from one time period to another, including to reduce peak demand, access lower energy prices or use available renewable electricity.
Off the Grid	Disconnection from, or lack of, mains electricity services in favour of on-site energy generation and provisioning (may also be used in reference to other utilities).
Peak alert/notification	A notification sent to energy consumers (e.g. households) informing them of a period of peak demand or network constraint, often accompanied by a rebate or incentive offered to consumers who reduce their peak demand for a specified period.
Peak electricity demand	The period in which the overall amount of electricity used is at its highest. May refer to daily, seasonal, critical or annual peaks.

Peak event/demand response event	Periods when electricity demand is projected to be particularly high, usually in response to extreme weather. Some energy retailers or distributors offer incentives to customers to reduce their energy demand during these times.
Peak solar	The maximum output of a solar system over one hour.
Place	The continually changing physical, social, and technological environment and circumstances of life.
Photovoltaic (PV)	Technology that converts sunlight into electricity (e.g. solar PV array).
Royal Automobile Club of Victoria (RACV)	An automobile club providing member's insurance, roadside assistance, and other automobile related services.
Smart	Infrastructure or appliances that are automated and/or connected to the internet that generate and communicate data. Also known as the Internet of Things.
Solar smoothing	Any technique that mitigates the intermittencies and power fluctuations of solar energy.
Tariff	The rate (price) at which the electrical energy is sold to a consumer.
Time-of-Use (tariff) (ToU)	An electricity tariff that charges different rates for electricity use at different times of the day. In Australia ToU refers to a 3-part daily tariff (peak, off-peak, and shoulder).
Virtual Reality (VR)	A technology that simulates an immersive environment, primarily through the use of a headset.
Vehicle to Grid (V2G)	Technology that allows the electricity stored in an electric vehicle battery to be discharged to the grid.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

INTRODUCTION

Current and future digital transformation, alongside environmental, social and cultural transformations related to climate change and the COVID-19 pandemic, have created a new context for the energy industry which demands updated and future-ready theories, concepts and knowledge.

To understand possible futures realistically and plausibly, the Digital Energy Futures team have undertaken a reframing exercise. Reframing entails adjusting dominant assumptions and models about the relationships between people, technologies and local environments towards a new future-ready framework supported by research evidence.

The reframings presented here, which we call foresighting concepts, are designed to inform scenario planning and residential forecasts in the energy sector. All of the concepts are designed to enable the industry to better incorporate changing trends and everyday life practices into how they plan the energy system.

- We recommend **14 Foresighting Concepts**, each of which reframes dominant assumptions currently held by the energy industry about how people do, or will, interact with energy and technology.

KEY FORESIGHTING CONCEPTS

The foresighting concepts build on cumulative findings from the Digital Energy Futures project to reframe existing industry conceptions about people's values, engagements, and practices in (future) energy systems.

The existing industry concepts and the new 'reframing foresighting concepts' are summarised in three tables and six illustrations in the following pages.

- People-Led Futures, Reframing Consumer Values
- Collaborative Futures, Reframing Engagements with Energy Systems
- Tailored Futures, Reframing Technology Practices of People

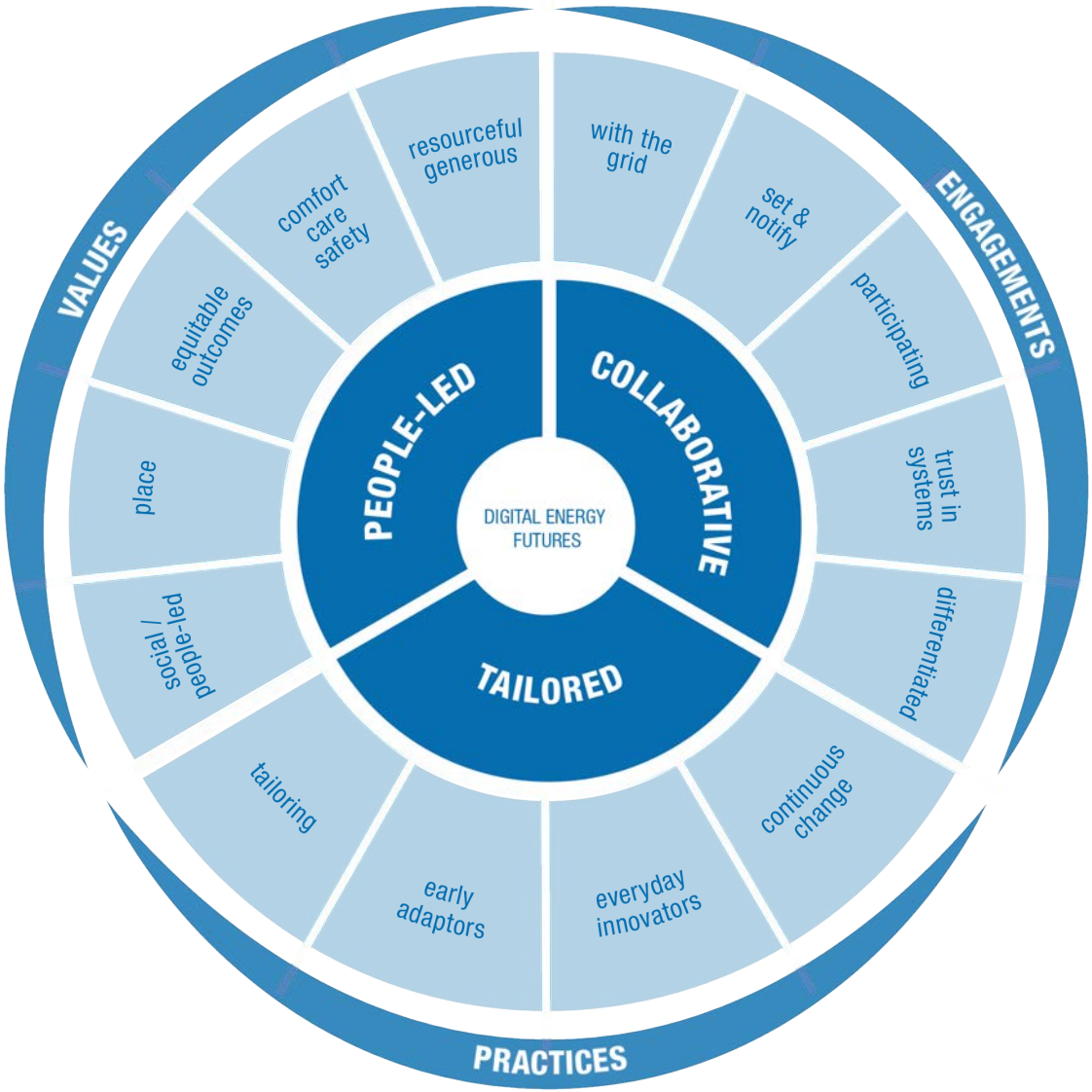
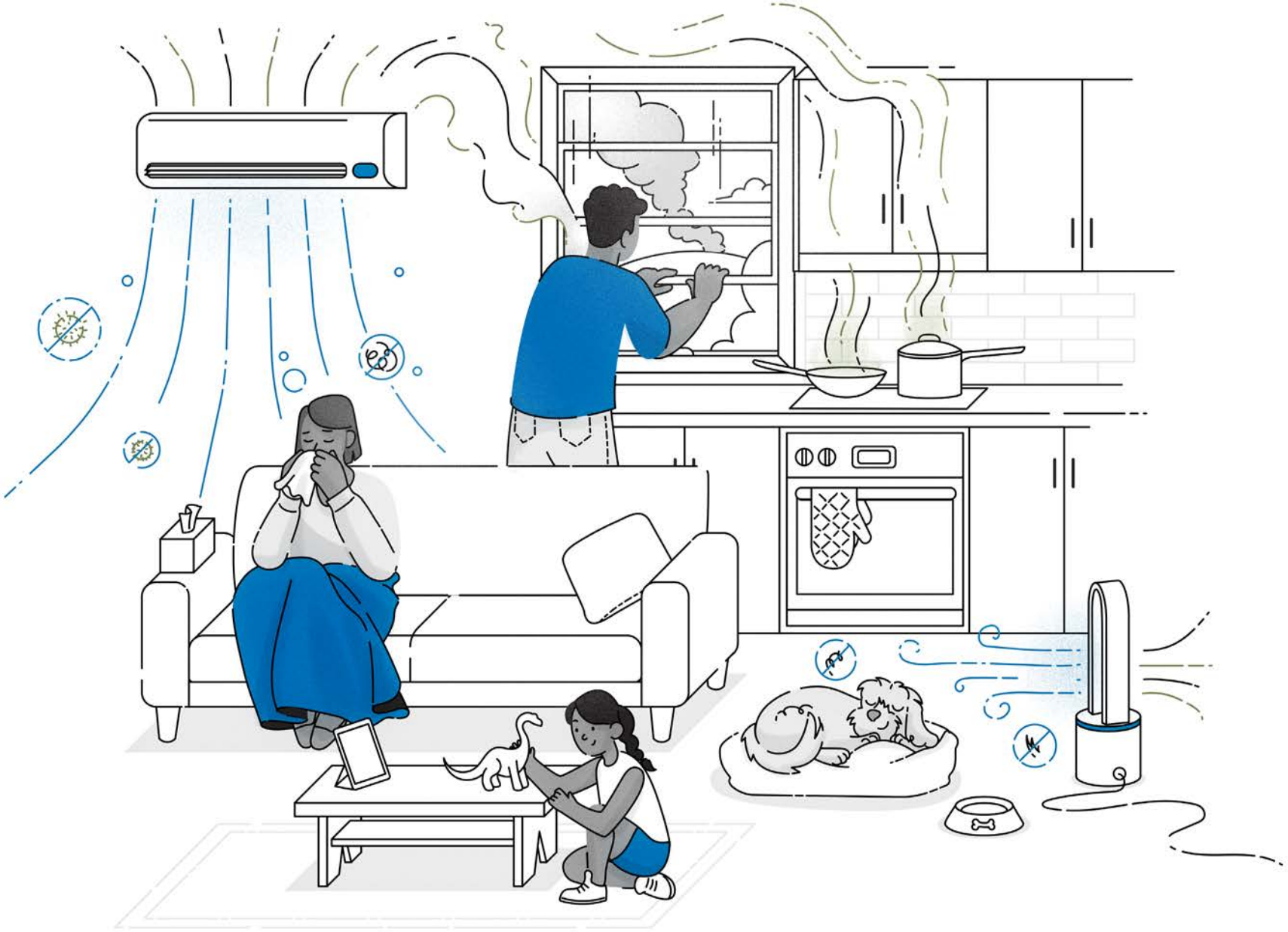


Figure 1 Digital Energy Futures: Reframing foresighting concepts

REFRAMING FORESIGHTING CONCEPTS

People-Led Futures, Reframing Consumer Values

	from	*to*	
1	TECH-LED FUTURES	**SOCIAL / PEOPLE-LED FUTURES**	understanding the real role that people will play in defining our energy futures
2	ZONES	**PLACE**	acknowledging the role of locality and place in defining how people will use energy
3	UNIVERSAL SMART SOLUTIONS	**LARGE-SCALE EQUITABLE OUTCOMES**	accounting for equity by replacing the focus on equal access to dominant technology solutions with a focus on diverse needs
4	CONSUMING	**COMFORT, CARE AND SAFETY**	accounting for the increasing importance of comfort, care and safety at the core of household lives
5	CALCULATING AND RATIONAL	**RESOURCEFUL AND GENEROUS**	understanding how people's moral values in relation to energy are evolving and that they will be decisive in our energy futures



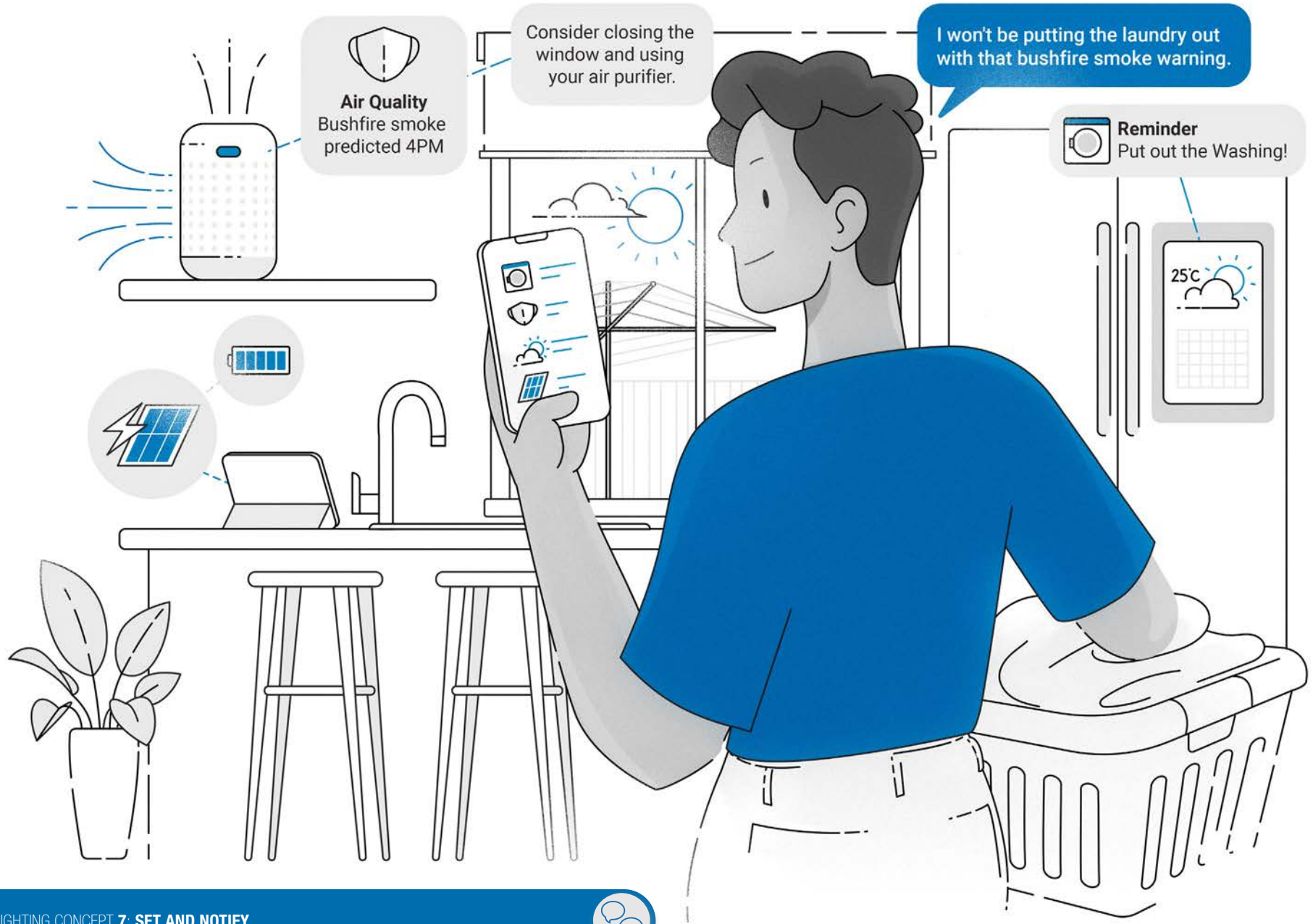
► FORESIGHTING CONCEPT **4**: **COMFORT, CARE, AND SAFETY**

► FORESIGHTING CONCEPT **5** : **RESOURCEFUL AND GENEROUS**

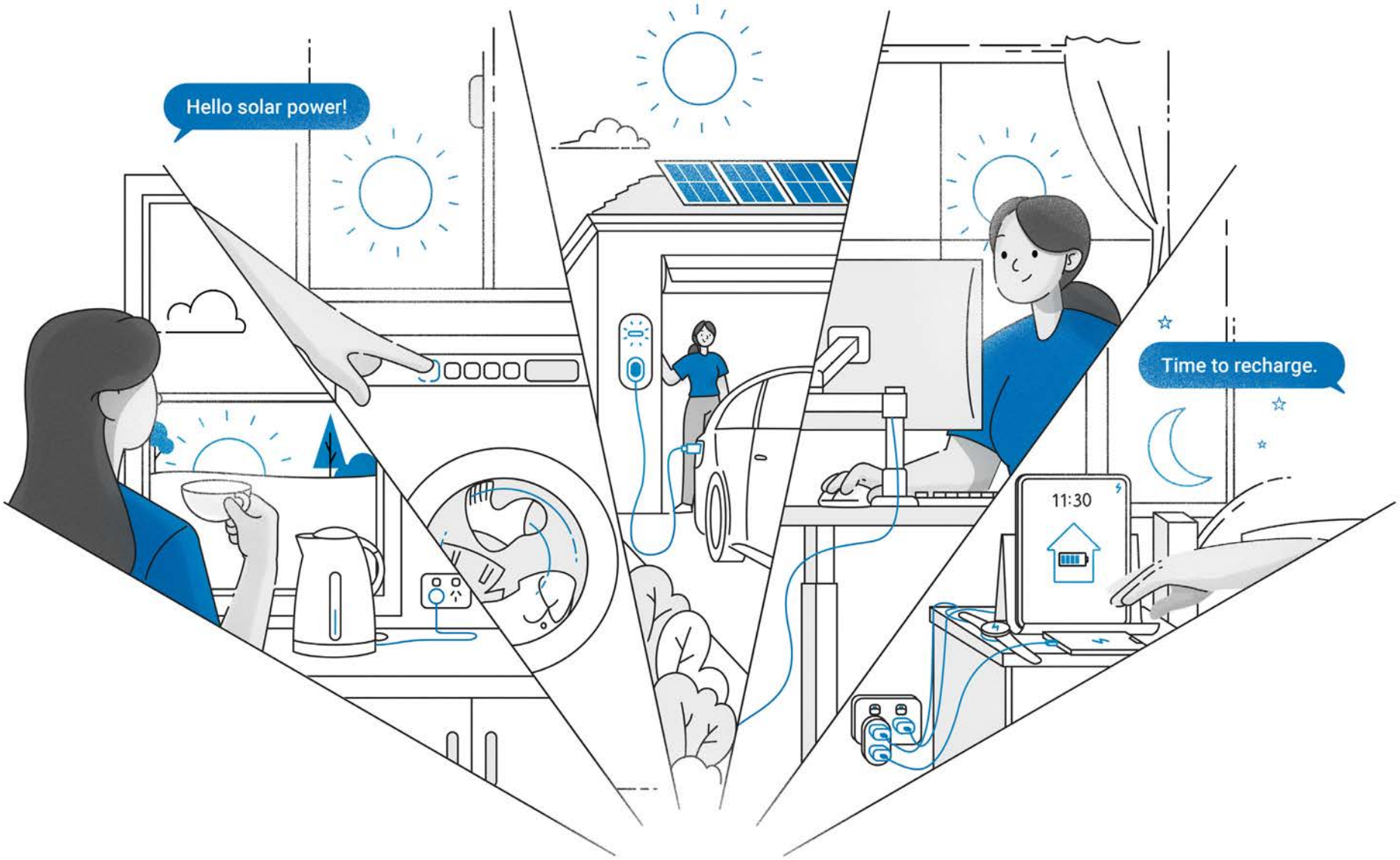
REFRAMING FORESIGHTING CONCEPTS

Collaborative Futures, Reframing Engagements with Energy Systems

	from	*to*	
6	OFF THE GRID	▶ **WITH THE GRID**	envisioning a collaborative relationship with the grid evolving, where people will use it as a backup or for sharing energy with others
7	SET AND FORGET	▶ **SET AND NOTIFY**	providing the transparency and control over automated systems that people will need to ensure the care and safety of their households
8	PROSUMING	▶ **PARTICIPATING**	people's participation in future energy systems will be driven by their household and community priorities rather than by the market
9	TRUST IN ENERGY COMPANIES	▶ **TRUST IN TAILORED SYSTEMS**	understanding trust as situational and generated in everyday and tailored setups, rather than as transactional and fixed
10	SEGMENTED	▶ **DIFFERENTIATED**	differentiating between different groups of people through their values, practices and needs, rather than as stable consumer segments composed of single homogenous consumers



► FORESIGHTING CONCEPT **7**: **SET AND NOTIFY**



► FORESIGHTING CONCEPT **8**: **PARTICIPATING**

REFRAMING FORESIGHTING CONCEPTS

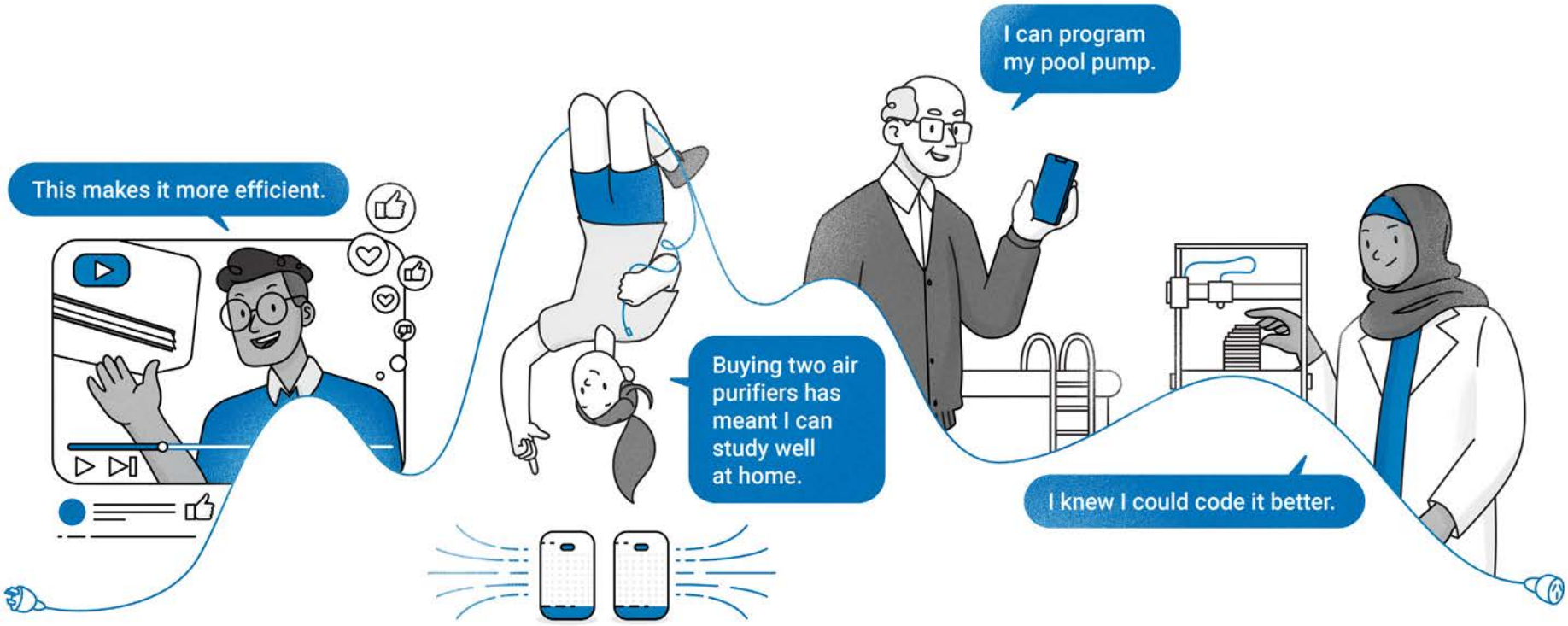
Tailored Futures, Reframing Practices of People

11 *from* PERSONAL-ISATION → *to* **TAILORING**: attending to how people tailor their preferences in everyday life above defining their preferences through predictive data analytics

12 EARLY ADOPTERS → **EARLY ADAPTERS**: accounting for how the pioneers of new technologies will create energy demand by adapting technology to their own needs

13 PLUG AND PLAY → **EVERYDAY INNOVATORS**: accounting for how the pioneers of new technologies will create energy demand by adapting technology to their own needs

14 BUSINESS AS USUAL → **CONTINUOUS CHANGE**: understanding the complex dynamics of household change as we move into futures and its implications for energy demand



FORESIGHTING CONCEPT **11**: **TAILORING**

► FORESIGHTING CONCEPT **13**: **EVERYDAY INNOVATORS**

KEY FORESIGHTS

This report presents new foresights designed to address three priority areas of focus relating to energy futures and emerging automated systems and technologies.

These areas were identified in collaboration with energy industry partners to represent new trends in technology and society, key challenges in forecasting, and core fields of social science knowledge.

The following pages present foresights in clusters by subject areas:

- future electric vehicle and battery charging
- future air technologies
- future routines and loadshifting

FUTURE ELECTRIC VEHICLE AND BATTERY CHARGING

(near future, 2027)

Charging at home and having a fully charged battery in the morning is likely to be a priority: people predominantly want to charge their future electric cars at home, but may be incentivised to charge elsewhere by cheap top-up charging, schemes for selling back, and other initiatives to avoid wasting 'excess' solar energy during the day.

People will object to EV charging infrastructures that disrupt local life and spaces: people value the aesthetics of their local areas and will prefer charging stations at practical local sites such as health, shopping, or leisure centres, rather than in town centres or other popular sites.

Personal electric car ownership will be more likely in areas where local driving, parking, and charging facilities are easily accessible: everyday use, place, and charging possibilities will be decisive in decisions about owning electric cars, and will vary across urban and rural settings.

Uneven access to charging facilities will lead to new inequalities: existing and unanticipated future inequalities will increase if careful consideration is not given to ensuring accessible EV charging for all, including renters and retirement communities.

Automated charging features which increase convenience will be welcomed by some: people will be open to certain features of automated charging where they increase convenience, especially when they are able to research and make decisions themselves.

Staying in control will be essential for an ageing population: retirees will want to be in control of lives and future routines that combine electric car use with leisure and care for grandchildren.

Future drivers will need to be able to depend on battery services and roadside assistance for electric cars: people will be keen to engage with future services and apps for roadside assistance and to pre-book charging stations.

EVs will be used as one of multiple transport options: people will own and use electric cars in combination with other mobility technologies and services.

Localised working hours and commutes will affect EV time of use and charging, particularly in the regions: local areas with a high proportion of people working in similar industries with early start times provide opportunities to charge personal EVs during early afternoon when rooftop solar is available.

EVs appeal to people for varied reasons and not all are environmentally sustainable: some future electric car owners are primarily concerned with performance, rather than with environmental and energy demand questions.

In the far future (2050) electric cars will become part of increasingly hybridised forms of transport and mobility services: in the future people will navigate their 'ownership' or subscription to diverse electric and automated mobility systems, technologies, and services, in relation to their shifting place-based and household needs.

FUTURE AIR TECHNOLOGIES

(near future, 2025-30)

People's future uses for air technologies will pivot on their knowledge and experience of their local environments: people's relationships to both place and technology are crucial to understanding the ways and extent to which people want to be involved with future air technologies.

Inequalities in home ownership will impact future uses of air technologies: homeowners will invest further in their homes, and are likely to install new air technologies, while renters will be more likely to use portable air purification and filtration systems where they are not already installed.

Future air technologies will be used more than existing air conditioning systems: technologies that combine heating and cooling with filtration and purification will likely be used more than existing air technologies.

Uses of future air technologies will be shaped by the demands of future work and study routines: this may create new peak demand times with intensified use of air technologies in the early evening and new peaks or load smoothing during the day.

People's future priorities will be for the health and safety of their households: people will prioritise the health and safety of their households above their relationships to energy companies when making decisions about when to use future air technologies.

People are acutely aware of privacy and digital safety issues, and will require them to be resolved in the future: privacy is a key concern for many people in the present and is likely to continue to be important in the future.

Participation and communication will be essential for engaging people's use of future air technology in relation to the grid: future systems and services involving effective communication and notification systems, and opportunities to participate that recognise the importance of care and safety, are more likely to be trusted by people in the future.

Most people are not prepared to enable their future air technologies to be run by automated and connected smart home systems: future air technologies are more likely to be used as standalone devices operated independently of other smart home technologies with a mix of automated and manual control.

Air purification technologies heighten people's experience of air impurities and will encourage greater use: the experience of air as impure will be heightened and this will increase air technology use and associated energy demand, most likely at peak times.

Financial incentives alone will not solve energy demand challenges: financial incentives are usually superseded by people's everyday values and priorities.

The availability of new energy data and air monitoring data will lead to new communities of actively engaged citizen scientists and technology enthusiasts: digital data, predictive analytics, and sensor technologies encourage new modes of engagement.

Generosity and social responsibility are key considerations for when people relinquish control over future air technologies: community generosity and social responsibility are more likely to lead people to agree to relinquish control of their energy for the common good than financial incentives alone.

In the future people will want to control their air technologies themselves and to tailor them to specific needs: the needs of multiple people within the home will be prioritised by tailoring technology to fit their needs, rather than the needs of the grid.

In the far future (2050), air technology will be increasingly integral to providing comfort, health, and safety: people will increasingly prioritise installing and using air technologies over natural ventilation, with safety and health integral to how people pursue comfort in their homes.

FUTURE ROUTINES AND LOAD-SHIFTING IN EXTREME WEATHER

(far future, 2050)

More frequent extreme weather is likely to shift the way institutions and households structure their everyday tasks and activities: routines and activities are likely to shift in ways that will help regularly avoid exposure to extreme weather, and which position the home, schools, and workplaces as places of shelter and safety.

Household routines will be structured around expectations of increasingly hybrid and flexible working arrangements: many work tasks will be increasingly conducted working from home online or with digital tools, and jobs that require on-site attendance will shift to hybrid and more flexible modes in the far future.

Schools will balance in-person learning and safety as priorities in the context of extreme weather: schooling will remain largely onsite, with flexible and hybrid-ready delivery modes to respond to extreme weather, transport to schools will become more coordinated and active.

Efficient, climate-controlled and communal workplaces and leisure sites will remain important physical hubs for social interaction: these sites will alleviate social isolation for people working from home and provide heat refuges for older and retired people, and may be a preferred option for people to reduce personal energy consumption and sustainability impacts.

People will become increasingly anxious about social isolation, seeking new ways to connect virtually and in-person: people expect technology innovations will provide new opportunities for social connection in virtual and physical environments during more frequent and extreme weather events, and help to alleviate social anxiety about isolation and disconnection.

Activities will be grouped together into new clusters of routines which could shift household peaks in demand: in response to more frequent extreme weather, people will re-organise their day into new clusters of activities with knock-on effects for household demand and the effectiveness of technology-facilitated sustainability goals.

The morning peak will be spread across a longer period of time: the morning peak will be extended in response to flexible work arrangements, extreme weather events, local environmental conditions, caring responsibilities for people, local environments and animals, and household hobbies

The evening peak will remain relatively constant with some activities occurring later at night due to extreme heat: the 5-9pm period will involve a cluster activity in the home, particularly eating, socialising (virtually or hosting), and spending time on personal devices before bedtime; social and outdoor recreational activities are likely to occur later in the evening on extremely hot days.

Exercising will increasingly happen at home during the day: air conditioned home gyms will become increasingly important for exercising, especially to avoid extreme weather; exercise equipment is likely to become a desired form of charging for small devices, especially when there is decreased availability of solar generation.

More frequent showers will become common, but some of them will be cold in response to hot weather: showering practices will shift in relation to shifts in exercise practices, working from home, and as a way to support bodily cooling and in response to extreme weather conditions.

Caring for animals and pets will shift earlier and later, with additional mid-day care or air-conditioning required: people will continue to prioritise the care of pets and animals within their homes and local environments; extreme weather and hotter temperatures are likely to shift the times of day for feeding and walking to earlier in the morning or later in the evening; air conditioned environments will become increasingly important to provide comfort and care for domesticated animals.

People will 'check in' with energy data to take advantage of solar energy availability for manual tasks: automation will need to be balanced with people's desires to maintain control over manual tasks, and to take advantage of available solar energy generation; energy data will provide an important 'check in' to support these priorities.

People will mostly charge their devices overnight or during the day during the solar peak: people will continue to oversee the charging of more devices and EVs in conjunction with different levels of automation or manual operation; charging is more likely to occur in the evening (overnight) or during the day when solar generation is available and when people are working from home.

Grocery and food deliveries will become increasingly common, and delivered in the late afternoon or early evening: people will increasingly depend on home-based deliveries for groceries and meal services, which are more likely to be delivered in the afternoon or early evening; drones, autonomous vehicles and electrified fleets that are resilient to environmental change and extreme weather will be increasingly responsible for delivering these services.

Laundering will remain a manual activity increasingly carried out during the day when solar power is available: laundry and other household tasks will be increasingly synchronised with available solar power when available; laundry will remain a manual practice, even if other household tasks are automated.

Digital technologies and new services will continue to prioritise pleasure, convenience, and experience over energy savings: alongside innovations in efficiency and sustainability, in the future, households will also incorporate new technologies and services that they think will enhance their quality of life.

NEXT STEPS FOR FORECASTING

The findings and foresights outlined in this report will inform the final stage of the Digital Energy Futures project in developing a qualitative forecasting methodology which places people's lives, values, and practices at the centre of scenario development, and of possible and plausible change.

RESEARCH DESIGN

ABOUT THE PROJECT

The Digital Energy Futures project is a four-year research project led by Monash University's Emerging Technologies Research Lab, involving three industry partners: **Ausgrid** and **AusNet Services** (distribution businesses managing networks in the Australian states of New South Wales and Victoria) and **Energy Consumers Australia** (a national advocacy body for residential and small business consumers).

The project aims to understand digital lifestyle trends and their impact on future Australian household electricity demand to inform energy forecasting.

EXISTING APPROACHES TO FORECASTING ENERGY DEMAND

Conceptualising the future in terms of probable and improbable enables operators and key stakeholders to strategically plan and prepare for future investment needs and risks.

In the energy sector, scenarios may be developed to optimise an envisioned environment, for forecasting a likely future, for backcasting a path to a desired future/s, or to provide foresight into possible futures. Because foresighting is broad in scope and exploratory in nature, the energy industry more commonly employs the methodologies of optimisation, forecasting, and backcasting. Quantitative modelling is commonly preferred, and approached as constructing the best simplified representation of a real-world energy system.

In the energy industry, foresighting is often associated with scenario creation and as offering visions of the future that are plausible, but broader and involving greater uncertainty than those presented by forecasting methods (Gilmore et al. 2022: 3).

Over the last few decades, the challenges of demand-side management and distributed energy resources (DER) have been exacerbated due to the lack of established modelling frameworks that capture uncertainties related to emerging technologies, changing lifestyles, and consumer behaviour or social practices.

There is now considerable innovation occurring in the energy sector to better account for possible and plausible futures through scenario-building, foresighting, and forecasting. However, these rarely account for how consumers themselves see their lives changing in the future.

Many of the required changes are conceptual, and require updated terminology to reflect the expectations of energy consumers about their emerging and future relationships with the energy grid, its associated services, and the practices that depend on it.

One conceptual and terminology change proposed by Energy Consumer Australia is to refer to DER as consumer energy resources (CER) in order to reflect the broader set of technologies associated with the localised generation, use and storage, and to more accurately represent how consumers themselves think about, and participate in the energy system. This report adopts the term CER when referring to technologies such as solar PV panels, home vehicles and electric vehicles normally associated with DER.

ETHNOGRAPHIC FORESIGHTING

While traditionally foresighting is a quantitative method, new approaches to 'ethnographic foresighting' have been developed by Human-Computer-Interaction (HCI) researchers to better understand how people are likely to experience possible future situations (e.g. Lindgren et al 2021). The key emphasis and shift is towards understanding how people experience possible futures, the ways in which they are likely to make decisions in contingent future circumstances, and how this is likely to manifest as changes in everyday routines and priorities.

The foresights presented in this report provide a key reference point for understanding how possible futures will plausibly and realistically come about. They remain relatively open to uncertainties, and can therefore be tested against a range of other future possibilities relating to technological, social, and environmental changes. They offer the conceptual and empirical material required for formulating qualitative forecasting scenarios, as well as the necessary material for adjusting these as new uncertainties emerge.

This flexibility and adaptability is possible because ethnographic foresights are built on research findings concerning what people do, feel, and say when imagining or participating in hypothetical scenarios or situations about their future lives. They are derived from two key characteristics of foresights: 'First, foresight is non-deterministic, in that it has a multiple vision of futures and is open to opportunities rather than being predictive' and 'Second, foresight encourages proactivity, and the possibility of, and ability to, appropriate the future away from the forecasts that predetermine the path to the future' (Lindgren et al 2021: 4).

The foresights presented in this report do not predict what people will do in the future, rather foresights report on what people's priorities and needs are likely to be as these situations play out and continue to evolve.

They do not refer to static future situations or end points, which should remain fixed in scenarios. Rather they identify how people's relationships with energy, technologies, other species, and their environments more generally will shift as uncertain futures unfold.

DESIGN ETHNOGRAPHIC FORESIGHTING

Design ethnographic foresights, unlike quantitative foresights elicited through surveys, are derived from on-the-ground ethnographic and design futures research with people in everyday life situations and simulated futures situations.

Therefore they represent life as it is actually lived, and simulated futures as they are experienced by people. Industry claims and predictions of the future of specific automated systems or technologies do not include this everyday and experiential knowledge.

By introducing this new knowledge, design ethnography foresights constructively complicate the ambitions for automated technologies in the futures anticipated by the energy industry, by showing how and where they do not align with possible societal and everyday life futures.

Design ethnographic foresighting enabled us to introduce and account for the following new variables in energy futures:

- How people are likely to make decisions about energy and technology in the future, on the basis of their own knowledge and expertise.
- How people are likely to want to feel (emotionally and sensorially) in the future, and how they will use energy and technology to ensure this.
- How people are likely to change their everyday life priorities and routines in future circumstances where climate, technology, and society is changing.
- What values are likely to become important to people in the future.
- The significance of place and locality for how people will live in the future.

METHODOLOGY

This report draws on all six stages of the Digital Energy Futures project.

Stage 1: desk-based review of 64 digital technology and energy industry reports speculating on the near (2025 to 2030) and medium-far (2030 to 2050) futures.

- This review investigated how digital technology futures and energy futures are currently envisioned across industry and policy reports. The findings of the review were synthesised into six speculative future scenarios that placed dominant industry visions into the home in an accessible comic strip form, which are presented in *Digital Energy Futures: Review of Industry Trends, Visions, and Scenarios for the Home (June 2020)*.

Stage 2: ethnographic research with 72 households across Ausgrid and AusNet Services distribution networks in New South Wales and Victoria.

- This research focused on the everyday lives of people and their visions for the future across seven everyday practice domains where the majority of energy consumption and peak demand occurs and/or is expected to grow or change in the near future. This research identified 45 digital energy future trends organised across seven domains of everyday activity in the home that are relevant to households today and are likely to affect energy demand in the near-future. It also provided principles for future home life to guide residential electricity planning and forecasting in the near and medium-far future. These findings are presented in the *Digital Energy Futures: Future Home Life report (July 2021)*.

Stage 3: Key findings from the Digital Energy Futures project informed the design of the Energy Consumers Australia's Energy Consumer Behaviour Survey (ECBS).

- The ECBS survey provides Australia's most extensive national picture of the attitudes and activity of residential and small business energy consumers, including questions about how people see their lives unfolding in the future. It was first published in October 2021 and again in October 2022. This report also draws on relevant findings from Energy Consumers Australia's *Energy Consumer Sentiment Survey (ECSS)*. The most recent ECSS data was released in June 2022.

Stage 4: Design Ethnographic Futures Workshops.

- Ten online workshops were held in early 2022 with 42 participants across Ausgrid and AusNet Services distribution networks in New South Wales and Victoria focusing on three key focus areas: healthy air and thermal comfort, mobilities and electric vehicles, and future routines in extreme weather.

Stage 5: Analysis of 14 industry reports presenting future energy scenarios.

- This analysis will go on to inform the project's final output: the development of a national forecasting methodology and a set of Digital Energy Futures scenarios for the sector, which has everyday life and consumer voices at its core (due for release in 2023).

Stage 6: Analysis of the ethnographic research with households to understand the potential impact on demand management.

- The *Digital Energy Futures: Demand Management Opportunities report (December 2021)* describes the relevance of Digital Energy Futures findings for household demand flexibility to respond to grid constraints and shifts in electricity supply, and is written for energy stakeholders with a role in the energy transition and demand management.

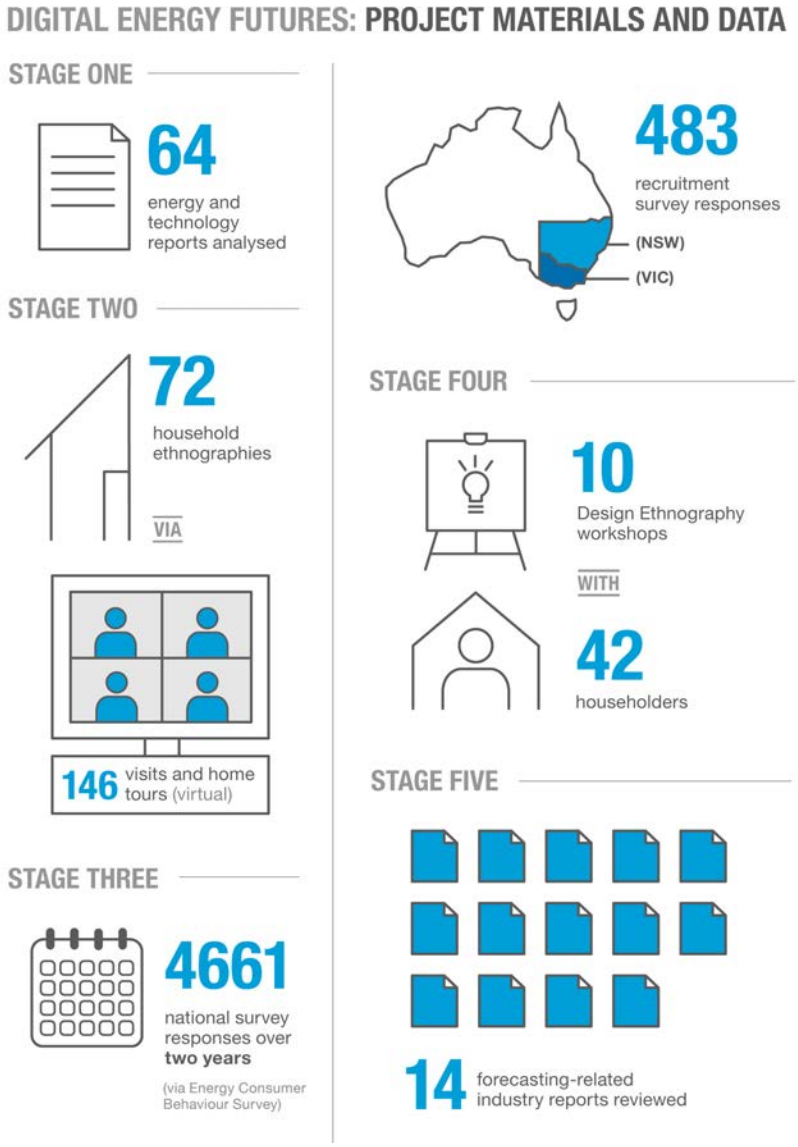


Figure 2 Cumulative project materials and data informing this report.

Foresighting Process

- Identification of three key focus areas as priority fields based on the findings of stages 1 to 3 of the Digital Energy Futures project and consultation with industry partners:
  - Electric vehicles and battery charging in local neighbourhoods (near futures - 2027)
  - Comfort, care, and safety in the home, and the rise of emerging air technologies (near futures - 2025 to 2030)
  - The reconfiguration of routines and load shifting in response to extreme weather (far futures - 2050)
- Deep dive into the lives of the participants in the ethnographic study selected according to consumer groups in urban, suburban, rural, and coastal areas across New South Wales and Victoria (Stage 2).
- Analysis of participant responses to future scenarios undertaken during the ethnographic study, regarding the key areas of focus (drawn from Stage 2 research).
- Ten design ethnography futures workshops (Stage 4) to address key questions relating to the three areas of focus.
- Cross-checking the trends and foresights with findings from the ECBS (Stage 3) with further reference to the ECSS.
- Development of foresighting concepts informed by stages one to four of the project and an analysis of industry scenario reports and their key assumptions about people and technology (Stage 5), developed in dialogue with anthropological and sociological theory.

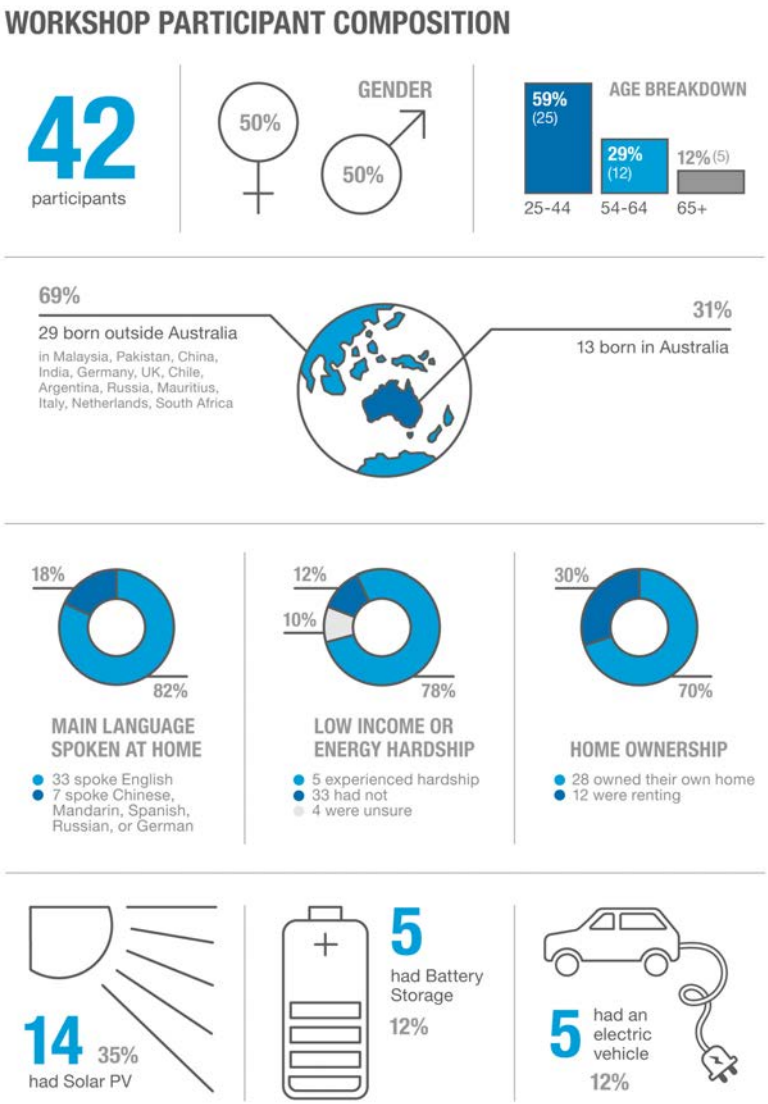


Figure 3 Design ethnographic futures workshops participant composition.

Design Ethnographic Futures Workshops Participant Sample

The workshop participants were drawn from approximately half of the Stage 2 participants, who had been selected to represent seven consumer groups: High demand homes, Early adopters - energy technologies, Early adopters - digital technologies, Apartment renters, New estate homes, Regional agricultural areas, and Sea or tree changers.

For Stage 4 of the study, these participants were grouped into locality-based clusters representing ten urban, suburban, rural, and coastal sites within the distribution network areas of our research partners, AusNet Services and Ausgrid, across Victoria and New South Wales. This grouping allowed a deeper exploration of the relationship between locality and future energy demand, and ensured consistency with the consumer group priorities in the Stage 2 ethnographic study.

Each workshop had between two and six participants from the same local area. The workshops were designed to be delivered online via Zoom video conferencing, using the online visual collaboration tool Miro in order to support three activities (below) which took approximately two hours. All workshops were recorded for analysis.

While these workshops were designed to be online, the methods and materials can also be translated into in-person discussions.

WORKSHOP ACTIVITIES METHODS

All workshop methods were designed with online and in-person options. Due to COVID-19 restrictions all workshops were delivered online by the Digital Energy Futures team in Zoom meetings and using templates on Miro boards designed for this exercise by the team. All Zoom meetings were recorded (video and audio) and Miro board outputs were kept for analysis.

The workshops focused on three subjects that were identified in collaboration with energy industry partners to represent new trends in technology and society, key challenges in forecasting, and core fields of social science knowledge.

Each workshop included three group activities, dedicated to in-depth exploration of:

1. future electric vehicle and battery charging,
2. future air technologies, and
3. far future routines and loadshifting in extreme weather.

The following pages summarise each of the three group activities that were used in the design ethnographic futures workshops.

Activity 1: Future Electric Vehicle and Battery Charging

(near future 2027)

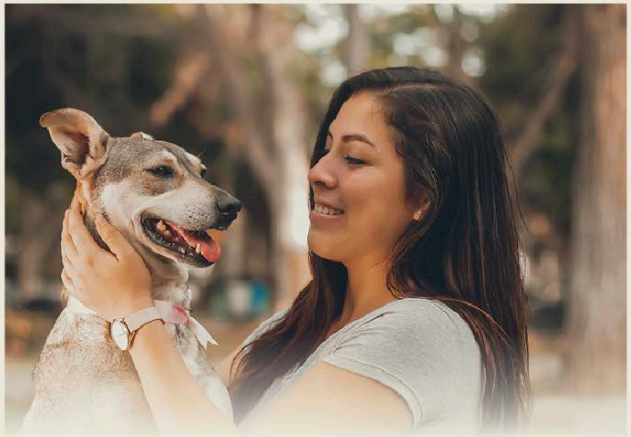
In the electric vehicle (EV) workshop activity, participants worked together in small groups to imagine charging and using electric cars in their local contexts in the near future (2027).

By grounding these future visions in specific localities, the workshop activity revealed how electric cars might impact place-based and family routines and how adoption of personal EVs might be influenced by (and co-constitute) locals' 'sense of place'.

Step 1: Participants introduced themselves by encapsulating what it is like to live in their local area in a single word (for example, participants described their area through words like 'peaceful', 'quiet', 'multicultural', 'community', 'convenient', and 'open').

Step 2: A 'future neighbour' card was introduced, presenting a fictional character who lives in their local area in the year 2027. The card provided basic details of this neighbour's everyday life (such as housing type, family, and work schedule) and the energy technologies they had at home (such as an EV and/or solar panels). It was made clear that these characters were not personas, but fictional characters to help imagine local futures and prompt group discussion (see Figure 4, right).

Step 3: As a group, participants brainstormed where this future neighbour might go as well as the motivations and challenges in their everyday travel, and annotated a digital map of their local area (prepared by the research team) to show a typical day's journey in the year 2027 (see Figures 5 and 6).



FUTURE NEIGHBOUR

Lisa

It's the year 2027 and Lisa lives in an apartment with her partner in inner Sydney. They purchased an electric vehicle, but do not have access to charging in their building and must park on the street. Lisa works from home 3 days a week and in an office in the CBD the other 2 days of the week. She cares for her mother who lives 50 km away and tries to visit her at least every couple of days. She likes to take her dog to the beach on nice weekends. **Today she is travelling...**

Figure 4 Example 'future neighbour' warm-up prompt.

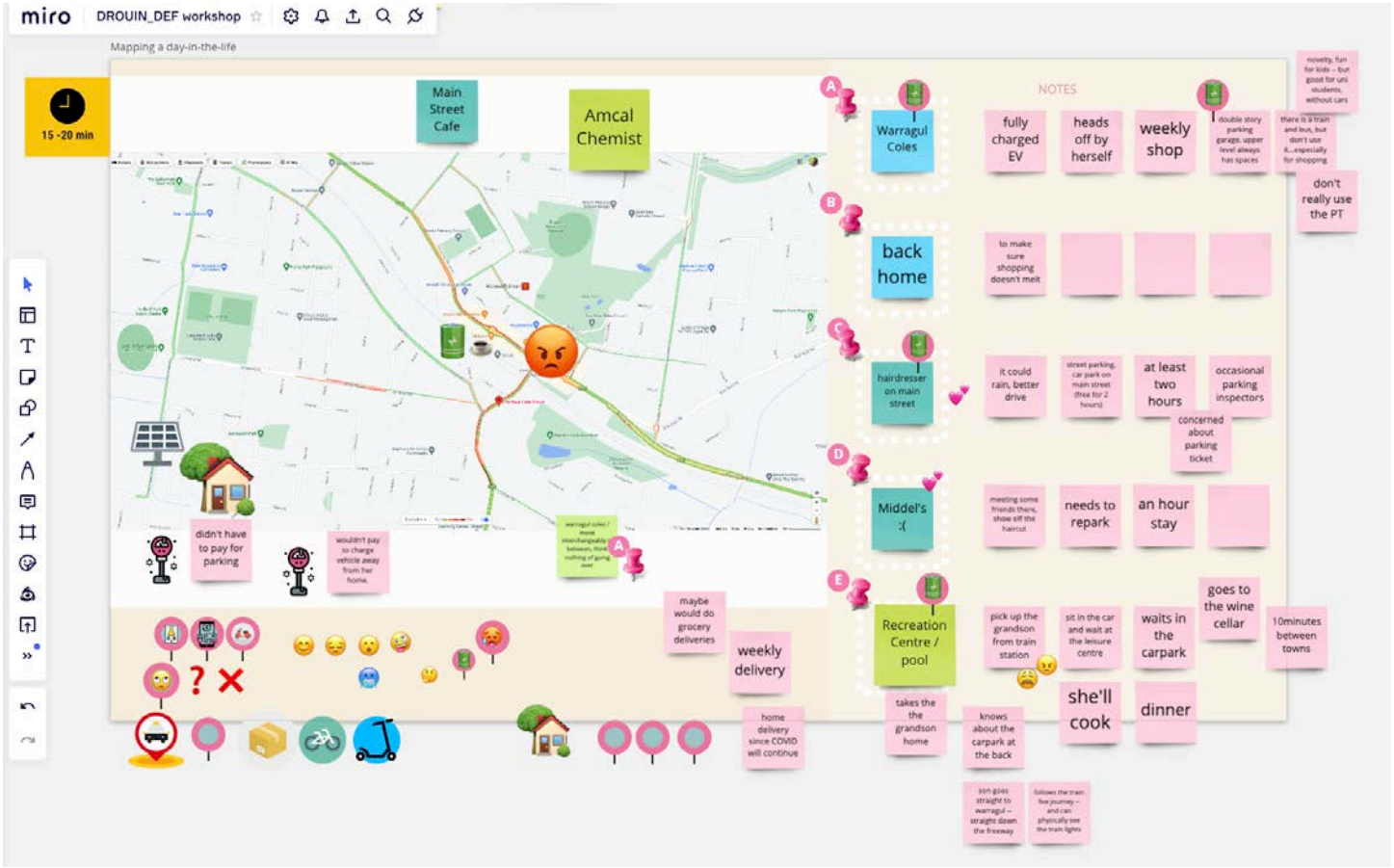


Figure 5 Examples of group journey mapping activities.

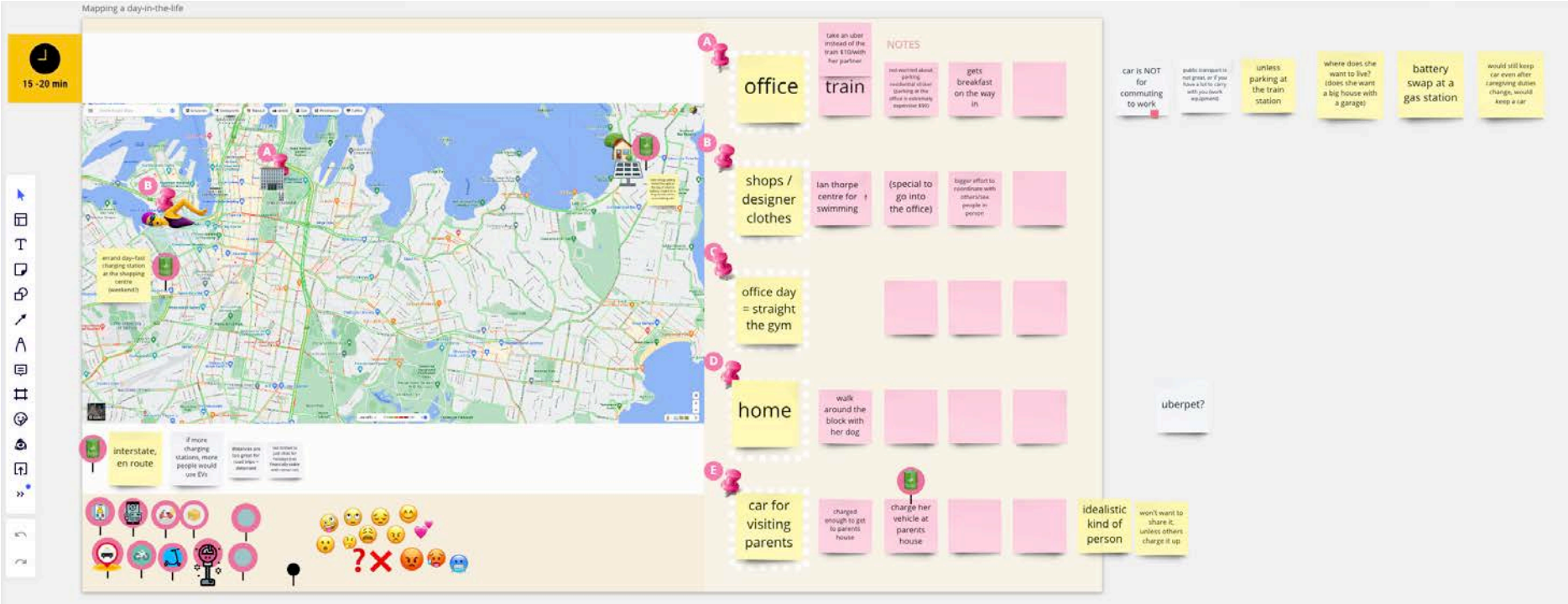


Figure 6 Examples of group journey mapping activities.

After brainstorming specific local places where they think their future neighbour might go, workshop participants mapped a typical day in the year 2027. Throughout the journey, they discussed their neighbour's possible future motivations and challenges while travelling, and the existing and speculative services and infrastructures that they might encounter in their area.

Activity 2: Future Air Technologies

(near future, 2025-30)

This workshop activity was designed to investigate the implications of the rise of emerging air technologies and values of comfort, care, and safety in the home for future energy demand.

Step 1. A simple word association activity to describe the perfect air quality each participant would each like to have in their homes in the near future.

Step 2. Participants used a template to design a speculative future air technology for their home that would help them achieve the conditions they had described. They were asked to name their device, use a series of symbols and lines to physically illustrate its form, and to choose its functions and its level of automation.

Step 3. To explore possible tensions between the wider electricity grid and the future household air technologies, a workshop activity was designed following the method of a "thing interview" (Nicenboim et al. 2020; Reddy et al. 2021), as part of the broader field of "thing ethnography" (Giaccardi et al. 2016). Participants were asked to role-play the device they had just designed (e.g. pretending to be their ideal 'air technology') while they were interviewed by a researcher who role-played the perspective of the electricity grid.

The researcher playing the role of the grid explored participants' values and practices through a series of questions relating to how the future air technology would mediate power relations, trust, care, privacy, and automation and how it would moderate flows of data, air, electricity, allergens, pollutants, and payments. This provided new knowledge about people's visions for near future air technologies and how they understood this in relation to the needs of the electricity grid.

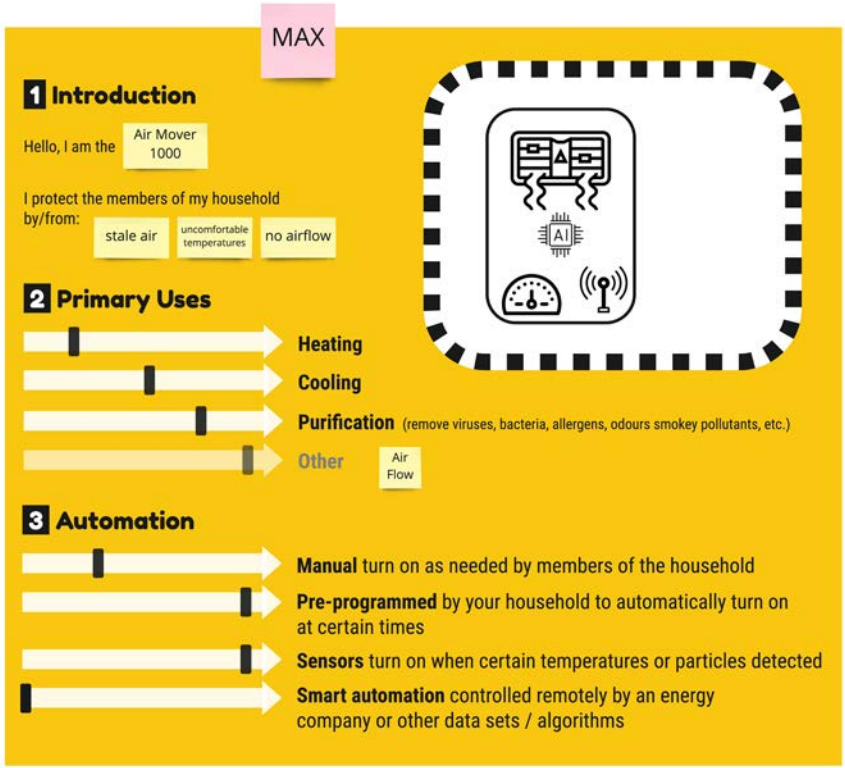


Figure 7 Example participant-generated future air technology.

Activity 3: Far Future Routines and Load Shifting

(far future, 2050)

Australia is likely to face increased incidences of extreme weather as a result of climate change. The World Economic Forum's past five Global Risk Reports noted extreme weather as the top global risk by likelihood (WEF 2021).

To investigate how such environmental conditions in a probable far future are likely to affect load shifting, we asked workshop participants to map their current routines, then presented them with the following future scenario for 2050 and asked them to visualise how this context might affect their everyday routines.

This activity builds on sociological and geographical research that has explored time-shifting and the flexibility of everyday life (and subsequently energy demand) through theories of social practice (e.g. Blue et al. 2020; Higginson et al. 2014; Nicholls & Strengers 2015; Powells et al. 2014; Torriti 2017; Shove et al. 2012; Walker 2014).

This activity was designed to help uncover 1) which everyday practices might be flexible or likely to shift in time or place in the future; 2) which practices were unlikely to shift, despite a different future context, and 3) participants' expectations for what everyday domestic life might look like in the far future (2050), and what new consumer practices, technologies, and services might emerge.

Figure 8 Extreme weather scenario card.

ANALYSIS

Design ethnographic foresighting analysis follows the following key stages:

1. Narrative and literal (where required) transcription of video materials and Miro board responses from all of the ethnographic interviews and futures workshop activities.
2. Organisation of findings to respond to research questions, and identification and tracing of new unexpected findings across the sample.
3. Identification of the significance of the findings in response to key design ethnographic concepts (e.g. innovation and improvisation, contingency, trust, values, practices).
4. Comparison and alignment of the findings to the ethnographic research (Stage 2), ECBS and ECSS (Stage 3), the two industry report reviews (Stage 1 and 5), and our broader ongoing research and monitoring of emerging trends.
5. Alignment of social science theory, concepts and future-focused empirical findings to extrapolate foresights.

FORESIGHT SCOPE

The foresights presented in this report are based on the Digital Energy Futures team's analysis of the experiences and views of the people who participated in this project or responded to related surveys. Some of these foresights may therefore be more applicable to the localities and environments represented by the distribution areas of Ausgrid and AusNet Services, and to the temperate climates that characterise the south-east of Australia. The research did not aim to, nor does it claim to, capture the diverse experiences or views of all Australians.

However, our ongoing industry, household and media research, and monitoring, strongly suggests that the foresights are likely to be broadly applicable to other Australian contexts and climates. They have been developed to reflect wider Australian lifestyle trends, values and practices, and correlated with national ECBS findings or other available data. Our methods have also been designed to respond to national and international energy and digital technology developments that have wide applicability.

The reframing foresighting concepts presented in the next section have a broader scope and are intended to be adaptable to new projects in the energy sector and elsewhere. The reframing is consolidated by established empirically based theoretical and conceptual research undertaken by the Digital Energy Futures team and other researchers internationally.

REFRAMING FORESIGHTING CONCEPTS

REFRAMING FORESIGHTING CONCEPTS

INTRODUCTION

Why we need new concepts

The ongoing and future digital transformation of the energy industry, alongside the environmental social and cultural transformations characterised by climate change, and challenges to our safety and health, require new conceptual and practical frames.

The energy industry has tended to rely on long-standing and dominant theories and assumptions about consumers and their energy demand, which do not adequately reflect both our changing society and people's relationships with emerging technology.

This section presents a set of future-ready concepts, which are recommended to guide the energy industry's understanding moving forward.

Each concept is illustrated through the evidence and foresights generated by the Digital Energy Futures project.

14 REFRAMING FORESIGHTING CONCEPTS

Our consultations with industry partners and the Digital Energy Futures Review of industry trends, visions and scenarios for the home report (Stage 1), Future Home Life report (Stage 2), Energy Consumer Behaviour Survey (Stage 3) and Demand management opportunities report (Stage 6) suggest that to create reliable foresights about energy futures we must account for the following three overarching categories:

- **People-Led Futures**, Reframing Consumer Values
- **Collaborative Futures**, Reframing Engagements with Energy Systems
- **Tailored Futures**, Reframing Technology Practices of People

Under the scope of these three categories we situate the 14 reframing foresighting concepts (shown in Figure 9).

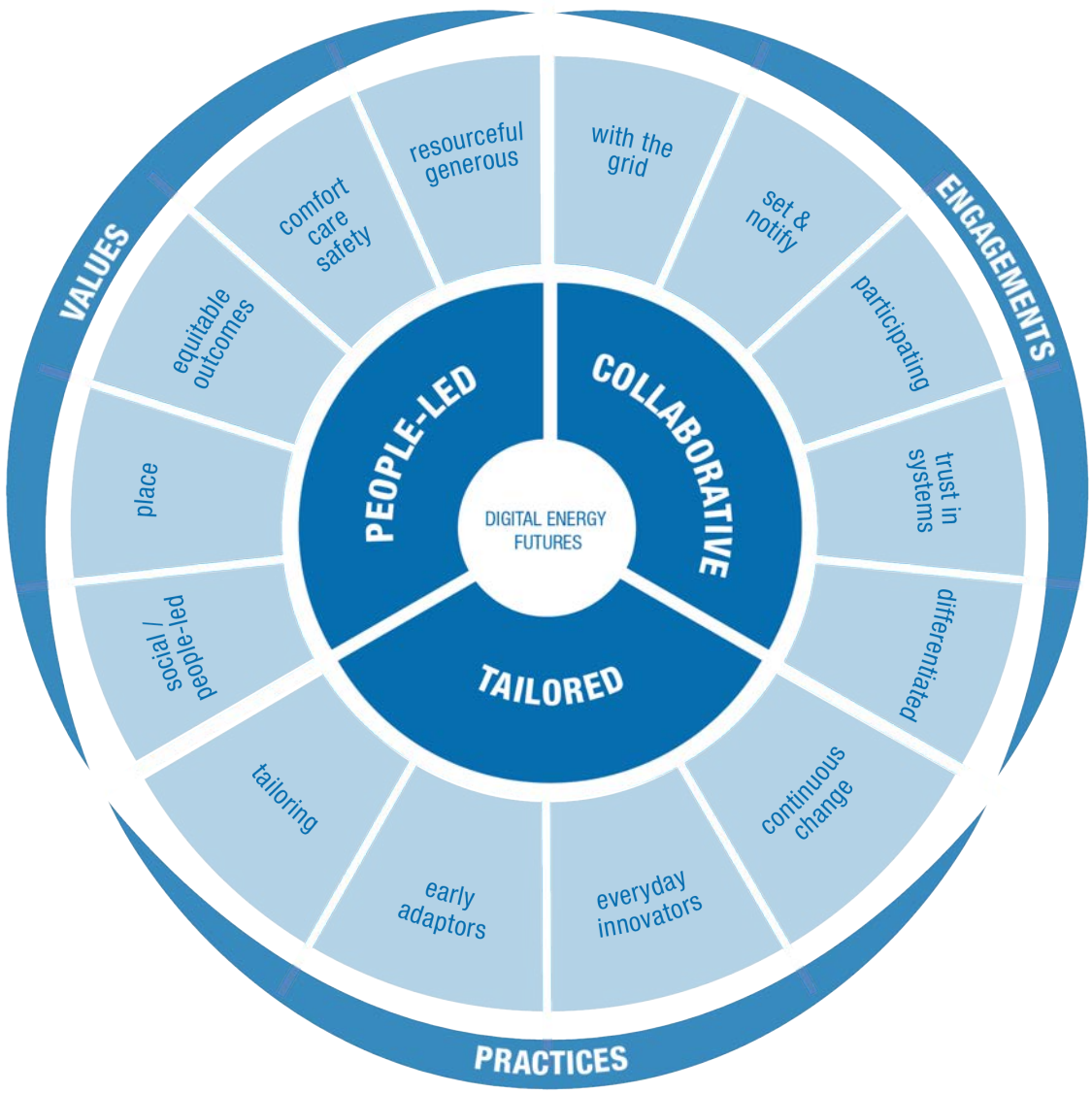


Figure 9 Digital Energy Futures: 14 Reframing Foresighting Concepts

PEOPLE-LED FUTURES

Reframing Consumer Values

INTRODUCTION

Our research indicates that the existing suite of concepts used to portray **people** (Reframing Foresighting Concept 1) in energy industry analysis, foresighting and forecasting need to be revised to better align with people's future values as they emerge in the everyday realities of future life across diverse circumstances.

Our own existing research, and a long history of work in the social sciences, has also demonstrated that life is **place-based** (Reframing Foresighting Concept 2). This means that whatever happens to people in everyday life is framed by their circumstances of place. Place is often associated with locality (which it is in our study), but it also encapsulates how wider influences, including remote digital technologies and media, politics, and environmental changes impact on people's lives. Place is where energy use intersects with the characteristics of, and people's knowledge of, the local. This includes their knowledge about local weather systems, the characteristics of their local relationships and communities, and much more. The future of energy demand, production, and use are inextricably connected to place. Therefore we accounted for place and how locality will inform peoples' everyday routines and decisions about energy.

Place-based analysis is also central to people's experiences of, and opportunities for, **equitable outcomes** (Reframing Foresighting Concept 3). Climate, housing ownership, housing quality, dwelling and property type, and location all impact on people's access to energy technologies. In addition, equitable outcomes are shaped by complex socio-demographic variables, values, and priorities, such as people's (in)ability to afford, understand, operate or want to participate in emerging energy technologies and programs. Our research indicates that it would be detrimental to presume a 'one size fits all' future. Instead, industry and governments need to prioritise the best available practical and place-appropriate options, which may not involve the latest or established smart technologies.

The experience of the COVID-19 pandemic has changed people's relationships to their homes and their work, how they use new technologies, and is reshaping energy demand. Our research, undertaken during and after the pandemic lockdowns, and uniquely from the perspective of everyday life, reveals the risks entailed in continuing to understand people's relationships to energy simply in terms of consumption. Existing prevalent concepts of the consumer and prosumer are no longer aligned to the contemporary context. Instead, values of **comfort, care and safety** (Reframing Foresighting Concept 4) and the ability to be **resourceful and generous** (Reframing Foresighting Concept 5) will be central to people's priorities for their households and will guide their motivations and their relationships to the grid and to other people in the future.

FORESIGHTING CONCEPTS AT A GLANCE

	from	to	
1	TECH-LED FUTURES	**SOCIAL / PEOPLE-LED FUTURES**	understanding the real role that people will play in defining our energy futures
2	ZONES	**PLACE**	acknowledging the role of locality and place in defining how people will use energy
3	UNIVERSAL SMART SOLUTIONS	**LARGE-SCALE EQUITABLE OUTCOMES**	accounting for equity by replacing the focus on equal access to dominant technology solutions with a focus on diverse needs
4	CONSUMING	**COMFORT, CARE AND SAFETY**	accounting for the increasing importance of comfort, care and safety at the core of household lives
5	CALCULATING AND RATIONAL	**RESOURCEFUL AND GENEROUS**	understanding how people's moral values in relation to energy are evolving and that they will be decisive in our energy futures

CONCEPT 1

FROM TECH-LED FUTURES

'Tech-led' industry visions assume:

- The application of new technologies will shift consumer behaviours and solve societal problems
- When consumers do not adopt new technologies as expected, their behaviours are seen as 'irrational' and as 'barriers' to the efficient automation of distributed energy resources (DER)
- Many technological solutions do not require the involvement of ordinary people at all

"Artificial Intelligence (AI) is one of those technologies, like advances in gene editing or quantum computing, which has the power to change life itself. It has the potential to transform economies, unlock new societal and environmental value and accelerate scientific discovery."

- CSIRO 2019a Artificial intelligence: Solving problems, growing the economy and improving our quality of life.

▶ TO SOCIAL / PEOPLE-LED FUTURES

Digital Energy Futures finds:

- People are not simply consumers but rather they drive our societal and energy futures because their values, ethics and priorities determine how they will use energy
- If technology is designed to enable people's future practices and routines, it will support people-led societal change towards consumer energy resources (CER)
- All technological change requires the involvement of the people who are affected

The application of new automated technologies is not a simple fix that can change people's behaviour either unconsciously or willingly. Some people will be indifferent to automated energy management systems if the automated systems do not disrupt their lives in undesirable ways (e.g. automated hot water systems). But most people will wish to use technologies to create changes they regard as ethical and beneficial for themselves and society.

Effective social/people-led energy futures reframe industry visions of consumers and how to communicate change processes to people. For people to be engaged and on board with changing their routines and practices to align with energy needs and ultimately to address societal problems, they must be empowered to drive this change themselves with automated technologies clearly assisting them.

In the future people will want to get the best out of changing weather systems for themselves, and will wish to use technology to help them do so. Household acceptance of automation is likely to vary depending on the appliance, for example whether it is an appliance that the household is used to having complete control over (e.g. air conditioning) versus an appliance that already usually operates without their input (e.g. hot water system).

ECBS and ECSS Survey Data and Participant Voices

30% anticipate that over the next 5-10 years, most of their home appliances will be internet-connected and automated.

ECBS 2022

Only 5-7% of households at any life stage prefer the idea of "fully automated" smart appliances. Most households prefer "complete control" of appliance settings (46%) or automation that they can override if needed (48%)

ECBS 2022

"Having automation, to me, is restricting what you can do, and I think technology should expand what you can do...I can walk out to my coffee machine on a Saturday afternoon and go, it's a cold day I feel like a hot chocolate…but if its programmed to make me a cappuccino at 2 o'clock every afternoon, well I don't get that choice."

— Sue

"I don't want technology to take control of me; I want more control through technology."

— Miles

Example participant response to comic strips depicting 'tech-led' industry visions:

Erin thought the Active Smart Charging Commuter comic strip made sense because "it's all automatic and you just need to feed clothes into the washing machine at your convenience and have them ready to go knowing that they'll be done whenever the energy's coming in and it's a suitable time."

The comic strip portrays the industry vision of a vehicle-to-grid future, where a commuter charges his car at work, while automated appliances complete tasks,such as laundry, at home. But Erin was uncomfortable with the reversal in power and decision making, and with "being dictated to by the technology as to when I'm going to do my washing."

In the future, Erin wants to control and make decisions based on her sense of the weather and her particular needs, which she didn't feel automated systems would sufficiently account for "if it's a good day I'll want to do three or four loads of washing and get it out on the line … rather than have a small load of washing go through every single day."

CONCEPT 2

FROM ZONES

Industry visions assume:

- Residential energy demand is conventionally understood and modelled as occurring in 'zones', which represent a geographically-affiliated load on the energy network
- Substations provide a proxy for energy modelling to determine the energy demand impact on the electricity grid, and to help forecast future infrastructure needs and demand response requirements
- Zones are understood through aggregated datasets (e.g. load, appliance/technology uptake, and weather), numbers of connections, household size and income and population data

"Price and incentive reform plus optimised networks and markets means distributed energy resources adoption is enabled and delivering network capacity reduction tuned to each zone substation."

— CSIRO and Energy Networks Australia (2017) Electricity Network Transformation Roadmap.

▶ TO PLACE

Digital Energy Futures finds:

- Energy demand occurs in place. The concept of place refers to the dynamic relationships between people and their social, material, natural and technological environments
- People are part of, and live in, their local neighbourhoods and environments and many of their future decisions will relate to their place-based knowledge of local weather, infrastructures and relationships
- People are increasingly digitally connected, many spend more time at home, living locally, and this will shape their future uses of energy and technologies
- Place shapes energy demand through the localised practices that occur in specific physical and relational spaces

People's connections to place vary across different types of places, and how long they have lived in a specific place. People with long-term attachments to a place will make decisions based on their deep knowledge of, and attachments to, the aesthetics of local environments, and this will generate specific energy demands and patterns of demand in local places.

Different places will also produce unique load profiles related to specific industries, lifestyle trends (e.g. working from home), or available technologies (e.g. rooftop solar PVs). People with transient or a non-localised sense of place (e.g. recent migrants or 'digital nomads' may rely more on digital and automated technologies to understand, interpret and regulate their sense of place (e.g. through weather data and temperature control).

Using the frame of place to consider digital energy futures foregrounds the role of local weather systems and environments, tailored home and technology systems, and embedded community, work and cultural dynamics.

ECBS and ECSS Survey Data and Participant Voices

Ensuring Australia's energy system is resilient to extreme weather events is especially important to rural households (37%).

ECSS 2022

In 2021, households reported changes associated with the COVID-19 pandemic, including: 35% worked or studied more from home; 40% used more heating or cooling; and 37% did more activities in the home (e.g. exercise).

ECBS 2021

11% expect they will move to a new housing estate on the edge of the city, and 14% expect they will move from the city to a country area in the next 5-10 years.

ECBS 2022

"This suburb has been built from the general plan, a single company built all the buildings here, so it's really nicely architectured and there's really nice gardening around it. …I am very far from a train station but I am near to a wharf from where I can travel to my work by ferry, so my customer experience is great from the time when I wake up, looking out of the window and seeing the gardens, to my commute on this beautiful ferry."

— Artem, Sydney

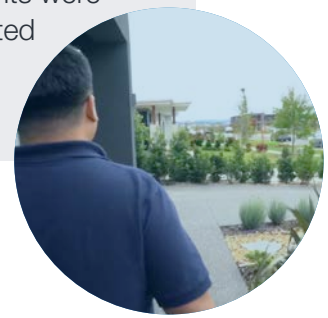
"Washing machine, dishwasher are both run during the day…we just turn them on when the weather's good…I know which time of the day the panels are getting the most sun."

— Jade, Sydney

Northern Beaches participants described their locality as 'paradise' and people from the Central Coast said they lived in the best place in the world. They knew their local weather systems, when the breeze cooled their homes, how the temperature changed through the year, and when back-burning smoke filled the neighbourhood.

They also knew their own homes intricately; their materials, the gaps that let smoke, pollution, heat or cold seep in, and how to manage the temperature by closing blinds or catching the cross-flow breeze.

They spoke of their family and household members, their needs, and preferences for warmer or cooler air, and their health conditions. All these participants were home owners and were invested in their homes financially and emotionally.



CONCEPT 3

FROM UNIVERSAL SMART SOLUTIONS

Industry visions assume:

- The energy market needs to provide equal access to digital and smart opportunities and technologies
- Smart technologies are a 'one size fits all' solution that people need to be supported to use and access equally

> *"Evolving customer expectations and a growing range of technologies are facilitating the democratisation of energy. Previously passive electricity consumers are becoming empowered 'prosumers' who make their own choices about how their energy is produced, stored and used."*
>
> — Transgrid (2021)
> Energy vision: a clean energy future for Australia

▶ TO LARGE-SCALE EQUITABLE OUTCOMES

Digital Energy Futures finds:

- Different people and households will need different opportunities and technologies in order to support their participation in future energy systems
- Some people may need extra support and alternative programs or technologies that enable them to realise digital energy futures and participate in energy markets
- Households with less interest or capacity to use technology need equitable access to affordable energy

The energy sector is focused on realising energy futures that revolve around a defined set of technologies and demand management programs. These include solar and battery storage, electric vehicles, energy-efficient appliances, home automation, and variable tariffs.

The focus is on ensuring that households and consumers can access these opportunities equally. However, our findings reveal that many households are unlikely to realise benefits from smart technologies or demand management initiatives at all. Tailored programs and technologies that may prioritise 'dumb' technology, or work with a household's and community's available infrastructure and distributed generation capabilities, will be needed to ensure all consumers receive equitable outcomes in the future energy system.

In particular, low income and vulnerable households, or people with low digital skills and confidence, may need programs that involve low technology and low cost opportunities.

The emergence of such inequitable futures is already an issue and must be addressed in planning for energy futures.

ECBS and ECSS Survey Data and Participant Voices

Even though use of technology such as voice assistants to reduce energy costs is low overall (6%), young (11%) and family households (10%) more commonly use this technology to help with energy management than older (4%) or retired households (2%).

ECBS 2022

The most common reasons why households have not bought an EV are cost (59%), lack of public charging stations (41%), having a vehicle that does not yet need replacing (27%), and not having a place to charge an EV at home (26%).

ECSS 2022

"We try in the whole day, we try open as much window as possible, get a fresh air because personally I don't feel comfortable using air-conditioning because I tend to get muscle pain, you know, from the air-conditioning, we try don't use very much air-conditioning."

— Victor, Kensington

"I think, well Elizabeth won the iPad so that was something that came into the house then but we didn't have the internet. I think it took a while for me to be able to afford the internet."

— Karen, Ringwood

One retired man, living in a retirement village in a rural Victorian town, drew on his own experiences to demonstrate invisible inequalities in EV charging at home.

He described how: "we've got [car parking] spots, you know not even for everyone, no way we could have a charger here … we just haven't got the facilities". He pointed out that this was a common problem, since "there are a lot of retirement villages where parking is a premium and there's just no room for charging."

Seniors are often invisible in technology design and this is one of many cases where inequalities are exacerbated because they are unaccounted for in design for accessible EV charging infrastructures.

In our participant's own words: "a lot of people like I think are going to be having them in their garages but we don't have garages so, it can't just be for people who've got the space, it's got to be for everybody."

CONCEPT 4

FROM CONSUMING

Industry visions assume:

- People's primary relationship to energy is through their consumption of it
- People make decisions and choices about their consumption, through the use of energy data and information
- Individual consumers are in control of the energy they consume in their homes

> *"Future change will be driven by a range of factors, from government policy that bans or discourages high-carbon activity to new innovative technologies and business models like 'energy as a service'...Consumers benefit from the end-to-end management of areas like their energy consumption, without making any upfront investment."*
>
> — National Grid ESO (2021: 57) Future Energy Scenarios.

► TO COMFORT, CARE, AND SAFETY

Digital Energy Futures finds:

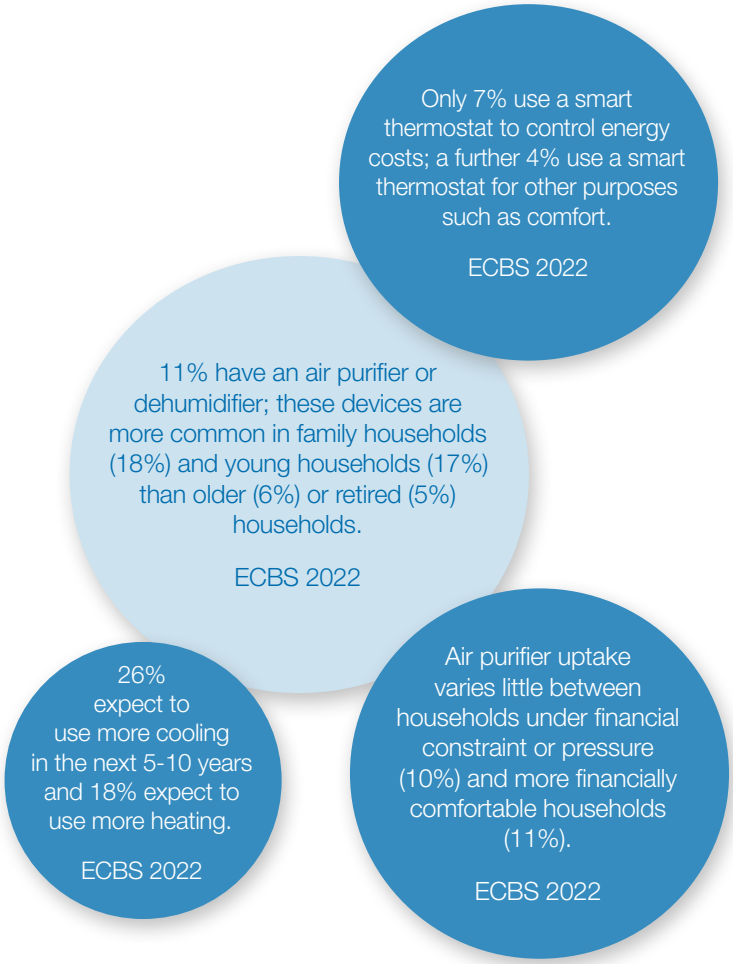
- In the future, rather than simply being consumers, people will apply new values to the ways they use energy
- Instead of primarily seeking comfort and convenience and calculating the best offer, people's top priorities will be values of comfort, care and safety for themselves, their households, and their local environments

While comfort will remain an important priority for people, new priorities of safety, health and care will become increasingly central to home life. Home safety management to ensure the physical and mental health of the family is likely to be central to people's future relationships with energy and automated technologies and systems.

Care will be performed through: the installation of air filtration and purification technologies to protect households from bushfire smoke, allergens and airborne viruses, as well as for the comfort of heating and cooling; the use of EVs for personal, household and extended family care-related activities including shopping, health care visits, driving grandchildren to school and extracurricular activities, as well as other local activities including work and socialising; future work, school, and transport routines that prioritise family care activities, such to ensure that children are protected from extreme heat.

These questions of control and care are likely to amplify for people as we move into the future.

ECBS Data and Participant Voices



"Last year, Peter had a bout of, well we think it was pneumonia. We're not sure. Ended up with the respiratory physician earlier in the year. Who suggested, because he's got this cough that comes and goes. …he suggested that we get an air purifier. So we now have one. I don't put it on every day, but if he seems to be coughing, I put it on a bit more."

— Marj, Drouin

"People always said to me when I installed solar panels, 'how long will it take for you to pay off the solar panels', and my answer is, 'I don't know and I don't really care that much, what I'm really interested in is the fact that I've reduced', and my wife's view is just as strong as mine, is that we've reduced our carbon footprint."

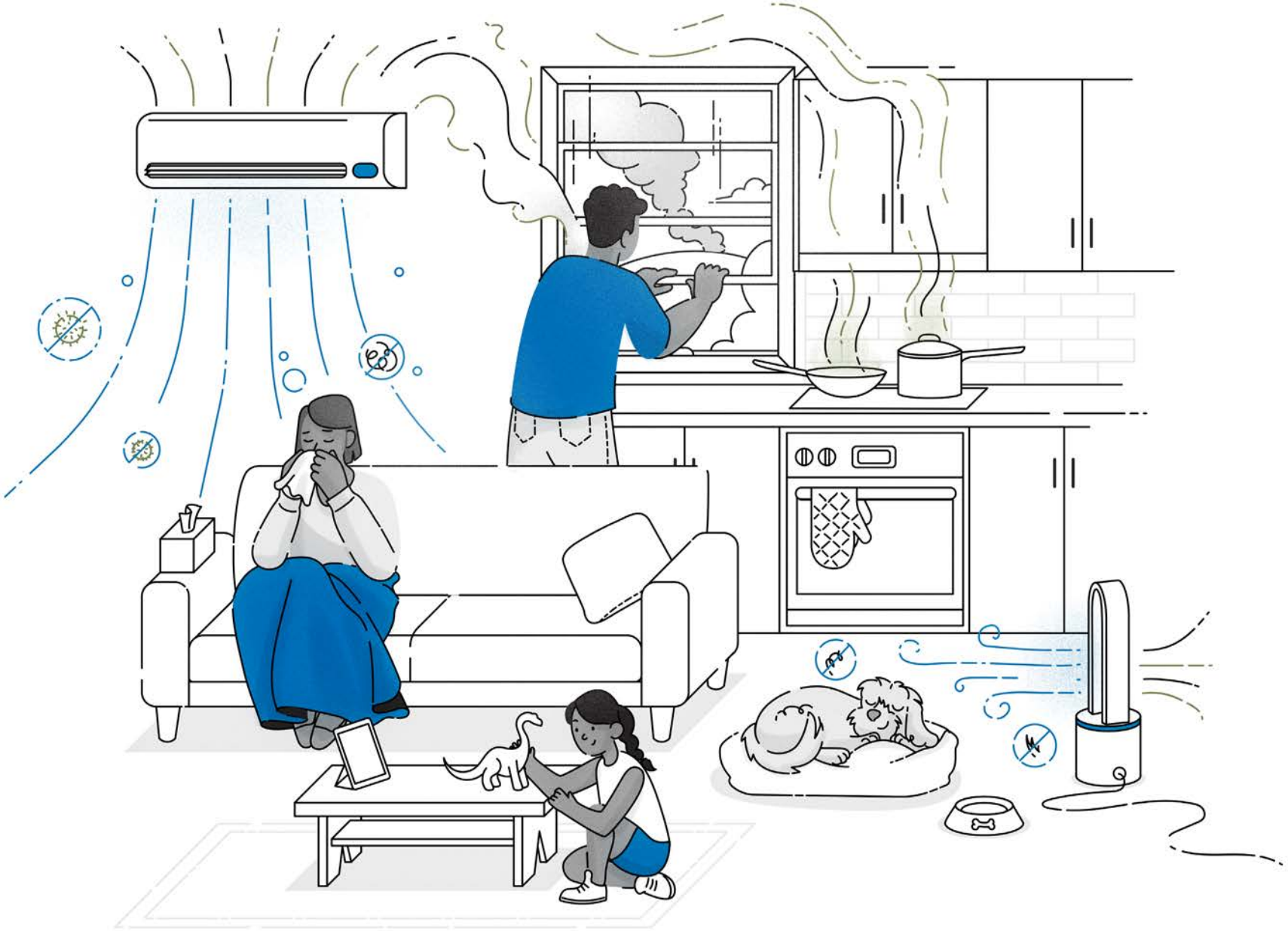
"I come down to this sort of idea about community responsibility and I just think that it's really important that we all make the kind of changes that are necessary in an age of global warming."

— Richard

Erin lived with her family in a rural location. She had "some real reservations about fully automated systems" since she believed "we lose a lot of our own choice, so I always like to have the options of partial automation."

In her household they gave voice commands to a digital voice assistant, asking it to perform tasks that they defined, because she said: "we need to be able to make those choices for ourselves, as to how hot we want our house, how cool we want our house, when we want that heating, when we want that coolness on, we need to be able to set for an air purifier exactly what we want the air purifier to do, rather than just having it running automatically."

She explained that "when it's hayfever season, I'd love to be able to say 'air purifier, right I want you to strip the pollen out of the air that's inside the house', and at another time of the year ... if … my husband comes home and we've had … some really bad COVID stuff, OK I want you to be able to strip the COVID virus particles out of the air that's inside the house to minimise our risk."



► FORESIGHTING CONCEPT **4**: **COMFORT, CARE, AND SAFETY**

CONCEPT 5

FROM CALCULATING AND RATIONAL

Industry visions assume:

- Consumers are likely to respond to incentives
- Consumers perform cost-benefit analyses about their participation in energy markets and use of energy technologies to maximise their own personal gain
- While the energy sector recognises that it cannot explain all human behaviour as a response to price signals, forecasting struggles to integrate alternate motivations

"The increasing electrification of the transport sector is expected to lead to greater charging infrastructure development and tariff change, providing consumers with greater choice to charge their vehicles in ways that are increasingly flexible, lowering user costs, while minimising grid cost and impact. As a result, AEMO anticipates growth over time in charging behaviour aligned to times of low overall demand, such as when distributed PV generation is high."

— AEMO (2021)
Inputs, Assumptions and Scenarios Report,
Australian Energy Market Operator

► TO RESOURCEFUL AND GENEROUS

Digital Energy Futures finds:

- People will put their own values at the centre of their approaches to energy
- People will want to realise a return on their investments and access 'good deals' but they will be willing to share excess energy and contribute to sustainable energy systems
- People will be resourceful in seeking not to 'waste' excess energy and generous when this energy could be used by others or contribute to the public good

Although financial considerations are important they are not the only motivation for households at present and are unlikely to be in the future. In the future, people are likely to be just as unaware of their tariff structures and precise electricity costs as they are today. But they will still seek to reduce their electricity use by being resourceful, thrifty and sometimes price-conscious. Because people dislike waste they will be generous with their excess energy.

People will be resourceful in different ways depending on the circumstances. When solar produces more than a household can use or store, many will prefer to give it away rather than 'waste' it. As renewables become increasingly abundant in the future, people will be generous with their excess energy for 'good' uses and to contribute to the common good.

They are likely to respond to demand management programs for generous motives such as helping the environment, educating children, and avoiding blackouts to ensure more vulnerable members of the community have the electricity they need.

While money is a consideration when people adopt CER, ethical orientations to the environment and the broader community are also priorities, and this is likely to be a growing trend for the future.

ECBS Data and Participant Voices

If asked to reduce electricity use a little during a very hot period, 47% are willing to do this without a financial incentive.

ECBS 2022

People also commonly chose 'To help the environment' (43%) and 'To ensure older or unwell households can run their air conditioning to keep cool' (26%) as reasons to respond to demand management.

ECBS 2022

The most commonly selected reasons to respond to demand management were: 'To reduce my energy use' (66%); "To avoid wasting energy" (54%); "To reduce stress on the electricity grid" (50%); and "To help prevent a power outage" (48%). 'To get a financial bonus on my energy bill' was the fifth highest response (45%).

ECBS 2022

"I think it's [the cost of energy is] reasonable…we just kind of pay the bill when it comes. So it's…not really something that would affect how much energy I use 'cause I try and be considerate like… not leaving the heating on when we're not home… it's like a habitual thing of like wanting to conserve energy".

— Linsay, Ultimo

"I actually chose it [demand management program] not for the payment or anything like that. I wanted to educate my kids on alternatives because I think we've become too reliant on creature comforts. So I looked at it as more of an educational opportunity for them to actually slow down and to live according to the conditions, rather than trying to make our conditions fit to what we want them to do."

— Erin, VIC

Dianne, Gary and their two adult children had recently installed solar panels and a small household battery. With a pool, three refrigerators, and their regular use of air conditioning, they were a high electricity usage household.

For Dianne and her daughter, purchasing the solar and battery was driven by their concern for the environment, and together they convinced Gary that it also had financial benefits. As a result Dianne became very interested in her energy, consulting the energy monitor on her computer several times a day. She was very interested in the idea of a community micro-grid, especially if she could give excess energy to a neighbour.

She described, "Ok, we get some tariff, feed in tariff …I also wouldn't mind giving that energy and having it used by someone else at no cost. I think that's something you can contribute which doesn't cost you very much but might change someone's life."

► FORESIGHTING CONCEPT **5** : **RESOURCEFUL AND GENEROUS**

COLLABORATIVE FUTURES

Reframing Engagements with Energy Systems

INTRODUCTION

The shifts in people's values and relations to place and technology will continue to be inextricable from the ways people will engage with the institutional and infrastructural dimensions of energy systems in the future. Our research suggests people will develop increasingly collaborative relationships **with the grid** (Reframing Foresighting Concept 6). People will want to make their own decisions in the future, and for this to be viable they will need to be in communication with a transparent grid, to be **notified** in a variety of ways (Reframing Foresighting Concept 7), and to be empowered to actively **participate** (Reframing Foresighting Concept 8) and feel ownership and responsibility as renewable energy becomes part of their local lives.

The question of what and whom people will trust in the future is central. Rather than trusting energy companies, people are more likely to **trust** (Reframing Foresighting Concept 9) in the local circumstances, relationships and environments through which they generate their own knowledge and make their own decisions about energy use. To understand how people's relationships with the future grid will vary, the conceptualisation of people as part of a segmented energy market must be reframed to understand their lives as **differentiated** (Reframing Foresighting Concept 10) from each others' across a range of cross-cutting and place-based socio-demographic and lifestyle considerations.

FORESIGHTING CONCEPTS AT A GLANCE

	from	to	
6	OFF THE GRID	▶ **WITH THE GRID**	envisioning a collaborative relationship with the grid evolving, where people will use it as a backup or for sharing energy with others
7	SET AND FORGET	▶ **SET AND NOTIFY**	providing the transparency and control over automated systems that people will need to ensure the care and safety of their households
8	PROSUMING	▶ **PARTICIPATING**	people's participation in future energy systems will be driven by their household and community priorities rather than by the market
9	TRUST IN ENERGY COMPANIES	▶ **TRUST IN TAILORED SYSTEMS**	understanding trust as situational and generated in everyday and tailored setups, rather than as transactional and fixed
10	SEGMENTED	▶ **DIFFERENTIATED**	differentiating between different groups of people through their values, practices and needs, rather than as stable consumer segments composed of single homogenous consumers

CONCEPT 6

FROM OFF THE GRID

Industry visions assume:

- Many people's desired goal is energy independence from the grid
- As people become more distrustful and frustrated with the energy system and energy retailers, they will seek complete independence
- When people say they want to go 'off the grid' they mean complete disconnection

> *"Third parties are successful in selling alternative energy supply solutions to customers and everyone who can go off the grid, does go off-grid. Consumers generate their own electricity and are largely energy self-sufficient as electricity demand is lower than other scenarios due to more energy efficient appliances and industry."*
>
> —Powerlink Queensland Network Vision (2020)

▶ TO WITH THE GRID

Digital Energy Futures finds:

- People want to work towards energy interdependence with the support of the grid
- Even when people discuss going 'off grid' they commonly wish to maintain a grid connection as 'backup'
- The grid will increasingly become a means of sharing energy with others

The role of the grid and people's relationships to it will shift over time, from a relationship of dependence to one of co-participation in a more mixed set of energy sources and programs. People will continue to look for ways to improve outcomes beyond their home by participating in emerging household and community energy initiatives, and by integrating energy technologies into their own lives. Households will want to sell or share their excess clean electricity to others or the energy system through the grid.

In the future going 'off the grid' will likely involve people seeking some energy independence while still being supported by the grid. The grid will increasingly be viewed as a 'backup' for local generation and storage, and as a mode of equitably distributing power to others in a more equitable energy system where values of generosity predominate.

Financial and technological arrangements that maintain people's sense of control and contribution around their energy exports are likely to mitigate interest in escaping high supply charges and unsatisfactory retailer relationships associated with grid connection.

In the future, people will want greater control and independence for their household's energy, but they will still need the security and reliability that a grid-connection offers.

ECBS and ECSS Survey Data and Participant Voices

While 32% of households with solar PV and battery storage consider it very likely (15%) or quite likely (17%) that they will disconnect their mains electricity connection in the next 1-2 years (ECBS 2022), ethnographic research findings indicate people are likely to maintain their connection to the grid as a back-up.

ECBS 2022

3% intend to soon install battery storage and a further 24% are considering storage over a longer term. 58% of these households cite "becoming less dependent on mains electricity" as a main reason to store electricity, making it the second most common reason behind "to save money" (70%).

ECBS 2022

"I assume that by then (2050) having a battery at home will be better. Especially if we are predicting blackouts. So it's probably good to have a back-up instead of a generator — you could have some nice batteries and you would check if they need charging or not, or maybe it's automated …everything would be online you wouldn't need to go to the physical thing. …maybe it's a good idea for a service offering (not sure if [networks] could do that) or if it would be the retailer side, or something."

— George, Cranbourne/Clyde

Kelsey (Hunters Hill) had solar panels and wanted to buy a battery so she could "be independent from the grid". She liked the solar system storing their electricity, because it enabled them to "make choices" but having to adapt to the rhythms of solar energy and change her "domestic habits" by using her appliances in the 2-8pm peak period was "annoying."

Karen felt that the size of the "rebate" gave her "no big advantage", so her future aim was to adapt the system to her own needs, to "tweak it and figure out how it works best, and then I'm my own woman with our electricity."

But Karen didn't want to be completely off the grid, since staying connected was her backup, for when, as she put it: "things break. We had the power cut… we were over a week without power and that was the worst. …. We got flooded big time and all that but that was just the worst …I don't want that."

CONCEPT 7

FROM SET AND FORGET

Industry visions assume:

- Consumers wish to delegate (energy) decision making to technology, captured in the phrase ‘set and forget’
- People want to automate, and once automation is established, people will not seek to regularly adjust or change the settings, but instead ‘forget’ about the automated appliance or device as it recedes into the background

> *“Digitalisation is changing the way consumers can engage in the electricity market … instead of having to actively monitor the electricity market and decide how or when to participate, can now ‘set and forget’ … Consumers can capture the benefits of participation by taking advantage of new technological developments that require very little action on their part.”*
>
> — AEMC (2019)
> How Digitalisation is Changing the NEM

▶ TO SET AND NOTIFY

Digital Energy Futures finds:

- In everyday futures people want to be engaged and feel in control of the safety and comfort of their households, so they will need to be able to monitor and ‘override’ automated technologies
- A ‘set and notify’ approach will enable people to engage and participate using local knowledge and to care for others

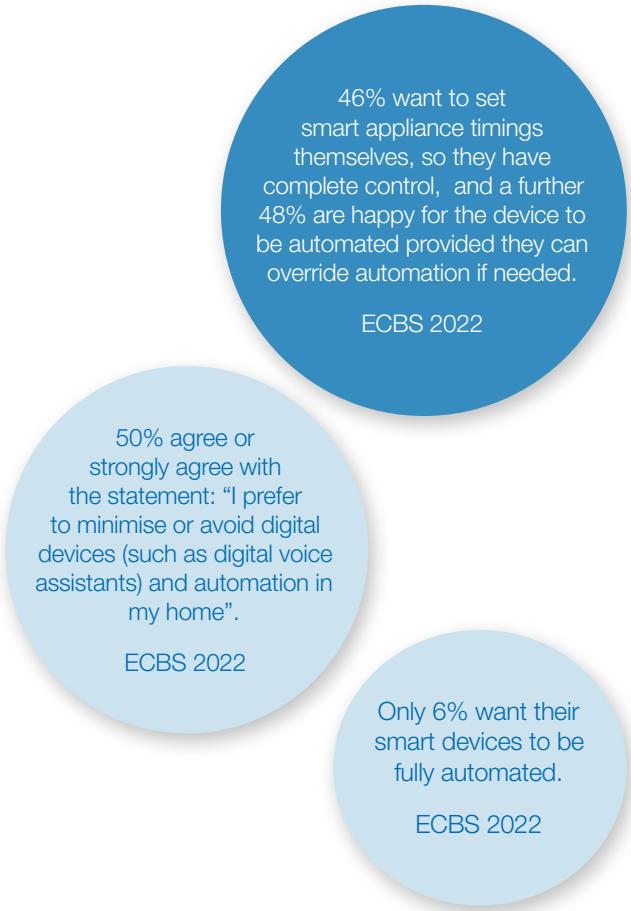
‘Set and Notify’ aligns with the way people want to live. It takes existing successful industry uses of notifications further, to empower people to make the right decisions for themselves and their families (within what is ethically and realistically viable for the energy grid, the environment and the community).

People imagine that smartphone notifications, which they are already familiar with, will help alert them to situations which may concern them, giving them the option to use their expert knowledge of their own homes, family safety and care needs, and environments to make the very best decisions.

While in the future the smartphone notification itself may be superseded by a new technology, the principle is the same: people will need to be notified so that they can be empowered to make decisions that are aligned with their values and priorities.

In the future people will attend to crucial notifications and use them to make decisions about automated responses.

ECBS and ECSS Survey Data and Participant Voices



Role-playing as a future air quality device, Mandy from rural Victoria voiced:

"I think my family would be mad with me if I closed the windows and they specifically left them open for a reason."

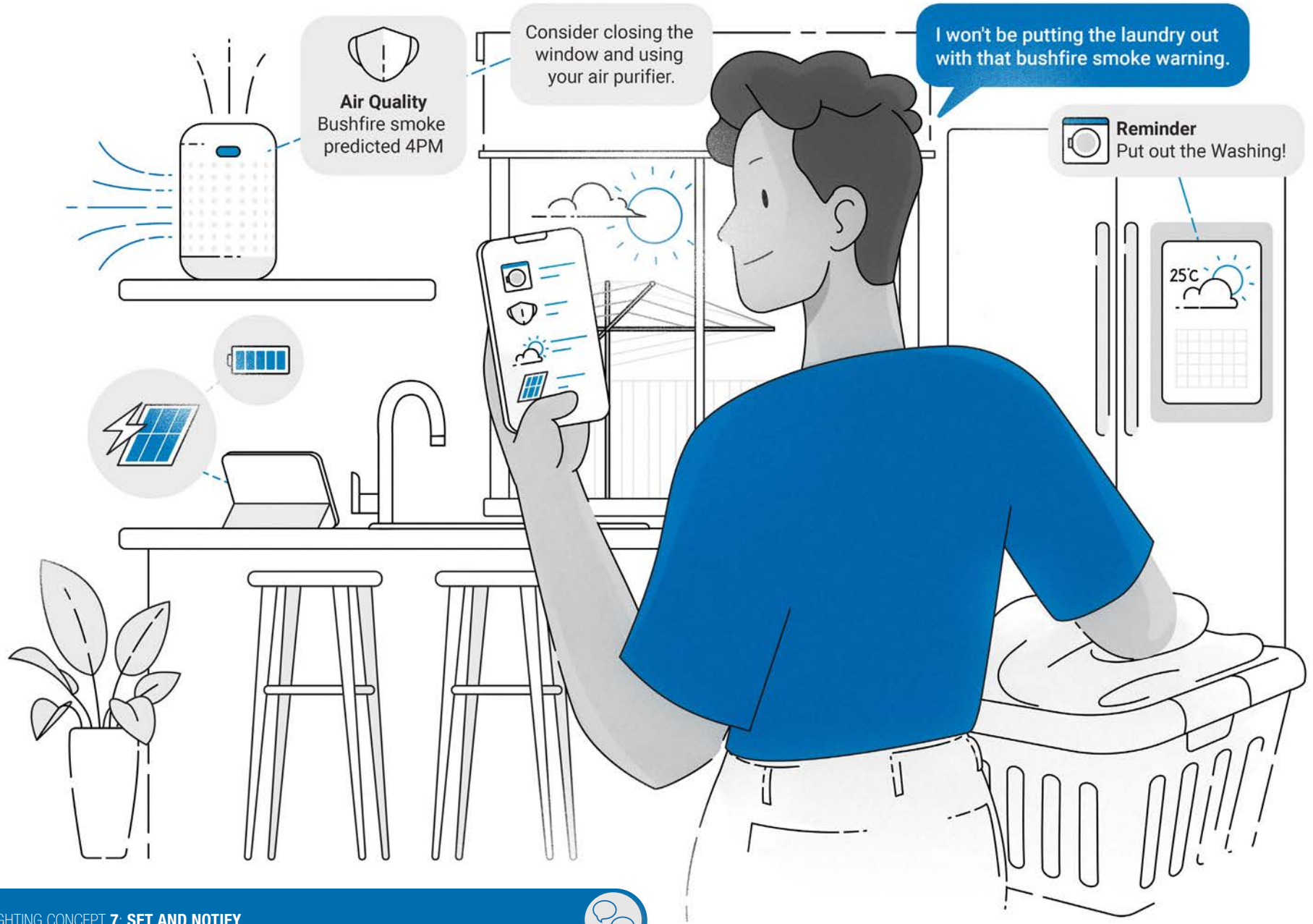
Even in a situation where the window was open and there was danger to the family, they would want "an alert message, a notification, just letting me know there's pollution detected in the house, you might want to close your windows."

"Definitely!" the other workshop participants echoed.

Al described his local air as clean and cool, and sometimes smoky from back burning. He had a purifier with its own cooling function, bought during the pandemic, for his son's allergies when he was studying at home. His main air quality concerns related to bushfires and when, "sometimes the breezes themselves have an impact because if it's early spring and you're in a hot day … and the pollen's starting to fly around on the wind."

He anticipated that new automated air technologies should have "a sensor that says there's a certain amount of smoke in the air or pollen in the air, then it would turn on automatically, but otherwise it wouldn't be needed except for maybe just a bit of air flow."

But Al also wanted to "have the ability to be on my phone, if I'm out, or in the home" to override the automated response, to "say … it's a bushfire down the road, it's been under control for the last 15 minutes, they've just put it out, don't lock up the house."



► FORESIGHTING CONCEPT **7**: **SET AND NOTIFY**

CONCEPT 8

FROM PROSUMING

Industry visions assume:

- People will act as micro-energy managers by balancing their consumption and on-site energy production of energy to maximise their investment return and participate in new market opportunities
- Energy consumption is primarily influenced through people's bills and tariffs, their relationship with energy providers, and energy management/ energy efficiency technologies and behaviours

> *"Consumers are likely to have a greater interaction with the electricity system, through Virtual Power Plants, smart electric vehicle charging and Vehicle-to-Grid technology. These 'prosumers' will be more sophisticated and diverse, not simply 'price takers' from the grid".*
>
> — Transgrid (2021:10)
> Energy vision: a clean energy future for Australia

▶ TO PARTICIPATING

Digital Energy Futures finds:

- People will participate in the energy system and transition in ways that make sense for their household and local community, in accordance with their lifestyles, practices and routines, and their values and priorities
- Energy will be juggled with life's changing priorities, sometimes other demands will mean that people cannot participate in energy systems or can only do so in limited ways
- Participation is broader than responding to market signals or maximising return on investment since it involves contributing to social, ethical and environmental outcomes as well as financial ones

In the future, as sources of energy diversify and automated systems become more likely, the idea of the energy prosumer, which is the participating version of the energy consumer, will become increasingly redundant.

The ways people participate in the energy system will re-shape and will pivot on people's values, ethics, practices and routines. The dominant model of engaging people through markets and technology will become less central to people's interest in participating in energy systems to achieve their own lifestyle or ethical objectives.

People will likely prioritise the values of care, safety and support for themselves, their households and families as they engage with energy systems in the future.

Therefore, people might produce their own energy, but how they use, store or share this will depend on how their practices require them to use particular technologies at specific times of day, alongside their environmental and social responsibility commitments.

In the future people's participation in the energy system will be contingent on the demands of their lives, and many will not be able to shift their routines to suit future energy systems.

ECBS and ECSS Survey Data and Participant Voices

"Making more efficient use of energy" at home (49%) and "protecting the environment" (40%) are common reasons to consider battery storage - behind saving money (70%) and becoming less dependent on mains electricity (58%).

ECBS 2022

60% are interested in learning about new ways of generating, storing and distributing electricity, and 20% indicate a strong interest.

ECBS 2022

"My son is doing the HSC [Higher School Certificate], I'm not going to bother him with 'don't put your computer on because I'm saving electricity', that's not the right thing. And if I don't ask stuff from him I can't do it to his sister, it has to be fair. If it was not such a tricky year and with the HSC and all that to get the kids more energy conscious … I would certainly have a try."

— Kelsey, Hunters Hill

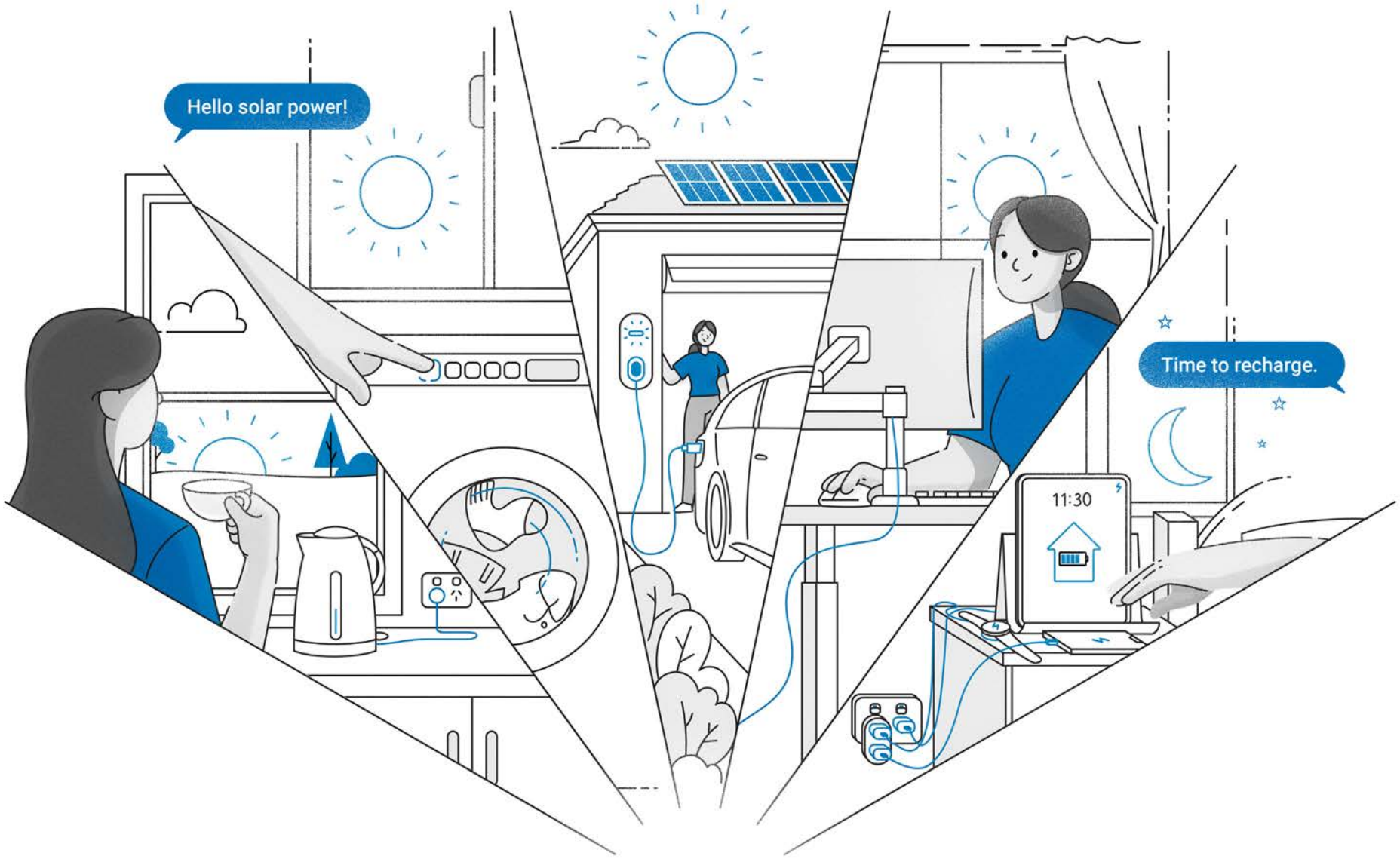
"I'll be quite financially conscious when it comes to things like take-aways or eating out or that sort of thing because I can control that, but … in terms of [electricity] the times and the rates …, well I've got to use electricity anyway, it's no point worrying about it, same with petrol."

— Dylan

Rachel was disappointed with her solar panels. They had not saved her the money on her electricity bills that she had anticipated. When she saw the load profiles for her household she said "we even do our clothes washing at the night time," realising that she was using the majority of her electricity in the evening and overnight when her solar panels were not producing electricity.

But she felt she could do "nothing" to shift her routines. Because Rachel was currently at home on maternity leave she didn't see the point of developing a whole new set of routines and then just going back to work.

As a busy mother of three children, ranging from a teenager to a baby, keeping routines was essential for her. Her mornings "aren't fun at all," they were busy and stressful getting the children ready and off to school. Energy had to fit into her busy family life, and even with solar panels, she could not shift her routines to the morning.



► FORESIGHTING CONCEPT **8**: **PARTICIPATING**

CONCEPT 9

FROM TRUST IN ENERGY COMPANIES

Industry visions assume:

- Trust is treated as static, transactional and as an interaction between entities
- People need to place their trust in energy companies in order to effectively participate in the energy transition

The energy sector largely frames trust either in relation to interactions between consumers and institutions or consumers and a singular technology.

> *"Consumers are not confident that the National Electricity Market (NEM) is working in their interests – only 25 percent think it is. This is down eight per cent from a year ago."*
>
> — Deloitte (2019)
> Beyond the Energy Transition

▸ TO TRUST IN TAILORED SYSTEMS

Digital Energy Futures finds:

- Trust is circumstantial and comes about in situations that are continually changing, but that are characterised by recognisable routines, practices and environments
- In the future people will trust in the systems they have set up, including their energy technologies (solar, batteries), tailored automation, household routines, and their ability to choose and switch service providers

People often say they don't trust energy companies and are unlikely to trust them in the future. However people trust systems that they have set up themselves or which they are familiar and confident in participating in.

The kinds of energy systems that people will trust in the future will include: automated smart home systems which technology-focused people will set up and manage themselves from scratch; and the low tech systems others will create to manage their energy use. People's future confidence in both high and low tech systems will come about because they can be confident that they will support their familiar routines and practices, and not because they trust the technology or energy companies per se.

People are more likely to invest in these systems because they trust in a greater cause such as supporting their community or reducing emissions to take action on climate change.

In the future people will trust systems that they have tailored themselves, above energy companies, whether these tailored systems are high tech or low tech.

ECBS and ECSS Survey Data and Participant Voices

Only 57% report confidence in tools and assistance available to manage energy use and costs.

ECSS 2022

Only 44% of householders are confident that the energy market is working in the long-term interest of consumers.

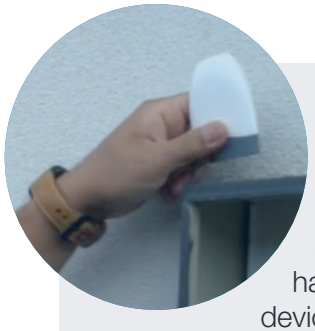
ECSS 2022

Trust that electricity companies do the right thing by their customers and by Australia (46%) is lower for young households (46%) than retired (60%), older (50%), and family households (53%).

ECSS 2022

"I got solar for the electricity…it was going alright for a while, and then I noticed it just kept going off…And then I discovered, and found by looking at what was happening, that the electricity company cuts you off in the day; they can do that automatically…they're getting too much from people with solar, so they cut it off. I started going around every morning checking, and then checking again and clicking it down, all you have to do is click it down and it went on again."

— Pamela



Nigel has a background in IT and had many smart appliances in his home as well as solar panels and multiple energy monitors. He had a powerpal, as well as a device called a Nurio which he imported from the US. The Nurio reads the frequency to create a digital fingerprint of devices so that Nigel can monitor the electricity usage of various devices in his household. He had to get special permission from AusNet in order to install the device. Because the device is American, many of the pre-programmed appliances did not work, so Nigel had to manually determine and enter his own appliances into the device.

As he admitted, "to be honest it was a bit tedious when we first started" but now he has seven of his major appliances programmed it has allowed him to analyse their electricity usage and develop ways to optimise it. For example he realised there was an optimal way to organise his fridge and freezer, as well as how to cool his house on hot days. Through comparing a day when he turned the air conditioning on earlier, to one when he waited until it was hotter, he realised that it was optimal "to use air con earlier, higher, rather than when it becomes really hot and becomes too late."

CONCEPT 10

FROM SEGMENTED

Industry visions assume:

- Consumption and consumers can be broken down into segments to provide more nuanced indicators of different consumers
- Segments can relate to life stage, and/or people's income and energy costs, environmental values, and key demographic variables (e.g. age)
- Consumers are becoming increasingly diverse in what they want and how they consume energy and engage with the energy market

> *"A shift towards enhanced customer choice, control and empowerment is being driven by increasingly diverse customer energy use and engagement, not well correlated with traditional factors like socio-economic groups or specific business types".*
>
> — CSIRO and Energy Networks Australia (2017) Electricity Network Transformation Roadmap: Final Report

▶ TO DIFFERENTIATED

Digital Energy Futures finds:

- Future-focused segmentation will need to become more focused on and nuanced to people's digital skills, interests and practices
- Segments will need to pay attention to how people's everyday practices are shaped by their values, such as their differentiated needs and desire for comfort, health and safety
- Future segmentation may be better focused on emerging lifestyles and practices, augmented by lifestage and demographic variables

Industry analyses are beginning to recognise the need for new forms of segmentation however they remain focused on people's relationship to energy, rather than on the services, practices and lifestyles that energy enables. Lifestage and socio-demographic variables will continue to be important for segmentation, but are unlikely to be the key indicator of differentiation in the future. Instead, household relationships to energy are increasingly complicated as people integrate emerging digital technologies into their everyday lives, and change their lifestyles to suit their circumstances and needs.

In the future, differentiation based on practices or lifestyle trends, including working from home, prioritising health, or depending on safe air, may be more significant for consumer segmentation than traditional segmentation attributes which involve socio-economic variables.

In the future people will respond to the demands of events and situations that put their own and others' health at risk, by developing strategies that may increase their energy demand. People may be differentiated in how they do this by different factors, including by occupation.

ECBS and ECSS Survey Data and Participant Voices

As reasons to respond to demand management, women's interest in helping the environment (42%) and ensuring vulnerable people can keep cool during a heatwave (27%) is higher than men's (35% and 19%). Whereas men are more interested in "reducing stress on the electricity grid" (39%) than women (34%).

ECBS 2021

Lifestage affects how welcome digital devices are in the home - 56% of retired households prefer to minimise digital devices and automation in the home compared with 35% of young households.

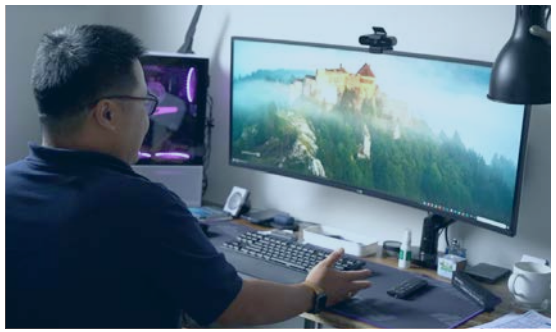
ECBS 2022

Helping the environment is more often seen as a reason to respond to demand management by inner metro (51%) than outer metro households (37%). Rural households (30%) are more concerned with ensuring vulnerable people can keep cool during a heatwave than inner metro households (23%).

ECBS 2022

"It's probably the single most powerful device in the house [my desktop]. I used to have a workplace where I'd leave at the end, and it would do all the work [running algorithms], but because of COVID, we had to move home, bring the desktop home. The desktop itself has 11 fans just to cool it down, so it's high in terms of energy."

— Nigel, Clyde



IT workers, like Nigel who work from home running large AI datasets, may have particularly unique energy needs that are important to consider, but do not map onto typical segmentations.

Farooq, 54, has a wife and three children and works as a chef at a university. He worked through the pandemic and lockdowns providing an essential service. Farooq had several close exposures at his workplace and the family was concerned about exposure to the virus.

In order to minimise their risk, the family developed strict routines around hygiene and laundering clothes, which drastically increased their energy usage. He explained how until he'd showered after work, "I'm not allowed to touch or talk to the kids." His kids also showered and put all their clothes into the washing machine on arriving home. Whereas before the pandemic, the family only did the laundry about once a week, now they found themselves putting the washing machine on seven or eight times a week.

Farooq's and his family's concern about their health, and his employment in an essential service had a dramatic impact on the family's energy use.

TAILORED FUTURES

Reframing Technology Practices of People

INTRODUCTION

Reframing foresighting concepts of people and engagements with energy systems are necessarily accompanied by a reframing of their relationships to the automated technologies and systems envisaged as part of future home life. People already wish for, and expect to have, considerable control over, and participation in, decisions and practices of using energy and technology in their everyday lives. They will use new technologies and resources in practices of caring for themselves and their households, and they are prepared to act caringly towards others. These priorities reframe **four further concepts**.

People do not want predictive data analytics to automatically personalise their future relationships to energy, but to **tailor** (Reframing Foresighting Concept 11) how technology and energy are used and available to their own needs. This means shifting the assumption that people will adopt technologies and change their behaviour to suit, to focus on how technology pioneers will **adapt** (Reframing Foresighting Concept 12) new technologies to their needs. Rather than letting the technology take over in a 'plug and play' mode to accrue the benefits that industry assumes they will bring, people will become **everyday innovators** (Reframing Foresighting Concept 13) by using technologies in the ways that best suit them. None of these shifts are static. They are part of a dynamic and shifting future, where there is significant risk in assuming there will be 'business as usual'. Rather, it is essential to acknowledge and account for **continuous change** (Reframing Foresighting Concept 14).

FORESIGHTING CONCEPTS AT A GLANCE

11 *from* PERSONAL-ISATION → *to* **TAILORING**: attending to how people tailor their preferences in everyday life above defining their preferences through predictive data analytics

12 EARLY ADOPTERS → **EARLY ADAPTERS**: accounting for how the pioneers of new technologies will create energy demand by adapting technology to their own needs

13 PLUG AND PLAY → **EVERYDAY INNOVATORS**: accounting for how the pioneers of new technologies will create energy demand by adapting technology to their own needs

14 BUSINESS AS USUAL → **CONTINUOUS CHANGE**: understanding the complex dynamics of household change as we move into futures and its implications for energy demand

CONCEPT 11

FROM PERSONALISATION

Industry visions assume:

- Personalisation will entail people's technology preferences being automatically determined on the basis of predictive data analytics and machine learning, making their lives more automated and convenient
- People will monitor their energy consumption and other metrics to determine how to consume

> *"How do you give customers what they want, delivered in a way that resonates with them individually? By prioritizing data and analytics, as the fuel for personalization, and as part of a sustained focus on digital transformation."*
>
> — Accenture (2022)
> New Energy Consumer: Transition on Demand

▶ TO TAILORING

Digital Energy Futures finds:

- People will tailor their everyday experiences by setting and controlling the level to which their technologies are automated themselves, and continually adjusting their systems to their needs
- People will sense the complex social, material, and weather environment around them to decide how to proceed or act

In the future people will want to achieve the desired unique fit between their lives, technology and energy in ways that differ from the notion of 'personalisation' employed by technology and energy industries. They wish to tailor their future experiences bottom up from the everyday, rather than allow an energy or technology company to personalise them from above.

A tailoring approach will empower people to judge when and how to let automated technologies and systems take decisions, and when they should personally intervene to guide those decisions. It introduces people's own valuable sensory and locality based expert knowledge, rather than simply depending on remote predictive data analytics.

Ensuring that people's unique knowledge about their own practices and values, neighbourhoods, communities, environments and local weather systems is accounted for will ensure that the best decisions are taken for local energy systems, communities and individuals. Digital data and predictive analytics alone cannot accrue sufficient knowledge to drive the best outcomes.

Automated systems do not always account for people's real needs, but better predictive analytics in the future is not necessarily the solution, as people enjoy and benefit from tailoring their systems to their own needs.

ECBS and ECSS Survey Data and Participant Voices

46% would prefer to set the timings on their smart appliances themselves so they have complete control.

ECBS 2022

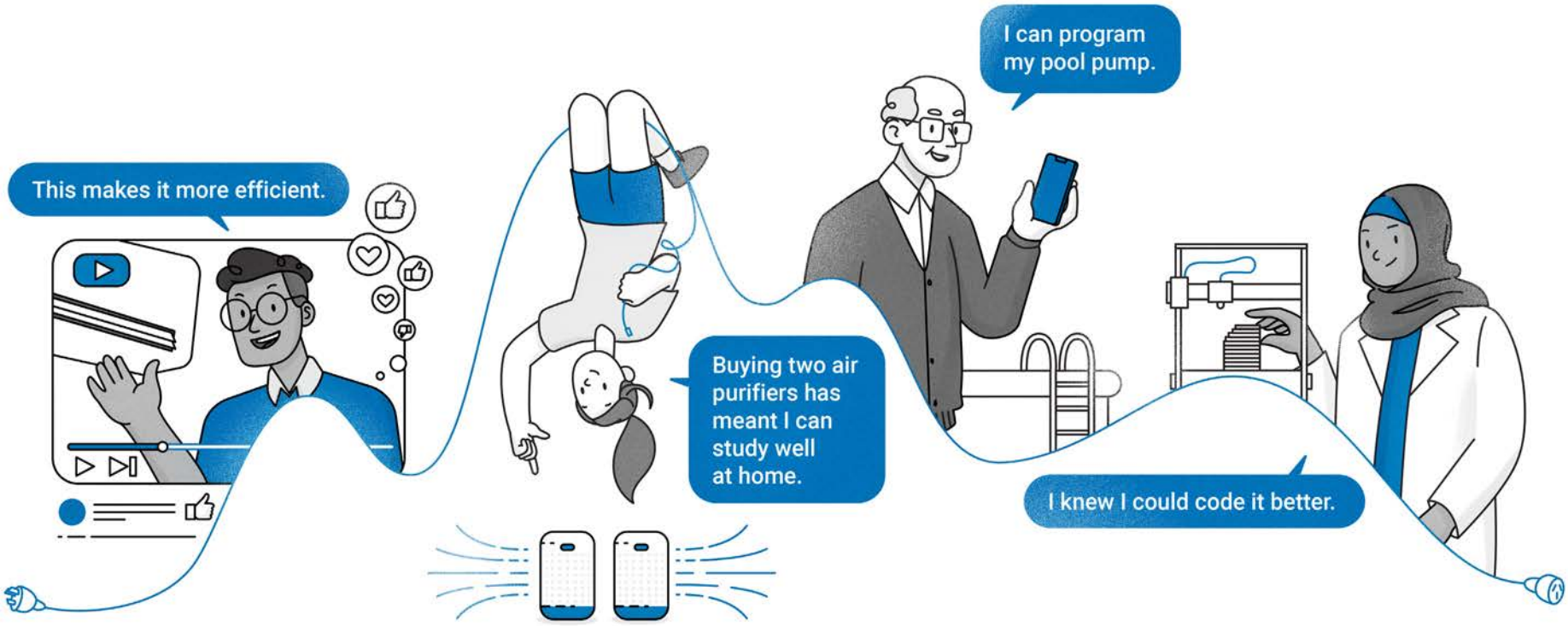
"Energy management systems will optimise water heaters and pool pumps to automatically run when energy is available… I'm happy with that, but again it needs to know when I'm planning to be using the pool. If I'm going to be away, then don't worry about it. If I'm not going to be likely to be using it, even if it's heated in winter time we don't worry about it, but then do I want it heated in summer time. There could be a lot of variables by adding to the system so that it does potentially do that, but I'm pretty good at being that management system myself when it comes to the things that I already have in the home."

— Naomi, Narre Warren

When Dianne tried automating her pool cleaning, pool pumps and heating she found the technologies were "more trouble than they're worth."

She tried a friend's robotic pool cleaner, which took more time to set up than it took to clean the pool, and her automated pool pump and heating modules allegedly "looked after themselves, but were always doing odd things." The automated modules just didn't align with her needs. "Often what I thought was a comfortable temperature and what its thermostat thought were different." On cooler days Dianne did want the pool to be "quite hot" but, as she put it, "if I knew that it was going to be 46 degrees, I don't want to get into a 38 degree pool."

Dianne wanted more flexibility than the automated system offered so when the automated pool pump broke she set up her own system, using outdoor wall plug timers on her power points to control the pool pump and heater.



FORESIGHTING CONCEPT **11**: **TAILORING**

CONCEPT 12

FROM EARLY ADOPTERS

Industry visions assume:

- Continued reliance on the 1962 concept of 'early adopters' (in Everett Rogers, *The Diffusion of Innovation*), which suggests there is a subset of local people who are influential in bringing new technologies into their communities
- Technology adoption follows a linear curve with a minority of 'early adopters' leading the way, followed by the majority and laggards
- Early adopters test products on behalf of industry
- Once adopted, technologies remain in the home and their use remains relatively constant and unchanged

"Many consumers still do not understand connected device value propositions [of the connected home] and early adopters face significant pain points that have yet to be addressed."

— McKinsey & Co
There's no place like (a connected) home.

▸ TO EARLY ADAPTERS

Digital Energy Futures finds:

- The 'early adopter' concept is out of date
- Technology pioneers will adapt new technologies to their own and their household's needs, rather than adopting them as expected, and this could generate unpredictable energy demand
- Some people will reject, retrofit or modify technologies rather than adopting them as intended by their designers or proponents
- People's technology use and needs will remain in a constant state of change which may change demand over time

'Early adopters' as conceptualised in 1962, are unlikely to exist in future real life, but there will be a significant subset of local innovators who are interested in and are the first to buy and adapt emerging technologies to their needs. These 'early adapters' are characterised by the creative and improvisatory ways they use smart home technologies.

Early adapters are not always wealthy, but they are often smart technology experts, already working in the technology industry, part of communities of experts, and adept in understanding and working with new technologies at home, often following (or making their own) YouTube videos for advice.

Early adapters adapt technologies and the possibilities they offer to their existing homes, values, priorities and environments. They remain in control of their homes and their technologies, and they lead the way by showing alternative ways of adapting technologies into life which are not static and can differ from dominant assumptions and design intentions concerning their use.

In the future early adapters will continue to use automated technologies to pioneer their own systems specific to their household's needs.

ECBS and ECSS Survey Data and Participant Voices

Only 6% strongly identify as early adopters. This is more common in young (11%) and family (10%) households than older (4%) and retired households (3%).

ECBS 2022

Despite less opportunities to modify their own home, renters' interest in early technology adoption (7%) is as high as owner occupiers (6%).

ECBS 2022

"I stumbled across a group called My Efficient Electric Home and didn't think too much of it at first but then the more I read about [switching from gas to electricity] it I was thinking, this kind of makes sense and it just seemed like the way of the future. So, we started off by getting a little Ikea induction hob and trying that out and seeing if it would work and what pots would have to change and experimenting there and it all just make more sense the more, we went down that path."

— Malcolm, VIC

"I started building one [a smart mirror] because I saw them on YouTube and there's instructions you can use..Yeah you can use your raspberry pi and it's really cool."

— Angus

Murphy, an engineer with a passion for smart technologies, set up an Apple HomeKit home automation platform, enabling him to control his home technology through a smartphone app or voice commands.

Murphy was very committed to this automated system, but he still made all the decisions himself. He controlled how the system operated, as well as making fine grained everyday decisions about when the smart lights, heating and cooling systems went on and off.

Getting a good night's sleep was a priority for Murphy and his wife with a young child and a baby, since he said, "we're generally woken up by the baby, we'll check our phones obviously then and make a note of when he did wake up."

His wife "likes a lot of control so we have a running log of all his sleeps and drinks and stuff" and they did "literally everything we can think of to make him comfortable" hoping he would sleep through, including using air conditioning to keep the temperature stable at night.

As an early adapter, Murphy had "lots of interaction with the app to, you know, check room temperatures, what's best with his [the baby's] room temperature because that's the only thing we can control."

CONCEPT 13

FROM PLUG AND PLAY

Industry visions assume:

- New technologies will be used as intended by their designers. People will just plug them in and 'play'
- If people use technologies as they should then they, the grid and society will gain the predicted benefits

> *"The foundation for customer trust and loyalty in the Energy Cloud is to create the kind of plug-and-play and dynamic platform environment that allows the customer the means to achieve their goals (i.e., cost savings, reliability, resiliency, and sustainability) while also remaining a customer of the energy company or utility."*
>
> — Navigant 2018
> Energy Cloud 4.0

▶ TO EVERYDAY INNOVATORS

Digital Energy Futures finds:

- New technologies are curated within the home environment and modified, adapted or tailored to suit people's lives
- People innovate with technologies to fit their values, priorities and practices

While most people will not be future 'early adapters' and do not have the technology skills to modify new technologies, they will innovate to adapt new smart home and energy technologies to their future lives.

People have clear visions of how they would use future smart home and energy technologies. Even people who are not technology savvy will determine themselves if there is any benefit to them of connecting smart home devices to each other, and in the future many will still prefer to use them independently.

Old technologies will endure in people's homes in the future, and some will still use analogue timers or smartphone alarms to manage their use of automated and smart technologies. Others will recycle technologies for new uses. People will innovate new systems and practices, which are easy to accomplish and may see no need for these to be automated.

People will continue to innovate in this way in the future to stay in control of their devices, and to mix old and new technologies to create systems that work for them, and that they understand.

ECBS and ECSS Survey Data and Participant Voices

59% are interested in new technology to help manage household energy bills and 19% indicate strong interest.

ECBS 2022

Half of older and retired households 'prefer to minimise or avoid digital and automation devices' in the home, so are unlikely to follow the digital home trends embraced by technology enthusiasts.

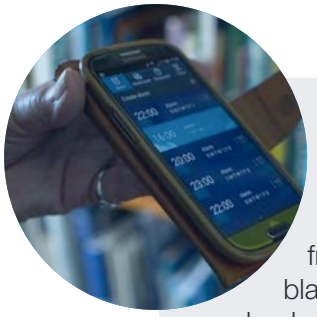
ECBS 2022

"Normally, I try to do my laundry off peak at night. I just put it on a timer because normally off peak is 11 o'clock at night until seven o'clock in the morning, it's off peak, so I always put my laundry on a timer or do it on the weekend at night."

— Kenny, Cranbourne North

"Okay, so that's, these are to all the laptops, and because they've been discarded by family, I've taken them and I'm going to tear them apart and turn them into smart mirrors…. Yeah, there's really good tutorials on You Tube about how to make them, and you can make them at any size."

— Fred, Clyde North



Pamela had recently retired and was very frugal with her electricity, taking full advantage of time of use tariffs. She preheated her house from 6-7am and exercised or used blankets to prevent turning the heat back on until the 8pm shoulder.

Pamela wasn't struggling financially, instead her frugality was driven by a desire to leave an inheritance to her children, having received an inheritance from her own mother which had helped her through a difficult time. She had recently purchased an electric vehicle, a Nissan Leaf, after her previous car, a Daihatsu Rocky, which she had driven for 25 years, was written-off after a small accident. She doesn't have a fast charger, and prefers not to use one in order to preserve the battery life, so she charges overnight.

Her son helped her set up the automated charging functions in the car so that it would only charge on the off-peak. However, she realised that if the battery was very low, it would override these timings and continue charging. So she developed a work around where she sets a timer on her phone to remind her to flip the switch on the wall at 10pm to begin charging on the off-peak. As soon as she wakes at 7am, she goes outside to shut it off manually, to ensure it only charges on the off-peak.

FORESIGHTING CONCEPT **13**: **EVERYDAY INNOVATORS**

CONCEPT 14

FROM BUSINESS AS USUAL

Industry visions assume:

- Demand will remain relatively predictable based on past behaviour; historical data is the best proxy for any future changes
- Households have mostly fixed routines that they are unable and unwilling to change
- People and households will continue to expect the same or similar levels of service and relationships with the energy market, and will primarily interact with the energy market through their role as a bill payer

"Current Trends Scenario: Ageing coal power stations are replaced with competitively priced large and small-scale renewables and storage. Economic growth, immigration and energy efficiency are consistent with historic and projected growth rates under present trends, taking into account current projections for the recovery from COVID-19. Electric vehicle, rooftop solar and behind-the-meter battery uptake is consistent with current central projections."

— Transgrid (2021)
Energy vision: a clean energy future for Australia

▸ TO CONTINUOUS CHANGE

Digital Energy Futures finds:

- Households are flexible with how they manage energy demand and routines in the home, and these are likely to continue changing over time
- People's expectations of the energy market will evolve in response to what they hear and experience across multiple domains
- People's homes, technologies and routines are constantly changing in relation to affordability, climate change, changing lifestyle expectations, and disruptions such as the COVID-19 pandemic

People live in a state of continuous change, which is sometimes punctuated by larger step changes. Lifestyles, homes and environments are always changing in small ways, such as when children move on to high school and parenting responsibilities change, when people change jobs, when a new road infrastructure is constructed; changing the commute to work, and when new technologies become ubiquitous.

Momentous changes such as the COVID-19 pandemic, or an area being destroyed by bushfires create dramatic, tragic and climate-change induced events. With these shifts come changes in household routines and practices, and subsequently changes in how people manage energy demand.

In the future energy demand will continue to be contingent on these continuous and more rapid moments of change, rather than being static or predictable based on past demand.

It is essential to investigate and account for changing lifestyle priorities and how these will shift when considering the future of energy demand and infrastructure.

ECBS and ECSS Survey Data and Participant Voices

29% report storing more refrigerated or frozen food over the past 12 months (compared to 9% reporting less cold food storage), and 20% anticipate increasing their fridge and/or freezer food storage capacity in the next 5-10 years.

ECBS 2022

49% have more electrical devices running at the same time than they did 5-10 years ago; 37% use the oven less often.

ECBS 2022

11% have already switched to mostly electric power tools, and 28% expect to in the next 5-10 years.

ECBS 2022

"I have been able to [take advantage of off-peak rates] now that I'm working from home. I do my washing during the day rather than at night, but I never really changed what I did because I was limited with the time. When I was working, I had to do the washing either at night or on the weekend, which I know is a higher tariff, is one of the peak times, and it's like 'Well, yes, it is a peak because that's when I have to do it'. it's just one of those things. It had to get done."

— Lucy

"Normally, my energy usage, … I tend to be finished about eight-thirty … [when]... everyone goes away from home. … We've got solar on [the] roof and nobody uses it…. But then the whole COVID turned that right upside down. So, literally you have a [load profile] graph completely upside down."

— Nigel, Clyde

The Digital Energy Futures Active Smart Charging Commuter comic strip, derived from industry reports (presented in the *2020 Digital Energy Futures: Review of industry trends, visions and scenarios for the home* report) portrays the industry vision of a vehicle-to-grid future. It depicts a commuter charging his electric car at work, before returning home to use the charged car battery to power his evening domestic energy usage.

While people often initially viewed this as a positive future, many also recognised that it did not account for their new working from home reality, which had come about due to the COVID-19 pandemic and associated lockdowns.

Richard laughed as he read the comic strip, explaining that, "the only thing I'm chuckling a bit about is the electric car being charged and ready for you to drive to work 'cause I think one of the things that is going to happen in the post COVID world is a hell of a lot of people aren't going to be driving to work."

ELECTRIC VEHICLE FUTURES

(NEAR FUTURE, 2027)

ELECTRIC VEHICLE FUTURES

(NEAR FUTURE, 2027)

Electric vehicles (EVs) are of central interest and importance for energy forecasting.

- Digital Energy Futures research suggests that home-based charging is expected to generate significant new energy demand, most likely during the evening and overnight.
- EVs present a significant load shifting opportunity for the energy sector, if their charging can be moved to the middle of the day to make use of available rooftop solar generation and other distributed energy. This could also address the emerging 'solar peak'.
- EVs present emerging battery storage options for households through 'vehicle to grid' (V2G) technology, which would be capable of returning electricity back to the grid and enable more load shifting opportunities.

Our research across urban, inner and outer suburban, rural, and coastal sites enabled us to understand how people will make electric cars part of a range of different locally and environmentally shaped lifestyles in the near future.

We focused on electric cars as a key future mobility device, while acknowledging that in the future people may have access to a greater range of other electric vehicles, such as scooters and bikes.

We found that the *time of day* that people will charge their electric cars in the future will be contingent on *where* they charge them, and that this will in turn be contingent on other variables that impact their lives. In this section we unpack how people's values, their relationships to the energy industry, and their everyday practices are likely to frame these futures.

Each page in this section provides a future **foresight** about how people are likely to live with electric cars in the near future, supported by **findings** from the project and a selection of illustrative quotes from participants and related ECBS survey findings.

2% already own an electric car for transport or leisure, and a further 31% consider it likely they will own an electric car in the next 5-10 years.

ECBS 2022

36% think they will buy an electric vehicle (EV) at some point in the future.

ECSS 2022

4% already own an electric bicycle, scooter or motorbike, and a further 19% consider it likely they will own one in the next 5-10 years.

ECBS 2022

Charging at home and having a fully charged battery in the morning is likely to be a priority.

Foresight

People predominantly want to charge their future electric cars at home, but those who can charge at home might also be incentivised towards cheap top-up charging as well as selling back their electricity from their car via schemes like supermarket loyalty offers when going about their usual everyday shopping routines, or at pubs. People are likely to be interested in convenient and affordable charging, but they will also be resourceful and reluctant to waste 'excess' energy that could be used.

Findings

Rural participants assumed that electric cars would be charged overnight. They envisaged a future where people would be able to start their days with a full EV battery but would also be able to charge while carrying out everyday errands and activities (like shopping, hair appointments, or during sporting events).

They imagined top-up charging or selling electricity back as a possibility when stopping at the supermarket, perhaps connected to a loyalty scheme, or cheap charging at a pub. However they felt that where possible taking advantage of their own peak solar at home, for charging during the day would be preferable.

Suburban participants' priority reasons for having an electric car included caregiving and recreational purposes (e.g. visiting parks, nature reserves, or beaches). Participants imagined electric cars would be fully charged in the morning before school drop-offs; however, they were also interested in charging their electric car when rooftop solar power was available while working from home.

"If you park your car at the supermarket, it connects to the charging unit that you're parked on, it also connects to your payment app, it charges your car and it charges your payment thing' while you've gone wherever you are then 'it just connects via a contactless charging method that would be a wonderful thing, but I don't know if that will be soon."

— retired man, rural Victorian town

The idea of topping up during the day was appealing to one younger woman participant:

"You might only go into the supermarket for you know not that long, … sometimes 15 minutes, sometimes half an hour, but it would be that you're charging bit by bit. I mean you charge your car, then you leave it, then you charge it again … and then at night time or whenever it gets its full charge."

— younger woman, rural Victorian town

EVs are most commonly charged overnight (30% 8pm to 6am), during the day (23% 9am to 3pm), and in the evening (20% 3pm to 8pm), while 11% of EV owners have variable charging times.

ECBS 2022

45% indicate their property is occupied most weekdays and a further 33% consider this likely in the next 5-10 years.

ECBS 2022

People will object to EV charging infrastructures that disrupt local life and spaces.

Foresight

People are unlikely to accept the installation of charging stations in places that take up the existing parking spaces they value in town centres or that disrupt the aesthetics of their towns. This, combined with the preference for charging at home, could mean that in the future there will be local resistance to the installation of charging stations in visible local sites. However, people are likely to use and benefit from charging stations when they are located at sites where they have to wait sometimes up to two hours already - such as health or recreation centres.

Findings

In rural areas, but also in affluent inner city suburbs, participants worried how charging infrastructure might change their local area. Participants perceived charging stations as bulky and ugly, a future "eyesore" in local parks and already taking up parking spaces in supermarket car parks. They did not wish to see them in their town centre. However they also believed that in the future, as electric car uptake goes up, more charging stations will be needed and that they will be difficult to place. Participants suggested charging stations at health centres and leisure centres in addition to the possibilities at supermarkets. However, participants unanimously felt that most electric car charging would be done at home especially if houses were equipped with solar.

Mark from Moe thought that "[EV charging stations would] take away from the scenery" if installed in the Botanic Gardens.

"Even those four [EV charging stations] we've got in the middle of Coles, they stand out like a sore thumb, I mean I've nothing against them but just like you say the visual thing, if you've got them everywhere they could be a bit visually not good."

— Workshop participant, rural town

55% think private industry should invest in necessary EV infrastructure and offer charging as a product; 45% think the government should spend taxpayers' dollars on necessary EV infrastructure.

ECSS 2022

Personal electric car ownership will be more likely in areas where local driving, parking and charging facilities are easily accessible.

Foresight

The extent to which personal electric car ownership will be appealing or viable depends on everyday use, place and charging possibilities. In rural and suburban areas where parking and charging spaces are available, personal electric car ownership will support people's local daily routines of driving to the shops, health and leisure facilities. In densely populated urban areas, uncertainties about the availability and anticipated costs of parking and charging stations may deter personal ownership.

Findings

Personal car ownership is part of life in rural towns and facilitates people's movement around their own town, as well as their lives in the town, their neighbouring towns, and aspects of the hinterland. People use cars to access everyday places and services nearby, including shopping, medical services, hairdressing, sports and parks, and to perform services and care for others including childcare. Participants would not use public transport for these purposes in the future.

Urban participants primarily imagined using electric cars to help fulfil caregiving responsibilities (including for pets), where complex travel or accessibility of public transport would make everyday travel difficult. Convenience was a priority for living in their local areas, and the day-to-day challenge of finding parking and charging opportunities for electric cars meant they questioned the benefit of owning an electric car, rather than using public transport or ridesharing services.

A group of participants from a rural town in Victoria discussed their concerns about the placement and accessibility of EV chargers.

A retired man pointed out that they were "bulky" and "fill up a lot of the parking spots" at the supermarket. These issues were also concerns for participants in relation to having charging stations at medical centres.

They felt it was already difficult to get parking spaces in hospital car parks, and that adding EV chargers which took up extra space would further strain the already busy car parks, asking "where are they going to put electric chargers around hospitals?"

2% already use a 'share car' service, and a further 9% expect to in the next 5-10 years.

ECBS 2022

The second highest reason for not already purchasing an EV is that there aren't enough charging stations and people are worried they will get stuck (41%).

ECSS 2022

"If we're going to make electric cars sustainable for people who live in the inner city, you need to make charging more convenient, because we don't need cars as much as someone further out, so we won't go to the same effort."

— Linsay, Inner East Sydney

Uneven access to charging facilities will lead to new inequalities.

Foresight

Existing inequalities, as well as unanticipated inequalities which come about due to inaccessibility of charging infrastructures for some people, are likely to create uneven access to electric cars for retirees and seniors in the near future. If left unattended, this will impact on retirement villages and community and health facilities where charging infrastructures and services would be beneficial.

Findings

Not all participants had equal access to car parking or charging possibilities at home, in both rural and urban areas. For example people living in retirement villages have less access to car parking spaces, no garages, and no space where charging facilities might be installed, and in this respect face similar issues to urban apartment dwellers.

However, people living in rural areas also lack access to alternative modes of transport to the private car (such as public transport or ride sharing services). Some older (and other) people might need to gain access to medical facilities, which could be at a distance, and if charging is not available prior to leaving or at the health centre car park, these people may be disadvantaged in terms of access.

Mark, who was living in a rural retirement community pointed out that not everyone had access to EV charging at home. He described that at his retirement community, there weren't even enough parking spaces for everyone, and no garages; "we just haven't got the facilities here … and there are a lot of retirement villages where parking is a premium and there's just no room for charging." He emphasised how with future visions of EVs, it's assumed that people are going to keep and charge them in garages, "but we don't have garages."

He felt this was also an equity issue, stating "it can't just be for people who've got the space, it's got to be for everybody I think."

Retirees are most concerned about the cost of EVs (74%) and are worried there aren't enough charging stations (50%).

ECSS 2022

59% haven't bought an EV yet because current models available in Australia are too expensive or out of their price range; 26% don't have anywhere to charge at home (34% for people living in a unit, flat or apartment).

ECSS 2022

Automated charging features which increase convenience will be welcomed by some.

Foresight

People will be open to certain features of the future automation of electric cars charging, as something that increases convenience for them, especially when they are able to research and make decisions themselves.

Findings

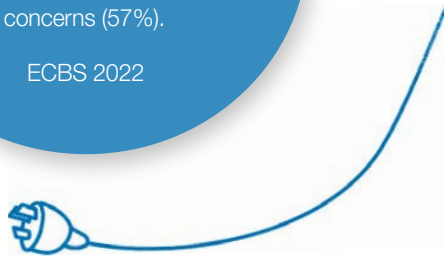
Certain kinds of automation were welcomed by some participants. For instance the idea that your car could be automatically charged as you drove up to a charging station was described as “amazingly convenient,” but this needs to be balanced with participants seeing this kind of public charging at the supermarket as supplementary to home charging with solar. Participants were also interested in using apps to find parking/charging spots in a digital platform based service.

A participant in a workshop in a rural town in Victoria, who had an EV, was enthusiastic about the merits of using an automated system to ensure that he didn’t forget to charge his car. But another participant in the same workshop felt differently, suggesting that most people would want the choice of when to charge, but that some automation that made charging itself simpler would be embraced.

This was summed up in the vision of a younger woman in the workshop who described how in the future, “If you could just drive up and not have to get out of your car, well obviously you can get out of your car, but if you don’t have to plug anything in, well how amazingly convenient is that” enabling her to make a choice about when to charge but to benefit from an automated charging system making it happen.

Interest in using new technology (e.g. automation) to manage energy bills is slightly higher in owner occupier (61%) and financially comfortable households (62%), than renter households (56%) and those with more financial concerns (57%).

ECBS 2022



Staying in control will be essential for an ageing population.

Foresight

Retirees are likely to want to be in control of their everyday lives in the future. They will decide how much time to dedicate to childcare, when and where they will charge their electric cars, if they will sell their energy back to the grid, and if they will use their EV batteries to put electricity back into their home energy systems.

Findings

Participants of all ages held strong views concerning how retirees would live with electric cars in the future, while juggling family, leisure, and other everyday life activities. They described possible scenarios where future retirees would decide which portions of their days they would spend with grandchildren, seeing a key part of their roles as involving collecting them from activities and transporting them between home, school and leisure. These activities would be coordinated with the way they manage their future energy by making their own decisions about when and where their electric car is charged or if they sell to the grid, and if they install systems to put charge back into their home from their cars.

In a workshop in a rural town in Victoria participants imagined the future choices for 'Kevin' a fictitious retired neighbour. They felt he wouldn't use public EV charging since it would be more convenient for him to charge the car at home if he had solar, or even overnight.

They thought that a retired person might want to weigh up the relative costs of charging at home and at a public place, as he likely had a constrained budget but some flexibility during the day's schedule.

The optimal time would be to charge for free at home from solar when the sun is shining and only top-up at a public location like the supermarket, if at all.

Retired households (40%) are more concerned about energy system resilience than young people (28%); young people are more concerned about reducing the amount of energy used in Australia (23%) than retired households (9%).

ECSS 2022

Older and retired households (54%) cite reduced dependence on mains electricity as a reason to adopt new energy technology (solar PV) more than young (42%) and family households (38%).

ECBS 2022

Future drivers will need to be able to depend on battery services and roadside assistance for electric cars.

Foresight

People are likely to want to feel secure with their future electric cars, and therefore will be keen to engage with services and apps that will enable them to access emergency breakdown services, and to be able to prior book charging station access to coincide with appointments which they will drive to.

Findings

Participants imagined a series of possible future services that could be part of an electric car future: a specialised RACV-like breakdown service for emergency charging boosts; an app so that people would not have to risk not being able to charge, for instance while waiting at the medical centre.

Not getting stranded on the road was critical for participants, who discussed carrying a spare battery or having a "kind of RACV roadside system which could provide a boost of power, rather than waiting hours for the car to fully charge."

— retired man, rural town in Victoria

"Sometimes we build purpose built car parks, like for a train station or something like that. But I'm just thinking if there was a really large space where they just had, you know, like 500 car charging spaces … you could book so you got your appointment and then hopefully it would be close, or you could call a taxi and that would take you to your doctors appointment, or if there was a shuttle bus service or something like that."

— young woman, rural town in Victoria

EVs will be used as one of multiple transport options.

Foresight

Even when owning future electric cars, people are likely to keep existing petrol cars for longer trips. People with multiple transport options (including electric scooters and other EV options, public transport, and ride sharing) may be willing to align their charging with grid services or enable direct load control. Incentives and messaging about environmental and community benefits are likely to play a role in such decisions.

Findings

Electric cars are seen as having a particular place in a larger set of transport options, particularly for participants in urban areas. While participants in rural areas emphasised that they currently relied on cars for all everyday travel, they also discussed how near-future use of electric cars might play out in their local areas in relation to other changes that were expected (e.g. the start or conclusion of major roadworks, rail or station upgrades or train timetabling adjustments, availability of wifi on public transport, and the arrival of more taxi services or ridesharing options).

"I think there's two categories of vehicle that are important to us, one is a four wheel drive, because we're going to into areas, bush areas with like waterfalls and that sort of stuff, and the other is to have what I would call an urban vehicle, and I have a little Mazda 2 which I've purchased in the last 18 months, and I find that that is perfect for the short stretch commutes, economical, easy to park, you know, all those sorts of things. And so an electric vehicle I could imagine would fit that bill quite nicely."

— Dianne, Heddon Greta

Localised working hours and commutes will affect EV time of use and charging, particularly in the regions.

Foresight

Local areas with a high proportion of people working in similar industries with early start times provide opportunities to charge personal EVs during the early afternoon when rooftop solar is available.

Findings

In rural and regional areas where a large percentage of the population work in similar industries, there are unique traffic patterns that differ from typical 9-5 working hours (e.g. early hours for construction or agricultural workers). This could enable early afternoon EV charging in specific localities and for people who do not work from home, but arrive home from work around 2-3pm.

Participants from the Central Coast of New South Wales described avoiding certain areas in the early morning and early afternoon due to the "earlier rush hour" local traffic "...yeah, that's what we call 'tradie o'clock'."

— Piers, Central Coast

25% of metro households cite a belief in benefits to their community as a main reason to buy an electric vehicle.

ECBS 2022

EVs appeal to people for varied reasons and not all are environmentally sustainable.

Foresight

Some electric car owners will be more interested in optimising the performance of their car and battery than optimising its relation to the electricity grid. These electric car owners will not be responsive to electricity price signals or environmental motivations.

Findings

Technology enthusiasts and energy/environmental enthusiasts are drawn to EVs for different reasons. EVs will be adopted for a variety of reasons, including not only for their environmental appeal or even their fuel source, but because of the appeal of the cutting edge technology they have or their premium features, acceleration, and even gimmicks.

"Yeah, I want one [EV] one day, but one of the nice ones. I actually went in a Tesla earlier this year and it was incredible, like in terms of the power you can get from electric vehicles are greater than what you can get from internal combustion engines. …. It's not something I'd buy if I was like a lot of people [who] buy electric vehicles for the environment … which I don't agree with because the production of the batteries is actually really bad for the environment. But it is something that I'd like when I've got a lot of money."

— Dylan, Kogarah

Young (10%) and family (15%) households cite family or friend recommendations as a main reason to buy an electric car.

ECBS 2022

In the far future (2050), electric cars will become part of increasingly hybridised forms of transport and mobility services.

Foresight

While it is difficult for Australians to envisage a future where contemporary cultures of car ownership have completely disappeared, in the future people will navigate their 'ownership' or subscription to diverse electric and automated mobility systems, technologies and services, in relation to their shifting place-based and household needs.

Findings

As part of their typical day in the year 2050, participants' use of public transport and personal vehicles decreased, while ridesharing and carsharing increased. Some participants discussed when they would charge their electric cars (either during the day, to make use of solar while working from home, or overnight).

However, in the far future routines activity of the workshop, participants did not often envisage themselves using personal electric cars within their everyday routines. Instead, mentions of electric or autonomous vehicles (AV) in the far future centred on their expected subscription to future automated and electric mobility services, rather than a privately owned car.

Consistent with the findings of our ethnographic study and EV workshop activity, participants viewed future EVs as co-existing amongst multiple future transport options and services, which they expected to become increasingly available in both urban and rural areas by the year 2050.

"I am envisioning that we are going to have carpool, mostly. So not many people would own a car, but they will just pick up what's on the street and use that."

— Miles, Inner West Sydney

"My daughter won't be taking 2-3 buses anymore, she'll be picked up by a robotaxi…the NDIS would probably pay for it because it's so cheap anyway…"

— Paul, Northern Beaches, Sydney

"Maybe what I would do is I would use those electric vehicles…I'd order one and they'd just sort of scoot me to this…social hub area…and I get delivered there rather than my nice little walk trotting along in the early morning…or maybe I'd walk there early and then hop on one of these things to get myself home…I don't use Uber..but maybe it's council-run so it's a bit like a bus but you're not left standing out in bad weather…far too many hours of my life have been wasted sitting around in bus stops not knowing what the hell's happening and just being in extreme discomfort."

— Karen, Ringwood, VIC

ELECTRIC VEHICLE FUTURES

UNCERTAINTIES AND CONTINGENCIES

- In industry, the market for EVs is commonly believed to be set to grow in Australia and globally. However many people remain unconvinced by the possibilities EVs offer, the infrastructure that supports them, or their practical application in everyday life. The history of EVs over the last 100 years is riddled with false starts and assumptions misaligned with everyday realities. Social science research needs to maintain a keen eye on the question of how, and which modes of EVs, become part of Australian lives in the near future, and how everyday imaginaries of EV futures shift over time.
- The research revealed an anticipated shift in the model of car ownership between the near and far futures, from privately owned vehicles to hybrid transport and mobility services. This potential shift from an ownership to service model will need to be monitored over time to understand the potential implications for residential and community battery charging.

IMPLICATIONS FOR FORECASTING

- Charging demand patterns will become increasingly localised in electricity networks, based on EV uptake and available rooftop solar generation, in addition to socio-demographic variations such as places with high numbers of people driving their children to school, working from home (e.g. ‘e-change’ areas), or working in trades (with earlier start and finish times).
- Programs that encourage daytime EV battery charging (particularly for solar smoothing), and that encourage and incentivise people to charge at particular times of the day are likely to contribute to load shifting away from overnight charging, especially where people are able to maintain control over tailored systems and technologies that allow them to do this.

AIR FUTURES

(NEAR FUTURE, 2025-30)

AIR FUTURES

(NEAR FUTURE, 2025-2030)

Heating, Ventilation and Air Conditioning (HVAC) is of central importance and interest for energy forecasting.

- Digital Energy Futures research suggests that HVAC is increasingly associated with the creation of a healthy and safe home, through the maintenance of clean air through air purification technologies, as well as with the priorities of comfort and convenience.
- Emerging air technologies such as standalone air purification and air humidification devices are becoming more common, and are increasingly being integrated into refrigerated air conditioning systems.
- In the near future increasingly advanced emerging air technologies are imminent; they are likely to impact energy systems and people anticipate that more intelligent technology will need to assist them with managing their home air quality.
- In the far future some air quality issues may be mitigated by improved housing design.

Our investigation was set in 2025 to 2030 to account for this context and create a baseline for further monitoring. We found a growing presence of, and interest in, air purification technologies. These technologies are commonly controlled by sensors that monitor and report on air quality, which can change depending on cooking fumes and smoke; allergens and pathogens; movement of people, pets and animals; presence of mould and mildew, and other disturbances to the air.

The relationship between the remote management or automation of energy supply to air technology needs to account for emerging priorities related to health, care and safety; in the practical sense of ensuring people and households are able to actively participate in healthy and safe air initiatives and agendas, in realistic communications strategies, and in ensuring that people are able to access comfortable, healthy and safe air when they need it.

More broadly this context raises new questions relating to the roles and responsibilities of energy companies, the grid, the government, the health authorities and institutions, and technology companies in shaping the possibilities for future air technology, including the roles of government

and other organisations responsible for our digital rights, regulation, inclusivity and privacy.

Creating the right balance between control and automation is crucial, as is forecasting for a future where this balance is understood. People want to make their own decisions about when they will agree or disagree with the decisions proposed by automated systems which might shut down or restrict their air technology. They do not trust energy companies (who they assume are driven only by economic priorities) to make the right decisions for their specific family health issues and priorities. They do not believe that automated systems will have all of the relevant contextual and local information needed to make decisions for them (although some anticipate this may be possible in the future).

However, many people are open to negotiating the use of their air technologies in relation to the grid, alongside their health and safety priorities, and experiences of their local environments.

Each page in this section provides a **foresight** about how people are likely to live with **air technologies** in the near future, supported by **findings** from the project and a selection of illustrative quotes from participants and related ECBS survey findings.

People's future uses for air technologies will pivot on their knowledge and experience of their local environments.

Foresight

People's relationships to both place and technology are crucial to understanding the ways and extent to which people want to be involved with future air technologies.

Findings

Australians living in rural and coastal locations were more likely to have deep knowledge of their local weather systems and how to live with them, as well as to be home owners. They have strong views regarding how to manage future air technologies, and will want to maintain control over them. People who are less locally embedded or have less knowledge of their local weather systems (for example migrant families living in urban sites), could be more interested in technological ways of knowing about, and regulating their environment, and more open to some modes of automation, but still want to be able to override automated decisions.

Belinda, a woman living in the Northern Beaches of Sydney, described how she preferred the sea breezes over air conditioning. "I like fresh air... We are fortunate because we do get that sea breeze come in the afternoon and the house, in the way it's been built, you know, has quite good flow through ventilation."

Her experiences living near the sea gave her a preference and responsiveness to natural weather conditions, something that affected how she envisioned a future air technology. She was most interested in the device controlling humidity and the purity of the air. She also imagined that she would not want much automation in the device: "I would always do it manually."

Inequalities in home ownership and income will impact future uses of air technologies.

Foresight

Home owners will invest further in their homes and are likely to install new air technologies. Renters cannot make such investments and will use portable air purification and filtration systems. Current renters imagine, and often plan, their future home ownership and the possibilities it offers.

Findings

We found that Australian renters and migrant families, more likely to be living in cities and in the suburban fringe, were already using air filtration and purification technologies. Those who were technology focused were more interested in setting up and using automated systems in the future. People were concerned about the costs of needing to run air-conditioning and purification systems more often in the future, and were also concerned for other more vulnerable people who may not be able to access or afford comfortable and safe air for their homes.

"Right now, there's not really anything in my life that I think would be beneficial to automate....I guess one thing I would love is to actually do all the lights because I do tend to use the Google Home to turn the lights on and off and that would be nice but, yeah, I'm in a rental now so I can't, or it's not worth buying all that stuff if I'm only here for six months."

— Morgan, Terry Hills

Affordable energy for all Australians is important for most households (63%); system resilience to extreme weather events (34%) and replacing old coal and old gas plants (33%) are the next highest concerns for the energy system.

ECSS 2022

The top three reasons for not buying a home battery system are because the current models available in Australia are too expensive or out of people's price range (32%), they are renting so have limited options (24%) or they don't have solar (22%). For people living in a unit, flat or apartment, renting is the top reason (51%).

ECSS 2022

Future air technologies will be used more than existing air conditioning systems.

Foresight

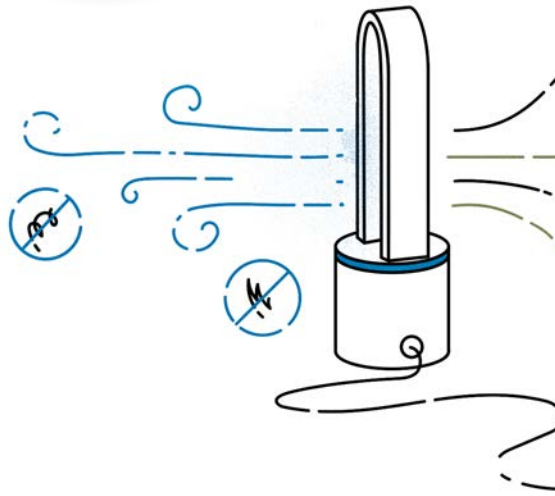
Future air technologies that combine heating and cooling with filtration and purification will likely be used more than existing air technologies, which would tend to be used seasonally. They are also likely to replace fresh air in situations where airborne allergens or other contaminants are present or suspected.

Findings

Participants' preferred future air technology would have filtration/purification capabilities as well as heating and cooling. It might also perform dehumidification. HVAC systems will become increasingly 'essential' (less discretionary) as people seek health and safety (as well as comfort) from their future air technologies. HVAC systems will also become increasingly integral to a wider range of practices such as cooking, cleaning, reducing household infections, exercising and working from home, and detecting and removing specific allergens.

11% already have an air purifier or dehumidifier at their property. Air purifiers are most common in inner metro locations (14%) and least common in regional and rural areas (7%).

ECBS 2022



Paul, from Sydney's North Shore did not own an air purifier, but he had looked at getting one, and he was interested in technology that might help him deal with mould issues in his home.

He designed a future air device which he named 'Goldilocks' because it was designed to get the household conditions "just right." He envisioned that the device would be smart and able to adjust to the conditions.

Role-playing the device, Paul said "I have a whole bunch of sensors that will look at my surroundings, factor in what my owners have programmed me to do, and I will turn on and off as per that program."

This expansive vision of a future device would always be on. Again role-playing as the device he stated, "...if I don't work my owners are very grumpy and very upset" and further explained that the only reason the device would not be on would be if the electricity grid turned the device off.

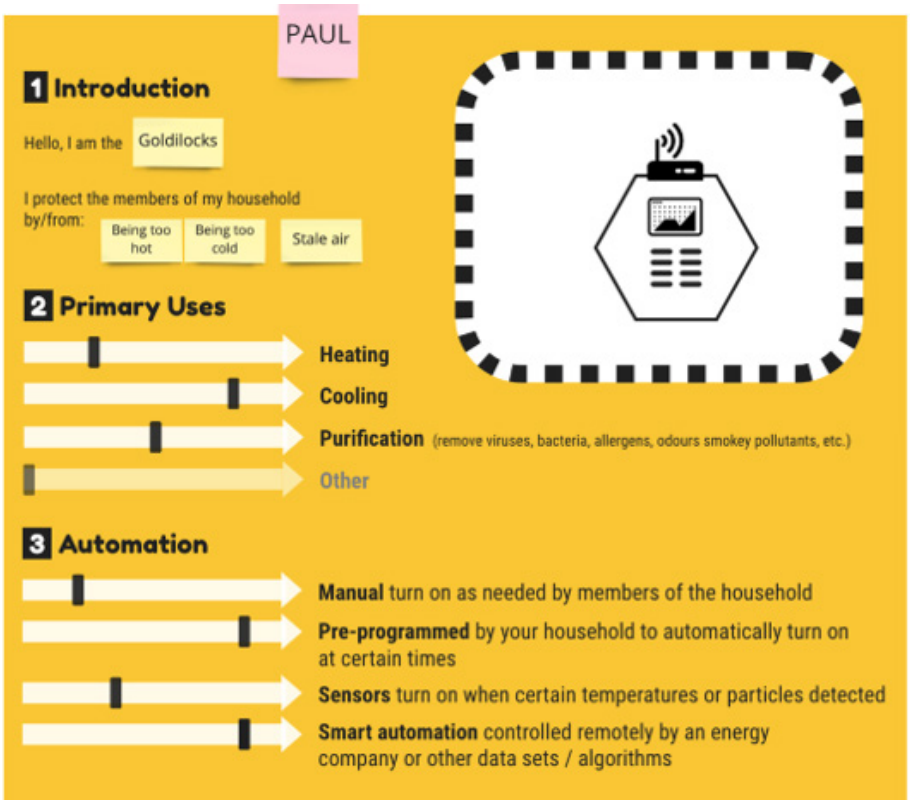


Figure 10 Example of a participant-designed future air technology, the 'Goldilocks' including desired features and functions.

Uses of future air technologies will be shaped by the demands of future work and study routines.

Foresight

In the future, daily routines are still likely to revolve around working and studying patterns, and uses of air technologies will be responsive to this. These uses of new air purifying and filtration systems, in combination with heating and cooling, will create new peak demand times, which are likely to involve intensified use of air technologies in the early evening as well as possible new peaks or smoothed demand during the day for people working from home.

Findings

In the future, participants expect that their everyday routines will be shaped by their family requirements and needs. Future routines could involve the majority of the household arriving home at the same time in the evening, or household members using air technology to prepare the house for working and studying from home in the morning and at key moments during the day in the summer. Participants subsequently envisaged using future air technologies at the specific times of day that are suited to their own routines and those of their families, in conjunction with the weather. This varied amongst different groups of participants, according to the type of work they did, if they worked from home, and if they had children.

Diya and her husband Elliott both worked in the technology industry. They had moved to Australia from India a few years earlier with their two children, and lived in Sydney's CBD.

They imagined a future automated air technology system and device, which Elliott said would be turned on all the time. He saw it as a smart technology with sensors and pre-programmed, which would turn on and off automatically in relation to how the conditions in the house change during a given day.

He described how "For example if it's the morning … and you're rushing out to work etc, you wouldn't need it fully switched on", while at night, it would run in a "low mode." If it gets hot during the day, it would use smart sensors to detect if they were at home, and if they were, it would maintain the right temperature and conditions.

Diya agreed that "in the future it will be mostly like sensors and they will detect if more people are there in the house and based on that it can modify the timing, the battery level and the power supply."

She saw the technology as "mainly … working really hard on really hot and sunny days… it requires more electricity to make it cooler and less humidity, and when there is too much pollution in the air … or a natural disaster, when something happens in nature … during that time it has to work a lot."

78% said it was likely (33%) or already applicable (45%) that there will be someone in their property on most days between Monday and Friday within the next 5-10 years.

ECBS 2022

People's future priorities will be for the health and safety of their households.

Foresight

People will prioritise the health and safety of their households when making decisions about how to use and control future air technologies. These priorities may override the market-based incentives of energy companies (e.g. tariffs) and are related to the desire to maintain control over future automated technologies. Appeals to shift or curb the use of air technologies will need to engage with people's health and safety priorities.

Findings

Healthy and safe air is a key priority that people think and speak about, and one that they see new air technologies as offering them. They see this as enabling them to care for, and guarantee the comfort and safety of, their household. We found that participants were particularly concerned to ensure that they had the ability to override automated systems and to guarantee their energy supply to ensure clean or filtered air for household and family members with respiratory conditions, and to keep heating and cooling in place for people and pets with medical conditions that led to heightened temperature related discomfort (including sleep related conditions).

In the next 5-10 years, 26% think their home will use more cooling and 18% think their home will use more heating.

ECBS 2022

49% doubted that their home will be comfortably cool in hot weather without using air conditioned cooling in the next 5-10 years.

ECBS 2022

30% said it was likely (22%) or already applicable (8%) that they would use heating or cooling to keep a pet comfortable, healthy or safe in the next 5-10 years.

ECBS 2022

Richard lived up on the hillside in a coastal location, and for him the breeze was integral to how he managed the air in his home. The cool north easterly breezes in the afternoon act as an air conditioner in their home, so they largely avoid using their split system.

However, he does use it, particularly during the colder days in winter, which cause him discomfort because of his rheumatoid arthritis. When he designed a future air technology, he named it The Weather God.

It was designed to attend to the two key issues that he and his wife experienced in the home, related to temperature. He needed to ensure that the home was warm enough for his medical condition while also providing the effective cooling that his wife needed when the weather was hot.

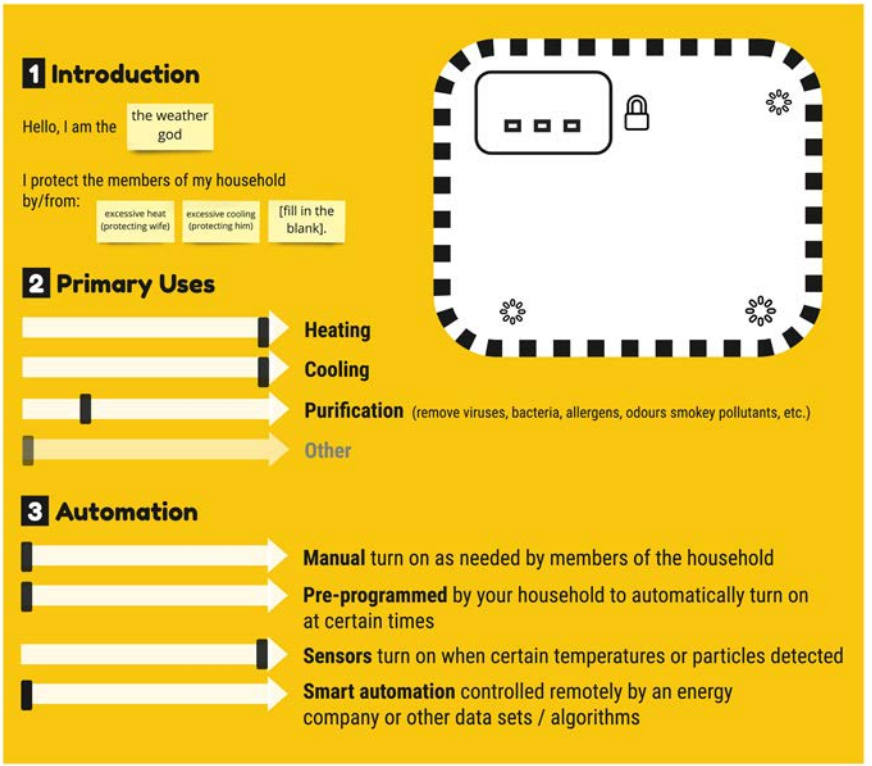


Figure 11 Participant-designed future air device 'The Weather God'

People are acutely aware of privacy and digital safety issues and will require them to be resolved in the future.

Foresight

Privacy is a key concern for many people in the present and is likely to continue to be important in the future. This will raise new questions about the future role of energy companies in assuming responsibility for and ensuring privacy across their own and other organisations' platforms.

Findings

Participants were concerned about privacy on a number of levels including sharing their personal data, sharing data about the air quality or contents of their homes, and enabling external access to infection detection data. Older participants in particular could be vulnerable to taking up digital technologies even when they have privacy concerns. Some people wanted to have privacy designed into the future air-technologies they imagined, for example through password protected devices. Others felt that the data collected would be inconsequential. Some participants were vulnerable to taking up digital technologies even when they felt uncomfortable in relation to their privacy.

Participants living in small rural towns developed a lively discussion about their individual and collective concerns about data privacy. Our discussions with women participants in particular showed how, as they learned about digital data, they had formed their own views about what they regarded as data privacy and digital safety.

Erin (Drouin) told her group that she thought they lived "in a time where we're increasingly becoming aware of how much data from devices from within our home is being shared." She emphasised that in this situation they needed "some kind of inbuilt privacy devices at some point whether owners of each device can select how much data they want to share and whether or not they're prepared to share data or be paid for sharing their data… and what they want to be shared and who it's going to be shared with." The other participants chimed in to agree with her as she continued, telling us that at the moment they were "not really sure what's happening", which for her meant that "the rules need to be tightened up around it [data privacy]."

The privacy and safety of future air technologies also relates to the personal data they collect and share relating to household conditions. Participants expressed fears about the future relationship between their digital safety and personal safety. One young mother envisaged a future scenario where she would have to risk one for the other, centred around the question of if sensor technologies would be able to detect COVID-19 in her home.

Participation and communication will be essential for engaging people's uses of future air technologies in relation to the grid.

Foresight

Future systems and services involving effective communication and notification systems, and opportunities to participate, are more likely to be trusted by people in the future, especially when they engage with people's priorities for health and safety.

Findings

People are reluctant to see their future air technologies as part of an automated and connected home. They sought ways to imagine themselves as always being aware of and participating in the decision making processes through which technologies would be used, and the responses made within the home in relation to air quality data they would collect. They were keen to become engaged through relevant and time-sensitive notifications (about energy availability, weather forecasts and air quality) which would help them to make decisions regarding when to enable or override automated systems and future air technologies.

Mandy, living in rural Victoria, imagined a future air device that would have relationships with different appliances in the house, for example her air device would know if the rangehood wasn't doing its job properly because her device "would definitely be able to sense the grease in the air" but she did not think the device should fully automated or be able to control all aspects of the home.

She described how her air device would also know if the family had left the window open, but she wouldn't want the device to be able to open or close the windows, because her device would not sufficiently be able to account for unforeseen reasons her owners might do this. Personifying the device, she explained, "I think my family would be mad with me if I closed the windows and they specifically left them open for a reason." However, she imagined that if there was a hazard the device could send "an alert message, a notification, just letting me know there's pollution detected in the house, you might want to close your windows."

Other participants wanted fewer on-the-spot notifications, but still wanted access to information and clear communication and transparency about how their technologies were operating.

For example, Artëm from Inner West Sydney thought that future air technology "should be mostly automated and smart but you should be able to override its default actions if you think it's doing something wrong. …It should display how it came to a conclusion to run particular devices…to gain your trust."

The availability of new energy data and air monitoring data will lead to new communities of actively engaged citizen scientists and technology enthusiasts.

Foresight

The availability of digital data, predictive analytics, and an increased use of sensor technologies and citizen scientists concerned with air quality could encourage greater participation in air quality monitoring and control.

Findings

Some people will become more engaged with home air technologies and data through their existing technology expertise and their passion for citizen science initiatives. While in the minority, they should be seen as pioneers, similar to early adaptors, who will innovate and demonstrate the possibilities offered.

Jodie from Moe was open to sharing data collected by her future air device with other devices in order to provide greater data about local air quality.

Living in a region which suffered not only bushfires, but also bad air quality as a result of a major coal mine fire that burned for 45 days in 2014, she recognised that the data future air devices might be useful for for "studies and research type things, could be beneficial to the wider community as a whole."

However, she maintained that this data sharing should give people the "option to opt in or out."

Most people are not prepared to enable their future air technologies to be run by automated and connected smart home systems.

Foresight

People are unlikely to set up future air technologies as part of IoT or connected automated smart home systems in the near future. They are more likely to be used as standalone devices which can be operated independently of other smart home technologies.

Findings

People are reluctant to see their future air technologies as part of an automated and connected home, or as responsive to other smart home technologies. They sought out ways to imagine themselves as always participating in the decision making processes through which the technologies would be used, and in the responses that would be made within the home in relation to air quality data they would collect.

For instance, most people specifically would not want their future air technology to be connected to smart windows, but could envisage using smart technologies, such as a digital voice assistant (DVA), to operate the technology themselves.

28% expect that most of their home appliances will be internet-connected and automated in the next 5-10 years; this already applies to a further 2%.

ECBS 2022

Only 6% want their smart devices to be fully automated. 42% want to set smart appliance timings themselves so they have complete control and 48% are happy for the device to be automated if they can override automation settings.

ECBS 2022

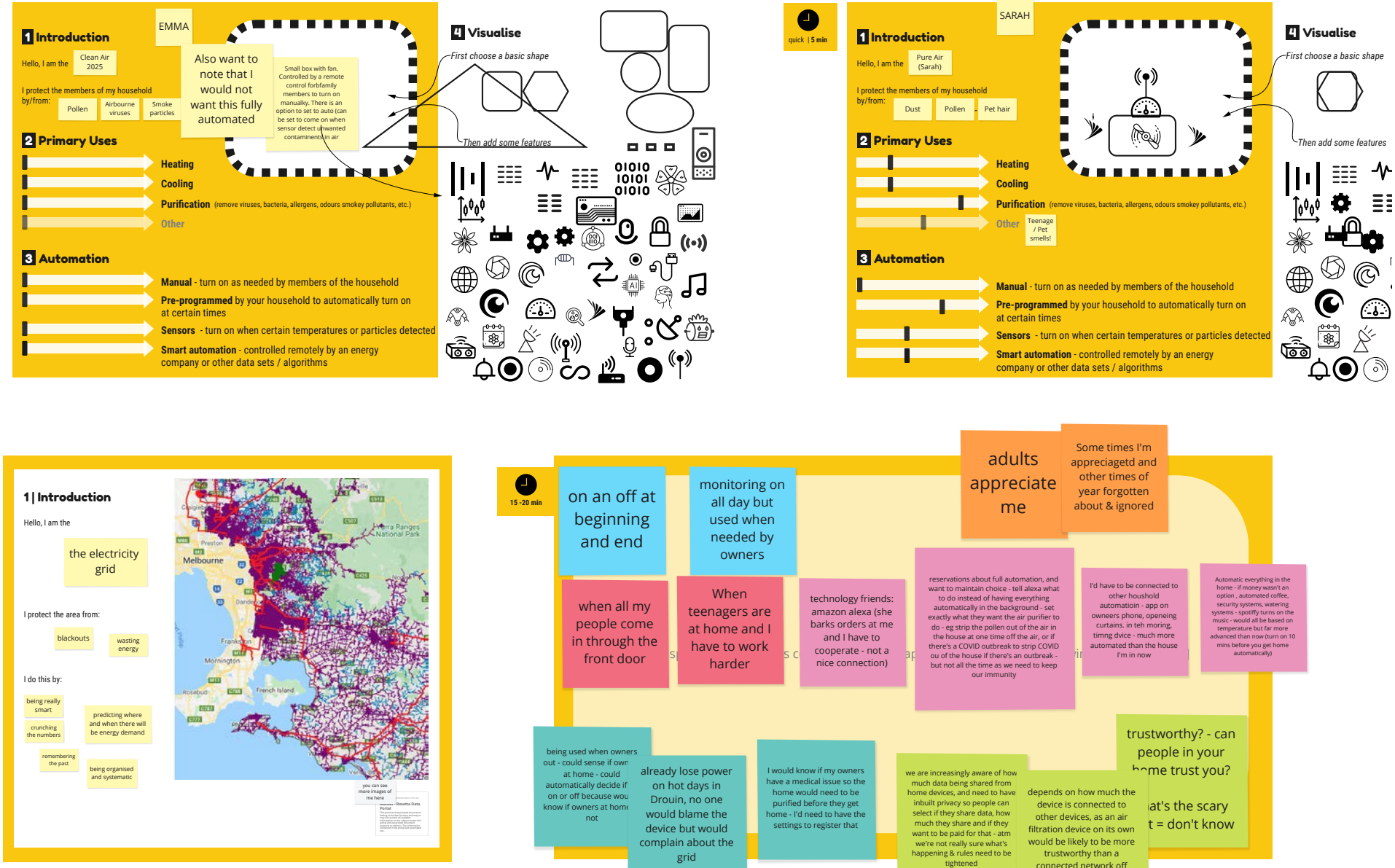


Figure 12 Screenshot of Air Futures workshop activities. Two participant-generated future air technologies and key discussion points around privacy and automation.

Generosity and social responsibility are key considerations for when people relinquish control over future air technologies.

Foresight

Appeals to community generosity and social responsibility are more likely to lead people to agree to relinquish, restrict or shift their use of air technology for energy or grid management objectives, than financial incentives alone.

Findings

Where households are asked to curb or shift the use of their air technology for a bigger grid disruption (e.g. storm, bushfire, heatwave) to avoid a potential power outage or to ensure use of available distributed electricity (e.g. rooftop solar PV generation), people are more amenable to respond for the greater good on an occasional basis. Participants would sometimes prioritise community needs (such as those of a hospital) over personal preferences. If the motivation or incentive was presented only as a financial reward or penalty (e.g. higher tariff), people were less likely to indicate they would reduce or shift their use of air technology.

Reasons to respond to demand management differ by lifestage: more older and retired households want to help prevent a power outage while more young and family households want to help the environment.

ECBS 2022

42% are willing to reduce their energy use as much as possible during a very hot period if they were asked to, even without a financial incentive (compared to 35% who would only shift their use if given a financial incentive).

ECBS 2022

Habib from Sydney's North Shore thought that in the future his air technology would be "open to [the grid's] feedback" and conceded that it "might run in efficiency mode during peaks", but he felt that "That's the best I can do. It's important to be cool and warm when required."

However, his views shifted when he was asked to consider if there was anything he could do to slow down his use of energy if the situation escalated towards a blackout combined with a storm or a heatwave.

Habib told us that he would want to know what was happening first, role playing the perspective of the air technology he said: "Let's say there's a bushfire and people are losing their lives. Yeah, of course, my owners would want to do their bit."

Other participants also became more open to reducing their use when presented with a potential blackout.

"If it's a critical thing that means I'm going to have no power, I am interested. If it's that you're struggling, but at what point is it going to be so critical that I'd have no power. No power is no good to anybody".

— Paul, Sydney's North Shore

"Ultimately if the power goes out there's not a lot I can do. If it's critical for life or the network or something, like if there's more important things to run, then some air purification is probably not the biggest deal to lose".

— Max, Sydney's North Shore

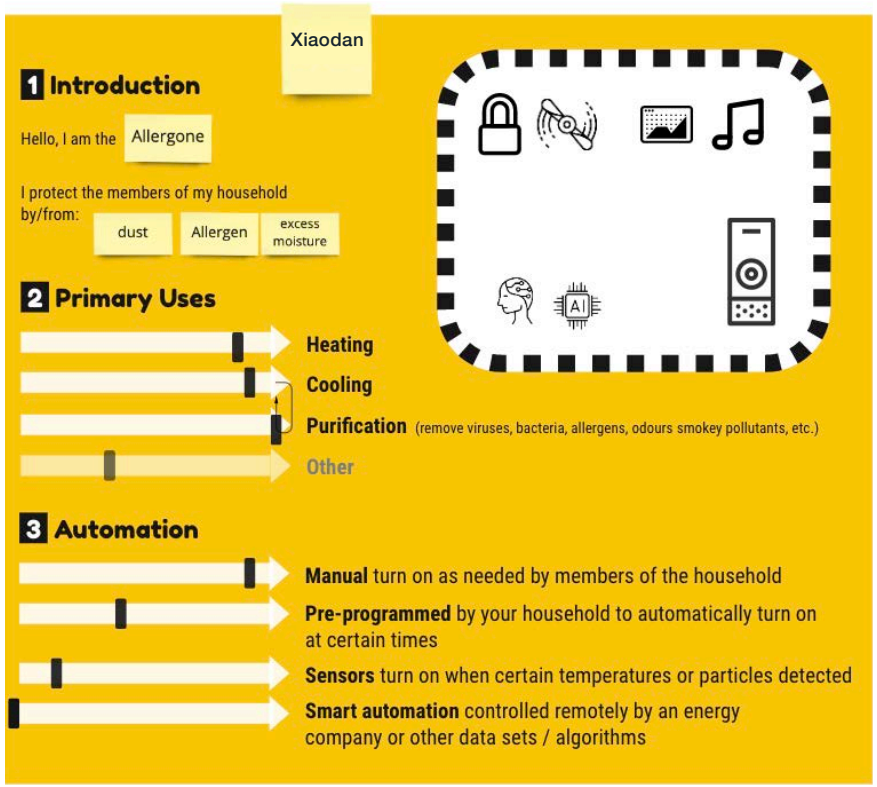
In the future people will want to control their air technologies themselves and to tailor them to specific needs.

Foresight

People will prioritise the health and safety of their households when making decisions about how to use and control future air technologies. These priorities may override the market-based incentives of energy companies (e.g. tariffs) and are related to the desire to maintain control over future automated technologies. Appeals to shift or curb the use of air technologies will need to engage with people's health and safety priorities.

Findings

Healthy and safe air is a key priority that people think and speak about, and one that they see new air technologies as offering them. They see this as enabling them to care for, and guarantee the comfort and safety of, their household. We found that participants were particularly concerned to ensure that they had the ability to override automated systems and to guarantee their energy supply to ensure clean or filtered air for household and family members with respiratory conditions, and to keep heating and cooling in place for people and pets with medical conditions that led to heightened temperature related discomfort (including sleep related conditions).



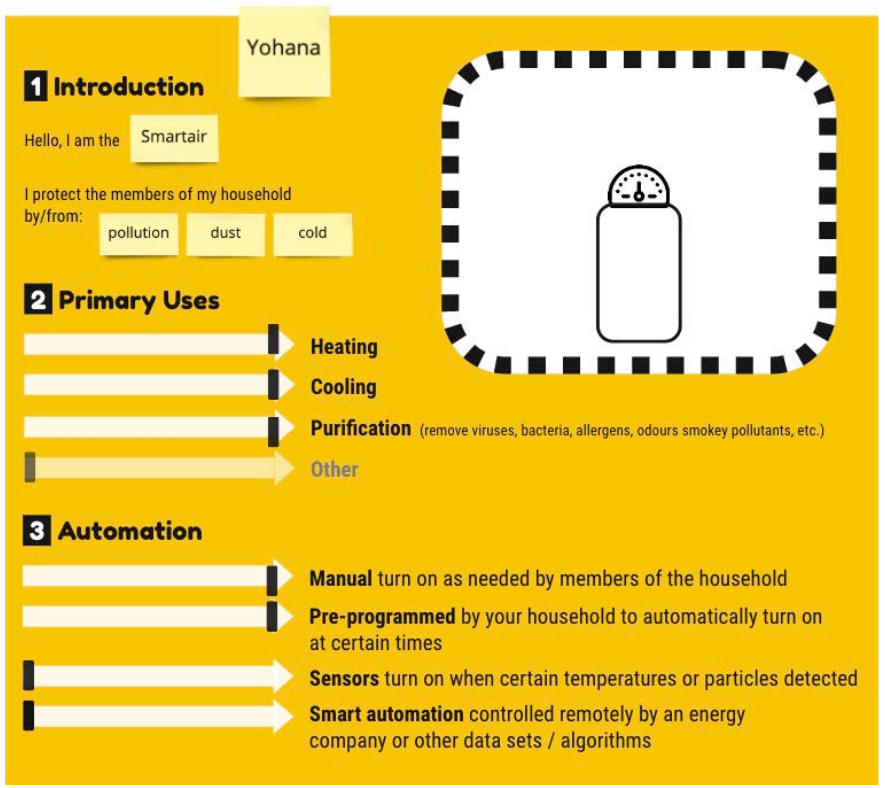


Figure 13 Screenshot of Air Futures workshop activities. Two participant-generated future air technologies.

A researcher asked Xiaodan and Yohana if everyone uses 'them' (their future air devices) in the same way. "No, we have very different opinions in our household just between the 3 family members…so it's best to have each room programmed in its own way. Some rooms are at 21, some might only be at 16."

Xiaodan explained that they also had small children at home who needed a different temperature in their rooms. Yohana agreed that everyone has different opinions. "...it would be really nice to have something that we can control, not in each room, because that is probably not an option, but have 2 or 3 different areas." Yohana designed her devices to be completely manual "because I want to know what I'm doing and not relying on sensors, just in case they have a fault or something, and sometimes they don't work."

Air purification technologies heighten people's experience of air impurities and will encourage more frequent and sustained use.

Foresight

Air purification technologies will become part of the sensory and material ways that people understand air impurities, which will heighten the experience of air as impure and increase air technology use associated energy demand.

Findings

The sensory experience of air purification can provide feedback which encourages greater use and the expansion or multiplication of devices. While the data and monitoring of air quality embedded in devices encourages the use of 'always on' automated functions, it is the sensory aspect of these that people relate to.

For example, the sound of the device ramping up, or the change in colour of the device, alerts the user to the impurity while also proving the device is needed and is 'doing something' about the air quality. Exactly what it is doing can be unclear even for those quite enthusiastic about the technology, however the essential point is that the presence of the technology offers people a sense of security.

This caused participants to reflect on the likelihood of more frequent use of air purification technologies in the near future, especially during periods of poor air quality (such as summer bushfires), and also more sustained use to continually maintain pure air.

Air purifiers are similarly common in households under financial constraint or pressure (10%) as in financially comfortable households (11%).

ECBS 2022

"It's got sensors, and the sensors do things [laughs].... It will detect it, it will kick in and it will do its job and deal with whatever's in the air, it seems. Again, I don't know what it is. It's just the light comes on, the fan picks up. Yeah, it's like yeah okay. Do it's job. I kind of feel better about it, I guess."

— Peter, Tumbi Umbi

Financial incentives alone will not solve energy demand challenges.

Foresight

Financial incentives and variable tariffs (such as ToU tariffs) - on their own - are unlikely to be a key solution to demand issues in the near future because they are usually superseded by people's everyday values and priorities. But people will be incentivised to make small changes, especially when these align with appeals of resourcefulness (e.g. using available solar power) or community responsibility (e.g. helping others in need).

Findings

People are unlikely to want to hand over control of their air technology to energy companies or turn off their air technology for financial incentives alone. They are more likely to be open to small modifications, such as complying with a 'power saving mode' initiative, for some incentives. They are also likely to embrace battery storage to assist with any demand challenges to avoid wasting energy and to support vulnerable people in extreme weather situations.

63% consider it very or quite easy to change the timing of charging electrical devices and 32% consider it easy to change air conditioner use times.

ECBS 2022

"Sorry Mr electricity grid–or Mrs electricity grid–no. I'm not turning off for anything. What my owners want me to do is important. I can help you with the struggles if you want. Feel free to send me a battery and I'll install that in the house and I'll work with that instead. I'm more than happy to do that. But just because you've got trouble with your infrastructure, my owners have no sympathy for you I'm afraid."

— Paul, North Shore

In the far future (2050), air technology will be increasingly integral to providing comfort, health and safety.

Foresight

People will increasingly prioritise installing and using air technologies over natural ventilation. Homes are more likely to be sealed to ensure air can be adequately purified in response to more frequent and extreme weather events. Safety and health will become integral to how people pursue comfort in their homes.

Findings

In the far future, participants envisioned more time indoors, especially during mid-day, and imagined using air conditioning and air purification technologies more often. This included days with poor air quality, not just extreme temperatures. Participants who currently manage the air quality in their homes through opening doors and windows, would instead keep their windows and doors closed, and many envisioned upgrades to the built environment that would allow for better insulation or enable their home to be 'air tight'.

"I [open] the window now, [but in 2050] I'm using the air con because I'm trying to close up and control the environment more."

— Peter, Northern Beaches

"The air condition[er] would be on all the way through the day, for sure, because of the extreme weather, so there won't be many alternatives to that."

— Miles, Inner West Sydney

"I have an air purifier which we do use now… because we both suffer from allergies depending on what time of year, but if the extreme weather were more constant, it would be used more…it would always be on…"

— Marj, Drouin

"When the bushfires happened, even in Ringwood, you could smell smoke. I had to close my bedroom window. And I'm asthmatic so I had to be a bit conscious of that…If it's not freezing, I always sleep with an open window. I have them open as long as it isn't too hot or too cold…if there's air quality issues [in the future], you have to use an air purifier…So I think one of the things that would have to happen is —I'm a renter— is that… there would be much more legislation around rental properties, and obviously for new builds, for this kind of air purifying to be available in the heating…just hasn't been legislated enough."

— Karen, Ringwood

AIR FUTURES

UNCERTAINTIES AND CONTINGENCIES

- Increasing demand and use of EVs is anticipated to improve air quality in local areas, and may alleviate some of the future need for air technology. Social scientists need to carefully investigate how people's perceptions of, and relationships to, air quality evolve over the near future.
- Detecting COVID-19 and other airborne diseases in the air could be a key benefit of future air tech, potentially assisting in the prevention or alleviation of future pandemics. Social scientists should have a key role in developing ethical, inclusive, and energy efficient modes of engaging emerging air technologies for such tasks.
- Improved housing and technology efficiency could reduce the need for future air technology and reduce energy demand associated with these devices (e.g. double glazed windows, insulation and improved thermal efficiency of buildings). However, this would require a national commitment and inclusive and equitable policy towards retrofitting existing housing stock, as well as engagement across consumer groups.

IMPLICATIONS FOR FORECASTING

- Future air technologies are likely to combine multiple functions together (e.g. air conditioning, air purification, dehumidification) to deliver comfortable, safe and healthy air. This is likely to increase demand during the afternoon and evening peak, and also smooth or extend demand during extreme weather events (e.g. during prolonged bushfire smoke haze).
- Energy demand for air technologies is likely to increase as these devices become embedded into more indoor spaces across the property, despite anticipated efficiency improvements.
- High peaks in demand for air technologies may be mitigated by demand response programs that prioritise safety, community and social responsibility messaging alongside financial incentives, and which encourage people to be resourceful with their available solar power.

FAR FUTURE ROUTINES

(FAR FUTURE, 2050)

FAR FUTURE ROUTINES

(FAR FUTURE, 2050)

Everyday life routines are of central importance and interest for energy forecasting.

- Everyday life routines are expected to occur earlier and later in the day in the far future, and be spread out over a longer period of time.
- Extreme weather conditions are expected to play a key role in structuring everyday life routines in the far future.
- More activities, such as working and studying, are expected to take place in the home in the far future, with institutional events characterised by frequent disruption.
- Emerging and automated technologies will create new possibilities for energy management and demand in the far future, and will become integrated in everyday life routines.

Digital Energy Futures examined how participants believed their everyday routines were likely to be impacted and adapted to place-based changing and extreme weather conditions, future technological possibilities, and new understandings of home and work. We focused on how the places and timing of everyday routines are likely to change, identifying where these overlap and intersect, in order to provide foresights into future peaks and troughs in demand.

We also identified shifts in demand in relation to anticipated changes in institutional timings, such as school and work hours.

While it is not possible to predict futures in 2050, our foresights represent plausible and realistic principles regarding how people will engage with future automated and energy systems and technologies, how they will live with extreme weather and the strategies they are likely to develop to keep themselves and their households safe and comfortable.

This activity reinforced findings from both the ‘Air Futures’ and ‘EV Futures’ workshop activities, contributing to the set of foresights about how we might expect people to use air technologies and EVs in the far future. The far future foresights specific to air technologies and EVs have been included in the previous sections.

We propose new understandings and foresights into how people’s needs, priorities, ethics and values will shape their everyday routines in lives that adapt to future extreme weather conditions and adapt future technologies and services to help support safe and comfortable living.

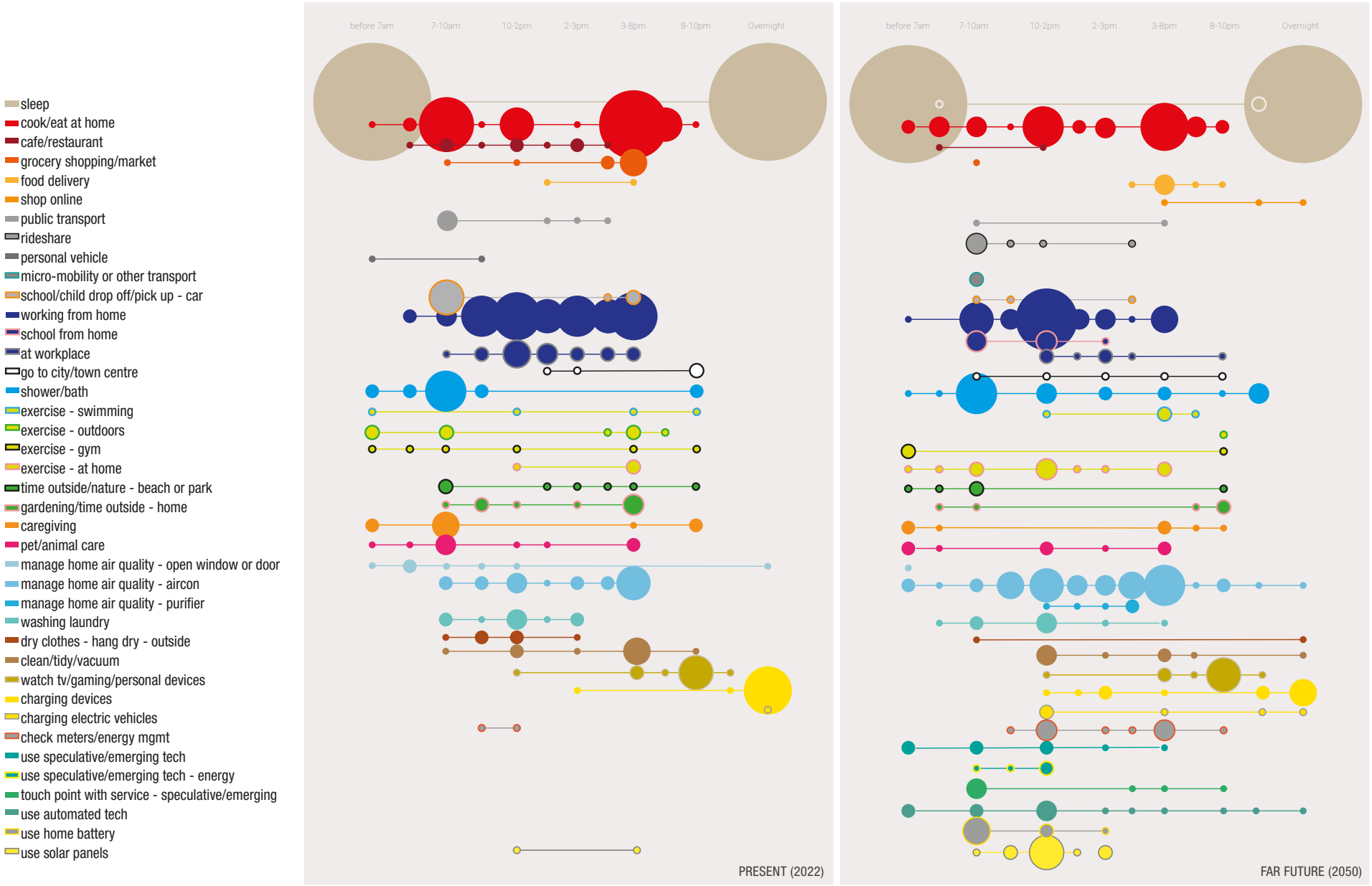


Figure 14 Current household routines compared to far future household routines.

More frequent extreme weather is likely to shift the way institutions and households structure their everyday tasks and activities.

Foresight

People's everyday lives are likely to become more entwined with the weather in the far future, as extreme weather events become more frequent and intense. Routines and activities are likely to shift in ways that will help regularly avoid exposure to extreme weather, and which position the home, schools, and workplaces as places of shelter and safety.

Findings

While today extreme weather disrupts our normal routines and everyday activities, workshop participants imagined more frequent extreme weather as a norm, rather than disruption, of everyday life. Participants immersed themselves in this future context, to imagine how these climate changes would affect everyday life both inside and outside their household.

People already manage their household routines to meet all their various caring responsibilities and in relation to wider energy systems. In the ethnography (Stage 2), we found strong conservation and frugality around energy, whereby people only want to use energy when it is 'needed' (both concerning being financially responsible and regarding their relationships with the environment and community). However, these energy needs are often inflexible when they come up against rigid institutional timing, and are thus likely to contribute to peakiness of the grid.

When envisioning the far future, the workshop participants often imagined that extreme weather would also influence shifts both in today's institutional timing and operations (such as work hours, schooling, and touchpoints with future services) and in the wider rhythms and social practices in their local area.

Participants varied in their visions about how drastic the changes to everyday life would be based on the scenario of extreme weather. For some, the year 2050 looked very similar to today.

However, all participants imagined some shifts in the timing of their everyday tasks and activities, as summarised in Figure 14 above.

Household routines will be structured around expectations of increasingly hybrid and flexible working arrangements.

Foresight

Hybrid and flexible working arrangements will become the norm in the far future, supported and augmented by digital technology, with many other work tasks increasingly conducted online or with digital tools. Some jobs that require on-site attendance now will also shift to hybrid and more flexible modes in the far future.

Findings

Participants unanimously saw future working hours as more flexible, often shorter and possibly with a longer midday break. Most participants envisioned working from home regularly in the future if their profession allowed. Most participants were currently employed in positions where it was possible for them to work from home, and had recent experience working remotely during the pandemic.

However, visions of shorter work hours and hybrid or remote work in the future also resonated with on-site shift workers, where digitalisation and technological advancements in the far future would decrease the number of hours they were required to spend onsite.

In 2021, 35% of households were doing more work or study from home than prior to the COVID-19 pandemic (ECBS 2021). This trend appears to be persisting as, in 2022, 21% said that in the past 12 months they had been doing more work or study from home, and slightly fewer (19%) said they were doing less work or study from home (ECBS 2022).

More households have air purifiers in the ACT (21%) than in any other state (ECBS 2022), with bushfire smoke impacts over the 2020-21 summer a likely contributor to higher uptake.

ECBS 2022

"Could we be working from home more and more? Also because of the temperature of the commute that will be more of a problem. What I'm thinking is, are we gonna work full days still? Or will we work half days? I'm under the impression that in 30 years we're not going to be bound to the 40 hours week as much as we are now…by then it will be more about the quality and less about the quantity."

— Miles, Inner West Sydney

Schools will balance in-person learning and safety as priorities in the context of extreme weather.

Foresight

School education will largely remain onsite but with flexible and hybrid-ready modes of teaching and learning in response to more normalised extreme weather and environmental change. Coordinated and active transport options will increasingly replace individualised school drop offs and pick ups.

Findings

In contrast to their emphasis on working from home, participants unanimously envisioned that children would continue to go to school at a physical institutional site.

However, they also envisioned a variety of possible changes for what this could look like in 2050, in the context of more normalised extreme weather. Some envisioned school hours shifting to later in the day, or having shorter or longer hours, and their futures often included more hybrid and remote learning modes. Some participants imagined that schools may need to shift more seamlessly into remote learning on dangerous weather days to avoid closing.

Parents often envisioned that, in the far future, schools would provide safe transportation for drop off and pick up. This would replace parents driving their children to and from school as well as all forms of active transport (like cycling or walking).

Miles (Inner West Sydney) expected to work remotely in the future in the context of more frequent extreme weather and also thought that school hours might shift in this scenario.

However, he is "not expecting [kids] to be homeschooled forever. It might shift in the day to afternoon or evening… but I'm not expecting fully homeschooled because I really hope that in 30 years we're going to still value the social aspect of things."

While he would want to work from home in 2050, he felt that "for kids, it's different."

Gabriel (Cranbourne/Clyde), another father, expressed similar reservations about remote learning "I was thinking there could be more online classes but if they actually sort how to do that because recent experiences are not the best…they must find a way to make it seamless… if they have to make a decision that is on-the-spot like 'today is online' we don't plan for it a week earlier, so it has to be seamless…You don't want kids to have that much change."

"[In] the future, instead of spending my time taking the kids to school and picking them up from school something will have happened by then and my kids would have a safe, affordable, way to get to school without me having to drive them there."

— Linsay, Inner East Sydney

Efficient, climate-controlled, and communal workplaces and leisure sites will remain important physical hubs for social interaction.

Foresight

Physical workplaces and leisure sites will remain important hubs of social activity to alleviate social isolation in between working from home and to provide heat refuges for older and retired people. Central in-person worksites are likely to remain a preferred option for some people to reduce personal energy consumption and sustainability impacts.

Findings

While participants envisioned that technology to support working from home would be common in the far future, many stressed the heightened importance of creating opportunities to come together to combat social isolation. In their visions, they often bundled any visits (whether regular or occasional) to the workplace with planned in-person social activities.

While most participants envisioned working from home to stay safe from extreme weather, some saw working centrally as a personal sustainability choice to decrease their own energy consumption from air conditioning. In addition to work, participants envisioned going into central locations (e.g. cinemas) or hubs (to work, shop, eat, meet, relax) throughout the day to escape the heat on extreme weather days.

"I go about things a little bit differently…climate change is a real concern of mine. …For me, to stay home with the AC on all day everyday is very counterintuitive. I would be contributing to climate change and the very thing that is causing me the discomfort…So, what I do now when it's a smoky day, when it's a really hot day, is I go into the city…I would be more likely to centralise… I would probably move to an already-climate-controlled environment to get the benefits of scale."

— Kylie, Inner West Sydney

People will become increasingly anxious about social isolation, seeking new ways to connect virtually and in-person.

Foresight

People expect that technology innovations will provide new opportunities for social connection in both virtual and physical environments by 2050. These technologies will support connection during more frequent and extreme weather events, and help to alleviate social anxiety about isolation and disconnection.

Findings

Isolation was a consistent concern in participants' visions of the far future, as their present-day casual meet-ups (e.g. coffee/lunch) decreased and working from home increased in their visions of everyday life in the year 2050.

Often participants imagined ways to stay connected virtually, but expressed that this would be inadequate and that they expected to see innovations in this area by the year 2050.

For example, they speculated about future careers and job opportunities being created around this issue as well as better climate-control in and along access routes to communal buildings, public transport, and other services to better support in-person gatherings during more frequent extreme weather.

"I think extreme weather could impact people's mentalities and people's minds might suffer more. The last two years I've been working for some charities and a lot of people have some mental problem because of lockdown. Extreme weather could make a situation worse. I think with extreme weather we have to educate people, how do you cope in such a situation?"

— Victor, Inner East Sydney

"I think if you're in touch with people over Zoom and stuff it's really not the same as real life. Even just the little social things like being able to go out and have a coffee and those little nice interactions…"

— Pei, Inner East Sydney

Activities will be grouped together into new clusters of routines which could shift household peaks in demand.

Foresight

In response to more frequent extreme weather, people will reorganise their day into new clusters of activities with knock-on effects for household demand and the effectiveness of technology-facilitated sustainability goals.

Findings

For all participants, it was rare that only a single activity would shift in their everyday far future routine. Instead, we found that adjustments to accommodate living with more frequent extreme weather had wider effects on how participants clustered their activities to structure their day into a series of time-dependent based routines.

For instance, participants often spoke about shifting a cluster of routines to earlier or later in the day to coordinate with work, school, exercise and leisure activities. This would likely shift household peaks, however there was considerable diversity in how participants saw this unfolding in their own lives.

Three examples of participants' shifting routines in Sydney's Inner East in response to more frequent extreme weather:

Unlike today, in 2050 **Pei** will not want to go out every morning to the gym, instead the gym will "feel like a treat." Because she won't be going out to the gym, she also won't get a coffee out in the morning or do her grocery shopping on the way home as she does now.

Instead of going out for coffee, Pei would invest in a coffee machine and make her own. She would still cook breakfast at home and shower at home in the morning. She would use a dryer for her laundry instead of hanging washing outside. She would work from home and wouldn't want to go into the city for work, which she does now.

While today she opens a door or window to cool her home on hot days, in the far future she says, "if it's really hot during the day I'm going to definitely want some sort of air con system."

She would "exercise more at home" during the middle of the day instead of going out/travelling into the city to meet friends for lunch, "...cook and eat instead of going out...and you know, I imagine if there's a lot of dust kicking up or outside that's coming in maybe a lot more tidying up, probably want to have a [second] shower to dust off after a long day."

Linsay's morning routine in the far future would change drastically.

Today, it is centred on school drop off but when describing her everyday routine in 2050 she said, "I took out taking the kids to school and picking them up because I imagine by that point they'll have to sort out transport for children that's safe...it's very hard for working parents to pick up their kids and drop them off. It's also the biggest traffic congestion in the city, if you drive around when it's not school term everything's free flowing ... so maybe a school bus that's more comprehensive, perhaps a network of school buses or maybe a more affordable service...someone's going to figure something out."

In the future, she imagines that schools will have a duty of care to provide safe transportation for students during extreme weather; instead of grouping her daily cycling exercise with school drop-off, which "wouldn't be viable in bad weather" she would instead exercise in the middle of the day at home and cluster this activity with a mid-day shower and cooking lunch.

She thought "perhaps this is unrealistic–but… taking out picking up and dropping the kids off would give me an extra bit of quality time with the kids although perhaps more realistically I would be working later to make up for bathing and exercising in the middle of the day."

Instead of an evening swim after dinner, she imagines an earlier swim session with the kids at an indoor pool before eating, as a safe alternative to playing outside at home while she prepares the meal.

She would still charge devices overnight and still use a dryer to dry everything for the laundry she does during the day while working from home.

Victor currently has a daily routine of going to a nearby park in the evenings to walk while talking to his friends on the phone. He also does a daily meditation before bed.

In the far future, he imagines that he would not go to the park in the evenings, and instead visit the park early in the morning and to do his daily meditation while the temperatures are cooler.

He also imagined trying to break up his work day into two segments, early morning and evening, to avoid the hottest parts of the day. "Yeah I think [there] could be innovations that change working hours according to weather, maybe work in the morning rather than afternoon, or maybe late evening rather than during the day... During the day, you can take a rest and recharge your body."

He imagines breaking in the middle of the day, with the drapes closed to keep out the heat. He also imagined taking "a cool shower" in the middle of the day to cool off when temperatures are hottest.

He lives in an apartment building and thinks that building upgrades (such as improved insulation) would need to happen alongside new practices of negotiating energy expenditure in a shared living context. "I think we have to think of it much more... like working together because at the moment we live in the strata in apartments and we have like the body corporate, but for everyone's benefit, we have to make great citizens…"

He worries about social isolation especially since he would no longer have a daily evening walk and phone call, but also imagined a community garden on the roof of his building, which he thinks would help keep the building cooler and promote connection.

The morning peak will be spread across a longer period of time.

Foresight

The morning peak will become more flexible and spread out in response to flexible work arrangements, extreme weather events, local environmental conditions, caring responsibilities for people, local environments and animals, and household hobbies and activities.

Findings

Participants unanimously imagined their morning routines changing in the far future, including shifts to the time they would start their day. However, this was split, with some envisioning earlier and others envisioning later starts.

Earlier starts were more common in suburban and regional areas, where outdoor exercise, gardening or taking care of animals would need to happen while the day was cool and air quality was best.

Later starts were preferred by those who imagined working from home without a commute, or having a more efficient commute enabled by autonomous vehicles.

However, in one instance, this split between earlier and later starts to the day took place amongst different members of the same household, based on individual preferences. In this situation, the household peak in the far future would spread out across both ends of the day.

In Bushra and Faizan's home in Sydney's North Shore, there are two preferred daily rhythms for each of the two members: one is an early riser and one prefers to sleep in.

They thought that the flexible future of work would allow for that divergence to become more pronounced, especially on extreme weather days when people might shift their work hours to avoid exposure to extreme heat in the middle of the day.

Faizan expected that "Given we're in Sydney, in the north shore area, [change] is going to be fast-paced. I think we will probably start late and I think there will be shorter working hours."

While Bushra would prefer to get an earlier start "I'm a very, very morning person" and finish the day early so she could rest in the mid-afternoon while the temperatures would be hottest.

This flexibility extended beyond work hours to other activities like the gym, which would continue to be an important part of the daily routine for both of them "I can't live without the gym, I need the gym."

However, Bushra would prefer to change her routine trip to the gym to early in the morning, while Faizan would prefer to shift his later in the evening.

The evening peak will remain relatively constant with some activities occurring later at night due to extreme heat.

Foresight

The evening (approximately 5-9pm) will continue to be an important hub of activities happening within the home, particularly for eating, socialising (virtually or hosting), and spending time on personal devices before bedtime. Social and outdoor recreational activities are likely to occur later in the evening on extremely hot days.

Findings

Participants imagined fewer changes to their evening routines than their morning and afternoon routines.

However, some participants imagined that social activities (e.g. visiting friends or barbecues) and outdoor recreational activities might regularly happen later in the evening in the context of more frequent extremely hot days.

However, some of the least flexible practices of the far future included the activities that participants would do to relax just before bed, such as watching television, gaming, using personal devices, or reading.

Marj, a retiree living in rural Victoria, described more regularly shifting her visits with friends from the early afternoon to later in the evening, when she could host people at home outside on her deck when the temperatures would be cooler.

"And sit outside hopefully, if it's not unpleasant…I think you could still do it if it was between 7-9pm or something like that…just a couple of hours in the early evening. You'd probably want to if you were stuck at home all day. You'd want to get out and socialise."

About half of households agree that their home now has more digital devices (49%) and/or electrical appliances (37%) running at the same time than 5-10 years ago.

ECBS 2022

40% of survey respondents agree their kitchen has a larger variety of electric appliances than 5-10 years ago.

ECBS 2022

Exercising will increasingly happen at home during the day.

Foresight

Air conditioned home gyms will become increasingly important for exercising, especially to avoid extreme weather. Exercise equipment is likely to be used to generate electricity to charge small devices, especially when there is decreased availability of solar generation.

Findings

Exercise practices shifted dramatically in visions of the far future. Participants envisioned relying more on an air conditioned home gym, with equipment such as stationary bikes, rather than exercising outdoors or travelling to a communal gym.

Exercising from home was often expected to take place in the middle of the day, often paired with a general expectation of a longer lunch break from work in the middle of the day.

Some participants suggested that they would like to use their future home gym equipment to help generate electricity to charge their small devices on cloudy or smoky days with decreased solar. Any regular outdoor exercise in the future would be pushed to earlier in the morning (before breakfast), or later in the evening (after dinner). The time of day that people would go swimming shifted to help cool off during hot days.

"…I do my exercise outside during the school drop-off routine. I usually put my bike on the car, ride my bike back home and then do my work and then ride my bike to the school and then pick the kids up. But that wouldn't be viable in bad weather. So I would exercise in the day…even during COVID we…rented some exercise equipment to exercise at home."

— Linsay, Inner East Sydney

"I'm quite outdoorsy at the moment, I'm getting up quite early and cycling, but in the future ok well that exercise would probably be at home because I won't want to go outside… so, you know, get on the trainer…and do my exercise at home instead of going out."

— Peter, Northern Beaches, Sydney

37% reported doing more activities in the household (e.g. using home gym, online exercise classes) during the COVID-19 pandemic

ECBS 2021

More frequent showers will become common, but some of them will be cold in response to hot weather.

Foresight

In response to more frequent extreme weather, showering practices will shift in relation to shifts in exercise practices, working from home, and as a way to support bodily cooling and in response to extreme weather conditions.

Findings

Bathing and showering practices will shift in relation to exercise shifts and participants generally envisioned showering more often (often twice a day or more regularly) in the far future. The extra shower might be to cool off during hot days, or because participants imagined needing to bathe more often when the air had more dust or smoke or after inclement weather and extreme temperatures.

"One of the threads that I picked up on was that we all would bathe and shower a lot more. So I imagine that water consumption as a society might go up quite a bit."

— Pei, Inner East Sydney

Caring for animals and pets will shift earlier and later, with additional mid-day care or air-conditioning required.

Foresight

People will continue to prioritise the care of pets and animals within their homes and local environments. Extreme weather and hotter temperatures are likely to shift the times of day for feeding and walking to earlier in the morning or later in the evening. Air conditioned environments will become increasingly important to provide comfort and care for domesticated animals.

Findings

Like outdoor exercise, participants envisaged pet care shifting to earlier in the morning and later in the evening (e.g. walking dogs or feeding chickens) when the weather would be most mild, to help protect them from dangerous temperatures.

People talked about increasingly using air conditioning to keep pets and farm animals safe during extreme weather and that they would spend more time checking in and taking care of their pets and animals during the middle of the day in extreme heat.

"…the heat that comes with the bushfires. It's hard to regulate chickens' temperature, they need to be kept at a good temperature. If they get too overheated they just kind of like flop on the ground, so you gotta use water to spray down the yard… taking care of pets, even if you take them out in the middle of the day now—I've got a black dog and he hates the sun without any water around–so I will probably have to do that earlier [in 2050]."

— Jenna, Central Coast

Grocery and food deliveries will become increasingly common, and delivered in the late afternoon or early evening.

Foresight

People will increasingly depend on home-based deliveries for groceries and meal services, which are more likely to be delivered in the afternoon or early evening. Drones, autonomous vehicles, and electrified fleets that are resilient to environmental change and extreme weather will be increasingly responsible for delivering these services.

Findings

Grocery and food deliveries were pervasive in participants' visions of the far future. No participants envisioned going grocery shopping in the context of more frequent extreme weather; instead groceries and supplies would be delivered to the home. Sometimes they expected these deliveries to be executed by autonomous vehicles or by drone. They always imagined grocery and food deliveries arriving at their home in the late afternoon or evenings, before dinner.

Participants imagined that future services (like delivery services) would be better equipped to handle extreme weather conditions and that they could rely on food delivery services to have their fleets charged and able to provide when required.

Peter (Northern Beaches, Sydney) thinks he would stop going to the market in the far future, which he does almost daily today "I'm a single guy living very close to shops, I shop a lot in terms of I'll buy fresh and I'll buy everyday, but if I'm not wanting to go outside, well maybe I'm going to get my food delivered now…I still love cooking and I presume I'll still continue to cook , but my shopping habits might change over to a more virtualised, gig economy-sides of things."

Gabriel, a father living in suburban Victoria, imagined that his family would be able to "stock up" on essential groceries through automated delivery of essentials overnight that refill based on daily data from the family's smart refrigerator.

Bushra and Faizan, young professionals in Inner West Sydney, imagine that they would stop grocery shopping entirely, reducing how often they left home during extreme weather, and prioritising time spent in nature over running errands when the weather allowed. As part of this future, Faizan would want a daily food delivery, usually "in the evening, just before we're watching a movie."

37% say that over the last 5-10 years, the oven is used less than previously.

ECBS 2022

In 2021, 20% reported having more prepared food delivered to the home (e.g. UberEats, delivered pizza or burgers) since the COVID-19 pandemic. In 2022 this trend eased, as more households reported reduced meal deliveries to the home (30)% than increased meal deliveries (14%) in the 12 months preceding July-August 2022.

ECBS 2021, 2022

In 2021, 59% said their household cooked at home more often since the COVID-19 pandemic. (ECBS 2021). This trend is likely to persist as, in 2022, 36% reported more cooking at home over the past 12 months, while only 11% reported less cooking at home

(ECBS 2022).

21% have three or more fridges/ freezers and 20% expect their fridge/ freezer space to increase in the next 5-10 years.

ECBS 2022

People will ‘check in’ with energy data to take advantage of solar energy availability for daily tasks.

Foresight

Automation will need to be balanced with people’s desires to maintain control over manual tasks, and to take advantage of available solar energy generation. Energy data will provide an important ‘check in’ to support these priorities.

Findings

In the future, people envisioned checking their energy metres, portals, apps or inverters more often throughout the day, to match activities and electric appliance use with available solar generation. For instance, they imagined checking their home battery storage levels in the mid-morning to manage whether they would save or make use of excess solar energy that day. The desire to balance available localised generation with household activities meant that people were less likely to see themselves handing over full control to automated appliances and devices.

In the far future, Jenna from the Central Coast, New South Wales would do “laundry early in the day” before it got too hot, “but while there was still enough solar energy to power the laundry devices and make maximum use of it.”

41% are aware of having a smart meter at home, and 18% of households use a smart meter to control their energy costs.

ECBS 2022

15% have smart control devices (such as programmable lights, smart plugs, or switches) in their homes, and just under half of these households use these smart devices to control energy costs.

ECBS 2022

“Despite the fact that I live in an apartment, I’d like to think that we’ve sorted things out and, you know, it might be like a community-based solar on the roof with individual batteries or something like that so, I’m checking the meters more…to see what my energy budget is for the day”.

— Peter, Northern Beaches, Sydney

Laundering will remain a manual activity increasingly carried out during the day when solar power is available.

Foresight

Laundry and other household tasks will be increasingly synchronised with available solar power when available. Laundry will remain a manual practice, even if other household tasks are automated.

Findings

While working from home more regularly, most participants envisioned doing laundry, vacuuming, or cooking lunch at times when solar power is available from late morning to mid-afternoon. For every participant who included laundry in their future routine, this activity always happened during the day, even if they envisioned automating other housekeeping tasks (e.g. vacuuming or watering plants overnight).

While participants varied in the number of domestic tasks they thought would be automated, laundry was the only housework task that was never discussed as an automated activity in participants' visions of the far future.

However, many expressed that they would wait for solar energy to be available before starting the washing machine. Most participants who hang dried their laundry today thought they would be more likely to use a dryer in the far future.

More people (34%) currently use dishwashers, washing machines and clothes dryers during the day (9am to 3pm) than at any other period.

ECBS 2022

The main reasons preventing households from being able to do tasks at a time where there is less demand for energy (e.g. the middle of the day or overnight) are "I need to do these tasks when it's convenient for me" (43%), "Not at home at those times" (28%), and "It's hard to plan when I need use these appliances" (25%).

ECBS 2022

"You know, you still gotta do your laundry. Previously, I'd hang it outside, [in the future] I wouldn't want to hang it outside because it's smoky…the conditions aren't good for it."

— Peter, Northern Beaches, Sydney

People will mostly charge their devices overnight or during the day during the solar peak.

Foresight

People will continue to oversee the charging of more devices and EVs, in conjunction with different levels of automation or manual operation. Charging is more likely to occur in the evening (overnight) or during the day when solar generation is available and when working from home.

Findings

Most participants envisioned charging their devices or electric vehicles (if they thought they would have one) overnight in the future. While not always specified, some were also interested in automated overnight charging. Less frequently, some participants also imagined changing the time they charged devices and vehicles so that they could take advantage of the solar peak while at home.

Young and family households in particular (17%) have set up 'charging stations' for their electronic devices and power tools. This practice is less than half as prevalent in older and retired households (6%).

ECBS 2022

11% try to charge their devices when solar electricity is available and 30% charge when 'off-peak' electricity times.

ECBS 2022

"If I have an electric vehicle, I'd charge that in the middle of the day when solar's at the highest. Previously, I was charging my devices at night because that was convenient."

— Peter, Northern Beaches, Sydney

Digital technologies and new services will continue to prioritise pleasure, convenience, and experience over energy savings.

Foresight

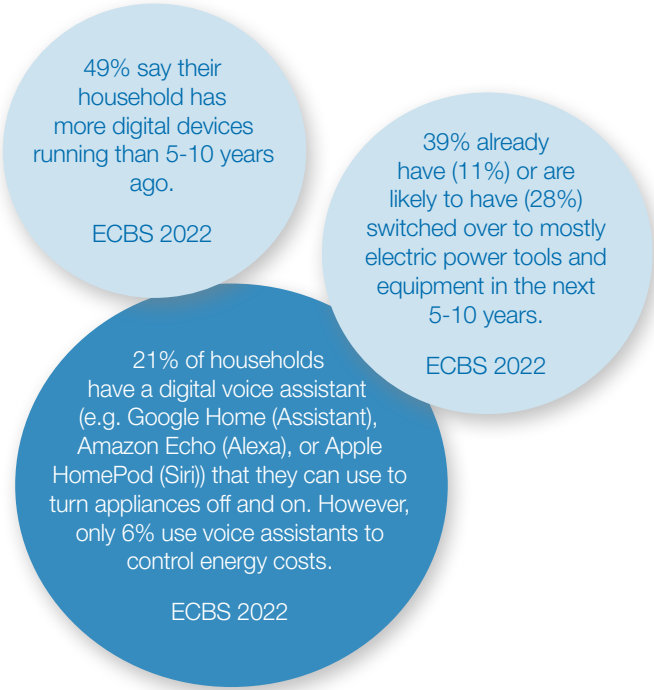
Alongside innovations in efficiency and sustainability in the future, households will also incorporate new technologies and services that they think will enhance their quality of life.

Findings

In their visions of the far future, participants included ideas about various new technologies and the touchpoints with services that they would want to use as part of their everyday life (e.g. a robotic assistant, or an adaptive alarm clock linked to weather data; a drone delivery or retrieval service).

Although not always specified, most of these would have energy requirements, and likely run on electric power or rechargeable batteries.

Less often, the speculative technologies of their everyday life were explicitly linked to energy savings.



"I think we're going to have drones come into play as well."

— Faizan, Sydney North Shore

"… probably someone will develop an app that has an adaptive alarm…you could hook it up to an information service thing: don't wake me up if there's a storm."

— Gabriel, Cranbourne/Clyde

FAR FUTURE ROUTINES

UNCERTAINTIES AND CONTINGENCIES

- Climate science is never exact. Social science research will need to be continued in ongoing dialogue with interdisciplinary modes of accounting for a range of extreme weather including extreme heat fluctuations and technology advancement in order to understand the moving implications of and possibilities for load shifting.
- As we move forward into an era of possible greater extreme weather events, energy social scientists will need to account for how the anticipation and management of events such as bushfires, flooding, asthma thunderstorms, and pandemics, plays out and the implications for people's routines and associated energy demand. This would involve considering the nexus between institutions (schools, places of work, government, public health and social services) and everyday life.

IMPLICATIONS FOR FORECASTING

- The changing timing and location of energy demand will remain critical ongoing issues for energy foresighting and forecasting. The load profile of typical 'mornings' and 'evenings' are likely to look considerably different in the far future than they do today. Similarly, new clusters of activity are likely to form with energy demand implications. Energy social scientists and industry forecasters will need to remain engaged with people's changing routines and lifestyles, and to look forward rather than back when proposing new scenarios of future living and energy demand.
- Forecasting that accounts for the far future will need to increasingly engage with changing institutional expectations and norms, emerging lifestyle and consumer technologies, services, and platforms, and household adaptations and innovations in response to macro-trends such as climate change.
- Forecasting methodologies and models will increasingly need to allow for greater flexibility in terms of incremental changes over the year, and crisis moments of rapid change.

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