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Digital Energy Futures:

Forecasting residential electricity demand

Professor Yolande Strengers
Dr. Kari Dahlgren

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Digital Energy Futures

4-year Australian Research Council Linkage project

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

Partner organisations

- **Ausgrid**
- **AusNet Services**
- **Energy Consumers Australia**





How will people live in the future?

...with digital and energy technologies

...what will that mean for energy forecasting and future demand?

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The energy smart home

- Efficiency
- Automation (including direct load control)
- Feedback/ Portals/ Data
- Micro-grids
- Solar PV and battery storage
- Smart meters
- Electric vehicle integration
- Variable price signals for electricity
- More flexibility and differentiation

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The lifestyle smart home

- Convenience
- Comfort
- Care
- Security
- Entertainment
- Aesthetics/ mood enhancers
- **Energy automation and distributed generation**
- Monitoring (of energy, people, pets)

Ratcheting expectations (and demand)

- ***‘“Savings” … so often turn out to be steps taken down an upward-moving escalator***’ (Sarah Darby, 2008: 502).

- ‘***SHTs*** *(smart home technologies)* ***may lead to more rather than less energy use, such as by creating new forms of energy demand, e.g. through pre-warming rooms, by normaliziing or even raising energy-intensive expectations***’ (Tom Hargreaves & Charlie Wilson, 2017: 10).

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Project stages

1. Analysis of industry visions, trends and scenarios
2. 45 trends identified from 72 households (ethnography)
3. Annual ECA Energy Consumer Behaviour Survey (ECBS) to quantify trends
4. Demand management innovation opportunities
5. Scenario exploration workshops with households
6. Integration with forecasting methodologies/ new methodologies

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Future Home Life

How do people think their own futures are unfolding, and how are their lives changing with digital and energy technologies?

Research with:

➔72 households
➔45 trends

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EVERYDAY PRACTICE DOMAINS

CHARGING & MOBILITY

electric vehicles; car and ridesharing; automated vehicles; public transport; battery charging; device charging stations battery operated gardening equipment

COOKING & EATING

multiplication of cooking devices and small appliances; food storage; refrigerators and freezers; smart kettles, coffeemakers and other appliances; meal delivery services

HEALTHY INDOOR AIR & THERMAL COMFORT

digital and connected heating, ventilation and air conditioning systems; changing expectations of heating and cooling; air purification, dehumidifiers, and diffusers.

LIVING & PLAY

multiplying or converging devices; livestreaming; home cinemas; video games; virtual and augmented reality; voice assistants and smart home technologies.

WORKING & STUDYING AT HOME

home-based work and study, home-based businesses and digital collaboration, flexible employment and schedules

CARING FOR THE HOME & ITS OCCUPANTS

home-based childcare and care of older people; changing trends in assisted living; care for pets; care for home and security systems

SAVING, SHIFTING, & STORING ENERGY

solar photovoltaics, smart meters, smart plugs and smart appliances, battery storage and automation, energy trading and sharing

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Shocks and changing home life

- **Bushfires** and smoke
- **Storms** involving flooding and power outages
- **Heatwaves** and very hot days
- **Financial** - sudden unemployment, rapidly rising house prices, recessions
- **COVID-19** pandemic
- **Technologies** - rapid rise of solar PV, AI, automation
- **Economic** - platform and gig economies

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Expecting the home to do more

- Workplace, School, University, Cinema/Gaming space, Construction site, Gym, Hotel, Restaurant...
- Multiple people's (and intergenerational) needs

→ Expansion of 'living space'

→ Bedrooms, attics, garages, sheds, pool cabanas, granny flats, outdoor kitchens, outdoor living rooms, AirBnB…

→ More spaces used, more of the time

→ More heating, more cooling, more devices

Air

Industry visions of household comfort involve heating and cooling, but we found new emphasis on **healthy and clean air**

- **Humidifiers and dehumidifiers**
  - Health reasons
  - Mold concerns (particularly in rentals)

- **Air purification**
  - 1 in 10 households already
  - Multiple reasons for adoptions

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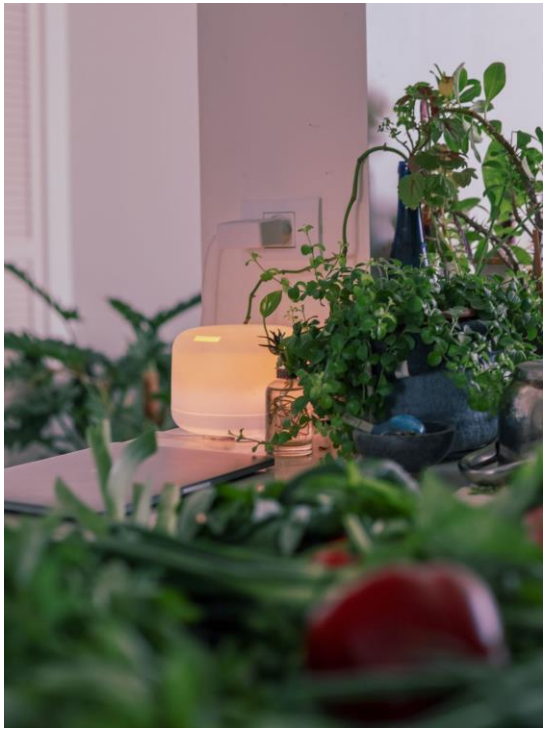

Air

Industry visions assume new smart tech will better manage energy, but air purification shows:

- **‘Smart’ features** not matched to energy pricing signals but air quality measurements
- Potentially a **new ‘necessity’**
- **Multiplication** of devices
- **Filters** installed within existing AC systems could **change usage patterns** and replace evaporative cooling

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Care

Industry visions pay insufficient attention to how shocks can **change seemingly stable practices.**

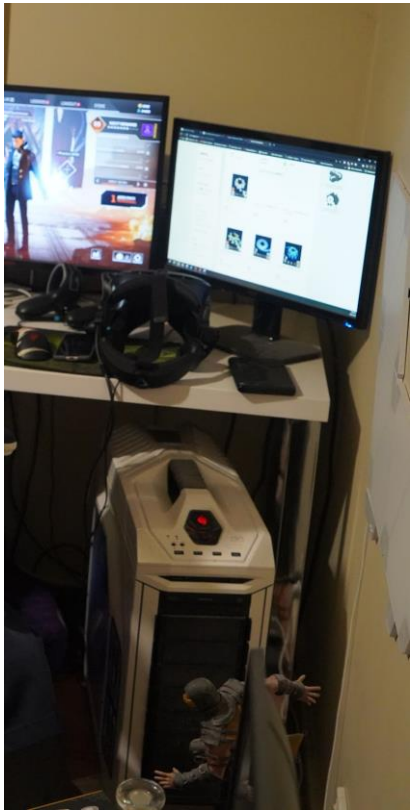
Proliferation of digital devices for care (demographics and shocks of COVID-19)

- Adults
  - Home-based healthcare and ageing
  - Multiple devices and continual operation (including critical medical devices)
- Pets
  - Increasing numbers
  - Heating, cooling, and other devices
- COVID-19 hygiene concerns
  - Hot water needs (showering, laundry)

Play

Industry visions assume that the energy demand of entertainment and digital devices is **small** but there are often **auxiliary devices**

- Multiplication of devices:
    - Often used in separate spaces, with heating and cooling needs
    - Auxiliary devices with unconsidered energy use



Behaviour Survey

October 2021

STAGE THREE:

Energy Consumers Behaviour Survey (ECBS)

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TRACKING THE TRENDS: NEW AIR TECH

24% of respondents said it is likely that **‘their home will use more cooling’** in the next 10 years.

11% of households already have air purifier or dehumidifier in the home.

BUSTING THE MYTHS
DIGITAL DEVICES AND AUTOMATION

47% prefer to minimise or avoid digital devices (such as digital voice assistants) and automation in their home

Only 7% want smart appliances to be fully automated, 42% want to set smart appliance timings themselves for complete control, 51% happy for smart appliances to be automation with override option.

STAGE FOUR:

Demand Management Innovation

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DIGITAL ENERGY FUTURES

DEMAND MANAGEMENT OPPORTUNITIES
DEC 2021

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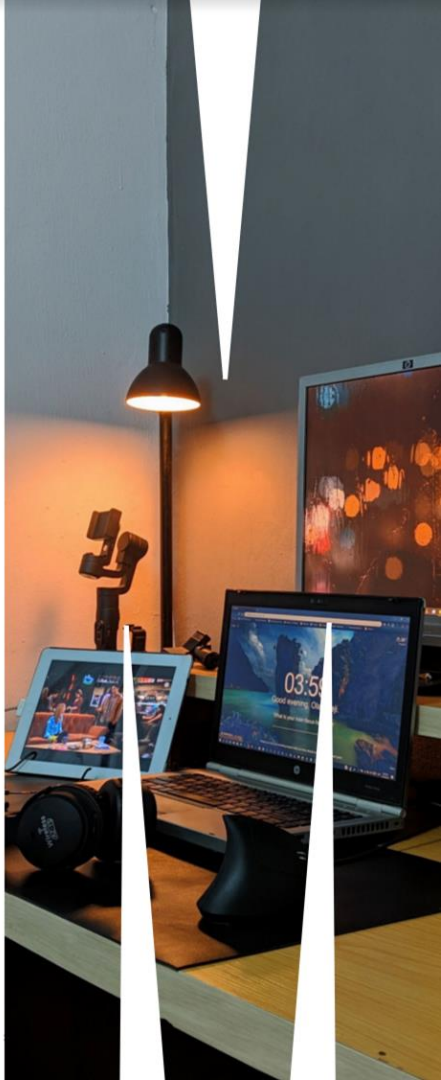


IDENTIFYING THE OPPORTUNITIES

Demand management approaches that:

- complement or extend beyond financial incentives
- involve some household participation
- are currently overlooked or underutilised in Australia

>> Six foundations of demand management

>> Fifteen tailored approaches

HEALTHY AIR IN THE HOME

- Summer peak demand initiatives should:
  - Engage with household concerns about healthy air in the home
  - Adapt advice and appeals to new ventilation practices and health needs to stay at home, especially people with underlying health conditions.

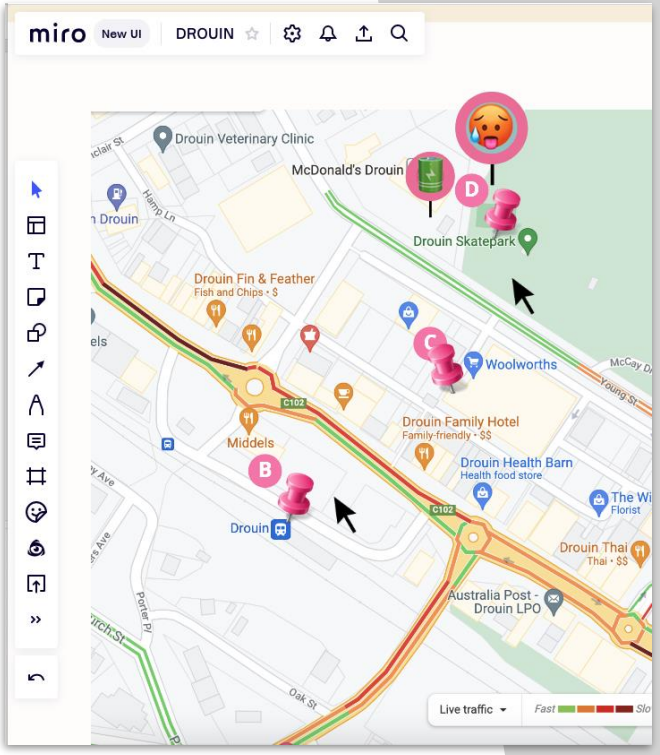
- Investigate ways to improve energy outcomes from the emerging practice of air purification + AC.

STAGE FIVE:

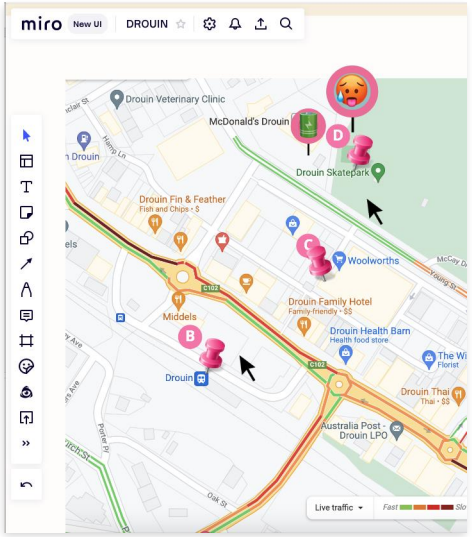
Design Ethnography Workshops

What could everyday life in the future be like?

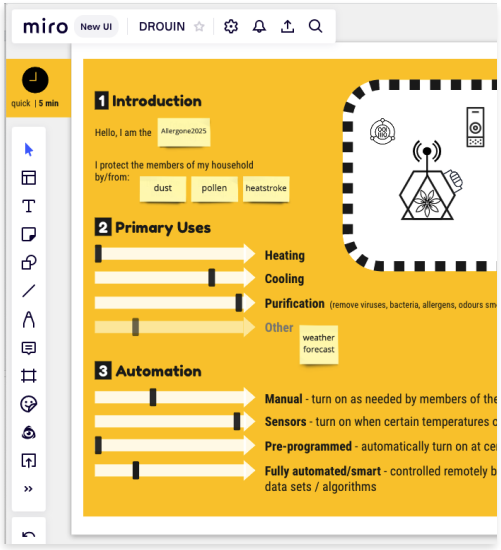
1. Using **electric vehicles**
2. Managing safe, comfortable, healthy **air** in the home
3. Shifting everyday **future routines** (peak demand impact)



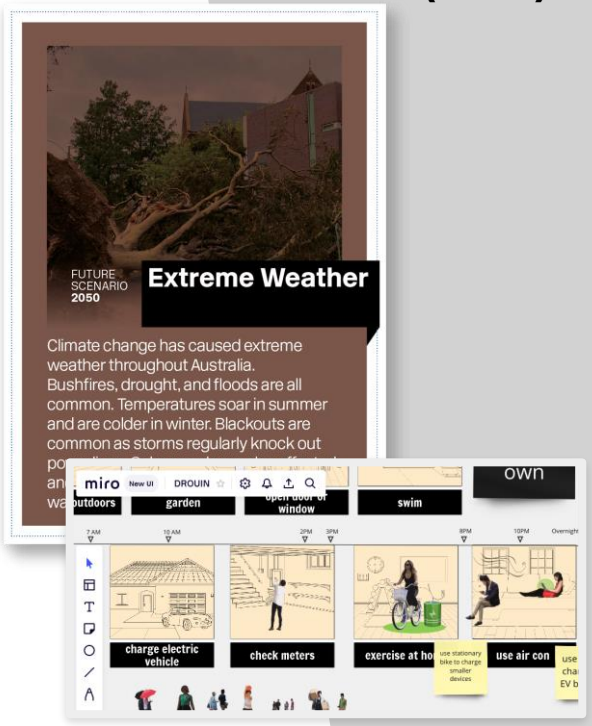
1. Electric Vehicles



2. Future Air Tech



3. Future Routines (2050)

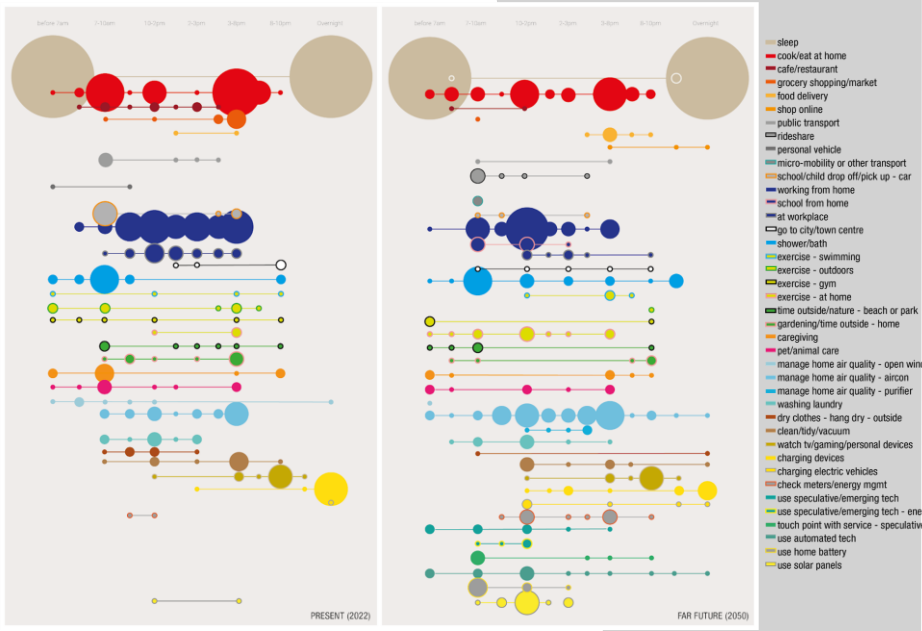


Far Future Foresights

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

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

Future Routines: The morning peak will be spread across a longer period of time &
The evening peak will remain relatively constant with some activities occurring later at night due to extreme heat



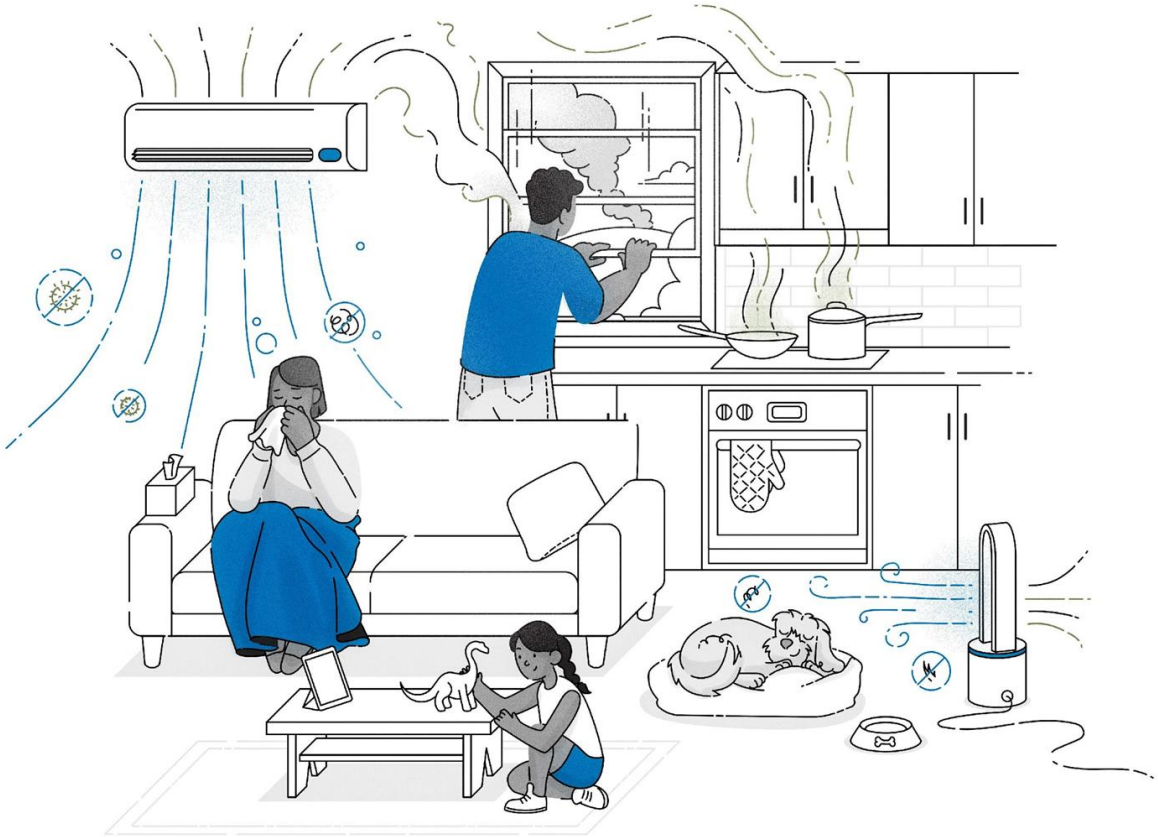
STAGE SIX:

Forecasting Methodology and Scenarios

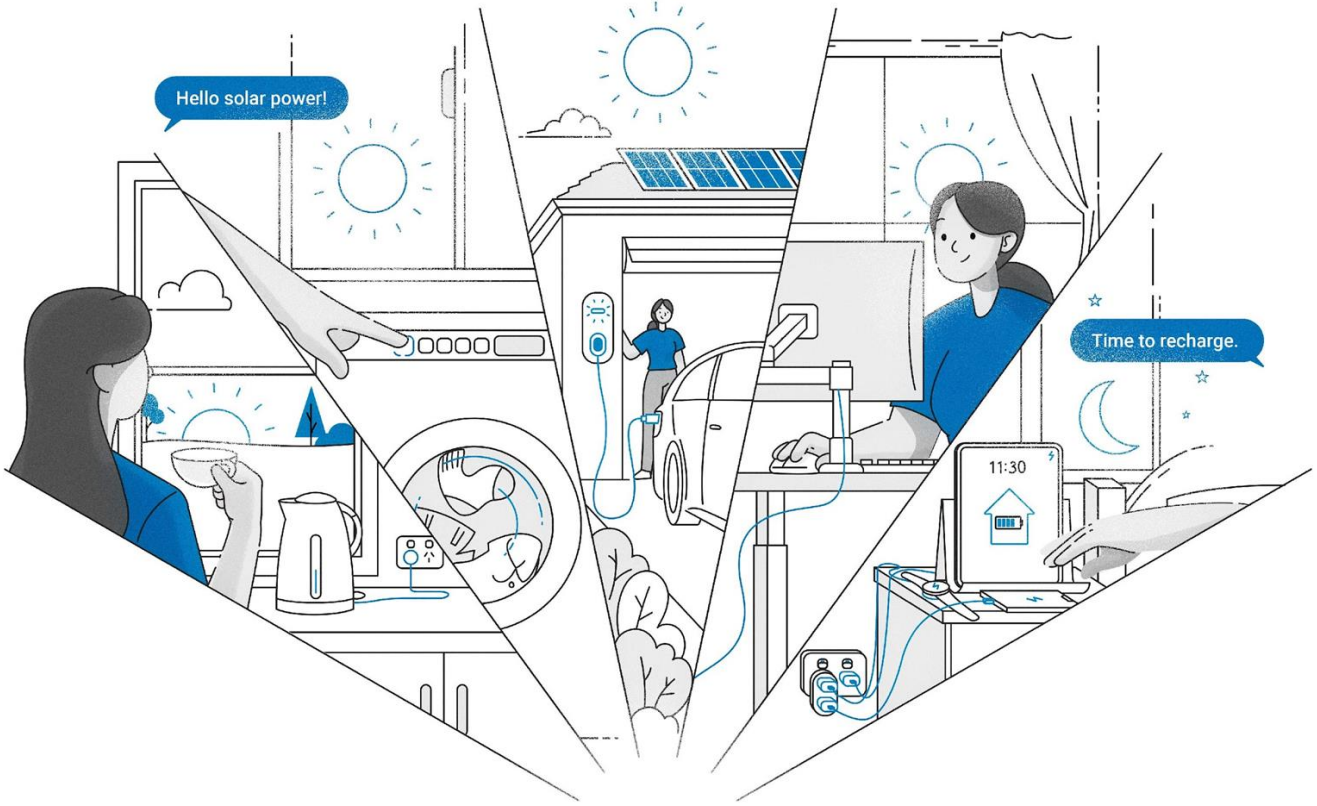
FORESIGHTING CONCEPTS

from *consuming*	⋯⋯▸	to ***comfort, care and safety***
from *prosuming*	⋯⋯▸	to ***participating***
from *calculating and rational*	⋯▸	to ***generous and resourceful***
from *set and forget*	⋯⋯▸	to ***set and notify***
from *off the grid*	⋯⋯▸	to ***with the grid***

from *consuming* ·····▸ to ***comfort, care and safety***



from *prosuming* ⋯⋯▸ to ***participating***



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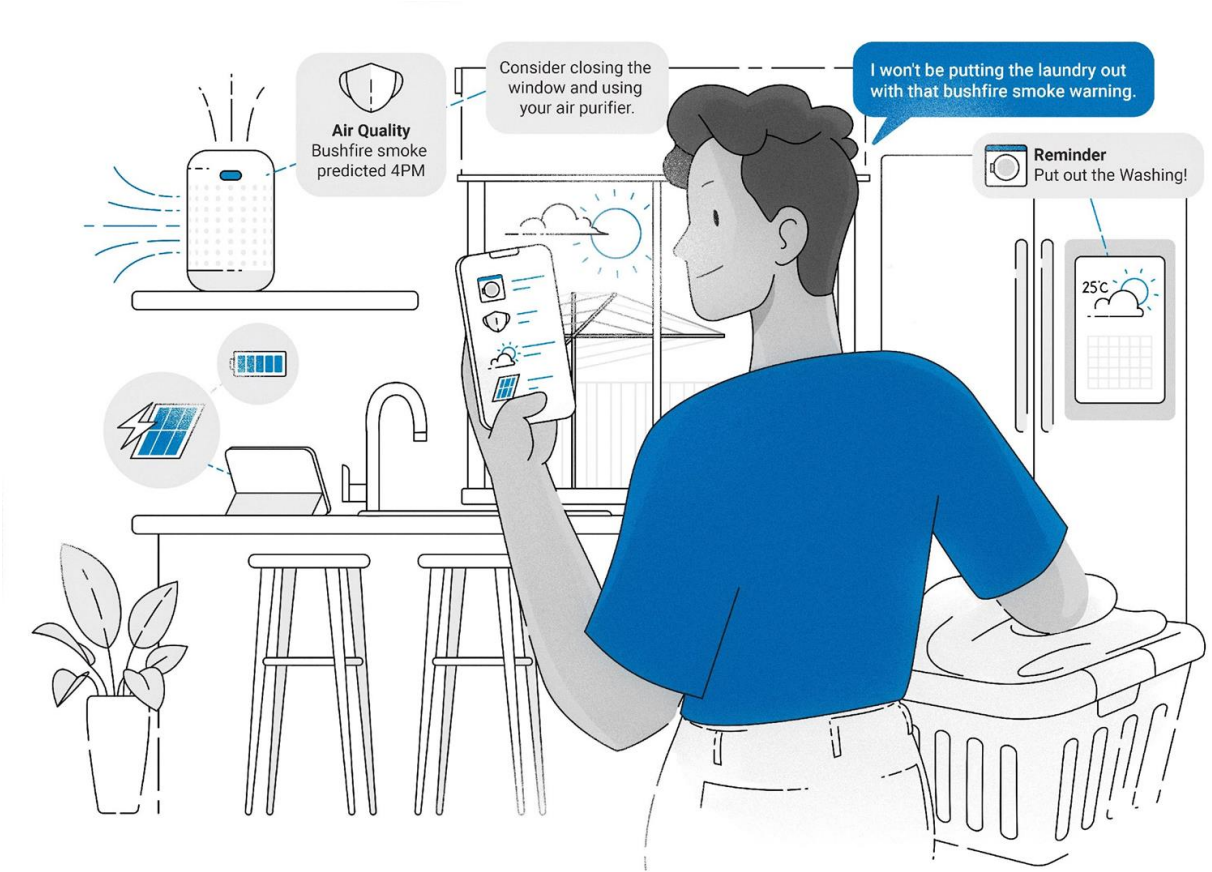
from *set and forget* ⋯⋯▸ to ***set and notify***



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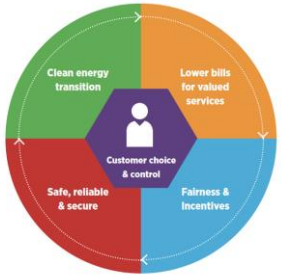
WHAT'S MISSING FROM INDUSTRY SCENARIOS?

- Most scenarios led with technology or macro-trends as key drivers of change
- Modelling did not integrate consumer drivers beyond historical demand or appliance uptake trends
- Most future energy scenarios made generalised assumptions about how consumers may behave differently in rela to macro trends (e.g. no data)
- Very little/ no engagement with lifestyle changes (e.g. working from home)



Customer-centric model
where customers consume, trade, generate and store electricity.

Prosumer power

Consumer choices and technology advancement drive a very high penetration of well-coordinated distributed energy resources into the energy system

- Extremely high uptake of rooftop solar, behind-the-meter storage and electric vehicles (many equipped with Vehicle-to-Grid capabilities)
- Artificial intelligence and automation enable the coordination of consumer devices to respond to local system and market conditions
- A net zero emissions economy is achieved by 2050

Consumer-led
with a focus on energy efficiency, DER, digital energy and step increases in global policy ambition

SCENARIOS FOR FUTURE LIVING

- **In progress…**
- **Our approach:** using foresights about people from data generated with people to develop plausible visions about how they will live in the future

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Thank you

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A partnership between:

MONASH University | Ausgrid | AusNet services | ENERGY CONSUMERS AUSTRALIA

DIGITAL ENERGY FUTURES: PROJECT MATERIALS AND DATA

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64 energy and technology reports analysed

483 recruitment survey responses

72 household ethnographies

VIA

146 (virtual) visits and home tours

14 forecasting-related industry reports reviewed

4661 national survey responses over **two years**

(via Energy Consumer Behaviour Survey)

10 Design Ethnography workshops

WITH

42 householders

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Consumer groups

Category	Total Households	Definition	Icon/Code
Early adopters - energy tech	11	Home has battery storage and/or an electric vehicle	
Early adopters - digital tech	24	Has four or more smart technologies in the home (excluding music/speakers or smart TVs), or has very novel smart technology (e.g. a robot or virtual reality), or uses a lot of automation/control, including via a digital voice assistant	
New estate homes	16	Capital city housing development on the urban fringe, home 10 or less years old (apartments and regional housing estates)	
Apartment renters	14	Living in a rented apartment (at the time of survey completion)	
High demand homes	13	Electricity bills >$600 per quarter (survey response) and or load profile data has high demand peaks (typically over 8kW in a 30-minute interval)	
Sea- or Tree-changers	10	Moved from a capital/major city to a coastal or regional/country area in the past 10 years	
Regional agricultural area	15	Includes rural and farm locations and residents of smaller regional towns (e.g. Drouin and Moe in Victoria; Singleton and Tumbi Umbi in NSW)	

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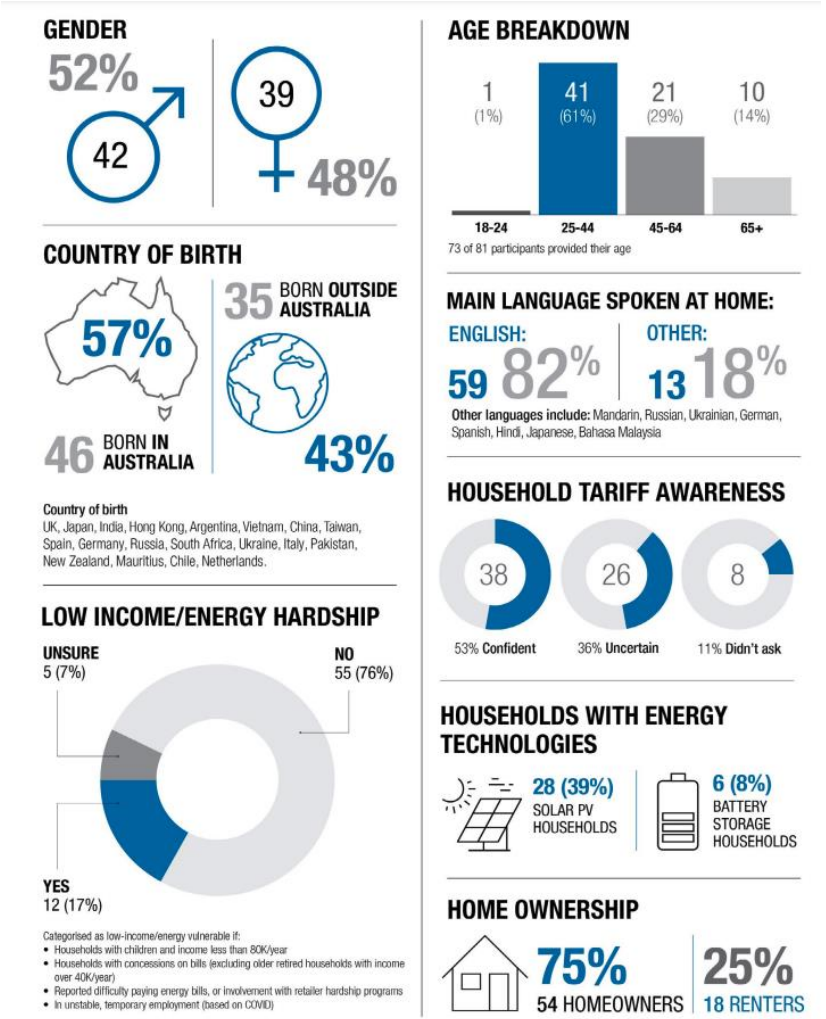
About the participants



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WORKSHOP PARTICIPANT COMPOSITION

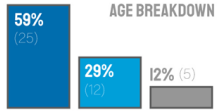
42 participants

GENDER

50% ♀

50% ♂

AGE BREAKDOWN



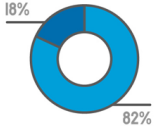
69%

29 born outside Australia

in Malaysia, Pakistan, China, India, Germany, UK, Chile, Argentina, Russia, Mauritius, Italy, Netherlands, South Africa

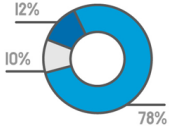
31%

13 born in Australia



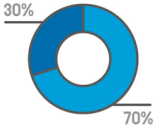
MAIN LANGUAGE SPOKEN AT HOME

- 33 spoke English
- 7 spoke Chinese, Mandarin, Spanish, Russian, or German



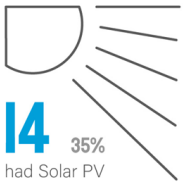
LOW INCOME OR ENERGY HARDSHIP

- 5 experienced hardship
- 33 had not
- 4 were unsure



HOME OWNERSHIP

- 28 owned their own home
- 12 were renting



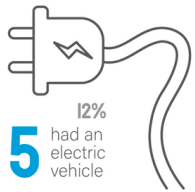
14 35%

had Solar PV

5

had Battery Storage

12%



12%

5 had an electric vehicle

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Digital ethnography process

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