



Technical Appendices: Deliberative engagement on the role of future fuels

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Project title: Deliberative engagement on the role of future fuels in a low-carbon future energy mix in Australia

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Project Information

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Research Program	RP2
Milestone Report Number	2.3
Description	This report provides the findings of two deliberative processes conducted across Western Australia and with a group of national young persons from across Australia. It shows the panels were effective in informing the public on the topic of future fuels and participants found the process valuable
Research Provider	University of Queensland
Project Leader and Team	Professor Peta Ashworth Dr Kathy Witt Dr Anna (Anya) Phelan Dr Amrita Kambo Mr Bishal Bharadwaj Mrs Andrea Arratia-Solar
Industry Proponent and Advisor Team	Brent Davis - Jemena Stephanie Judd/ Kristen Pellew/ Kristin Raman - AGIG Jordan McCollum - APGA Michael Malavazos/ Lynette Day - SA Gov Briony O'Shea – GPA Nives Matosin - APA Peter Shaw – ATCO Ashley Kellet – AshleyK Consulting Ross Jamieson – Sitgas/GAMAA
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1. Appendix: Questions via Deliberations

Table 1. Climate change

Theme	Questions from participants
Net-zero emissions and climate change	Is it (even) possible to achieve net-zero emissions?
	What evidence is there that humans are causing climate change?
	Is there a predicted 'point of no return'? Is there a point of no return? A tipping point where we can say it's too late to act?
	Is the economy more important than climate change?
	Does this mean it is getting hotter with less rain?
	Has increased freshwater (as a result of increased Arctic and Antarctic melting and subsequent Ocean flows) been factored in? I noticed a minimal impact on the Californian coast.
What role can Australian's play?	How much of a responsibility does Australia have to solve this global issue?
	What can we do now that is small and simple? What can I do personally today or tomorrow to help? Will individual contributions make a difference? What can we all do then? As everyday citizens, what are some real changes we can make in our active/everyday lives to limit our personal impacts on the climate? What can we, as individuals, do to affect the blue line and positively impact climate change?
	What can we do as individuals, governments, and big corporations?
What can we do as individuals, governments, and big corporations?	Who owns our energy companies?
	How much energy went into exports?

Table 2. Biogas

Theme	Questions from participants
Understanding biogas and how it is made	Could food waste gasses be used?
	Harvest Gamba Grass and make biogas. 3 birds with 1 stone - New energy source, weed management, reductions to CO2 emissions. Could be a worthy research project
	Can existing sewer systems be used to produce Biomethane?
	[Biogas from] human waste?
	I heard that cows contribute the vast majority of methane to our environment. Would we have another apparatus to siphon or collect this from them? I wonder if this were implemented; would that reduce the uptake by communities concerned about animals?
	Biomethane production requires energy, is this efficient?
Biogas vs waste-to-energy plants	If the methane is already being produced we may as well use it. Is the waste to energy plant in WA biomethane then? Is this what it is?
	Can we harvest methane - another highly volatile gas - in the same way the previous Professor mentioned harvesting hydrogen - it looks like the same cost & learning curve...
	Difficult to harness CH4 compared to H2
	How feasible would it be just to build plants on top of existing landfill locations?
	Is the Waste to Energy Power Plant uses biomethane?
Biogas at home or in the neighbourhood	Does it solve the waste problem though or just change it to another problem?
	Could this system be localised to each district in a cost-effective way and dealt with locally?
	Has there been some study into the idea of single-household systems? As in, how much of the average household power requirements can be met by the average household waste production?
	Is it a feasible option that in the future individual houses could have their own small biogas collection system in place to power their property?
	Could bio-methane be collected from residential septic systems to power a household?
Might this be a good local source of energy in long term emergency events if other systems go down?	

Theme	Questions from participants
	How will they collect food and animal waste? If people do not want to do that. Will that affect the levels. Can we incentivise households for roadside pickup? (e.g. via financial reimbursement) How will they collect food and animal waste? If people do not want to do that. Will that affect the levels.
Biogas costs and affordability	How cost-effective would biogas be? Would it be more cost-effective? Methane is quite costly, so how affordable?
Biogas and amenity	Does biogas smell?
Australian policy on bioenergy	Why don't we hear about this energy? It's all about solar and wind but we don't hear about this? It solves the waste problem as well, so could be a good thing. Biogas sounds really exciting, how soon would it be able to be rolled out and what are some of the challenges that are being faced in a nation-wide rollout? What policy has been [enacted] to promote this initiative? How does the overlap between the current and new energy system looks like?
Biogas and emissions	How much CO2 does it actually emit? Precisely how much CO2 will be released in producing Biomethane? But biogas still produces CO2 when burnt, isn't that what we are trying to get rid of? Why can't we just get rid of CO2 from methane? How much CO2 is emitted in the process of creating biogas? How worthwhile is it to invest considering trade-offs? Carbon emissions?
Using biogas and biomethane	You could use Biomethane to produce Hydrogen? Does pure Biomethane have special use cases? How can we infuse more than 10% H2 into biomethane? Can we combine hydrogen and biogas? Can biomethane mix with hydrogen? As consumers, are we going to need to decide which type of future fuel we use in our household etc, or would it depend on what is available in our local area? What action can an individual or special interest groups do to accelerate the transition of future fuels to society?

Table 3. Hydrogen

Theme	Questions from participants
Hydrogen and safety	In a hydrogen car is there an increased risk of explosion during an accident compared to a petrol car?
	User experience will be similar...volatility risk is xx% greater?
	What is the risk for accident for H2 vehicles compared with current? Would it provide a steadier price?
	How safe is hydrogen in a vehicle?
	How safe are the hydrogen tanks in vehicles?
	Hydrogen cars - what happens in an accident? Are they any more dangerous than current vehicles?
	Have they done due diligence on safety? thinking of Hindenburg, etc. Will they be safe?
	Canada has used Propane for years...hydrogen is simply far more volatile - fuel tanks would need to be 5 times thicker...
	In terms of hydrogen fires will fire fighters need to be trained in dealing with that differently and does that open new opportunities for employment?
	Is hydrogen better option than nuclear?
Cost and the benefits over nuclear for hydrogen	
Why isn't Australia looking at Nuclear anytime soon?	
Fuel cells, passenger vehicles and	Will solar-hydrogen storage system on a vehicle able to be used for outdoor recreation activities and still have enough fuel for commuting? H2 car range... Kg's of H2 per KM for H2 vehicles?

Theme	Questions from participants
public transport	How does the weight of the hydrogen tanks compare to petrol/diesel?
	Is it only Toyota making hydrogen cars? Is Hyundai? Is a Korean company looking at this as well? (the context is assumed to be around Hydrogen vehicles)
	Will hydrogen fuelled devices be designed only for hydrogen combustion and cannot be used with other form of fuel?
	Are there going to be hybrid hydrogen cars?
	How will it compare to electric vehicle cost?
	Is hydrogen intended to replace other alternative fuel uses, such as electric vehicles?
	If the only emission made from a hydrogen fuel cell is water, then why are battery powered vehicles winning the 'arms race' (as it were) towards the next phase of vehicular transport?
	Would like to know how fuel cells work and how it converts to energy?
	Can you retrofit existing cars to become hydrogen? Such as with cars using LPG?
	Perth Hydrogen Bus Trial results?
Emissions and environmental impacts	Interesting question about hydrogen fuel cells in bus trial in WA?
	Are there still CO2 emissions from producing hydrogen?
	Do different types of hydrogen have different levels of "green"?
	CCS Hydrogen - What is done with the Emissions and what are the risks?
	With carbon dioxide storage would it be bad for the ground it goes into? Is it sacrificing the ground for the atmosphere?
Infrastructure, timeframes and costs	Are there any predicted future detractors with using hydrogen as a fuel source? Currently it looks as though there are only positive outcomes - which I'm sure could have been the case in the early days of burning fossil fuels as an energy source?
	Does Australia have enough water to support green hydrogen?
	[Hydrogen] Fuel source for private cars? Will they use current infrastructure?
	What will be the timeframe for [battery] electric cars to be accessible to the consumer?
	How fast can we build these refuelling plants vs. how fast will they be built?
	How does it translate to rural and remote? Who is helping?
	What are the plans for transitioning to hydrogen? How will it happen?
	What sort of timeframes is expected before it can be readily available like petrol/diesel?
	10% injection into gas pipelines changed up and so would the appliances. Is that a new unit? Do people have to change heaters?
	Is hydrogen a fuel source that will eventually be depleted from use?
	How does it work if we have to use energy to get [hydrogen] energy - do we make enough to make it worthwhile?
	It requires energy to create hydrogen...and that creates CO2...what is the recovered % ... is it that viable? Or are there other alternatives that are close?
	Process in reducing the cost - how soon it might happen. How would they reduce cost to make it more consumer friendly?
	What are the cost of going hydrogen? Are the costs higher or lower with Hydrogen?
	How much does it cost to make hydrogen renewable energy?
	What is the timeframe on getting it to a price where it is a competitive option? The graph seems to go on forever...
	Where does the cost come from for H2 production?
	Seems lengthy process, how much longer until it is developed?
	Timeframe for development?
	How much fossil fuel or fossil fuel energy needed to produce hydrogen? Does it balance out? Is it worth it?
What are the different processes of producing hydrogen?	
What will be the primary hydrogen production method in the future?	
How can hydrogen be used in different applications?	
Will there be domestic benefits or all export?	

Theme	Questions from participants
	Are we going to be able to use it and benefit from it here or is it all geared for export?
	What are hydrogen applications and barriers other than cost?
	Will we need special infrastructure to be able to use it? Will there be big infrastructure required to produce/store/export/use it?
	How affordable for most residents based on average salary? (The assumed context is for hydrogen in the household)
Storage	Storage? How is H2 stored?
	Thinking about underground storage of H2 - how much will there be?
	What are the storage efficiency of Tesla home electric battery compare to 'Hydrogen' home battery?
	\$2 per kg how does this relate to energy i.e. kJs etc.
	Hydrogen's large weight and volume seem to be an issue. Wonder what the solutions to this may be?
Export and economy	How does exporting hydrogen work?
	How Australia compared in technology implementation to other countries?
	With the million\$ fund provided, why are the jobs produced just 8000?

Table 4. Future scenarios

Theme	Questions from participants
Future fuels and energy sources	Future Fuels - is there something comparable to the hydrogen/gas option? - seems to be the only real option presented in the past 3 weeks. - why aren't other options being presented. (Pumped hydro - Molten Solar - Nuclear etc.) The presentation seems very biased towards Hydrogen/Gas
	What is a good way to communicate information to people about the efficiencies of different energy sources?
	Our group is interested in the proportion of different energy use between WA & VIC?
	Is the most easily achievable goal to just fully electrify all energies or is electricity alone going to be inadequate to power our society?
Energy poverty and thermal comfort	Is skin temperature not the defining factor for health and comfort - not air temp?
	Energy poverty - if it's too cold, wear a blanket. If it's too hot, what do you do?
	Does the building code need to be changed for different environments (tropical/arid)?
Energy rebates and concessions	Should there be greater energy concessions for Northern Australia? - Darwin for Instance, more often than not has temperatures well above 25 degrees.
	What about no interest loans to the energy poor to upgrade their home?
Role of government	Where is the leadership at Federal level to support this well-grounded knowledge base we have and head us as a nation in the right direction?
	How much of this do we entrust to our governments?
	What is the resistance to change? Media, and business influence (+ government) was raised.
	Loved the comment about Mayoral leadership and those areas that decide they are going to do it well, versus those that hang their heads moaning. Gives me hope that action will result in good outcomes. What will it take to get our leaders at all levels into that first group? (A little bit rhetorical but not entirely!)
	Loved the comment about Mayoral leadership and those areas that decide they are going to do it well, versus those that hang their heads moaning. Gives me hope that action will result in good outcomes. What will it take to get our leaders at all levels into that first group? (A little bit rhetorical but not entirely!)
	Why isn't anyone considering NT in their studies?
	Will plans going forward be at federal / state level or down to consumer choice / discretion?
	What is the current government policy or reaction to the financial stress that transitioning to cleaner energy will have on the population? It seems that the government is always emphasising what individuals need to do/pay for rather than what industry need to do.
	What is a federal government in the world that is a great example of implementing FF correctly?
	Government is committed to a decarbonisation of the gas sector.....what about other sectors?
	Seeing the urgency and greater understanding of the need for change, technology being a key - will the changes be supported by the government?

Theme	Questions from participants
Appliances	Could the sale of new Gas appliances be banned/limited to assist with this transition?
	It would be interesting to see the transition and if you need to change appliances in home to suit?
	Do we really need to switch over appliances if we make a 10% mix? Would the changes be made federally or in states?
Victoria Gas Transition Roadmap	It appears that the existing appliances in UK are able to be upgraded with a kit [for hydrogen?] that can be fitted. Is this something that will be possible in Australia?
	The model chose minimal energy efficiency?
	What does it mean by 'All Gas' under Solar graphs?

2. Appendix: Survey to Citizen Panels

PRE-DELIBERATION

Session information

Which deliberation session are you attending (click one option)?

Wednesday

Thursday

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process. To do so, enter:

Your first name:

Post Code:

Age:

For example, my name is Peter, my postcode is 4070, and my age is 37. My unique code would be Peter407037

Please write this down and keep it in a safe place, as you will need this code again.

Energy perceptions

How strongly do you agree or disagree with the use of the following energy sources and related technologies as potential ways of generating Australia's future energy needs?

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
Hydrogen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gas or coal with carbon capture and storage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wind	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solar PV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oil (e.g. diesel/petrol for transport)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nuclear (for power)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biomass	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Below are some statements about energy sources and priorities for Australia. Please indicate how close each statement is to your own point of view.

	Strongly against my point of view	Moderately against	Slightly against	Neither (neutral)	Slightly aligned	Moderately aligned	Strongly aligned with my point of view
Australia should focus on renewables, even if we need to invest more in infrastructure to make the system more reliable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should focus on renewables but in the meanwhile continue to use gas as a transition fuel to make the transition smooth and affordable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should focus on traditional energy sources such as coal & gas, even if the environment suffers to some extent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should focus on traditional energy sources such as coal & gas in a post-COVID environment to allow for economic recovery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

There are several considerations Australia needs to make now to transition towards a low-carbon energy future. Please indicate the importance of the following considerations. Rank your answer from 1 (most important) to 7 (least important)

- _____ Political
- _____ Environmental
- _____ Social
- _____ Behavioural
- _____ Technological
- _____ Economic
- _____ Cultural

Below are some statements about energy export and priorities for Australia.
Please indicate how close each statement is to your own point of view.

	Strongly against my point of view	Moderately against	Slightly against	Neither (neutral)	Slightly aligned	Moderately aligned	Strongly aligned with my point of view
Australia should continue to export coal to developing countries, to help them reduce poverty and develop their economies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia has an abundant supply of fossil fuels and we should continue to export them to keep our economy strong	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should develop a renewable energy industry for export (such as hydrogen), to help other countries reduce their carbon emissions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should continue to export fossil fuels to keep our economy strong in a post-COVID environment and use some of the profits to establish renewable energy industry for export	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Energy policy can involve difficult trade-offs between the economy and the environment.
Which one (1) of the following statements best describes your view?

- The highest priority should be given to protecting the environment, even if it hurts the economy.
- Both the environment and the economy are important, but the environment should come first.
- Both the environment and the economy are important and balancing the two should be the highest priority.
- Both the environment and the economy are important, but the economy should come first.

- The highest priority should be given to economic considerations even if it hurts the environment.

How much do you know about the following?			
	I have never heard of it	I have heard of it	I know about it and could describe it to a friend
How hydrogen is produced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of hydrogen fuel cells in vehicles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of hydrogen fuel cells in homes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hydrogen as an energy storage medium for electricity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hydrogen refuelling stations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Burning hydrogen as a replacement for natural gas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Overall, how do you feel about hydrogen as a possible solution for energy and environmental challenges?

- Very unsupportive
- Unsupportive
- Slightly unsupportive
- Neither supportive nor unsupportive
- Slightly supportive
- Supportive
- Very supportive

Display This Question:

If the previous question = Neither supportive nor unsupportive

Why did you select "Neither supportive nor unsupportive" for hydrogen as a possible solution for energy and environmental challenges?

- I do not know enough about hydrogen to decide
- I do not have any feelings either way (positive or negative)
- There are pros and cons of hydrogen, which makes my support neutral
- I did not understand the question
- I have no opinion on this issue
- I don't care
- Other reason (please specify) _____

If hydrogen were available today, how willing would you be to use it in your home for the following uses?

	Very unwilling	Moderately unwilling	Slightly unwilling	Neither willing nor unwilling	Slightly willing	Moderately willing	Very willing
On-site electricity generation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cooking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using natural gas that contains some hydrogen (i.e. a blend)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
For driving hydrogen fuel cell electric vehicles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot water heating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Space heating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Overall, do you think using hydrogen for energy in Australia would be:

	-3	-2	-1	0	+1	+2	+3	
Very Worthless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very worthwhile
Very useless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very useful
Very harmful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very beneficial
A very bad thing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	A very good thing

When you think about the use of hydrogen in Australia, please indicate how it makes you feel:

	-3	-2	-1	0	+1	+2	+3	
Very angry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very calm
Very embarrassed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very proud
Very uninspired	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very inspired
Very sad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very happy
Very unconcerned	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very concerned

If a hydrogen economy was to be developed in Australia, to what extent do you agree or disagree that the following groups would act in the best interest of the consumer?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Federal government	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
State government	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Local government	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electricity generation companies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fuel/gas supply companies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Car/appliance manufacturers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Universities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CSIRO	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Media	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Environmental Non-Government Organisations (ENGOS)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

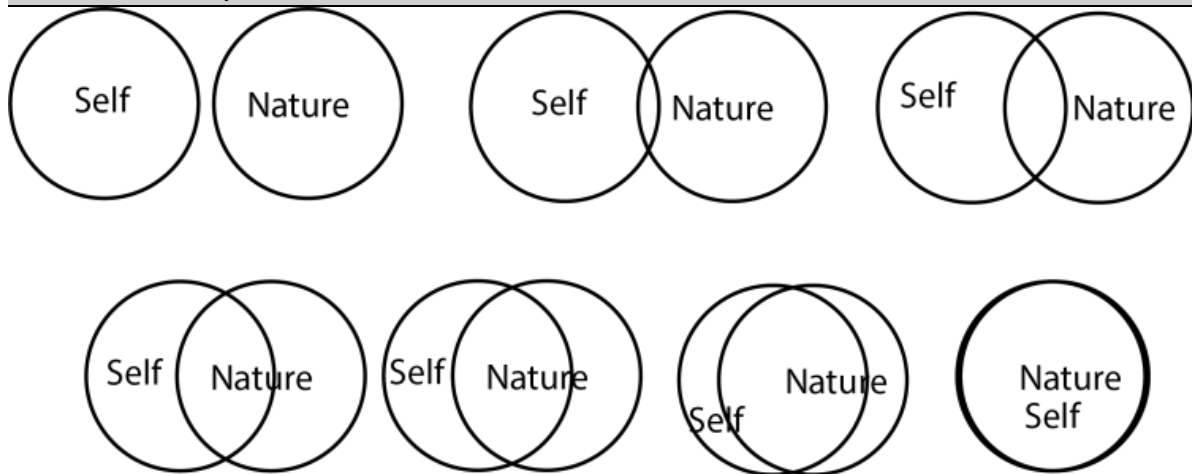
Do you believe climate change is happening now or will happen in the next 30 years?

- Yes, it is already happening
- It will start happening within the next 30 years
- No, it is not happening and won't
- I do not know/ I am not sure

How convinced are you that climate change represents a real problem for Australia?

- Very unconvinced
- Unconvinced
- Slightly unconvinced
- Neither convinced nor unconvinced
- Slightly convinced
- Convinced
- Very convinced

Please select the image below that best describes your relationship with the natural environment. How interconnected are you with nature?



Demographics, Household Characteristics and Energy Use

What is your Gender?

- Male
- Female
- Other (please specify _____)
- Prefer not to say

Do you use the following in your household?

	Yes	No
• Electricity (grid connected)	<input type="radio"/>	<input type="radio"/>
• Gas (mains)	<input type="radio"/>	<input type="radio"/>
• Gas (bottled)	<input type="radio"/>	<input type="radio"/>
• Solar hot water	<input type="radio"/>	<input type="radio"/>
• Solar PV (e.g. rooftop panels)	<input type="radio"/>	<input type="radio"/>
• Battery storage unit	<input type="radio"/>	<input type="radio"/>
• Battery electric vehicle	<input type="radio"/>	<input type="radio"/>
• Hybrid vehicle	<input type="radio"/>	<input type="radio"/>

Do you subscribe to a green bin to collect garden waste?

- Yes
- No
- My council doesn't offer this service

Do you subscribe to renewable energy (sometimes called GreenPower) from your electricity provider?

- Yes
- No

Display This Question:

If the previous question = Yes

What percentage of the renewable energy do you subscribe from your energy provider?

Percentage (%) of renewable _____

Is your dwelling

- Owned outright
- Owned with a mortgage
- Purchased under a shared equity scheme
- Rented
- Occupied rent free
- Occupied under a life tenure scheme
- Other

What is the level of the highest qualification you have completed?

- Year 10 or below
- Year 11 or equivalent
- Year 12 or equivalent
- Trade certificate or Apprenticeship
- Certificate I or II
- Certificate III or IV
- Advanced Diploma / Diploma
- Bachelor or Honours degree
- Postgraduate degree (e.g. Masters, PhD)
- Other (please specify)

Which best describes your income level (before tax)?

- \$3,500 or more per week or \$182,000 or more per year
- \$3,000 - \$3,499 per week or \$156,000 - \$181,999 per year
- \$2,000 - \$2,999 per week or \$104,000 - \$155,999 per year
- \$1,750 - \$1,999 per week or \$91,000 - \$103,999 per year
- \$1,500 - \$1,749 per week or \$78,000 - \$90,999 per year
- \$1,250 - \$1,499 per week or \$65,000 - \$77,999 per year
- \$1,000 - \$1,249 per week or \$52,000 - \$64,999 per year
- \$800 - \$999 per week or \$41,600 - \$51,999 per year
- \$650 - \$799 per week or \$33,800 - \$41,599 per year
- \$500 - \$649 per week or \$26,000 - \$33,799 per year
- \$400 - \$499 per week or \$20,800 - \$25,999 per year
- \$300 - \$399 per week or \$15,600 - \$20,799 per year
- \$150 - \$299 per week or \$7,800 - \$15,599 per year
- \$1 - \$149 per week or \$1 - \$7,799 per year
- \$0 or nil income
- Negative income

Which of the following best describes your occupational status?

- Student
- Household duties
- Employed – Part Time
- Employed – Full Time
- Unemployed not looking for work
- Unemployed looking for work
- Retired
- Not able to work
- Other (please specify) _____

Which occupational sector do you work in (or worked in prior to ceasing work)?

- Agriculture, forestry, fishing
- Mining
- Manufacturing
- Electricity, gas, water, waste services
- Construction
- Wholesale trade
- Retail trade
- Accommodation and food services
- Transport, postal and warehousing
- Information, media and telecommunications
- Financial and Insurance services
- Rental, hiring and real estate services
- Professional, scientific, technical services
- Administrative and support workers
- Public administration and safety
- Education and training
- Health care and social assistance
- Arts and recreation services
- Other services
- Not applicable

In which country were you born?

- Australia
- Foreign country

*Display This Question:
If the previous question = Foreign country*

If foreign, which country were you born

▼ Afghanistan ... Zimbabwe

Are you of Aboriginal or Torres Strait Islander origin?

- No
- Yes, Aboriginal
- Yes, Torres Strait Islander
- Prefer not to answer

Which best describes your situation in relation to your electricity bill?

- Paying my electricity bill in full is never a problem for me
- I sometimes find it hard to pay my electricity bill when it becomes due
- I always struggle to pay my electricity bill when it becomes due
- My electricity bill is usually in credit after factoring in solar feed-in tariffs
- I pre-pay my electricity bill
- I do not pay for electricity in my house

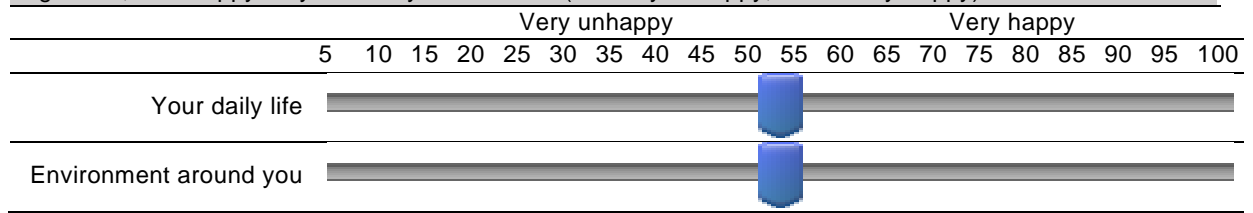
What is your current status in relation to solar energy?

- I have solar PV panels installed to supply my home
- I have batteries at home to store solar energy
- I intend to install solar PV panels within the next 5 years
- I intend to have batteries at home to store solar energy
- I do not intend to install solar PV panels
- I do not know
- Other (please specify) _____

Which of the following best describes your household?

- Group household
- Single person household
- One parent with children
- Couple with children
- Couple with no children
- Other family (e.g. extended family household)

In general, how happy do you think you are with? (0 = very unhappy, 100 = very happy)



FEEDBACK FROM WEEK 1

Session information

Which deliberation session are you attending (click one option)?

Wednesday

Thursday

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process.

Your first name:

Post Code:

Age:

For example, my name is Peter, my postcode is 4070, and my age is 37. My unique code would be Peter407037

Please write this down and keep it in a safe place, as you will need this code again.

Feedback Form

After listening to the presentations and talking to other members of your community, to what extent did you find you changed or broadened your views about climate change and energy as a result of this week's workshops?

- Not at all
- To a small extent
- To a moderate extent
- To a fairly great extent
- To a great extent

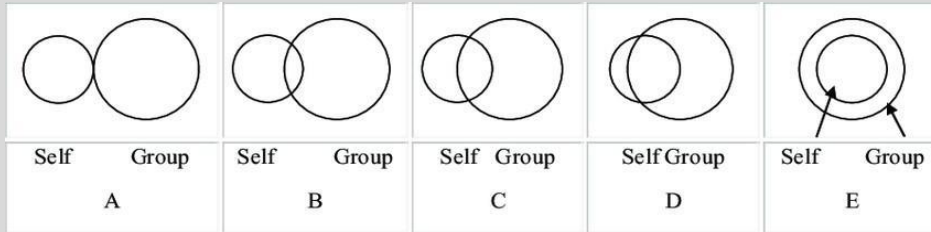
How well did you feel you were able to:

	Not well at all	Slightly well	Moderately well	Very well	Extremely well
Understand the purpose of the research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand your role in the research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand the key issues under discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn about the issues that were discussed in the breakout rooms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Listen to what others in your breakout room have to say about the topics under discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Express your own views on the topics under discussion in the breakout rooms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

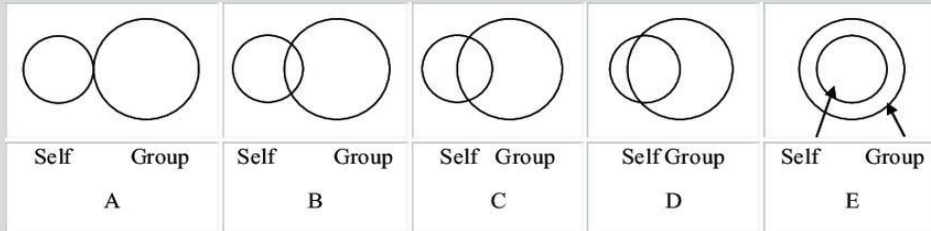
How much do you believe that:

	Not at all	To a small extent	To a moderate extent	To a large extent	Definitely
Your participation was encouraged by the breakout room facilitator	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your contribution was valued and respected by the other participants in your breakout room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The discussions in your breakout room resulted in useful conclusions and outcomes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your overall experience with the presentation on Climate Change:					
	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your overall experience with the presentation on Current State of Energy:					
	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If the circle on the left represents you and the circle on the right represents people in your breakout room, select the diagram that best describes your relationship with the other fellow citizens in your breakout room:



If the circle on the left represents you and the circle on the right represents all the people in Zoom meeting, select the diagram that best describes your relationship with the other fellow citizens that attended the workshop today:



Do you have any comments or suggestions that you would like to share with us?

FEEDBACK FROM WEEK 2

Session information

Which deliberation session are you attending (click one option)?

Wednesday

Thursday

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process.

Your first name:

Post Code:

Age:

For example, my name is Peter, my postcode is 4070, and my age is 37. My unique code would be Peter407037

Please write this down and keep it in a safe place, as you will need this code again.

Feedback Form

After listening to the presentations and talking to other members of your community, to what extent did you find you changed or broadened your views about climate change and energy as a result of this week's workshops?

- Not at all
- To a small extent
- To a moderate extent
- To a fairly great extent
- To a great extent

How well did you feel you were able to:

	Not well at all	Slightly well	Moderately well	Very well	Extremely well
Understand the purpose of the research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand your role in the research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand the key issues under discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn about the issues that were discussed in the breakout rooms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Listen to what others in your breakout room have to say about the topics under discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Express your own views on the topics under discussion in the breakout rooms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much do you believe that:

	Not at all	To a small extent	To a moderate extent	To a large extent	Definitely
Your participation was encouraged by the breakout room facilitator	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your contribution was valued and respected by the other participants in your breakout room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The discussions in your breakout room resulted in useful conclusions and outcomes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Your overall experience with the presentation on 'Introduction to future fuels and hydrogen:

	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

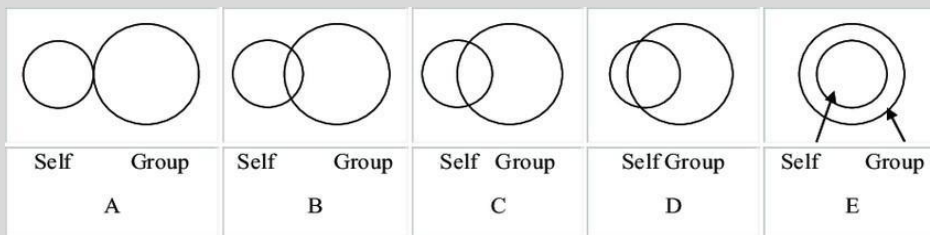
Your overall experience with the presentation on 'Uses of hydrogen– export, domestic, transport

	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

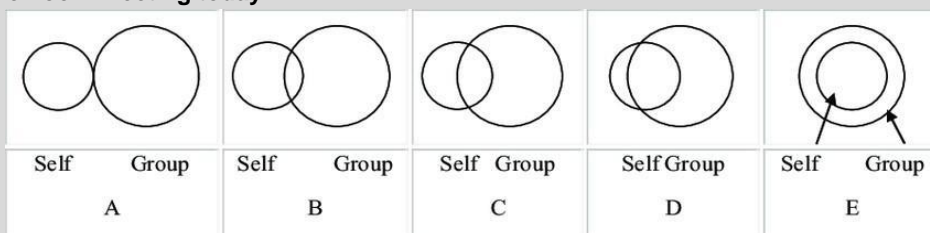
Your overall experience with the presentation on Introduction to Biomass/Biogas

	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If the circle on the left represents you and the circle on the right represents people in your breakout room, select the diagram that best describes your relationship with the other fellow citizens in your breakout room:



If the circle on the left represents you and the circle on the right represents all the people in Zoom meeting, select the diagram that best describes your relationship with the other fellow citizens that attended the Zoom meeting today:



A B C D E

Do you have any comments or suggestions that you would like to share with us?

FEEDBACK FROM WEEK 3

Session information

Which deliberation session are you attending (click one option)?

Wednesday

Thursday

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process.

Your first name:

Post Code:

Age:

For example, my name is Peter, my postcode is 4070, and my age is 37. My unique code would be Peter407037

Please write this down and keep it in a safe place, as you will need this code again.

Feedback Form

After listening to the presentations and talking to other members of your community, to what extent did you find you changed or broadened your views about climate change and energy as a result of this week's workshops?

- Not at all
- To a small extent
- To a moderate extent
- To a fairly great extent
- To a great extent

How well did you feel you were able to:

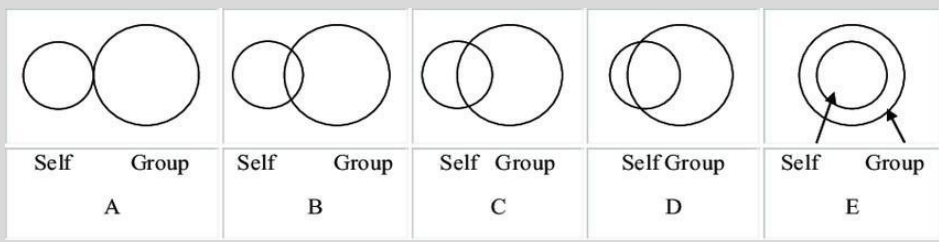
	Not well at all	Slightly well	Moderately well	Very well	Extremely well
Understand the purpose of the research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand your role in the research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand the key issues under discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learn about the issues that were discussed in the breakout rooms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Listen to what others in your breakout room have to say about the topics under discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Express your own views on the topics under discussion in the breakout rooms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much do you believe that:

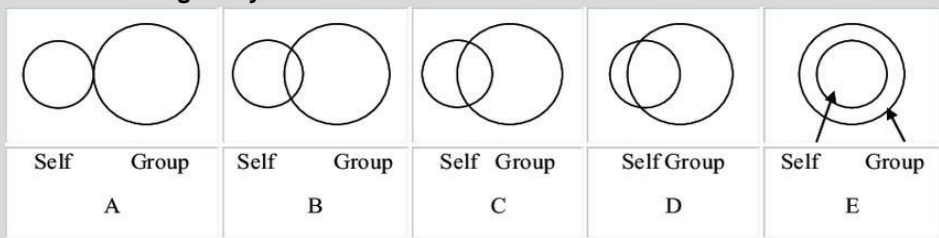
	Not at all	To a small extent	To a moderate extent	To a large extent	Definitely
Your participation was encouraged by the breakout room facilitator	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your contribution was valued and respected by the other participants in your breakout room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The discussions in your breakout room resulted in useful conclusions and outcomes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your overall experience with the presentation on: Understanding and addressing energy vulnerability					
	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your overall experience with the presentation on: Trade-offs and challenges for energy transitions					
	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your overall experience with the presentation on: Natural gas substitution Roadmap – Vic Government					
	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your overall experience with the presentation on : Potential decarbonisation pathways					
	Strongly disagree	Tend to disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

I understood everything that was presented by the speaker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trusted what the speaker said	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information presented by the speaker was relevant and helpful to the small group discussions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If the circle on the left represents you and the circle on the right represents people in your breakout room, select the diagram that best describes your relationship with the other fellow citizens in your breakout room:



If the circle on the left represents you and the circle on the right represents all the people in Zoom meeting, select the diagram that best describes your relationship with the other fellow citizens that attended the Zoom meeting today:



A B C D E

Do you have any comments or suggestions that you would like to share with us?

POST DELIBERATION

Session information

Which deliberation session are you attending (click one option)?

Wednesday

Thursday

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process. To do so, enter:

Your first name:

Post Code:

Age:

For example, my name is Peter, my postcode is 4070, and my age is 37. My unique code would be Peter407037

Please write this down and keep it in a safe place, as you will need this code again.

Energy perceptions

How strongly do you agree or disagree with the use of the following energy sources and related technologies as potential ways of generating Australia's future energy needs?

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
Hydrogen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gas or coal with carbon capture and storage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wind	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solar PV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oil (e.g. diesel/petrol for transport)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nuclear (for power)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biomass	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Below are some statements about energy sources and priorities for Australia. Please indicate how close each statement is to your own point of view.

	Strongly against my point of view	Moderately against	Slightly against	Neither (neutral)	Slightly aligned	Moderately aligned	Strongly aligned with my point of view
Australia should focus on renewables, even if we need to invest more in infrastructure to make the system more reliable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should focus on renewables but in the meanwhile continue to use gas as a transition fuel to make the transition smooth and affordable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should focus on traditional energy sources such as coal & gas, even if the environment suffers to some extent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should focus on traditional energy sources such as coal & gas in a post-COVID environment to allow for economic recovery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

There are several considerations Australia needs to make now to transition towards a low-carbon energy future. Please indicate the importance of the following considerations. Rank your answer from 1 (most important) to 7 (least important)

- _____ Political
- _____ Environmental
- _____ Social
- _____ Behavioural
- _____ Technological
- _____ Economic
- _____ Cultural

Below are some statements about energy export and priorities for Australia.

Please indicate how close each statement is to your own point of view.

	Strongly against my point of view	Moderately against	Slightly against	Neither (neutral)	Slightly aligned	Moderately aligned	Strongly aligned with my point of view
Australia should continue to export coal to developing countries, to help them reduce poverty and develop their economies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia has an abundant supply of fossil fuels and we should continue to export them to keep our economy strong	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should develop a renewable energy industry for export (such as hydrogen), to help other countries reduce their carbon emissions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Australia should continue to export fossil fuels to keep our economy strong in a post-COVID environment and use some of the profits to establish renewable energy industry for export	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Energy policy can involve difficult trade-offs between the economy and the environment.

Which one (1) of the following statements best describes your view?

- The highest priority should be given to protecting the environment, even if it hurts the economy.
- Both the environment and the economy are important, but the environment should come first.
- Both the environment and the economy are important and balancing the two should be the highest priority.
- Both the environment and the economy are important, but the economy should come first.
- The highest priority should be given to economic considerations even if it hurts the environment.

How much do you know about the following?

	I have never heard of it	I have heard of it	I know about it and could describe it to a friend
How hydrogen is produced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of hydrogen fuel cells in vehicles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of hydrogen fuel cells in homes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hydrogen as an energy storage medium for electricity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hydrogen refuelling stations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Burning hydrogen as a replacement for natural gas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Overall, how do you feel about hydrogen as a possible solution for energy and environmental challenges?

- Very unsupportive
- Unsupportive
- Slightly unsupportive
- Neither supportive nor unsupportive
- Slightly supportive
- Supportive
- Very supportive

Display This Question:

If the previous question = Neither supportive nor unsupportive

Why did you select "Neither supportive nor unsupportive" for hydrogen as a possible solution for energy and environmental challenges?

- I do not know enough about hydrogen to decide
- I do not have any feelings either way (positive or negative)
- There are pros and cons of hydrogen, which makes my support neutral
- I did not understand the question
- I have no opinion on this issue
- I don't care
- Other reason (please specify) _____

If hydrogen were available today, how willing would you be to use it in your home for the following uses?

Very unwilling	Moderately unwilling	Slightly unwilling	Neither willing nor unwilling	Slightly willing	Moderately willing	Very willing
----------------	----------------------	--------------------	-------------------------------	------------------	--------------------	--------------

On-site electricity generation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cooking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using natural gas that contains some hydrogen (i.e. a blend)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
For driving hydrogen fuel cell electric vehicles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot water heating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Space heating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall, do you think using hydrogen for energy in Australia would be:								
	-3	-2	-1	0	+1	+2	+3	
Very Worthless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very worthwhile
Very useless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very useful
Very harmful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very beneficial
A very bad thing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	A very good thing
When you think about the use of hydrogen in Australia, please indicate how it makes you feel:								
	-3	-2	-1	0	+1	+2	+3	
Very angry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very calm
Very embarrassed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very proud
Very uninspired	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very inspired
Very sad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very happy
Very unconcerned	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very concerned

If a hydrogen economy was to be developed in Australia, to what extent do you agree or disagree that the following groups would act in the best interest of the consumer?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Federal government	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
State government	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Local government	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electricity generation companies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fuel/gas supply companies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Car/appliance manufacturers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Universities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CSIRO	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Media	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Environmental Non-Government Organisations (ENGOS)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

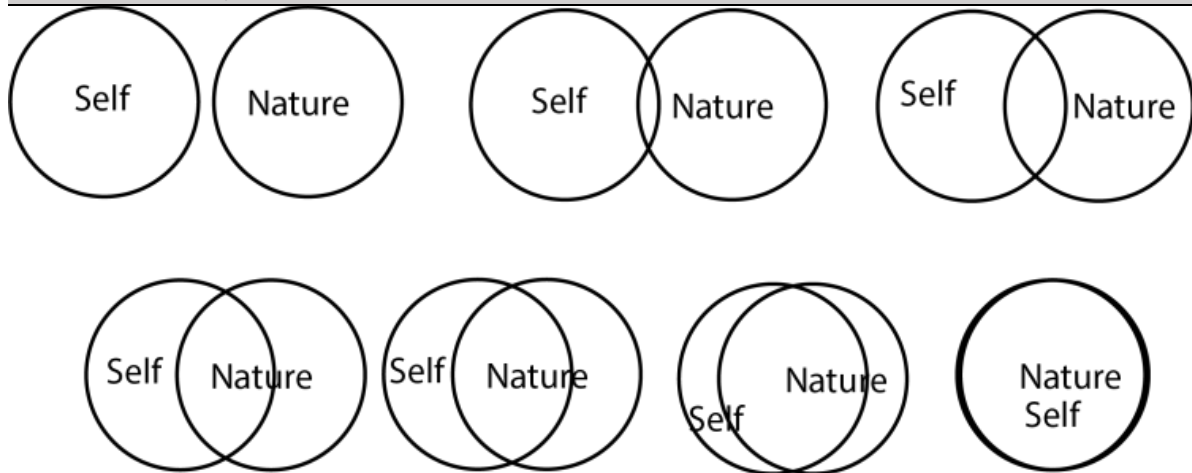
Do you believe climate change is happening now or will happen in the next 30 years?

- Yes, it is already happening
- It will start happening within the next 30 years
- No, it is not happening and won't
- I do not know/ I am not sure

How convinced are you that climate change represents a real problem for Australia?

- Very unconvinced
- Unconvinced
- Slightly unconvinced
- Neither convinced nor unconvinced
- Slightly convinced
- Convinced
- Very convinced

Please select the image below that best describes your relationship with the natural environment. How interconnected are you with nature?



Demographics, Household Characteristics and Energy Use

What is your Gender?

- Male
- Female
- Other (please specify) _____
- Prefer not to say

Do you use the following in your household?

	Yes	No
• Electricity (grid connected)	<input type="radio"/>	<input type="radio"/>
• Gas (mains)	<input type="radio"/>	<input type="radio"/>
• Gas (bottled)	<input type="radio"/>	<input type="radio"/>
• Solar hot water	<input type="radio"/>	<input type="radio"/>
• Solar PV (e.g. rooftop panels)	<input type="radio"/>	<input type="radio"/>
• Battery storage unit	<input type="radio"/>	<input type="radio"/>
• Battery electric vehicle	<input type="radio"/>	<input type="radio"/>
• Hybrid vehicle	<input type="radio"/>	<input type="radio"/>

Do you subscribe to a green bin to collect garden waste?

- Yes
- No
- My council doesn't offer this service

Do you subscribe to renewable energy (sometimes called GreenPower) from your electricity provider?

- Yes
- No

Display This Question:

If the previous question = Yes

What percentage of the renewable energy do you subscribe from your energy provider?

Percentage (%) of renewable _____

Is your dwelling

- Owned outright
- Owned with a mortgage
- Purchased under a shared equity scheme
- Rented
- Occupied rent free
- Occupied under a life tenure scheme
- Other

What is the level of the highest qualification you have completed?

- Year 10 or below
- Year 11 or equivalent
- Year 12 or equivalent
- Trade certificate or Apprenticeship
- Certificate I or II
- Certificate III or IV
- Advanced Diploma / Diploma
- Bachelor or Honours degree
- Postgraduate degree (e.g. Masters, PhD)
- Other (please specify) _____

Which best describes your income level (before tax)?

- \$3,500 or more per week or \$182,000 or more per year
- \$3,000 - \$3,499 per week or \$156,000 - \$181,999 per year
- \$2,000 - \$2,999 per week or \$104,000 - \$155,999 per year
- \$1,750 - \$1,999 per week or \$91,000 - \$103,999 per year
- \$1,500 - \$1,749 per week or \$78,000 - \$90,999 per year
- \$1,250 - \$1,499 per week or \$65,000 - \$77,999 per year
- \$1,000 - \$1,249 per week or \$52,000 - \$64,999 per year
- \$800 - \$999 per week or \$41,600 - \$51,999 per year
- \$650 - \$799 per week or \$33,800 - \$41,599 per year
- \$500 - \$649 per week or \$26,000 - \$33,799 per year
- \$400 - \$499 per week or \$20,800 - \$25,999 per year
- \$300 - \$399 per week or \$15,600 - \$20,799 per year
- \$150 - \$299 per week or \$7,800 - \$15,599 per year
- \$1 - \$149 per week or \$1 - \$7,799 per year
- \$0 or nil income
- Negative income

Which of the following best describes your occupational status?

- Student
- Household duties
- Employed – Part Time
- Employed – Full Time
- Unemployed not looking for work
- Unemployed looking for work
- Retired
- Not able to work
- Other (please specify) _____

Which occupational sector do you work in (or worked in prior to ceasing work)?

- Agriculture, forestry, fishing
- Mining
- Manufacturing
- Electricity, gas, water, waste services
- Construction
- Wholesale trade
- Retail trade
- Accommodation and food services
- Transport, postal and warehousing
- Information, media and telecommunications Financial and Insurance services
- Rental, hiring and real estate services
- Professional, scientific, technical services
- Administrative and support workers
- Public administration and safety
- Education and training
- Health care and social assistance
- Arts and recreation services
- Other services
- Not applicable

In which country were you born?

- Australia
- Foreign country

*Display This Question:
If the previous question = Foreign country*

If foreign, which country were you born

▼ Afghanistan ... Zimbabwe

Are you of Aboriginal or Torres Strait Islander origin?

- No
- Yes, Aboriginal
- Yes, Torres Strait Islander
- Prefer not to answer

Which best describes your situation in relation to your electricity bill?

- Paying my electricity bill in full is never a problem for me
- I sometimes find it hard to pay my electricity bill when it becomes due
- I always struggle to pay my electricity bill when it becomes due
- My electricity bill is usually in credit after factoring in solar feed-in tariffs
- I pre-pay my electricity bill
- I do not pay for electricity in my house

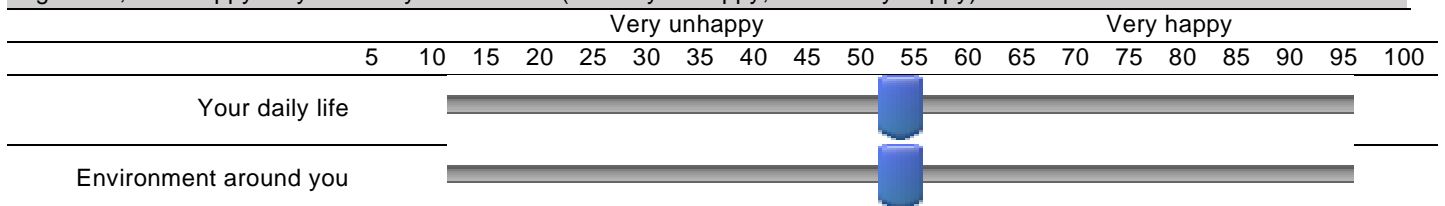
What is your current status in relation to solar energy?

- I have solar PV panels installed to supply my home
- I have batteries at home to store solar energy
- I intend to install solar PV panels within the next 5 years
- I intend to have batteries at home to store solar energy
- I do not intend to install solar PV panels
- I do not know
- Other (please specify) _____

Which of the following best describes your household?

- Group household
- Single person household
- One parent with children
- Couple with children
- Couple with no children
- Other family (e.g. extended family household)

In general, how happy do you think you are with? (0 = very unhappy, 100 = very happy)



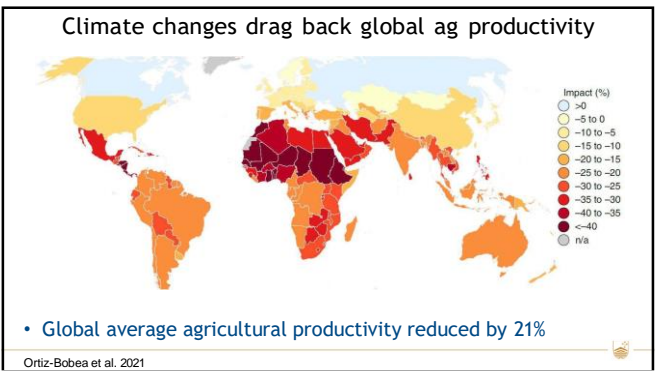
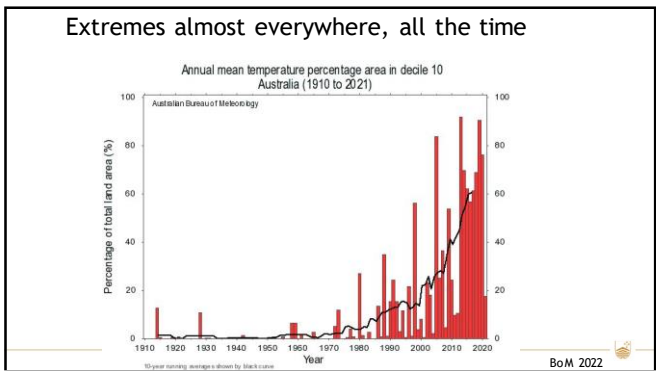
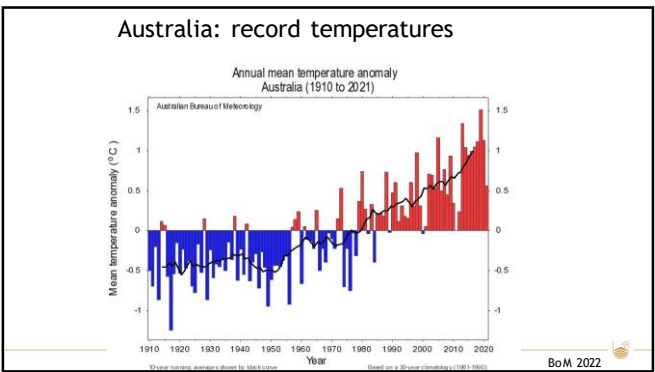
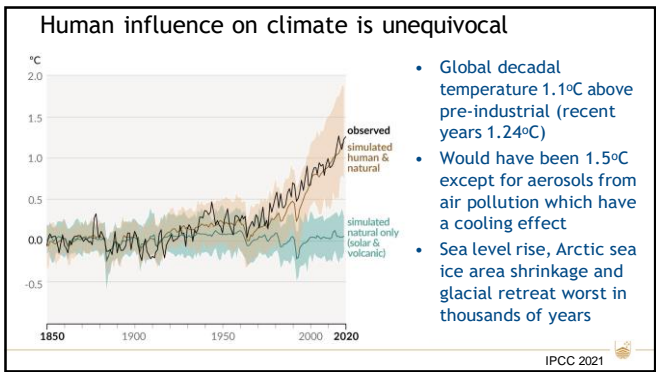
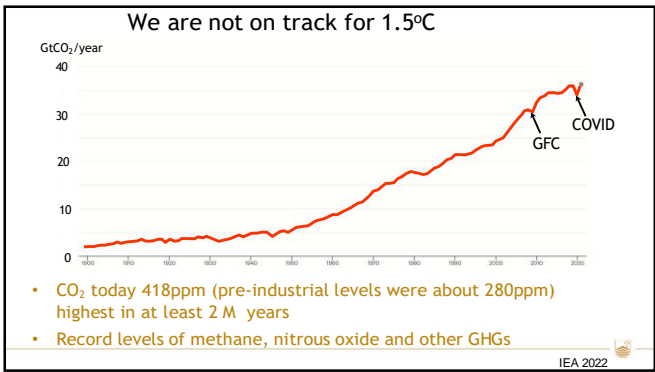
3. Appendix: Presentations to Citizen Panels

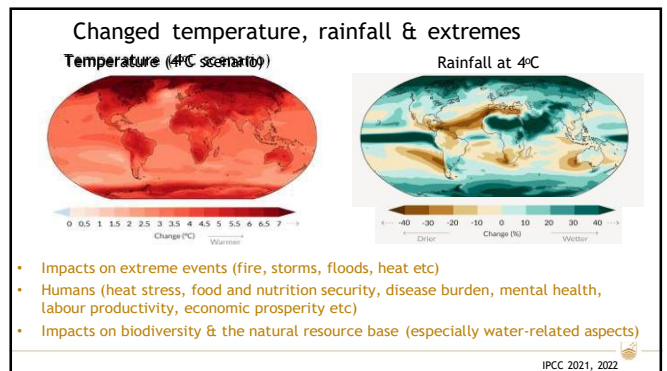
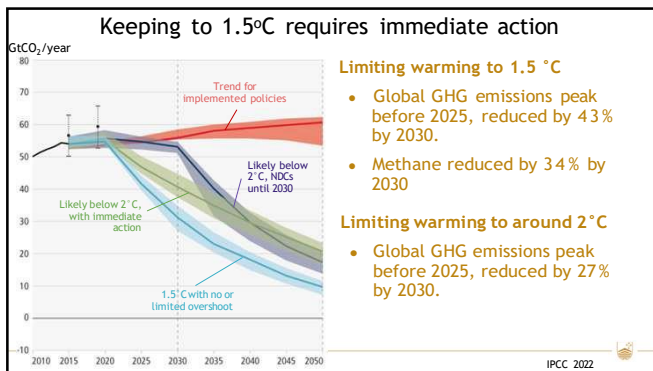
Understanding climate change, climate extremes, adaptation and mitigation

Professor Mark Howden
ANU Institute for Climate, Energy and Disaster Solutions

Chair, ACT Climate Change Council
Vice Chair, IPCC Working Group II

@ProfMarkHowden

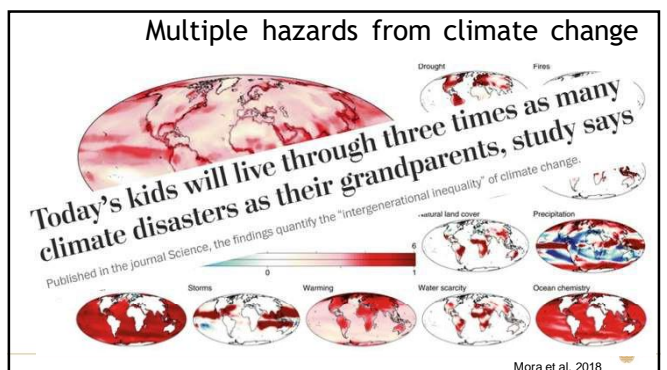
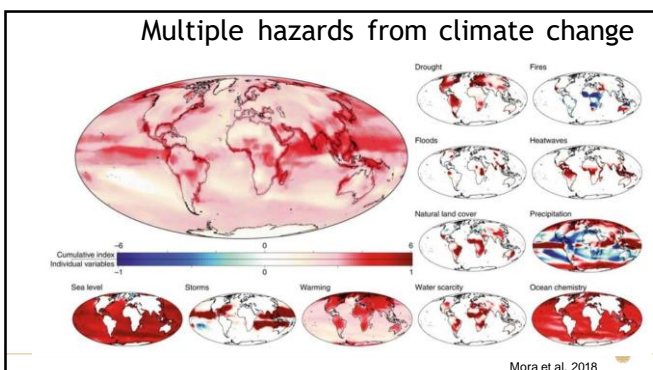
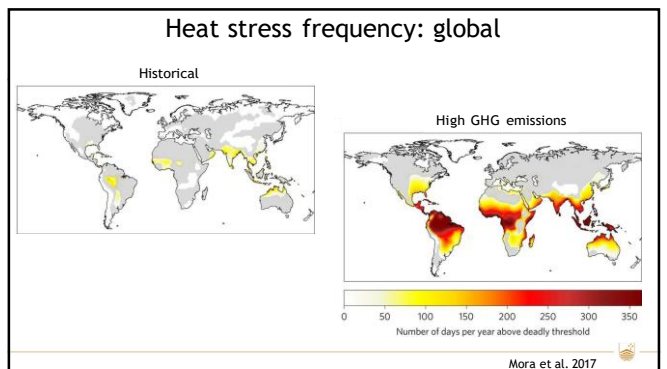


Impacts on human systems - strongly negative

(b) Observed impacts of climate change on human systems

Human systems	Impacts on water scarcity and food production				Impacts on health and wellbeing				Impacts on cities, settlements and infrastructure			
	Water scarcity	Agriculture crop production	Animal and aquaculture health and productivity	Fishes, birds and other aquatic production	Infectious diseases	Heat, malnutrition and other	Mental health	Displacement	Island flooding and associated damages	Floods and erosion in coastal areas	Damage to built assets	Damage to key economic sectors
Global	+	-	-	-	-	-	-	-	-	-	-	-
Africa	+	-	-	-	-	-	-	-	-	-	-	-
Asia	+	-	-	-	-	-	-	-	-	-	-	-
Australasia	+	-	-	-	-	-	-	-	-	-	-	-
Central and South America	+	-	-	-	-	-	-	-	-	-	-	-
Europe	+	-	-	-	-	-	-	-	-	-	-	-
North America	+	-	-	-	-	-	-	-	-	-	-	-
Small islands	+	-	-	-	-	-	-	-	-	-	-	-
Arctic	+	-	-	-	-	-	-	-	-	-	-	-
Cities by the sea	+	-	-	-	-	-	-	-	-	-	-	-
Mediterranean region	+	-	-	-	-	-	-	-	-	-	-	-
Mountain regions	+	-	-	-	-	-	-	-	-	-	-	-

IPCC

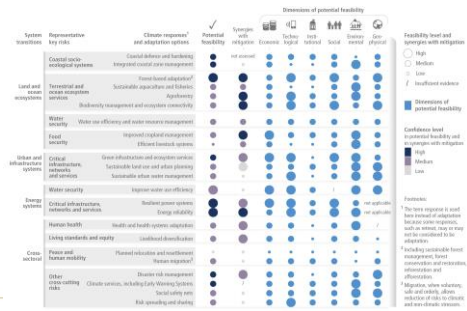


Adaptation

- Climate change impacts are potentially large, systemic, rapid and net negative
- Requiring an adaptation response that is large, systemic, rapid and very positive
- Unfortunately, most observed adaptation is fragmented, small in scale, incremental, sector-specific, designed to respond to current impacts or near-term risks and focused more on planning rather than implementation

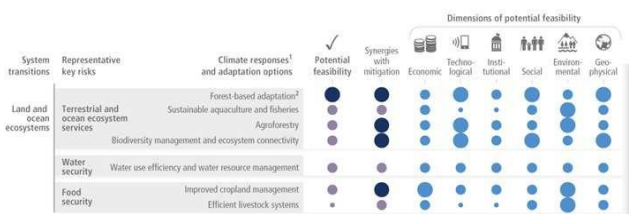
IPCC 2021

Adaptation options feasible for every sector



IPCC 2022

Feasibility assessment of adaptations



IPCC 2022

Adaptation is core to meeting the SDGs



IPCC 2022

Increased evidence of emission-reduction action



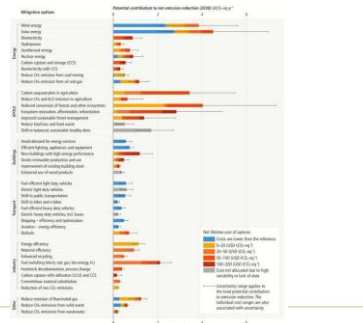
Some 18 countries have achieved a steady decrease in emissions consistent with limiting warming to 2°C



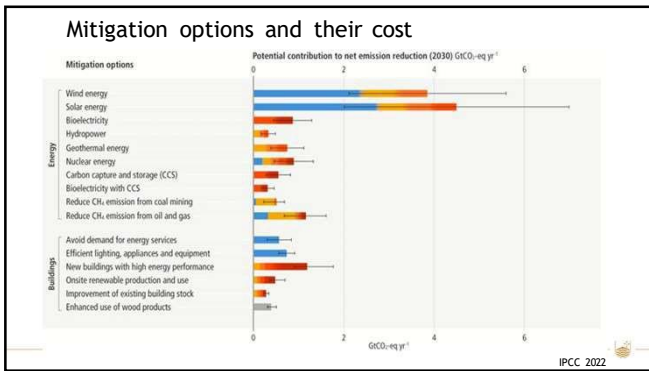
Zero emissions targets have been adopted by at least 826 cities and 103 regions

IPCC 2022

Mitigation options and their cost



IPCC 2022



Thankyou

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Vice Chair, IPCC Working Group II

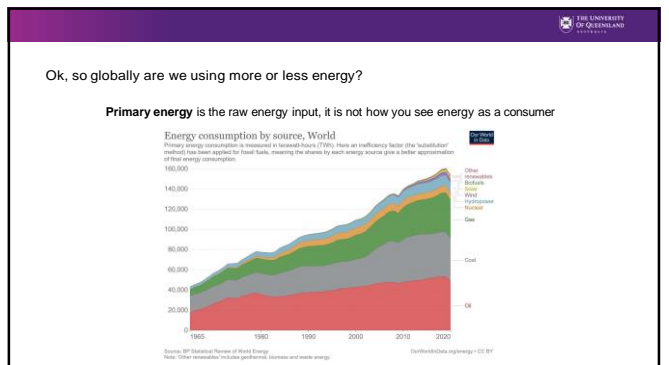
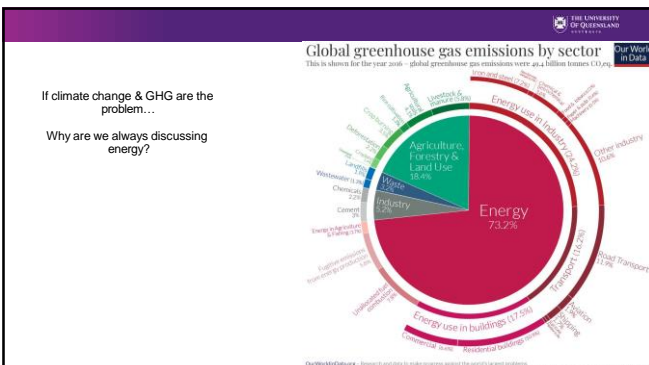
Every half a degree matters
 Every year matters
 Every choice matters

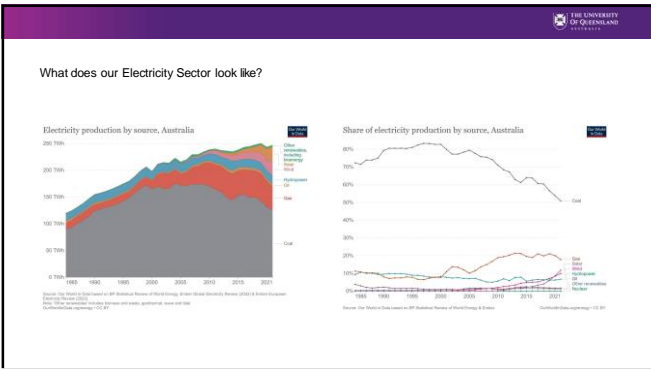
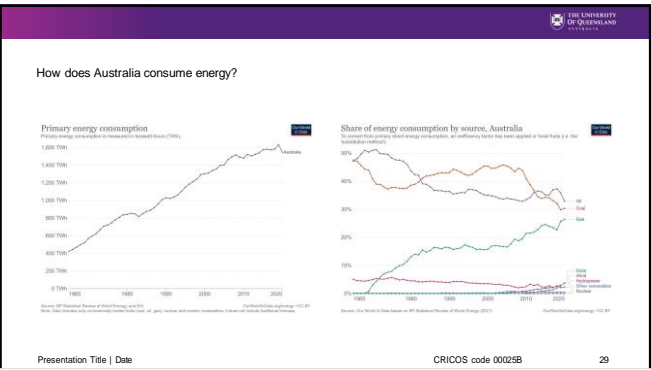
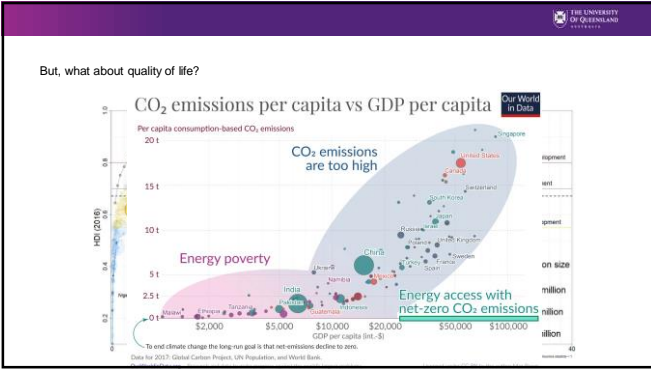
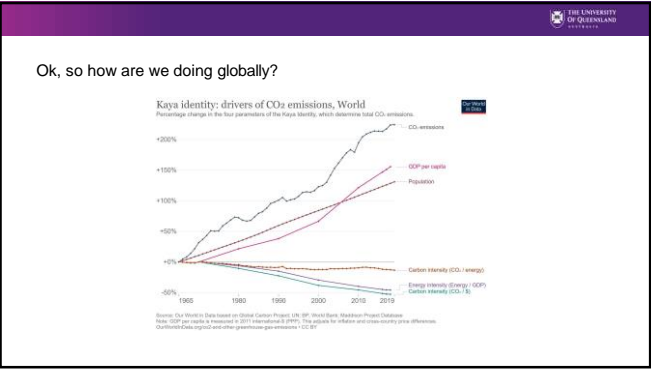
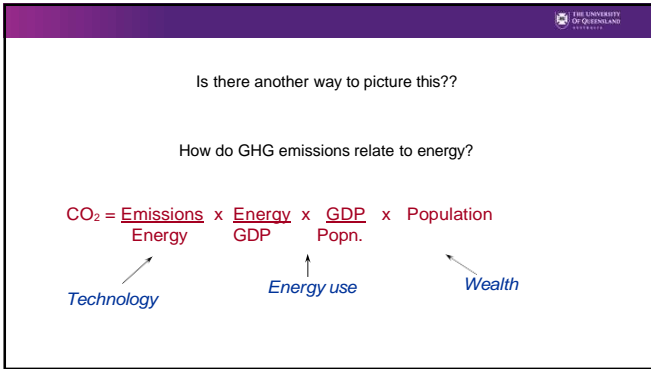
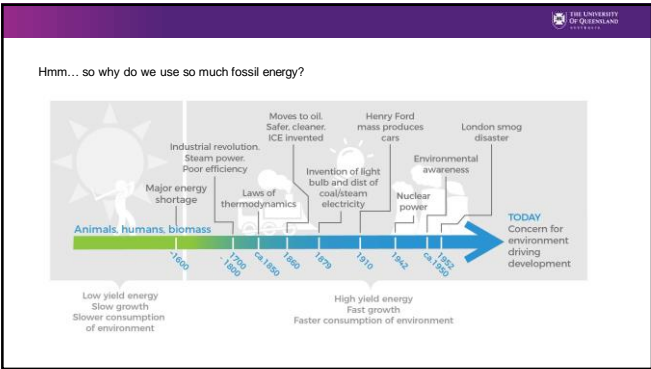
Howden and Colvin 2018

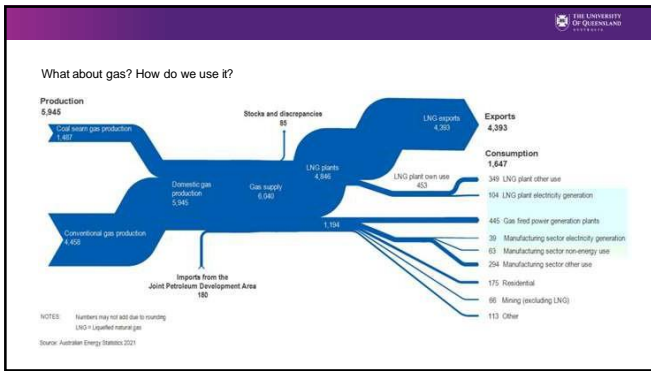
THE UNIVERSITY OF QUEENSLAND
 AUSTRALIA

CREATE CHANGE

Energy
 Current State of Play



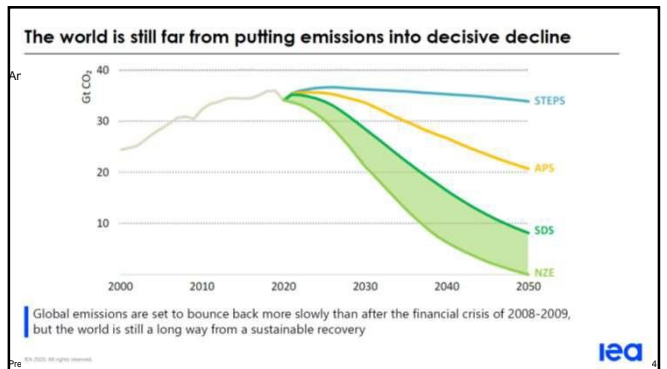
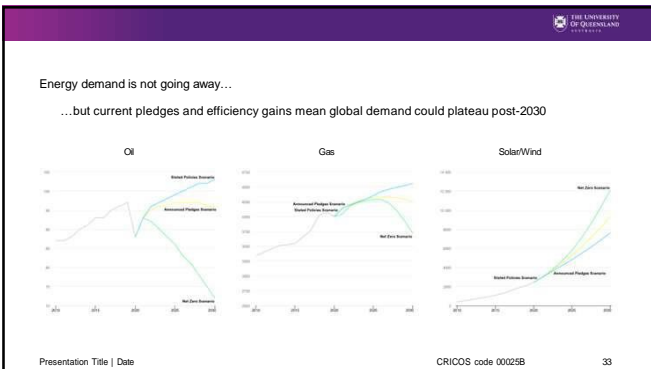




What can we look forward to?

What do the energy and emissions forecasts look like?

Presentation Title | Date CRICOS code 00025B 33



The University of Queensland CREATE CHANGE AUSTRALIA

Thank you

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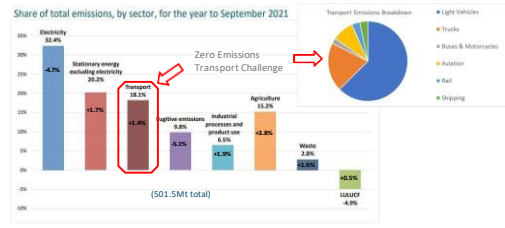
Future Fuels & Hydrogen

Future Fuels CRC Citizens Panel
3rd May 2022

Dr Patrick Hartsley
CSIRO Hydrogen Industry Mission Lead
3rd May 2022

Australian National Science Agency

Why do we need Future Fuels : Australia's Greenhouse Gas Emissions



2 | CSIRO Hydrogen Industry Mission | Dr P Healey

What are Future Fuels?

fuel
 /fjuːl/ (noun)
 a substance that is used to provide heat or power, usually by being burned.

- Fuels can be solid (eg coal), liquid (eg petrol) or gas (eg natural gas)
- Almost all of our current fuels produce Carbon Dioxide (CO₂) when consumed. This is a greenhouse gas (GHG) which contributes to global warming
- Future Fuels** are being developed which have much lower or even zero GHG emissions. Various options exist:
 - Transport Fuels: renewable electricity, biofuels and hydrogen
 - Domestic & Industrial heating: renewable electricity, biogas & hydrogen
 - Power generation: renewable energy, nuclear

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Hydrogen as a Future Fuel: What is Hydrogen?

- Hydrogen, Chemical Symbol H₂, is the lightest and most abundant element on earth **but only** exists on earth in chemical compounds with other elements eg with oxygen in water: H₂O or carbon in methane (CH₄, natural gas)
- Energy is needed to extract Hydrogen in its molecular form, H₂, from water and other chemical compounds
- H₂ stores this energy, and can release it when it is burnt or used in chemical reactions. The only product is water, so hydrogen can be used as an energy carrier which produces **zero greenhouse gas emissions at point of use**
- Hydrogen is already extensively used in major industries e.g. in fertilizer production

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Where do we get Hydrogen?

From Fossil Fuels and Water

Steam Methane Reforming

$$CH_4 + 2H_2O \xrightarrow{\text{CO}_2} CO_2 + 4H_2$$

From Electricity and Water: 'Water Splitting'

Electrolysis

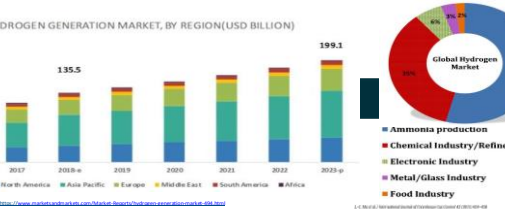
$$2H_2O \xrightarrow{\text{e}^-} 4H_2 + O_2$$

Global H₂ Production

- Coal Substrate
- Steam Methane Reforming

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Hydrogen as a Feedstock



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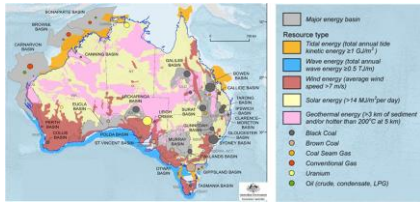
Why Hydrogen as an Energy Carrier?



- Hydrogen can be used to decarbonize and couple diverse energy & feedstock value chains
- Establishing an Australian hydrogen industry offers additional opportunities in associated industries

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Why Hydrogen for Australia?



Australia has Abundant energy resources which can be used for making hydrogen

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National Hydrogen Strategy Development

Council of Australian Governments (COAG) Energy Council Joint Ministerial Statement (December 2018):
 "We commit to working together to develop and implement a national strategy for hydrogen, in close consultation with industry and the community"

Alignment of State, Territory & Federal Government Strategies



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Government Investments: Hydrogen Project Support

- February 2018: South Australia Hydrogen Project Funding
- April 2018: Victoria / Aust. Government / Japan Consortium
- September 2018: Australian Renewable Energy Agency (ARENA)
 - August 2019: Queensland Hydrogen Industry Development Fund
 - March 2020: Tasmania Renewable Hydrogen Action Plan
 - April 2020: ARENA Hydrogen Deployment Fund
 - May 2020: Clean Energy Finance Corporation (CEFC)
 - August 2020: Western Australia Renewable Hydrogen Fund
 - September 2020: Federal Govt Low Emissions Technology Statement
 - April 2021: Federal Govt Low Emissions Technology Statement
 - October 2021: NSW Hydrogen Strategy
 - September 2021: Federal Govt Hydrogen Hubs Program
 - March 2022: 'HyGATE' Germany – Australia Initiative
 - \$50m ARENA Program
 - €50m PJU (Germany)

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Australia's Hydrogen Demonstration Projects: Snapshot

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Thank you

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Using Hydrogen as a Future Fuel

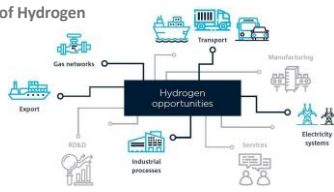
Future Fuels CRC Citizens Panel
3rd May 2022

Dr Patrick Hartley
CSIRO Hydrogen Industry Mission Lead
3rd May 2022



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Uses of Hydrogen

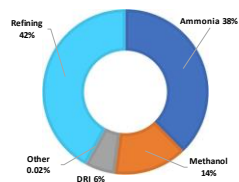
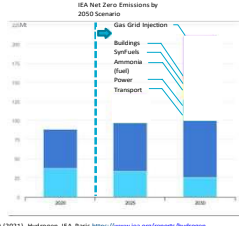


- Hydrogen can be used to decarbonize and couple diverse energy & feedstock value chains
- Establishing an Australian hydrogen industry offers additional opportunities in associated industries

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Hydrogen Use Today: Industrial Feedstock

Today's Market: Global Demand (2020) = 90Mt

IEA (2021), Hydrogen, IEA Paris <https://www.iea.org/energydata/graphics-and-commodities-publications>

Hydrogen Mobility Technology: Fuel Cell Electric Vehicles (FCEV)



Engine : 1.2kWh (182Hp) FCEV
Battery : 1.2kWh Li-ion
Accel.: 0-97km/h 8.7 Sec.
Max Speed: 175 km/h

Range: 647 km (EPA)
Hydrogen Tanks: 3 x hydrogen tanks = 141 liters = 5.6 kg
Tank weight ~100kg

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Hydrogen in Transport

- Zero Emissions (CO₂, Pollution)
- High Energy Density Fuel allows Longer routes: Range similar to diesel vehicles (300-600km)
- Short refuelling (~10 mins)
- Familiar user experience
- 'Back to base' models mean less reliance on refueller networks

→ Road vehicles complementary to battery EV, choice depends on operating characteristics

Key Challenges

- Refuelling Infrastructure (Cost, Availability)
- Competing technologies eg BEV
- Vehicle Availability
- Retail Cost of Hydrogen



	LCOT 2018 (\$/kWh)	LCOT 2020 (\$/kWh)	LCOT 2028 (\$/kWh)	LCOT 2050 (\$/kWh)
Passenger Vehicle				
ICE	0.75	0.73	1.83	1.85
BEV	1.29	0.66	1.66	1.60
FCEV	1.43	0.70	2.96	1.84

Comparison of Vehicle Type by Lowest Cost of Transport (LCOT)
CSIRO National Hydrogen Roadmap (2018)


Hydrogen in Gas Networks

Delivering today for a better future

- Hydrogen can be blended with natural gas up to ~10% and burned in existing appliances for heat to reduce overall emissions
- Australia's extensive gas distribution networks could be used to store and move hydrogen around the country

Key Challenges

- Increasing content above 10% may require changes to pipeline materials and appliances
- Hydrogen is currently high cost fuel for this application relative to natural gas



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Hydrogen in Industrial Processes

- Hydrogen use in industrial processes eg ammonia production is an existing large market
- Replacing existing 'dirty' industrial hydrogen demand with 'clean' hydrogen could lead to significant industry emissions reductions
- Scaling up industrial demand should lead to hydrogen supply cost reductions (economies of scale)
- Could lead to new industries such as 'Green Steel'



Key Challenges

- Switch over is capital intensive
- Innovation required for new industry opportunities to be realized (eg green steel)

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Hydrogen in Electricity Systems

- Electrolysis & Fuel Cell technologies can 'sector couple' hydrogen with electricity systems
- Hydrogen can be stored for extended periods 'seasonal storage' cf. batteries
- Electrolysis is a flexible load which could be used to smooth out 'boom and bust' renewable energy production on the grid



Key Challenges

- Capital cost of infrastructure
- Price point of competing technologies eg batteries

- LAVO HESS System
- 40kWh Storage
 - 5kW Power output
 - Unit weight: \$324kg
 - 20,000 Cycle Lifetime

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Hydrogen Export Partnerships

Australia has the resources and skills to build a sustainable hydrogen export industry

Australia's comparative advantage:

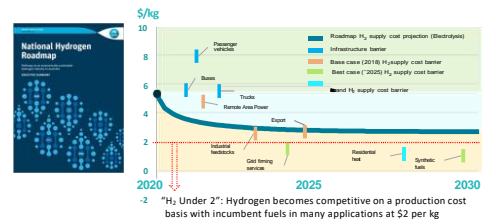
- Extensive natural resources (solar, wind, fossil fuels, CO₂ storage, available land)
- Geographical proximity
- Existing trade relationships (e.g. JAEPA, KAFTA)
- Existing Energy Resource Trade (eg LNG)
- Skilled workforce



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Costs Competitiveness Analysis: CSIRO National Hydrogen Roadmap



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Australia's Hydrogen Hubs

- Prospective Hydrogen Hubs have existing capabilities, infrastructure and resources which could aggregate supply and demand opportunities, share infrastructure, and realize economies of scale
- \$464m Hydrogen Hub Development & Design / Implementation grant round announced by Federal Government (20th September 2021)
- Most include hydrogen export opportunities as well as domestic applications

State/Territory	Hydrogen Hub
New South Wales	Bluebird Hydrogen Hub (Sydney)
Western Australia	North West Shelf Hydrogen Hub (Perth)
Queensland	Abbot Point Hydrogen Hub (Townsville)
South Australia	Port of Adelaide Hydrogen Hub (Adelaide)
Tasmania	Port of Hobart Hydrogen Hub (Hobart)
Victoria	Port Phillip Hydrogen Hub (Melbourne)
Western Australia	Port of Albany Hydrogen Hub (Albany)

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FUTURE FUELS

THE UNIVERSITY OF ADELAIDE

CSIRO

Biomethane Production from Organic Wastes

Dr Tara Hosseini (University of Adelaide & CSIRO)
Professor Peter Ashman (University of Adelaide)

May 2022

Organic Waste generation

- Waste produced in Australia are 68.9 million tonnes during the year 2016-17.
- Of the total waste produced, 21.9 % (15.1 MT) are organic waste.
- Organic wastes has a potential to be converted to a green fuel called "Biomethane"

(Australian Bureau of Statistics, 2016-2017)

The University of Adelaide

Drivers for biomethane industry

- 40% of the Australian waste is disposed to landfill because of :
 - Access to massive landmasses
 - Many abandoned open-pit mines converted into landfill
- Drivers for biomethane
 - Demand for CO₂ neutral energy production
 - Increasing electricity and gas prices
 - Rising landfill levys
 - Biomethane is easily storable and could be used with the natural gas in any proportions
 - Demand for digestate from biomethane process as soil fertiliser

(Energy Networks Australia and Bioenergy Australia, Biogas Symposium, 2019)
Photo credit: [Biogas, Green Gas, or Biomethane? Explained \(selectra.com\)](#)

The University of Adelaide

Biogas from landfills and wastewater treatment plants

- Most landfill site operations will include the collection of methane from underground.
- In some cases, the methane is burned in engines to generate electricity that can either be used on-site or sold into the electricity grid
- But in all other cases the methane is burned without recovering useful energy.
- This is done for environmental reasons since the greenhouse gas potency of methane is so much higher than carbon dioxide (21 times!).
- And so, environmentally, it is better to burn methane and release CO₂ than to emit the methane directly, which would happen if the methane was not collected.

[Methane Capture and Use | Climate Change | US EPA](#)

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Food/Garden Waste generation

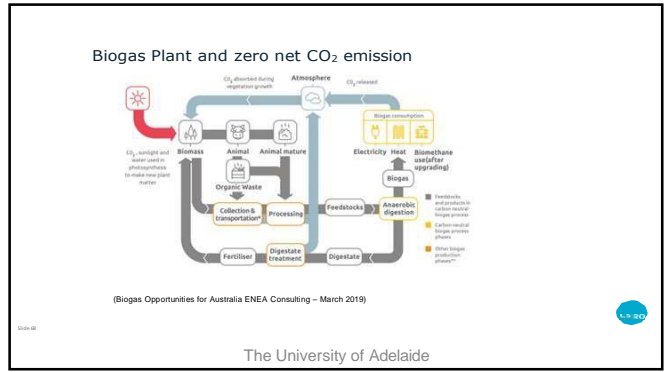
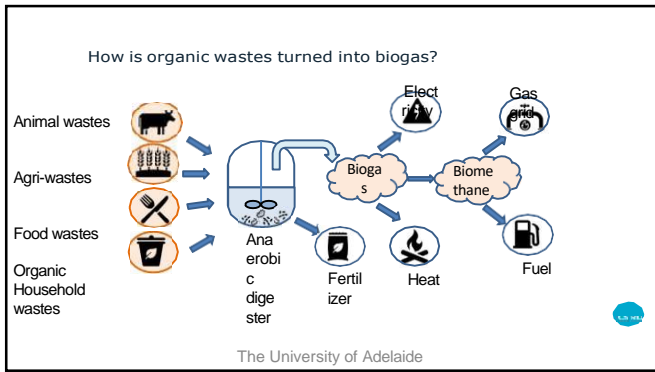
- Food waste from Kerbside Collection
- Garden waste from Kerbside Collection

(Ref: National Waste Reporting Mapping tool, Department of Agriculture, Water and Environment)

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Role of biomethane in Circular Economy

The University of Adelaide



Biogas Production status in Australia

- The Australian biogas industry is emerging. In 2016-17, electricity generation from biogas was about 1,200 GWh.
- The biogas industry in Australia is mostly dominated by landfills and wastewater plants.
- The total estimated biogas potential in Australia is 103 TWh which is comparable with current biogas production in Germany.
- Australia's biogas potential is equivalent to almost 9% of Australia's total energy consumption in 2016-2017
- Considering the current average size of biogas units in Australia, this could represent up to 90,000 biogas units .

(Biogas Opportunities for Australia ENEA Consulting – March 2019)

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Conclusions and Summary

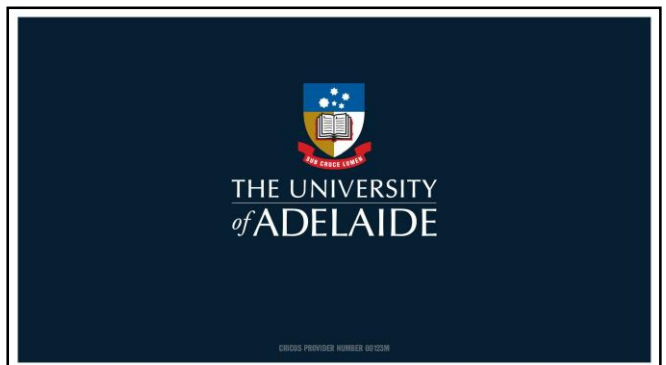
- Advantages of biomethane:
 - Resolves the organic waste problem
 - Renewable & sustainable
 - Emits less CO₂ than natural gas
 - Adapts to current infrastructure
- Biomethane can be injected into the gas grid and serve several uses for consumers such as heating, industrial purposes or fuel for gas vehicles.
- The biogas industry provides an alternative route for waste treatment while contributing to the development of local economies.
- It can be made from a large variety of organic resources, including industrial waste, agricultural wastes, energy crops, sludge from waste water treatment and biowaste

The University of Adelaide

Thanks for your attention


Any question?

Contact us:
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Peter.Ashman@adelaide.edu.au




RMIT Classification: Trusted

Understanding and addressing energy vulnerability



Dr Nicola Willand
RMIT University

FFCRC Citizens Panel, 10 May 2022





In 2015/16
- over 2% of Australians could not heat their homes.
- about 10% of Australians struggled to pay gas, electricity or phone bills.

Sources of statistics: ABS 2017, Household Expenditure Survey, Australia: Summary of Results, 2015-16, 11. Financial Stress Indicators, Claiborn.

RMIT Classification: Trusted

What is energy poverty?

No single definition – energy/ equity/ housing/ health


Lack of access to affordable, safe, renewable and reliable essential energy services (Bouzarovski 2013; Thomson, Bouzarovski & Snell 2017; UN 2019; Bouzarovski, Petrova & Tirado-Herrero 2014)

Fuel poverty = "... the inability to heat one's home to an adequate (i.e. comfortable and safe) temperature, owing to low household income and low energy efficiency" (WHO 2008)

Energy stress = "paying disproportionately more of their income on energy than the national average" (ACOSS, BSL, ANU SR&M 2018)


Energy vulnerability = intersection of risk and sensitivity to fuel poverty and adaptive capacity (Middlemiss & Gillard 2015)

Temporary/persistent (VCOSS 2018) **Spectrum**




RMIT Classification: Trusted

How should we measure it?



"It is a societal expectation that people can heat their home to a comfortable temperature"¹




¹ Regulatory Impact Solutions 2020, Regulatory Impact Statement Residential Tenancies Regulations 2020.
² https://www.ec.europa.eu/eurostat/en/web/energy/energy-poverty


RMIT Classification: Trusted

Energy vulnerability = risk of harm due to energy poverty

= Intersection of risk and sensitivity to energy poverty and adaptive capacity



Sources: Bouzarovski (2013), Middlemiss & Gillard (2015), The Energy Vulnerability Index (2017), UN (2019)



How should we measure it?


Vulnerability approach

Adaptive capacity

- Agency
- Choice
- Control
- Education
- Energy literacy
- Financial literacy
- Access to technology & information
- Dwelling characteristics
- Tenancy and consumer laws
- Negotiation of the energy market

Sensitivity

- Old and very young people
- Physiological illnesses
- Mental illnesses



(ACOSS & BSL 2019; ACOSS, BSL & ANU CSRAM 2016; ACOSS, BSL & TCI 2017; Liu & Judd 2017; Watt et al. 2016; Willand & Horne 2018)

Why does it matter?

Because it may be a physiological health risk

Energy deprivation

Cold home


Infectious diseases

Mould & dampness

Hypothermia, chill blains

Respiratory & cardiovascular diseases

Avoidable winter deaths



(Chard & Walker 2016; Liddell & Guiney 2015; Marmot Review Team 2011; Nicholls et al. 2017)

Evidence

Studies:

Unexpected high incidence of hypothermia when staying indoors, even in summer (VIC, SA)

Risk factors:

- age >65 years,
- chronic disease,
- living on a pension,
- social isolation

(Bright et al. 2014; Forcay et al. 2019)




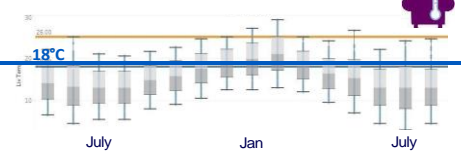
Photo from Pixabay

Example

Retired woman, owner occupier, living alone, Tasmania,

- perceived home as being uncomfortably cold,
- Went to bed early at night to keep warm (Willand et al. 2019)

→ Adequate minimum temperature threshold 18°C (WHO 2018) not achieved in any month, even in summer



Why does it matter?


Because it may be a physiological health risk

Energy deprivation

Hot home

Hyperthermia

Avoidable summer death



(Chard & Walker 2016; Liddell & Guiney 2015; Marmot Review Team 2011; Nicholls et al. 2017)

Why does it matter?

Because it may be a mental health risk

- Anxiety about bills
- Perceived lack of control

"Next month is going to be a shock. Because we know that in the winter we're going to have a large bill."
George, age 78

Because it may be social health risk

- Compromising on
- Social activities
- School trips
- Job interviews that require transport

"We're not in Probus, they go on trips... and think like that. We spent money in that, and we've got that in our pockets now, so that makes it a bit easier for us, with our bills."
Larry, age 83

Why does it matter?

Because it may be a hidden problem

Some people may not seek help due to

- Pride
- Frugality
- Priorities in paying bills
- Support shifting

"I take the money off of the food to make sure the bills are paid."
Natalie, age 69

"We've never had to struggle about paying our bills. We go without."
Emily, age 85





Photo by Roman Lachev from Carva

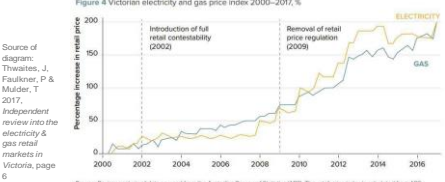


Why does it matter?


Because the problem is likely to increase

- Energy prices are increasing more than income support
- Cost of housing is becoming more unaffordable
- More people are renting

Figure 4 Victorian electricity and gas price index 2000–2017, %



Source: Review analysis of data sourced from the Australian Bureau of Statistics (ABS). The retail price index is calculated from ABS Consumer Price Index (CPI) figures. The CPI calculates the price using relative standing offers.



Why does it matter?


Because the low carbon transition should not disadvantage any people

- Paris Agreement:

Parties should [...] respect, promote and consider their respective obligations on human rights, the right to health, [...] persons with disabilities and people in vulnerable situations [...]. (UN 2015)

Because affordable and clean energy is a Sustainable Development Goal

- Ensure access to affordable, reliable, sustainable and modern energy for all. (UN 2019)



Mapping Vulnerability to Future Fuels: A Scoping Review

Role of gas in energy disadvantage and vulnerability in Australia

35 sources – little differentiation of energy carriers

! multifaceted

- individual factors - employment, health conditions, disability and age.
- external - living in rental houses and social housing, housing with poor thermal performance, inefficient technology.
- policy and market factors - gas price structures, access to retailer hardship, government support programs




Mapping Vulnerability to Future Fuels: A Scoping Review

Influence of future fuels on energy vulnerability

15 sources – mostly UK and EU, no research/data in Australia

"decarbonisation of heat" (fuel poverty)

- higher cost of energy
- cost to change appliances
- + better access to reliable energy for rental
- + security of energy supply through diversification
- + lower energy costs from utilising existing infrastructure





Photo by Emma Charlton from Unsplash

+ positive opportunity costs of moving to low carbon gas



Energy vulnerability measures

- Policies & programs**
- Local level**
- Individual level**





Photo by Pavel Danilyuk from Pexels

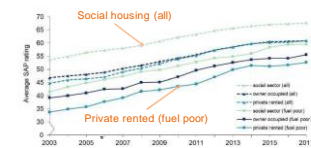


Policies and programs

Promotion of housing energy efficiency

- Minimum energy efficiency standards for rental properties
- Target retrofit subsidies at vulnerable households (SA 100%, ACT 30%, VIC 0%)
- Ensure benefits of solar PV for vulnerable households
- Improve energy efficiency of social housing

Figure 1: Average SAP rating by tenure, fuel poor and all households, 2003-2017?



Source of diagram: BEIS 2019, Consultation on the Fuel Poverty Strategy for England, EIS Department for Business, page 9

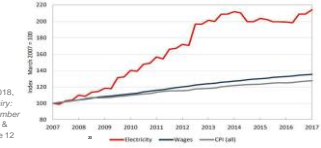


Policies and programs

Energy concessions

- Ensure equality among states (type, amount)
- Extend beyond welfare recipients (e.g. 'working poor')
- Improve identification of eligible households
- Ensure easy application processes
- Ensure effectiveness

Figure 1.3: CPI for electricity compared with other sectors and wage growth



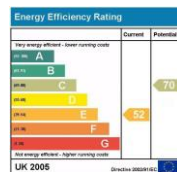
Source of diagram: ACCC 2018, Retail Electricity Pricing Inquiry, Preliminary Report, 22 September 2017, Australian Competition & Consumer Commission, page 12



Policies and programs

Information provision

- Advice on energy bills, energy practices, income support
- Tailor energy advice to individual households (language, type of home, avoid entrenching of existing curtailing practices)
- Collaborate with trusted intermediaries, e.g. community groups
- Introduce mandatory energy efficiency assessments for existing dwellings



Source of image: Grato, via Wikimedia Commons



Policies and programs

Protection of consumers in the energy market

- Ombudspersons – independent complaint-handling services
- E.g. Victorian Default Offer (electricity only)
- COVID19-triggered measures in VIC:
 - No disconnection of hardship customers
 - Credit pay-on-time discount even if payment is late
 - Temporary obligation for energy retailers to check eligibility for concessions

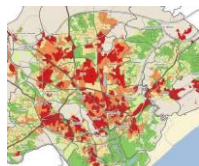


Local level

Council-led initiatives

- Top-up subsidies, bulk-buy schemes, community education
- E.g. UK, Europe: local initiatives and collaborations
 - Identification (maps, GPs, other front-line workers)
 - Single point of referral
 - Comprehensive assistance
 - Employment of long term unemployed people

e.g. UK Poor housing map – prevalence of EPC E/F/G rated dwellings



Source of image: FRESH 2021, The FRESH Suite of Maps, Warm Wales - Cymru Cymnes Cymen Cymroedd Cymunedol, viewed 20 February 2021, https://www.fresh-energy.org/energy-maps/2021-08-06-01



Individual level

What YOU can do:

- Ensure energy efficiency in your rental properties
- Watch for hidden energy poverty
- Help family members, friends and neighbours
- National resources
 - [Energy Consumers Australia](#)
 - [Energy Made Easy website](#)
 - [DISER Households](#) (look for your state)



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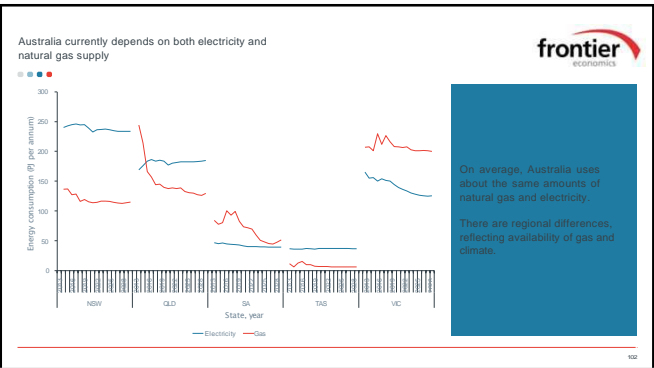
Willard, N, Ambrose, M, Watson, P & Tromsley, J 2019, Collecting and analysing indoor temperatures for health: A review of methods, paper presented to Increasing Residential Energy Efficiency (IREE) 2019 Conference, Brisbane.

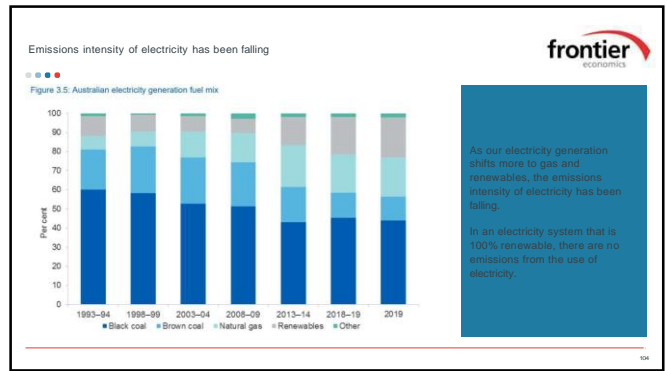
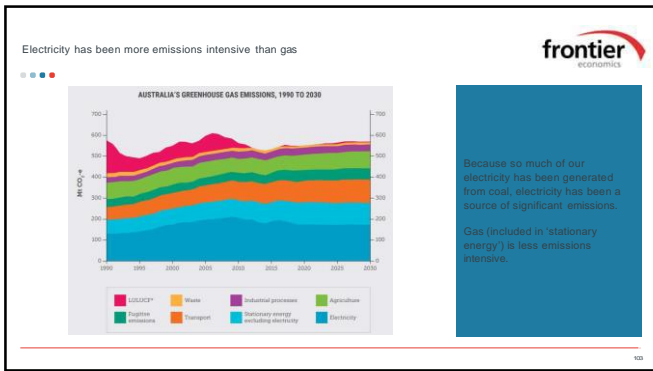
Willard, N & Horne, R 2019, "They are grinding us into the ground" - The lived experience of energy (in)justice amongst low-income older households, Applied Energy, vol. 228, pp. 61-70.



Thank you

Email: ecola.willard@rmit.edu.au



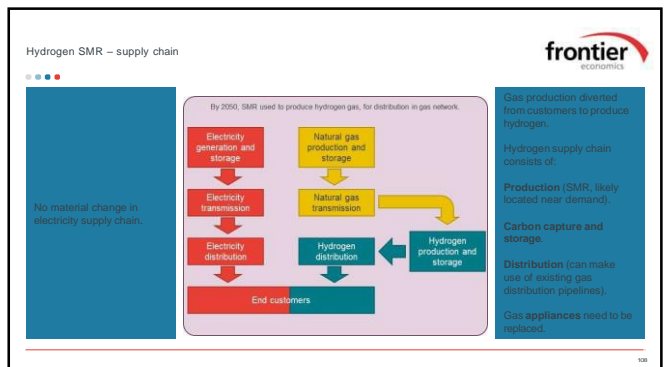
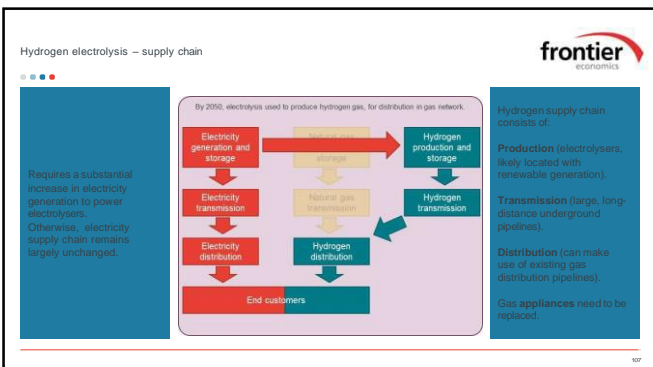
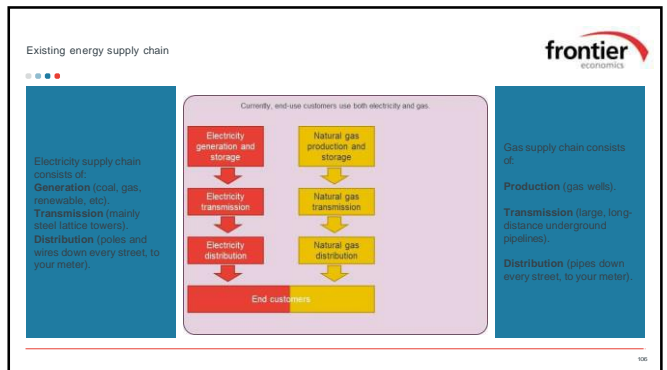
Reducing emissions from the use of natural gas is more challenging

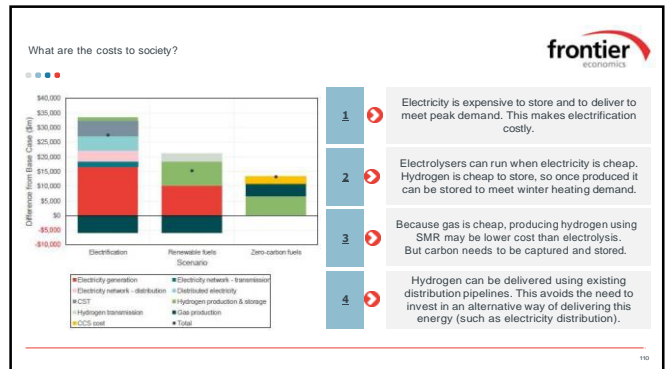
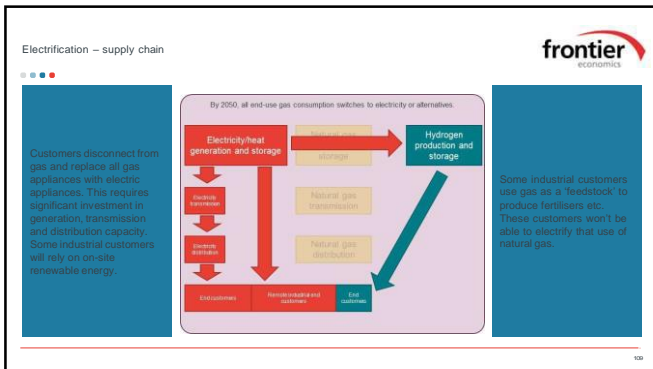
Emissions occur when natural gas is combusted in appliances. These emissions can't be avoided or captured, which means that alternative approaches to reducing emissions from this energy use are required.

Option 1: Hydrogen electrolysis	Switch to using hydrogen instead of natural gas. Produce hydrogen using electrolysis powered from renewable electricity.
Option 2: Hydrogen SMR	Switch to using hydrogen instead of natural gas. Produce hydrogen using natural gas SMR. Capture the carbon emissions from SMR, for storage or use.
Option 3: Electrification	Switch to using electricity instead of natural gas. Generate electricity from renewable sources.

Other options are also possible, such as biomethane or other forms of renewable for industrial customers.

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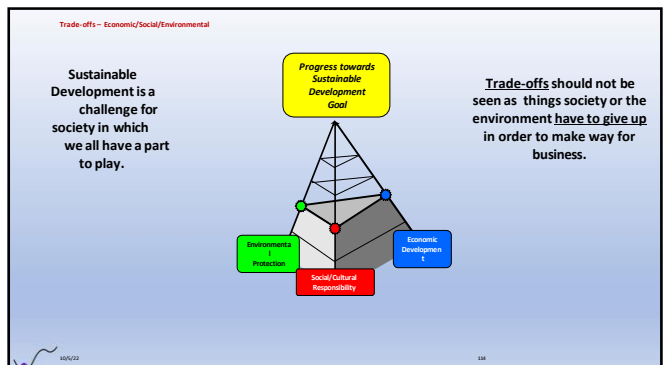


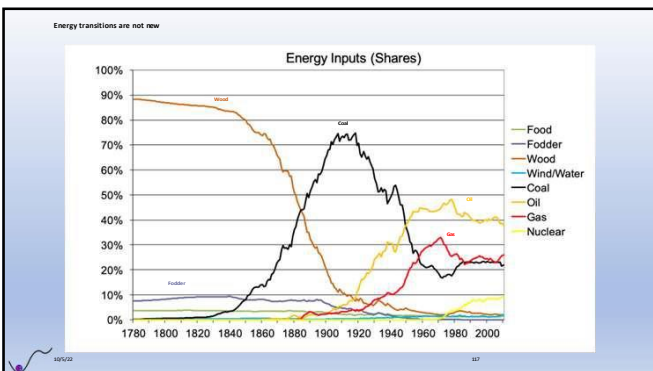
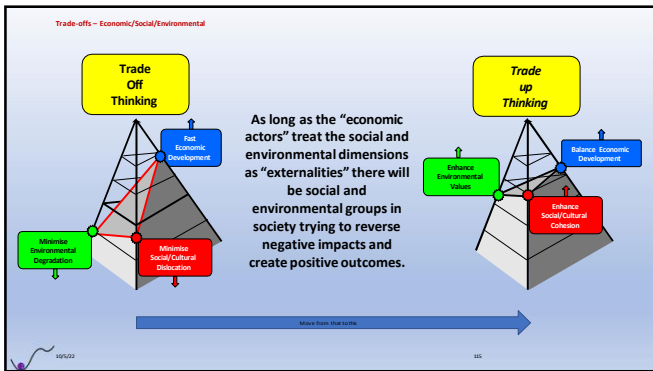
- ### What are the implications for households?
- Households that currently use gas appliances would need new appliances:
 - Hydrogen blends up to 10% can be used in existing appliances. Beyond that, new appliances will be needed.
 - Households that electrify will need new electric appliances (heat pumps, electric cooktops, etc).
 - Households that electrify will also face additional costs. These could include, additional wiring, re-wiring to increase capacity, upgrading power supply, etc.
 - Households that electrify may increase the value of their solar panels by being able to consume more of the electricity they generate.
 - What happens to total bills is uncertain:
 - Gas is typically cheaper than electricity.
 - But electric appliances can be more efficient than gas appliances.



Trade-offs and Challenges of Energy Transitions

Greg Bourne - Climate Councillor
Formerly Chair - Australian Renewable Energy Agency
CEO - WWF Australia
Regional President - BP Australasia





Transitions bring change and trade-offs

All social and economic transitions come with:

- Job creation – Job losses
- Resistance to change – Acceptance of change
- Incumbent Pains – New entrant Gains
- Location of Pains – Location of Gains

Job changes affect different groups very differently!

Transitions bring change and trade-offs

Economic changes - domestic and exports

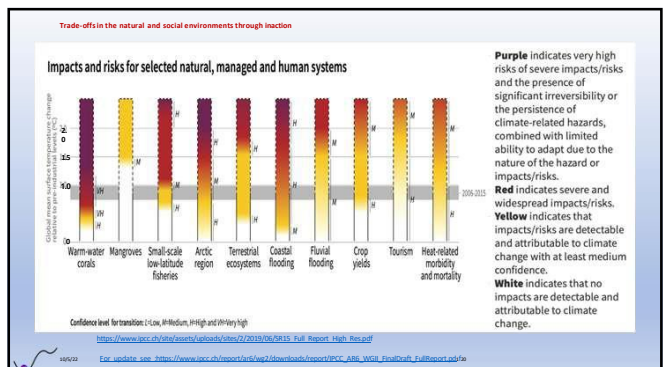
- Coal phases out – Cleaner air – health benefits
- Gas (Natural gas) phases down - Hydrogen phases in – Cost penalty?

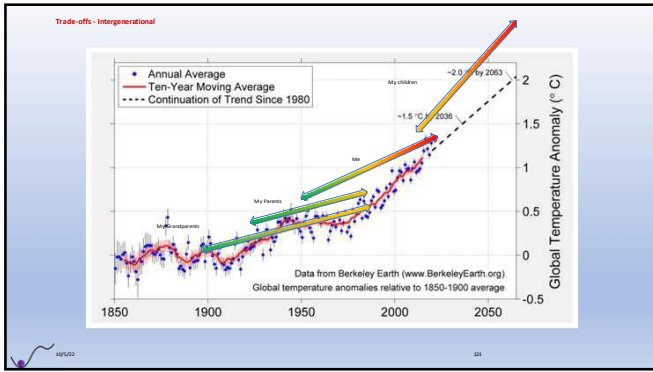
Gasoline and diesel phase out – electricity for EVs phases in – electricity bills higher, but petrol/diesel bills lower.

Less aquifer and watershed pollution and land pollution from mining and gas extraction.

More visibility of energy generation and storage

- wind, solar, batteries, pumped hydro storage





Thank you and
 questions
 comments!

VICTORIA'S GAS SUBSTITUTION ROADMAP*

Victoria State Government
 Environment, Land, Water and Planning
 10 May 2022

*Presentation is not included upon request of Victoria Government

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Future Fuels CRC

Enabling the Decarbonisation of
Australia's Energy Networks



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Australian Government
Department of Industry, Science,
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