THE UNIVERSITY OF QUEENSLAND
AUSTRALIA
CREATE CHANGE

Clean Fuels – Considerations

Presentation to Carmageddon

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NO MORE WIND TURBINES
FOR SOUTH GIPPSLAND
BRACKS COASTAL VANDAL
on the PROM COAST
NO WIND POWER STATION
NEAR FOSTER NTH HOMES
EFF OFF!


NO FRACKING
FRACKING

Hydrogen

What do Jack Nicholson and H_2 have in common?

Back in 1978….

Why hydrogen?

- Low carbon
- Can be used as an energy carrier when electrons are not the optimal choice (i.e. long haul trucking, renewable energy export)
- Seasonal storage
- Industrial applications (zero emissions steel and fertilisers)
- Maintaining diversity in our fuel choices (electricity goes down stored hydrogen similar to gas back up)

Colours of hydrogen

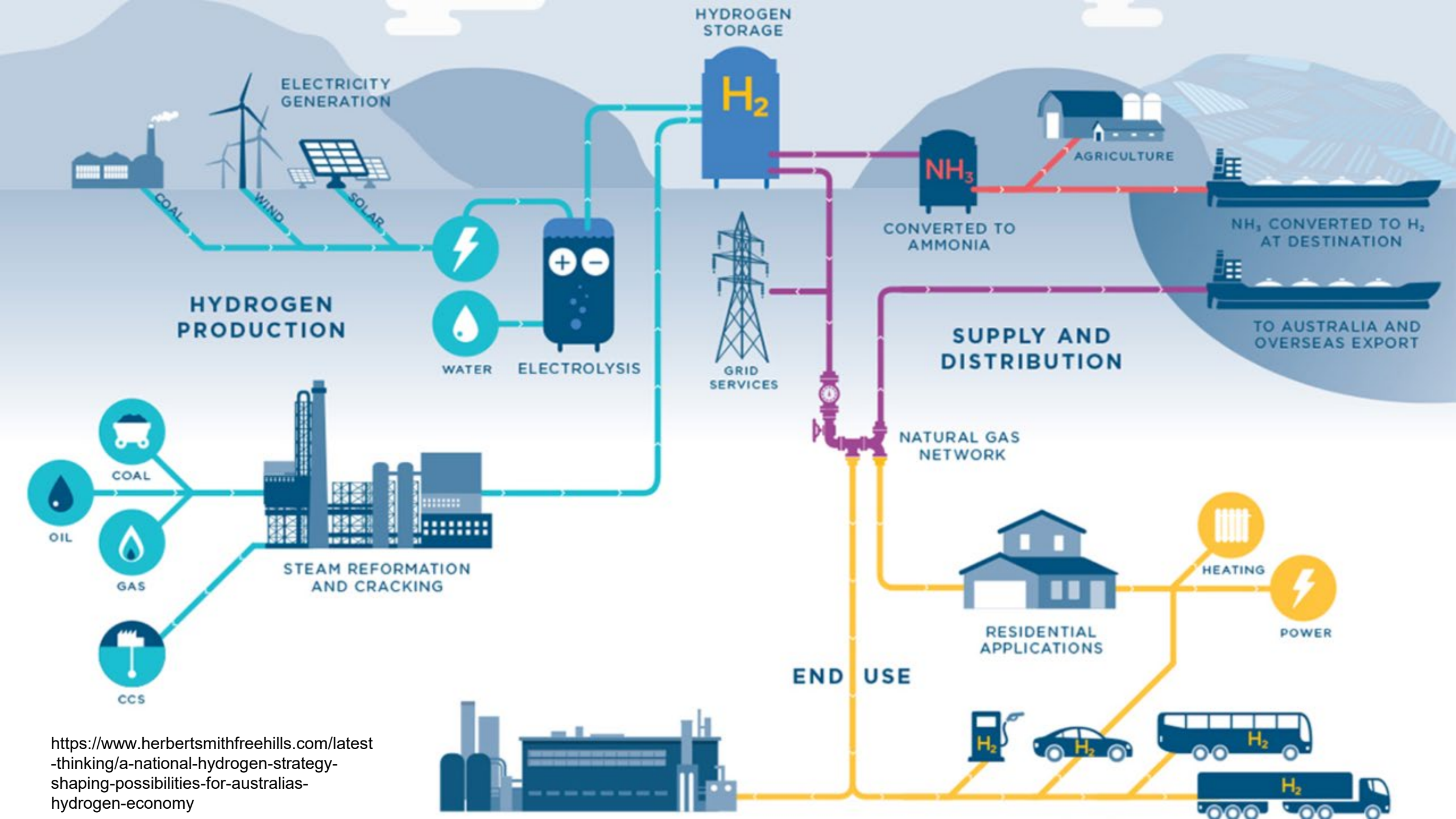
Black H_2: Hydrogen formed through coal gasification, emits CO_2.

Brown H_2: Hydrogen formed through lignite gasification, emits CO_2.

Grey H_2: Hydrogen formed through processing of hydrocarbons, such as via SMR, emits CO_2

Blue H_2: Hydrogen from grey, black or brown hydrogen but CO_2 is is captured, utilised (CCUS)

Green H_2: Hydrogen formed via electrolysis of water using renewable electricity and no CO_2 emissions.



https://www.herbertsmithfreehills.com/latest-thinking/a-national-hydrogen-strategy-shaping-possibilities-for-australias-hydrogen-economy

Mission Innovation 8 – 5 Key success factors

Needs a convincing project concept with a hydrogen value chain coverage that leverages local assets (e.g. abundant renewable energy sources) and addresses local needs (e.g. the decarbonisation of local industrial production)

Needs to develop a viable business case that links competitive clean hydrogen production with the off-takers' willingness to pay

Needs to obtain public support and/or funding (potentially from multiple sources) that closes any remaining funding gaps

During project development,

Needs effective partnering and stakeholder cooperation that ensures continuous commitment from all parties involved

Needs to gain political backing from policy makers and support by the general public

Four Barriers to Hydrogen Valleys

1. **Securing funding**
   a. creating awareness about the technology at funding entities,
   b. initiating proactive dialogues about funding criteria, and
   c. remaining flexible regarding the potential adaptation of the project concept to tailor it to public funding requirements
2. **Securing off-take** commitments for clean hydrogen.
3. **Securing private investment** using a structured development approach, early involvement of off-takers and equity partners that de-risk the project as well as early feedback from the lending community. Involving local private investors might additionally be attractive for locally anchored valleys (hubs).
4. To mitigate technological readiness and technological performance barriers – remain flexible regarding the project's general direction. Even adding other applications into the portfolio

Transport - EVs

Dr Jake Whitehead
Tritium E-Mobility Fellow
Advance Queensland Industry Research Fellow

6 ways to enable Queensland's Cheap, Efficient, Sustainable Transport Future

1. Vehicle electrification
2. Electric vehicles as "batteries-on-wheels"
3. Unlocking the potential of Mobility as a Service (MaaS)
4. Finding a pathway forward for transport pricing
5. Highlighting the need for system-level + multi-dimensional thinking in transport
6. Strategic application of energy vectors where fit-for-purpose + maximise emissions reductions







TRANSPORT EMISSIONS IN AUSTRALIA

Transport emissions by source

- 85% Road
- 4% Rail
- 9% Air
- 2% Ship

TRANSPORT IS THE **3RD LARGEST** source of emissions

18% of **Australia's greenhouse gas emissions** in 2015

Highest growing source of emissions

51% SINCE 1990

ROAD TRANSPORT = 85%

of all transport emissions

CARS = 46%

of all transport emissions

2016 GLOBAL RANKINGS: TRANSPORT ENERGY EFFICIENCY

TOP

1ST INDIA

2ND ITALY

3RD JAPAN

4TH CHINA

BOTTOM

22ND AUSTRALIA

23RD SAUDI ARABIA

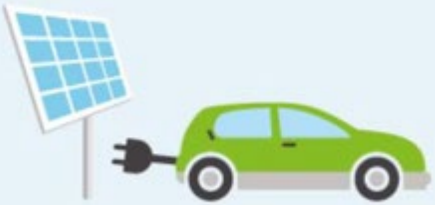
WHY?

- High distance travelled by car per person
- High emitting cars
- No emissions standards
- Low use of public transport
- Low government spending on public transport

KEY SOLUTIONS

Public Transport

Mandatory Greenhouse Gas Emissions Standards



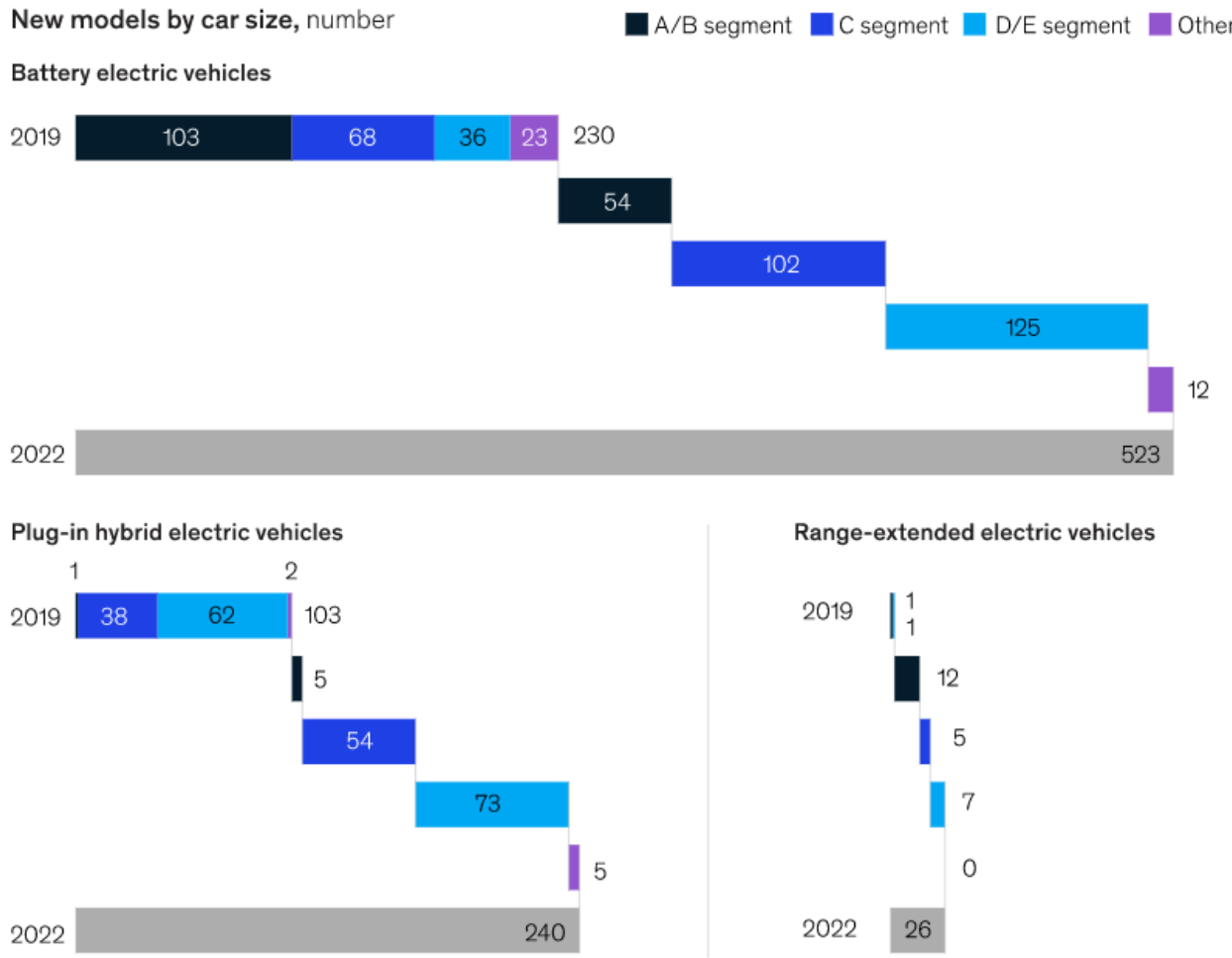
Electric Vehicles Powered by Renewables

Light Vehicles - a clear leader

- Includes battery-electric (BEV), plug-in hybrid (PHEV) and range-extended electric (REEV)
- Highest energy efficiency = lowest TCO
- Can deliver energy sector co-benefits

About 450 new electric-vehicle models will be launched through 2022.

New models by car size, number

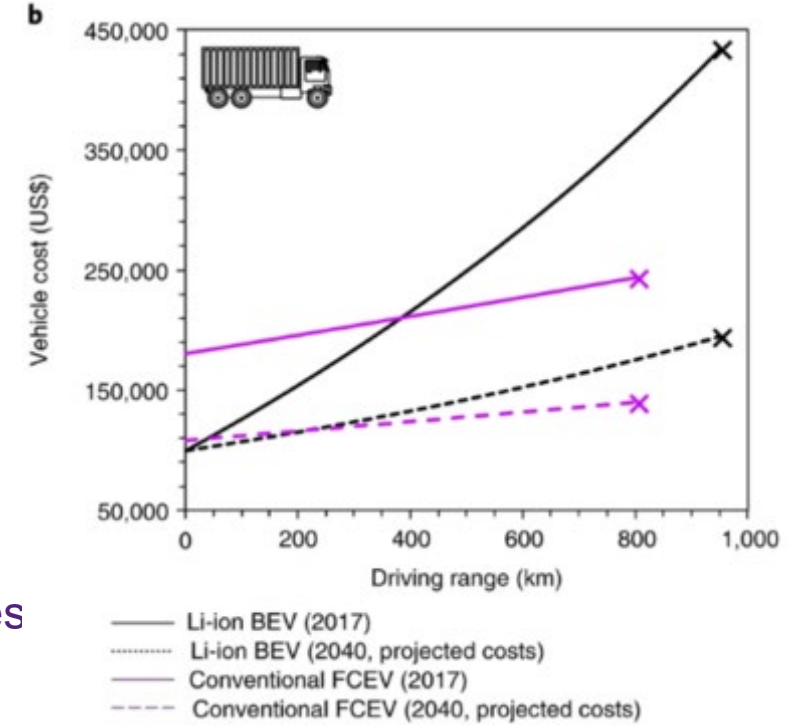


Source: IHS Light Vehicle Powertrain Forecast, May 2020

McKinsey & Company

Heavy Vehicles - challenging

- Less clear in terms of dominant pathways
- Battery-electric at TCO parity with diesel for many short-haul applications today (city buses, trucks)
- More challenging for long-haul; depends on capital and operating cost-curves
- Likely a mix of:
  - Battery-electric
  - Hydrogen fuel cell (primarily around H2 hubs, with other H2 applications)
  - Biofuel/Hybrids for remote applications
  - Potential also for road electrification to support electric/hydrogen/hybrid vehicles on major routes



Marine and Aviation - most challenging!

Electric / Hybrid (Short Haul)

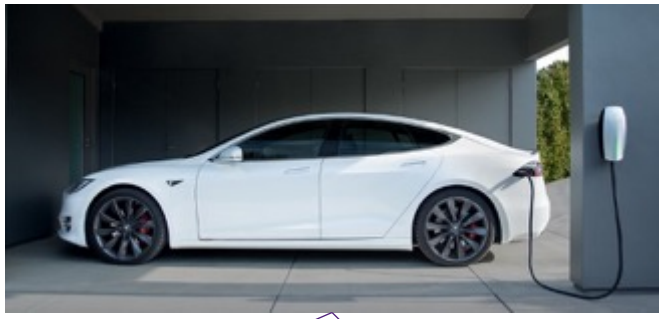
Electric / Hybrid (Short Haul)

Hybrid / Hydrogen / Hydrogen-derivative (Long Haul)

Hybrid / Biofuels / Synthetic Fuels (Long Haul)

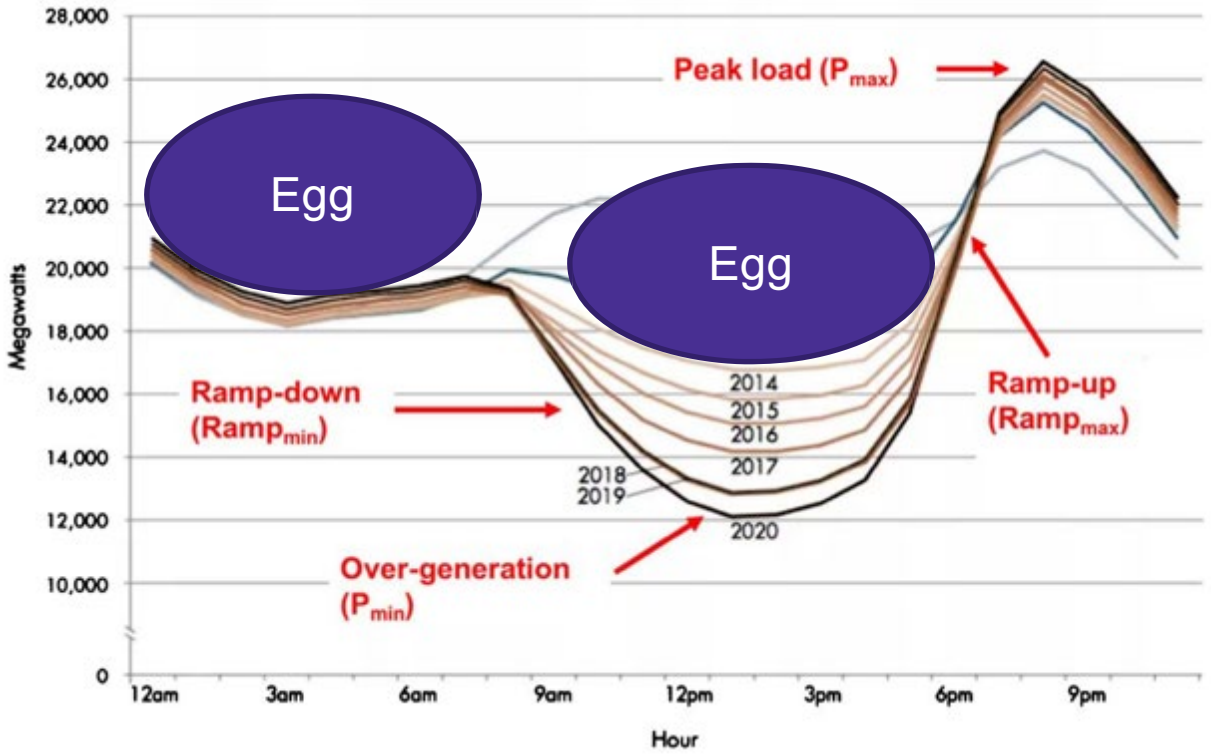
Also consider the Transport-Energy Nexus

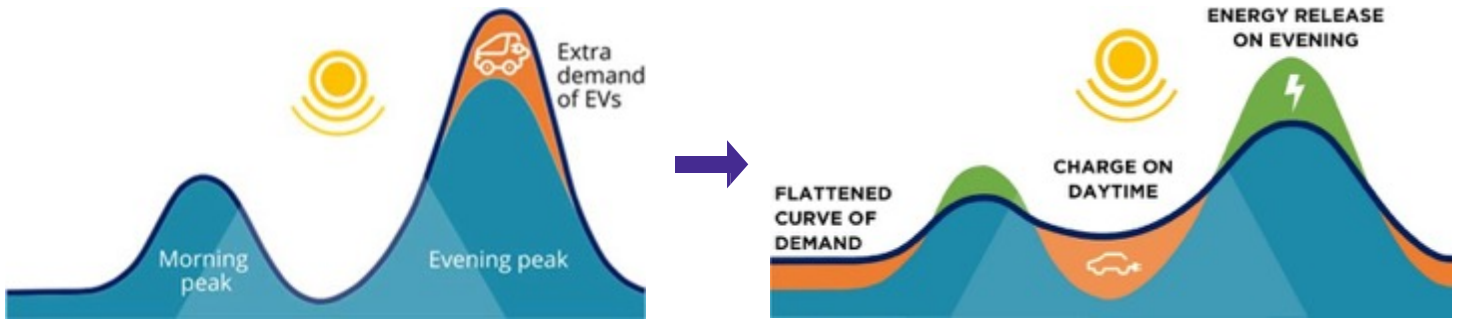
- Electrification of transport presents a number of opportunities to leverage energy storage
- As “batteries-on-wheels”, parked 90%+ of the time, can soak up excess solar/wind + support grid stability + backup for blackouts + other mobile uses (camping, electric tools)



EV Smart Charging → "The Duck's Eggs"

- Opportunity for EVs to absorb solar generation during day through smart charging regimes (V1G)
- Export electricity to grid during early evening to minimise grid ramp up through vehicle-to-grid (V2G) chargers
- Charge again overnight (if required) utilising wind/excess baseload , further flattening load profile
- Approx. 14M cars in Australia → if all 300-km EVs, store enough to power nation for 24-hours and still meet average transport demand (daily kilometres)





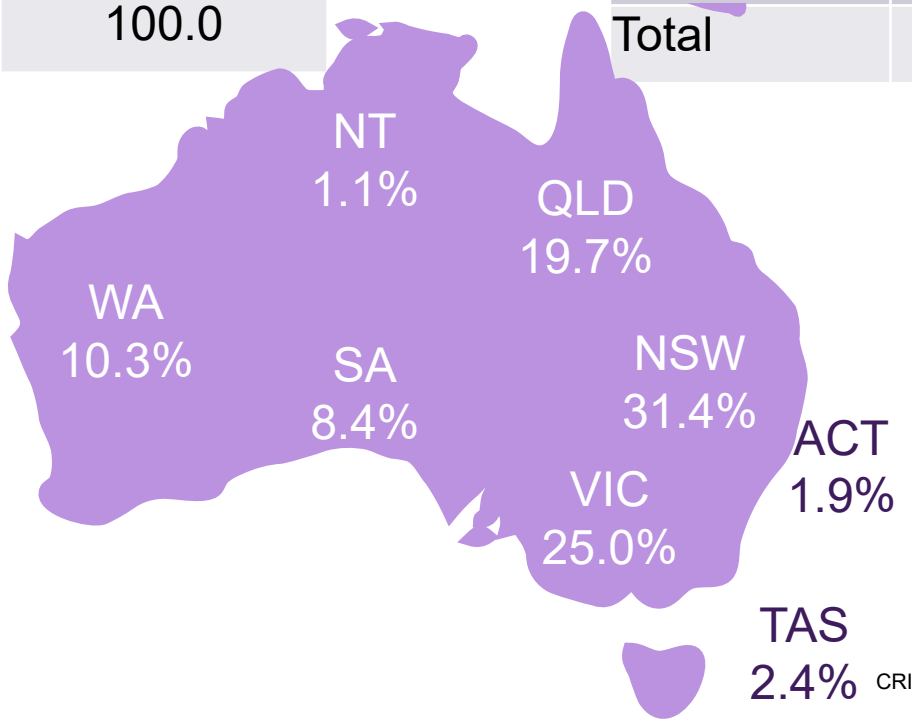
Recent national survey results, 2021

Social License to Operate Work Package:
Funding from the Future Fuels CRC

Who participated?

Age group (years)	*n*	%
18 - 34	899	29.8
35 - 54	1026	34.0
55+	1095	36.3
Total	3020	100.0

Gender	*n*	%
Female	1543	51.1
Male	1463	48.4
Other	14	.4
Total	3020	100.0



When you hear the word hydrogen what are the first things that come to mind?

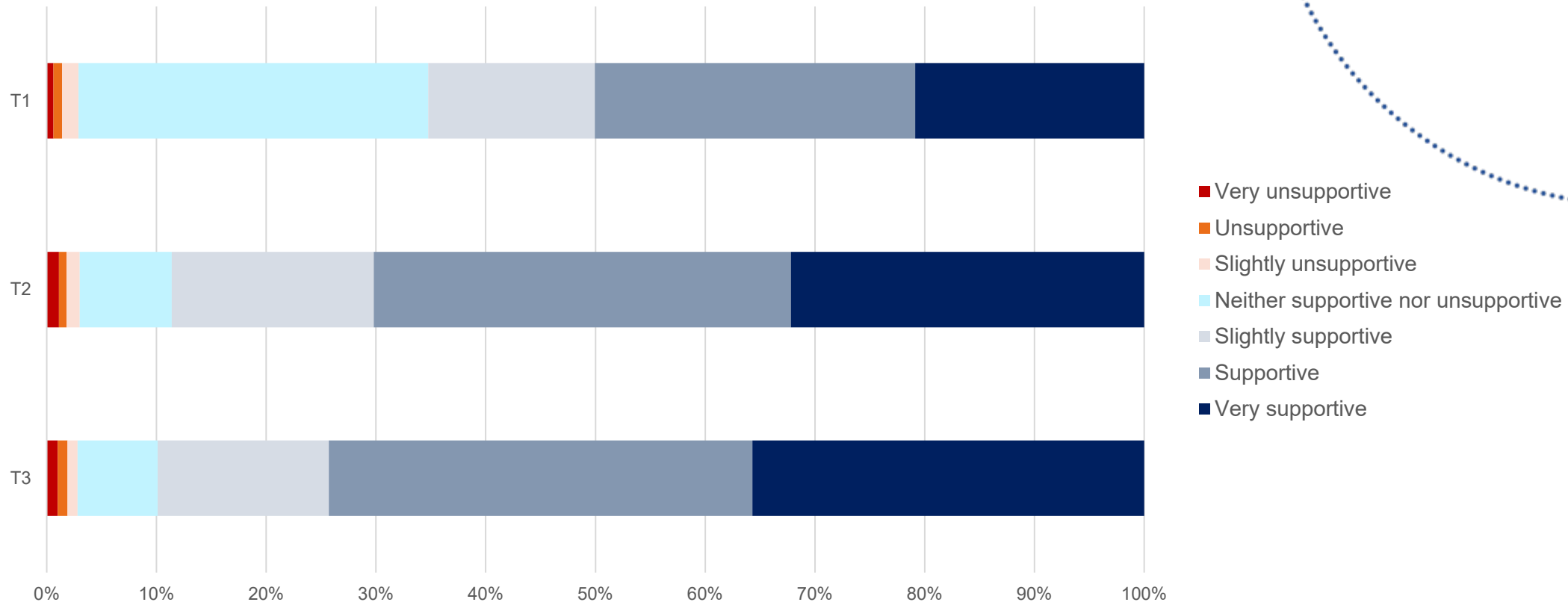
Category	Example responses	n	%
Chemical/chemistry	a chemical; atom and elements; first element on the periodic table; science;	1373	45.5
Energy/power/fuel(s)	a fuel; a source of energy; alternative power source	660	21.9
Water	water; part of water; emits water	627	20.8
Bomb/nuclear weapon	bomb; nuclear weapon; Hiroshima	281	9.3
Hydrogen properties	flammable gas; lighter than air; explosive	180	6.0
Nothing/none/don't know	don't know; I am not sure; I have no idea	152	5.0
Air/atmosphere	fresh air; part of the air we breathe; a compound in our atmosphere	102	3.4
Balloons	balloons; gas used to blow up balloons; hot air balloons	63	2.1
Hindenburg/blimp	Hindenburg disaster; blimp; used in early airships;	56	1.9

There has been discussion about using hydrogen in Australia recently

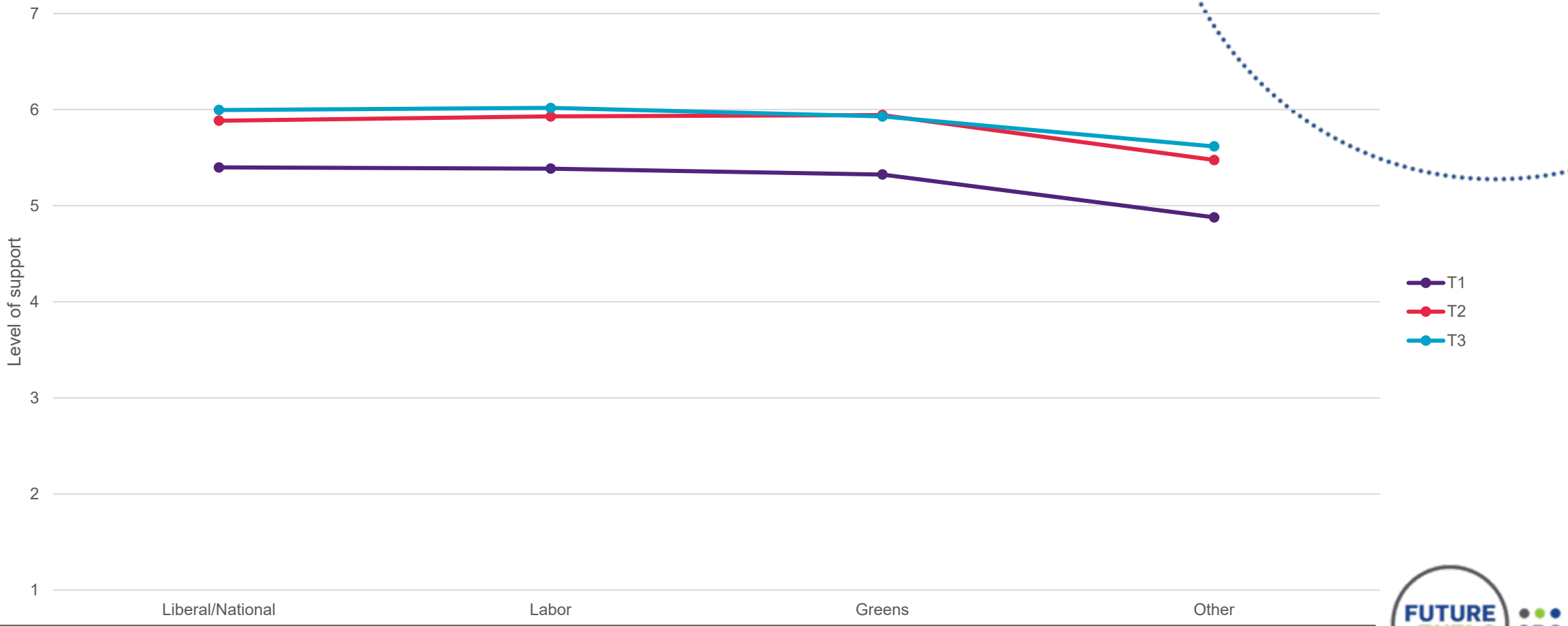
Please respond to the following statements.	Yes		No		Unsure	
	n	%	n	%	n	%
I have heard about a project blending natural gas and hydrogen for domestic use	628	20.8	2007	66.5	385	12.7
I have heard about a hydrogen production project in Australia	817	27.1	1808	59.9	395	13.1
I have heard about hydrogen in the media	1171	38.8	1528	50.6	321	10.6
I have heard about the National Hydrogen Strategy	443	14.7	2202	72.9	375	12.4

More people in Tasmania (51.0% more than expected), Northern Territory (26.4%), New South Wales (9.7%), South Australia (9.2%), and the Australian Capital Territory (3.9%) had heard about a hydrogen project in Australia.

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



Level of support for hydrogen by political party preference?



Australian Attitudes Towards the use of Hydrogen in the Transport Sector (2018)

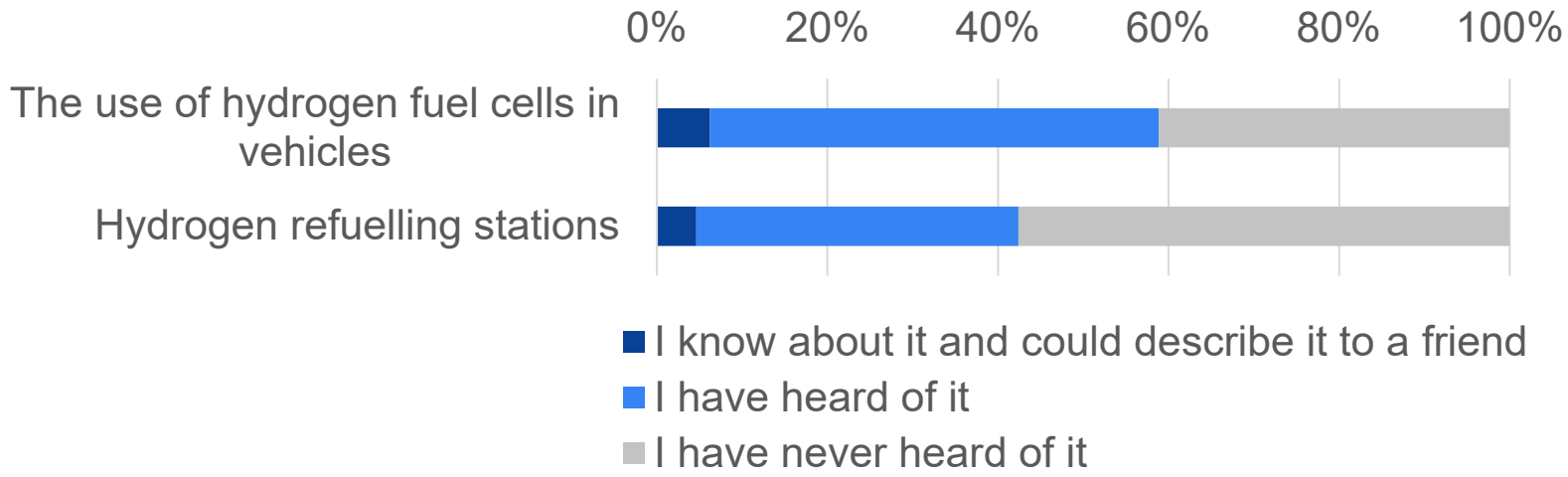
Work funded by ARENA

Aim and approach

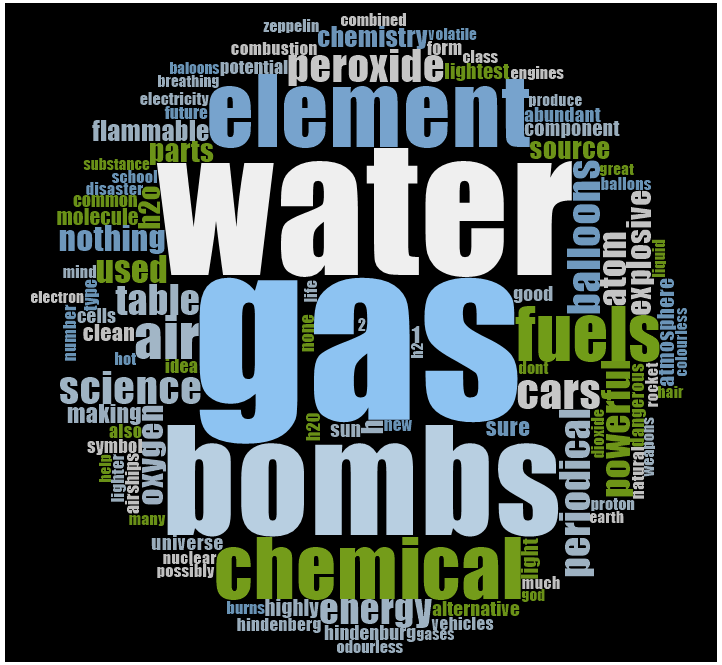
- *To gain an understanding of the Australian public's attitudes towards hydrogen*
- 10 focus groups (N=92) in June 2018
  - SA: Adelaide, Whyalla
  - VIC: Melbourne, Traralgon
- National survey (N=2785) during September 2018
  - Export (N=916)
  - Transport (N=948)
  - Domestic uses (N=921)

Hydrogen knowledge is limited

Awareness of hydrogen energy technologies is low



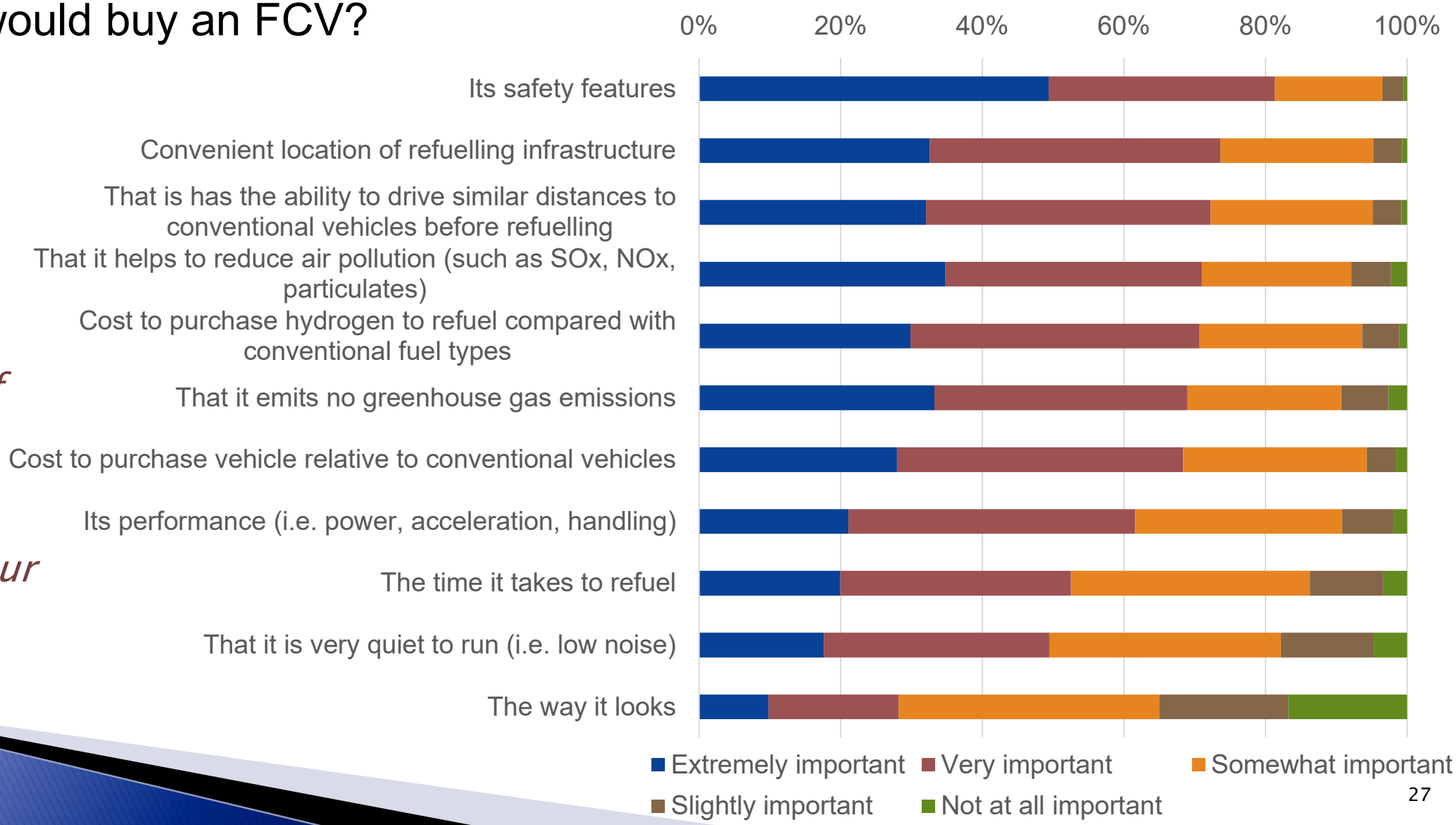
What are the first things that come to mind when you hear the word hydrogen?



- Neutral: 81% (e.g. gas, energy, water)
- Negative: 13% (e.g. bomb, explosion)
- Positive: 3% (e.g. clean, future)
- Did not know: 4%

Safety is *highest* priority

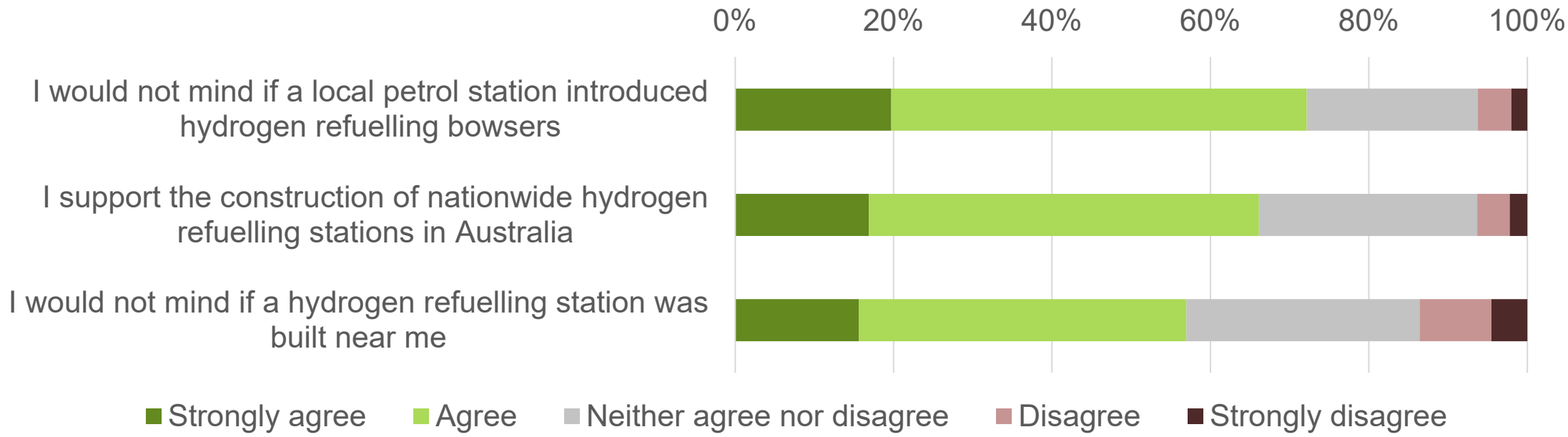
- How important are the following factors in determining whether or not you would buy an FCV?



"Bottom line, if you are in a catastrophic accident in a car…what's your survivability?"

Support for refuelling stations

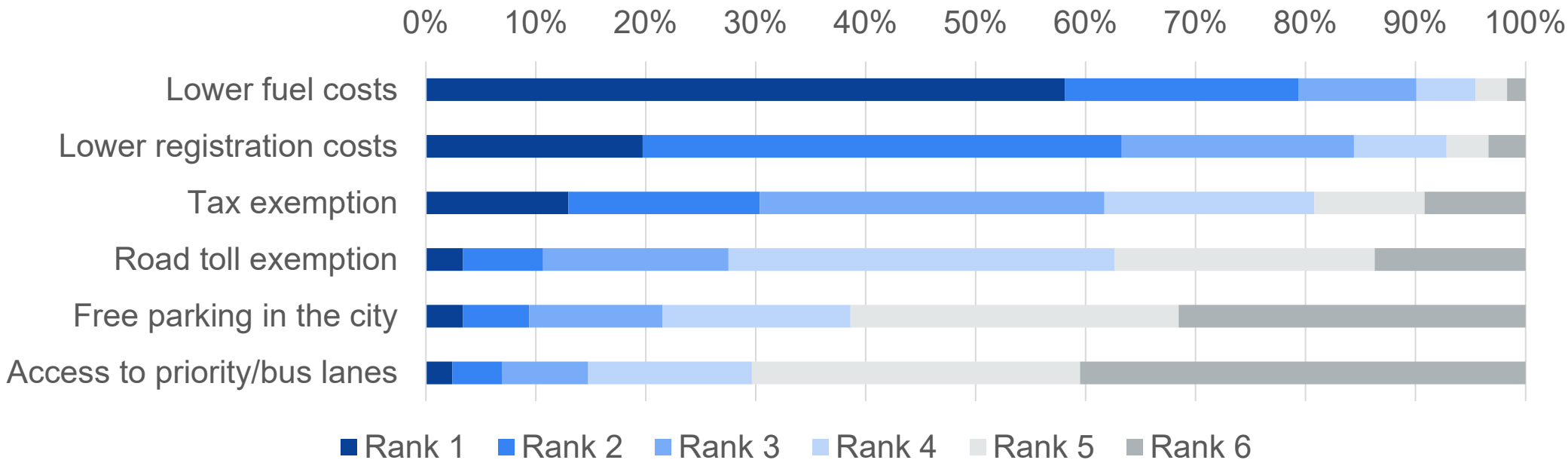
- Convenience of refuelling infrastructure 2nd most important



"It's got to be convenient and easy as well"

Ranking of government incentives

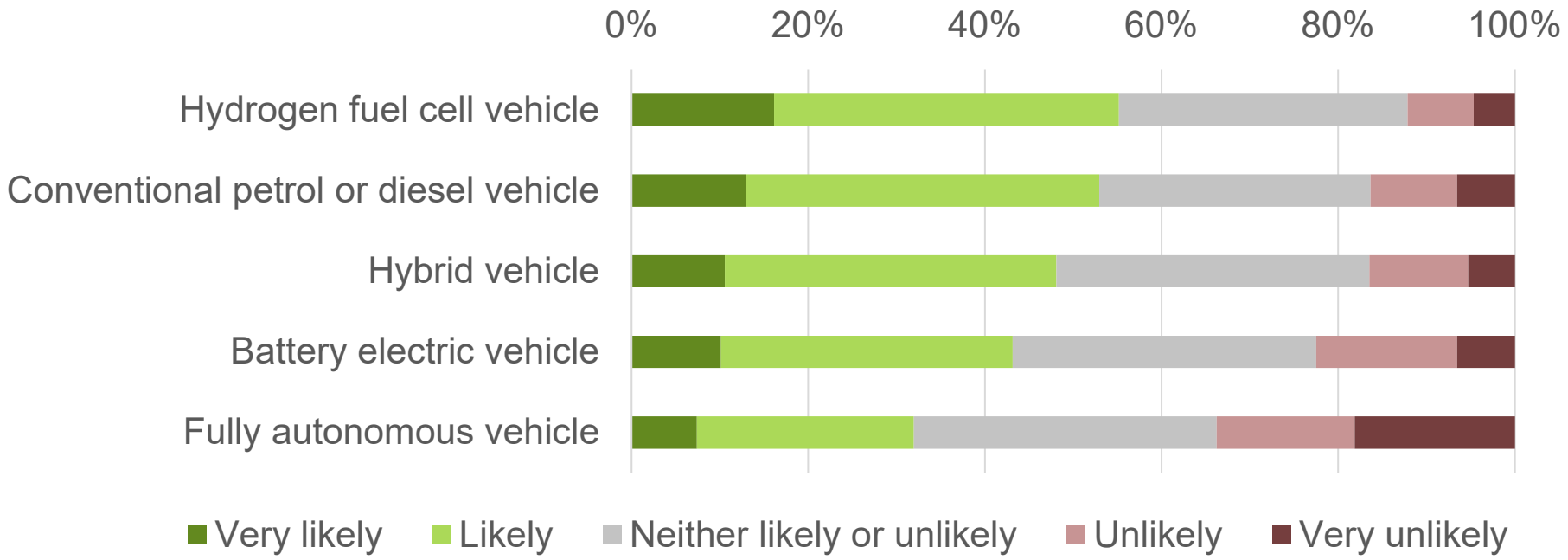
- Which of the following government incentives would likely motivate you to purchase a hydrogen fuel cell vehicle?



61% would be happy to buy a hydrogen vehicle if the cost was the same

Vehicle preference

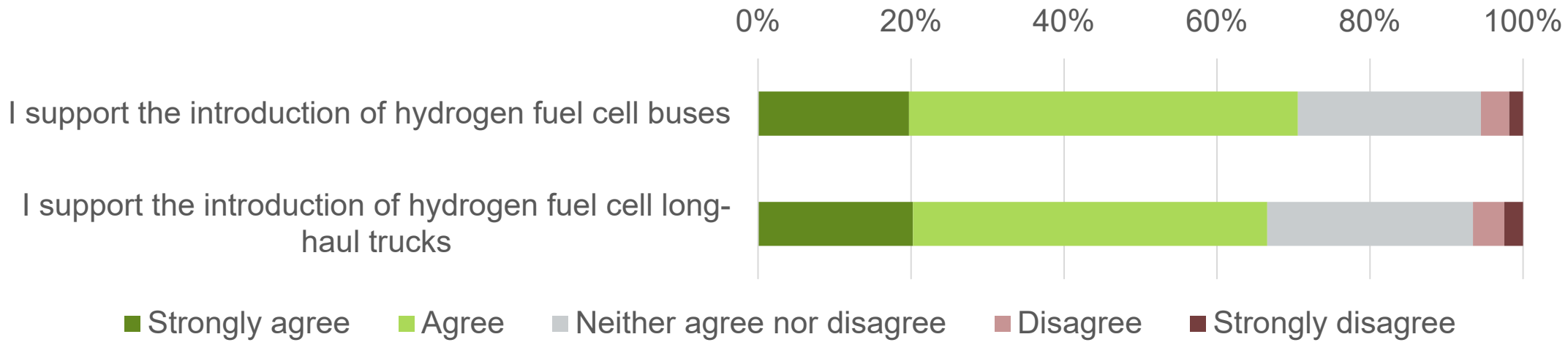
- If price, features, design, brand etc. were the same, how likely would you be to purchase the following type of car?



"…the longer travel range, that's very appealing."

Buses and long haul trucks

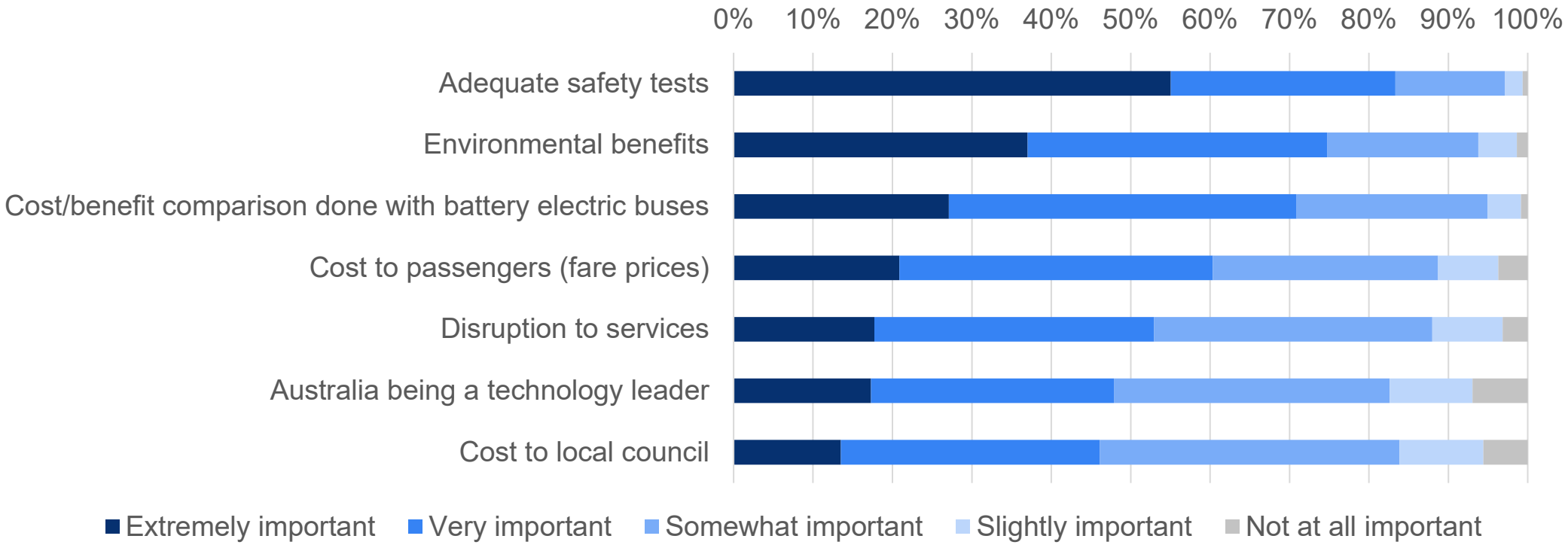
- Support for buses and trucks is strong



"I think it is a good idea for public transport to start with hydrogen before even the public do. That is probably a good transition"

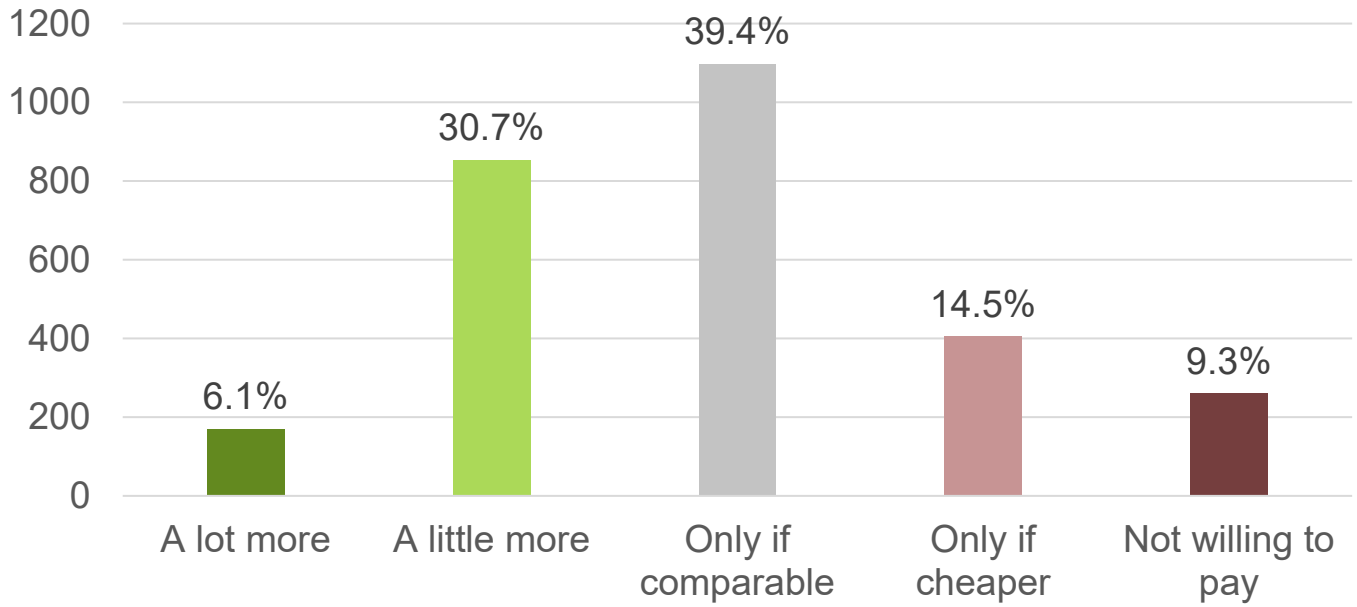
Importance for fuel cell buses

- How important are the following factors in determining whether or not you would support the introduction of fuel cell buses?



Willingness to pay

- What would you be willing to pay for hydrogen technologies if there were clear environmental benefits?



Less than 40% willing to pay more for environmental benefit

"It's a lovely pipe dream, but they need to make it affordable"

Benefits

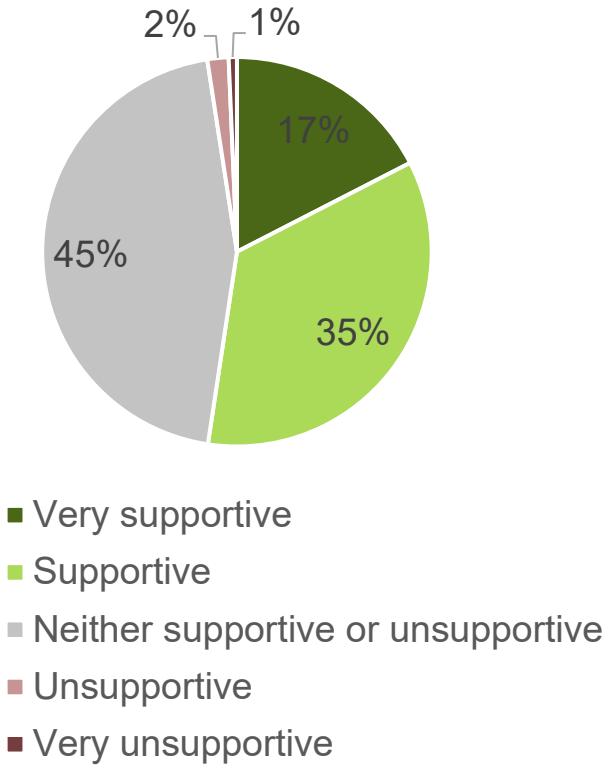
Concerns

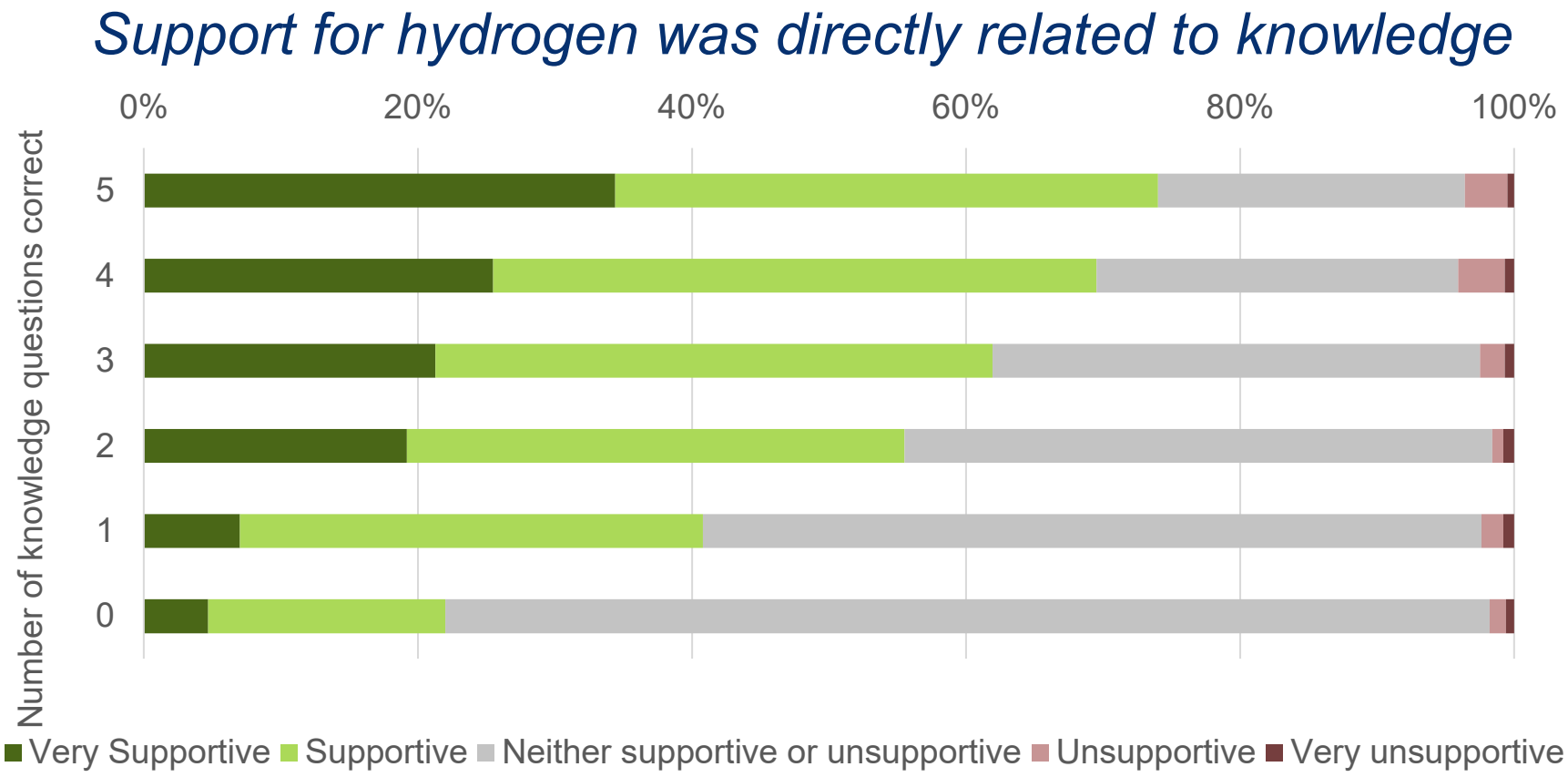
77%

believe there will be adequate safety precautions to keep the risks under control

Support for hydrogen

- How do you feel about hydrogen as a possible solution for energy and environmental challenges?





Conclusion

- Australian public is generally supportive of hydrogen for transport
- Public transport and long-haul hydrogen vehicles could help build confidence in the early stages
- Safety is of utmost importance
- Convenient refuelling is paramount

"If it was proved that you are not disadvantaged in any way, in terms of the power of the car, the longevity, the cost, all those sort of things, then why wouldn't you do it I suppose?"

Thank you

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