Hydrogen Workshop

Commences at 1300

For workshop support please send a “chat” to Levi.

This workshop will be recorded.

Please reach out with further thoughts, ideas or future collaboration: Energy.forecasting@aemo.com.au

Welcome

Nicola Falcon, Acting Chief SD&E Officer

Agenda

1	Welcome – Nicola Falcon, Acting Chief AD&E Officer	1300
2	Key workshop background and information	1305
3	Exploring hydrogen's possible role in the energy system	1310
B1	Break outs 1 (suggested time allocation)	1340
	Group introductions	(1340)
	Individual time	(1345)
	Discussion time	(1350)
	Create the narrative	(1410)
	Report back – *whole of group*	(1420)
	15 minute break – return by 2:50pm AEST	1435
4	Perspective uncertainty and survey results	1450
B2	Break outs 2 – discuss information presented on Mural (suggested time allocation)	1530
	Discussion time, reflecting on slides	(1530)
	Top five considerations that might influence a hydrogen scenario	(1550)
	Report back – *whole of group*	(1600)
5	Whole of group discussion and wrap up	1615
	Meeting ends	1630

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Background

- Why are we here?
  - There are strong signs of growth and commitment to hydrogen development both nationally and internationally.
  - *However*, the choice of technology, timing and scale are all highly uncertain.

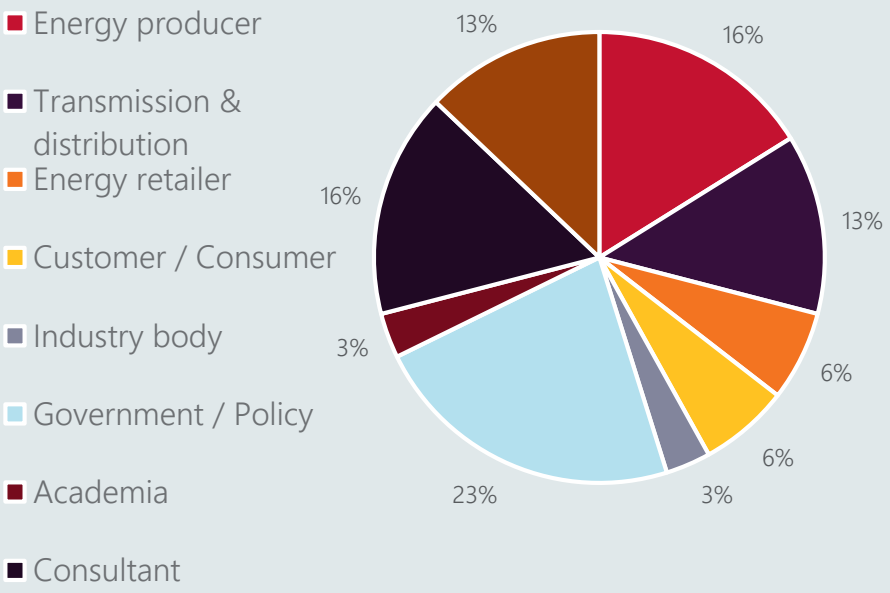
- What does AEMO hope to achieve?
  - Gather new insights from the collective wisdom here – identify issues and concerns.
  - Avoid siloed thinking and look for opportunities to broaden our horizon and avoid unnecessary surprises.
  - Form a consensus on the way that hydrogen will be handled for the coming Gas Statement of Opportunities (GSOO) – particularly regarding potential scenario narrative, timing and scale.

- Throughout the workshop we will be sharing insights from the pre-workshop survey; please consider these as prompts for discussion. They are not intended to be conclusive or exhaustive.

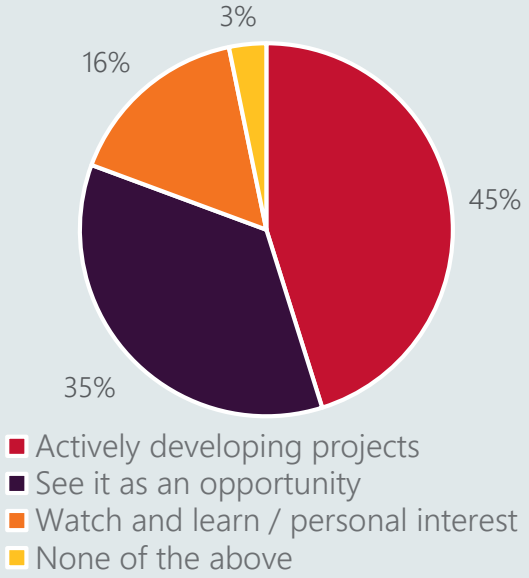
Who is represented?

- Each break out session has been targeted to include people with different backgrounds and expertise as well as from different states.

Which part of the energy sector are you from?

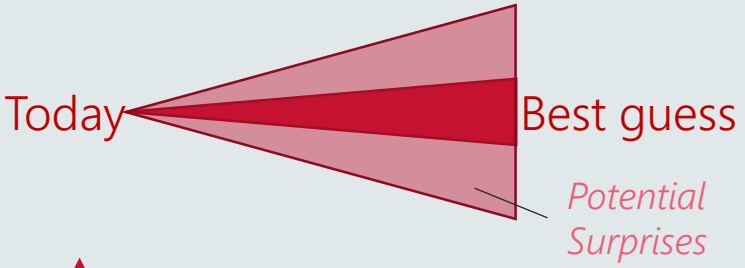


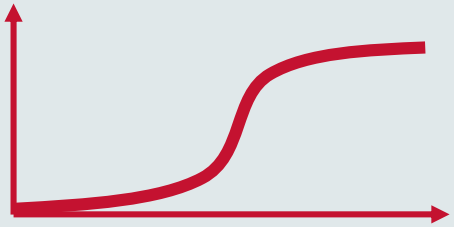
Describe your interest in hydrogen.

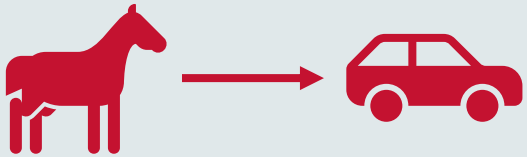


Guidelines for today's collaboration

- Be open to a wide cone of uncertainty, *and* maintain a view on what can be relied upon.
- Look for the s-curve, recognising tendency to overestimate the short-term and underestimate the long-term changes.
- Hold strong opinions weakly, be open to new information and ideas.
- When considering potential disruption, use your knowledge of historical changes.







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Show Mural

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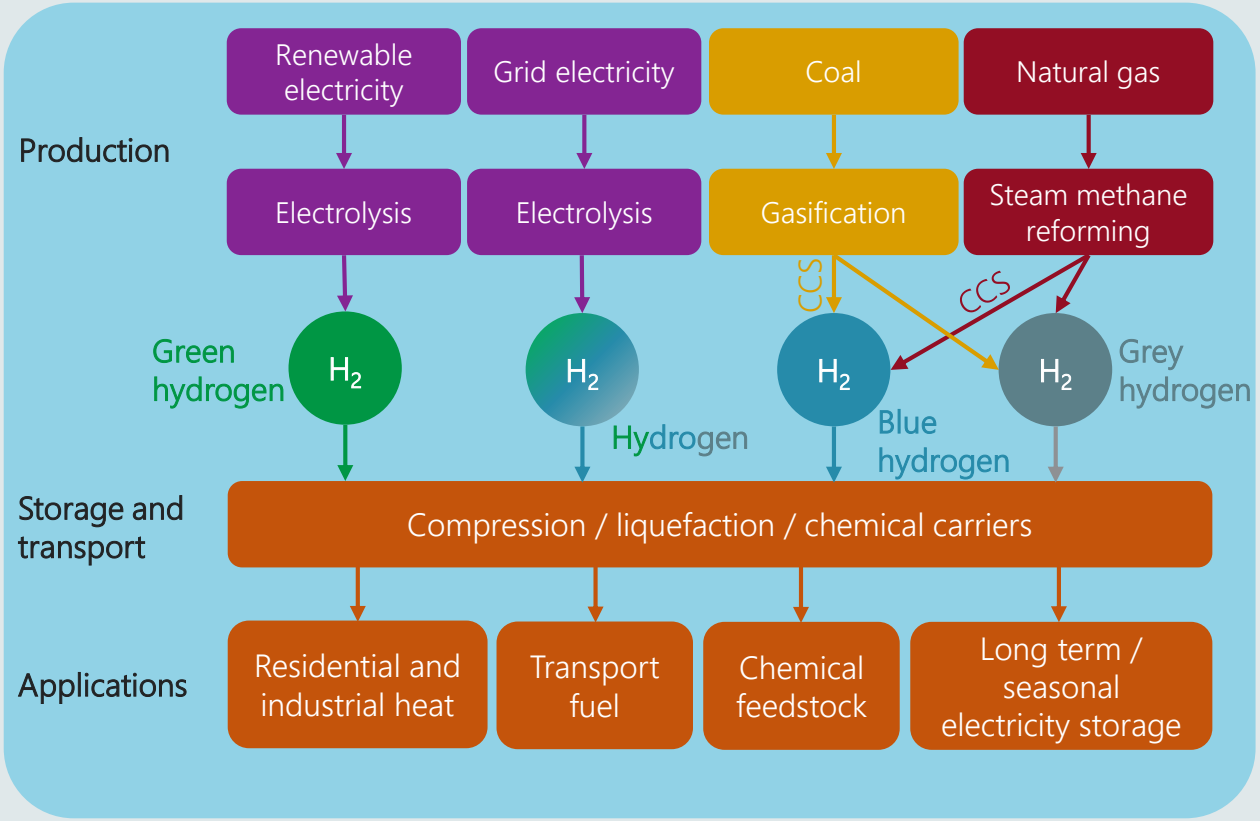
Exploring hydrogen's possible role in the energy system

AEMO's need to understand hydrogen

Depending on how hydrogen is made, used and transported, hydrogen may interact with both electricity and natural gas markets. This could affect supply, demand and transmission.



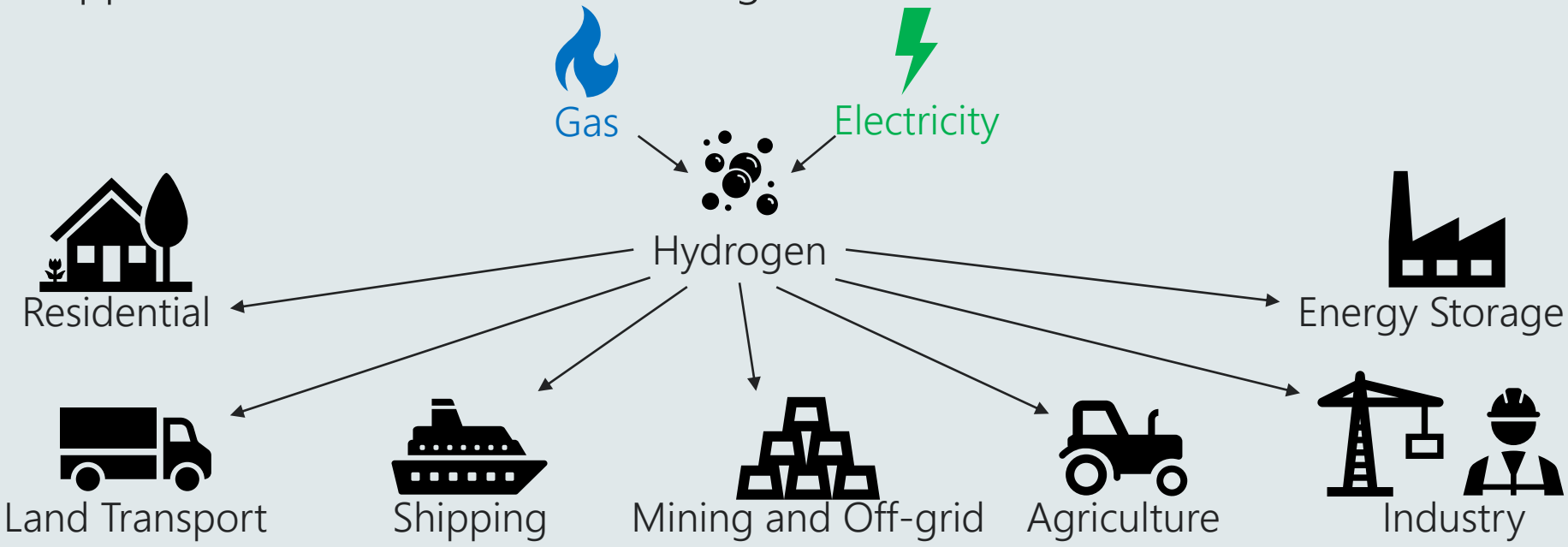
Australia has a highly competitive position for becoming a major hydrogen exporter.

The domestic market could also have notable impact depending on uptake.

It is also worth noting that the "colours" of hydrogen are losing favour and relevance in some areas.

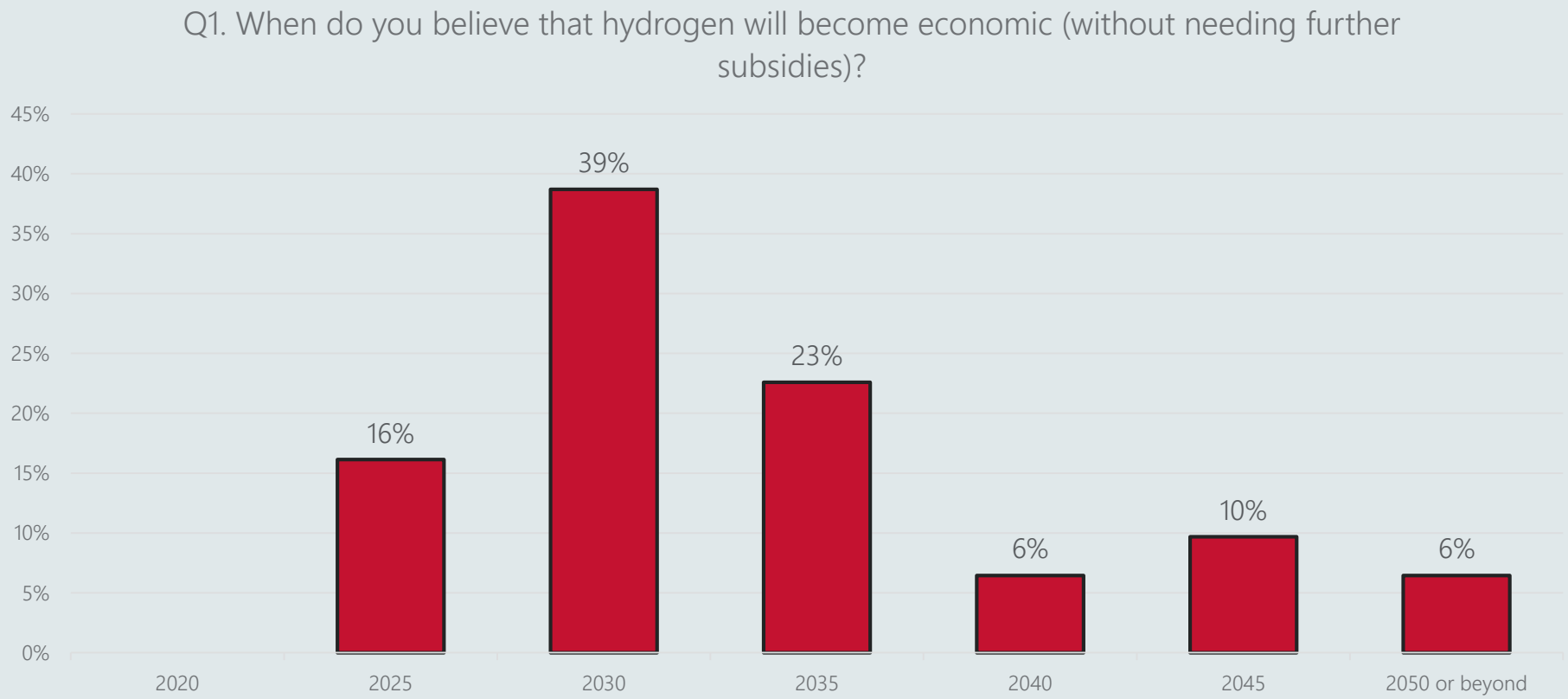
AEMO's need to understand hydrogen

- Hydrogen has a wide range of possible applications that could substantially affect both Australia's gas and electricity systems. This may increase or decrease stress on the systems.
- As an energy carrier hydrogen has the potential to cause interactions between previously uncoupled sectors – it creates new vectors, new opportunities and also new challenges.



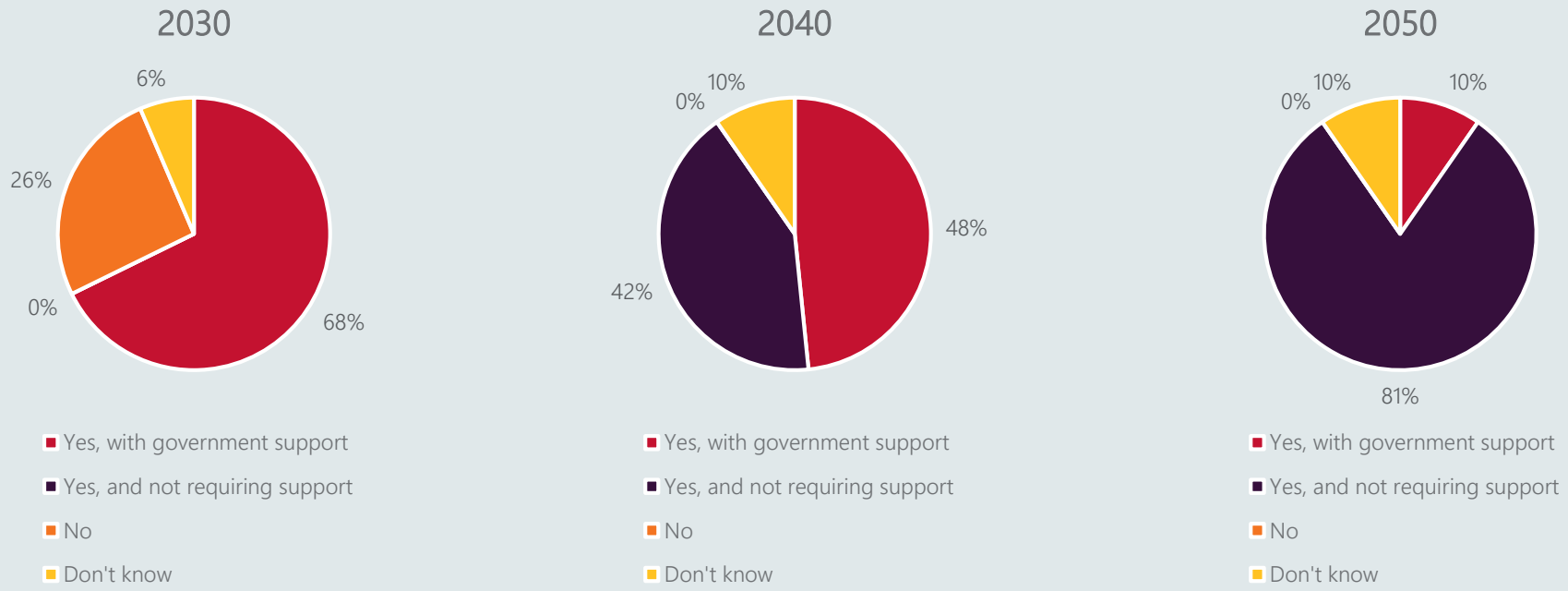
Perceived timeline for hydrogen

There was strong consensus that hydrogen would become economic, and therefore relevant, within the next twenty years. 77% answered *before* 2040.



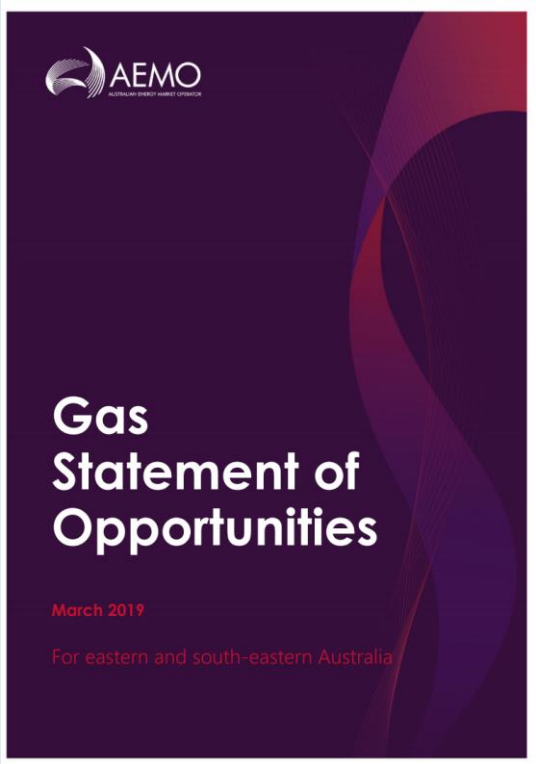
Perceived timeline for hydrogen

Q2. Do you believe that hydrogen development will play a major role in Australia's energy future by:



What is the GSOO?

- The Gas Statement of Opportunities (GSOO) is an annual analysis of resource adequacy for the eastern and south-eastern Australian gas markets.
- The GSOO identifies the needs for investments over a 20 year horizon.
- It is focused on providing an adequacy assessment in the short to medium term, and identifying future gas market development needs.
- It uses a scenario planning approach to identify the future opportunities given uncertainty affecting Australia's energy sector



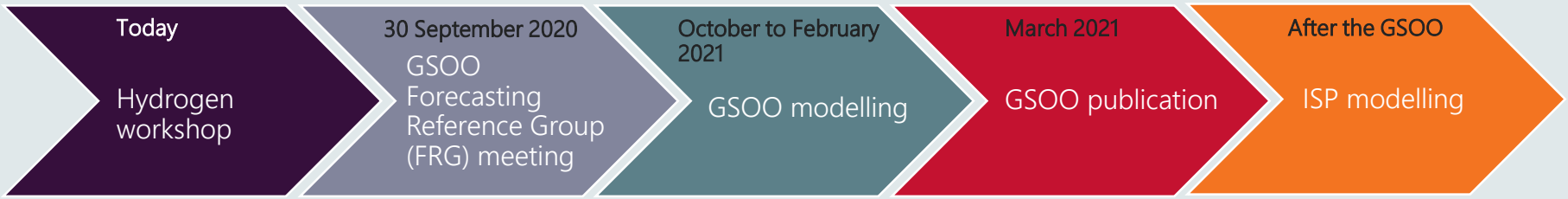
What is the ISP?

- The Integrated System Plan (ISP) is an actionable roadmap for eastern Australia's power system to optimise consumer benefits through the energy sector transition.

- It is a whole-of-system plan for the National Electricity Market efficiently achieves power system needs across a planning horizon of at least the next 20 years.

- It uses a scenario planning approach to identify the investments that deliver the least-cost and least-regret transition of the NEM, given uncertainty affecting the pace and scale of Australia's energy sector transition.

Timeline for the GSOO



Context of GSOO scenarios

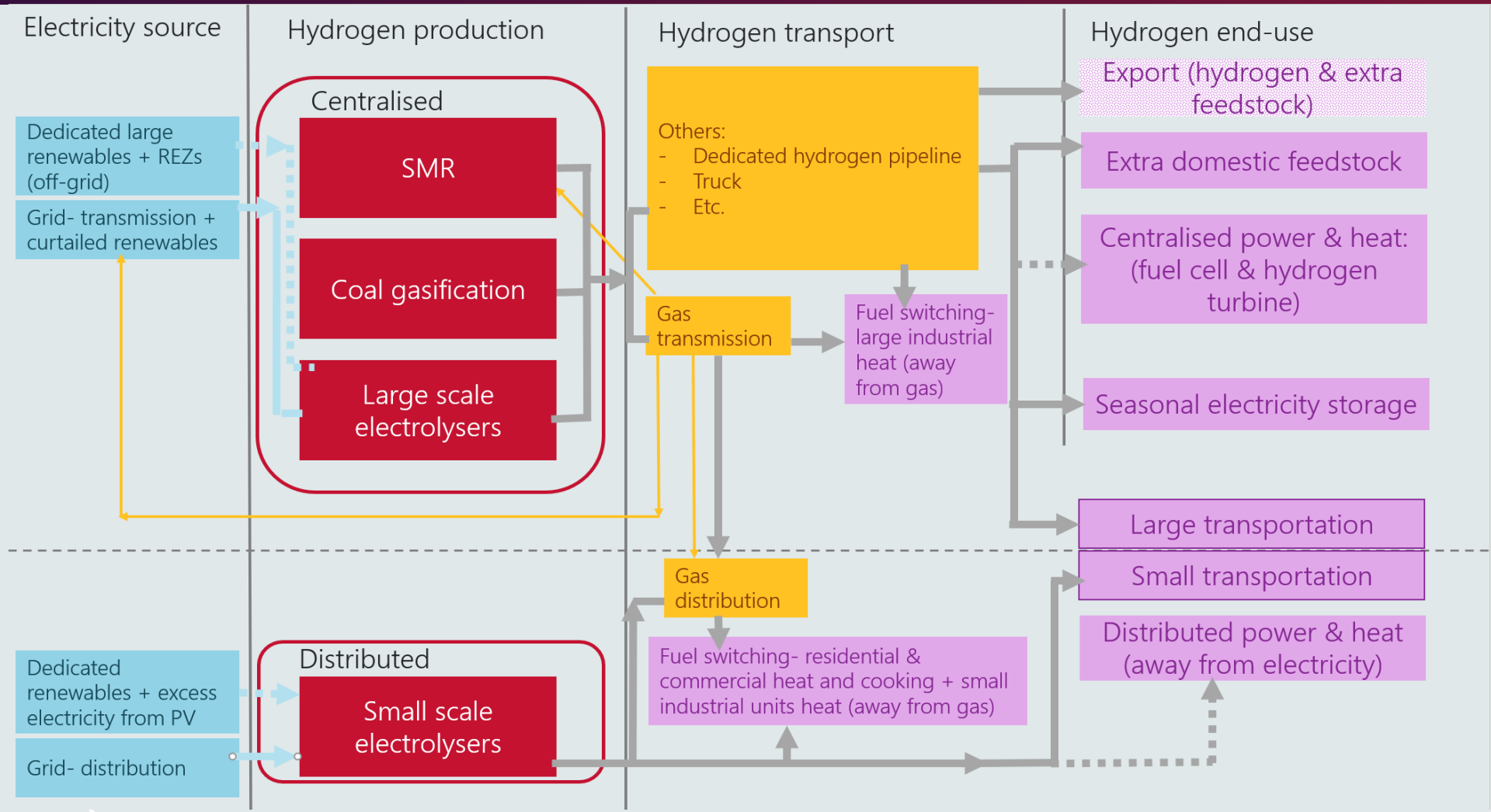
To better establish the context for hydrogen's influence on AEMO's gas scenarios, it is important to understand the scenario themes:

Scenario	High level description
Current scenarios	
Slow change	Energy-transition slowdown, lesser economic activity, slower technology changes and therefore reduced investments in decarbonisation
Central	Current pace of energy sector transition, under current policy settings and technology trajectories
Step change	Stronger decarbonisation ambition, with greater economic activity, faster technology changes and stronger consumer-led electrification to achieve decarbonisation goals. Limited decarbonisation of the gas sector.

Today's workshop

Today's workshop will explore the impact of hydrogen on these scenario themes, and focus on broadening this set with material hydrogen uptake within the planning horizon.

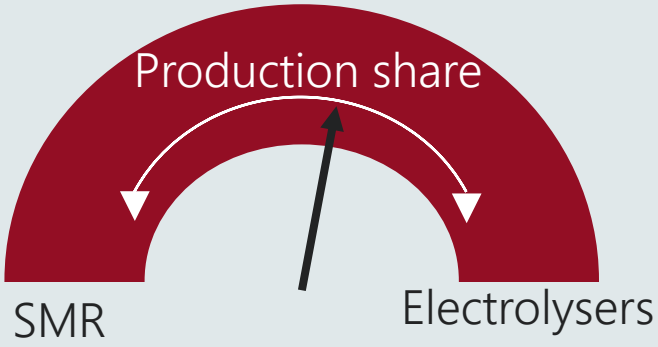
Sector coupling with electricity and gas systems (demonstration of complexity)

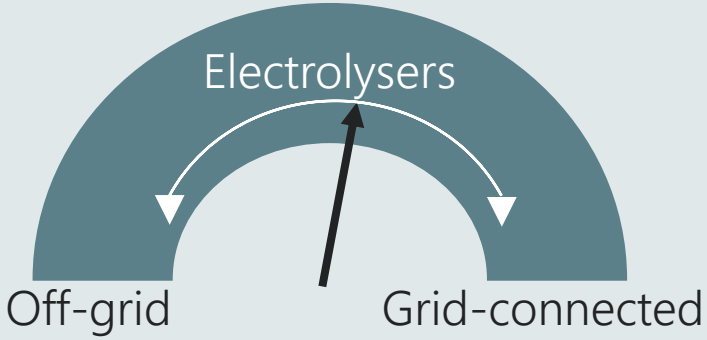


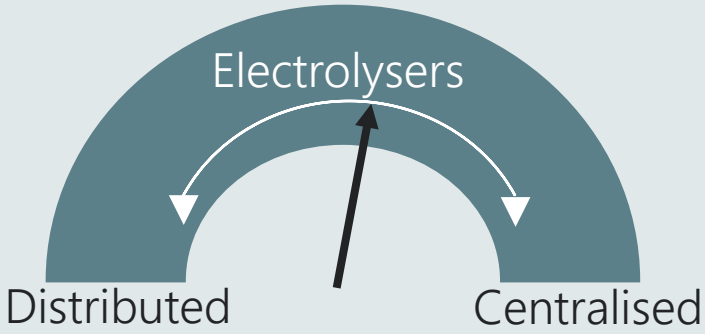
<u>Legend:</u>
SMR: Steam-methane reforming || **REZ:** Renewable Energy Zone || **PV:** Photovoltaic

Developing a hydrogen scenario

We need to develop a shared understanding of these indicators to be able to conduct our gas and system planning for Australia.







Today we will also look to explore…

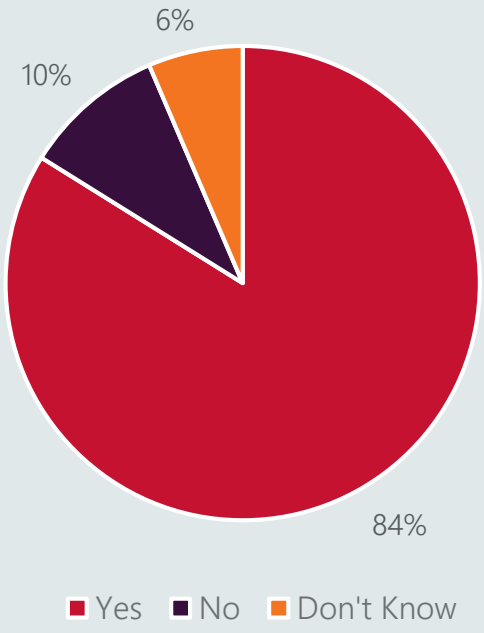
- Which domestic applications?
- Where? (Regional allocations)
- When? (In which timeframe)
- Scale

But, what will drive these outcomes?

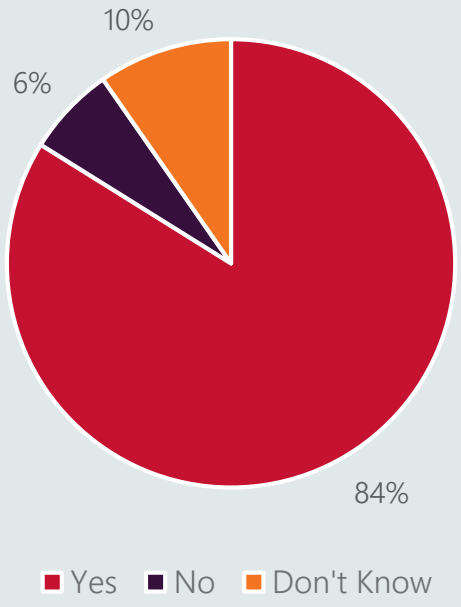
Sample drivers of a hydrogen future (to be considered in break out)

Perceived importance of decarbonisation

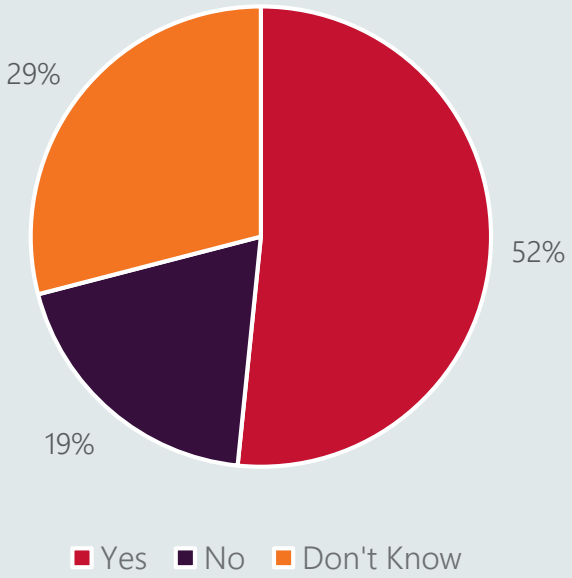
Q3. Does Australia's hydrogen future rely on a strong global drive for decarbonisation?



Q4. Would more aggressive decarbonisation targets for Australia be a key driver for increased domestic hydrogen consumption?



Q5. Would steam methane reforming (SMR) require carbon capture and storage to be considered a viable option for growth?



Note: this appears inconsistent with answers to Q3 and Q4.

Breakout 1: Developing a narrative

How might substantial hydrogen adoption impact the gas and electricity sectors?

In this next session we are asking you to help develop a suitable narrative to help set the context. The Mural boards have some prompts and information provided for support of this discussion.

For example:

- What driver(s) would be the main force behind high hydrogen uptake?
- Given the theme of substantial hydrogen adoption, how fast will this occur and what secondary applications might be unlocked?
- What decarbonisation target should be set in a high uptake hydrogen scenario?

Imagine we are in a future world with large hydrogen consumption – how did we get here? Tell a story… what has made and enabled this future having substantial hydrogen development?

We are in the break out sessions

For workshop support please send a “chat” to Levi.

Report back to the whole group

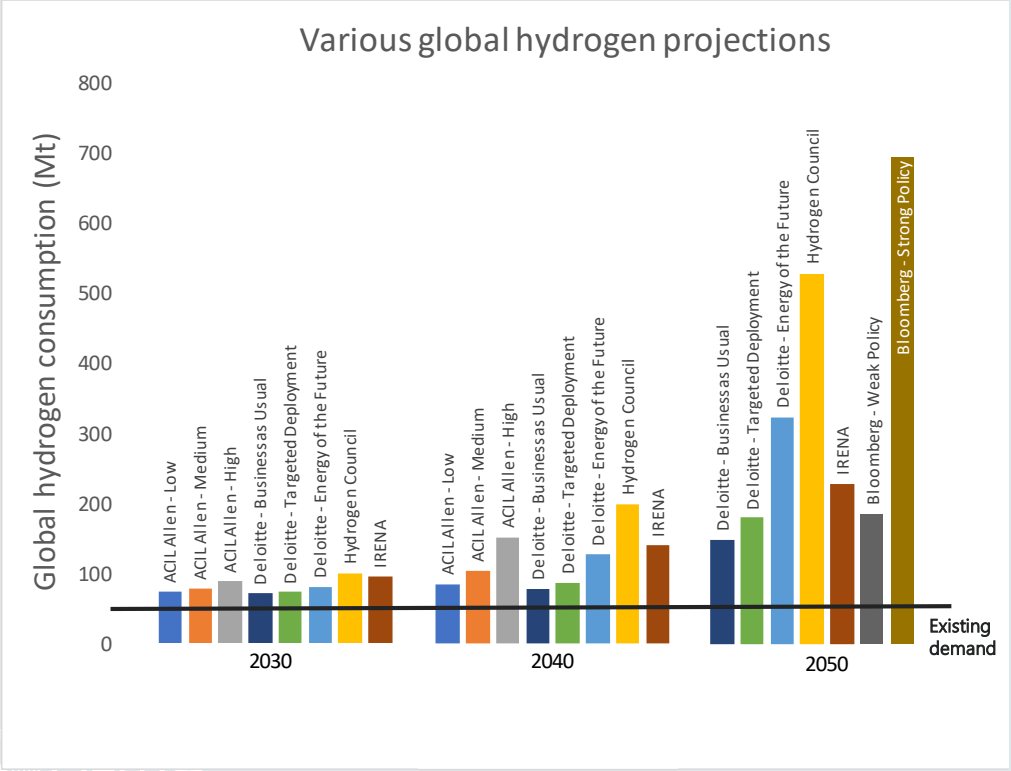
Brief break – we will be back at 2:50pm AEST

For workshop support please send a “chat” to Levi.

Perspective on uncertainty and survey results

Scale in different models/scenarios

- Present global H_2 demand is estimated between 55 and 80 million tonnes. This is 6,600 to 9,600 PJ (mainly used as chemical feedstock).
  - In terms of scale, the global LNG trade is around 17,000 PJ.
  - Eastern Australia exports around 1,250 PJ of LNG and consumes around 600 PJ domestically.
  - *The current hydrogen demand is already high, mainly delivered from SMR.*

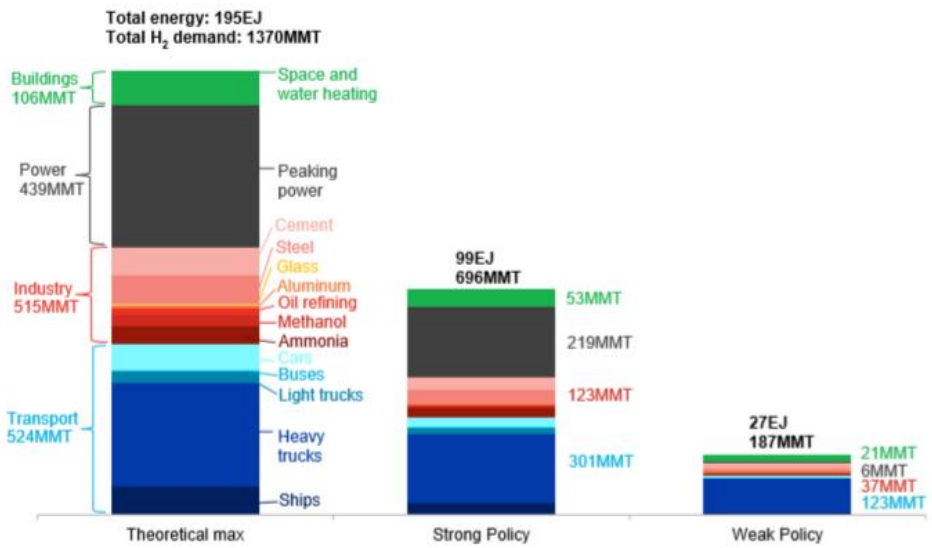


- Australia is already making large bets on hydrogen.
- Recent news indicates green shoots of commercial viability in the US…
  - Generate Capital – forklifts
  - PlugPower – fuel cells
- Europe has a strong commitment and plan for hydrogen development (including a pipeline backbone)

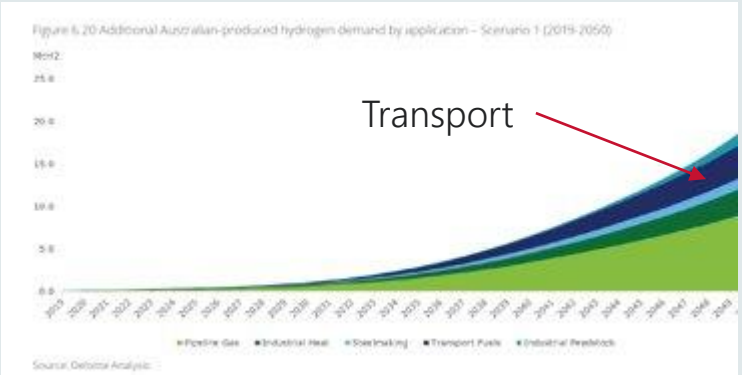
Projected uses of hydrogen

Hydrogen has the potential to decarbonise hard-to-abate sectors, but there is notable uncertainty about the opportunities.

Figure 11: Potential demand for hydrogen in different scenarios, 2050

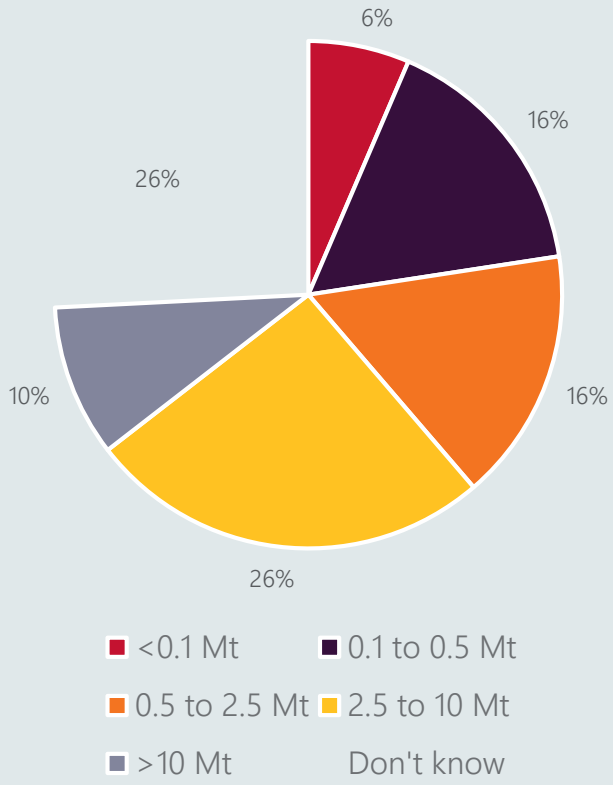


Source: BloombergNEF. Note: Aluminum demand is for alumina production and aluminum recycling only. Cement demand is for process heat only. Oil refining demand is for hydrogen use only. Road transport and heating demand that is unlikely to be met by electrification only: assumed to be 50% of space and water heating, 25% of light-duty vehicles, 50% of medium-duty trucks, 30% of buses and 75% of heavy-duty trucks.



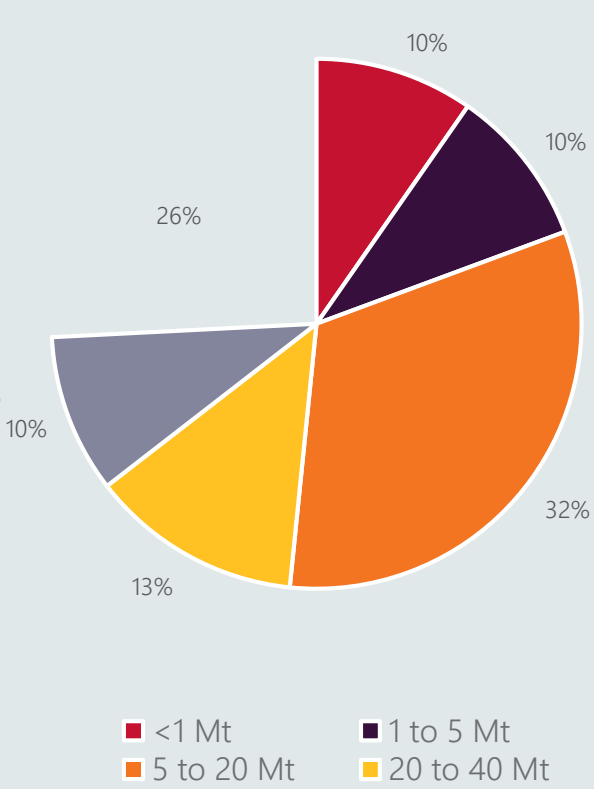
Survey: Australia's contribution to new global hydrogen consumption by…

Q6. …2030?



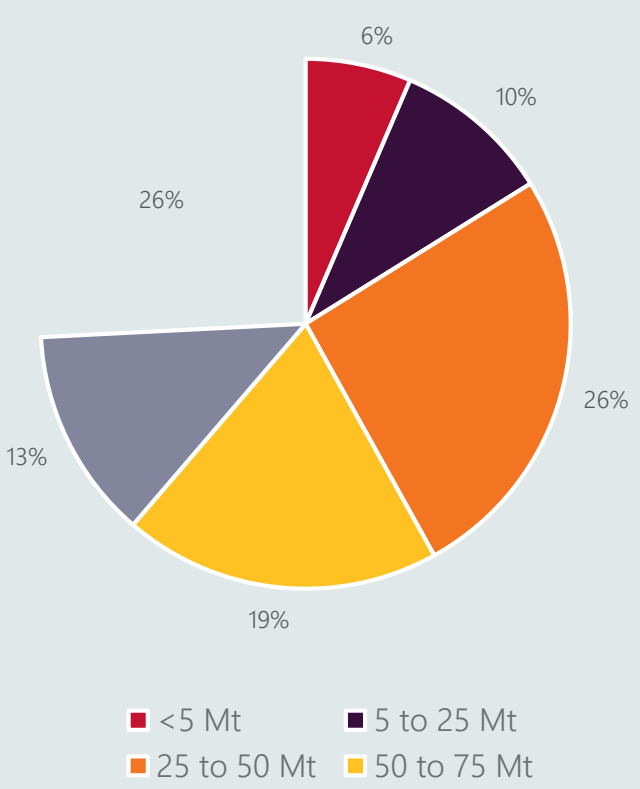
Weighted average = 3.8 Mt
Mode: 2.5 to 10 Mt

Q7. …2040?



Weighted average = 16 Mt
Mode: 5 to 20 Mt

Q8. …2050?



Weighted average = 44 Mt
Mode: 25 to 50 Mt

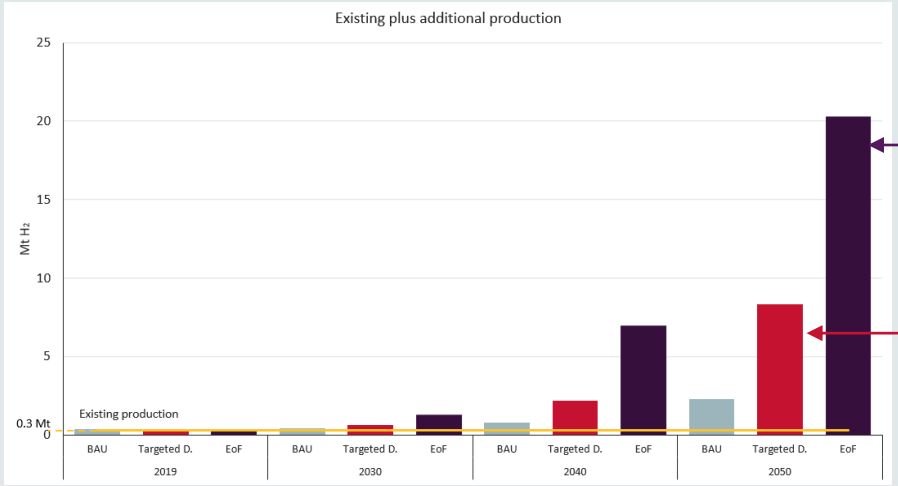
Perspective on the scale

Pre-workshop survey results	Additional hydrogen production (Mt)	% of additional* global demand	Load if all supplied by electricity		Load if all supplied by gas	
			TWh	"NEMs"	PJ	"Eastern domestic gas"
2030	3.8	30	190	1	591	1
2040	16	30	800	4	2486	4
2050	44	17	2200	11	6838	11

** This is calculated on the basis of the average of all projections from the range of reports shown earlier*

Note: None of these numbers include present hydrogen demand.
Existing NEM generation capacity: ~200 TWh
Existing eastern domestic market: ~600 PJ
Australia's LNG export: over 4,000 PJ
Australia's coal export: over 11,000 PJ

Comparing against one set of projections



Perspective on additional water consumption

Pre-workshop survey results	Additional hydrogen production (Mt)	Water use (GL)	
		Electrolysers	SMR
2030	3.8	53	80
2040	16	224	336
2050	44	616	924

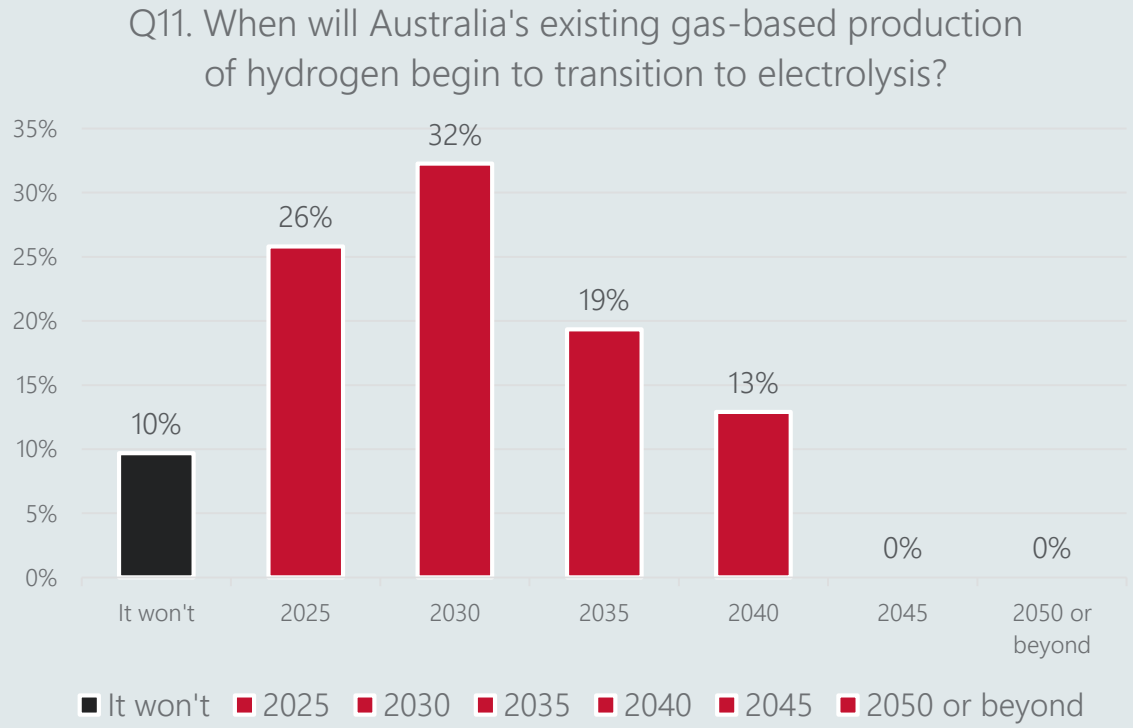
This can be compared against residential water consumption of 1800 GL.

As another contrast, Hydro Tasmania has around 14,000 GL of water flow through its power stations.

However, it should be noted that this is *additional* water consumption that would need to be sourced.

Switch of existing production to electrolysis

- 10% of respondents said that the existing gas-based production of hydrogen won't transition to electrolysis.
- All other respondents said it would begin by 2040 (or before); within AEMO's planning horizon.
  - *Most thought that this would occur by 2030.*

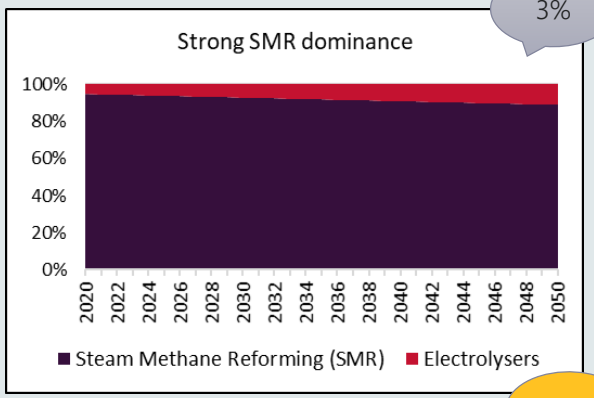


Note: If Australia's present ammonia production (1 Mt of ammonia = ~0.18 Mt of hydrogen) was electrified it would take around 10 TWh, or around 4.1 GW of solar or 2.7 GW of wind.

Perspective on production options

The strong preference from the survey results was for the exponential transition from SMR to electrolysers, although strong electrolyser dominance and linear transition also got a reasonable share of votes.

3%



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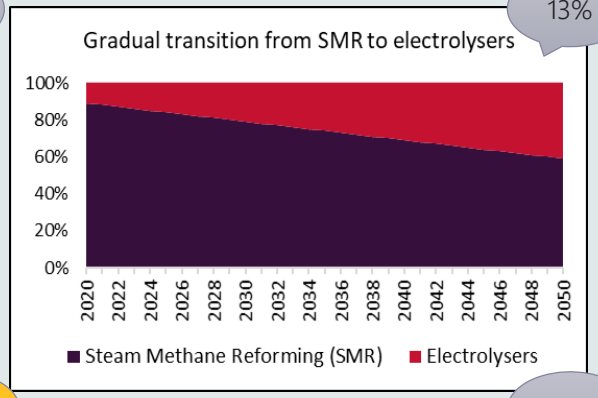

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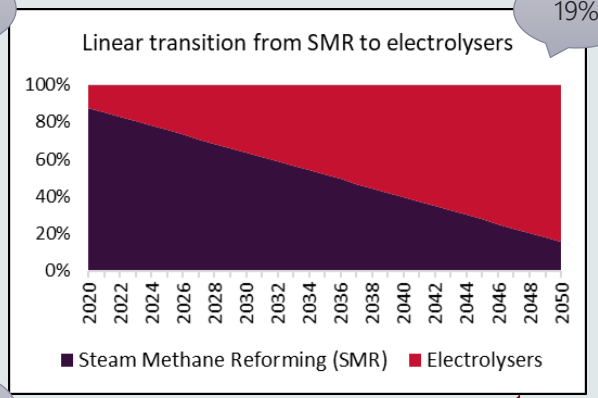
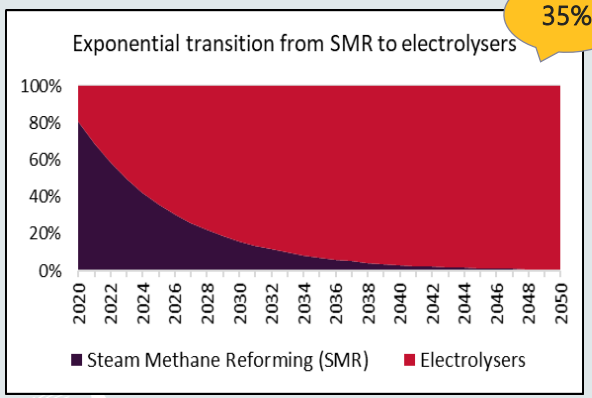


35%



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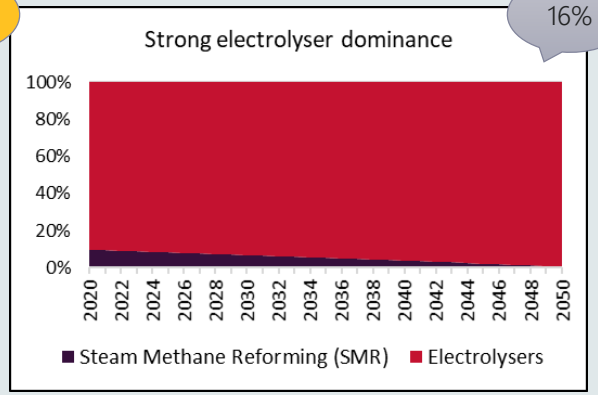


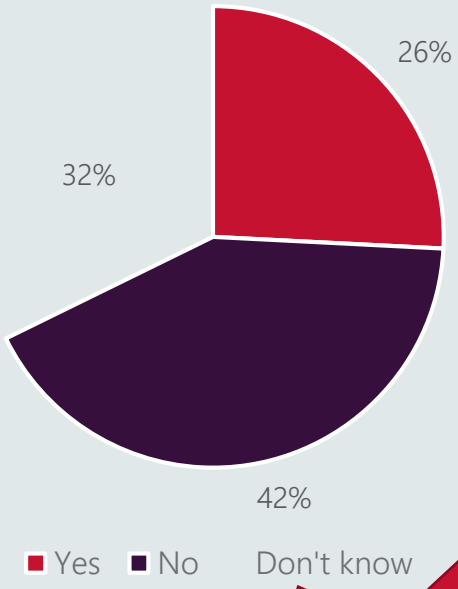
Don't know: 13%

Vast majority of pilot projects are for electrolysis

Will coal gasification play a role?

Q12. Will coal gasification play a notable role in Australia's hydrogen production?

- The split here was much more even than in other questions.
- Reading the additional explanation, most people gave the caveat that the "yes" assumed effective carbon capture and storage (CCS).
- Some gave economics or politics as the driver.

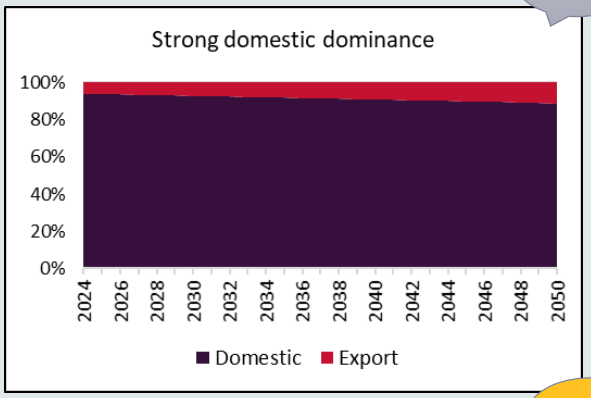


Note that one pilot project is undertaking brown coal gasification

Perspective on the target market

The strong preference from the survey results was for the exponential transition from domestic to export. The others each got between 10-16% of the vote.

16%



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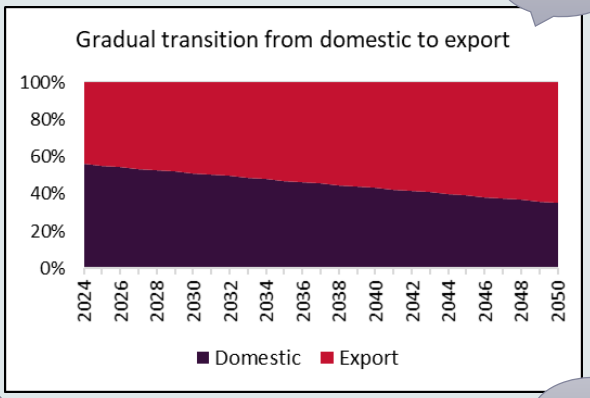

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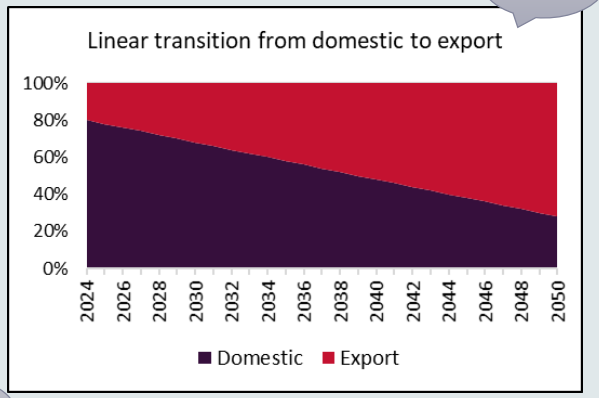

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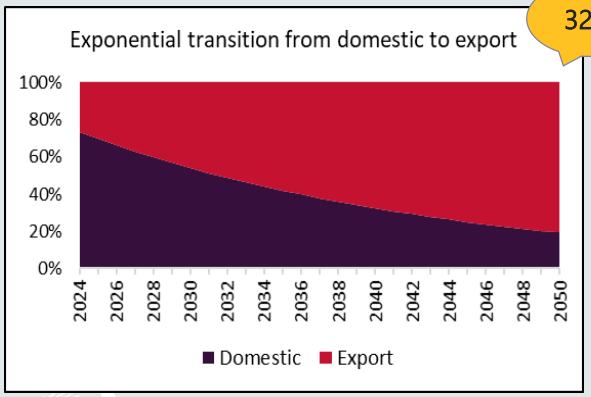

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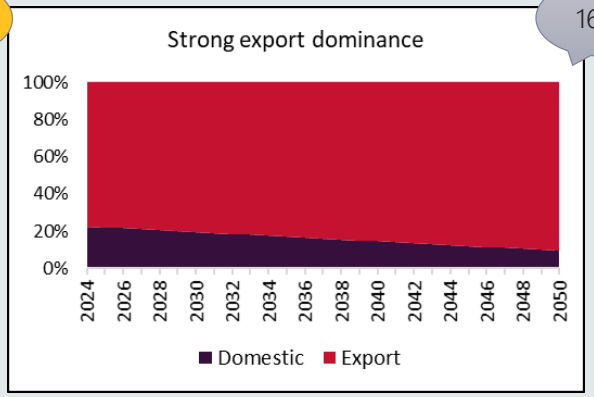
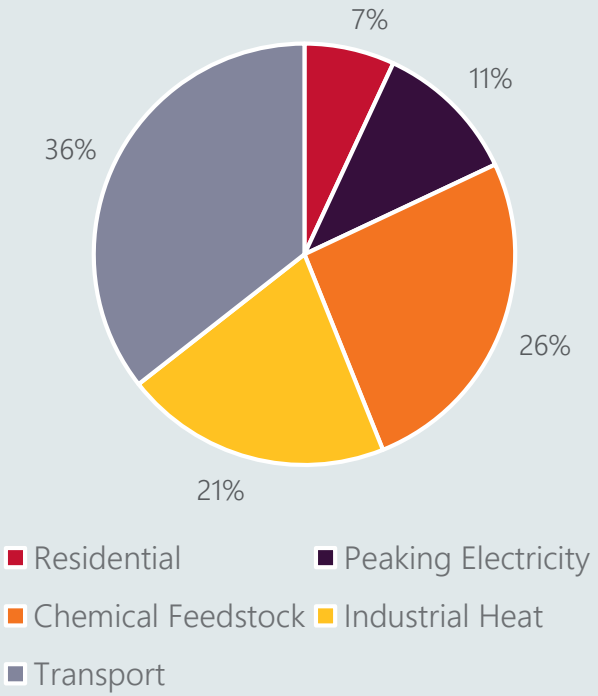
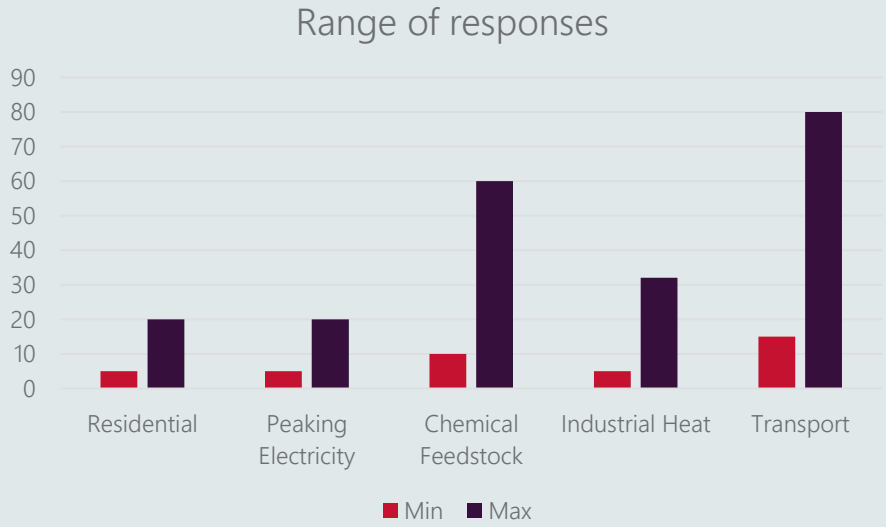


Don't know: 13%

Perspective on consumption

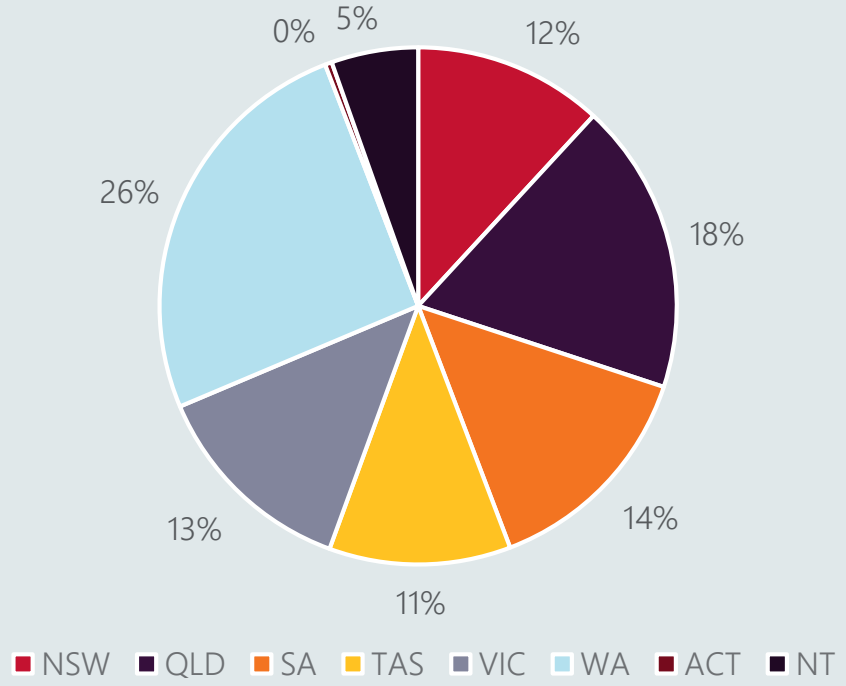
Q14. How much of Australia's domestic hydrogen consumption would you expect to be used by each category in 2035?

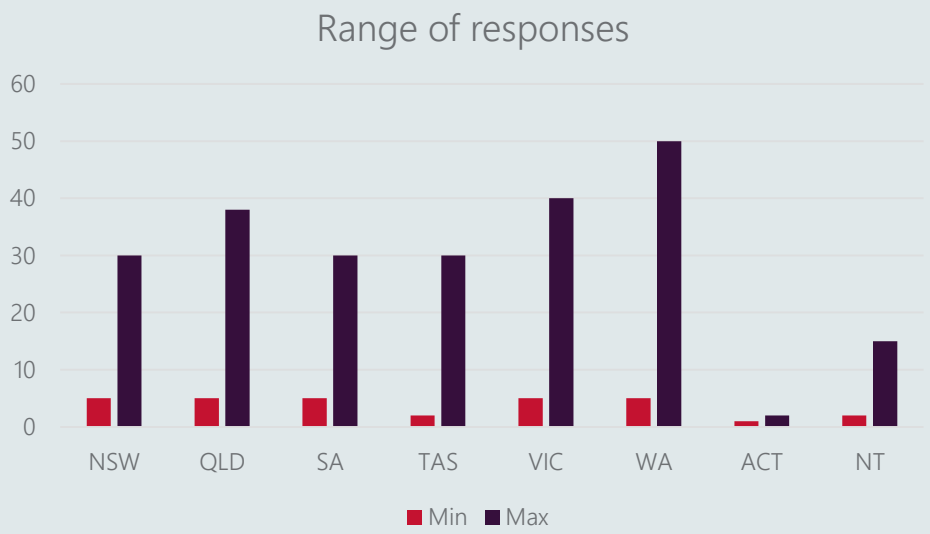




Perspective on regional allocations

Q13. Assuming a fairly consistent division over time, how much of Australia's new hydrogen would be produced in each state/territory?

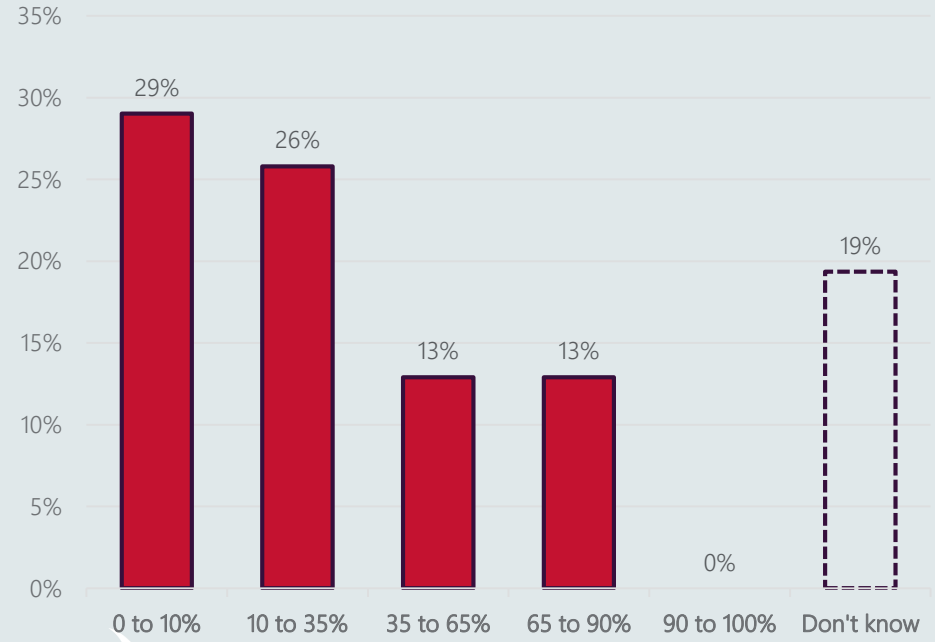




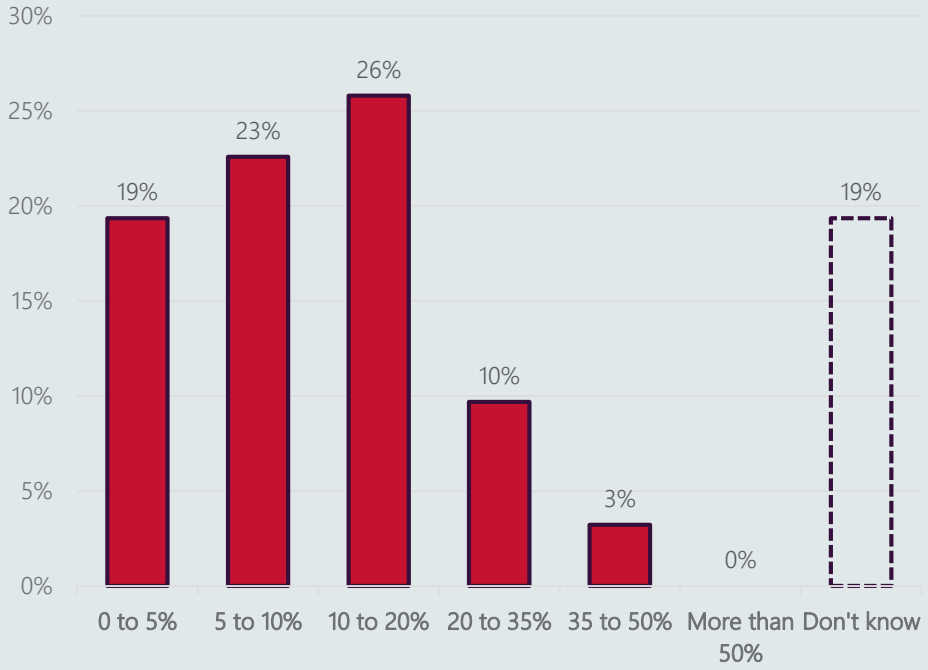
Perspective on electrolysers

The responses showed a fairly high degree of off-grid production and substantial distributed production given the scale suggested.

Q15. What percent of Australia's electrolyser production would be produced off-grid (assuming a fairly consistent division over time)?



Q16. What percent of Australia's electrolyser production would be from small, distribution-level, sources (assuming a fairly consistent division over time)?



Considering what you have learned/heard today…

In your break out groups you will find these slides are now on your Mural boards.

Please review them and provide comments and perspectives.

Here are some key discussion points:

- How much?
- How fast?
- Where?
- Which technology and application?
- Which target market (export vs domestic)?
- What source of electricity?
- Does the context provided align with the narrative that you developed earlier?
- Would you suggest altering the numbers and/or your narrative?

We are in the break out sessions

For workshop support please send a “chat” to Levi.

Report back to the whole group

Whole of group discussion

What else needs to be said?

Thank you

We will be sharing a post workshop survey and a copy of the slides will be provided to all participants.

Please reach out with further thoughts, ideas or future collaboration: Energy.forecasting@aemo.com.au