Hydrogen Highways

A path to net zero or road to nowhere?

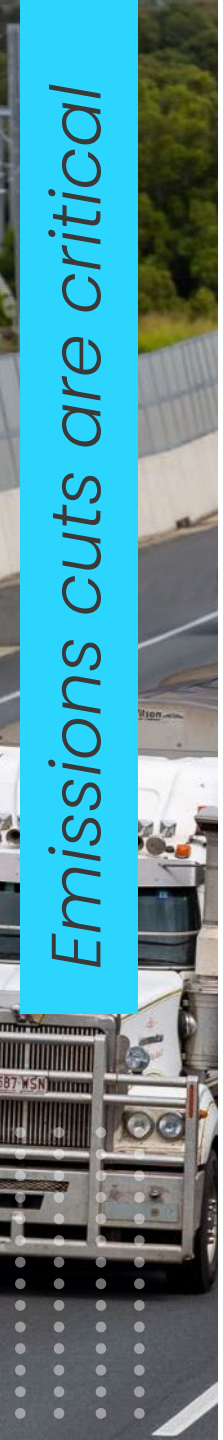
An Australian perspective

10th International Workshop on Sustainable Road Freight, Cambridge

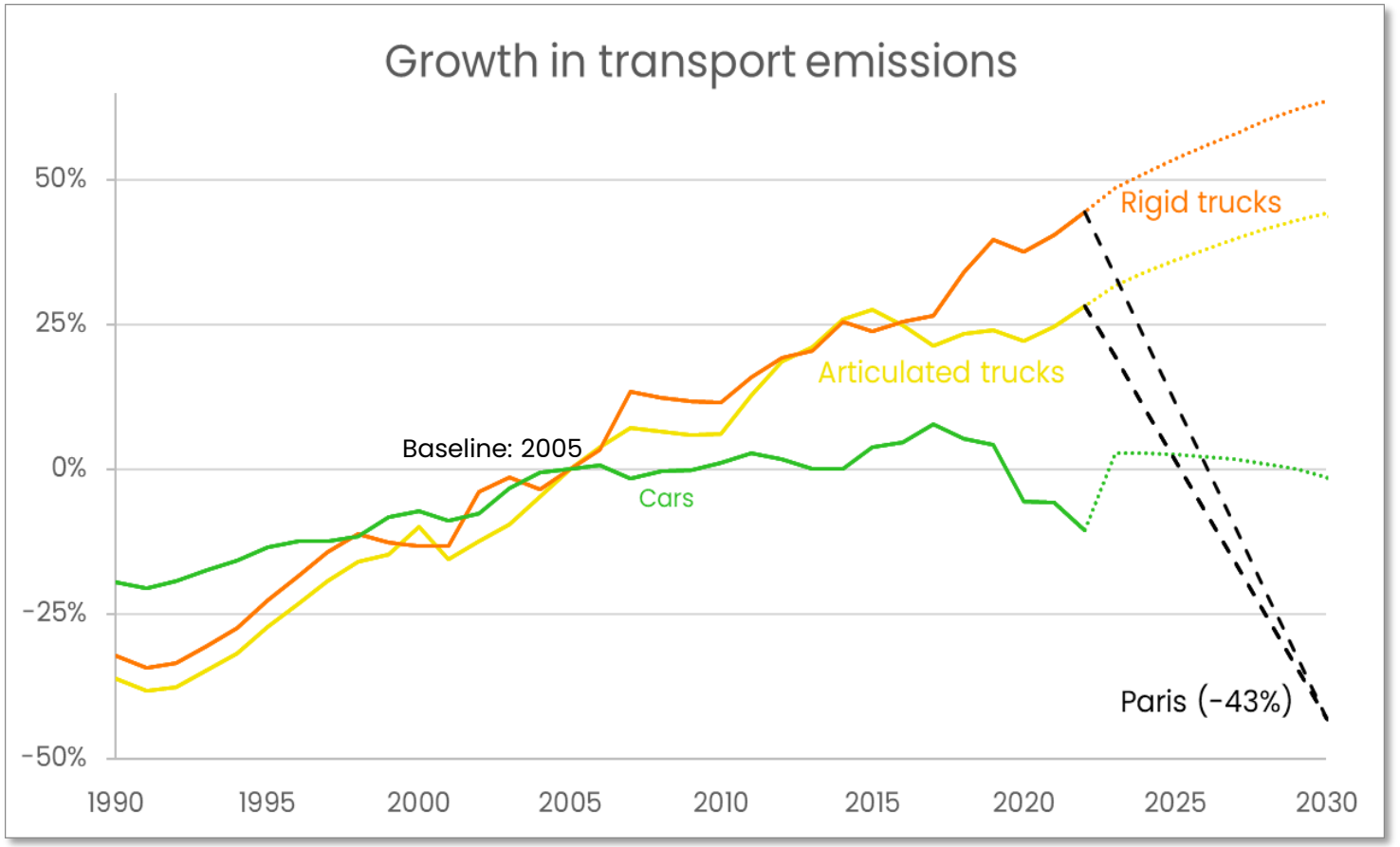
4 December 2023

Mark Gjerek

MOVEMENT



Emissions from trucks are going the wrong way



Efficiency, productivity & alternative fuels have had little impact to date

We need Zero emission trucks (battery-electric & fuel cell) ASAP!!

H2 for heavy/long haul

Accepted wisdom is BET and FCET complement, not compete → BETs for light/urban, FCET for heavy/long haul

"FCEVs are best suited for…long-range, heavier payloads…"

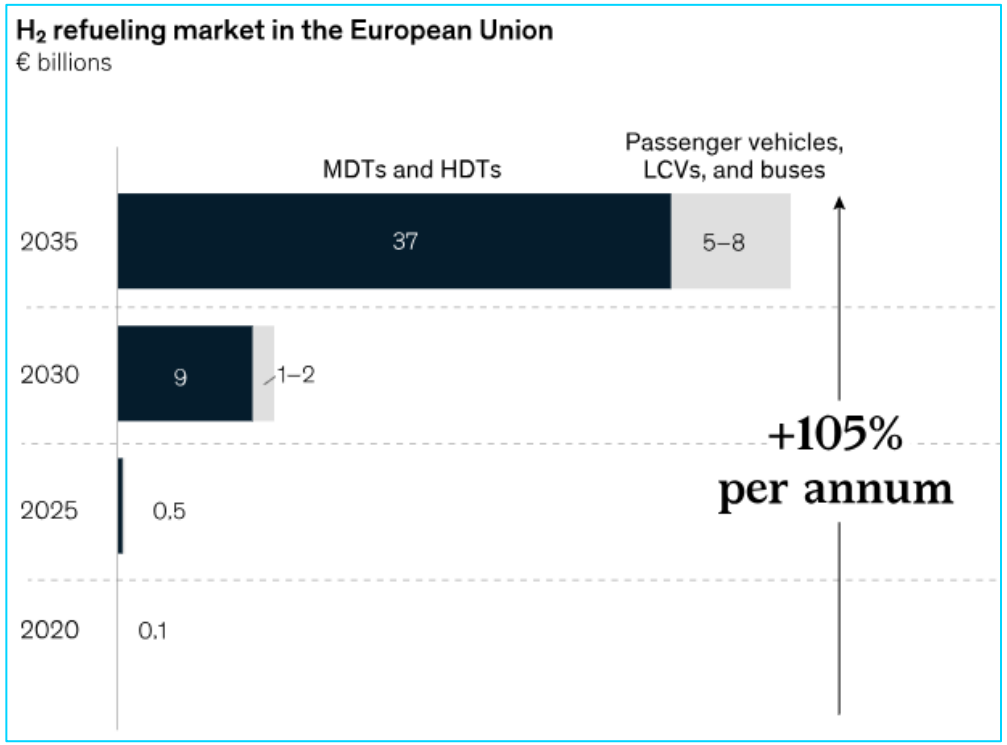
- Hydrogen Council, 2017

"Hydrogen-based fuels can play an important role in… long-distance transport, shipping and aviation."

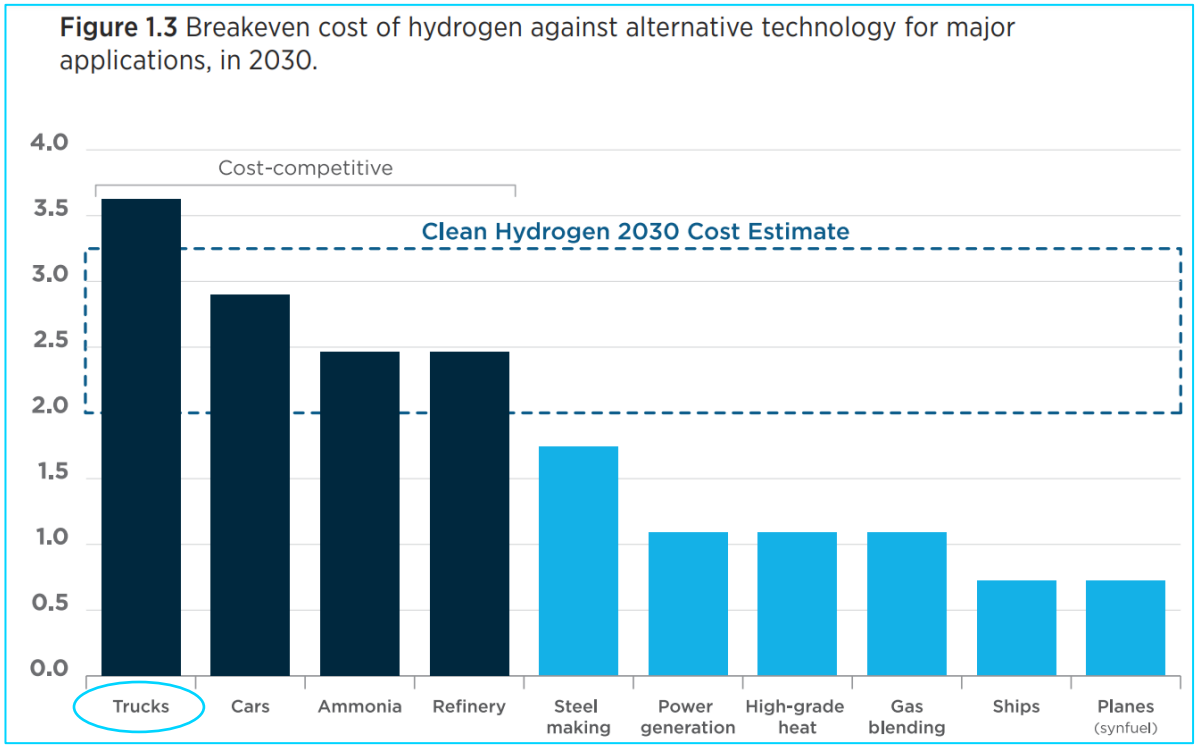
- International Energy Agency, 2023

"The transport opportunity for hydrogen is…long distance heavy haul."

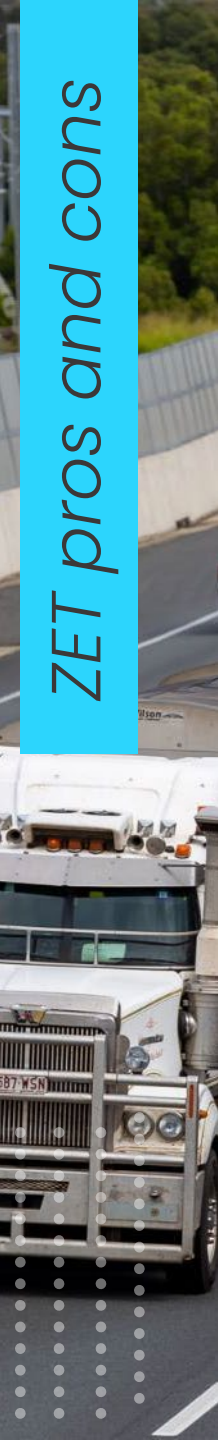
- Dr Alan Finkel AO, Australia's former Chief Scientist, 2023



McKinsey & Company, 2023



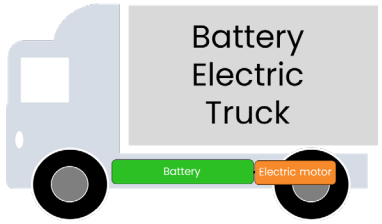
Australian National Hydrogen Strategy (2019)

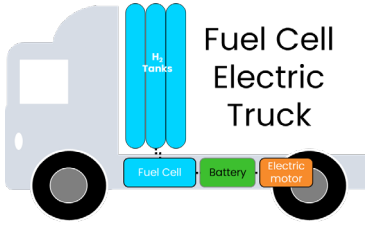


ZET pros and cons

Battery & fuel cell technologies are not diesel equivalent…. yet

All fleets consider 3 critical questions (+ many others)

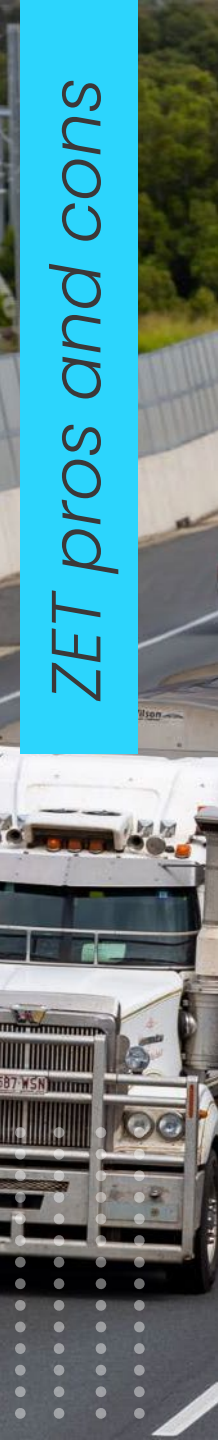




Can it do the job?

How much will it cost?

Can I get it? (and keep it fuelled)



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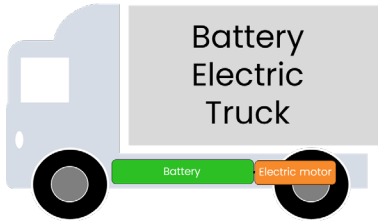
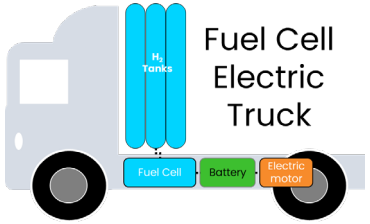
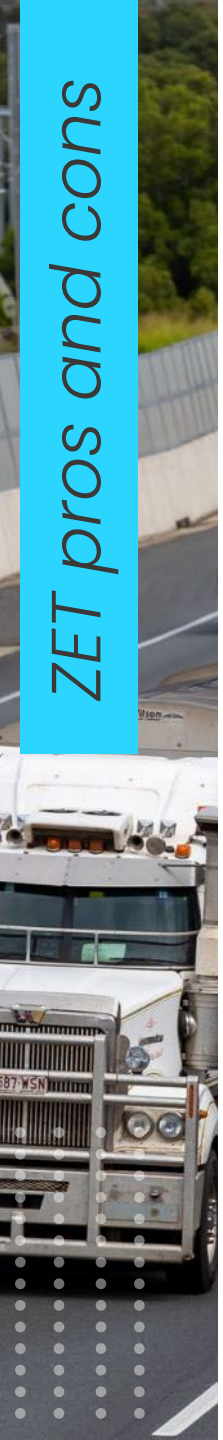




Can it do the job?

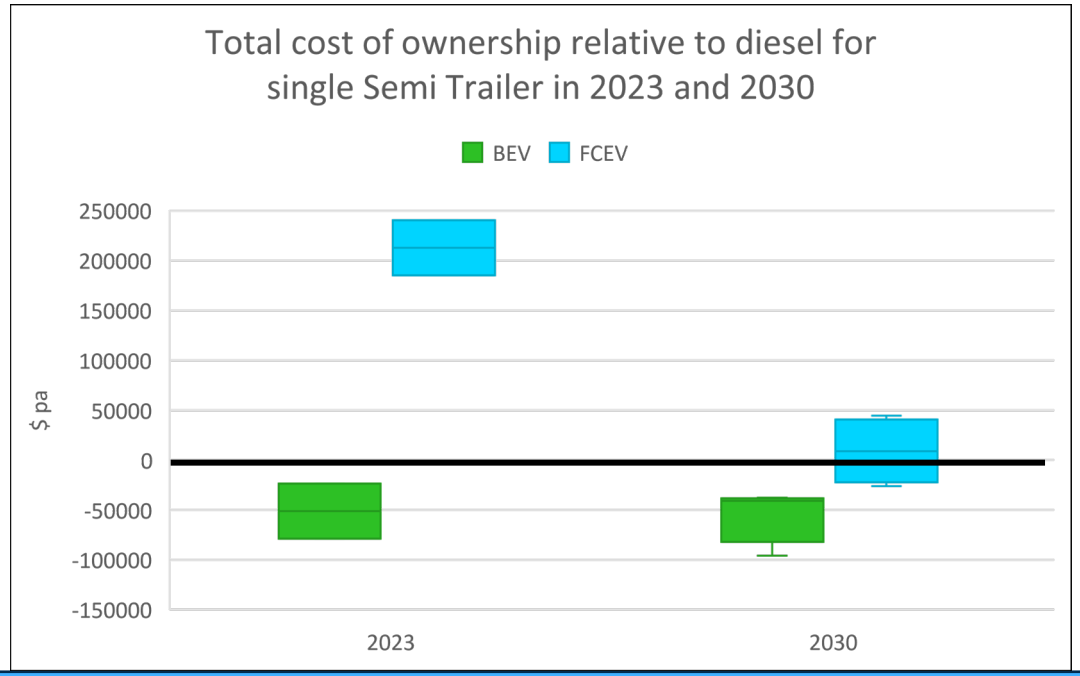
~450km max	**Driving range**	*varies*
+ 1-2 tonne	**Extra weight**	*+ 0-1 tonne*
+ 2-10 hours	**Refuelling time**	*varies*



ZET pros and cons

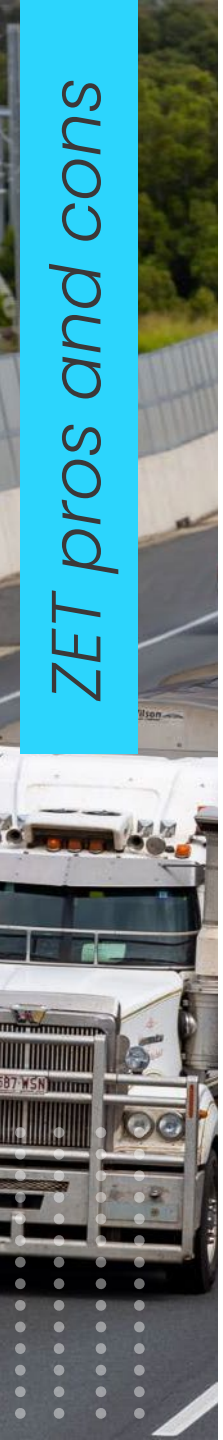
Capital cost is a big barrier in both cases

All fleets consider 3 critical questions



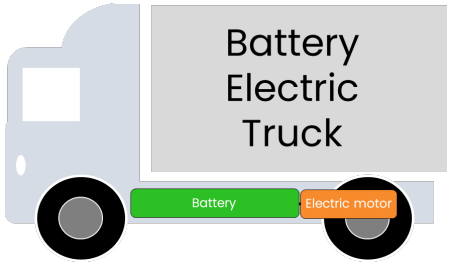
How much will it cost?

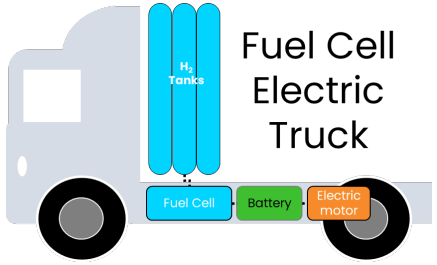
2x - 3x diesel	**Upfront cost $**	*3x - 4x diesel*
Less than diesel	**Running cost $**	*20-50% more*



ZET pros and cons

Is it a choice between lost productivity & lower cost (BEV), versus operational compatibility with much higher cost (FCEV)?





Expanding	**Models / OEMs**	*very few*
Need high power grid connection	**Charge/fuel access**	*None yet*
	Energy supply	*Distribution viability?*

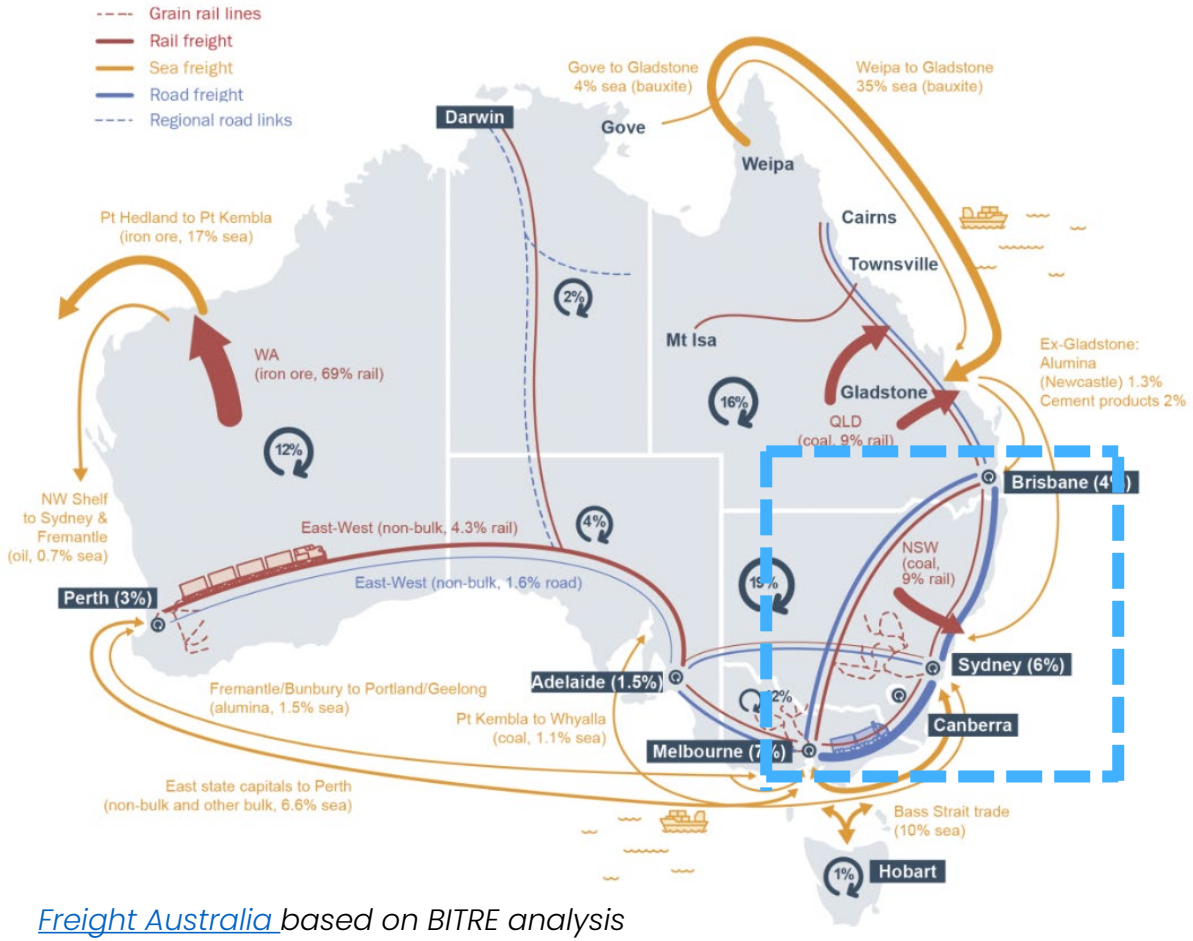
Can I get it? (and keep it fuelled)

Long haul freight task

How much of the freight task is contestable BEV-FCEV?

Eastern capitals generate most interstate freight: Melbourne -> Sydney -> Brisbane. Much of the intrastate task is also longer-distance regional.

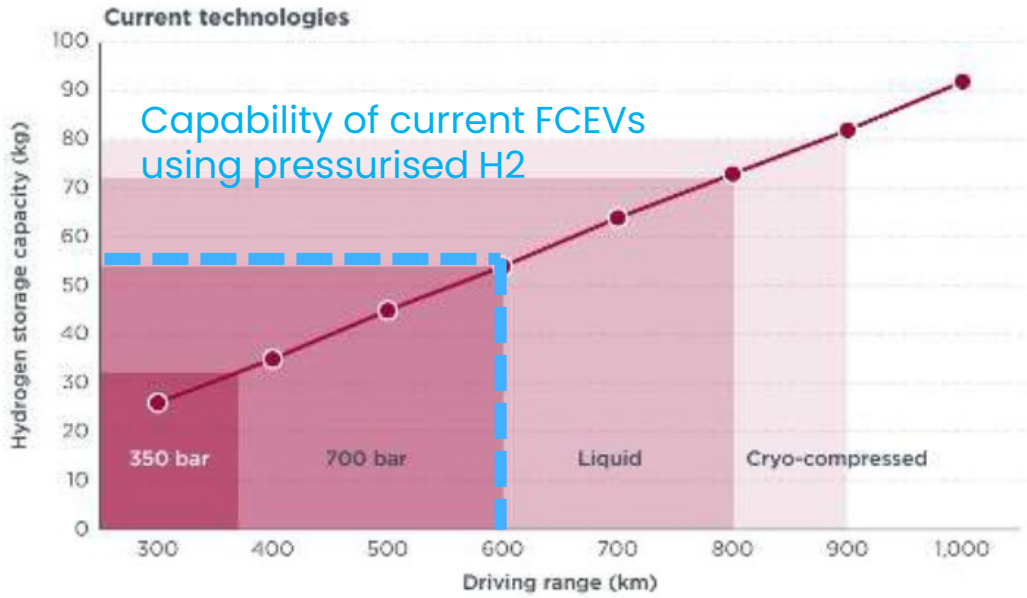
Major Freight Flows in Australia (by volume per mode)



Freight Australia based on BITRE analysis

Inter-capital distances of 800-1,000km.

Rest breaks and trailer swaps along the route.



Maximum achievable driving range for different hydrogen storage technologies considering onboard volume constraints for hydrogen storage

ICCT 2023

What if conventional wisdom is wrong on BET disadvantages?

Most current assumptions reflect "Gen 1" BET (diesel truck platform)

Tesla Semi is a Gen 2 starting point for other OEMs (dedicated BET platform)

Gen 1		Not far off FCET today Gen 2 (today)	Gen 3 (2027-2030)
~450km max.	**Driving range**	~750km	~1,500km **
+2-10 hours	**Recharge time**	40-60 mins	20-30 mins **
1-2.5t	**Payload penalty (weight)**	<1t *	0-0.5t **
? (varies)	**Battery life**	1.6 million km guarantee?	> 1.6 million km ??

*Based on US Class 8 Diesel-vs-Tesla breakdown estimate

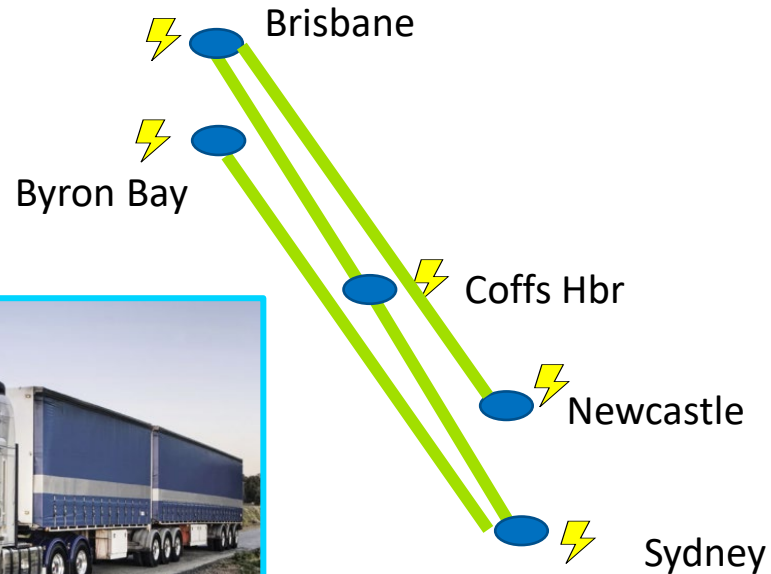
** Toyota, Argonne, others claim Li-Air and solid-state battery breakthroughs with 2-4x range, half the weight

What If there was Megawatt Charging Brisbane-Sydney

SINGLE SEMI TRAILER

- Based on real-world Tesla performance with Pepsi
  - energy consumption 1.1 kWh/km
  - Max. driving range <500 miles (~750km)
  - 10% - 90% charge in 30-40 mins
  - Full load (max GVM)
- Brisbane→ Sydney Busy freight route but 920km not possible w/o charge
- Brisbane→ Newcastle (770km) possible; Sydney→ Byron Bay (760)
- More likely: Syd → Coffs Harbour → Brisbane,
  - protect battery health with >35% charge remaining
  - Shorter charge (20 mins)

Tesla 2023



HYPOTHETICAL B-DOUBLE

- 25% increase in energy consumption
  - 1.35 kWh/km, 40-50mins charge (MegaWatt)
- Sydney → Brisbane with just 1 rest break halfway (Coffs Hbr)
  - 20% SoC remaining, preserving battery

NHVR 2022

What If … technology expands to battery swap?

- “Swap-and-Go” battery systems
- Half of all electric trucks in China use swappable batteries
- Battery swap in minutes: no waiting for chargers
- Slower recharging reduces grid load/costs

ICCT 2023

Example: Janus electric

- 400-600km of range (indicative)
- Battery swap quicker than diesel refuel (mins)
- Conversion compatible with 80-90% models
- Trial underway NOW up to 165 tonnes triple road train
- Other trucks placed in concrete, forestry, mining

Implications

01

Today's BETs (Gen 1) suffer in weight, driving range, charging time.

But costs (TCO) can already undercut diesel.

02

Gen 2 BET technology is already in the (US) market.

Charging time and location can align with rest stops.

03

Mass will be the biggest BET barrier unless axle limits are relaxed.

Local grid impact may also constrain BET uptake in some areas.

04

FCET theoretical advantages over BETs need to be shown in the real world.

These may not remain as BET technology improves.

05

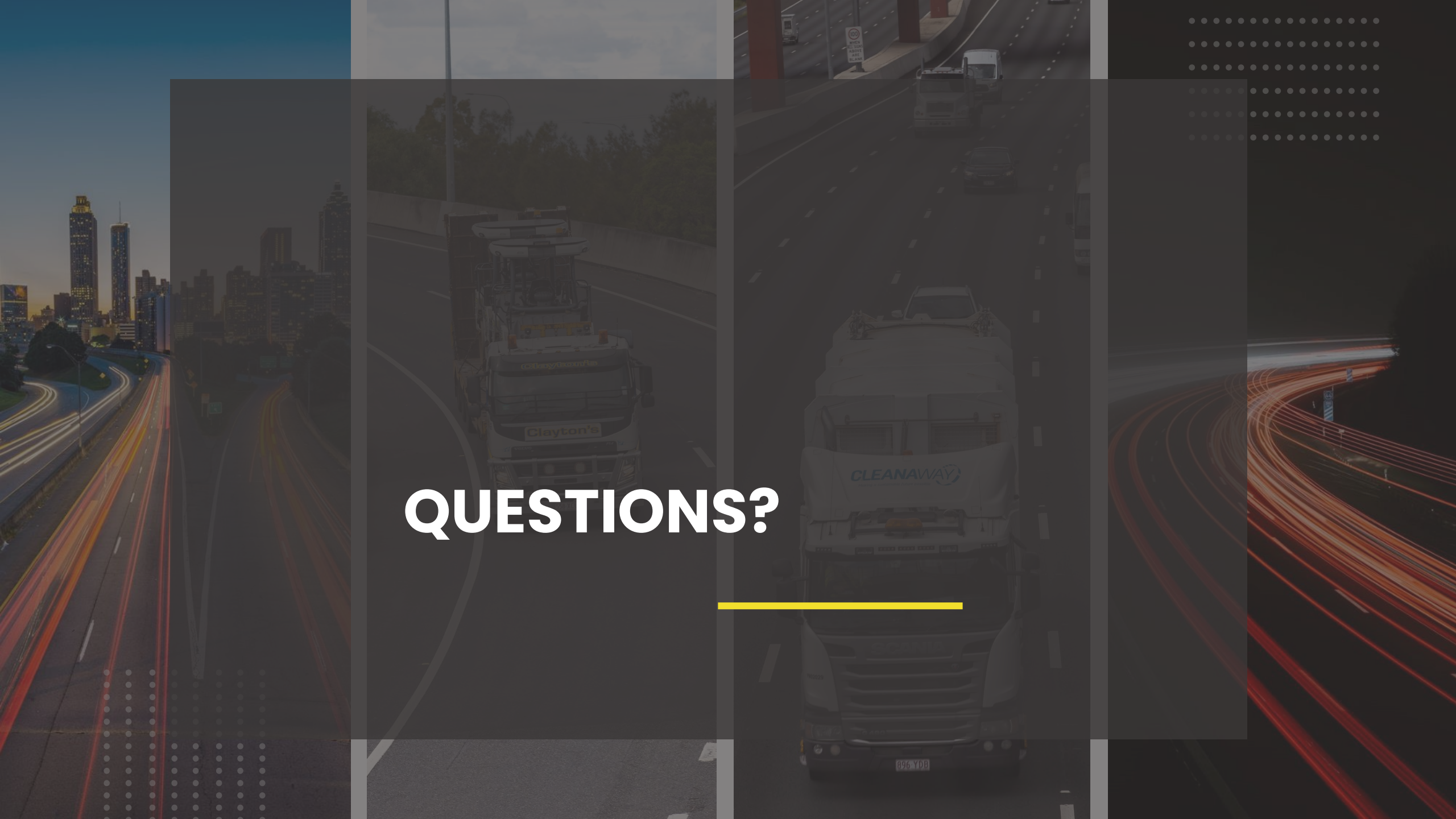
Decarbonisation is an urgent challenge and investment is limited.

H2 has a role to play, but not necessarily a big role in road transport.

06

Don't wait for tech to meet extreme use cases. Not all trucks operate fully loaded or double shift 24/7.

BET rollout should be supported NOW where it can work.



QUESTIONS?