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The need for collaborative research to develop the transition path for hydrogen trucks in Australia

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1. Introduction

This paper, developed by senior practitioners with considerable collective experience, sets out the need for the development of a research agenda to demonstrate a viable business case and transition path for hydrogen fuel cell electric vehicle (H2, FCEV) truck fleets in Australia, to meet zero emissions targets without compromising economic productivity. Its scope is not to expand the knowledge base per se, but to flag the need for research groups to form between industry (overcoming proprietary concerns) and researchers, to develop empirical data to present a solid business case for government and investors. The aim of the paper is also to provide a transition path from which others can modify and expand upon, and lead to more discussion and debate from which a broader consensus can emerge amongst the wider community of stakeholders leading to the most appropriate research avenues.

Unlike the bus sector –critical mass for hydrogen technology in the logistics space cannot be mandated through state-let contracts to achieve critical mass and scale economies of production and consumption. In the absence of legally binding emissions standards and penalties, as are present in other jurisdictions, this currently leaves the decision to 'go hydrogen' with the private sector. As things currently stand, in the absence of a regulatory framework and state support to encourage scale, a decision to do this now would incur additional costs and operational risks.

Traditional small to medium size hauliers operate in very price sensitive markets. It is presumed that until the technology is a considerable way along the adoption curve, or zero emissions vehicles are mandated through contractual obligations, these firms will continue to procure new diesel fleet or keep sweating their current older (and more polluting) assets. The situation may be different for the major listed retailers and hauliers. For these firms pressures from environment, social and government (ESG) ratings and funds, and the need to present a green image, may make a move to hydrogen more desirable relative to electric propulsion, but the economics, risks, timing, and transitional milestones need to be clear. There will also be difference depending on the task at hand – the energy intensivity of garbage trucks is likely to differ to that for long-haul refrigerated freight.

This paper - emphasising scale, range, the capacity of competing technologies, and market realities - stresses the need for participatory research to develop these transitional guidelines. It is hoped that by documenting the need for parties to coalesce to craft the prerequisites of mass

hydrogen truck fleet adoption, that a solid business case can be presented to governments as to the necessary level and location of policy and investment support needed to reach critical mass where the market can sustain itself. The paper takes the line that FCEV trucks are likely to play a considerable role in achieving Net Zero emissions in long-distance freight transport, and the authors note this is not a given but an opinion. Moreover, as an abridged paper, it is limited by volume, but in further work the question of the cost increments needed to move freight to FCEVs affecting other modes' attractiveness e.g., rail freight through schemes such as 'Inland Rail', would need to be expanded upon; for this paper this is out of scope.

2. Policy context

Within Australia policy statements relating to zero emissions targets abound at State and Federal level and documenting them in detail lies outside the scope of an abridged paper. An example at Federal level, however, is the 'First Low Emissions Technology Statement 2020*'* (Department of Industry, Science, Energy and Resources, 2020; Department of Industry, 2021). For the Australian states an example would be the New South Wales 'Net Zero Plan Stage 1: 2020 – 2030' (Department of Planning, Industry and Environment, 2017). Broadly speaking, the aspirations entail achieving net zero transition by 2050, with interim targets in place for 2030. Unlike other countries or trade blocks, Australia has no targets enshrined in law, so the transition either has to be underwritten by government or left to the market to decide when the time is right (Stephens, 2021).

The costs and ease of carbon abatement and the leverage of government, however, differs by sector and sub-sector. Analysis by Goldman Sachs (2021) shows that the largest gains, at the highest cost, are to be found in the transport sector. Leaving aside shipping, aviation, and rail, in the road transport space, this means a greater uptake of zero emission cars, buses and trucks. It is here that policy makers encounter the current sectoral 'battle' that is battery-electric versus hydrogen propulsion (Jones and Neilson, 2021).

3. Trucking – a natural market for H2 at scale?

There are a plethora of articles, reports, and papers, that contrast battery-electric versus hydrogen propulsion in the transport sector, but the core issue under debate is usually range – the distance that can be travelled without the need to refuel. This is largely a function of the weight being carried and the energy capability of the propulsion method. The argument breaks down by the needs of the passenger or freight transport sector in each locational context.

There is also the question of existing supply chains, with hydrogen fuel cell infrastructure arguably mimicking the current structure for diesel trucks. It could be argued that battery electric trucks introduce new operating paradigms and infrastructure investment considerations. Furthermore, there is the issue of decisions, both commercially and governmentally, within Australia, being made by studying outcomes in Europe, the USA and China, where technologies are more mature, and conditions and government intervention differs from the Australian context. In addition, there is the issue of spreading large, fixed investment costs across Australia's small population, tax and market base . This has acted as a constraint on Australian transport investment in the past, though some of these factors may be ameliorated in urban centres.

In the Australian urban bus sector, battery-electric solutions seem to be the technology which governments are backing at least in the short term. In two recent large-scale Sydney and Melbourne tendering exercises, a transition to battery-electric fleet was a condition of contract.

Hydrogen *is* being trialed in the bus sector and small-scale initiatives are underway - in Victoria linked to existing local hydrogen generation projects - but there has as yet been no announcement of planned scale adoption. Similarly, the immediate future for the H2 car and light van market looks relatively bleak with commentators such as Baxter (2020) stating:

> The bulk of the car, bus and light-truck market looks set to adopt [battery electric technology], which are a cheaper solution than fuel cells…Volkswagen, meanwhile, made a statement comparing the energy efficiency of the technologies. "The conclusion is clear" said the company. "In the case of the passenger car, everything speaks in favour of the battery and practically nothing speaks in favour of hydrogen."

Collins (2022) notes that even the CEO and co-founder of US hydrogen truck and bus maker Hyzon Motors 'does not see a bright future for hydrogen cars'. Hydrogen trucks, however, are described as 'the only viable carbon-free solution to long-distance trucking' due to the capacity limitations of the electricity grid, volume of required charge points, and the weight of truck batteries. The authors do not contest this position and for this paper take the line that 'the future of long-haul heavy trucking probably includes lots of hydrogen' (Walker, 2021).

But scale is needed. When fuel cell penetration is relatively high, it will bring down the costs of trucks, and higher saturation of fuel cell trucks in turn increases the demand for hydrogen fuel. This lowers the incremental cost of infrastructure, optimising the cost of liquification and reducing long term fuel costs by up to 40% (Kumar, 2021; Yaïci and Longo, 2022; Liu et al., 2019). Plus, moving to electric fleet at scale, will incur electricity grid and connector upgrades which may not have been accounted for in comparative analyses. These factors are particularly important given the fixed costs issues alluded to earlier. Put another way:

> Doing a few battery electric trucks is easy; doing hundreds is near impossible…doing a few fuel-cell trucks is a pain…doing hundreds is a walk in the park (Collins, 2022)

How to achieve this scale? The trucking industry is not the same as the bus sector, where states can mandate and underwrite a critical mass of fleet and infrastructure through concession agreements or making procurement decisions when they are the sole service provider and/or asset owner. The freight haulage industry is operated by the market in extremely competitive circumstances. Currently, 'going hydrogen' would, in the absence of legally binding emissions standards and penalties, as are present in other jurisdictions, be a risky decision for small to medium sized trucking firms in terms of stranded asset potential, additional capital and operating cost, uncertain regulatory environments, and distribution concerns. Goldman Sachs (2021) note that in rural road transport it is significantly more expensive to achieve carbon abatement than other transport sectors. Given this, most firms are likely to continue to purchase new diesel fleet. The absence of a formal carbon pricing or taxation regime in Australia exacerbates, this issue given that the market lacks investment price signals.

The situation *may* differ for large scale retailers and freight firms who are potentially under considerable pressure to present to government, customers, and shareholders a green footprint. Moreover, in the absence of formal carbon pricing, high ratings from Environment, Social and Governance (ESG) funds will be important going forward as a proxy for future regulatory risk. Better ESG scores:

> …translate to about a 10% lower cost of capital. This correlates to lower regulatory, environmental, and litigation risks associated with high ESG-scoring companies. ESG is far more than mere window dressing—it is an…imperative (Rapier, 2022).

4. What is needed is a research agenda to inform government

To realise the potential of hydrogen-based transportation trucks, Kumar (2021) highlights government support is needed in: research and development; regulatory certainty on vehicle, planning, and energy standards; infrastructure development and; financial incentives.

What is required next, is for industry and investors to develop a holistic business case for the hydrogen trucking transition, to present to state and federal government to demonstrate the critical mass needed for the market to generate self-sustaining momentum (as noted in Panoutsou et al., [2021] and Lajevardi et al., [2022]). The hydrogen industry is not yet commercial, and considerable capital and operational investment is needed, supported by regulatory certainty. Until the industry has achieved sufficient production economies of scale grant funding is *essential*. Public investment will unlock 'several times its value from the private sector' (Australian Hydrogen Council, 2021).

At present Federal and State funding for hydrogen has focused on energy production, seeking to develop facilities that can be scaled to achieve export production levels. The heavy vehicle transport sector is best positioned to be an early adopter of local hydrogen although there has been comparatively little funding directed at industry within Australia to facilitate a local market, or in trucking parlance, "get the rubber on the road". An example thus far of state support for the nascent hydrogen trucking industry is the $20m being invested by the New South Wales and Victorian Governments for hydrogen refueling facilities on the Hume Highway between Sydney and Melbourne (DELWP, 2022).

But more is required to show the required investment at urban and regional level (Liu et al., 2019). Whilst the arrival of international hydrogen firms may be expected in the coming years, regulatory clarity will doubtless ease this process.

What is needed is 'whole of supply chain' modelling to address production, delivery, and consumption, to set out the framework for engagement at a community level and showcase necessary regulatory instruments. A significant impediment is that the Australian policy framework has been fragmented or 'scattered' (Allens, 2022). An excess of policy documents, trials and regulations, spread across states, will not be to the sector's benefit. Investors and manufacturers are interested in Australia as a national market, not a series of smaller opportunities across individual states, with a risk that scale economies may not be achieved.

If resources and efforts are not pooled there is a risk that policy makers, communities, and industry, will fail to see a consolidated roadmap to scale and choose other countries to focus their efforts. The research community has a crucial role to play in bringing these endeavors together and working with parties (many of them concerned about market positioning or proprietary information) to elevate hydrogen's profile by showing workable schemes at scale, first by modelling them, and then through their delivery.

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