5 December 2025

Productivity Commission
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Dear Commission Chair

Productivity Commission - Zero Emission Heavy Vehicle infrastructure

Our submission is in response to the Federal Treasurer's request to the Productivity Commission (PC) for a report to address removing the regulatory barriers to improve the availability of Zero Emission Heavy Vehicles (ZEHV) charging infrastructure. Our response focuses on the PC's call for view, data and evidence in relation to the practical barriers and policy issues affecting the long-term implementation of an effective network of ZEHV publicly accessible charging infrastructure.

40% of global shipping is for transporting fuels. 50% of Australia's oil imports, or 30 billion litres, is diesel imports with around 15 billion litres of that diesel for road freight transport. Those diesel freight vehicles contribute 11.5% to Australia's annual GHG emissions. From a productivity perspective, reducing diesel importation volumes alone reduces those fuel emissions by one-quarter before considering the cost savings from reduced fuel movements etc.

Australians then bury 22 million tons of waste each year, emitting up to 33 million tons of CO_2e, and costing the Australian economy $7 to $8 billion or more per year in terms of productivity inefficiencies.

So, how are waste and diesel connected to enable an effective publicly accessible ZEHV recharging infrastructure?

Consider that 22 million ton of waste is capable to be upcycled locally to produce 2.2 billion kg of hydrogen annually. Hydrogen can be substituted to avoid the importation of 15 billion litres of diesel, with capability to supply 100% of the trucks and buses on our roads as ZEHV across all available and emerging zero emission powertrains.

Reimagine: The circular economy at the core of affordable ZEHV infrastructure

From a productivity perspective, upcycling waste to hydrogen yields 5.5 times more hydrogen per kWh of renewable energy than is produced by electrolysis hydrogen. As compared to incineration, 6 times greater energy yield potential arises from the upcycling of waste to low carbon fuels rather than burning it. Less inwards power for upcycling reduces the demands on land degradation for new renewable infrastructure. Less inwards energy lowers hydrogen production costs such that hydrogen as a product, or as fast charge power, can be delivered at diesel price parity.

Low carbon products capable to be supplied through a repeatable network of 70 to 80 localised Sustainability Precincts (i.e. repurposing existing waste management sites often nearby to major transport routes). Precincts supplying as many nearby ZEHV refuelling stations as required (i.e. station locations are not limited by grid connection issues as is the case with battery electric only solutions). Essentially a series of integrated networks, hub and spoke or point to point, micro-grids or community style approaches to establish the required new ZEHV refuelling infrastructure. Delivering a variety of zero emission outputs for differing zero emission powertrains, optimising technology synergies to lower upfront and ongoing costs with enhanced productivity and circularity outcomes.

The productivity gains are enormous when you consider that the waste (to hydrogen or fast charge power) alone as a diesel substitute generates $26+ billion in annual additional economic value. Importantly there is an 80% reduction in inwards renewable energy infrastructure demands for upcycled hydrogen, with more focus on expanding generation capacity than transmission infrastructure. This improves the social licence to operate, reduces regional community anxiety as well as lowers the capital expenditure program for the ZEHV transition by $100 to $250 billion as compared with either a singular battery electric or electrolysis hydrogen pathways.

The advantages continue: 12,500 new jobs; stimulus for new value chain manufacturing in Australia; 16% in GHG emissions saving bridging the gap to Australia's 2035 net zero target; health and community benefits for using ZEHV. All materially enhances Australia's energy security profile with the domestic production of over 20% of Australia's fuel requirements – Future Made in Australia.

Rethink: Australia's energy security and 2035 net zero leadership potential

As already recognised by the PC, reducing Australia's road freight emissions will need to be addressed by a variety of vehicle powertrains, not only battery electric powertrains. Consistent with that we are working to progress a ZEHV refuelling infrastructure that affordably supplies low carbon fuels (specifically hydrogen and methanol upcycled from waste) to supply hydrogen internal combustion and hydrogen dual fuel powertrains as well as all fuel cells whether:

- stationary (to recharge battery electric ZEHV), or
- mobile (to recharge on board hydrogen fuel cells ZEHV).

Rethinking Australia's ZEHV refuelling infrastructure needs to provide duality of supply through a comprehensive network of Fast Charge Hydrogen Refuelling Stations (FC-HRS). Ideally solving two hard to abate sectors, waste and transport, with similarly, leverageable infrastructure. Ones that are capable to be delivered now with today's technology.

We have started. We are delivering Australia's first Precinct in Gippsland, Victoria, upcycling waste to manufacture a range of low carbon fuels. We welcome the opportunity to share some of our observations and experiences of our journey. Importantly, to action change clarity of the government policy framework and implementation pathway needs to cater for four unique features of the Australian waste and heavy vehicle transport landscape:

1. 98% of freight transport is operated by businesses with less than 20 employees. Of the remaining 1,100 businesses, we estimate the largest 20 freight companies, plus large waste management companies (i.e. Cleanaway alone that has over 6,000 vehicles) operate around 90,000 heavy vehicles contributing around 15% towards road freight emissions. Governments then coordinate or operate an additional 45,000 public transport diesel buses. So, a handful of organisations can in fact affect big change to start the build of the required ZEHV infrastructure,
2. Around 10% of Australian freight is hauled by multi-trailer vehicles hauling more than 40 tons each. Each vehicle capable to be transitioned to hydrogen dual fuel powertrains delivering it sufficient torque and power for hauling demands to be maintained. The higher torque requirements of these larger freight movements are often beyond that of hydrogen fuel cell or battery electric powertrains,
3. Australia's national and arterial road network is 126,000 km, comparatively linear, with longer distances and infrequent large population centres as compared to Europe's, and
4. Waste is a resource capable to be upcycled, being generated at/near suitable ZEHV infrastructure.

Methanol production is a US$38 billion global industry, expected to grow exponentially as this low carbon fuel use expands into decarbonising road, rail, air and ship transport. Australia's current share of global methanol production is less than 1%. China comprehensively embraces methanol as part of its lower emission freight transport solutions, recently announcing a 20% investment subsidy for additional low carbon methanol production capacity.

Redesign: Community infrastructure to deliver productivity gains leveraging today's technology

Technology is available today to increase Australia's productivity across the vehicle, refuelling and waste sectors. Australian Federal and State governments need to redesign the multi-sector synergies available, rather than a continual siloed response to issues. A holistic multi-sector perspective will improve productivity outcomes.

The European Union (EU) has clearly guided its' ZEHV policy direction with the TEN-T program for heavy vehicles. One targeting battery electric recharging stations every 60 km and 430 hydrogen refuelling stations every 200 km. This is stimulating investment into a greater availability of hydrogen fuel cell and battery electric vehicles and infrastructure. New Zealand organisations like Change Fuel Technologies are rolling out the retrofit of dual fuel hydrogen and diesel powertrains to those heavy vehicles required to retain high power demands and deliver lower emissions, typically 30% to 50% lower per vehicle. OEMs are encouraging similar EU vehicle efficiency standards.

Australia has a significant opportunity to lead global circular economy pathways, create investment opportunities and provide a deflationary lever for waste and fuel costs to contain the spiralling cost of diesel and waste management in this country. Enhancing a pathway that dovetails with higher productivity and a ZEHV infrastructure and use strategy to create regional jobs and investment through incrementally creating transport green corridors.

Green corridors sustained by Precincts increase recycling across the country. Precincts that can supply multiple ZEHV refuelling stations with more affordable hydrogen and fast charge power. ZEHV refuelling stations capable to replicate Australia's existing diesel refuelling network, connecting intermodals, ports, airports, and road networks.

We believe that regional Australia can be a key stepping stone in building out that green corridor network. We have discussed with many local councils and organisations as to what is needed for further hubs, each focused to essentially recycle local waste into a valuable resource to build-out that green corridor network across the country.

Throughout that engagement process, feedback received is that policy direction is inconsistent or non-existent, there are extensive gaps and most importantly there are no waste or fuel penalties, mandates or requirements to change. In many cases current regulations reflects a bias towards older technologies that create community unease or don't dramatically enable a step down in Australia's escalating waste management or transport costs, nor emissions.

The PC has provided separate interim reports on improvements in the circular economy and heavy road vehicle transport. To advance Australia's productivity in the ZEHV sector, together with the circular economy, we have six recommendations for the PC and Federal Government to consider:

1. Streamline policies and approvals,
2. Stimulate the development of transport Green Corridors,
3. Lower the Safeguard Mechanism to 25,000 tpa,
4. Introduce a ZEHV Owner guarantee scheme,
5. Co-invest with the States in state-based E-Mobility Clean Energy Sustainability Funds, and
6. Enable a ZEHV Business Investment Allowance.

We have detailed these and additional background in the Appendices.

We would welcome the opportunity to meet to discuss how best to action and accelerate Australia to lead in the global transport and circular economy transition.

Best regards

Craig Allen
Director
[redacted]

Appendix A - Six Productivity and Circularity Recommendations

We have provided the following illustrative, real life, and insightful case study of the significant gaps in Australia's current policy settings that are undermining productivity in the transport and waste sectors. On a macro level we have also outlined in Appendix B the potential productivity gains of an Australia wide upcycling transition as compared to some alternatives. This Geelong example is repeatable across Australia and highlights the productivity and investment opportunities that are currently curtailed by existing Federal, State and Local government policies, laws and regulations.

Case Study

Water yields around 7% hydrogen using electrolysis, requiring large water volumes. Using Hydrogen by Plasma Assisted Gasification (HPAG) and typical mixed household waste streams, hydrogen yields are 10% to 11% of solid waste feedstocks with negligible water consumption. HPAG is proven thermochemical technology, currently being commercially scaled, that can deliver higher hydrogen yields upcycling waste, requiring 17% of the inwards energy of electrolysis. Lower inward energy demands, higher yields, and use of the accompanying captured CO_2 enable the delivery of a more affordable hydrogen product, as well as low carbon chemicals and low carbon fuels like methanol, across a wider network.

For context, on average it takes about 1 kg of hydrogen to replace 5.4 litres of diesel in heavy vehicle road transport. So, to be competitive with a current $2.20 per litre diesel retail cost, hydrogen as a fuel needs to have a retail price at around $12.00 per kg to vehicle operators. HPAG combined with other commercially available technologies can achieve that economic outcome to increase Australia's recycling rates, upcycle waste to a valuable product, and enable positive environmental outcomes.

As a comparator, Viva Energy's $61 million investment in one Geelong hydrogen refuelling station (using electrolysis) has a refuelling capacity for 15 hydrogen fuel cell trucks. Viva's hydrogen retails at $33 per kg hydrogen, around 3 times the diesel equivalent and represented an invested capital cost of $713 per ton of CO_2e saved. Barwon Water, in the Geelong region, is then looking spend another $85 million to solve mandated FOGO recycling requirements with a Regional Renewable Organics Network (RRON) anticipated to result in at best 2% Return on Investment, albeit it a lower invested capital cost of $272 per ton of CO_2e saved. The low ROI a direct function of low product yields, and low-end product prices for organics to digestate and biochar (retailing for $10 per ton).

Neither investment has solved Geelong's residual solid waste problems, nor materially reduced CO_2e emissions or provided zero emission capacity for Geelong's estimated 3,000 heavy vehicle trucks and buses to decarbonise. Scaling up Viva's infrastructure investment alone for 3,000 heavy vehicles would seemingly cost $12.2 billion.

If available, Geelong's household waste feedstock should enable core upcycling capacity for around 1,500 zero emission heavy vehicles for a capital program less than 3% of the expanded Viva station cost example. Each one capable to provide DC fast charge power and/or hydrogen capabilities. A strategy providing cost of living relief through lowering household rates by $300 to $400 per annum per household. Additional business waste in the region (i.e. not imported from Melbourne) could be upcycled in Geelong providing additional capacity for the supply requirements to lead towards 3,000 zero emission heavy vehicles.

Geelong currently has 52 petrol stations. Utilising methanol as a hydrogen carrier each existing station and bus depot could be repurposed with containerised methanol reformer units and using methanol be upgraded to be a FC-HRS station. Methanol is an efficient hydrogen carrier, enabling the energy equivalence of 12 tankers of hydrogen gas to be transported in one tanker of methanol. Methanol is reformed to hydrogen using commercially available methanol reformer technology. This leads to each ZEHV refuelling transformation being undertaken at a fraction of the cost to build the existing one hydrogen refuelling station.

To improve productivity, enhance security, create jobs and attract business and investment we have six specific recommendations for the Productivity Commission to consider and recommend to the Australian Government and National Cabinet.

Recommendation 1 – Streamline policies and approvals

Prioritise and streamline approvals processes for net zero, transport, and circular economy initiatives, including Waste to Hydrogen to X (W2X), across and within the three levels of government and the multiple government departments and the strategies involved (i.e. climate, hydrogen, waste, transport, energy, circular economy, regional planning, biodiversity, manufacturing).

The hurdles and barriers to a lower emission transport and circular economy are four-fold:

1. **Enable more 'green pathways' and less 'red tape'** specifically the lack of alignment of the multiple strategies and government departments with respect to interrelated net zero, transport and circular economy initiatives into a streamlined approval process. We experience at least 11 overlapping, often competing, and many times contradictory government policies in place across the three tiers of government.
2. **Lack of foundational funding support** to enable local governments to advance and stimulate decision making for Sustainability Precincts developments encompassing upcycling and ZEHV infrastructure.
3. **Stimulate end markets** Our Recommendations 2, 3, 4, 5 and 6 are focused on creating and stimulating end user demand for locally produced hydrogen, and methanol, into ZEHV to enable transport green corridors to be established.
4. **Keep the goal simple yet clear.** In the EU, Article 6 of the EU Alternative Fuels Infrastructure Regulation as part of the EU TEN-T program is a tangible overseas example which can be adopted in progressing a clear strategy for Australia. Consistent with this all our recommendations represent clear, simple achievable goals.

Within any streamlined policy outcome and agenda, we would encourage:

- Vehicle emission standards to allow for and stimulate a transition for ZEHV with hydrogen internal combustion and dual fuel hydrogen powertrains together with battery electric and hydrogen fuel cell electric, and
- Developing National Environment Standards to accommodate repurposing of waste management sites to hydrogen and methanol manufacturing precincts, incorporating FC-HRS infrastructure. This could include repurposing adjacent closed landfill sites as solar farms to supply a Precinct's renewable energy needs.

Recommendation 2 – Stimulate the development of transport Green Corridors

The Australian Government does not have a policy as to the establishment of zero emission charging and refuelling infrastructure. That uncertainty and absence of direction undermine the willingness to invest or transition in that zero emission infrastructure for the value chain businesses that arise from or support those investments. Increasingly we observe voluntary actions in the waste and transport transition are scarce at Australia's largest organisations. Seemingly mandated actions, high impactful, at the lowest cost for participants are required.

We recommend the development of a specific transport Green Corridors policy direction and initiative. That policy being consistent for the construction of one multi-purpose Fast Charge and Hydrogen Refuelling Station (FC-HRS) every 250 km on the Australian core road network by the end of 2032, as well as one FC-HRS in every urban node. The stations are to have a minimum daily supply capacity of two tons of hydrogen with a carbon intensity below 0.6 kg CO_2e per kg hydrogen for all modes of road transport, with duality of ZEHV hydrogen and DC fast charge power. Urban nodes are areas where different components of the transport infrastructures such as ports, passenger terminals, airports, railways stations, bus terminals and logistic platforms, are interconnected with each other.

When one considers that on the Australian east coast there is around 14,500 km of national road networks, this mandates around 70 FC-HRS by 2032, plus additional FC-HRS at ports, passenger terminals, airports, railways stations, bus terminals and logistic platforms. All capable to be supported under a 'hub and spoke' model from 30 initial phase Sustainability Precincts. Each Precinct that could start with hydrogen production capacities of 4,000 tpa hydrogen, upcycled from 40,000 tpa waste each. Precincts can be expanded and added to as ZEHV demand grows.

Initially an eco-system reducing emissions by around 4 million tons CO_2e annually, 100 million tons CO_2e before 2050. An interim 2030 target of 30 Precincts upcycles 1.2 million tpa waste to reduce solid waste and diesel transport emissions by around 7%, above with the Safeguard Mechanism target reduction of 4.9% per year. Each of those delivering economic stimulus and carbon mitigation infrastructure to the respective regions. We are currently working to progress five Precincts for development in South East Queensland to supply and enable a net zero 2032 Games and then provide the first east coast Green Corridor connection with Victoria's Gippsland Precinct. Early adoption of these recommendations would enable early development, enabling Australia's next 2032 Games to be net zero.

We have assessed the higher priority and other suitable Precinct locations and previously provided a copy of that to the PC and Federal Government aligned with this recommendation. State specific roadmaps have also been provided to all State Governments as part of the frequent waste strategy reviews that occur.

Recommendation 3 – Lower the Safeguard Mechanism to 25,000 tpa

The Australian Government should address the lack of coverage of smaller emitters by immediately lowering the Safeguard Mechanism coverage threshold to 25,000 tons of CO_2e per year. Ensure the definition of facilities is capable to encompass all waste facilities, landfill and heavy vehicle transport modes.

In this way it would apply to transport organisations with vehicles cumulatively above that threshold, which is generally around 200 heavy or articulated vehicles. A 4.9% annual reduction would stimulate demand for at least 10 ZEHV per year from these larger transport and waste organisations to achieve the threshold targets.

Recommendation 4 – Introduce a ZEHV Owner guarantee scheme

We agree with the PC's recommendation that *"The Australian Government should introduce a new emissions-reduction incentive to cover heavy vehicles. The incentive should be as technology-neutral as possible, meaning that it should create the same incentive to reduce emissions by switching from fossil fuels to electric vehicles, low-carbon liquid fuels or any other method to reduce emissions."*

Typically, a significant component of truck and bus manufacture and assembly already occur in Australia. Higher levels of ZEHV truck and bus purchases would stimulate additional demand for those existing organisations, as well as componentry manufacturers for those ZEHV vehicles.

Recognising that 98% of truck operators are small enterprises and that a switch to a ZEHV is a significant investment, we recommend introducing a ZEHV Owner guarantee scheme, akin to the current housing affordability scheme. Similar guarantee schemes operate globally to transition aspiration to action, for both private and public organisations. Chile's recent scheme is a demonstration of the success of this recommendation. These guarantees could take a variety of forms covering residual value and/or credit guarantees (i.e. in the case of smaller operators).

The suggested framework for early mover ZEHV owner / operators involves stapled seven-year hydrogen supply and lease program through which:

1. Vehicle Operator - Meets Vehicle Guarantee Scheme eligibility,
2. Small deposit – Vehicle Operator pays 3% deposit of new Vehicle purchase price,
3. CEFC guarantee – CEFC provides Guarantee to Participating Lender to enable the Vehicle Operator to enter 'stapled' hydrogen supply and vehicle lease,
4. Lease from Participating Lender – Participating Lender provides Lease to Vehicle Operator at discounted green interest rate, e.g. less bank and CEFC green discount,
5. Hydrogen from Precinct Owner – Precinct Owner provide hydrogen to Vehicle Operator at capped and discounted hydrogen price (inclusive of any eligible HPTI offset), and
6. Vehicle use – Vehicle Operator uses and operates Vehicle.

The Participating Lender receives a nominated green loan interest rebate from CEFC.

Recommendation 5 –

Co-invest with the States in state-based E-Mobility Clean Energy Sustainability Funds

Currently Federal and State waste management polices aspire to recycle 80% of waste generated by 2030. Often initiatives we've observed and in place, and in fact the PC has reported on, are less impactful in terms of savings emissions or are costly and difficult to finance or justify. A few foundational steps are required:

- Prioritise higher waste to fuels initiatives that address both waste and fuel emissions,
- Reprioritise non-electrolysis hydrogen production pathways as equal to electrolytic technologies, and
- Invest in and encourage the scale up of circular economy precincts, ones that focus on reducing waste management and fuel costs and emissions.

In addition to the $10 billion in annual Federal government diesel fuel excise collections, Australian States collect more than $3 billion in annual waste levies. Transitioning from diesel to ZEHV and from landfill to recycling creates fiscal collection gaps for both levels of government.

Veolia recently completed a study with University of Sydney highlighting that more effective recycling arose in the UK and EU when waste levies collected were directed into funds to progress high carbon saving impact recycling projects. To profile the carbon impact savings from various forms of recycling South Australia and NSW governments report the CO_2e savings from various recycling projects per ton of waste recycled as being:

- Organics – 0.57 tons CO_2e per ton waste,
- Glass – 0.53 tons CO_2e per ton waste,
- E-waste – 0.43 tons CO_2e per ton waste,
- Plastics – 0.38 tons CO_2e per ton waste, and
- Paper and cardboard – 0.05 tons CO_2e per ton waste.

Recycling these resources is important and should complement reduce and reuse campaigns. Nevertheless, there is inviably a residual waste stream that by volume dwarfs other recycled waste streams. Sustainability Precincts are designed to recycle these residual wastes to fuels, with eco-system greenhouse gas savings at between 3.2 and 3.4 tons CO_2e per ton of waste (i.e. 6 to 8 more beneficial than current recycling activities). The recycling of hydrogen, carbon, and oxygen molecules into fuels to replace transport fossil fuels achieves higher outcomes and so with government clarity and support, the acceleration of infrastructure and pathways to net zero is delivered - upcycling.

We have already recommended to the States that each State Government establish state-based E-Mobility Clean Energy Sustainability Funds (Funds) from the waste levies collected. Funds to stimulate the development of and co-ownership with local governments and businesses of up to 70 Sustainability Precincts across Australia. These Funds would provide revenue streams and Zero Waste pathways for the States. In total, the Funds would develop Precinct capacities across the States to upcycle the 14 million tpa of household Municipal Solid Waste thus delivering capacity to manufacture up to 1.4 billion kg of Grade A+ hydrogen and/or suitable low carbon methanol volumes.

For Commercial & Industrial (C&I) waste streams we recommend this Precinct capacity is fully funded by the private sector to upcycle the remaining 8 million tpa of C&I waste currently disposed of to landfill. This could into a range of sustainable fuels including hydrogen, methanol and/or Sustainable Aviation Fuels (SAF) to decarbonise the road, rail, ship and/or air transport sectors.

The establishment of multiple circular economy Precinct capacities better positions all tiers of government to achieve aspirations to divert 80% of waste from landfill by 2030. Manufacturing low carbon content hydrogen should attract Federal Hydrogen Production Tax Incentive (HPTI) funding, which if eligible could be passed through to in part transitioning cornerstone ZEHV operators in accordance with Recommendation 4.

Governments as co-investors:

- through NRF, enable the Australian Government to then collect new sources of employee, company and goods and services taxes together with Precinct investment distributions to fully fund and offset the phasing out of diesel fuel excise collections and the HPTI, and

- through each of the State Funds each would collect payroll taxes and Precinct investment distributions to fully fund and offset the phasing out of waste levies.

Please contact us if you would like the commercial in confidence modelling of this specific recommendation.

For clarity, upcycling is not incineration or the burning of waste. Rather upcycling is the thermochemical separation of waste molecules for recycling purposes, capturing the separated molecules for higher value recycling to be available for an array of purposes. The technology features are ideally suited to ZEHV infrastructure buildouts.

At a time that EU and UK countries are specifying 90% carbon capture minimum standards for new incinerators, Australia's position is absent. The lack of mandated carbon capture for incinerators is undermining Australia's circular economy advancement, net zero outcomes and now Australia's energy security potential for ZEHV infrastructure.

From a productivity perspective, incineration is inefficient and detracts from Australia attaining higher productivity in waste management and ZEHV infrastructure given that:

- **Energy inefficient** – less than 18% of the waste's energy potential is captured as compared to upcycling. That is 6 times more waste is required to be burnt to achieve the same energy potential outcomes as compared to upcycling,
- **No carbon capture** - to comply with higher EU Best Available Technology standards incinerators are being redesigned or retrofitted with a limited range of carbon capture technologies. The extra technology itself then consuming 60% to 80% of the incinerator power output, further reducing an incinerator's energy efficiency, and
- **Higher upfront capital** – extra carbon capture equipment adds 30% to 40% to the upfront capital expenditure further challenging the productivity and economics of burning waste to produce grid power competing with other lower carbon intensive forms like solar, wind or hydro.

By extension, burning an average of 600,000 tpa of waste in 8 to 10 proposed new Australian incinerators, reduces the longer-term opportunities for Australia to recycle that waste as a diesel substitute for ZEHV. As one example, presently the Gold Coast City Council is advancing a 660,000 tpa incinerator, recently upsized to cater for more than twice the MSW generated on the Gold Coast and to maintain its economic viability. Located at the northern end of the Gold Coast, transport emissions will rise given the significantly longer hauling distances for waste to a single site. An incinerator's impacts to reduce CO_2e emissions are modest, and with an increasing transition to a renewable power grid its benefits decline dramatically. Presently, the Gold Coast City Council is projecting 71,000 tpa CO_2e emissions savings in 2032 with emissions rising to 102,000 tpa CO_2e by 2050. Essentially burning waste provides nothing more than baseload power generation and is akin to a quasi-coal power station sterilising higher value pathways for the waste generated.

With a clearer and enhanced Australian Government policy framework that Gold Coast urban waste stream could be redirected and recycled to establish four separate Precincts and multiple FC-HRS along 75 km of one of Australia's busiest Federal highways. In that way, it could provide sufficient fuel supply to transition 11,000 to 15,000 diesel trucks and buses to zero emission and reduce 2.2 million tpa CO_2e (i.e. 0.5% of Australia's CO_2e emissions).

As a further example of the outcomes from alternative pathways, we completed a recent study for an 80,000 person community organisation considering the value drivers for a new zero emission bus depot. The value factors encompassed: land use; energy inward needs 24/7; greenhouse gas emissions; jobs created and water consumption. A summary of those findings is presented in Figure 1.

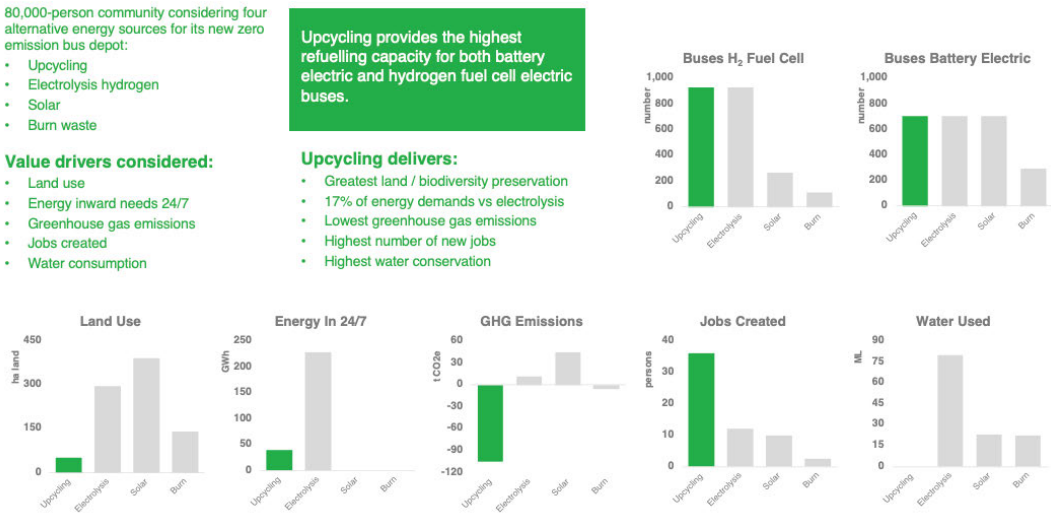

Figure 1 – *Value driver outcomes for alternative zero emission pathways for a new bus depot*

Recommendation 6 – Enable a ZEHV Business Investment Allowance

We note the PC statements that *"Technologies like electric trucks, hydrogen trucks and renewable diesel are relatively expensive and are not ready for widespread use. The Australian Government expects that a broader uptake of these technologies will only be possible from the 2030s; and, in the case of electric and hydrogen trucks, a 'mass market adoption' will only be viable in the 2040s (DITRDCSA 2024, p. 7)."*

Different low-emissions options will play different roles in reducing heavy vehicle emissions.

- *Electric vehicles will likely be suitable for businesses carrying lighter loads over shorter distances.*
- *Hydrogen vehicles may be an option for heavier loads over longer distances.*
- *Renewable diesel could be used to decarbonise the longest and heaviest freight, as well as reduce emissions in the short term since it can be used in conventional heavy vehicles."*

These generalised statements overlook lower cost technologies that provide a dual fuel alternatives to heavy vehicles through the installation of technologies like that provided by Change Fuel Technologies. Already available and proven technology in New Zealand and emerging now in Australia, the cost of the installation is materially below that of purchasing a new ZEHV. The benefits suit multi-trailer ZEHV scenarios and should appeal to small and medium owner / operators that want to transition away from diesel and cannot always afford a new ZEHV. The rollout to date and experiences reported are demonstrating that it is a suitable pathway to transition to quasi hydrogen ZEHV. OEM in the EU are also demanding regulatory vehicle efficiency changes there to accommodate this transition solution.

If hydrogen upcycled from waste is consumed, the emissions benefits as similar to transitioning to full hydrogen fuel cell ZEHV. To further contain the Total Cost of Ownership of ZEHV we can demonstrate that hydrogen can be delivered at diesel price parity from upcycling Precincts.

We recommend the Australian Government, as an early mover measure to stimulate ZEHV purchases, provide a general business investment allowance for purchases before to 2030 with a:

- 60% investment allowance to heavy vehicle owners installing hydrogen dual fuel technology, and
- 40% investment allowance to purchasers of new ZEHV, phasing down by 10% every 2 years thereafter.

These new vehicles will range from ZEHV heavy, medium, and light waste collection vehicles, public bus transport, general freight transport, government vehicle fleets and those vehicles used by suppliers to governments.

Appendix B – Circular Economy Productivity Gaps

Enabling affordable green corridors - upcycling

We are an advanced recycler of mixed waste products, operating across the Waste to Hydrogen to X (W2X) technology spectrum. A spectrum that utilises various technologies to recycle waste to produce a range of low carbon products, typically chemicals and fuels. The X representing the array of products capable to be produced from the first element on the periodic table, hydrogen. In our case, recycling designed to end landfills and build eco systems to reduce greenhouse emissions 2 to 7 times more effectively than alternatives, hence the term upcycling. Our modular technology is capable to recycle mixed waste streams with minimal separation, sized for communities upwards from 40,000 people. As such, we have a solution suite that actions many of Australia's policy agendas.

To be a successful recycler and attract investment, we need access to suitable non-controversial feedstock to produce low carbon products that are comparably priced to the high carbon product we are looking to replace. In our experience, few consumers are looking to pay a green premium for low carbon or recycled products. On balance, for much of Australia's mixed residual solid waste the highest opportunity is to produce hydrogen and methanol to displace a range of fossil fuels used in transport, whether by road, rail, ship or air.

Hydrogen are molecules capable to carry energy. When hydrogen is combined with oxygen in a fuel cell it creates electricity (energy) and water. Hydrogen combined with carbon dioxide creates methanol, an effective liquid hydrogen carrier. Methanol reformed with water creates hydrogen. Hydrogen and methanol are also key product inputs to the chemicals industry for a range of non-fuel products including fertilisers, steel, plastics and a range of polymer materials.

Australia's ZEHV infrastructure and energy demands delivered to enhance productivity

Upcycling 22 million tpa of waste to hydrogen when combined with oxygen via a fuel cell can deliver around 37,000 GWh of renewable energy available for ZEHV. Importantly, hydrogen or renewable energy is available at a Precinct instantly or when released from storage in batteries, but the energy is also able to be stored and be transportable (as methanol) and then able to be made available through a network of refuelling stations. As a result, utilising methanol and hydrogen, a ZEHV refuelling infrastructure network can be established on a micro-grid style basis, is vehicle powertrain agonistic, and does not require full connection to the national power grid. As such, a strategy able to best replicate the mobility benefits of the existing fuel network.

Currently when building out new renewable energy zones, like the current NSW Central Orana Renewable Energy Network, the transmission costs component is around 70% of the upgrade costs being around $1.3 million per GWh. The balance being the new generation costs for solar, wind or BESS. The closer the renewable energy generation is where it is consumed the higher the efficiencies and productivity gains. Australia currently has around 2,000 landfill and waste transfer stations, often with extensive buffer zones. Precinct building footprints are comparatively small, between 3,000 and 6,000 m^2 depending on capacity, and with a largely closed loop operation emission levels are low. So repurposing existing or closed landfills or transfer stations buffer zones as solar farms adjacent to new Precincts reduces the reliance on the significant transmission upgrade costs to deliver inward renewable power.

Australia's current grid generation capacity is reported as 284,000 GWh. When you extrapolate ARENA's recent report for the current 700,000 rigid and articulated vehicles on our roads to be a fully grid connected battery electric vehicle only transition this would require around 87,000 GWh of new renewable energy capacity. That represents another 30% of the current grid capacity at an estimated upgrade cost of around $112 billion. A strategy singularly reliant on renewable energy delivered through 170 to 300 grid connected recharging stations. That estimate is before considering the costs of the on-site recharging infrastructure required for the vehicles.

ARENA modelled that scenario for light commercial and heavy vehicles, with our analysis projecting that around 28,000 GWh of that demand is for rigid and articulated heavy vehicles only – demand sufficiently accommodated with an upcycled waste strategy targeted at ZEHV as well as buses, public transport or commuter style.

Australia currently has around 7,000 refuelling stations, so with ARENA's modelled site capacity shrinking that footprint by 95% it translates to lower transport sector productivity and losses projected at over $4 billion per annum through longer distances to recharge, plus additional waiting times. Larger land footprints for recharge only stations, plus longer recharge times (estimated at 1.5 hours) for battery electric vehicles far exceeds that for alternative hydrogen orientated powertrains with refuel times less than 15 minutes. The current European experience with battery electric trucks has confirmed this experience, requiring significant schedule and route planning to mitigate these losses.

Remembering that ARENA's scenario does not improve Australia's circular economy and the ongoing emissions from waste disposal or burning. As an alternative to upcycling, if Australia was to embrace incineration as the solution, extrapolating the $1.1 billion capital cost for Australia's first 400,000 tpa waste incinerator this increases the required capital expenditure by $85 to $120 billion. So, an estimated $232 billion to fully electrify Australia grid for freight capacity and burn all its waste with a siloed approach to action.

Australia's circular economy potential is being curtailed

Illustrative of what has happened across Australia in 2017, Victoria reports collecting 2.2 million tpa waste from households at a cost of $432 million. Seven years later, Victoria reports collecting 0.1 million tpa more waste, yet costs have escalated $308 million to $740 million, up 81% well beyond inflation. Over that period Victoria's policy focus has been on waste separation and mandates irrespective of whether that achieves the highest environmental or economic outcomes. This is only the tip of the extensive layering of higher collection and other costs, low end market demand for recycled products, longer transport distance, and productivity inefficiencies now present. Disappointingly waste CO_2e emissions are also up 23% over the same time, so the current framework doesn't appear to be leading to greenhouse gas reductions.

Current Victorian laws direct around 77% of household waste towards sub-optimal recycling outcomes, yielding less than 5% of its recycling potential. For Victoria's 3.2 million tpa of organics waste (1.5 million tpa which is still buried) annually this represents a $4.2 billion missed economic opportunity for Victoria. An opportunity by itself capable to reduce 10.8 million tpa CO_2e and as eco-system to create jobs across Victoria. With Victoria's organic waste generated anticipated to grow to 4.6 million tpa by 2050 this lost opportunity will only grow.

Upcycling waste using HPAG to manufacture low carbon fuel products translates to products worth around $1,300 per ton of waste. Far higher than as biochar or compost and should yield greater advantages for Victorians. Like most States, current Victorian regulations support recycling technologies to yield a product worth $1 to $63 per ton of waste and materially lower greenhouse gas savings.

To illustrate the outcomes, we've summarised three supported organic waste recycling technologies: composting, Anaerobic Digestion (AD) and biochar. These are reported studies of potential investments that we have compared to upcycling using HPAG, if access to the same market opportunities were available.

Source Technology		Grampians Compost	Grampians Biochar	Geelong AD + Biochar	Xseed Upcycling
End market product value	$ / t waste	12	1	63	1,300
GHG savings annually	t CO_2e	794,849	4,062,213	579,638	10,756,892
Economic uplift annual	$ pa	7,721	3,189	146,857	4,145,114
Extra recyclable waste	tpa	623,900	3,188,550	2,318,550	3,188,550
Capex per GHG saved	$ / t CO_2e	18	20	272	41

Higher circular economy outcomes for organics

In today's world, technologies are frequently emerging aimed at solving complex decarbonisation issues. Waste and transport are described as "hard to abate" sectors. Our strategy addresses both sectors with a broad-spectrum technology solution.

Composting and AD are Australia's preferred technologies for recycling organics but are proving challenged to be viable economically. Waste is capable to produce low carbon fuels and chemicals using a variety of thermochemical and other processes ranging from electrolysis, Fischer-Tropsch, torrefaction, gasification, pyrolysis, AD, and steam methane reforming. Typically processes that separate or combine molecules in the feedstock to produce other products.

State laws are increasingly mandating waste separation activities to divert organics from landfill without regard to the productivity losses involved. There are now several published reports available to illustrate the market outcomes. In one reported example, Logan City Council concluded after its' detailed review that an investment in an AD process for FOGO was not financially viable.

Two further Victorian examples are summarised below.

Geelong – Barwon Water Regional Renewable Organics Network (RRON)

We compared the economic and environmental features of the RRON to a potential Geelong Sub.Zero Sustainability Precinct concept. That high-level analysis is summarised below utilising a comparable 50,000 tpa waste feedstock throughput volume using HPAG at a Sustainability Precinct with mixed solid waste.

	RRON	Precinct	Precinct advantage
New jobs	14	80	More jobs more economic activity
GHG emissions saving annually (t CO_2e)	12,500	168,700	Accelerates net zero transition
Energy potential output (MWh)	16,667	83,325	Precinct produces products that translate to more energy potential
Capex / t CO_2e saved	272	41	Significant capex intensity savings
Return on Assets (illustrative %)	2%	24%	Higher returns yield - greater savings to residents

Grampians Central West

Grampians Central West regional councils reported that to create a separate FOGO transfer and recycling system it would cost $23 million across the regions and would yield a NPV benefit only marginally above the “do nothing” case. This investment would not address the continued need for:

- separate collection processes and procedures to limit contamination of the FOGO waste,
- another solution to recycle red bin waste and end local landfills, and
- establishing a ZEHV refuelling infrastructure.

Regional areas tend to have lower waste volumes than urban areas, making incineration uneconomic, or requiring the waste to be transported long distances to planned incinerators increasing greenhouse gases emissions from that transport. The likely introduction of a vehicle road user charge will make that option even more costly.