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This version was republished on 29 September to correct an error in the citation link contained in footnote 4 and table 3. There are no changes to the substance of the submission.

Dear Commissioners

We welcome the opportunity to respond to the Commission's interim report on investing in cheaper, cleaner energy and the net zero transformation.

Energy Futures Foundation is a new Australian non-profit, independent, non-partisan organisation dedicated to finding and solving the unloved or unrecognised commercial and policy hurdles that could unlock zero-emissions transport and energy at scale.

Our founding international partner is T&E, Europe's leading clean energy and transport advocates who bring 35 years of rigorous evidence based policy expertise, substantial data and analytics capability and access to relevant global market data and policy analysis for Australia's energy transition.

This submission supports the Commission's draft recommendation to introduce a new emissions-reduction incentive to cover heavy vehicles. It covers:

- Part 1 - Design principles for net-zero at least cost
- Part 2 - Market data suggests battery electric viability this decade
- Part 3 - Analysis of policy options (response to Recommendation 1.3)

We would welcome the opportunity to discuss any of this material with the Commission and also take feedback on what industry, market and policy analysis would support and complement the Commission's work to validate the most robust policy framework for Australia.

Yours sincerely

Bruce Hardy
Chair
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Executive Summary

Heavy vehicles represent Australia's most urgent decarbonisation opportunity and policy gap. With 56% of our 757,000 truck fleet reaching replacement age within five years, the 420,000+ vehicle decisions made in this period will either lock in decades of avoidable emissions or secure Australia's pathway to its 2035 target.

To achieve net-zero at least cost, policy must be guided by two complementary principles: technology neutrality to foster innovation, and system efficiency to reflect true economic costs. Currently, the market is blind to a critical efficiency gap: battery-electric trucks require 2-3× less renewable electricity than hydrogen and 5× less than synthetic fuels per tonne-kilometre. This persistent thermodynamic advantage is well-documented, yet invisible at the point of purchase. Left uncorrected, this coordination failure will burden Australia with 36-91 TWh of unnecessary annual electricity demand—equivalent to 8-20 times the Snowy Hydro Scheme.

Technology readiness and economics already align for deployment. Total Cost of Ownership parity exists today for urban delivery routes covering most rigid truck operations. With battery costs falling 10% annually, regional and long-haul segments will reach parity this decade. The Netherlands demonstrates what aligned policy achieves—71% of new truck registrations were battery-electric in H1 2025. Yet Australia faces an artificial supply crisis: operators can access only 15 electric truck models versus 156 available globally.

The Energy Futures Foundation proposes an integrated policy package that preserves technology neutrality while making system efficiency visible:

- **Immediate (2026):** Reform Fuel Tax Credits with \$50m entity caps, generating \$1.0-2.5b annually while protecting all 59,000+ SME operators. Designate Green Freight Corridors as nationally significant infrastructure.
- **Near-term (2027-28):** Implement Heavy Vehicle CO_2 Standards using NVES architecture to unlock model availability. Introduce Low Carbon Fuel Standard with infrastructure credits for technology-neutral demand signals.
- **Long-term (post-2030):** Transition to distance-based road user charging when ZEV market share exceeds 30%.

This approach enables market-driven technology selection while preventing massive economic inefficiency. Hydrogen and synthetic fuels retain critical roles for hard-to-electrify segments, but policy must ensure investment signals reflect full system costs during this critical fleet replacement window. Delay beyond 2026 risks missing the concentrated replacement cycle, compromising both the 2035 target and imposing decades of unnecessary energy system costs.

In response to Recommendation 1.3, EFF proposes a mutually-reinforcing policy package:

1. *Heavy Vehicle CO_2 Standard leveraging NVES architecture with staged intensity reductions*. Australian analysis prepared for Transport for NSW showed that this supply-side push which would increase model availability, is the single most impactful lever to accelerate freight transition.[1]
2. *Low Carbon Fuel Standard integrated over time with the Safeguard Mechanism.* Together with a heavy vehicle emissions standard. This would create a technology-neutral demand pull. Critical design features: infrastructure credits for charging/hydrogen deployment, price containment mechanisms, and technology-neutral carbon intensity targets.
3. *Targeted Fuel Tax Credit reform* - The Energy Futures Foundation endorses targeted FTC reform that protects SMEs while generating substantial transition funding. We support the phased approach proposed by Climate Energy Finance and supported by Fortescue,[2] to commence by implementing a $50m annual cap affecting only eight largest mining companies. Hypothecate $1-2.5 billion annually to: SME truck purchase incentives, depot charging infrastructure, DNSP connection upgrades, and corridor fast-charging. Consumer impact remains minimal.[3]
4. *Green Freight Corridors designated as nationally significant infrastructure under a coherent National Charging and Refuelling Plan*, unlocking federal coordination for charging hubs, mass/dimension allowances, and streamlined grid connections.
5. *Long-term transition to distance-based road user charging triggered when ZEV market share exceeds 30% and metering technology matures*. Design principles: avoid chilling effect on developing market; carbon-intensity weighting to maintain decarbonisation signals; revenue hypothecation during transition period to support infrastructure and SME fleet upgrades; exemptions structured to recognise value created by battery electric vehicles, for example for commercial fleets providing grid services through V2G. This sequencing ensures RUC reform doesn't undermine early ZEV adoption while establishing sustainable long-term road funding.

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[1] Swinburne University of Technology & The University of Queensland 2023, *Emissions and economic modelling of road freight in NSW: Final Report*, Transport for NSW, Sydney, p. Xviii, accessed at: https://www.transport.nsw.gov.au/system/files/media/documents/2025/Emission-and-economic-modelling-of-road-freight-in-NSW-Final-Report.pdf

[2] Pollard, M., & Buckley, T. (2025, August 20). *Transition tax incentive: Reforming fuel tax credits into a decarbonisation tailwind*. Climate Energy Finance. https://climateenergyfinance.org/wp-content/uploads/2025/08/CEF_Transition-Tax-Incentive-Report-FINAL_20August2025.pdf.

[3] Previous Grattan analysis suggests that FTC reform would have a small overall impact, in the order of 35c on a $100 grocery bill if 50% reduced - Grattan Institute. (n.d.). *Fuelling budget repair: How to reform fuel taxes for business*. https://grattan.edu.au/report/fuelling-budget-repair/

Recommended modelling to validate these priorities

EFF would welcome the opportunity to discuss and support the Productivity Commission with deeper economic analysis to validate the alignment of this policy package with the Commission's Target-Consistent Carbon Values framework and the net-zero trajectory modelling release by Treasury and the CSIRO last week as part of Australia's national net-zero plans. This could include: abatement cost curves, fiscal flow analysis, and distributional impact assessment by operator size and region. EFF is also working to demonstrate the specific total cost of ownership horizons for battery electric freight.

Contents

Part 1 - Design principles for net-zero at least cost

To achieve the Commission's stated goal of "net-zero at least cost," policy for heavy vehicles must be grounded in two complementary economic principles: technology neutrality and system-wide efficiency. Technology neutrality is essential to foster innovation and competition between all viable decarbonisation pathways. System-wide efficiency ensures that market outcomes reflect the true, full-system costs of those pathways, preventing the lock-in of inefficient solutions.

Currently, Australia's heavy vehicle market is prevented from achieving an efficient, technology-neutral outcome due to a series of market failures. The profound difference in energy requirements between drivetrains—where a hydrogen or e-fuel truck requires 2-5 times more renewable energy than a battery-electric one—represents a system cost that the market is currently blind to. Policy intervention is required not to pick a winner, but to correct these failures so that all technologies can compete on their full economic merits.

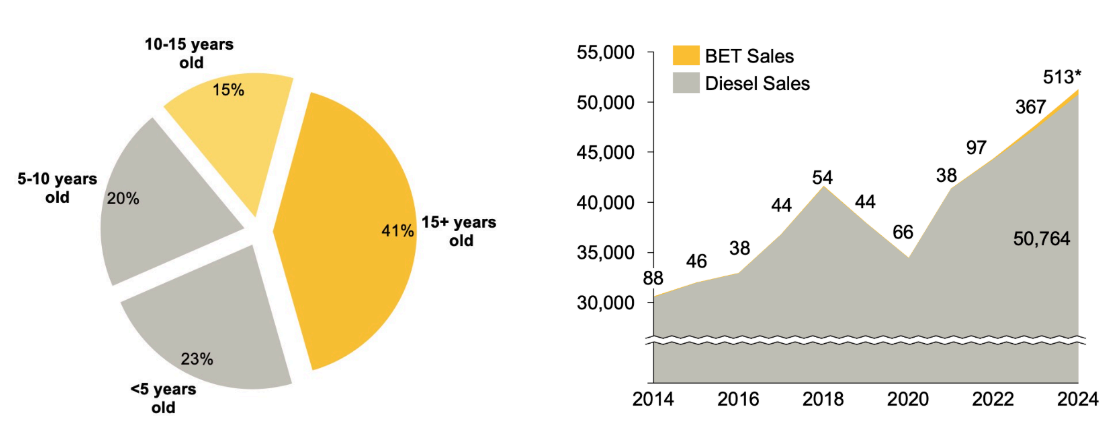
The system-efficiency imperative in heavy freight

Industry replacement cycles are an opportunity and if missed a great cost

Australia faces a concentrated replacement wave in trucking over the next 5 years. 56% of the fleet are 10 years or older and could face a replacement decision in the next 5 years. The technology split of these 420,000+ replacement decisions will have a material impact on Australia's renewable energy demands.

Australian heavy vehicle fleet profile (BITRE, 2024)

- **Size**: ~754,000 trucks (≈630k rigid; ≈124k articulated)
- **Age**: 56% of trucks are 10 years or older and could upgrade in the next 5 years
- **Energy consumption**: articulated and rigid trucks together consumed ≈328 PJ of end-use energy (diesel), equivalent to ≈91 TWh (1 PJ = 277.78 GWh)
- **BET penetration:** Battery electric fleet nascent - 513 sales in 2024



Quantifying the battery electric advantage

Electric drive trains have a large and *persistent* energy advantage over hydrogen and e-fuel engines requiring ~2-5x less renewable energy overall to drive the same freight. Electric engines achieve this advantage because they are much more efficient at converting energy into movement and avoiding the energy losses associated with creating chemical energy. These advantages are well documented in the scientific literature.[4]

The table below shows the relative energy intensity under US duty cycles and payload/occupancy assumptions. The physics of conversion losses (electrolysis, liquefaction/compression, synthesis, fuel-cell/engine) that drive the hierarchy are mode and geography agnostic and therefore generalisable, but absolute intensities will vary with vehicle mass, aerodynamics, duty cycles and ambient conditions and so there would be an absolute difference in Australian estimates, but the *relative* position of battery electric vehicles would remain materially unchanged.

[4] Wallington, T. J., Woody, M., Lewis, G. M., Keoleian, G. A., Adler, E. J., Martins, J. R. R. A., & Collette, M. D. (2024). Green hydrogen pathways, energy efficiencies, and intensities for ground, air, and marine transportation. *Joule*, *8*(8), 2190-2207. https://doi.org/10.1016/j.joule.2024.07.012

Table 1 - Energy required per tonne-kilometre Long-haul truck[5]

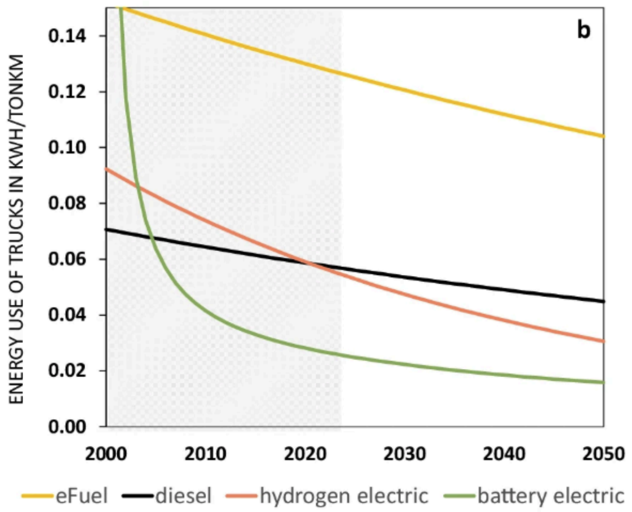
Technology	MJ per t-km	kWh per t-km	Ratio vs BEV
BEV	**0.302**	**0.084**	**1.0×**
H_2 fuel cell (gas)	0.963	0.268	3.19×
H_2 fuel cell (liquid)	0.963	0.268	3.19×
H_2 ICE (gas)	1.060	0.294	3.51×
H_2 ICE (liquid)	1.060	0.294	3.51×
E-diesel (ICE)	1.240	0.344	4.11×
E-diesel + DAC (ICE)	1.590	0.442	5.26×

Table 2 - Energy required per tonne-kilometre short-haul truck[6]

Technology	MJ per t-km	kWh per t-km	Ratio vs BEV
BEV	**0.279**	**0.078**	**1.0×**
H_2 fuel cell (gas)	1.150	0.319	4.12×
H_2 fuel cell (liquid)	1.150	0.319	4.12×
H_2 ICE (gas)	1.260	0.350	4.52×
H_2 ICE (liquid)	1.260	0.350	4.52×
E-diesel (ICE)	1.550	0.431	5.56×
E-diesel + DAC (ICE)	1.990	0.553	7.13×

[5] Ibid.
[6] Ibid.

Importantly, this dramatic 2-5x advantage persists long term, even when taking into account the likely improvement curves across all current technology types:



Source: Hoekstra, A., & Alkemade, F. (2025). Using learning curves to guide the energy transition with the example of heavy electric trucks. *npj Sustainable Mobility and Transport*, 2, 14, Figure 3B. https://doi.org/10.1038/s44333-025-00029-5

Quantifying the system wide impacts

Gross energy consumption and renewable energy build required

Due to this 2-5x persistent energy advantage, prioritising battery electric vehicles can have a profound cost saving impact at a system level, by reducing our overall system energy demands for freight. As an illustration of the potential impact size, the table below shows that the overall renewable build out cost is highly sensitive to the percentage of hydrogen and efuel vehicles in the fleet.

Table 3 — illustrative annual electricity required to decarbonise heavy road freight (see Appendix for method and assumptions)

Scenario	kWh/t-km	TWh/y	Δ vs BEV-only (TWh/y)
BEV-only (100% BEV)	0.176	43.9	–
Efficient neutrality (70% BEV, 20% H_2-FCEV, 10% e-diesel w/DAC)	0.367	91.4	+47.5
Balanced mix (40% BEV, 40% H_2-FCEV, 20% e-diesel w/DAC)	0.558	138.9	+95.0
Hydrogen-priority (20% BEV, 60% H_2-FCEV, 20% e-diesel w/DAC)	0.642	159.8	+116.0

Notes: data from Wallington, T. J., Woody, M., Lewis, G. M., Keoleian, G. A., Adler, E. J., Martins, J. R. R. A., & Collette, M. D. (2024). Green hydrogen pathways, energy efficiencies, and intensities for ground, air, and marine transportation. *Joule*, *8*(8), 2190-2207. https://doi.org/10.1016/j.joule.2024.07.012
(1) Intensities are from the paper's freight "heavy-duty vocational" rows (MJ renewable electricity per t-km) converted to kWh: BEV 0.634, FCEV 2.15, e-diesel w/DAC 4.47; H_2 ICE 2.36 shown for context.
(2) The paper explains that freight values reflect full loading and will vary with operating conditions. The method links intensities to GREET vehicle energy use and the Sankey-diagram energy chains.
(3) This data is for the US environment - while absolute numbers would change for Australia, the relative positioning should not materially change, owing to the geographically agnostic properties of the engine types.
(4) Direct Air Capture is not suggested as the only pathway to net-zero bio-diesel, but illustrates one pathway.

Grid co-benefits: value is real, but must be sized realistically

Electric trucks, independent of their energy efficiency, are valuable grid assets and represent a substantial pool of customer-funded flexibility that could reduce regulated infrastructure requirements. To illustrate the materiality, and why detailed modelling should be pursued:

- AEMO's 2024 ISP states that coordinating consumer batteries could avoid **$4.1 billion** in grid-scale investment.[7] Yet the scale of this opportunity pales compared to the untapped potential of commercial electric vehicles.

- Current projections under AEMO's step change scenario, show residential and business small-scale batteries reaching approximately **38 GWh** by 2050 across the NEM and SWIS.[8] Meanwhile, the NEM's commercial EV fleet—approximately 4.5 million vans,

[7] Australian Energy Market Operator (AEMO), 2024 Integrated System Plan Overview, https://www.aemo.com.au/-/media/files/major-publications/isp/2024/2024-integrated-system-plan-overview.pdf
[8] Graham, P., & Mediwaththe, C. (2024). *Small-scale solar PV and battery projections 2024*. CSIRO. Commissioned for AEMO's draft 2025 Input, Assumptions and Scenarios Report. https://www.aemo.com.au/-/media/files/major-publications/isp/2025/CSIRO-2024-Solar-PV-and-Battery-Projections-Report.pdf

trucks and buses by 2050[9]—will carry between **650-860 GWh** of battery capacity, with a central estimate of **740 GWh**.[10]

- On this basis, commercial EVs will carry **20 times** the battery capacity of the entire consumer storage fleet. Even if only **5-10%** of this commercial capacity provided grid services through a depot-based vehicle-to-grid during off-peak windows, it would deliver **37-74 GWh** of flexible capacity—matching or exceeding all projected consumer batteries.

We note that to realise these benefits themselves will require substantial network upgrades. Any further modelling should take this into account, but it is anticipated that the overall costs of avoided grid scale storage would likely produce a net positive result.

The market cannot adequately price this value

Four specific failures prevent efficient technology deployment:

1. **Coordination failures**: Australia's freight concentration on key corridors (Hume, Pacific, Bruce) creates infrastructure lock-in risks[11]
2. **Learning spillovers**: Battery costs fell 90% over the past decade; early adopters cannot capture full system benefits[12]
3. **Missing markets**: No compensation mechanism for V2G, managed charging, or avoided grid investment.
4. **Split incentives**: Capex/opex misalignment between asset owners, operators and shippers slows adoption despite positive lifecycle economics in many BEV use-cases..

Conclusion on least cost principles

The data clearly shows that profound differences in energy efficiency exist between technologies. Rather than prescribing a hierarchy, policy should focus on making these costs visible to the market. This involves pricing externalities, creating markets for grid services like V2G, and providing targeted support for enabling infrastructure. A market that can see the full picture is a market that can find the least-cost path to net zero.

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[9] Graham, P., Mediwaththe, C., & Green, D. (2025). *Electric vehicle projections 2024*. CSIRO. Commissioned for AEMO's draft 2025 Inputs, Assumptions and Scenarios Report. https://www.aemo.com.au/-/media/files/major-publications/isp/2025/stage-2/electric-vehicle-projections-2024.pdf

[10] Calculation derived from AEMO Stepchange assumptions of number of vehicles per category, multiplied by a market bench mark for assumed storage capacity. Pack sizes (anchors): LCV: eSprinter 113 kWh; E-Transit 68 kWh usable; MLCV: LDV eDeliver 9 88.55 kWh; Rigid truck: ~468 kWh; Articulated: 621 kWh installed (eActros 600). Bus: 31×368 kWh + 9×422 kWh (ARENA Leichhardt depot) → ~380 kWh avg.

[11] BITRE analysis shows Hume, Pacific, and Bruce highways carry majority of interstate freight task.

[12] BNEF *Lithium-Ion Battery Price Survey* (2023) - see also Rocky Mountain Institute analysis: https://rmi.org/the-rise-of-batteries-in-six-charts-and-not-too-many-numbers/

Part 2 - Market data suggests battery electric viability this decade

EFF is currently preparing updated total cost of ownership analysis for the Australian market to validate the bands and horizons of TCO parity for Australian specific heavy duty cycles and to inform policy design. We intend to test the following hypotheses through this work:

1. A substantial portion of Australian duty cycles align with current BEV capabilities,
2. TCO has arrived for urban duty cycles and will arrive before 2030 for regional duty cycles,
3. Model availability remains a constraint on the Australian market

Our analysis is framed to support the Commission's least-cost, technology-neutral approach to transport decarbonisation, by identifying the duty cycles where battery-electric trucks already minimise total system cost and those where other low-emissions options may be needed over time.

We would welcome the opportunity to discuss this analysis further with the Commission. In the meantime we provide the following preliminary data to inform the Commission's assessment.

Hypothesis #1 - A substantial portion of Australian duty cycles align with current BEV capabilities

Australia's heavy vehicle productivity exceeds global benchmarks—with 60% of articulated vehicles operating above 60-tonne GCM versus Europe's 44-tonne limit. However, this is not the road block to electrification that it is often presented to be. Indeed, patterns already favour electrification.

This is because, of Australia's 757,000-vehicle truck fleet:

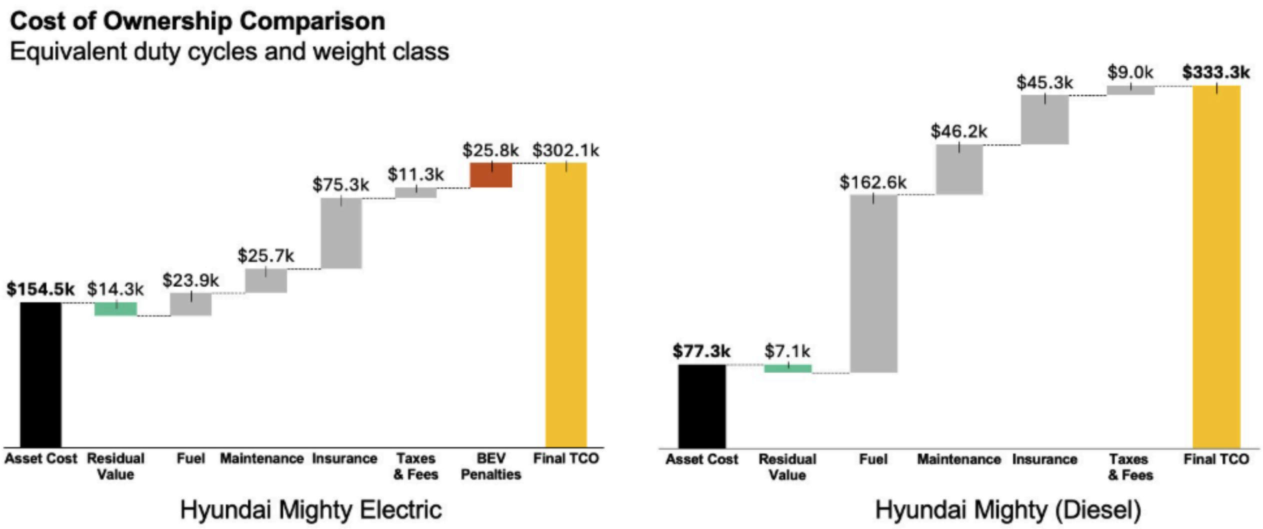
- 83% (633,000 vehicles) are rigid trucks[13], with two-thirds operating in urban environments.[14]
- Average daily ranges of 103.6km for articulated trucks and 60.5km for rigid vehicles in capital cities fall well within current BEV capabilities[15]
- Multi-trailer electric combinations are already demonstrating viability, with battery-swapping configurations pulling 115 tonnes in Western Australia[16] and electric road trains operating at Brisbane ports.[17]

[13] BITRE. 2024. Road Vehicles, Australia, January 2024. Table 4.
[14] Austroads. 2021. Options for Managing the Impacts of Aged Heavy Vehicles. Section 3.2
[15] NatRoad. 2023. Australian road freight transport decarbonisation. P5.
[16] The Driven. 9 December 2024. "Heaviest road going electric truck in the world:" First electric road train takes to Australian roads.
[17] Big Rigs. 28 May 2025. SEQH launches world-first electric road train.

Hypothesis #2 - TCO has arrived for urban duty cycles and will arrive before 2030 for regional duty cycles

EFF initial modelling demonstrates that despite higher capital costs, operational savings deliver positive TCO for urban depot duty cycles today.

Fig. 2: Electric trucks are at TCO cost parity for some urban depot duty cycles
Savings in fuel and maintenance outweigh higher upfront costs, excluding capex on charging infrastructure



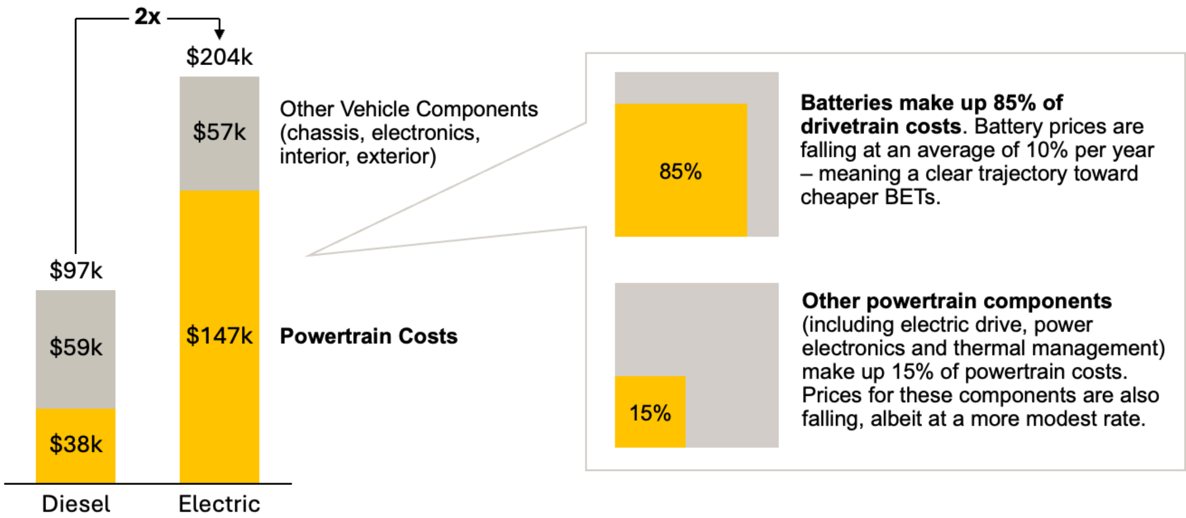
Source: Energy Futures Foundation Analysis

Scope and sensitivities: These illustrative results for urban depot duty cycles exclude site-specific connection upgrades and assume off-peak charging. In the full model we are considering scoping in supply sensitivity curves for electricity/diesel prices, depot demand charges, utilisation, and battery life to show the range where parity holds.

The remaining purchase premium is driven almost entirely by battery costs, which have declined 90% over the past decade and continue falling at 10% annually. McKinsey projects that even long-haul applications will reach cost parity within 5 years assuming conservative battery cost trajectories. More aggressive but realistic scenarios suggest 2-3 years for most duty cycles.

Fig. 3: Batteries drive the current purchase price gap, but are falling at a rate of 10% per year

If battery efficiency and cost improvement continues, even our heaviest truck models will approach parity

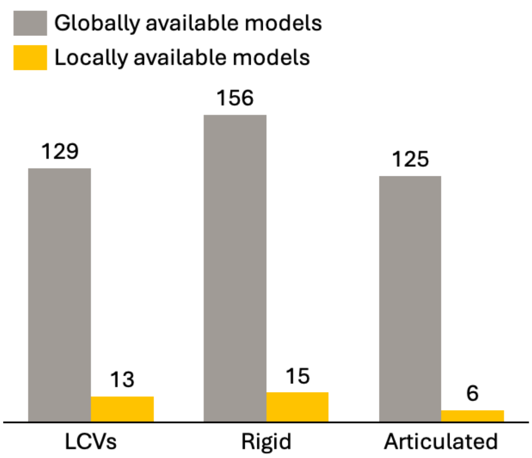


Source: McKinsey Centre for Future Mobility; BNEF *Lithium-Ion Battery Price Survey* (2023)

Hypothesis #3 - Model availability remains a constraint on the Australian market

Australian operators can access only 15 rigid electric truck models versus 156 available globally—a 95% reduction in choice that inflates costs and limits operational flexibility. This artificial constraint, driven by regulatory misalignment rather than technology limitations, represents a critical policy failure that immediate action could resolve.

Fig. 4: Different rules mean less model availability
Australian truck buyers have far less variety, meaning reduced operational flexibility and increased costs.

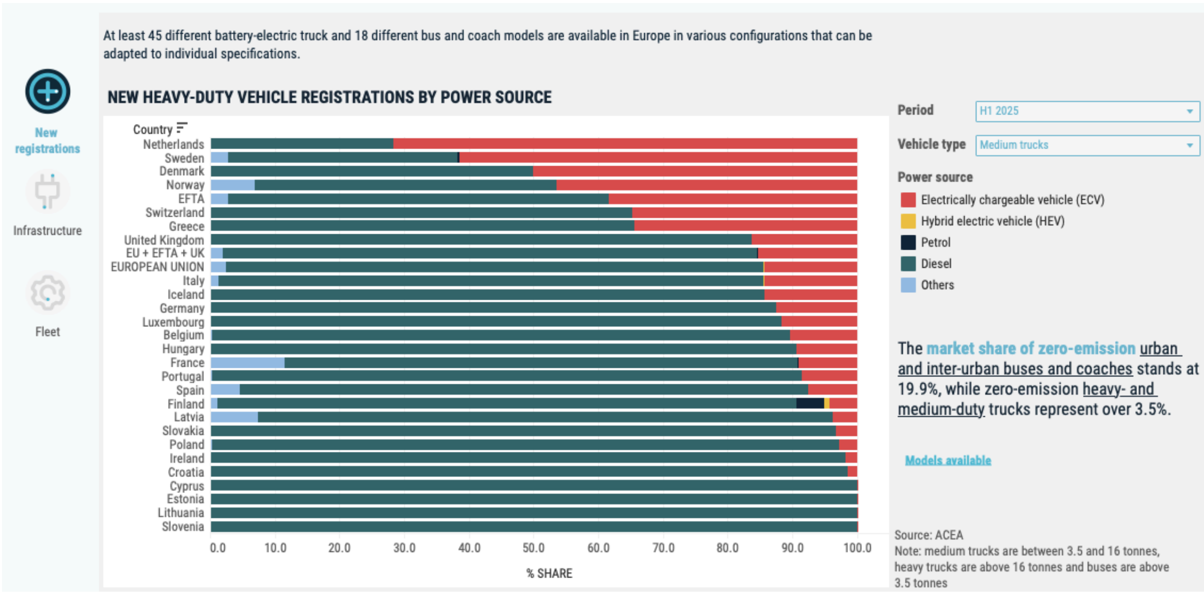


Source: Australian Design Rules 43/04; AECOM, *Electrifying Road Freight* (2025)

Additional global data

Looking globally, the IEA has stated in its 2025 Global Outlook for Electric Vehicles that it expects Battery electric trucks to become competitive for long-haul applications *this decade* in China and Europe[18] and in the first half of 2025, the Netherlands battery electric trucks were an impressive 71% of all new registrations:

Fig. 5: European Automobile Manufacturers' Association (ACEA) - EU registrations dashboard



Source: European Automobile Manufacturers' Association (ACEA). (2025). *New heavy-duty vehicle registrations by power source, H1 2025*. In "Mapping Europe's zero-emission transformation" interactive dashboard. Brussels: ACEA. Retrieved from:
https://public.tableau.com/app/profile/acea.european.automobile.manufacturers.association/viz/shared/SGTDMWQ7S

[18] Ibid at no. 5.

Part 3 - Analysis of policy options (response to recommendation 1.3)

Evaluation Framework and Policy Package Design

EFF evaluated each policy option against four criteria essential for effective heavy vehicle decarbonisation:

1. **System efficiency:** Minimising total economic costs including energy infrastructure
2. **Technology neutrality:** Enabling market-driven technology selection where appropriate
3. **Speed to deploy:** Implementation feasibility within the critical 2025-2030 window
4. **Distributional equity:** Protecting SME operators while driving transition

Our analysis shows that no instrument meets all criteria. Heavy vehicle decarbonisation requires a complementary package that sequences interventions based on market maturity, addresses distinct market failures, and leverages policy synergies.

Recommended integrated policy package

Core components by implementation priority:

1. **Fuel Tax Credit Reform** - Immediate funding mechanism ($1-2.5b annually)
2. **Green Freight Corridors** - National infrastructure coordination framework
3. **Heavy Vehicle CO_2 Standard** - Supply-side market transformation (highest impact)
4. **Low Carbon Fuel Standard** - Technology-neutral demand pull with infrastructure credits
5. **Safeguard Mechanism Integration** - Long-term price signals once market matures
6. **Road User Charging** - Future-state solution when ZEV share exceeds 30%

Additional Recommendation: Expand the Commission's Recommendation 2.2 (environmental approvals strike squad) to designate Green Freight Corridors and Hubs as nationally significant infrastructure. This unlocks federal coordination for charging networks, harmonised mass/dimension allowances, and streamlined grid connections—addressing the infrastructure coordination failure that no single policy instrument can solve.

Sequencing and rationale

Phase 1: Foundation (2026)

- **FTC reform** with $50m entity caps → generates $1-2.5b transition funding
- **Green Freight Corridors** designation → enables infrastructure deployment
- **Complete reviews** of NVES and Safeguard → establish implementation frameworks

Rationale: Creates funding pool and coordination framework before market interventions and complete critical policy reviews to inform design

Phase 2: Market Development (2027-2028)

- **Heavy Vehicle CO_2 Standard** using NVES architecture → addresses supply crisis
- **Low Carbon Fuel Standard** with infrastructure credits → creates demand pull
- **SME transition programs** funded by FTC revenue → ensures equity

Rationale: Supply push and demand pull work synergistically once infrastructure pathway clear

Phase 3: Market Maturation (2029-2030)

- **Safeguard Mechanism** integration for fuel wholesalers → carbon price signal
- **Transitional RUC** design with ZEV exemptions → preparation for long-term
- **Performance review** and recalibration → adjust based on uptake

Rationale: Price signals become effective once technology available and infrastructure deployed

Why this package succeeds where single instruments fail

Market failure alignment: Each instrument addresses specific failures identified in Part 1:

- FTC reform → funds learning spillovers and early adoption
- HDV standards → solves coordination failure in vehicle supply
- LCFS → creates missing markets for infrastructure investment
- Targeted support → addresses split incentives for SMEs

Synergistic effects: The package creates reinforcing dynamics:

- Infrastructure investment (enabled by corridors + LCFS) makes vehicles viable
- Vehicle availability (driven by standards) justifies infrastructure investment
- Early funding (from FTC) bridges the gap until market mechanisms mature
- Carbon pricing (Safeguard/RUC) locks in long-term incentives

Risk mitigation: Multiple pathways reduce single-point-of-failure risk while maintaining momentum if individual policies face delays.

Option 1 - CO_2 component in the future road user charging scheme

A distance/mass RUC with a per-tonne-CO_2 element, requiring trucks to pay for both road damage and emissions.

Advantages

- Creates a comprehensive, technology-neutral pricing signal aligned to Target-Consistent Carbon Values once markets mature
- Aligns with international best practice for long-term transport decarbonisation

Disadvantages

- **Market timing fundamentally undermines policy effectiveness**. Zero-emissions heavy vehicles represent less than 0.1% of Australia's ~757,000 truck fleet. Implementing carbon pricing on nascent technologies violates established innovation economics - early-stage markets require support, not penalties. The EU is currently proposing to extend its RUC exemption for zero-emissions trucks until 2030 precisely because premature cost imposition destroys adoption pathways.[19]

- **Implementation timeline renders near-term decarbonisation impossible**. National RUC requires:
    - High Court-compliant federal legislation
    - Technical infrastructure deployment across 900,000km road network
    - Fleet telematics installation across 600,000+ heavy vehicles

This execution timeline realistically means likely zero emissions reductions before 2035 - incompatible with Australia's fresh national 2035 target.

EFF proposal - Transitional RUC design while market develops

- **Immediate:** Implement fuel tax credit reform generating $1-2.5b annually for transition support.
- **Long-term:** Implement distance-based RUC triggered when ZEV market share exceeds 30% with preferential treatment for low-emission vehicles.
- **Design principle for long term RUC:** Split RUC on road wear and carbon. Apply discounts on the carbon component aligned to both emissions reduction and abatement costs of technology.
- **Adjacent supports**: Fund incentive package (charging grants, SME truck purchase incentives, Green Freight Corridors as nationally significant infrastructure) through

[19] European Commission, Directorate-General for Mobility and Transport. (2025, June 27). *Commission proposes toll exemptions to boost demand for zero-emission lorries and buses* - https://transport.ec.europa.eu/news-events/news/commission-proposes-toll-exemptions-boost-demand-zero-emission-lorries-and-buses-2025-06-27_enhttps://transport.ec.europa.eu/news-events/news/commission-proposes-toll-exemptions-boost-demand-zero-emission-lorries-and-buses-2025-06-27_en

100% hypothecation of $2-2.5b annual FTC reform revenue. Legislate HDV standard, LCLF standard and integrate fuel supply into Safeguard over time (see option 2).

Recommended further analysis

- Model revenue impacts of split-component design vs full RUC waiver.
- Quantify SME cash flow impacts given 98% of operators have <20 trucks at 2% margins.
- Define specific exit criteria linking waiver phase-out to infrastructure coverage and TCO parity metrics.

Option 2: Apply the Safeguard Mechanism to fuel wholesalers

Treat fuel wholesalers as Safeguard facilities based on downstream emissions from fuel they sell; exempt direct transport emitters to avoid double-counting.

Advantages

- **Proven administrative efficiency at scale**. The EU's ETS2 demonstrates this model's viability - from 2027, fuel suppliers rather than end-consumers will monitor and surrender allowances for transport emissions, creating a streamlined system covering over 1 billion tonnes of CO_2.[20] Australia's concentrated fuel market makes this even more efficient: just four major companies (Ampol, Viva Energy, BP Australia, ExxonMobil) dominate petroleum wholesaling, compared to 59,100 trucking businesses that would need individual compliance under direct regulation.[21]
- **Technology-neutral price signals that markets can optimise**. Upstream pricing lets operators choose their least-cost decarbonisation pathway - whether battery-electric for urban delivery, hydrogen for long-haul, or biofuels for hard-to-electrify segments.

Disadvantages

- **Implementation complexity undermines near-term effectiveness**. The PC correctly identifies the double-counting risk with aviation/rail but underestimates the regulatory architecture required. EU's ETS2 required a three-year preparatory phase (2024-2026) for monitoring and reporting before trading begins.[22] Australia would need similar lead time to establish baselines, verification systems, and registry infrastructure.
- **Price signals alone cannot overcome structural barriers:** Even strong carbon values won't address: only 15 electric truck models available in Australia versus 156 globally; state-based vehicle mass limits penalising battery-electric trucks by 2-3 tonnes; 12-18 month grid connection delays; split incentives where fleet operators can't capture charging infrastructure value.
- **Political sustainability requires careful design.** Sixteen EU nations are demanding stricter price controls on ETS2 ahead of 2027 launch,[23] warning of consumer backlash. The Australian trucking industry operates on low margin (2%) and the operators are a vulnerable market population of small business owners.

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[20] EU Commission, ETS2: buildings, road transport and additional sectors https://climate.ec.europa.eu/eu-action/carbon-markets/ets2-buildings-road-transport-and-additional-sectors_en
[21] IBISworld, Petroleum Product Wholesaling in Australia - Market Research Report (2015-2030) https://www.ibisworld.com/australia/industry/petroleum-product-wholesaling/344/
[22] Ibid at no. 24.
[23] Outlook Business. (2025, June 26). *EU nations demand stricter controls in 2027 carbon market amid price fears*. https://www.outlookbusiness.com/planet/industry/eu-carbon-market-price-controls-ets2-2027

EFF Proposal - Low Carbon Fuel Standard bridging to Safeguard

Unlike pure carbon pricing, LCFS could allow operators to earn revenue from infrastructure investments immediately, before vehicles arrive.

1. **Phase implementation to build market readiness:**
    - 2025-2026: LCFS begins using existing fuel standards framework while voluntary Safeguard reporting establishes baselines
    - 2027-2028: Shadow pricing with revenue hypothecation to truck electrification fund
    - 2029+: Full Safeguard integration when battery-electric trucks reach >30% fleet share
2. **Low Carbon Fuel Standard for immediate action:**
    - Create technology-pull through credit generation for charging/hydrogen infrastructure
    - California's LCFS achieved 13% carbon intensity reduction while adding only 17-23 cents/gallon.[24]
    - Set declining carbon intensity benchmarks (for example, 5% by 2027, 10% by 2030)
    - Infrastructure investments earn compliance credits, accelerating deployment
3. **Address non-price barriers simultaneously:**
    - Streamlined grid connections for transport electrification projects.
    - Regulatory harmonisation for zero-emissions vehicles weight and permitting allowances.
    - Infrastructure acceleration fund from shadow pricing revenue.

Recommended further analysis: Model the price impact of Safeguard Mechanism on heavy vehicle operating costs at various carbon prices ($50-150/tonne) to identify tipping points for industry viability. Quantify how LCFS infrastructure credits could accelerate charging deployment—California's experience suggests 3-5 year acceleration. Compare the fiscal efficiency of LCFS credit mechanisms versus direct infrastructure subsidies for achieving equivalent charging coverage on key freight corridors.

[24] California Air Resources Board, "CARB Announces Latest LCFS Updates Will Be Implemented Next Month," News release, June 2025, https://ww2.arb.ca.gov/news/carb-announces-latest-lcfs-updates-will-be-implemented-next-month. See also Colin Murphy, "No, Your Gas Prices Will Not Rise by 65 Cents per Gallon in July," UC Davis Institute of Transportation Studies Blog, June 30, 2025, https://its.ucdavis.edu/blog-post/no-your-gas-prices-will-not-rise-by-65-cents-per-gallon-in-july/.

Option 3: Fuel tax credit reform

Summary of PC proposal: Add an emissions component of 18.4c/L to on-road diesel for heavy vehicles (RUC remains 32.4c/L). Using NGA diesel factors (~2.7kg CO_2/L), this equals ~$68/tonne CO_2-e.

Advantages

- **Fast implementation via existing systems.** Uses established BAS processes (label 7D for FTC claims, 7C for adjustments) with rate changes implementable through ATO without new infrastructure.
- **Large fiscal capacity for transition.** FTC scheme cost $9.6 billion in 2023-2024,[25] with mining claiming 45% and transport 19% of total credits.[26] Partial reform generates billions for targeted support.
- **Simple price signal at point of use.** Operators can choose the lowest-cost abatement pathway—vehicle efficiency, BEV/FCEV, or mode shift. Note: not fully CO_2-intensity neutral until certification enables renewable diesel differentiation.

Disadvantages

- **Policy incoherence for full FTC recipients.** Where 50.8c/L applies (off-road mining), the implied -$188/tonne signal undercuts ~$33-36/tonne ACCU prices by 5x. On-road recipients face -$68/tonne implicit subsidy.[27]
- **No current differentiation for renewable diesel.** Chemical indistinguishability once blended prevents FTC distinction between fossil and renewable diesel—requires certification solution.
- **SME vulnerability.**

EFF Proposal - Surgical FTC reform with transition pathways

The Energy Futures Foundation endorses targeted FTC reform that protects SMEs while generating substantial transition funding. We support the phased approach proposed by Climate Energy Finance and supported by Fortescue.[28]

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[25] The Australia Institute, "Fossil Fuel Subsidies in the 2023-24 Federal Budget," May 11, 2023, https://australiainstitute.org.au/post/fossil-fuel-subsidies-in-the-2023-24-federal-budget/

[26] Australian Taxation Office, "2022-23 Taxation Statistics Released," https://www.ato.gov.au/media-centre/2022-23-taxation-statistics-released.

[27] Pollard, M & Buckley, T 2025, *Transition Tax Incentive: Reforming Fuel Tax Credits into a Decarbonisation Tailwind*, Climate Energy Finance, Sydney, viewed 17 September 2025. https://climateenergyfinance.org/wp-content/uploads/2025/08/CEF_Transition-Tax-Incentive-Report-FINAL_20August2025.pdf.

[28] Pollard, M., & Buckley, T. (2025, August 20). *Transition tax incentive: Reforming fuel tax credits into a decarbonisation tailwind*. Climate Energy Finance. https://climateenergyfinance.org/wp-content/uploads/2025/08/CEF_Transition-Tax-Incentive-Report-FINAL_20August2025.pdf.

Core Reform Design: $50 Million Annual Cap

We propose implementing a $50 million annual cap on FTC claims per consolidated entity group. This targeted intervention delivers multiple benefits:

- **Protects SMEs:** Affects only the largest claimants (approximately 8-10 entities) while fully protecting all 59,000+ small and medium enterprise operators[16]
- **Generates transition funding:** Creates an estimated $1.0-1.5 billion annually for heavy vehicle transition programs (subject to ATO verification of claimant distributions)[17]
- **Aligns with industry practice:** Corresponds with major miners' disclosed internal carbon prices, which already exceed $100/tonne CO_2-e[18]

This approach ensures that reform targets only those entities with the greatest capacity to transition, while maintaining critical support for smaller operators during the energy transition.

Long-Term Reform Trajectory

While the $50 million cap provides an immediate and politically feasible starting point, comprehensive FTC reform will be necessary to prevent ongoing market distortions. As zero-emission alternatives become commercially available and cost-competitive, continuing diesel subsidies will:

- Create artificial competitive advantages for fossil fuel technologies
- Delay the natural market transition to cleaner alternatives
- Contradict carbon pricing signals from the Safeguard Mechanism
- Undermine Australia's net-zero commitments

The ultimate goal must be transitioning from blanket fuel subsidies to technology-neutral support mechanisms that reward emissions reduction rather than fossil fuel consumption. This ensures market efficiency while maintaining necessary support for regional and remote operations during the transition period.

Option 4 — Targeted policy for low-carbon liquid fuels

LCLFs can decarbonise hard segments and be used in existing engines. The Government has an open consultation on renewable diesel and SAF policy options.

EFF assessment, in light of the government's announcements of a 1.1B Cleaner Fuels Program, EFF limits this submission to the following points, pending further analysis of the government's announcements:

- Low carbon liquid fuels have a role for specific hard-to-abate segments where battery-electric solutions face infrastructure or operational constraints—particularly remote mining operations, emergency services, and ultra-long-haul freight exceeding 800km daily runs.
- **Critical constraints demanding strict policy design:**
    - **Feedstock scarcity:** Scaling renewable diesel requires imported feedstocks or purpose-grown crops, creating land-use competition and price volatility risks.
    - **Energy inefficiency:** Renewable diesel production requires 2-3x the renewable electricity per tonne-km compared to direct electrification, fundamentally limiting its role in a renewable-constrained economy.
- **Essential policy parameters:**
    - **Strict lifecycle GHG threshold:** Minimum % emissions reduction versus fossil diesel (following EU RED III standards)
    - **Declining support trajectory:** Phase down production incentives
    - **Volume cap:** Limit support to target annual production (for example, % of heavy vehicle fuel demand).
    - **Transition to LCFS:** Sunset production subsidies by 2035 in favor of a Low Carbon Fuel Standard and later full integration with Safeguard Mechanism.

Option 5: Heavy-Vehicle CO_2 Standard

The PC raises a manufacturer fleet-average CO_2 standard (similar to EU HDV regulations) as a targeted policy option, but flags technology-neutrality concerns because standards "would not provide an incentive to switch to clean fuels" like renewable diesel.

Advantages

- **Directly addresses Australia's supply crisis.** Only 15 electric truck models are available in Australia versus 156 globally.[29] A CO_2 standard compels manufacturers to allocate efficient and zero-emission vehicles to Australia rather than prioritising regulated markets. NSW modelling shows supply-side standards deliver the highest impact of any single lever for freight decarbonisation.[30]
- **Proven global effectiveness at scale.** The EU's HDV standards (-45% by 2030, -65% by 2035, -90% by 2040) are already reshaping markets: electric truck registrations rose ~300% year-on-year following adoption.[31] Netherlands achieved 71% battery-electric share of new truck registrations in H1 2025, demonstrating rapid transition once supply improves.
- **Minimal fiscal burden with strong investment signals.** Unlike subsidies, standards operate through regulatory compliance rather than public expenditure. The EU's excess-emissions penalties create material incentives while generating revenue for transition support.[32]

Disadvantages

- Not technology neutral without a complementary low carbon fuel standard.
- Standards alone don't address in-use fleet turnover.

EFF Proposal - Australian Heavy Vehicle CO_2 Standard with complementary LCF

Design a uniquely Australian standard that preserves technology neutrality while accelerating the 56% fleet replacement opportunity identified in our analysis.

1. **Phased implementation building on NVES architecture:**
    - 2026-2027: Establish measurement protocols using simplified VECTO methodology
    - 2028-2029: Voluntary reporting with early-action credits for zero-emission vehicles
    - 2030+: Binding targets aligned with fleet replacement cycle (-15% by 2030, -45% by 2035)
2. **Technology-neutral compliance design:**

[29] See EFF analysis in Part 2.
[30] Ibid at no. 7.
[31] Ibid at no.6.
[32] European Commission Regulation (EU) 2024/1610

- Fleet-average targets allow manufacturer flexibility across efficiency improvements, BEV, FCEV, and hydrogen combustion
- Integrate Low Carbon Fuel Standard credits for verified renewable diesel use, addressing fuel pathway concern

3. **Revenue hypothecation from penalties:**
    - Direct excess-emissions penalties to SME truck purchase incentives
    - Fund grid connection upgrades for depot charging

Recommended further analysis

Model the supply response elasticity to CO_2 standards using EU market data. Quantify the interaction effects between heavy vehicle standards and LCFS in preserving technology neutrality while optimising for system efficiency (battery-electric's 2-3× energy advantage). Assess compliance cost pass-through to freight rates under different market structures, particularly for SMEs. Calculate the abatement achieved by capturing the 56% fleet replacement window with standards versus business-as-usual trajectory.

Appendix - Methods and calculations for Table 3

A1. Data inputs:

- BEV: 0.634 MJ renewable electricity per t-km → 0.634 × 0.27778 = 0.176 kWh/t-km.
- FCEV: 2.15 MJ/t-km → 0.597 kWh/t-km.
- e-diesel (with DAC): 4.47 MJ/t-km → 1.242 kWh/t-km.
- (Context) H_2 ICE: 2.36 MJ/t-km → 0.656 kWh/t-km.

A2. What the intensities mean.
These are grid-to-wheel measures: the renewable electricity required at the system boundary to deliver 1 t-km of freight, derived by combining GREET vehicle energy use with the paper's Sankey-diagram energy chains (charging losses, electrolysis/liquefaction, synthesis, drivetrain conversion, etc.). Freight values are full-load and will change with back-haul rates, duty cycles and payload.

A3. Freight task Let annual heavy road-freight task be T t-km. I use T = 250 × 10^9 t-km/y (rounded), consistent with recent BITRE-based summaries used in the EFF material. Replace T with the latest Yearbook figure to update the totals; results scale linearly with T. ^EFF - Trucking Brief

A4. Weighted intensity by scenario For scenario shares sBEV, sH2, sefuel summing to 1 and technology intensities IBEV, IH2, Iefuel (kWh/t-km):

Imix = sBEV × IBEV + sH2 × IH2 + sefuel × Iefuel

A5. Annual electricity

Eyear (TWh/y) = [Imix (kWh/t-km) × T (t-km/y)] / 10^9

A6. Worked example (70% BEV, 20% H_2-FCEV, 10% e-diesel w/DAC) Weighted intensity: 0.7 × 0.176 + 0.2 × 0.597 + 0.1 × 1.242 = 0.367 kWh/t-km Annual electricity: 0.367 × 250 × 10^9 / 10^9 = 91.4 TWh/y.