**Total Cost of Ownership Models for Electric Trucks – Global Review and Australian Adaptation**

**Introduction**

Electric heavy vehicles are gaining attention as a pathway to decarbonize road freight. However, their adoption will ultimately depend on ecty, often evaluated through **Total Cost of Ownership (TCO)** analysis.

TCO modeling accounts for **all costs over a vehicle’s life**, including purchase price, energy/fuel, maintenance, taxes, and residual value, to compare electric trucks with diesel equivalents. Numerous TCO models have been developed globally by researchers, governments, and industry. This report reviews 5–10 prominent TCO models for electric trucks, comparing their assumptions and findings, and examines how to **adapt these frameworks to Australian conditions**.

Key considerations include Australia’s long-distance routes, harsh climates, road user charging, energy prices, and regulatory settings. We also identify **reliable Australian data sources** and propose a **recommended TCO modeling framework** tailored to Australian heavy trucking, including methodological guidance on timeframes, uncertainty, and sensitivity analysis.

**Global TCO Models for Electric Trucks**

Worldwide, several leading organizations and researchers have developed TCO models to analyze battery-electric truck (BET) economics relative to diesel and other alternatives. Below is an overview of prominent TCO models and tools:

* **ICCT’s Heavy-Duty Truck TCO Models (Europe, US, Asia)** – The International Council on Clean Transportation (ICCT) has published detailed TCO analyses for heavy trucks in Europe, the United States, India, China, and other regions. These studies typically compare diesel trucks with **battery-electric** and sometimes **fuel-cell electric** or other powertrains. The ICCT model encompasses vehicle purchase cost, **fuel/energy costs, maintenance, road charges/tolls, taxes, and infrastructure**, summed over an ownership period and discounted to present value. For example, a 2023 ICCT European study assessed seven decarbonization pathways (battery electric, hydrogen fuel-cell, hydrogen combustion, biofuels, etc.) for multiple truck classes. It found that **battery-electric trucks are on track to become the lowest-TCO option for most truck segments by 2030**, with lower operating costs offsetting higher upfront costs. Similarly, an ICCT US analysis for Class 8 trucks projected that by 2030, **electric long-haul trucks would have lower TCO than diesel in all studied states**, even accounting for the substantial battery packs needed for high daily mileage. ICCT’s models are notable for their granular component-level costing (using bottom-up estimates for batteries, fuel cells, etc.) and inclusion of region-specific policies (e.g. European road toll discounts, US tax credits). They typically assume a first-owner horizon of ~5 years with residual value considered, reflecting the high annual mileage and depreciation rates in freight operations.
* **NREL/US DOE and National Lab Studies (USA)** – In the United States, the Department of Energy (DOE) and national labs have sponsored TCO analyses through tools like Argonne’s **AFLEET** and studies by NREL and UC Davis. A 2022 UC Davis review paper (Wang et al. 2022) compared **10 recent TCO studies** for electric trucks in the U.S., including analyses by California regulators (CARB), national labs (ANL, LBL), consultancies (ICF), ICCT, and industry groups (CALSTART). These studies covered use-cases from **heavy long-haul trucks to medium-duty urban delivery**. The review highlighted that TCO outcomes vary widely between stuy due to differences in assumptions on truck price, battery cost, energy efficiency, fuel prices, maintenance, and utilization. For example, some U.S. studies assumed future battery pack costs below $100/kWh and included incentives like California’s Low Carbon Fuel Standard credits, yielding optimistic TCO parity timelines, while others used conservative assumptions and found longer payback periods. Nonetheless, general findings across many U.S. analyses indicate that **for high-mileage operations, battery-electric trucks can achieve lower $/mile costs than diesel this decade**, especially as battery prices fall and if charging electricity remains around $0.15–$0.25/kWh. Notably, a DOE-sponsored study by Burke et al. (2023) reviewed multiple class 8 truck TCO scenarios and found that **by 2035, many battery-electric heavy trucks approach cost parity with diesel, but outcomes are sensitive to input assumptions**. National lab tools like AFLEET allow fleets to input their own data (vehicle cost, fuel price, incentives) to project TCO under various scenarios.
* **Academic Research Models** – Academia has contributed numerous TCO analyses for electric trucks worldwide. A recent comprehensive review by Danielis et al. (2025) surveyed **195 TCO estimates from 25 studies** across Europe, North America, Asia, and Oceania. These include early studies like den Boer et al. (2013) in Europe, which projected TCO of 2012/2020/2030 trucks, and more recent works (2018–2024) examining countries such as Germany, Norway, China, the UK, Iceland, and New Zealand. Academic models often use detailed simulation for energy consumption and may incorporate local factors (e.g. Norway’s low electricity costs and high diesel taxes). For instance, Hovi et al. (2019) analyzed multiple truck types in Norway and found electric trucks already competitive in certain urban delivery applications by 2019, whereas long-haul remained challenging without incentives. Another study by Tanco et al. (2019) evaluated break-even points for electric trucks in five Latin American countries, highlighting that outcomes depend strongly on fuel price subsidies and duty cycles. **Common trends** identified in the literature include: (1) Light- and medium-duty electric trucks achieving TCO parity earlier (around 2020–2025 in some cases), (2) Heavy-duty long-haul trucks generally not reaching parity until the 2030s without policy support, and (3) European and Asian analyses being more favorable to BETs than North American ones, largely due to higher diesel prices (from fuel taxes) in Europe/Asia. Academic models vary in scope – some exclude taxes or subsidies for a “pure” cost comparison, while others explicitly model incentives or carbon prices. Many academic studies also explore alternative powertrains (hydrogen fuel-cell, catenary electric roads, etc.) alongside battery-electric, using TCO to identify least-cost technology for given scenarios.
* **Industry and OEM TCO Tools** – Truck manufacturers and industry groups have developed TCO calculators to help fleets make purchasing decisions. For example, **Volvo Trucks North America’s TCO Tool** (launched in 2022) allows fleets to compare the lifetime costs of a Volvo electric truck (e.g. VNR Elest a diesel truck. This tool evaluates **purchase price (net of grants), maintenance, energy/fuel costs, expected infrastructure investment, and even applicable tax credits** to produce a customized cost comparison. Volvo emphasizes that while e-trucks have higher upfront cost, savings from **fuel (electricity vs. diesel) and maintenance** plus incentives can yield competitive TCO. Other OEMs offer similar calculators or TCO studies – Daimler Trucks has published TCO analyses for its Freightliner eCascadia, and Scania has reported that electric trucks can achieve parity in certain routes with sufficient utilization. In addition, industry collaborations lRT\*\* in California and the **North American Council for Freight Efficiency (NACFE)** have created TCO estimation tools and reports. CALSTART’s 2021 **electric truck TCO calculator** incorporated California’s incentive schemes (HVIP vouchers, LCFS credits) and showed that including these can reduce TCO by tens of thousands of dollars. NACFE’s reports (e.g. *Run on Less Electric*) provide real-world data on energy consumption and operating costs from fleet trials, which inform TCO assumptions (often validating that electricity costs per mile are significantly lower than diesel). **Government reports** also contribute models: for instance, the EU’s Joint Research Centre and national agencies in China and India have developed their own TCO projections for policy planning. A key takeaway from induels is the inclusion of **practical operational factors** (downtime, charging logistics) and **localized incentives**, giving fleets a realistic, site-specific view of cost implications.

**Comparison of Models:** Despite different contexts, most TCO models conclude that **battery-electric trucks can be financially viable in the near-term for certain segments**, especially where daily mileage is high and diesel fuel is expensive. Light and medium trucks (urban delivery, drayage) are often found to have already reached or are nearing TCO parity with diesel, whereas long-haul heavy trucks might need until the late 2020s or 2030s unless strong incentives or low-cost charging are in place. There is broad agreement that **declining battery costs and lower energy costs** drive the TCO advantage for electric trucks, ([A total cost of ownership comparison of truck decarbonization pathways in Europe - International Council on Clean Transportation](https://theicct.org/publication/total-cost-ownership-trucks-europe-nov23/#:~:text=Key%20findings%20from%20the%20study,indicate%20that))remain the main barrier. However, results differ across regions: European studies show BETs with a stronger competitive position than in the US, due to Europe’s higher diesel prices and carbon taxes. Many models highlight that **financial incentives** (purchase subsidies, tax credits, carbon pricing) and **infrastructure support** can accelerate parity by several years for heavy trucks. Conversely, lack of infrastructure (e.g. sparse high-power chargers for long-haul) and uncertainty in residual values are cited as factors that can hinder TCO competitiveness. These global insights provide a foundation, but applying them to Australia requires careful localization of assumptions, as discussed in later sections.

**Key Parameters and Assumptions in TCO Models**

TCO mo ([A total cost of ownership comparison of truck decarbonization pathways in Europe - International Council on Clean Transportation](https://theicct.org/publication/total-cost-ownership-trucks-europe-nov23/#:~:text=Key%20findings%20from%20the%20study,indicate%20that))ctric trucks share a common set of cost components, but tharameters and assumptions\*\* used can vary. Here we extract and compare key assumptions from ([Total cost of ownership of alternative powertrain technologies for Class 8 long-haul trucks in the United States - International Council on Clean Transportation](https://theicct.org/publication/tco-alt-powertrain-long-haul-trucks-us-apr23/#:~:text=The%20analysis%20also%20finds%20that,reach%20TCO%20parity%20with%20battery))els, focusing on capital costs, operational expenses, vehicle specifications, battery performance, maintenance, residual value, and lifespan. Table 1 summarizes how different models handle these parameters:

**Capital Costs (CAPEX):** This inc ()**vehicle purchase price** (truck chassis and powertrain) and sometimes the cost of dedicated charging infrastructure. Diesel truck prices are generally based on market data (list prices or fleet purchase prices). Elecices are higher; models either use current observed prices or \*\*bottom-up cost moT’s model estimates the retail price of e-trucks by summing component costs (glider, battery, electric motor, etc.). In 2023, ICCT assumed battery packs cost ~€220 per kWh and would drop to ~€95 by 2040 with mass production. Many studies similarly assume rapid battery cost decline (on the order of 50–70% reduction over two decades). Upfront cost assumptions vary: an Indian study (Rajagopal et al. 2024) found current BETs cost **2–3× the diesel truck price**, while ICCT’s India analysis assumed 4–6× for heavier11†L118-L126】. By 2030–2040, most models foresee the cost gap narrowing substantially (e.g. heavy BEV truck only ~20–40% higher upfront than diesel by 2040). **Infrastructure costs** (like chargers) are included in some models as part of CAPEX. Volvo’s TCO tool, for instance, adds the estimated cost to purchase and install charging stations into the analysis. ICCT’s analysis amortizes depot charger costs assuming a fleet of 10 trucks shares the investment. Other models (especially academic)ure or treat it separately. **Financing**: Some TCO models incorporate financing costs (interest on a loan or lease for the truck). ICCT applies a financing cost via a discount rate (9.5% in th) when computing NPV, whereas other frameworks might calculate an equivalent annual cost of capital or simply assume the operator buys outright (implicitly absorbing cost of capital). In summary, CAPEX assumptions are critical: **models that assume aggressive cost reductions for e-trucks project earlier TCO parity**, whereas those using today’s high prices without subsidy show longer paybacks. In Australia, electric trucks currently are very expensive (often imported in small numbers); one source notes **diesel trucks are 30–50% cheaper than an equivalent BEV in upfront price**, making subsidies or lower operating costs essential for parity.

**Operational Costs (OPEX):** These are costs incurred during use, notably **fuel or energy**, **maintenance**, and other running costs (tires, oils, AdBlue, etc.), as well as **insurance, registration, and road charges**. A major advantage of electric trucks is lower energy cost per km: electricity (per kWh) is cheaper than diesel (per liter) for the same work, especially if off-peak power is used. Models typically assume a diesel fuel economy (L/100km) and an electric energy consumption (kWh/100km) for the vehicle. For example, an Australian electric rigid truck might use ~93 kWh/100 km (unladen) vs a diesel at ~29 L/100 km. For a heavy articulated truck, real-world Australian data show ~**55 L/100km** average diesel consumption; an equivalent electric may consume on the order of **1.5–2.0 kWh per km** (depending on payload and terrain). Fuel prices assumed in models can greatly impact TCO: European studies often use diesel prices of €1–€1.5/L (including taxes) and electricity ~$0.10–0.20/kWh, whereas U.S. studies might use $0.7/L for diesel (untaxed) and $0.1/kWh for electricity. **Taxes and levies** are sometimes included – e.g. ICCT’s EU TCO explicitly added average road tolls, fuel taxes, and carbon pricing where applicable. In contrast, some academic models exclude taxes to focus on underlying cost. **Maintenance costs** are another key parameter. Battery-electric trucks have no engine oil changes, fewer moving parts, and regenerative braking, theoretically reducing maintenance. Many models assume EVs have 20–50% lower maintenance cost per km than diesels. The ICCT U.S. study assumed substantially lower routine maintenance for BEVs, contributing to their TCO edge. However, there is uncertainty here – some fleet data suggests current electric trucks still incur significant maintenance (cooling system, software, battery checks, etc.). A literature review noted **large uncertainty in BET maintenance costs**, and that not all analyses agree on the savings. Empirically, a range of **$0.15–$0.20 per mile** for diesel truck maintenance and **$0.05–$0.10 less per mile for electric** is often used as a rule of thumb. Other operational items: **residency fees, registration, insurance** – typically similar for both, though some regions offer registration discounts for zero-emission trucks. **Road user charges** are evolving: in Europe, some tolls are waived for zero-emission trucks (modeled as a cost reduction in TCO). In Australia, diesel fuel excise (currently 47c/L) is partly refunded for heavy vehicles, but electric trucks do not pay fuel excise – effectively an advantage today. Future distance-based road user charges for EVs (like the 2.5¢/km charge on EV cars in Victoria) may need to be included in long-term TCO scenarios. In summary, OPEX assumptions generally favor electrics (lower “fuel” and maintenance), but the magnitude varies. Models that assume **high diesel prices and stable or cheap electricity show huge savings for EVs**, whereas if one assumes very low electricity cost escalation for diesel, the savings narrow. Australian TCO modeling should use local energy prices (diesel **A$1.50–2.00/L** range in recent years, electricity ~**A$0.10–0.30/kWh** for commercial supply depending on time and location) and account for any differences in maintenance regimes in Australian conditions (e.g. dust or heat potentially affecting maintenance schedules).

**Vehicle Specifications and Performance:** TCO models must assume or simulate the **technical performance** of the trucks, as this affects cost. Key specs include **payload capacity**, **battery size (range)**, energy efficiency, and **vehicle lifetime (years or km)**. Many studies segment analysis by truck type: e.g. **Light-duty (3.5–12t)** urban trucks doing ~100 km/day, **Medium-duty (~12–26t)** doing 150–200 km, and **Heavy-duty (haul > 40t GCW)** doing 400+ km per day. A truck’s required **range/battery size** is crucial: larger batteries increase upfront cost, weight, and potentially reduce payload. Some models assume opportunity charging to allow smaller batteries – for instance, ICCT’s EU long-haul scenario assumed a ~500 km range battery with 350 kW en-route fast charging during the driver’s mandated rest break. Others, like the UC Berkeley study, examined a 375-mile (~600 km) range battery truck and found it could save over $300k in lifetime costs versus diesel, given the ability to recharge during breaks. **Payload impact**: Adding a heavy battery can reduce payload (and thus revenue) if weight limits are reached. Some European and U.S. analyses note this as a minor issue for most routes (UC Berkeley found only ~5% payload reduction in worst cases, which could be offset by allowances or lightweighting). In Australia, this is a concern for high-mass road trains, but regulators are beginning to grant **weight exemptions** (e.g. an extra 1-tonne on electric truck axles) to compensate for battery weight. **Lifetime and utilization:** Many models assume a certain lifespan or **analysis period**. ICCT uses 5 years for first owner, while others use 8–10 years or a total km (e.g. 1,000,000 km). If a full lifetime is considered, a **residual value** is included as the negative cost (resale value at end). If only a shorter period is considered, it’s implicitly a first-owner perspective and requires residual to compare fairly. **Residual values:** This is one of the more uncertain parameters. Conventional diesel trucks have well-known depreciation curves (perhaps ~20% value after a decade, depending on km). For electric trucks, second-hand value is speculative due to battery degradation and limited market history. Some models conservatively assume low residual for BETs (or even require a battery replacement mid-life to achieve similar residual). ICCT has approached this by estimating residual of each component (chassis, battery, fuel cell) based on remaining life cycles. For example, if after 5 years a battery has, say, 70% of its cycle life remaining, they attribute a proportionate residual. Most other studies simply apply a depreciation rate or assume residual value is a fraction of initial cost for both diesel and electric (e.g. 30% after 5 years). Uncertainty in residuals is noted as a limitation in reviews – real data from used EV truck sales is scant.

**Summary of Key Assumption Differences:** Different models may produce divergent TCO results mainly because of assumptions like: **Diesel price** (high in EU vs low in US), **Electricity cost structure** (flat vs with demand charges), **Annual mileage** (higher mileage greatly favors EV due to more fuel savings per year), **Discount rate** (higher rates penalize future fuel savings and residual, favoring lower upfront cost diesel), **Battery replacement** (if assumed needed, it adds a big cost for EV), and **Incentives** (including or excluding grants/carbon costs can swing results). Best practice is to clearly list these inputs. Table 1 (below) outlines how a few representative models treat major parameters:

*Table 1: Comparison of assumptions in selected TCO models.* (Sources: ICCT, Danielis (review), EVC/Queensland report, Volvo press release)\*

The above comparison highlights the range of inputs. Australian-specific modeling will need to choose appropriate values (discussed in Data Sources section) and possibly test high/low cases to reflect these global variations.

**Australian-Specific Challenges and Considerations**

Adapting TCO models to the Australian context requires addressing several unique challenges:

* **Long Distances and Duty Cycles:** Australia’s freight routes are famously long. Line-haul trucks often travel **hundreds of kilometers between stops**; a single articulated truck averages ~79,000 km per year according to the ABS, and many long-haul trucks easily exceed 120,000 km annually (e.g. Sydney–Melbourne line-haul runs). These long distances mean electric trucks may require **very large battery packs or frequent fast-charging**. A route like Brisbane to Melbourne (~1700 km) would necessitate multiple charging stops or battery swap to be feasible for a BET. Most global TCO models have focused on routes up to about 500–800 km/day with overnight charging. In Australia, inter-capital freight runs might push this envelope. The TCO impact is twofold: a **bigger battery** raises purchase cost and weight, but if it enables more diesel displacement, it could still be economical if utilized fully. Also, if a battery-electric truck cannot complete a route in the same time as a diesel (due to charging downtime beyond mandated rest), more trucks or drivers might be needed to maintain freight flow – an indirect cost. *How models handle this:* Some analyses assume opportunity charging during driver rest breaks (e.g. 45 minutes can add >200 km range with high-power charging). Australian modeling should explicitly consider **charging strategies for long-haul**: e.g. one could assume an emerging network of 350 kW or 1 MW chargers at rest areas on major highways by 2030, and include the time or cost impact of charging. Another approach is to consider **range-extender technologies or alternative powertrains (like hydrogen fuel-cell)** for the longest routes. Indeed, Australian fleets may adopt a mix – battery trucks for metro/regional and hydrogen or biofuel for extreme long-haul – but a TCO model tailored to Australia should be able to compare such options. Additionally, **higher average speeds** (due to open highways) and high payload mass (road trains) can increase energy consumption, so using local data on kWh/km under Aussie conditions is important (e.g. a road train in the Outback will use more energy per km than a single semi in Europe’s temperate climate).
* **Extreme Temperatures and Climate:** Australian conditions range from very hot (over 40°C in summer in the interior) to cold alpine winters (–5°C in Snowy Mountains). Batteries are sensitive to temperature: extreme heat can degrade batteries faster and reduce charging efficiency, while cold can temporarily reduce available capacity and require energy for heating. TCO models rarely include climate explicitly, but indirectly it affects **energy consumption (HVAC loads)** and **battery life**. For instance, an electric truck in tropical Queensland may need robust cooling systems, drawing power and possibly shortening battery lifespan if consistently hot. In TCO terms, this might mean slightly higher electricity usage per km (to run AC or battery cooling) and potentially a faster battery replacement cycle. Australian modeling might incorporate a **de-rating factor** for energy efficiency under extreme temps (e.g. +10% kWh/km in very hot regions) or adjust the battery life assumption. Also, dust and corrugated roads in remote areas can increase maintenance needs (for any truck), so assumed maintenance savings for EVs should consider harsh usage – fewer moving engine parts won’t help if suspension and chassis still take a beating. Extreme climate can also influence **charging infrastructure costs** – e.g. needing canopies or cooling for fast chargers in hot climates. While these factors are hard to quantify, a robust model will allow scenario inputs (e.g. “hot climate scenario: battery life = X years instead of Y”).
* **Road User Charges and Taxation:** Australia is in a transition regarding how road infrastructure is funded. Diesel fuel excise (currently 47.7 cents/L) has traditionally contributed, but heavy vehicle operators receive a fuel tax credit, effectively paying a reduced “road user charge” of 27.2 cents/L for on-road use (as of 2022). Electric vehicles currently pay no fuel excise, and light EVs in some states (Vic, NSW, SA) are subject to per-km charges (~2–2.5 cents/km) to compensate. For heavy trucks, a distance-based road user charge scheme is being considered federally to eventually replace the fuel-tax system. **Implication for TCO:** In the short term, an electric truck in Australia effectively avoids most fuel-tax-related charges, giving it an operational cost advantage beyond just energy efficiency (diesel truck operators still pay ~$0.27 per liter in net road use tax, which for a 55 L/100km consumption is about 15 cents/km in road taxes). However, it is likely that by the time electric trucks reach significant numbers, a per-km charge will apply to them. TCO models should be flexible to include or exclude such charges. A near-term model might show electric trucks benefiting from a “fuel excise holiday,” but a forward-looking model for say 2030 should prudently add a road user charge for EVs (perhaps similar per-km cost as diesel trucks pay). Conversely, some state incentives might waive registration or offer discounts to zero-emission trucks in early years – those could marginally reduce ownership costs for EVs (registration for a prime mover can be thousands of dollars annually, so e.g. a 50% discount would save a bit). Additionally, **Australian toll roads** (e.g. CityLink, EastLink) could introduce lower tolls for zero-emission trucks as a policy measure, though none exists yet – this could be modeled as a sensitivity (since in Europe, toll reduction is real and included in TCO). In summary, Australian TCO analysis should include **taxation differences**: currently a small perk for EVs (no fuel excise), but assume long-run neutral policy (road charges converging).
* **Local Energy Market Dynamics:** Australia’s electricity market has unique characteristics. It has high peak retail prices (commercial/industrial users often face demand charges), abundant solar PV (cheap daytime energy), and varying grid carbon intensity by region (Tasmania almost 100% renewable vs. Victoria coal-heavy). For TCO, the **cost of electricity** and how it’s procured is crucial. Many global models assume a flat rate per kWh. In Australia, a truck depot might secure an off-peak rate of say $0.10–0.15/kWh at night, but if they need daytime fast charging, they could pay $0.25–0.40/kWh or incur demand charges for high power draws. A best practice for an Aussie TCO model is to **differentiate energy costs**: e.g. model a scenario where depot charging at night is primary (low cost), versus one where opportunity fast-charging on-route (possibly at higher tariff) is needed. The **potential for on-site solar** is another local factor – a fleet in Brisbane or Perth could install solar panels and get very low effective energy cost at noon, though storing that energy for night use would require batteries. Integrating such possibilities (perhaps as a reduction in effective electricity cost or a separate capital expense for PV) could be considered for completeness. Additionally, **diesel pricing in Australia** can be volatile and region-dependent – remote areas pay much more for diesel than capital cities (due to transport cost and less competition). Meanwhile, electricity in remote areas might be from off-grid diesel generation (very high cost unless renewables are added). So, for long-haul routes through remote regions, both diesel and electricity might be expensive – but an electric truck could potentially carry energy (battery) from cheaper-grid regions or use solar at truck stops. These nuances mean an “average” energy price might not apply universally; the model could allow inputs for specific routes or use cases (e.g. Sydney local delivery: electricity $0.15/kWh, diesel $1.70/L; vs. Outback hauling: electricity $0.50/kWh (diesel genset) vs diesel $2.00/L). From a regulatory perspective, the Australian National Electricity Market (NEM) is transitioning to more renewables, so grid power is expected to become cleaner and possibly cheaper off-peak. A TCO model could incorporate **escalation rates** or a forecast for electricity and diesel – e.g. assume diesel rises X% real per year (or include a future carbon cost), and electricity tariffs remain flat or decrease off-peak due to renewables.
* **Australian Design Rules (ADR) and Vehicle Regulations:** ADRs govern vehicle dimensions, weight, and safety. Until recently, Australia’s stricter width limit (2.50 m) and weight limits posed a barrier for some imported electric trucks (which were designed to European 2.55 m width and often heavier due to batteries). In Sept 2023, the federal government **increased the width limit to 2.55 m** for trucks, aligning with Europe and removing one barrier – this helps because manufacturers can bring existing models without redesign. There are calls to also introduce a **mass allowance (e.g. +1 tonne)** for zero-emission trucks. NSW and other states have begun trials to allow heavier axle loads for EV trucks (e.g. NSW permits up to 1 tonne extra on the steer axle in a trial). For TCO, these regulatory changes influence the **payload factor**: if no extra mass allowance exists, an operator might lose payload capacity with an electric truck (potential revenue loss per trip, which could be quantified if payload is usually at max). With an allowance, that cost disappears. Thus, modeling two cases – with and without the 1-tonne concession – would be wise. Additionally, if certain large trucks (like triple road trains) are not yet approved in electric form, the model might limit consideration to those use-cases in later years or assume technology like battery swap or hydrogen for them. **Reliability and standards**: New technology might have unknown downtime rates initially, though probably not something to quantitatively put in TCO without data. But it is a perceived risk that could be mentioned qualitatively.

In summary, **Australian TCO adaptation** means ensuring the model can handle **very long distances**, incorporate **charging strategies and possibly different powertrain for extremes**, adjust for **climate effects**, model the current **tax regime and future changes**, use **local energy costs** (which might mean time-of-use pricing), and reflect **regulatory allowances** that affect payload. These factors will be layered on top of the usual cost elements captured in global models.

**Data Sources for Australian TCO Parameters**

Building a TCO model tailored to Australian conditions requires sourcing reliable local data for inputs. Below we identify key parameters and recommend data sources, along with notes on reliability and limitations:

* **Vehicle Specifications & Costs:** For truck purchase prices and specs (weight, battery size, etc.), Australian-specific data is limited because electric heavy trucks are only beginning to enter the market. One source is **manufacturer/OEM data** provided through local trials or announcements. The Electric Vehicle Council’s 2022 report with the Australian Trucking Association noted only ~14 electric truck and van models were available in Australia at that time – primarily light/medium trucks. Prices for those were often not published, but one can use international pricing and add import costs. **CSIRO/Swinburne iMOVE Project:** The ongoing “Zero Emission Heavy Vehicles” project (2023–24) led by Swinburne and CSIRO is expected to gather such data; its goal includes a detailed TCO for Australian heavy vehicles. In absence of a comprehensive database, **quotes from local dealers or demonstration programs** (e.g. SEA Electric, Janus Electric conversions) can give examples: a SEA Electric 8-tonne might be ~$250k, a converted prime mover ~$400k, etc. We recommend using **global projections (like ICCT or BNEF)** for future cost trajectories – e.g. assume battery cost in AUD will fall to around A$150/kWh by 2030 – but validate against any local purchase that occurs. For now, diesel truck prices are known (a new diesel prime mover ~A$250k). **Reliability:** OEM data is generally reliable for specs (battery kWh, range) but pricing may vary widely with low-volume early sales. This is a data gap that will improve as more electric trucks are sold.
* **Diesel Fuel Prices:** The **Australian Institute of Petroleum (AIP)** publishes weekly average diesel prices by major city, and the **Australian Bureau of Statistics (ABS)** and **Bureau of Infrastructure and Transport Research Economics (BITRE)** publish retrospective averages. For example, BITRE’s **Yearbook** or the ABS “Motor Vehicle Use” report give average diesel prices and total fuel consumption. In recent years, retail diesel in Australia has ranged roughly A$1.30–1.50/L (pre-2022) and spiked to A$2.00+ in 2022 with global oil issues. A reasonable baseline might be A$1.50/L (excluding GST, ~A$1.65 incl GST) for metro fuel. **Regional variation:** note that remote areas can see +10–30% higher. Data on **fuel excise** and rebates is available from the Australian Taxation Office (ATO) or Department of Infrastructure (for the heavy vehicle road user charge). For TCO, one might use net diesel cost to operator (after fuel tax credit) for a freight company: e.g. if excise is 47c and road-user charge is 27c, eligible fleets reclaim ~20c, meaning effective cost per liter is lower for them. This nuance is important when calculating true operating cost. We have reliable numbers for excise and the credit; the usage of credits depends on on-road/off-road split (most line-haul is on-road so no full rebate). For modeling, it may be simplest to use the **net diesel price** (e.g. A$1.50/L gross – A$0.20 rebate = A$1.30 effective per liter). **Reliability:** Fuel price data is very reliable for current values; forecasting it is the challenge (can test scenarios like +2% real increase/year or stable real price).
* **Electricity Prices:** Australia’s energy market data can be sourced from the **Australian Energy Regulator (AER)**, which reports on retail electricity offers, and **AEMO** for wholesale prices. For a fleet depot, likely on a commercial tariff, the cost comprises energy charges (which might be ~$0.10/kWh off-peak, ~$0.20–0.30/kWh peak for large users) plus demand charges (charged per kW of peak demand per month). **Energy Made Easy** (government website) provides typical tariffs by postcode. Many large facilities also negotiate **corporate energy contracts** with retailers. As a starting point, one might use: Off-peak rate $0.15/kWh, peak rate $0.25/kWh, and assume smart charging enables majority off-peak usage. If including demand charges, one could amortize it per kWh (e.g. a 50 kW demand charge at $15/kW could add a few cents per kWh if utilization is low). For **public highway charging**, costs will likely be higher – perhaps $0.30–0.50/kWh, akin to public EV fast chargers today, to reflect infrastructure and demand costs. Data on public charger pricing for trucks specifically isn’t available yet (since networks like Ampol, Evie, etc., are just starting to plan truck sites), but using EV fast charging rates as proxy is reasonable. Another aspect: **future tariffs** – as more renewables come, off-peak might get cheaper. AEMO’s Integrated System Plan and CSIRO’s GenCost could give projections for electricity costs. For **renewable sourcing**, if an operator installs solar, the effective cost of that energy can be modelled (e.g. levelized cost of solar generation could be ~$0.05–0.10/kWh). **Reliability:** Current grid tariff data is reliable and public. The main limitation is that actual prices paid will depend on an individual fleet’s size and usage pattern – large energy users get better rates. We might use a moderate value and later adjust in sensitivity.
* **Vehicle Energy Consumption:** To estimate fuel and electricity use per km, local testing or drive cycle data is ideal. In absence, we use proxies: The **ABS Survey of Motor Vehicle Use** provides average fuel consumption for trucks (e.g. articulated trucks ~55 L/100km, rigids ~29 L/100km). For EVs, one can derive kWh/km by assuming diesel efficiency and electric drivetrain efficiency. If 1 liter of diesel ≈ 38.6 MJ and electric driveline is 3× more efficient, then roughly 1 L diesel work ≈ 3.6 kWh electric. So 55 L/100km ~ 55\*3.6 = 198 kWh/100 km, or 1.98 kWh/km for a loaded semi. This ballpark aligns with limited data from overseas: a fully loaded 40-tonne electric truck in Europe might use ~1.5–2 kWh/km. For lighter loads or urban, consumption is lower. Australian trials: If any, e.g. Linfox trial of an EV truck in Sydney or Brisbane might have reported energy use (reports from companies or ARENA trials can be mined for such data). **CSIRO’s upcoming analysis** may include simulation for Australian routes – if available, those numbers should be used. Until then, we can use a range: 1.0 kWh/km (light urban rigid) up to 2.5 kWh/km (road train in outback) depending on scenario. **Reliability:** Diesel consumption figures from ABS are aggregated averages (reliable for broad use, but a specific fleet might do better or worse). EV consumption is currently an estimate; more real-world data is needed. A conservative approach is to err on the higher side for kWh/km to not underestimate costs.
* **Maintenance and Repair Costs:** Hard data on Australian fleet maintenance costs can be sourced from industry surveys or the Trucking Association. For diesel trucks, companies often know their maintenance cost per km. If not directly available, we extrapolate from global sources: e.g. $0.20 per mile (~A$0.124 per km) is often cited for U.S. class 8 maintenance. Australian costs might be a bit higher due to longer distances and possibly higher parts costs. We can assume something like **A$0.20–0.30 per km** for a diesel prime mover (including tires, engine, etc.). For EVs, since there are far fewer in operation, we rely on projected reductions (no engine overhauls, less brake wear). Maybe assume **30–40% lower** per km initially. However, note that **parts costs for EVs in Australia might be high due to low volume** (if something breaks, it might be expensive to source). Also, **downtime costs**: if an EV truck has fewer maintenance events (good) but each event (say battery issue) is specialized (potentially bad), there’s uncertainty. It’s reasonable to follow global estimates (e.g. maintenance savings of 20–50%) but do sensitivity analysis. Data sources to validate maintenance: seek input from bus operators (electric buses have been running in Australian cities and their maintenance data could be analogous). For instance, some transit agencies report significantly lower service costs for e-buses. Another source is **mining industry electric vehicles** – e.g. Rio Tinto trialing electric haul trucks (if any data published). **Reliability:** maintenance cost data is inherently variable; use global benchmarks and adjust with local mechanic labor rates. Include a wide uncertainty band.
* **Emissions and Environmental Data:** While not a direct financial parameter, if we want to quantify emissions benefits or include carbon cost, we need emissions factors. The **Department of Climate Change (Climate Active)** publishes **National Greenhouse Accounts Factors** annually. From that: Diesel (combustion) ~ **2.68 kg CO₂ per liter**, plus ~0.5 kg upstream (well-to-tank) – so ~3.1 kg CO₂e/L total. Electricity: use state-based factors or NEM average. In 2023, NEM average might be ~0.70 kg CO₂ per kWh and falling as renewables rise. Victoria on the high end (~0.9), Tas ~0.1, etc. If doing social cost analysis, one could apply a cost per ton (like A$75/tonne, which is roughly Australia’s current carbon credit price under the Safeguard Mechanism). That would translate to about 23 cents per liter diesel external cost. This is optional data for adding non-financial benefits context. **Reliability:** These factors are official and updated regularly. For local air pollution (NOx, PM), one could get emission rates from NSW EPA or similar, but monetizing those is complex (could cite health studies, but beyond typical TCO unless doing a societal cost).
* **Operational Patterns:** How trucks are used (e.g. days per year, shifts per day). ABS and BITRE provide averages: e.g. average km/year as noted, average load factors. For TCO, we might assume a truck operates 5 days a week, ~48 weeks a year (allowing for maintenance downtime) – ~240 operational days. If 800 km/day for line-haul, that’s ~192,000 km/year (which is plausible for a truck doing nightly trips). Urban trucks might do 100–200 km/day. These assumptions should match the use-case being modeled. Data can be drawn from **industry case studies** (for example, Woolworths electric delivery trucks might publish that they do ~150 km per day). **Reliability:** Use-case specific, but industry associations or previous studies (like NTI’s trucking benchmarking) can provide typical utilization.
* **Infrastructure Costs:** For depot charging, data can be obtained from charger manufacturers and pilot projects. A 50 kW AC charger might cost ~A$20k, a 150 kW DC fast charger ~A$100k, and a 350 kW charger $300k+, plus installation and possible grid upgrade. **ARENA** has funded some depot charging projects (e.g. in Brisbane for bus depots) – their reports often detail costs. Also, the **Clean Energy Finance Corporation (CEFC)** has guides for depot electrification costing. **Grid upgrades** could be significant if a depot wants multiple 350 kW chargers – perhaps a new transformer etc. In TCO, this can be allocated per truck: e.g. if a depot spends $1 million for charging infrastructure for 10 trucks, that’s $100k per truck upfront (which could be amortized). Public infrastructure costs are typically borne by charging providers and built into the per-kWh price that we pay, so a fleet using public chargers can just pay a higher electricity price rather than directly accounting for charger capex. For **hydrogen infrastructure** (if considered), data is even sparser in Australia – but outside scope if focusing on electrification. **Reliability:** Costs are highly site-specific; use ranges and perhaps example case studies. Also consider future cost trends (charger costs may come down with mass production; e.g. megawatt chargers in a few years).

To summarize, **Australian data is available for fuel use and prices, and somewhat for usage patterns, but is limited for electric-specific data** (costs, consumption, maintenance). We will rely on a combination of **official statistics (ABS, BITRE)** for baseline diesel data and **global benchmarks adjusted to Aussie context** for electric assumptions, validating where possible with any local trial information. Table 2 provides a quick reference for recommended data inputs and sources:

*Table 2: Key Australian TCO inputs, sources, and assumptions.*

The above values serve as a starting framework. It is crucial to update these as new Australian-specific data becomes available (for example, actual performance of trucks in Australian trials, changes in energy prices, etc.). Some inputs like maintenance and residual are flagged as uncertain – these should be revisited periodically.

**Methodological Approaches in TCO Modeling**

Different TCO models employ varying methodologies to calculate and compare costs. The main methodological considerations include the treatment of time (annualized vs. net present value), the analysis period, whether a **cash-flow approach** is used, and how uncertainty is handled. We compare approaches and recommend a method for the Australian model:

* **Annualized Cost vs. Net Present Value (NPV):** Some models compute an **annualized cost per year or per km** – effectively spreading capital costs over the life and adding operational costs to yield a uniform yearly cost (or cost per km). This is useful for getting a single metric like $/km. Other models explicitly sum **cash flows over time and discount them** to present value, then compare NPVs or derive a levelized cost. The ICCT model, for instance, converts all costs into discounted cash flows over a 5-year ownership period. The choice might not change the conclusion if done correctly, but NPV allows more nuanced handling of timing (e.g. if fuel prices change each year, or if maintenance costs grow as vehicle ages). **Recommendation:** Use an NPV approach with a suitable discount rate (e.g. real discount ~7% reflecting a commercial fleet’s weighted cost of capital). This allows incorporation of any year-by-year variations (like a battery replacement in year 8, or fuel escalation). After computing NPV, one can still derive an equivalent annual cost or cost per km for easier interpretation.
* **Timeframe (Analysis Period):** As discussed, some analyses take the first-owner perspective (e.g. 5 years), others the full life (10-15 years). Australian trucks have long lifespans (the average truck on road is 13+ years old), so it’s informative to consider a longer period. However, the first few years are also critical for purchase decisions (fleet managers often want payback within 3-5 years). **Recommendation:** Perform the TCO analysis over the **full expected life (e.g. 10 years or 1,000,000 km)** for a heavy truck, *and* optionally examine a shorter horizon with resale value to see payback. The model can output metrics like “5-year cost difference” and “10-year total cost” to inform both perspectives. In NPV terms, a 10-year horizon with residual at year 10 will capture the long-term economics.
* **Cash Flow Structure:** A year-by-year cash flow would include: Year 0 purchase (capital outlay for truck and charger), each year’s operating costs (fuel, maintenance, insurance, etc.), any periodic costs (maybe battery change at year N if applicable), and at final year a salvage value. Each of these should be properly discounted if using NPV. If comparing two technologies, it’s helpful to compute the difference in cumulative cash flow over time – this can show in which year the EV “breaks even” (cumulative costs equalize). For example, an electric truck might cost more upfront but have lower running costs – the breakeven year is when the savings catch up the initial gap. This approach resonates with fleet managers as a “payback period.” If incentives are involved, they might apply at purchase (reducing year 0 cost) which the cash flow captures easily.
* **Sensitivity Analysis:** All major studies stress the importance of sensitivity or scenario analysis. Given the uncertainties (fuel prices, battery life, etc.), a good model will allow adjusting inputs and seeing the impact. Common sensitivities to test: **Diesel price high/low** (e.g. ±30%); **Electricity price high/low**; **Battery cost or truck price** (if they fall faster or slower); **Annual km** (if utilization is less, does payback still occur?); **Discount rate** (some companies may have higher hurdle rates for investments); **Maintenance differential** (what if EV maintenance savings are smaller than expected?). One can run these as separate scenarios or do a formal sensitivity analysis calculating percent change in TCO per percent change in each input. A **tornado chart** (ranking inputs by impact) could be produced to identify which assumptions the outcome is most sensitive to. This guides where improving data matters most. For example, if TCO outcome hinges heavily on diesel price, one might emphasize getting accurate fuel forecasts or hedging strategies.
* **Uncertainty and Probabilistic Analysis:** A step beyond simple sensitivity is doing a Monte Carlo simulation where each uncertain input is given a distribution (e.g. diesel price ~ Normal or triangular distribution around a mean). This could generate a probability distribution of TCO difference outcomes (e.g. “there’s a 80% chance the EV truck will have lower total cost than diesel under these distributions”). However, this requires quantifying uncertainties and might be overkill for initial purposes. It could be useful for risk-averse decision-makers. Initially, scenario analysis (best case, worst case, base case) is probably sufficient and easier to communicate: e.g. **Best-case** (cheap electricity, high diesel, gov incentives) vs **Worst-case** (low diesel, higher EV costs, etc.).
* **Comparing Multiple Technologies:** Some frameworks compare not just diesel vs BEV, but also alternatives like hydrogen fuel-cell or hybrid. If the scope is strictly truck electrification (battery electric focus), we may not need to model others. But given interest in long-haul, one might include hydrogen FCEV in the model to see at what hydrogen price it becomes competitive with BEV or diesel. That requires additional assumptions (fuel cell cost, hydrogen price, etc.). If included, it should be a module that can be toggled. Similarly, if one wanted to evaluate a scenario like catenary electric trucks or dynamic charging roads, that’s more specialized. For now, likely focus on diesel vs battery-electric, with possibly a hydrogen scenario for completeness in long-term thinking.
* **Reporting Metrics:** Decide how to present results. Commonly: **TCO per km** (or per mile) for each option – this gives a unit cost that can be compared. Also the **total cost over period** (NPV or undiscounted) for each. Possibly **payback period** as mentioned. And if environmental factors are included, maybe **cost per tonne CO₂ abated** if comparing an EV to diesel (i.e. difference in cost divided by difference in emissions, to see how economically the emissions reduction is achieved – useful for policy). Given the question’s scope, likely we will present qualitative comparisons rather than actual numerical results, but when building an Aussie model, these metrics will be outputs.
* **Granularity:** Another methodological aspect – do we simulate operations at a fine granularity (e.g. hour-by-hour to capture charging time and time-value of money for downtime)? Most TCO models do not go that granular; they assume averages (like X km/year, Y charges). But one could incorporate, for example, that an electric truck might need an extra half day of downtime per week for charging beyond what a diesel would need for refueling (though in practice drivers need rest anyway, and maintenance downtime for diesel might be higher). If one wanted, they could add a cost for lost productivity if any.

**Recommended Approach for Australia:** Use a **discounted cash flow model over 10 years** with the ability to adjust to shorter horizons. Include all relevant costs (purchase, infrastructure, fuel, maintenance, etc.) in the cash flow. Perform **scenario analyses** for key use-cases: e.g. **Urban delivery (low km/year)**, **Regional freight (mid km)**, **Long-haul (high km)**. For each, run at least three scenarios: *Baseline*, *Optimistic for EV* (high fuel price, low battery cost), *Pessimistic for EV* (low fuel, high electricity, etc.). This will illustrate the range of outcomes. Ensure transparency of assumptions so stakeholders can understand how results were derived and perhaps input their own data.

By following this approach, the model will be flexible and robust, addressing the methodological pitfalls. The importance of context (truck type, usage, location) should be emphasized when interpreting results – as the UC Davis review put it, policymakers and fleets should avoid assuming a “simple average TCO across all situations” and instead consider the specific scenario at hand.

**Incorporating Non-Financial Benefits in TCO**

Traditional TCO focuses on direct financial costs to the owner, but electric trucks bring **external or non-financial benefits** that, while not always included in TCO, are increasingly of interest. These include **greenhouse gas and air pollution reduction, lower noise, and energy security benefits**. We assess to what extent existing models quantify these and how an Australian framework might account for them:

* **Greenhouse Gas Emissions:** Most TCO studies will calculate the emissions of each option (diesel vs electric) but not assign a monetary value to it in the base TCO. Some analyses, however, do explore an internal carbon price or the social cost of carbon. For instance, the Berkeley study noted that if environmental benefits (like avoided CO₂ and air pollution) are monetized, the effective TCO of electric trucks would be **30% lower** than diesel. This was based on valuing emissions reductions over the truck’s lifetime – effectively treating those as a benefit (negative cost). In policy-driven models (like some government cost-benefit analyses), a carbon price or social cost per tonne (SCC) is added. In Australia, one might use a value (e.g. $75/ton as mentioned, or a lower SCC of say $50/ton) as a sensitivity to see how that changes the “societal TCO.” **Recommendation:** Keep the core TCO as private cost, but optionally show a case where a carbon cost is applied to diesel (or credit to EV) to reflect societal perspective. This helps illustrate that even if an electric truck is slightly costlier for an operator, it might be net beneficial when accounting for emissions – useful for policy justification.
* **Air Quality and Health:** Diesel trucks emit NOx and PM, causing health issues especially in urban areas. Electric trucks eliminate tailpipe emissions, improving local air quality. These benefits are rarely monetized in TCO models because it requires complex epidemiological modeling. However, some studies have done it at a high level. For example, Abhyankar et al. (2022, Berkeley) projected **70,000 avoided premature deaths by 2050** in the U.S. with truck electrification, and one could assign an economic value to those health outcomes (they estimated $1 trillion in savings by 2050 including health and fuel savings). For an Australian context, one could reference studies on health cost of transport emissions (e.g. by the Climate Council or University researchers) – there’s a known figure that transport air pollution costs Australia billions per year in health costs. If needed, a per-km or per-kg pollutant cost could be applied. But again, this would be outside the usual TCO framework unless doing a societal CBA. Likely, we acknowledge these benefits qualitatively: e.g. note that electric trucks reduce particulate and NOx emissions, which is especially beneficial in freight corridors and city centers (reducing smog and respiratory diseases).
* **Noise Reduction:** Electric trucks are much quieter, especially at low speeds. This has operational benefits – for example, they could allow night-time deliveries in urban areas without disturbing residents (where diesel trucks might be banned at night due to noise). This benefit can translate into **logistical flexibility** and potentially cost savings (if deliveries can be done in off-peak hours faster). Some fleet operators value this, but it’s hard to put a dollar figure unless you specifically model that one EV truck can do more trips by avoiding congestion or using nighttime slots. **In TCO models, noise is usually not monetized**, but it can be mentioned as a “soft” benefit. In an Australian setting, cities might eventually have noise regulations that favor EVs – for instance, an operator might get permission for 24/7 deliveries if using zero-emission quiet trucks, which increases truck utilization (thus more revenue per truck). If that scenario is relevant, one could indirectly incorporate it by assuming higher km/year possible for an EV in city delivery than a diesel (because of extra nighttime operation). That effectively improves the TCO because higher utilization spreads the capital cost more. So rather than a direct monetary credit for “quietness,” we adjust operational assumptions.
* **Energy Independence and Fuel Security:** Australia currently imports a large portion of its diesel, which is a fuel security concern. Electric trucks can use domestically produced electricity (including renewables). The EVC/ATA report emphasized using Australian-made renewable energy to power transport improves **fuel security**. While a trucking company might not directly care about national energy security in their TCO, the government might value reduced exposure to oil price shocks. If desired, one could simulate an oil price shock scenario – e.g. diesel temporarily at $2.50/L – to stress-test TCO, highlighting that EV operations have more stable costs (electricity prices are more insulated from global oil markets). This is more of a scenario analysis than a built-in benefit.
* **Brand and ESG Value:** Intangibles like improved company image, meeting corporate sustainability targets, and staying ahead of regulations are increasingly cited by fleets in adopting EVs. These don’t show up in a spreadsheet but can tip decisions. Some firms might even count an internal “carbon price” in their investment decisions to align with ESG goals. If an operator assigns, say, $50/ton CO₂ internal cost, that effectively becomes part of their TCO calculation favoring EVs. This can be handled by the carbon price method above.

In conclusion, **most TCO models keep these non-financial factors separate** or in appendices/side calculations. For the Australian TCO framework, we propose: **quantify emissions differences** (e.g. an electric truck saves ~X tonnes CO₂ and Y kg NOx per year), and optionally present a “with carbon pricing” scenario to give a sense of societal benefit. We should document noise and flexibility benefits qualitatively – e.g. note that quieter trucks could enable operational efficiencies, which in practice might improve the business case even if not easily monetized. The key is to ensure policymakers see the full picture: **when environmental and health benefits are accounted for, the case for electric trucks strengthens significantly**, often showing that even a small subsidy to bridge any remaining cost gap yields net positive social returns.

**Infrastructure Cost Allocation and Future Cost Trajectories**

Two important factors in TCO are how to handle **infrastructure investments** (like charging stations and electrical upgrades) and assumptions about **future technology cost trends** (batteries, vehicle costs, electricity tariffs). We address each:

**Charging Infrastructure Costs:** Unlike diesel trucks which rely on public fuel stations (cost built into the diesel price), electric trucks often require new infrastructure either at the depot or en route. There are a few ways models handle this:

* *Per-vehicle allocation:* If a fleet installs chargers at its depot specifically for its trucks, the cost of that infrastructure (hardware, installation, any grid upgrades) should be amortized over the trucks using it. ICCT’s model, for example, assumed a depot of 10 trucks sharing chargers, and included a prorated cost per truck. The Volvo tool also explicitly adds “the cost to purchase and install charging infrastructure” into the TCO comparison. For Australia, if a company buys, say, two 150 kW chargers for its four electric trucks at a total cost of $300k, one could allocate $75k per truck initial cost (or finance it and treat as an annual cost). The **lifetime** of chargers can be ~10-15 years, so if our analysis is 10 years, we can amortize fully or assume some residual for the charger too. The model might have an input for number of trucks per charger and charger cost to calculate per-truck share.
* *Public charging usage:* If trucks rely on public fast chargers (e.g. along highways or third-party depot charging), the cost is effectively in the **electricity price** they pay (provider will recoup infrastructure cost via fees). So we might not need to add a separate infrastructure cost, but rather use a higher $/kWh for those energy portions. For example, if 20% of energy is from public chargers at $0.35/kWh, that price includes the infrastructure cost recovery. In scenarios where a truck uses mostly public charging (like a truck with no home depot charger), we can simply set a higher average electricity cost and zero infrastructure capex.
* *Grid upgrade costs:* Sometimes, beyond just buying a charger, a depot needs a new transformer or substation upgrade to supply high power. These can be significant (hundreds of thousands). They are essentially a fixed cost that should be allocated over all electric trucks (and possibly other EVs) using the site. If our model is looking at one truck in isolation, it could unfairly penalize that one truck with the full cost. So better to assume a certain scale (e.g. plan for 5-10 trucks) to distribute it. Alternatively, treat infrastructure cost as a separate line that user can toggle: “if using existing grid capacity = 0 cost, if needing upgrade = $X”.
* *Future infrastructure cost reductions:* As technology matures, charger costs may come down (though installation and labor often dominate). Also, innovative solutions like **battery swapping** or **modular megawatt chargers** could change cost structure. In Australia, companies like Janus Electric propose battery swap stations on highways, which shifts cost from truck (smaller onboard battery) to infrastructure (swapping stations+batteries). That could be considered, but to avoid complicating too much, we might stick to conventional charging scenarios but acknowledge these alternatives.

For our recommended framework: If focusing on **depot-charged operations**, include a per-truck infrastructure cost (maybe ~A$50k per truck as a baseline, which could represent a share of a couple of fast chargers and minor upgrades). If focusing on **long-haul with public charging**, maybe omit direct infra cost and instead model higher energy cost. One can also present results both including and excluding infrastructure to see its impact. Some studies have found infrastructure costs add only a small increment to per-km cost if well-utilized, while others note it can be a barrier for small operators (who can’t afford a big upfront outlay).

**Future Cost Forecasts:** TCO models often examine not just current costs but future scenarios (e.g. “When will parity happen?”). This requires forecasting:

* *Battery costs:* We have discussed that many use sources like BloombergNEF or similar. The trend is a significant decline in the 2020s (somewhat already realized with lithium iron phosphate cells now ~$100/kWh at pack level in China). By 2030, some project $80/kWh pack. We should define a trajectory in the model (maybe a linear or stepped decrease). Or allow user to input for a given analysis year.
* *Vehicle costs:* Tied to battery cost for EVs, also to economies of scale. Many assume a learning curve: as production volumes increase (and competition with Tesla Semi, etc.), prices will drop. Diesel truck cost might increase slightly if emissions standards tighten (e.g. Euro VII components cost more) – ICCT noted including future emission compliance cost adding to diesel price. So one can project diesel truck price to rise a bit in real terms. For EV, project decline. Our earlier assumption table already does something like 2.5× diesel cost now to maybe 1.5× in 2030.
* *Fuel and electricity prices:* Fuel: could assume a modest rise in real terms due to carbon policy or depletion, but also could be volatile. Some do a high/low scenario rather than pick a single forecast. Electricity: with more renewables and maybe smarter charging, could even drop in off-peak, but on the other hand more electrification could increase demand and capacity charges. AEMO’s Integrated System Plan might give some guidance on wholesale prices to 2030 (which are expected to decline as coal retires and cheaper renewables fill in, although with investment needed). Perhaps assume diesel +1% real annually, electricity 0% real (or electricity tied to CPI but offset by efficiency gains in charging… probably safest to keep flat or moderate increase). If carbon pricing is expected, that would hit diesel more (since electricity can decarbonize).
* *Battery replacement & residual in future:* If one is modeling beyond 2030, perhaps battery life improves (more cycles, so maybe no replacement needed even for long life). Also, second-life battery value might appear (old truck batteries could be reused for stationary storage – giving them a residual beyond just scrap). Those are speculative but interesting to note.
* *Technology improvements:* Electric drivetrain efficiency could improve a bit, but not huge leaps; maybe ~10% by 2030. More importantly, **charging speeds** will improve – by 2030, megawatt chargers could make charging stops extremely quick, reducing the “downtime cost” and making even cross-continental trips feasible with minimal delay. If we consider that in TCO, faster charging doesn’t directly change cost per se (except if demand charges apply), but it can reduce the need for additional trucks/drivers.
* *Policy changes:* Future carbon taxes or road charges have been mentioned – incorporate if likely. Also potential future incentives (if government decides to subsidize EV trucks more heavily in say 2025–2030 to push uptake, that effectively lowers purchase cost in those years).

In practice, one might run the model for different **target years**: e.g. TCO for a truck purchased in 2023 vs 2025 vs 2030, using the corresponding cost assumptions for those years. Many studies do this, showing parity year – e.g. “by 2027 parity for medium trucks”. For an Aussie model, we can do similar: find at what year and under what assumptions does the electric option become cheaper. If it’s far out, that suggests need for intervention; if it’s soon for certain segments, that segment can be encouraged now.

**Recommendations for Handling in Model:** Build in a **timeline slider or input** for analysis year that adjusts costs (vehicle, battery, fuel). Alternatively, provide separate sheets for e.g. 2023, 2030, 2040 scenarios. For infrastructure, consider economies of scale in the future (more standardization = cheaper per charger maybe, or if trucks have more range maybe fewer chargers needed). Also consider **learning from pilot projects**: e.g. an initial truck might incur a lot of one-time setup costs (training, facility changes) that subsequent trucks won’t. Possibly treat first unit vs later units differently (though that’s more for micro-level analysis of a company’s transition rather than societal average cost).

In summary, **robust TCO modeling must be forward-looking**, not just static. Given the rapid improvement in EV tech, a static snapshot can be misleading. Thus, include the ability to model future scenarios and incorporate cost decline assumptions from credible sources. Sensitivity analysis on these trajectories is also wise – e.g. if battery tech stalls, how much does that delay parity?

**Best Practices, Limitations, and Gaps in Existing Models**

Through this review, we’ve identified several **best practices** in TCO modeling, as well as limitations and gaps that need addressing (especially for the Australian context):

**Best Practices from Existing Models:**

* **Include All Relevant Cost Elements:** The most comprehensive models incorporate not just purchase and fuel, but also maintenance, insurance, taxes, infrastructure, and residual value. This full-system approach is critical to avoid bias. For instance, ignoring infrastructure would favor diesel; ignoring fuel taxes or incentives would misrepresent regional differences. A best practice is to make sure no significant cost is left out (even if some are hard to estimate, include placeholders).
* **Use Real-World Data and Drive Cycles:** Models grounded in empirical data (e.g. actual energy consumption from truck trials, actual maintenance logs from fleets) tend to be more credible. The North American NACFE demonstrations and some European pilot projects have provided such data. As Australia begins trials (for example, NSW’s trial of electric freight trucks), feeding that data into models will improve accuracy. Another practice is to simulate usage on real routes (e.g. use a drive cycle or GPS data to estimate energy use rather than a simple average). This can capture regenerative braking benefits in stop-start urban duty or higher drag losses at highway speed.
* **Segment by Duty and Weight Class:** One-size-fits-all doesn’t work well. Good studies break the analysis into categories (urban delivery vs long-haul, etc.). This reveals which segments are viable sooner. For example, the review by Danielis et al. showed light trucks can be competitive much earlier than heavy long-haul. Our model should follow this segmentation approach.
* **Transparent and Updatable Assumptions:** Many models (especially academic or NGO ones) document their assumptions in tables or appendices. This transparency allows stakeholders to update parameters as new information comes. Given the fast pace of EV tech, models must be living documents. Providing an Excel tool or at least tables of inputs for Australia would let users plug in new diesel prices or etc. when needed.
* **Sensitivity and Scenario Analysis:** As emphasized, treating point estimates as gospel is risky. The best studies clearly communicate uncertainty – e.g. “in our central case EV has a 5% lower TCO, but under pessimistic assumptions it could be 10% higher”. Policymakers and fleet managers appreciate knowing the range of possible outcomes.
* **Consider Policy Incentives Explicitly:** Rather than burying subsidies or taxes in other numbers, explicitly modeling them (like “with $X rebate, TCO is Y, without it is Z”) helps show the impact of policy. ICCT’s US analysis explicitly examined the effect of the Inflation Reduction Act credits and found even without them BEVs outcompete hydrogen in most cases. For Australia, one might test: what if a subsidy of $50k per truck is introduced – how does that change uptake economics?
* **Review and Validation:** Some level of validation of model outputs against real operators’ experiences is ideal. Since electric truck uptake is just starting, we have limited real TCOs to compare. But as years go on, we can compare a model’s prediction for early adopters to what those fleets actually incurred. Adjustments can then be made (maybe maintenance wasn’t as cheap as thought, or batteries lasted longer than expected, etc.). The involvement of industry in model development (through surveys or collaboration) can improve buy-in and accuracy.

**Limitations and Gaps Noted:**

* **Residual Value Data:** A recurring gap is the uncertainty in residuals for electric trucks. No one knows how second-hand buyers will value used batteries. This could swing TCO if, say, EVs end up with very low resale (making them effectively more expensive per km for first owner). We flagged this and likely need to keep monitoring the used market. It might be that early EV trucks will be kept longer by first owners (to use up the value of the costly battery) rather than sold at 5 years. Our model might consider both cases (sell at 5 with low residual vs keep 10 years).
* **Maintenance Cost Uncertainty:** As noted, the “lower maintenance” claim is plausible but not yet well quantified for heavy trucks. Some components like brake life clearly improve; others like power electronics might introduce new maintenance items. Gaps in data here mean models might either over or under-estimate OPEX savings. We consider this a high-priority area for data collection (through trials or sharing of maintenance logs from bus fleets which have analogous tech).
* **Infrastructure and Operational Constraints:** Many models assume charging fits neatly into existing schedules (charging overnight or during breaks). In practice, depot power limits or scheduling complexities can occur (e.g. if many trucks return at same time, staggering charging may be needed). These are operational considerations that pure TCO models don’t capture well. They might add intangible costs (like needing a smart charging software or adjusting dispatch timings). While hard to quantify, these are real-world integration issues. It’s a gap that might be addressed by broader “total cost of operation” analysis beyond ownership – including logistical costs. For now, one might note that “TCO assumes ideal charging scenarios; any required changes to operations are not monetized.”
* **Lack of Australian-specific Trials:** Currently, one gap is simply the scarcity of local trials providing empirical inputs. This will change, but initially our model will lean on overseas data. Differences in environment and usage mean overseas results may not fully translate. Bridging that gap quickly with local pilot programs (and feeding results back into models) will be important to refine the Australian TCO outlook.
* **Externality Quantification:** As discussed, most models don’t include health or noise benefits in dollars. For a holistic view, especially for government investment decisions, these should be considered. Right now, that’s a gap in most analyses. For example, a government might justify an EV truck incentive by the emissions reduction benefit. Our framework should at least list these benefits and point to how they might be valued (so policymakers can factor them outside of the direct fleet TCO).
* **Small Operators vs Large Operators:** TCO can differ if you’re a big fleet versus a small business. Large fleets might get bulk fuel discounts, have capital to invest in infrastructure, and can optimize usage (ensuring high km/year). A small trucking business might have capital constraints (needing financing, concerned about upfront cost) and lower utilization (maybe the truck isn’t running full-time). This could lead to very different TCO outcomes – an aspect not always explicitly separated in studies. In Australia, where a large portion of trucking businesses are small operators (98% are small or family businesses, as per EVC/ATA), this is crucial. Our model should allow different assumptions for utilization and financing to reflect that. It’s a gap if we only produce one answer without considering scale of operator.

To mitigate these gaps for the Australian model, we recommend: establish a data-sharing initiative with early adopters (perhaps via the Australian Trucking Association or Electric Vehicle Council) to get real cost data; keep the model flexible to update inputs; and clearly denote which assumptions have high uncertainty. Using conservative assumptions for uncertain inputs (err on side of making EV look a bit worse in those areas) can avoid over-promising. It’s better to underestimate benefits and then find the operator actually did better, than vice versa.

**Recommendations for an Australian TCO Modeling Framework**

Drawing on the global insights and Australian context discussed, we propose a framework for evaluating the TCO of electric trucks in Australia. This framework outlines key parameters, data inputs, and methodological steps that together form a tailored TCO model. The goal is to provide a tool that Australian fleet operators and policymakers can use to assess electrification decisions with confidence in the assumptions.

**1. Define Use-Case and Vehicle Parameters:** Start by specifying the scenario – e.g. **Truck type and duty cycle**. For each analysis, clearly define: vehicle category (e.g. 6x4 prime mover with 68 tonne GCW B-double, or a 10t rigid delivery truck), average payload, and typical operation (urban stop-start vs highway line-haul). From this, set the technical parameters: diesel fuel consumption (L/100km) and electric energy consumption (kWh/km) appropriate for that duty. Use Australian data or validated estimates (Table 2 provides guidance). Also set annual utilization (km/year) and planned ownership period for the analysis. Example: “**Interstate Line-Haul:** 600 km/day, 5 days/week, ~150,000 km/yr over 8 years, primarily highway driving, 50+ tonne gross.”

**2. Input Cost Parameters:** Gather the costs relevant to that use-case: vehicle purchase prices (diesel and EV), infrastructure cost if needed, fuel and electricity prices, maintenance rates, etc., using Australian values as per **Data Sources**. Ensure to include **road charges and any available incentives**. For instance, if analyzing a scenario in 2025, factor in the NSW government’s purchase incentive (if one exists by then) or assume none if not. Include **registration and insurance** if doing total operating cost – these often scale with vehicle weight and value. (In many TCO analyses, insurance is similar % of vehicle value for both, possibly slightly higher for EV if value higher). If the electric truck requires, say, a charger installation, add that capital cost here.

**3. Set Financial Assumptions:** Choose a **discount rate**3. Set Financial Assumptions:\*\* Choose a **discount rate** to represent the time value of money and financing costs. For Australia, a real discount rate in the range of 7–10% is typical for private sector analyses (for example, ICCT used 9.5% in Europe). If analyzing from a public policy perspective, a lower social discount (around 4–7%) might be used. Also decide on the **analysis period** (e.g. 8 or 10 years) and how to handle residual value. For a full-life analysis (say 10 years), include a salvage value for the truck at year 10 (using percentages from Table 2, e.g. 20% of original for diesel, possibly less for EV). If doing a first-owner period (e.g. 5 years), include the larger residual at that point. The model should be flexible to either include residual or assume the cost is fully amortized. Also set inflation or use real values consistently. For simplicity, conduct the analysis in **real terms (constant dollars)**, which means escalate none of the costs except where relative price changes are expected (like fuel vs electricity trends).

**4. Calculate TCO Cash Flows:** Construct a year-by-year cash flow for both the diesel and electric truck (and any other technology being compared, like hydrogen if desired). In Year 0, record the **initial costs**: purchase price (net of any subsidies) and infrastructure investment (for the EV). In each subsequent year up to the horizon, include **operating costs**: fuel or electricity cost ( = price \* annual consumption), **maintenance cost** (= rate per km \* km that year), and other costs (insurance, registration, oil/AdBlue for diesel, etc.). Deduct any **government incentives** allocated annually (for instance, some schemes might give annual grants or tax credits – currently Australia doesn’t have annual EV truck incentives, but if a scenario included something like reduced registration fees for EVs, that could be a slight annual saving). At the final year, add the **residual value** (as a positive cash flow for selling the asset). With these cash flows, compute the **Net Present Value (NPV)** for each vehicle type by discounting each year’s net cost back to present. Alternatively, convert to an **equivalent annual cost** or cost per km: for example, sum all discounted costs and then divide by total km to get A$/km, or use an annuity formula to spread NPV over years. Both approaches should yield the same relative comparison. Key metrics to compute and report include: **Total NPV cost** over period, **Average cost per year**, and **Cost per km**. These metrics can be tabulated for diesel vs electric. For clarity, one might also compute the **difference** (e.g. “Electric truck saves $X (NPV) over Y years compared to diesel” or “Electric costs $0.Y0 per km vs diesel $0.Z0 per km”). Additionally, if the electric has higher upfront cost but lower running cost, calculate the **payback period**: the year when cumulative costs of the EV equal cumulative costs of diesel. This can be done by looking at cumulative cash flow difference year by year.

**5. Compare and Interpret Results:** Present the outcomes for the chosen scenario. If multiple scenarios (use-cases) are modeled, compare their results side by side. For example, the model may show that for **urban delivery trucks**, the electric option already has a slight TCO advantage over 8 years (due to high fuel savings on relatively high km/year for a city truck), whereas for **interstate haulage**, the electric truck might remain a bit more expensive until battery prices drop or diesel prices rise further. In interpretation, highlight which costs drive the differences. Often, charts are helpful: e.g. a **stacked bar chart** of TCO components for diesel vs EV can visualize that the EV has higher capital cost but much lower “fuel” and maintenance costs. If including hydrogen fuel-cell or other tech, include them too for completeness, though focus on battery EV vs diesel for the primary analysis. Ensure to note any **Australian-specific policy impacts**: e.g. “Under current fuel tax credits, diesel fuel cost to operators is reduced, but EVs avoid paying any road user charge at present – this gives EV an edge of about X cents/km in tax advantage, which could change with future policy.” If applicable, compute **emissions** for each case (tonnes CO₂ per year) to illustrate environmental outcomes, even if not monetized in the base TCO.

**6. Conduct Sensitivity Analysis:** Identify the key inputs that the TCO results are most sensitive to, and test variations. Based on global studies and Australian context, critical variables include: **diesel price**, **electricity cost**, **annual km utilization**, **battery cost / EV purchase price**, **maintenance cost differential**, and **discount rate**. Perform one-at-a-time sensitivity (e.g. increase diesel price by 30% and see how TCO changes) or define alternative scenarios:

* *High Fuel Price Scenario:* Diesel $1.80/L (instead of $1.50) while electricity holds at base – likely makes EV more favorable.
* *Low Electricity / High Demand Charge Scenario:* Perhaps electricity average cost rises to $0.30/kWh (due to demand charges or daytime charging), narrowing the fuel cost savings.
* *Lower Utilization Scenario:* If the electric truck only runs 60,000 km/year (maybe a smaller operator or more downtime), does it still pay off? Lower utilization means fewer fuel savings to offset the upfront cost.
* *Battery Price Breakthrough:* Consider EV truck price drops faster (say battery $100/kWh immediately), how soon does parity occur?
* *No Maintenance Savings:* As a stress test, assume EV maintenance costs same as diesel (or only 10% lower) – see if TCO still holds up.
* *Policy Changes:* Introduce a hypothetical road user charge for EVs (e.g. 2¢/km from 2027 onward) or a carbon cost on diesel (e.g. add 20¢/L by 2030) to see their effects. For each sensitivity, record the new TCO outputs. This can be summarized in a **sensitivity table or tornado chart** that shows how much the diesel vs EV cost gap changes under each assumption change. The analysis should identify which factors are “make or break.” For instance, it might show that at diesel below $1.20/L, the diesel truck is always cheaper, but above $1.50/L the EV pulls ahead – indicating fuel price is a pivotal factor. Or it might show that if an EV can’t drive at least 80,000 km/year, it won’t pay off – indicating a need to allocate EVs to high-utilization routes first. Sensitivity analysis is crucial for addressing uncertainties and guiding **risk mitigation** (e.g. if electricity price volatility is a concern, maybe invest in solar or fixed-rate contracts).

**7. Incorporate Non-Financial Benefits (Optional Layer):** While the core model focuses on direct costs, it’s beneficial to add a supplementary analysis of **external benefits**. Using emissions data, calculate the **CO₂ emissions saved** by using an electric truck (taking into account Australia’s grid emissions factor) and perhaps the reduction in diesel particulate/NOx emissions. If possible, approximate the **social value**: e.g. “Each electric truck avoids ~X tonnes CO₂ and Y kg NOx annually, which corresponds to $Z in societal benefits if valued at $A per tonne CO₂ and health damage valuations for NOx.”. This can be a separate output to inform policy. We do not necessarily add it to the TCO from the fleet’s perspective, but it can be used to argue for incentives (i.e. the size of subsidy justified by external benefits). Also, note qualitative benefits such as noise reduction, which could allow operational changes like night deliveries, potentially improving productivity (though not quantified, fleet managers should be made aware). This section of the output ensures that even if the financial TCO is a close call, the **broader value proposition of electric trucks** is recognized. As one study noted, accounting for environmental benefits makes electric trucks about **30% lower cost** when societal perspective is considered.

**8. Address Data Gaps and Plan Updates:** Acknowledge where assumptions had to be made due to limited data (e.g. EV maintenance costs, residual value). For each such gap, the framework should identify how to improve over time – e.g. “Track performance of the NSW Electric Truck trial in 2024 to update maintenance cost estimates” or “Update battery price assumptions annually with BNEF reports or CSIRO projections.” By having this adaptive approach, the model remains relevant. The framework could even be delivered as an **interactive tool or spreadsheet** that allows users to plug in new values as industry knowledge grows. Encourage collaboration with organizations like the Australian Trucking Association, Electric Vehicle Council, or CSIRO to feed new data (like Survey of Motor Vehicle Use updates, or results from the iMOVE heavy vehicle project).

By following these steps, the resulting TCO model will be **comprehensive, transparent, and tailored to Australia’s conditions**. It will enable nuanced comparisons of electric vs diesel trucks, accounting for everything from purchase costs and energy prices to the vast distances of the outback and the nuances of local policy. Ultimately, this provides a solid foundation for decision-making: fleet owners can identify which use-cases make economic sense to electrify first, and policymakers can identify what levers (incentives, infrastructure support, regulatory changes) are needed to close any remaining TCO gaps and accelerate zero-emission truck uptake in Australia.

**Conclusion**

Electric trucks are poised to become increasingly competitive on a total cost of ownership basis, and global models consistently show a trend toward cost parity in many segments before 2030. Adapting these models to Australia requires careful consideration of local factors – **long distances, extreme climates, unique tax regimes, and energy markets – all of which influence costs.** This report has reviewed leading TCO models from around the world, compared their assumptions, and identified what adjustments are needed for Australian conditions. It has also outlined a recommended TCO framework for Australian electric trucks, specifying data sources, parameters, and methodological approaches to ensure robust analysis.

In summary, the key findings and recommendations are:

* **Global TCO Model Insights:** Battery-electric trucks already offer lower TCO than diesel in certain use cases (especially light/medium urban deliveries) and are expected to beat diesel across most truck segments in the next 5–10 years as battery costs decline. High diesel prices or carbon costs accelerate this trend. Fuel-cell trucks may compete later (mid-2030s) but will depend on very low hydrogen prices. These findings, largely from Europe and North America, set a optimistic outlook for electrification.
* **Australian Context Considerations:** Australia’s context modifies some of these conclusions – relatively cheap untaxed diesel (for now) and very long-range routes make heavy electric trucks slightly less competitive in the immediate term. However, Australia also has **cheap solar electricity potential** and a need to reduce reliance on imported diesel, which could favor EV economics. Policy changes like width and weight allowances are already reducing barriers. The recommended approach is to target early electrification where it makes most sense: high-utilization urban and regional freight, where range requirements are modest and fuel savings substantial. For long-haul, closely watch technology developments (battery energy density, megawatt charging, hydrogen fuel cell availability) and consider interim solutions such as battery swap or hybrid approaches until full electrification becomes viable.
* **Data and Model Framework:** We have identified sources for Australian data on vehicle usage (ABS, BITRE), costs (industry reports, EVC, etc.), and created a blueprint for an Australian TCO model. That model should be periodically updated as local data improves (e.g. results from the CSIRO/Swinburne heavy vehicle TCO project in 2024). Critical parameters like **battery cost trajectory, fuel and electricity prices, and maintenance costs** should be kept under review.
* **Policy and Non-Financial Impacts:** Non-financial benefits of electric trucks – lower emissions, less pollution and noise – are significant in Australia’s push for net-zero by 2050. While not directly in TCO, these bolster the case for public support. Indeed, when accounting for environmental and health savings, society’s effective cost of electric trucking is much lower. Policies such as purchase incentives, infrastructure grants, or road charge reforms could be justified by these external benefits and can bridge any remaining cost gap for operators.

The **recommended TCO framework for Australia** (summarized in the previous section) provides a comprehensive way to evaluate investments in truck electrification. By using this framework, Australian fleet operators can make fact-based decisions, and policymakers can design targeted measures to drive uptake. In doing so, Australia can overcome its unique challenges and leverage the global momentum and local renewable energy advantages to electrify its trucking sector in a cost-effective manner. The result will not only be financial savings over the vehicle life but also a cleaner, quieter, and more sustainable freight industry – delivering economic and social benefits well beyond the balance sheet.