Economic and Social Benefits of Electric Public Transport Vehicles

Battery Electric powered public transport vehicles reduce operational emissions. The energy source is cleaner and cheaper than oil. Even when the electricity comes from the dirtiest coal-dominated grid, electric vehicles (EVs) still produce less global warming pollution than their conventional counterparts, and with fewer exhaust emissions.

Electric Vehicles in Australia

Worldwide, the number of electric vehicles sold annually is growing at rate of 40% in recent years (2011 – 2017). Electric Vehicles in Australia make up 0.1% of total vehicle ownership. A breakdown of this is represented by 64% Fleet Owners, 34% Private Owners and mere 2% Government Owned. With two identified major Electric Vehicle Manufacturers established in Australia [Bustech, South Australia and Avass, Victoria – *Both Commercial Public Transport Manufacturing Sector*], there is a significant opportunity for Australian Government to lead Electric Vehicle uptake.

Electric vehicles and the energy sector - Impacts on Australia's future emissions

An increase in electric vehicle use will result in:

- lower CO_2 and air pollutant emissions from the road transport sector itself
- an overall net benefit in terms of lower emissions of carbon dioxide (CO_2) and the air pollutants nitrogen oxides (NOx) and particulate matter (PM)
- an overall increase in Sulphur Dioxide (SO_2) due to emissions from the electricity-generating sector
- higher emissions from associated electricity production [high volume manufacturing]

Alternative electricity generation or renewable power generation technology may need to be considered for the future in Australia to meet the extra energy demand arising from EV manufacturing. However, in Australia, Carbon capture and storage (CCS) a proven, safe technology is being used. High-efficiency, low emission (HELE) coal-fired power stations integrated with CCS can reduce emissions by up to 90%.

High shares of electric vehicles will require significant additional electricity generation which, in the absence of coordinated investment, may put stress on electricity infrastructure. Even between countries with a similar share of renewable energy, management strategies to accommodate the charging of many electric vehicles can be very different, depending on the types of renewable energy and conventional power generation in each country. In countries with highly fluctuating renewable energy supplies, coordinating the energy demand from electric vehicles may become a major challenge.

It is clear, for example, that countries with high solar energy generation capacity, for which the preferred charging peak will be during the day, will need to apply different grid and power management strategies from countries that have only wind, or combined solar and wind electricity production. In regions with a weak network infrastructure, additional grid reinforcement or implementation of specific “smart charging” approaches may be required to ensure an efficient and flexible electricity generation and distribution infrastructure.

Increasing the numbers of electric vehicles can significantly reduce direct emissions of CO_2 and air pollutants from road transport. However, these positive effects are partially offset by additional emissions caused by the additional electricity required and continued fossil fuel use in the power sector.

Overall, the avoided CO_2 emissions in the road transport sector outweigh the higher emissions from electricity generation. In Australia with high shares of coal fuelled power plants, electric vehicle demand in high volumes could, however, lead to higher CO_2 emissions. The environmental benefit of electric vehicles in these instances would therefore not be fully realised with current charging technology.

For air pollutants, an 80% share of electric vehicles in the next three decades will significantly reduce direct exhaust emissions of NOx, PM and SO_2 from road transport, for each pollutant by more than 80% in comparison with 2010 levels. However, as for CO_2, the overall reduction for NOx and PM will to some degree be offset by additional emissions coming from the electricity-generating sector — by 1% for NOx and 3% for PM10 (particulate matter with a diameter of 10 μm or less). The situation is different for SO_2. The w SO_2 emissions from road transport, coupled with the use of coal in power generation, will result in additional SO_2 emissions, which exceed the reduction made in the road transport sector by a factor of 5. Additional abatement of the higher SO_2 emissions would be required.

The difference in emissions of air pollutants from the road transport sector and electricity generation cannot be compared directly in terms of their respective impacts on human health. Their impact depends to a large degree on the location, intensity and type of emission sources. Emissions from road transport occur at ground level and generally in areas where people live and work, such as in cities and towns, so much of the population is exposed to them. In contrast, power stations are generally outside cities, in less populated areas. Because of this lower exposure, a shift of emissions from the road transport sector to the power generation sector can therefore be beneficial for health.

Australia’s High-efficiency, low emission (HELE) technology enables coal-fired power stations to operate at higher temperatures and pressures, delivering electricity more efficiently and reducing emissions by up to 40%.

Moving towards the future

A large share of electric vehicles on Australian roads in the future will have implications for the electricity generation and distribution infrastructure. Integrating the additional electricity demand poses diverse challenges. It is important that the road transport and energy sectors become more closely coupled, and that policy and investment decisions across both sectors are closely integrated.

Electric vehicles are just one way in which Australia can move towards a more resource efficient economy and decarbonised transport system. Replacing conventional vehicles with electric vehicles can help reduce emissions, although how much it helps depends significantly upon the source of the electricity used to charge vehicles (renewable, nuclear power or fossil fuel sources).

Emissions Associated with Electric Vehicle Charging

Generally, EVs are promoted as CO_2 neutral, which is true when considering very local area (e.g., a city centre), where there is no direct emission from the vehicle. In fact, the electricity that powers them must be generated in a power station, transmitted to a charging point and then it is fed into the battery. The amount of CO_2 emitted by the EVs is depended upon the technology used for power generation. The more fossil fuels are used in generation, the greater CO_2 emission. Also, when considering CO_2 emissions from EVs, power transmission and battery charging losses need to be considered.

Unlike carbon fuel storage, electric grid storage has virtually no real-time storage of energy. With coal fired power plants, each kWh generated, 0.95 kg CO_2 is emitted. Divided by 1.8 kms / kWh “fuel” economy of a Public Service Bus means that an EV will effectively emit 0.52 kg of CO_2 per kms driven. Carbon Fuel [Diesel] bus emits 9.07 kg CO_2 per litre. That, compared with average fuel economy of a Euro 6 standard diesel bus means 1.60 kg of CO_2 emitted per km driven.

According to recent studies, coal-fired power plants often operate below full capacity at night, so they are available to be dispatched in response to new night-time load, like electric vehicle charging.

Controlled Charging Policies

From an economic perspective, deploying the planned amount of EVs increases the variable generation costs of the power system by around 3.36–5.46%. Controlled charging strategies outperform uncontrolled charging strategies in terms of the generation costs, as they can shift EV charging from peak load hours to off-peak load hours. With the shift, EV charging can be fuelled by existing coal generation, and the clustering of the EV charging load with the peak load of the power system is avoided.

On average, the generation/fuelling cost of EVs is around 75% lower than with fossil fuel powered vehicles. Although the average fuelling costs of EVs might slightly vary depending on the differences between the coal price and fossil fuel price, it indeed sends a clear incentive for consumers as they can save substantially on fuel costs when using EVs instead of fossil fuel powered vehicles.

From an environmental perspective, deploying EVs increases the CO_2 emissions of the power system by around 2.74–3.74%. Specifically, with uncontrolled charging strategies, the CO_2 emission associated with EVs is around 172–174 g/km, which is 20% less than fossil fuel powered vehicles. Imposing controlled charging strategies increases the CO_2 emissions associated with EVs by around 31–35% than uncontrolled charging, which makes fossil fuel powered vehicles outperform EVs in such cases.

Policy makers should evaluate the performance of the charging strategies. Compared with uncontrolled charging, controlled charging will demonstrate absolute advantages in mitigating the peak load arising from EV charging and reducing generation costs and EV charging costs.

Summary

To have any kind of impact on the grid, good or bad, EVs must reach scale. Assuming adoption meets expectations, utility rate programs and energy management technologies stand to play a significant role in shifting the EV load to other, grid-beneficial hours. With adequate demand-side planning and active load management, greater EV adoption could prove to be a significant supporting mechanism for overall grid stability.

Enhanced technologies in batteries and management systems (such as Avass technology) coupled with efficient grid connected charging platforms can reduce cycle losses and smart grid controlling.

Electric vehicles are now more efficient, traveling further on less power. Even if carbon emissions were equal between driving a typical internal combustion engine vehicle and charging an electric vehicle using power from a fossil fuel plant, there could still be an overall health benefit from driving an EV. The emissions emitted by tailpipes and power plants contain more than just carbon dioxide. There's also ozone, particulate matter and carbon monoxide.

These emissions are identified as criteria air pollutants (CAP) which cause asthma, respiratory disease, heart disease in individuals. Minimising people's exposure to these emissions improves health as well as confining CAP emissions to power plants, most of which are located farther away from where people live.

When analysing differences in of Electric Public Transport Vehicles and fossil fuel powered Vehicles, both operational costs and initial investment comparison undoubtedly has higher initial capital outlay involved when electric energy is being added/used. However, operational costs, including energy costs, show opposite picture, especially with large annual distances covered – electrical energy is substantially cheaper. Initial investments of changing public transportation fleet to electric buses and the costs of battery replacement still outweighs the monetary advantages gained from lower operational costs and additional environmental benefits with rapid returns on investment (ROI).

Government incentives with policies encouraging uptake of electric vehicles and subsidies for infrastructure can significantly contribute to consideration for future EV network of consumers and owners.

Equally important, Australian Government, at State and Local levels must support Australian Based Manufacturers creating jobs and wider community benefits with procurement.

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