Electric Vehicle Standards in Australia

A scoping study

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# Electric Vehicle Standards in Australia – A Scoping Study

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Executive summary

About this paper

At a meeting on 12 September 2008, the Council of Australian Federation (CAF) asked the Victorian Government to investigate the extent to which Australian standards will need to be developed to support the introduction of electric vehicles on Australian Roads. The Victorian Government subsequently commissioned Standards Australia (working in partnership with Rare Consulting Pty Ltd) to undertake a scoping study to provide advice on the development of Australian standards for electric vehicle operation.

This paper discusses the key findings of the scoping study and concludes by providing some comments on the timing and priorities of standards development of electric vehicles in Australia.

Guiding strategic insights

The findings presented in this paper were developed from a series of strategic insights derived from an investigation into the likely nature of the electric vehicles market in Australia. These insights can be summarised as follows:

∼ There is currently a lack of industry consensus with respect to the likely development (nature and timing) of the electric vehicle market in Australia

∼ The industry is characterised by a high level of technology dynamism, suggesting that performance-based standards should be pursued in the first instance (as opposed to prescriptive technology standards)

∼ Small numbers of electric and plug-in hybrid vehicles (PHEV’s) are expected to be in operation by the end of 2010 and are likely to be available as niche market offerings in the early years of market development

∼ The high cost of new OEM electric vehicles will likely create a market demand for aftermarket vehicles in the short to medium term

∼ The GHG performance (Scope 1 and Scope 2 emissions) of electric vehicles relative to conventional petrol vehicles will vary according to the GHG intensity of the electricity supplied to the vehicle

∼ The provision of feed-in capability (i.e. vehicle to grid transfer of electricity) for recharging infrastructure may create challenges and opportunities for the operation of the national electricity grid

∼ The operation of home-based recharging infrastructure may create some challenges, most notably associated with the operation of level II recharge systems if these become common

∼ The global nature of the electric vehicle industry highlights the need to harmonise Australian vehicle standards with international vehicle standards

∼ Electric vehicles will introduce a new and unfamiliar operating paradigm for road users, the vehicle repair industry, and rescue authorities

∼ Development of the electric vehicle market is likely to occur in three distinct stages, albeit that likely timing of these stages is subject to a degree of conjecture.

Scope of future standards development for electric vehicles in Australia

The discussion presented in this paper identifies five interrelated work streams (incorporating 17 work items) for the development of Australian standards to support the introduction of electric vehicles in Australia. It is suggested that this framework, as summarised in Figure A, could be used to guide future work in this area.
Figure 4
Summary of potential areas for investigation of Australian standards for introduction of electric vehicles
Three priority areas for standards development

Three main areas of high priority were identified following consideration of the likely nature of the early development of the Australian electric vehicles market. A brief discussion of each of these priority areas is provided below:

1. Development of standards for aftermarket conversions.

   Given that small numbers of aftermarket vehicles are already being sold into the Australian passenger car market, there is an urgent need to develop a series of standards that ensure these vehicles deliver the same level of safety as OEM vehicles in terms of:
   - crash protection
   - electrical protection
   - overall vehicle operation and electrical system durability.

   These standards would ideally be developed in the same manner as previously undertaken in respect of LPG conversions in Australia and would largely take account of the quality of the installation.

2. Development of standards for Level 2 recharging

   The study identified an immediate need to develop standards relating to the design of vehicle recharging systems to ensure technology interoperability and successfully manage the inherent risks associated with the future operation of the national electricity grid. Given this observation, it is strongly suggested that there is a need to develop specific standards in relation to the:
   - standardisation of plugs, cords and sockets to be used for vehicle recharging;
   - development of standards governing the design and installation of Level 2 home-based charging systems.

3. Standards relating to the provision of vehicle user and GHG information

   Electric vehicles constitute a new and relatively unfamiliar operating paradigm for road transport in Australia. The adoption of this paradigm creates considerable challenges in respect to the management of the inherent risks of electric vehicle operation for vehicle users, the vehicle repair industry, road rescue authorities and the community at large.

   Market unfamiliarity with this technology also means that consumers are not aware of how to discern the real-world benefits of electric vehicles and conventional vehicles in terms of emissions performance and energy efficiency (i.e. fuel efficiency versus electrical efficiency). As a consequence, there is a need to develop standardised consumer information in the form of:
   - Minimum consumer information in vehicle handbook and at point-of-charge
   - vehicle labelling and labelling of high voltage components
   - standardised information of relative energy efficiency and GHG performance.

Maintenance of a comprehensive stakeholder dialogue

A major and somewhat unexpected finding from this study related to the complete absence of a national industry dialogue addressing the key issues associated with the introduction of electric vehicles in Australia. In providing feedback to the national tele-workshops conducted on 27 August 2009, a number of stakeholders commented on the need to continue the national dialogue that had been initiated by this project.
Study recommendations

The following recommendations are made in respect of the need to develop Australian standards to support the introduction of electric vehicles in Australia.

1. That a rolling work programme be established for the progressive development of Australian standards in the areas of:
   a. vehicle design (OEM and aftermarket vehicles)
   b. power systems
   c. vehicle recharging
   d. rescue, repair and vehicle recovery
   e. user information and GHG assessment.

2. That priority be given to the immediate development of Australian standards for electric vehicle operation in respect of:
   a. the design of aftermarket electric vehicles
   b. the design and operation of Level 2 recharging systems
   c. the standardisation of user and GHG information relating to electric vehicles sold in Australia.

3. That a national Electric Vehicle Working Group be formed to oversee the national standards development programme, largely comprising the stakeholders that participated in the consultation conducted for this study.

4. That a state-to-state working group be established to investigate opportunities for coordination in respect of (a) regulating/approving after-market conversions, and (b) adoption of consistent approaches to vehicle identification of electric vehicles.
1 About this paper

Growing community concern about the global supply outlook for conventional transport fuels and the growing contribution of road transport to greenhouse gas (GHG) emissions has generated significant interest in the real world application of alternative fuels and alternative drivetrain technologies. Within this context, electric powered vehicles are increasingly being promoted as a strategy for (a) reducing societal dependence on conventional transport fuels, and (b) reducing GHG emissions from the global passenger car fleet.

Analysis of this opportunity reveals that a number of global car manufacturers plan to release a small number of electric vehicles into the global market place from mid-2010. In addition, a number of innovative technology companies are working to develop comprehensive recharging solutions ranging from commercial home-based charging products to commercial vehicle recharging stations.

As with any new product or technology, the introduction of electric vehicles into wider society will require careful consideration of the need to successfully manage related public safety issues and consumer protection issues. In the case of new vehicles, these two objectives have been traditionally managed via a combination of national regulations (in the form of Australian Design Rules), related consumer legislation, and industry standards. The very nature of electric vehicles, however, suggests that there will be a need to look beyond traditional vehicle standards to consider issues relating to the design of electric vehicle components and vehicle recharging infrastructure.

At a meeting on 12 September 2008, the Council of Australian Federation (CAF) asked the Victorian Government to investigate the extent to which Australian standards will need to be developed to support the introduction of electric vehicles on Australian Roads. The Victorian Government subsequently commissioned Standards Australia (working in partnership with Rare Consulting Pty Ltd) to undertake a scoping study to provide advice on the development of Australian standards for electric vehicle operation.

In conducting this study, Standards Australia recognised that any discussion about the need for Australian standards had to be constructed from a base-level appreciation of the current nature and future development of the Australian electric vehicles market. To this end, the study was accommodated to provide the Victorian Government (and CAF) with:

- a high-level appreciation of the current state of play of electric vehicle technologies in the Australian market place relative to key national priorities relating to energy independence, greenhouse emissions and enhanced automotive industry competitiveness (10% of study effort);
- an understanding of the key challenges and market barriers associated with the take-up of electric vehicle technologies in the Australian light vehicle market (20% of study effort);
- an understanding of the potential role of standards in supporting the early delivery of electric vehicle technologies in Australia (70% study effort).

This paper discusses the key findings of the scoping study and concludes by providing some comments on the timing and priorities of standards development of electric vehicles in Australia.

It should be noted that, in addition to the development of specific standards for vehicle operation and recharging, the introduction of electric vehicles may require changes to both existing vehicle regulations and the operation of the national electricity market. These aspects were deemed to be outside the scope of this study and are not discussed in this paper.

2 Study methodology

This study involved the completion of three discrete but interrelated pieces of work. A brief discussion of each of these work tasks is provided in the following subsections.

2.1 Literature scan (Task 1)

The first task involved a review of national and international literature relating to electric vehicles and electric vehicle standards. The purpose of this review was two-fold. The first objective was to develop a series of strategic insights about the current nature of the electric vehicles market in Australia and the likely challenges that will be
encountered in the increased market adoption of electric vehicles in the future. The findings of this work were used to guide the design of the stakeholder consultation process (Section 2.2) and develop an appreciation of the likely timing and nature of the Australian electric vehicles market.

The second objective was to understand the nature and extent of existing international standards relating to the design and operation of electric vehicles around the world. The key outcomes of this work (Appendix 1) were used to identify the degree to which Australia will need to develop new standards for electric vehicles, as opposed to the adaptation of existing international standards.

2.2 Stakeholder discussions (Task 2)

The second task involved conducting a series of interviews with key stakeholders in the Australian electric vehicle industry.

It was first necessary to compile a list of primary stakeholders in the development of the Australian electric vehicles market. These stakeholders were identified via a series of preliminary discussions with organisations and individuals that had been publicly associated with the national electric vehicles agenda. These discussions led to the identification of additional stakeholders (not publicly associated with the agenda) who had a genuine stake in the introduction of electric vehicles in Australia.

Seven core groups of stakeholders were identified (Figure 1). These stakeholder groups included:

- ELECTRIC VEHICLE MANUFACTURERS (INCORPORATING BATTERY MANUFACTURERS). This group will sell and maintain electric vehicles to the Australian motoring public, and includes domestic and international vehicle manufacturers.
- ENERGY NETWORK OPERATORS. These operators have a key stake in ensuring that electric vehicles do not affect the safe and efficient supply of electricity to the Australian community.
- AFTERMARKET CONVERSION INDUSTRY. A new group of organisations who will be involved in the conversion of existing conventional vehicles to electric vehicle operation.
- GOVERNMENT AGENCIES. A number of state and federal government agencies are likely to have a direct stake in the introduction of electric vehicles in Australia. These include the federal Department of Transport, state registration authorities, environmental agencies and industry development agencies.
- VEHICLE REPAIR AND RECOVERY INDUSTRY. This group comprises a group of diverse organisations ranging from vehicle repair workshops to roadside assistance organisations and accident rescue authorities.
- VEHICLE CONSUMER ORGANISATIONS. These groups play a prime role in ensuring that the purchasers of electric vehicles are protected in the face of new technology delivery.
- SPECIALIST ASSOCIATIONS (AND INDIVIDUALS). This group comprises industry enthusiasts, industry bodies, and the scientific and academic community who are working to deliver improved technologies.

In-depth interviews of 30–60 minutes duration were conducted with stakeholders in each of the seven stakeholder groups during July and August. A full listing of the individuals and organisations who participated in this process is provided in Appendix 2.

The key findings of the consultative process were then combined with the key findings of the literature scan to prepare a workshop presentation that detailed the draft study findings. This presentation was subsequently discussed during two separate tele-workshops held on 27 August 2009. The objective of these workshops was to validate the stakeholder input that had been collected to date and ‘disaster check’ key study findings. Feedback from these workshops was used to refine the draft study findings with a view to preparation of the final report.

2.3 Synthesis of findings (Task 3)

The third and final task involved the synthesis of all information to produce a framework for the development and/or adaptation of standards for electric vehicle operation in Australia. The aim of this task was to provide the reader with guidance in respect of:
∼ specific areas where standards will be required;
∼ the degree to which these standards can be harmonised with existing international standards versus areas where specific Australian standards will need to be developed;
∼ suggested timing (and priority) of individual standards development based on an assessment of the degree to which the development of specific standards will need to be timed with key stages in the evolution of the Australian electric vehicles market;
∼ possible strategies for engaging stakeholders in standards development (and broader market development dialogue) in the short to medium term.

This task concludes with the assembly of a strategic framework for the coordination of all work considered necessary in respect of developing Australian standards for electric vehicle operation.

Figure 1
Key stakeholders in the development of electric vehicles in Australia
3 The electric vehicle market in Australia

3.1 Overview

For the purposes of this paper, an electric vehicle refers to a vehicle that is entirely powered by an electric drivetrain or a vehicle that is powered by a series hybrid electric drivetrain that needs to be plugged into the electricity grid for battery recharging.

An electric car uses electric motors and motor controllers in place of an internal combustion engine. Generally, the energy for the motor is stored chemically in battery packs (e.g. lithium-ion battery) that are located on board the vehicle. These batteries are then charged at the home, at the workplace, or via publicly accessible recharge stations.

In a plug-in hybrid electric vehicle (PHEV), the drive wheels are powered by an electric motor. A smaller petrol engine is fitted to the vehicle to generate power for the electric motor. The on-board batteries can also be charged by plugging the vehicle into the electricity grid.

In addition to charging from the electricity grid, most fully-electric vehicle and PHEVs take advantage of regenerative braking systems that charge the on-board batteries.

A key challenge associated with the widespread market acceptance of fully-electric vehicles is the current high cost of this technology relative to conventional vehicles, and limited operating ranges between vehicle recharging. This issue is being progressively addressed by significant investment in battery technology and battery management systems with a view to extending the operating range of these vehicles in the future.

The electric vehicle market in Australia is at the embryonic stage, with only a handful of electric vehicles currently in operation around the country. Vehicle recharging is currently constrained to charging via standard general power outlets (i.e. GPOs). The future shape of the market is therefore likely to be defined by the future availability of electric and PHEV vehicles and the nature of future vehicle recharging systems.

3.2 Vehicle range and availability

A limited but increasing range of electric vehicles is becoming available in various parts of the world. These vehicles predominantly target the niche ‘micro car’ and ‘high-value eco conscious’ segments of the global passenger car market.

An increasing number of electric ‘micro car’ products are becoming available on the global vehicle market with suggestions that a number of these vehicles are likely to become available in Australia in the near future. A brief overview of some of the electric and PHEVs that are likely to become available in Australia in the near future is provided below.

∼ MITSUBISHI iMIEV (FULLY ELECTRIC). This four-dour ‘micro car’, will be powered by lithium-ion batteries and is being advertised as having an operating range of up to 160 km between recharges. The vehicle will accommodate recharging via home-based ‘trickle-charging’ systems together with provision for faster charging via public recharging stations. The vehicle has been predominantly developed for the Japanese car market, but a limited number are likely to be made available for sale in Australia by mid-2010 (http://www.mitsubishi-motors.com.au/microsites/imiev.aspx).

∼ GM VOLT (PHEV). General Motors launched the GM Volt concept car at the 2007 New York Motor Show and plans to launch the vehicle in North America in mid-2010 (http://gm-volt.com). This two-door plug-in series hybrid vehicle is being marketed as the ‘Prius Buster’ with an operating range of more than 600 km on a single tank of fuel (around 38 litres). General Motors has indicated that a right-hand version of this vehicle is likely to become available in Australia in mid-2012.

∼ NISSAN LEAF (FULLY ELECTRIC). Nissan plans to release a small fully-electric four-door sedan to the Japanese market in 2010. An Australian version is likely to be made available to the Australian market in 2012. The vehicle will be powered by lithium-ion batteries and is expected to have a design operating range of around 160 km between vehicle recharging (http://www.nissan.com.au/webpages/about/Electric_vehicles.html).
~ **TOYOTA PRIUS (PHEV)**. Toyota is understood to be working towards the release of a plug-in variant of the third generation parallel hybrid electric vehicle. This vehicle will utilise a lithium-ion power pack in place of the current nickel metal hydride batteries used in the latest generation vehicle. Details on likely market availability are somewhat sketchy, but it is understood that Toyota is hoping to make this vehicle available in the Japanese and North American markets in 2010 (http://www.popularmechanics.com/automotive/new_cars/4227944.html). A small number of prototypes of this vehicle are already in operation, including one being operated by the NSW Department of the Environment and Climate Change in Sydney.

~ **BLADE ELECTRON (FULLY ELECTRIC)**. Blade EV is an Australian start-up company that provides conversion kits for the Hyundai Getz. This technology utilises lithium-ion battery technology and regenerative braking systems to produce an Australian Design Rules compliant Australian vehicle with an operating range of up to 120 km between recharges. Vehicle recharging is via the standard GPO and the total cost of the vehicle is in the order of AUD$46,000 (http://www.bev.com.au/). A small number of these vehicles have been purchased by Australian local government organisations including Melbourne City Council and Melton, Moorabool and Nillumbik Shire Councils.

~ **ENERGETIQUE evME (FULLY ELECTRIC)**. Another Australian start-up company, Energetique markets a full electric conversion of a Mazda 2. This fully-electric concept vehicle utilises lithium polymer battery technology and is reported to have an operating range of approximately 200 km (http://evme.com.au).

In addition to the above vehicles, there are a number of other electric vehicles either being sold in the global market now, or likely to be released in the near future. The future availability of these vehicles was unknown at the time of writing this report, but a brief description of these vehicles is provided below for completeness:

~ **SUBARU R1e (PHEV)**. Subaru America is currently undertaking an evaluation of its R1e fully-electric vehicle in partnership with the New York Power Authority. The R1e is a variant of the original R1 production car that was solely developed for (and subsequently released to) the Japanese car market in 2006 (http://www.subaru.com.au/about-subaru/subaru-and-the-environment/electric-vehicles). The vehicle utilises lithium-ion batteries and has an average operating range of around 80 km between charges. Subaru has not made any firm commitment with respect to the supply of these vehicles outside the Japanese and North American markets at this stage.

~ **RENAULT KANGO AND FLUENCE (FULLY-ELECTRIC VEHICLES)**. Renault has teamed up with Nissan to produce the world’s first mass produced electric vehicle – the Fluence family sedan. The partnership will also see the provision of the Kangoo – a fully-electric light commercial vehicle (http://www.renault.com). Both of these vehicles are being developed for release in Israel in 2010 and later in Denmark. There are currently no plans to make these vehicles available in Australia; however, Better Place – one of the partners in the Israeli project – is actively working to engage Australian government agencies in the electric vehicles agenda.

~ **TESLA ROADSTER**. This vehicle is a fully-electric sports car which is in production in the United States of America and retails for around US$109,000 (http://money.cnn.com/galleries/2008/autos/0806). The vehicle utilises lithium-ion batteries, has a top speed of 200 km per hour and an operating range of around 330 km between recharges.

~ **VOLVO RECHARGE (CONCEPT PHEV)**. This vehicle is a variant of the Volvo C30 and combines wheel hub motor technology with a series hybrid electric powertrain and a flexifuel 1.6 litre combustion engine (http://www.conceptcarz.com/vehicle/z14099/2008-Volvo-ReCharge-Concept.aspx). The concept vehicle has a battery-only operating range of approximately 160 km and was officially launched at the 2009 Frankfurt Motor Show.

~ **MINI QED (CONCEPT PHEV)**. Developed by British Company PML, the Mini QED is an aftermarket conversion of the BMW Mini One that utilises four wheel hub motors powered by a combination of lithium-ion batteries and a bank of ultra-capacitors (http://www.worldcarfans.com/10607246585/pml-builds-640hp-electric-mini). This vehicle is still at the pre-production level and will likely be marketed as a high performance eco vehicle that is similar to the Tesla.
∼ **CHRYSLER GEM (FULLY ELECTRIC).** This vehicle has a similar dimension to an electric golf buggy. The vehicle utilises nickel metal hydride batteries and is solely marketed in North America as a low-speed vehicle that can only be driven on roads with a sign posted speed limit of less than 60 kph. The principal benefit of this vehicle is its cost, at less than US $13,000 (http://www.gemcar.com).

∼ **ZENN (FULLY ELECTRIC).** Another limited use vehicle that is constrained to low-speed urban road networks, this fully-electric vehicle is manufactured by a Canadian start-up company and is being sold in small volumes throughout North America (http://www.zenncars.com). The vehicle uses lead acid batteries, is relatively cheap at around US$16,000, and has an operating range of around 60 km between recharges.

### 3.3 Vehicle recharging systems

Analysis of vehicle recharging systems revealed that there are three forms of vehicle recharging that can be utilised for electric vehicles. A brief description of these recharging ‘levels’ is provided below.

#### 3.3.1 Level I – Trickle charging (average 8 hours recharge time)

Trickle charging is the simplest (but slowest) form of vehicle recharging and typically involves voltages of around 220–240 volts and transfer rates in the order of 10 amps. This form of charging is generally suited to all forms of battery technology being sold into the electric vehicles market.

As the name implies, this form of recharging involves the passive transfer (or trickle) of electricity from the grid to the vehicle via a standard GPO at the home or workplace. The process is relatively ‘low-tech’ in comparison with other forms of recharging but the lower transfer rate means that this form of vehicle recharging is also the safest.

This type of vehicle recharging operates on a draw-down basis only – no provision is made for the return of electricity (or feed-in) from the vehicle to the electricity grid.

Given that this form of recharging involves only the use of standard GPO outlets and relatively low levels of draw-down, Australia appears to be relatively well placed to support this level of vehicle recharging in the first instance. As the number of electric vehicles in the market increases, there may be a need to consider the impact of vehicle recharging on the safe and efficient operation of the national electricity grid.

Victoria is replacing all its electricity meters with ‘smart’ interval meters that have two way communication to facilitate intelligent ‘time shifting’ charging and vehicle to grid power transfer. The other States of Australia have commenced discussions to consider a national roll out of smart meters. Unless the growth of EVs is high, smart grid developments over the next five years should facilitate large quantities of EVs in the future.

#### 3.3.2 Level II – Standard charging (average 3–4 hours recharge time)

A number of industry stakeholders suggest that consumer demand for faster charging rates will inevitably drive a consumer demand for higher levels of vehicle charging. With this in mind, Level II ‘standard charging’ is considered to be the natural step beyond ‘trickle charging’ systems. This form of charging typically involves voltages of around 220–240 volts and transfer rates of 30–80 amps and is generally suited to all forms of batteries - although the application of high transfer rates for some technologies can theoretically create heat/fire risks.

At the lower transfer rates (i.e. 30amps), vehicle recharging can be conducted via the upgrade of the standard GPO. At higher rates (i.e. 60-80amps) it will likely be necessary for the homeowner to upgrade to three phase power circuits and install specialised recharging hardware (if not already provided with the vehicle).

At these higher transfer rates, some recharging systems can be used to feed in electricity from the vehicle to the electricity grid and/or provide the electricity utility load control of the charging point (i.e. ability to discontinue the supply of electricity during peak periods of network demand).

Level II recharging will likely create a series of challenges in respect of (a) the safety of residential circuits in Australian homes and (b) efficient management of load demand for energy network operators, particularly during existing peak periods of demand.
3.3.3 Level III – Fast charging (average 30 minutes recharge time)

At voltages of around 400 volts and transfer rates of up to 600 amps, fast-charging theoretically provides the most rapid and user-convenient solution for recharging electric vehicles. The development of this technology is still in its infancy and there appears to be considerable debate about the safety and practicality of using this form of recharging for some battery technologies.

In addition it is yet to be seen if battery manufacturers will accept fast charging as not damaging the batteries. If driven continuously most EVs will fully discharge in 1.5 hours, so it is possible that this may be the maximum charging speed some manufacturers will allow.

This form of recharging, however, cannot be practically accommodated by residential circuits, nor can it be readily accommodated at the workplace or via on-street charging facilities. Essentially, this form of recharging requires the provision of dedicated high-current recharging hardware that is fed by industrial level circuitry, most likely provided at commercial recharging stations.

The high current demands of these recharging systems dictate the need for sophisticated management of the upstream interface to support load control of the recharging point by the electricity network operator.

The analysis completed for this study suggests that the high cost of providing these stations and the significant demands of this form of recharging on the Australian electricity grid is likely to result in this form of recharging being viable in the long term only – if at all.

3.4 Battery swap

An option that is being promoted as an alternative to fast charging is the concept of rapid battery change-out or battery swap. This concept works in the same way as changing LPG cylinders, with electric vehicle owners driving into a battery swap station and having their expired batteries replaced with fully charged ones.

The concept is novel and attractive in terms of its apparent simplicity. The Better Place Consortium is understood to be working to implement this concept in a number of countries simultaneously, with trials of the concept being planned for 2010/2011 prior to larger scale roll outs planned for 2012. It is envisaged that fully operational swap stations would be used for the occasional long distance trips if electric vehicles are to be developed as a practical substitute for conventional vehicle technologies.

4 Key strategic insights

Analysis of the findings of the literature review and stakeholder discussions gave rise to a series of key considerations that helped identify the potential future role of Standards Australia in supporting the introduction of electric vehicles in Australia.

A brief discussion of these strategic considerations (or insights) is presented in the following subsections.

4.1 Lack of industry consensus with respect to the nature and timing of the electric vehicle market in Australia

The stakeholder consultations revealed two contrasting industry positions in respect of the likely development of the electric vehicle market in Australia. On the one hand, some stakeholders believe that the market will likely remain in its infancy for more than a decade owing to the combined effect of the high relative price of electric vehicles, practical limitations on vehicle range and recharging time, and the high carbon intensity of Australian electricity generation.

Other stakeholders advanced a view that suggested current high levels of industry investment in electric vehicle technology and likely future government assistance in the establishment of electric recharging infrastructure would result in the mainstreaming of this technology within a decade.

Resolution of these differences was considered to be outside the scope of this study, but the contrasting views highlighted the need for the adoption of a market-responsive stance to the development of national standards for electric vehicle operation in Australia.
4.2 High level of industry dynamism

Analysis of the nature of the current electric vehicle industry reveals a high degree of dynamism with respect to the design and operation of vehicle batteries, battery management systems, and related vehicle componentry. This dynamism will be a key characteristic of the continued development of the industry as vehicle providers strive to provide electric vehicle solutions that compete with conventional vehicles in terms of price and operational performance.

Given the changing nature of this industry, there will be a need to adopt a performance-based approach to standards development rather than develop prescriptive technical standards.

4.3 Small numbers of electric vehicles will be in operation by the end of 2010

At the time of writing this report, a handful of electric vehicles were already in operation. These vehicles included a PHEV Toyota Prius concept vehicle owned by the NSW Department of Environment and Climate Change, three PHEV Prius owned by SPAusNet in Melbourne, and a number of Blade Electron vehicles being operated by a number of Victorian local government organisations. In addition, it was understood that a small number of cottage electric vehicle conversions were owned and operated by private individuals.

Mitsubishi Motor Corporation plans to introduce a small number of iMIEV fully-electric vehicles for sale to government and corporate organisations in mid to late 2010. Other OEM manufacturers are expected to make small numbers of electric vehicles available in Australia by 2012, including the GM Volt (PHEV) and Nissan Leaf (fully electric).

This observation suggests that the Australian market is unlikely to have large numbers of these vehicles in the short term, providing a window of opportunity for the careful consideration of the standards required for the widespread market take-up of this technology in the medium to long term.

The majority of OEM manufacturers indicated that new electric vehicles were only likely to be produced in small volumes in the near future, with most of this production targeted for sale in niche segments of the Japanese and North American markets.

Analysis of the characteristics of these vehicle offerings reveals that they will be marketed as micro passenger cars and/or higher performance eco sports vehicles. The high cost of these OEM vehicles – relative to equivalent sized conventional vehicles – suggests that potential buyers of electric vehicles in Australia will likely be confined to government organisations, eco-conscious corporations, and high-wealth urban households.

4.4 The high cost of new vehicles in the first instance will likely create a ready market for aftermarket vehicles in the early years of introduction

Discussions with potential OEM vehicle providers for the Australian electric vehicle market indicate that electric vehicles are likely to be considerably more expensive than equivalent conventional vehicles – at least in the early years of introduction. For vehicles travelling high annual kilometres, however, the much lower cost of electricity will likely offset the higher vehicle cost.

Better Place, for example, expects to provide an electric vehicle solution that delivers whole-of-life costs that are similar to that of a conventional vehicle travelling 30,000km per year (As the cost of battery technology comes down, the relative costs of an electric vehicle are also likely to decrease).

The high initial cost of electric vehicles, combined with the increasing availability of cheaper electric vehicle conversion systems from countries like China, suggests that early consumer demand for electric vehicles may create a new market opportunity for aftermarket conversions.

On the face of it, after-market conversions must comply with all relevant ADR’s – as applied at the date of manufacture of the vehicle concerned. Compliance with this requirement is enforced by State and Territory Motor Registration Authorities.

Current after-market convertors of electric vehicles are relatively small in number and at least one of these companies has recently subjected their vehicles to the same crash tests as apply to conventional vehicles.

A ‘grey area’ exists, however, with respect to the possible emergence of smaller ‘electric vehicle conversion companies’ (e.g. mechanics workshops). In addition, the conversion of older vehicles to electric vehicle operation...
is expected to raise issues that were not covered by the standards that applied to these vehicles at the time of their original manufacture (e.g. electrical system integrity).

Given this observation, there is likely to be an immediate need for the development of standards and/or regulations that ensure these vehicles afford the same level of occupant safety and public safety as OEM delivered vehicles – without unduly constraining the emergence of this new industry in the future.

4.5 Greenhouse performance will depend upon GHG intensity of electricity

Electric vehicle technology is often referred to as ‘zero emissions technology’. While the air quality benefits are excellent at the point of use of the energy (at the car), the zero emissions description is misleading. The air quality and life cycle greenhouse emissions from fully-electric vehicles are heavily influenced by the electricity generation technology. Vehicle batteries charged from coal-derived electricity would have an emissions footprint that is definitely not zero, and far larger than if they were charged from solar, wind or some combination of renewables.

Proponents of the electric car indicate that fuelling the world’s 700 million cars with renewable electricity would bring about a 10% reduction in carbon dioxide emissions (Better Place 2008). Potential emission reductions in Australia however need to be viewed with considerable caution given that the benefits of nil tailpipe carbon dioxide and particulate emissions from electric vehicles can potentially be outweighed by emissions arising from the generation of the electricity. Given Australia’s heavy dependence on coal for electricity generation, the carbon dioxide emissions intensity of Australia’s electricity production is significantly higher than the world average (Figure 2), and poses both challenges and opportunities to the shift to electric vehicles.

![Figure 2](source: IEA (2007))

**Figure 2**

**Carbon dioxide emissions intensity of electricity production (2005)**

The average increase in life cycle emissions that results from the use of electricity as fuel in Australia poses short-term challenges (Figure 3). Specifically, the Garnaut Review modelling shows that based on the average emissions intensity of the Australian grids, an electric car today would generate about 30% more emissions than a similar petrol-fuelled car (Garnaut 2008). The increase would be even higher (at 6%) if the car drew its power from the coal-dependent supplies of Victoria.

However, to illustrate the importance of the electricity source, and the opportunity for long-term emissions reductions, the modelling also indicates that drawing on the power supplies of Tasmania (predominantly hydroelectricity) an electric car would generate about 85% fewer emissions than the equivalent petrol car (Garnaut 2008).

This effective tying of a segment of transport emissions to the stationary energy sector presents a dual emissions reduction opportunity, with the decarbonising of the power generators also decarbonising the transport sector.
The above analysis reveals that the quantum of indirect emissions (i.e. scope 2) of an electric vehicle can exceed the direct (scope 1) and indirect emissions of a conventional petrol-powered vehicle, depending on the source of the electrical energy used in the vehicle operation. As a result, there is a need to ensure that this factor is duly recognised in the consumer marketing of these vehicles in the future.

![Electric passenger car emissions relative to conventional petrol-fuelled](image)

**Figure 3**
Carbon dioxide emissions of an electric passenger car relative to an equivalent petrol-fuelled car

4.6 There may be challenges associated with feed-in recharging systems

Advocates of electric vehicles suggest that these vehicles can be used as a secondary source of electrical energy during peak periods of load demand by reversing the flow of electrical energy when the vehicle is plugged into a charge point. For this operation to occur in practice, the vehicle charging infrastructure must be equipped with a feed-in mechanism (or inverter) similar to that used today with roof-top solar PV panels.

Commercial offerings of feed-in capable recharging infrastructure are already available in the global market and some electric vehicle manufacturers are understood to be planning to provide this functionality as part of the vehicle recharging system supplied with the vehicle.

Despite the apparent ready availability of feed-in capable vehicle recharging systems, the practical application of vehicle feed-in may bring challenges. These include:

~ the need to ensure that electrical distributors have the capacity to adapt to the demands of electric vehicle systems

~ retailer variations in the unit cost of electricity draw-down versus feed-in tariffs

~ the small financial reward that individual customers could earn per year.

Analysis of these issues suggests that, while the provision of feed-in capability for vehicle recharging infrastructure may be desirable in the future, the real-world application of this process is complex and will require

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1 Retailers are not obliged to purchase non-renewable power from customers

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close liaison with energy network operators. Feed-in functionality of vehicle recharging infrastructure may not be practical in the short term.

The study team also noted the current Victorian Government roll out of 2.6 million smart meters will provide some useful insights into the best way of managing energy feed-in from electric vehicles in the future. The Commonwealth Government has also announced an advanced $100m smart grid demonstration of up to 40,000 customers to start in 2010, and the CSIRO electric driveway project about to commence will also add to the technical tools that will manage electrical vehicle charging in the grid.

4.7 Home-based recharging is not without some challenges

Advocates of electric vehicles in Australia rightly point to the fact that one of the key advantages of a future move to the use of electricity for passenger cars is the fact that much of the recharging infrastructure is already in place – in the form of the millions of GPOs already in existence around the country.

This observation is only correct for Level I vehicle recharging. This form of recharging is relatively slow and many industry stakeholders suggest that electric vehicle consumers will likely demand faster charging rates (at least to Level II) as the popularity of electric vehicles increases (Although the average car is parked for 22 hours per day and for most drivers rapid charging may not be required very frequently).

Most Australian households are fitted with single-phase electrical circuits that are supported by a 70 amp supply. The accommodation of faster charging rates can be facilitated by single phase 15A and 32A outlets at relatively small cost. Whilst some customers may install 3 phase power, it would be fairly costly to do so.

4.8 International vehicle supply supported by domestic electricity supply

With the exception of a small number of vehicles sold by Australian aftermarket companies, the majority of Australia’s electric vehicles are likely to be sourced from global vehicle suppliers. Consequently, Australian standards for electric vehicles will need to be harmonised with international standards as far as practical to maximise the range of electric vehicles available to Australian consumers (The study team noted that the iMiEV secured all necessary ADR approvals within 3 months of applying, suggesting this process is unlikely to be unwieldy for vehicle manufacturers whose products meets USA, EU, or Japanese emission requirements).

The specific nature of the Australian electricity grid, with its current load demand profile and physical operating characteristics, suggests that there may be a need to tailor the design of recharging infrastructure to meet the requirements of the upstream electricity supply (specifically via the specification of plug and socket design to be used in Australia).

4.9 Electric vehicles will introduce an unfamiliar operating paradigm for road users, the vehicle repair industry and road rescue authorities

The higher operating voltages of electric vehicles will create new and unfamiliar hazards for the Australian motoring public, the Australian vehicle repair industry, and the road rescue industry. There will be a need to ensure that sufficient information is provided to all of these groups to minimise the risk of electric shock and that high-risk electrical componentry is clearly identified.

4.10 Development of the electric vehicle market is likely to occur in three distinct stages, albeit that the timing is subject to a degree of conjecture

Analysis of all available information suggests that there are likely to be a series of key milestones relating to the increased availability of OEM electric vehicles and increasingly sophisticated recharging infrastructure. These milestones will likely comprise three distinct stages of market development as described below.

~ MARKET INFANCY (STAGE 1): This stage will be characterised by small numbers of high capital cost OEM vehicles and cheaper aftermarket conversions. Vehicle recharging will be via home-based and workplace charging using standard GPOs (with no provision for feed-in). Source electricity will be predominantly coal-fired electricity as per the average carbon intensity of the national electricity grid, but will likely be offset by the purchase of ‘green power’.
MARKET ESTABLISHMENT (STAGE 2): This stage will be characterised by an increasing range of OEM electric vehicles with increased market appeal. OEM vehicles will still be relatively expensive owing to utilisation of more advanced technology, potentially resulting in the emergence of ‘cottage industry’ for cheaper aftermarket conversions. Vehicle recharging will likely comprise the use of standard charge recharging units at the home or the workplace, supported by on-street recharging points. Source electricity will predominantly be coal-fired electricity as per national average grid intensity, albeit that EV consumers are considered likely to offset the inherent emissions via the purchase of ‘green power’.

MARKET MATURATION (STAGE 3): This final stage will be marked by widespread availability of electric vehicles and the establishment of commercial recharging stations in Australia’s major capital cities and along Australia’s major highways. Electricity could potentially be sourced from dedicated renewable energy supply.

5 Vehicle design considerations

The study team conducted a review of the need for standards in the area of vehicle design. The key factors considered included the need to:

- protect the safety of vehicle occupants and the community at large in terms of both vehicle crash risk and shock risk;
- harmonise vehicle standards with international standards as far as practical given the global nature of electric vehicle supply;
- ensure that early delivery of technology does not shut out new technology providers in the future or create supplier vulnerability for electric vehicle consumers (in terms of vehicle selection or vehicle recharging).

The resulting review identified the need to develop Australian standards governing four specific areas as discussed in the following subsections.

5.1 Occupant safety (crash)

5.1.1 Guiding rationale

The design of electric vehicles differs significantly from conventional vehicles in terms of engine mass, structural components and battery pack mass. There is a need to ensure that the resulting ‘vehicle package’ affords the same level of safety as conventional vehicles, with a particular focus on rear-end structural integrity (considered important for electrical vehicles given the need to protect the batteries from direct impact); this requirement is likely to be covered by Australian Design Rules for new passenger vehicles.

While it is expected that OEM vehicles will be required to demonstrate compliance with existing crash-related Australian Design Rules for conventional vehicles, there is a potential loophole for aftermarket installations.

5.1.2 Scope of investigation

There appears to be a need to investigate the need for development of Australian standards in the following specific areas:

- new requirements for the safety certification of aftermarket installations, including the physical security of battery packs (Such requirements might be derived from work already being undertake by VicRoads in respect of current approval processes);
- the possible adaptation of existing crash test regimes for standard vehicles to accommodate an increased focus on the assessment of the rear-end crash integrity of electric vehicles (i.e. assess nose-to-tail crash vulnerability).

5.1.3 Suggested approach

It is suggested that Australian standards for the testing of aftermarket electrical vehicle conversions be developed and applied. These standards would differ slightly from conventional NCAP testing owing to the need to assess intrusion into the battery storage area and might be initially adapted from existing international standards such as

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SAE International 1766 *Recommended Practice for Electric and Hybrid Vehicle Battery Systems – Crash Integrity Testing.*

5.1.4 Priority

Given that electric vehicle conversions are already being sold into the Australian marketplace, this issue is considered to be a **high priority** for standards development.

5.2 Occupant safety (electrical)

5.2.1 Guiding rationale

The introduction of high voltage electric vehicles on Australian roads creates a new paradigm for the management of electric shock hazards in the Australian community. These shock hazards will likely be unfamiliar to vehicle users and the wider community at large, requiring careful management of this public safety risk in the early years of electric vehicle operation.

A key element in the satisfactory management of this risk will be to ensure the electrical integrity of the electrical system with a primary focus on those elements that are not part of the OEM electrical vehicle delivery chain – that is, aftermarket installations and non-OEM electrical components.

5.2.2 Scope of investigation

There appears to be a need to develop Australian standards that manage the inherent shock risk of increased electric vehicle operation in terms of:

~ identification and labelling of hazardous electrical system components for all electric and PHEV vehicles
~ testing of the electrical integrity of aftermarket installations
~ testing of the electrical integrity of non-OEM spare parts for electric vehicles.

A potential further area for investigation concerns occupant exposure to electromagnetic radiation, although stakeholder views appear to be relatively divided on the need for such a focus. While it can largely be argued that many individuals are subject to electromagnetic radiation from other everyday devices, it may be worthwhile considering the development of a non-onerous standards to deal with the ‘public relations’ aspect of this technology in the first instance.

5.2.3 Suggested approach

Specific Australian standards for the identification and labelling of hazardous electrical system components should ideally be harmonised with developing international agendas in this area.

Standards stipulating testing regimes for aftermarket installations and non-OEM vehicle spare parts could be adapted from existing national appliance testing standards and protocols.

In respect of the measurement of electromagnetic radiation, the US Department of Energy has developed a test procedure for assessing the electromagnetic radiation generated by hybrid vehicles ([http://www1.eere.energy.gov/vehiclesandfuels/avta/pdfs/hev/htp009ra.pdf](http://www1.eere.energy.gov/vehiclesandfuels/avta/pdfs/hev/htp009ra.pdf)). This procedure might provide the foundations for the establishment of an appropriate national standard in this area.

5.2.4 Priority

Given that aftermarket offerings are already available in Australia and that this issue concerns the general safety of electric vehicle users, the development of Australian standards in this area is considered to be a **high priority**.
5.3 Recharging interface (flexibility)

5.3.1 Guiding rationale

An examination of European and North American standards reveals that these jurisdictions specify different plug design and circuit ratings for electric vehicles. Australia will therefore need to develop specific standards for the design of plugs in Australia.

In addition, there will be a need to provide a degree of flexibility with respect to vehicle charging rates and the design of the physical vehicle interface with the electricity supply. There is a risk that, unless core elements of these designs are not coordinated from the outset, there will be a significant risk of incompatibility of vehicles and recharging infrastructure.

5.3.2 Scope of investigation

There is a need to develop Australian standards for the standardisation of electric vehicle plugs, cords and charging sockets. These standards should accommodate all three levels of charging and facilitate inter-operability between recharging infrastructure, thereby maximising the potential reach of electric vehicles in the first instance.

5.3.3 Suggested approach

Australia may need to develop specific equipment standards for Level 2 and Level 3 vehicle charging. These standards would need to be developed in close consultation with overseas standards organisations, vehicle suppliers and energy network operators.

5.3.4 Priority

ChargePoint has suggested that recharging equipment that is capable of Level 2 charging could be sold in Australian from 2012. As a consequence, the development of this standard is considered to be a high priority.

5.4 Aftermarket installation

5.4.1 Guiding rationale

There are already a number of niche-based commercial electrical vehicle offerings that are developed around the conversion of an existing conventionally-fuelled vehicle to electric vehicle operation. By their very nature, these vehicles are not subject to the same degree of scrutiny in terms of installation quality, component quality and conformity of production.

There is a need to ensure that Australian purchasers of these vehicles are afforded the same level of safety as the purchasers of OEM vehicles via the establishment of minimum performance standards for aftermarket systems.

5.4.2 Scope of investigation

There is a need to develop a specific Australian standard for the aftermarket conversion of conventional vehicles to electric vehicle operation. This standard will need to be supported by an additional standard relating to the post-installation testing of key vehicle components for fire risk and electric shock risk. These standards might be developed along similar lines to the standards previously developed for LPG conversions of conventionally powered vehicles.

5.4.3 Suggested approach

It is suggested that new standards covering aftermarket installations could be derived by the adaptation of the testing regimes applied for OEM-supplied electric vehicles sold in Australia.
5.4.4 Priority

The development of standards in this area is considered to be a high priority given the recent emergence of aftermarket providers of electrical vehicles and the likely price attractiveness of these vehicles in the near term, relative to higher priced OEM alternatives.

6 Power systems

The heart of an electric vehicle is the power system comprising the on-board vehicle batteries and the battery management system. Technological variations in the power system can affect both the real-world safety of the vehicle and vehicle performance (i.e. range).

As a consequence, the study team investigated the need to develop standards governing the design and operation of vehicle power systems. The key factors considered included the need to:

∼ protect the safety of vehicle occupants and the community at large in terms of fire-related risks;
∼ harmonise vehicle standards with international standards as far as practical;
∼ ensure that consumers have sufficient information to gauge the relative performance of different power systems;
∼ reduce the environmental impact of battery waste.

The resulting review identified the need to develop Australian standards governing four specific areas as discussed in the following subsections.

6.1 Battery safety

6.1.1 Guiding rationale

As battery technologies develop different vehicle manufacturers will provide different battery technologies in the global electric vehicle market. Some of these technologies are lower cost and proven while others are both complex and expensive. As a consequence, a variety of different battery technologies (with possibly varying levels of safety) may appear in the market place.

While the specific safety risks of different battery technologies (e.g. thermal risk from lithium-ion batteries) can be managed by installing battery management systems that are capable of managing these risks, there appears to be a need to set minimum criteria for safety testing of all electric vehicle batteries sold in Australia.

6.1.2 Scope of investigation

There is a need to develop a standard testing regime for all electric vehicle batteries. This testing regime would ideally incorporate independent testing of the battery under varying thermal conditions, together with the assessment of the performance of the battery pack in a crash test.

6.1.3 Suggested approach

There are a variety of existing international standards that outline testing regimes for electric vehicle batteries, including SAE J2464 and British Standard EN61982. Whilst none of these Standards/Guidelines appear to be mandated at present, it is suggested that these documents could form the basis for development of an appropriate Australian Standard.

6.1.4 Priority

Given the inherent public safety risks associated with this issue, it is suggested that the development of standards relating to the testing of electric vehicle batteries should be considered a high priority.
6.2 Battery durability

6.2.1 Guiding rationale

Apart from possessing different levels of inherent safety, variation in electric vehicle battery technology is also likely to result in a variance in the durability of electric vehicle batteries. While real-world battery performance will likely be a function of both the battery/battery management system and the ultimate drive-cycle of the vehicle, there appears to be a case for assessing and reporting the performance of electric vehicle batteries to provide a degree of consumer protection to electric vehicle consumers.

6.2.2 Scope of investigation

Accommodation of this issue will require the development of a test regime for assessing the life and endurance of batteries used for electric vehicle operation in Australia.

6.2.3 Suggested approach

Australian standards for the testing of electric vehicle batteries could be adapted from existing international standards and guidelines such as SAE J1798 and SAE J2380. The ultimate testing regime could be used to develop a performance rating system that provides consumers with an independent assessment of the relative performance of different electric vehicle batteries sold in Australia.

6.2.4 Priority

The development of Australian standards in this area is considered to be a medium priority given the low number of vehicles likely to be sold in Australia in the near future. As the number of different vehicles sold in the country increases, the priority of this issue will simultaneously increase.

6.3 Battery recycling

6.3.1 Guiding rationale

There appears to be a need to develop a testing regime for assessing the recyclability of a battery at the end of its useful life. Given the strong interrelationship between battery durability and battery recyclability in terms of waste battery volumes, there is a need to ensure that such a standard incorporates simultaneous consideration of battery durability.

6.3.2 Scope of investigation

It is suggested that a standard be developed for testing the recyclability of electric vehicle batteries and that such a test regime should simultaneously assess the durability of the battery (i.e. vehicles with a low degree of recyclability but a long operating life are likely to be just as beneficial as those batteries that have a high degree of recyclability but a low service life).

6.3.3 Suggested approach

A scan of current international standards and guidelines failed to identify any significant standards or guidelines in this area. As a consequence, there may be a need to partner with relevant international organisations to develop an appropriate standard and a rating system that considers both the degree of recyclability and the average durability of different electric vehicle technologies.

6.3.4 Priority

This issue is essentially a long-term issue that, relative to some other issues associated with the imminent introduction of electric vehicles, is considered to be a medium priority. The importance of this issue will increase as the number of electric vehicles sold worldwide increases.
6.4 System safety and efficiency

6.4.1 Guiding rationale

Different combinations of battery technology and power systems will result in significant variations in the real-world safety and efficiency of electric vehicle power systems under similar ambient operating conditions and driving conditions. These variations are likely to be significant but not readily appreciated by the purchasers of electric vehicles.

Given this fact, there appears to be a need to develop a testing regime that assesses the overall safety and efficiency of the integrated electric vehicle power system (i.e. battery and battery management system) fitted to different models of electric vehicles.

6.4.2 Scope of investigation

There appears to be a need to develop a standardised testing regime for assessing the safety and performance of electric vehicle power systems.

6.4.3 Suggested approach

A review of existing international standards and guidelines revealed that while there are a variety of publications that cover aspects of this issue, there is no one standard that addresses the safety and performance testing of battery and battery management system combinations.

As a consequence, this issue would be best addressed by the synthesis of existing standards and guidelines and liaison with overseas agencies (e.g. SAE J2293 and SAE J2288) to create a new international standard in this area.

6.4.4 Priority

Given the relative infancy of the electric vehicle market in Australia, this issue is considered to be a medium priority for standards development. As with a number of the previous items discussed in this section, the priority of this issue will increase as increased numbers of electric vehicle offerings become available in the Australian market.

7 Vehicle recharging

The third area of standards consideration adopted under this study related to the potential need for development of electric vehicle standards in respect of vehicle recharging. Unlike the first two areas of investigation (i.e. vehicle design and electric vehicle power systems), the requirement for standards in this area is driven by domestic considerations (relating to the Australian electricity) rather than harmonisation with existing international standards.

Given the different types of vehicle charging, the discussion presented in this section considers the need for standards in three categories (i.e. home-based, on-street and commercial charging). Consideration was also given to issues relating to the interface with upstream electricity supply given the unique nature of the Australian supply environment.

The key factors considered in the investigation of the need for standards in this area included the need to:

~ successfully manage the inherent safety risks associated with home-based and on-street vehicle recharging;
~ successfully manage the inherent risks to the national electricity grid, including the risk of localised power failures (largely covered by existing connection rules enforced by distribution companies) and home fire risk;
~ ensure that provision is made to allow the effective management of the national electricity grid in the face of the increased demand associated with electric vehicle operation, most likely via the national role out of smart grid technology;
~ provide the necessary level of inter-operability that maximises user access to vehicle recharging infrastructure.
The resulting review identified the need to develop Australian standards governing four specific areas as discussed in the following subsections.

7.1 Home-based (and workplace) charging

7.1.1 Guiding rationale

Home-based recharging is likely to be introduced in two distinct stages, or generations. First generation recharging infrastructure will likely be limited to trickle recharging via a standard GPO – no provision will be made for vehicle-to-grid transfer of electricity. This first generation recharging can be largely accommodated by existing domestic electrical infrastructure.

Increasing consumer demands for faster charging, if battery companies allow this, (and capital constraints on the early provision of public recharging infrastructure) may likely see the emergence of second generation recharging systems for home use. It is envisaged that these systems would accommodate standard charging rates (i.e. 32 amps and greater), and would likely require the upgrade of domestic electrical circuits.

It is further envisaged that second generation recharging systems would incorporate a degree of functionality permitting feed-in and facilitating load control on the part of energy network operators.

7.1.2 Scope of investigation

Level 1 home-based recharging can be accommodated without the need for additional standards. Any move towards the adoption of second generation commercial home recharging will require development of equipment and installation standards for Level 2 recharging systems.

7.1.3 Suggested approach

New Australian standards could be developed by (a) adapting existing international standards for recharging equipment, and (b) adapting existing Australian wiring standards.

7.1.4 Priority

It is understood that some vehicle providers plan to sell Level 2 charging systems (with feed-in mechanisms disabled) with their vehicles from 2012. As a consequence the development of standards for Level 2 home (and workplace) charging is considered to be a high priority.

7.2 On-street charging

7.2.1 Guiding rationale

On-street vehicle charging involves the provision of public recharging points on the public road network. Access to this infrastructure would be provided on either a subscriber basis or a pay-as-you go basis (i.e. electronic payment capacity). This form of recharging would likely comprise Level 2 recharging in the first instance, but potentially could be expanded to incorporate Level 3 charging.

The draw-down of these charging facilities may require that network operators have load management capacity with the ultimate right to disconnect the charging point from the grid during periods of critical demand. (the modelling of this effect was outside the scope of this study and may need to be undertaken prior to progressing this work).

Consideration will also need to be given to the design and siting of these facilities to ensure that they do not pose an undue safety risk to electric vehicle users and the community at large, and then enforced by local planning legislation.

7.2.2 Scope of investigation

Given the above considerations, there appears to be a need to develop a national standard for the provision of on-street electric vehicle recharging infrastructure in terms of hardware design (i.e. system leakage and safety in
the event of damage). This standard will need to stipulate minimum requirements in terms of physical design and system functionality.

7.2.3 Suggested approach

The development of a national standard relating to the design of on-street vehicle recharging infrastructure might best be undertaken by (a) adapting international equipment standards, and (b) modifying existing Australian standards governing the provision of electrical appliances in public areas.

Given the potential significance of this form of recharging on the future operation of the national electricity grid, there will be a need to work closely with network operators to ascertain the level of minimum system functionality required for both load control and vehicle feed-in to the grid.

7.2.4 Priority

While home-based and workplace charging are likely to be the dominant form of vehicle recharging during the early stages of market operation, on-street recharging will likely become attractive to electric vehicle users owing to faster charge times. At least one provider of on-street recharging systems was known to be considering the provision of this type of recharging infrastructure within the next 5 years. For this reason, and in consideration of the significant issues involved in developing national standards in this area, this work is considered to be a high priority.

7.3 Commercial recharging

7.3.1 Guiding rationale

As with home-based vehicle recharging, commercial recharging of electric vehicles is likely to occur in two distinct phases or generations. The first generation of commercial recharging infrastructure will likely comprise the provision of Level 1 and Level 2 recharging outlets in public car parks, shopping centres and office complexes. There will be a need to ensure that this infrastructure is designed to accommodate public and building safety considerations.

The second generation of commercial recharging infrastructure is considered to be a longer term proposition that would involve the provision of commercially operated recharging stations – in much the same way as petrol stations now operate. These stations would predominantly provide Level 3 vehicle recharging and would need to be designed to accommodate core consumer issues (in relation to transparency of charging) and inter-operability of recharging infrastructure.

7.3.2 Scope of investigation

It is suggested that the emergence of commercial recharging would require the development of discrete national standards for both generations of recharging infrastructure. The accommodation of first generation infrastructure would require the development of national equipment standards (i.e. recharging hardware) for Level 2 vehicle charging.

The accommodation of second generation commercial recharging will likely require the development of a comprehensive set of national standards governing key aspects of the design of this type of infrastructure, including:

- physical siting of the facility;
- equipment standards required to support inter-operability;
- dispensing and metering systems that meet consumer requirements in the same way that the design of petrol bowsers is regulated;
- minimum fire safety and incident response systems, possibly adapted from existing standards for petrol stations;
- minimum functionality in respect of load control, albeit that this element may not be required for some years given the slow take-up of electric vehicles;
minimum requirements in respect of the quality of feed-in energy (possibly adapted from existing standards for solar and wind power feed-in);

7.3.3 Suggested approach

The accommodation of the requirements of this work item will require the adoption of a two-fold approach. The first might involve the review of existing building standards and related codes to make provision for the installation of Level 1 and Level 2 vehicle charge points. The second would involve the development of new standards for vehicle recharging stations that might be adapted from international standards and guidelines for commercially operated recharging stations.

7.3.4 Priority

Development of standards for the provision of commercial charge points (i.e. Level 1 and Level 2) in public buildings is considered to be a high priority. Given the likely timeframe and cost associated with the provision of commercially operated recharging stations, the development of standards in this area is considered to be a low/medium priority.

7.4 Upstream interface

7.4.1 Guiding rationale

Higher forms of vehicle recharging (Level 2 and Level 3) potentially create challenges for management of the total energy load on the national grid, particularly given the relative lack of spare capacity on some parts of the national network. While this issue will not become significant until large numbers of vehicles become available in Australia, it would be prudent that future recharging infrastructure operating at this level includes communications systems to allow for management by the operator should it be required in the future.

The Victorian (and foreshadowed future national) rollouts of smart meters and move to the development of a national 'smart grid' will require that the design of all vehicle recharging interfaces is compatible with core communication protocols (i.e. upstream mesh networks and downstream Zigbee protocols).

The provision of feed-in energy may also be a significant consideration in the future.

7.4.2 Scope of investigation

The accommodation of the above issues will require the development of a national standard for the upstream communications interface with Level 2 and Level 3 vehicle recharging infrastructure.

It is envisaged that the standard would identify requirements in respect to the quality of feed-in energy, upstream functionality with respect to load control capacity, and consistency with core communication protocols required for future smart grid operation and be developed via liaison with the electricity distributors.

7.4.3 Suggested approach

The development of a national standard in this area will require the engagement of the Australian electricity industry and the emerging vehicle recharging industry.

7.4.4 Priority

Given that Level 2 recharging systems will likely appear in the next two to three years, the development of a standard specifying the design of the upstream interface with electric vehicle recharging infrastructure is considered to be a medium priority.
8 Rescue, repair and vehicle recovery

Apart from some of the more obvious areas for standards development pertaining to vehicle design and the design of recharging stations, the study team identified the need for standards in several areas associated with the operation and repair of electric vehicles in Australia. The key factors considered in the investigation of the need for standards in this area included the need to:

∼ protect members of the vehicle repair industry from exposure to increased shock risk;
∼ accommodate the requirement of rescue authorities to remove trapped occupants from damaged vehicles quickly and without exposing occupants or rescue personnel to increased risk of electric shock.

The resulting review identified the need to develop Australian standards in three areas as discussed in the following subsections.

8.1 Vehicle maintenance and repair

8.1.1 Guiding rationale

Electric vehicles will create a new repair paradigm for the conventional vehicle repair and vehicle maintenance industry in Australia, as highlighted by some early experiences with the repair of hybrid electric vehicles in Australia. This new paradigm will create significant challenges for the industry in terms of the effective repair of electric vehicles without exposing members of the industry to increased risk of electric shock.

Feedback from vehicle maintenance bodies suggests that past approaches employed for the hybrid vehicles (i.e. vehicle manufacturer training workshops for repair personnel) were largely inadequate, owing to the detailed nature of the information involved and the time lag between the receipt of training and working on a subject vehicle.

As a consequence, there appears to be a clear need to develop standards relating to the provision of electric vehicle information at the point of vehicle maintenance.

8.1.2 Scope of investigation

The inherent industry risks associated with the maintenance and repair of electric vehicles might be managed by the development of:

∼ a standard requiring the provision of standardised information to the Australian vehicle repair industry in relation to the repair of individual makes and models of electric vehicles sold in Australia;
∼ a standard for the design and management of electric vehicle workspaces. This standard might be progressed along similar lines as that applied for the work area for gas-fuelled vehicles.

Essentially, standards would be developed in respect to minimum information requirements for repair personnel and the design of electric vehicle working spaces. All other issues relating to this element could likely be covered with the development of skills-based training programmes.

8.1.3 Suggested approach

It is suggested that the development of a standard for the provision of electric vehicle information to the national vehicle repair industry might be derived by adaptation of existing standards such as ISO 8713. The development of a standard for the safe management of electric vehicle work areas could involve the modification of AS2746 for electric vehicles.

8.1.4 Priority

The development of standards to support the safe repair of electric vehicles is considered to be a high priority given that electric and PHEVs are already appearing on the Australian road network.
8.2 Rescue and vehicle recovery

8.2.1 Guiding rationale

Electric vehicles will create a series of challenges for Australian road rescue authorities in respect of both (a) making the accident scene safe, and (b) safely removing trapped occupants from a wrecked vehicle. Given the likely variance in the architecture of the electric vehicle systems of electric vehicles to be sold in Australia, there appears to be a need to work with electric vehicle suppliers to standardise procedures for the disconnection of the power source in the vehicle and standardise practices for occupant rescue.

8.2.2 Scope of investigation

The development of an Australian standard that stipulates requirements for disabling the power systems of electric vehicles (i.e. battery packs and quick discharge of high voltage components) would provide a workable solution to this issue.

8.2.3 Suggested approach

An analysis of current national and international guidelines suggests that this issue appears to be a 'blind spot' in the consideration of electric vehicle operation. Accordingly, Australia has an opportunity to lead the way in the development of standards in this area via a dialogue involving vehicle manufacturers and road rescue authorities, but should ideally progress this work in collaboration with relevant international agencies.

8.2.4 Priority

The development of standards in respect of vehicle rescue and recovery procedures is considered to be a high priority.

8.3 Vehicle labelling

8.3.1 Guiding rationale

The clear identification of electric vehicles is likely to be a key element in managing the potential electric shock hazard associated with the operation, maintenance and accident recovery of electric vehicles in Australia.

8.3.2 Scope of investigation

Consideration of this issue suggests that there may be an opportunity to develop a standard for the external labelling of electric vehicles. In addition, consideration could be given to the development of a standard requiring the clear identification (i.e. labelling and/or colour coding) of high voltage cables and electric vehicle components. (it should be noted that these aspects are not covered by AS3000, as this Standard relates to all internal wiring "behind" the GPO).

8.3.3 Suggested approach

Priority Once again, the study team failed to identify any standards in relation to this area of investigation. As a consequence, the development of any future standard in this area will require collaboration with electric vehicle manufacturers, the vehicle maintenance industry and road rescue authorities.

In the first instance, the use of a number plate sticker (such as that used for LPG vehicles in most States and Territories) could be applied. Road rescue authorities suggested, however, that number plate stickers should only be considered an interim first step given that number plates are often obscured in a vehicle accident.

8.3.4 Priority

The development of standards in respect of vehicle labelling is considered to be a medium/high priority.
9 Miscellaneous considerations

In addition to the four areas of investigation discussed in the preceding sections of this paper, the study team identified two further areas where standards may be required to support the introduction of electric vehicles in Australia.

9.1 User information

9.1.1 Guiding rationale

The operation of electric vehicles will, by its very nature, differ markedly from the operation of conventional vehicles. As a consequence, the human harm risk associated with vehicle modification or incorrect charging practices is likely to be higher than for conventional vehicles. The degree of this public safety risk could be reduced by providing electric vehicle operators with an increased level of information.

9.1.2 Scope of investigation

It is suggested that Australian standards could be developed to (a) specify the format of specific vehicle user information (and warnings) that should be provided in the vehicle handbook supplied with electric vehicles sold in Australia, and (b) specify the safety information that should be provided at all on-street and commercial charge points. Given the related liability issues surrounding this topic, there will be a need to work closely with vehicle manufacturers in identifying the key risks and developing appropriate user information.

9.1.3 Suggested approach

Both of the standards suggested above would require the development of discrete Australian standards, with some information derived from ISO8713 in relation to standard terminology for electric vehicles and electric vehicle operation. While the study team was made aware of some international guidelines in respect of vehicle chargepoints, none of this material appeared to be sufficiently robust.

9.1.4 Priority

The development of a standard for the provision of electric vehicle information to electric vehicle operators is considered to be a high priority.

9.2 GHG performance

9.2.1 Guiding rationale

Analysis of the early marketing efforts of electric vehicle suppliers indicates that these vehicles are predominantly being marketed on the basis of their superior GHG performance relative to conventional vehicles and popular alternative vehicle technologies.

While such an observation is true with respect to the relative tailpipe emissions of electric vehicles, the pre-combustion emissions associated with the generation of electricity is far more significant than the GHG emissions associated with the production of conventional transport fuels.

As a consequence, the degree to which electric vehicles deliver superior GHG performance relative to conventional vehicles is a factor of both the overall system efficiency of the electric vehicle and the source of the electricity used in the vehicle.

9.2.2 Scope of investigation

Given the significant potential for consumers to be misled in respect of the GHG performance of these vehicles there appears to be a need to develop (a) a standard methodology for comparing the GHG and energy efficiency of electric vehicles with conventional vehicles, and (b) a standard requiring the display of an energy efficiency label to compare the relative performance of different electric vehicles.
9.2.3 Suggested approach

The study team noted that the European Standards Organisation has already identified the measurement of the GHG performance of electric vehicles as a priority work area with the formulation of EN13444-1. Given that this document was produced eight years ago, there may be a need to revisit the structure of this document and apply GHG intensities that are pertinent to the Australian environment.

9.2.4 Priority

The development of a standard for the measurement of the GHG emissions of electric vehicles is considered to be a high priority given the need to protect consumers from exaggerated claims in respect of the GHG performance of these vehicles.

10 Summary

10.1 A framework for moving forward

The discussion presented in this paper identifies five interrelated work streams (incorporating 17 work items) for the development of Australian standards to support the introduction of electric vehicles in Australia. It is suggested that this framework, as summarised in Figure 4, could be used to guide future work in this area.

While this finding may at first appear a little daunting, a number of these work items merely require the adaptation of international standards and guidelines to suit the likely Australian operating environment. These items include standards relating to the design of OEM electric vehicles and power systems, where harmonisation of any future Australian standard with international standards is a key consideration given the global nature of the electric vehicle market.

10.2 Three key priority areas

The study identified three main areas of high priority. A brief discussion of each of these priority areas is discussed in the following sub-sections.

10.2.1 Development of standards for aftermarket conversions

A key priority emerging from the study is the need to develop a series of standards for the provision of aftermarket electric vehicles. These vehicles typically involve conversion of existing conventional powered vehicles to electric vehicle operation and are generally not subject to the same quality control procedures as OEM developed vehicles.

While VicRoads is understood to be doing some work in this area, electric vehicles create a new paradigm that is more dominated by electrical considerations than traditional mechanical considerations. In addition, there is a need to develop a mechanism for national conformity.

Given that there are some parallels with the LPG conversion industry in this area, it is considered prudent to develop standards governing the quality of key safety elements of aftermarket installations (similar to the development of AS1425 for LPG vehicles in Australia).

Given that small numbers of aftermarket vehicles are already being sold into the Australian passenger car market, there is an urgent need to develop a series of standards that ensure these vehicles deliver the same level of safety as OEM vehicles in terms of:

- crash protection - It is understood that VicRoads is investigating options for approval of small production numbers without the need for a crash test. This work will need to be considered in any future investigation of this issue
- electrical protection – these vehicles impose a new operating paradigm that requires special consideration in terms of occupant and public safety
- overall vehicle operation and electrical system durability - Agreement on a durability protocol will likely be very challenging, but was considered to be a key priority by many industry and consumer protection stakeholders.
10.2.2 Development of standards for Level 2 recharging

The study also identified an immediate need to develop standards relating to the design of vehicle recharging systems to ensure technology interoperability and manage the inherent risks associated with the future operation of the national electricity grid. It is strongly suggested that there is a need to develop specific standards in relation to the:

~ design of plugs, cords and sockets to be used for vehicle recharging;
~ development of standards governing the design and installation of Level 2 home-based charging systems;

10.2.3 User and GHG information

Electric vehicles constitute a new and relatively unfamiliar operating paradigm for road transport in Australia. The adoption of this paradigm creates considerable challenges in respect to the management of the inherent risks of electrical vehicle operation for electric vehicle users, the vehicle repair industry, road rescue authorities and the community at large.

Market unfamiliarity with this technology also means that consumers are not aware of how to discern the real-world benefits of electric vehicles and conventional vehicles in terms of emissions performance and energy efficiency (i.e. fuel efficiency versus electrical efficiency).

These two factors suggest that the third priority for the development of standards lies in the development of standardised consumer information in the form of:

~ consumer handbook and point-of-charge information
~ vehicle labelling and labelling of high voltage components
~ standardised information of relative energy efficiency and GHG performance.

In progressing this issue, discussions should be held with relevant Commonwealth Agencies (i.e. Department of Transport and Regional Services and the Department of Climate Change), the Australian Competition and Consumer Commission (in respect of recent examination of GHG marketing), and a raft of state consumer agencies.

10.3 Continuation of a national dialogue

In providing feedback to the national tele-workshops conducted on 27 August 2009, a number of stakeholders commented on the need to continue the national dialogue that had been initiated by this project.

It is suggested that this action could not only be used to coordinate the delivery of the work programme outlined in this paper but could also be used for future consultation on broader issues associated with the Australian electric vehicles agenda.

11 Recommendations

The following recommendations are made in respect of the need to develop Australian standards to support the introduction of electric vehicles in Australia.

1. That a rolling work programme be established for the progressive development of Australian standards in the areas of:
   a. vehicle design (OEM and aftermarket vehicles)
   b. power systems
   c. vehicle recharging
   d. rescue, repair and vehicle recovery
   e. user information and GHG assessment.
Figure 4
Summary of potential areas for investigation of Australian standards for introduction of electric vehicles
2. That priority be given to the immediate development of Australian standards for electric vehicle operation in respect of:
   f. the design of aftermarket electric vehicles
   g. the design and operation of Level 2 recharging systems
   h. the standardisation of user and GHG information relating to electric vehicles sold in Australia.

3. That a national Electric Vehicle Working Group be formed to oversee the national standards development programme, largely comprising the stakeholders that participated in the consultation conducted for this study.

4. That a state-to-state working group be established to investigate opportunities for coordination in respect of (a) regulating/approving after-market conversions, and (b) adoption of consistent approaches to vehicle identification of electric vehicles.
## Appendix 1

### Summary of existing standards and guidelines

<table>
<thead>
<tr>
<th>1. VEHICLE DESIGN (OEM &amp; aftermarket)</th>
<th>Area of investigation</th>
<th>Key consideration</th>
<th>Existing standards and/or industry guidelines</th>
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<tbody>
<tr>
<td><strong>Occupant safety (crash)</strong></td>
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<tr>
<td></td>
<td>Safety certification of aftermarket installations, including the physical security of battery packs.</td>
<td>No international standards</td>
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<tr>
<td></td>
<td>Assess nose to tail crash vulnerability</td>
<td>ISO/TR 7861:2002 presents injury risk curves that can be used for injury risk assessment in the evaluation of occupant protection in road-vehicle frontal impact.</td>
<td>SAE International 1766 Recommended Practice for Electric and Hybrid Vehicle Battery Systems – Crash Integrity Testing.</td>
</tr>
<tr>
<td><strong>Occupant safety (electrical)</strong></td>
<td>Need to develop Australian standards that manage the inherent shock risk of increased electric vehicle operation in terms of:</td>
<td>ISO6469 Electric road vehicles – Safety specifications – Part 1, 2 &amp; 3.</td>
<td>ISO 11451 Road vehicles – Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy Part 1, 2 &amp; 3. ISO11452 Road vehicle – component test methods for electrical disturbances from narrowband radiated electromagnetic energy Part 1, 2, 3, 4, 5, 6 &amp; 7.</td>
</tr>
<tr>
<td></td>
<td>• identification and labelling of hazardous electrical system components for all electric and PHEV vehicles</td>
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<td></td>
<td>• testing of the electrical integrity of aftermarket installations</td>
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<tr>
<td></td>
<td>• testing of the electrical integrity of non-OEM spare parts for electric vehicles.</td>
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<tr>
<td><strong>Recharging interface (flexibility)</strong></td>
<td>Different plug design and circuit ratings for electric vehicles. Australia will therefore need to develop specific standards for the design of plugs in Australia.</td>
<td>IEC 62196 Plugs, sockets, vehicle couplers and vehicle inlets – conductive charging of electric vehicles.</td>
<td>Standards of electric vehicle plugs, cords and charging sockets.</td>
</tr>
<tr>
<td><strong>Aftermarket installations</strong></td>
<td>Need to develop a specific Australian standard for the aftermarket conversion of conventional vehicles to electric vehicle operation. This standard will need to be supported by an additional standard relating to the post-installation</td>
<td>No international standards</td>
<td></td>
</tr>
</tbody>
</table>
testing of key vehicle components for fire risk and electric shock risk.

## 2. POWER SYSTEMS (battery and battery management systems)

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<tr>
<th>Area of investigation</th>
<th>Key consideration</th>
<th>Existing standards and/or industry guidelines</th>
</tr>
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<tbody>
<tr>
<td>Battery safety</td>
<td>Need to develop a standard testing regime for all electric vehicle batteries.</td>
<td>ISO 16750 Road vehicles – Environmental conditions and testing for electrical and electronic equipment Part 1, 2, 3, 4 &amp; 5. ISO23273 Fuel cell road vehicles – safety specifications Part 1, 2 &amp; 3.</td>
</tr>
<tr>
<td>Battery durability</td>
<td>A test regime for assessing the life and endurance of batteries used for electric vehicle operation in Australia.</td>
<td>ISO 61982 Secondary batteries for the propulsion of electric road vehicles Part 1, 2 &amp; 3. ISO12405 Electric road vehicles – test specifications for lithium – ion traction battery systems part 1 &amp; 2.</td>
</tr>
<tr>
<td>Battery recycling</td>
<td>A standard be developed for testing the recyclability of electric vehicle batteries and that such a test regime should simultaneously assess the durability of the battery.</td>
<td>No international standards</td>
</tr>
</tbody>
</table>
### 3. VEHICLE RECHARGING (trickle, medium charge & fast charge)

<table>
<thead>
<tr>
<th>Area of investigation</th>
<th>Key consideration</th>
<th>Existing standards and/or industry guidelines</th>
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<tbody>
<tr>
<td><strong>Home-based</strong></td>
<td>Level 1 home-based recharging can be accommodated without the need for additional standards. Any move towards the adoption of second generation commercial home recharging will require development of equipment and installation standards for Level 2 recharging systems.</td>
<td>No standards required</td>
</tr>
</tbody>
</table>
| **On-street charging**| A need to develop a national standard for the provision of on-street electric vehicle recharging infrastructure in terms of hardware design (i.e. system leakage and safety in the event of damage). This standard will need to stipulate minimum requirements in terms of physical design and system functionality. | IEC 61851.1 Electric vehicle conductive charging system Part 1 – General requirements.  
IEC 61851.21 Electric vehicle conductive charging system Part 22 – Electric vehicle requirements for conductive connection to an AC/DC supply.  
IEC 61851.22 AC electric vehicle charging station.  
IEC61980 Electric vehicle inductive charging systems Part 1 & 2 (Draft stage). |
| **Commercial**        | The accommodation of second generation commercial recharging will likely require the development of a comprehensive set of national standards governing key aspects of the design of this type of infrastructure, including:  
- physical siting of the facility;  
- equipment standards required to support inter-operability;  
- dispensing and metering systems that meet consumer requirements in the same way that the design of petrol bowsers is regulated;  
- minimum fire safety and incident response systems, possibly adapted from existing standards for petrol stations;  
- minimum functionality in respect of load control, albeit that this element may not be required for some years given the slow take-up of electric vehicles; | DD CLC/TS 50457.1 conductive charging for electric vehicles DC charging station  
DD CLC/TS 50457.2 Conductive charging for electric vehicles. Communication protocol between off-board charger and electric vehicle. |
<table>
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<tr>
<th><strong>Upstream interface</strong></th>
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<tbody>
<tr>
<td>Development of a national standard for the upstream communications interface with Level 2 and Level 3 vehicle recharging infrastructure.</td>
<td>No international standards</td>
</tr>
</tbody>
</table>

### 4. RESCUE, REPAIR, & RECOVERY

<table>
<thead>
<tr>
<th><strong>Area of investigation</strong></th>
<th><strong>Key consideration</strong></th>
<th><strong>Existing standards and/or industry guidelines</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance and repair</strong></td>
<td>A standard requiring the provision of standardised information to the Australian vehicle repair industry in relation to the repair of individual makes and models of electric vehicles sold in Australia; A standard for the design and management of electric vehicle workspaces. This standard might be progressed along similar lines as that applied for the work area for gas-fuelled vehicles.</td>
<td>ISO 8713 Electric road vehicles – vocabulary ISO 8715 Electric road vehicles – Road operating characteristics</td>
</tr>
<tr>
<td><strong>Rescue and recovery</strong></td>
<td>An Australian standard that stipulates requirements for disabling the power systems of electric vehicles (i.e. battery packs and quick discharge of high voltage components) would provide a workable solution to this issue.</td>
<td>No existing international standards</td>
</tr>
<tr>
<td><strong>Vehicle labelling</strong></td>
<td>A standard for the external labelling of electric vehicles. In addition consideration could be given to the development of a standard requiring the clear identification (i.e. labelling and/or colour coding) of high voltage cables and electric vehicle components.</td>
<td>No international standards</td>
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</table>
### 5. MISCELLANEOUS CONSIDERATIONS

<table>
<thead>
<tr>
<th>Area of investigation</th>
<th>Key consideration</th>
<th>Existing standards and/or industry guidelines</th>
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<tbody>
<tr>
<td><strong>User information</strong></td>
<td>Australian standards could be developed to (a) specify the format of specific vehicle user information (and warnings) that should be provided in the vehicle handbook supplied with electric vehicles sold in Australia, and (b) specify the safety information that should be provided at all on-street and commercial charge points.</td>
<td>ISO/TR11955 Electric road vehicles – externally chargeable hybrid electric road vehicles – guideline for charge balance measurement. Further investigation required.</td>
</tr>
<tr>
<td><strong>GHG performance</strong></td>
<td>Need to develop (a) a standard methodology for comparing the GHG and energy efficiency of electric vehicles with conventional vehicles, and (b) a standard requiring the display of an energy efficiency label to compare the relative performance of different electric vehicles.</td>
<td>ISO 23274 Hybrid electric road vehicles – Exhaust emissions and fuel consumption measurements Part 1 &amp; 2.</td>
</tr>
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Appendix 2

List of primary stakeholders in the Australian electric vehicles agenda

<table>
<thead>
<tr>
<th>State-based Regulators</th>
<th>ENA</th>
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<tbody>
<tr>
<td></td>
<td>Michael Kilgariff – National Director</td>
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<td>Mob: 0418 627 995</td>
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<tr>
<td></td>
<td>Inclusive of ENA – Electric Vehicle Working Group</td>
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<tr>
<th>Manufacturers</th>
<th>Federal Chamber of Automotive Industries</th>
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<tr>
<td></td>
<td>James Hurnall</td>
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<td>FCAI – Working Group includes:</td>
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<th>Philip McKenzie</th>
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<tr>
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<th>David Wynne</th>
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<td>Director – Quality &amp; Service</td>
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<th>Greg Snart</th>
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<tr>
<th>Consumers</th>
<th>Consumer Federation of Australia</th>
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<tr>
<td></td>
<td>Jo Higginson</td>
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<td>Standards Co-ordinator</td>
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<tr>
<th>Testing Organisations</th>
<th>National Association of Testing Authorities</th>
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<td>Graeme Drake – General Manager</td>
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<tr>
<td>Conversion Companies</td>
<td>Blade Electric Vehicles</td>
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<td>Ross Blade</td>
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<tr>
<th>Charging Infrastructure Companies</th>
<th>Better Place</th>
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<tbody>
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<td>Guy Pross</td>
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<td>Vice President</td>
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<table>
<thead>
<tr>
<th>Specialised Organisations</th>
<th>Australian Electric Vehicle Association</th>
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<td>Kevin Woodhouse</td>
<td>Director</td>
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<thead>
<tr>
<th>Australian Automobile Association</th>
<th>Craig Newland</th>
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<td>Director Technical services</td>
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<thead>
<tr>
<th>Motor Trades Association of Australia</th>
<th>Colin Duckworth</th>
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<tr>
<td>Policy</td>
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<tr>
<th>Australasian Road Rescue Organisation</th>
<th>Daryl Rush</th>
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<tr>
<td>Manager Operational Planning</td>
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Appendix 3

Glossary

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<th>ADR</th>
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<td>CAF</td>
<td>Council of Australian Federation</td>
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<td>GHG</td>
<td>greenhouse gas</td>
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<td>GPO</td>
<td>general power outlets</td>
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<td>OEM</td>
<td>original equipment manufacturer</td>
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<td>PHEV</td>
<td>plug-in hybrid electric vehicle</td>
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Appendix 4

References

