CSIRO Electric Driveway Project

Supporting Electric Vehicle Adoption in Australia: Barriers and Policy Solutions
ABOUT THE CSIRO ELECTRIC DRIVEWAY PROJECT
The CSIRO Electric Driveway Project is undertaking a comprehensive assessment of potential electric vehicle (EV) uptake and use under Australian conditions, exploring potential future synergies between the different components of Australia’s electricity and transport sectors. The research project is hosted by CSIRO’s Energy Transformed Flagship and draws on the strengths of CSIRO, a Victorian Government consortium, university collaborators and industry in a creative and effective partnership.

For further information visit www.electricdriveway.com.au

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ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BEV</td>
<td>Battery Electric Vehicle</td>
</tr>
<tr>
<td>DE</td>
<td>Distributed Energy</td>
</tr>
<tr>
<td>ED</td>
<td>Electric Driveway</td>
</tr>
<tr>
<td>EV</td>
<td>Electric Vehicle</td>
</tr>
<tr>
<td>EVSE</td>
<td>Electric Vehicle Supply Equipment</td>
</tr>
<tr>
<td>HEV</td>
<td>Hybrid Electric Vehicle</td>
</tr>
<tr>
<td>ICEV</td>
<td>Internal Combustion Engine Vehicle</td>
</tr>
<tr>
<td>MSRP</td>
<td>Manufacturer’s Suggested Retail Price</td>
</tr>
<tr>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
</tr>
<tr>
<td>V2G</td>
<td>Vehicle to Grid</td>
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</table>
EXECUTIVE SUMMARY

The Electric Vehicle revolution has begun.

The world’s major car manufacturers, including General Motors, Nissan and Mitsubishi, have started to mass-produce Electric Vehicles (EVs). Widespread and rapid adoption of EVs in Australia has major potential benefits for the environment, the economy and the electricity system. Coordinated government policy leadership could be instrumental in both tapping these benefits and in mitigating costs and risks.

This report examines barriers to the widespread adoption of electric vehicles (EVs) and suggests possible policy solutions. In particular, the report focuses on current and likely future technical and institutional barriers. Understanding these barriers can inform consideration of potential policy instruments to encourage a smooth and rapid transition of the current vehicle fleet to electric drive. The report describes a broad, but not exhaustive, list of over 50 potential policy options to address these technical and institutional barriers.

The research casts a broad net to consider policy options from every scale of government (local to national) and a range of stakeholders (manufacturer, customer, etc) with case studies drawn from Australia and overseas. While such a broad list of options is useful in canvassing the opportunities for change, it is also important to prioritise options into a set of harmonised policies that could maximise the impact in terms of increased EV uptake, in the shortest possible time, at least cost to individuals, industry and government.

Accordingly, a novel multi-criteria analysis approach was used to develop a short-list of prioritised policy options for Australia, based on a broad examination of potential policies. To this end, policy options were evaluated according to the following criteria:

- Effectiveness at increasing adoption of EVs in Australia
- Implementation cost for government and industry
- Expected level of public support for the measures
- Urgency of implementation
- Importance of additional benefits not related directly to EV adoption.

Through this process, the policy options list was narrowed down and synthesised to 20 priority policies for ease of analysis and discussion by ISF. The list has then been further refined down to 13 via a survey circulated among stakeholders. The 13 options were then discussed and narrowed down further at a stakeholder workshop.

After reaching consensus on a list of six priority policy options (from the original list of over 50), ISF further analysed these selected options in terms of the broad costs, resources and timelines for potential implementation, drawing on international case studies of related policy. The six priority policy options are:

**Common metric for lifetime cost comparison.**
The creation of a consistent measurement tool for comparing the lifetime costs of vehicle ownership including factors such as purchase price, fuel and maintenance would provide a simple method for consumers to compare all types of vehicles including ICEVs, HEVs and EVs.

**Coordinating federal and state EV strategies.**
Not so much a policy option, but a framework for coordinating options, this involves the federal government and state governments developing coordinated strategies on how best to work with industry and the public to encourage adoption of EVs and ensure a smooth and rapid transition to EVs.
Connecting renewable energy targets to EV sales.
Relating renewable energy targets to EV sales will ensure that future growth in electricity demand associated with EVs is linked to growth in low carbon energy. As Australia has one of the most carbon intensive electricity systems in the world, EVs will need to be charged using renewable energy to ensure significant greenhouse gas emission reductions. This policy is important not just to reduce emissions but to address market resistance to EVs.

Green registration discounts.
Related to the previous option, this policy involves offering discounts on annual vehicle registration costs for EV drivers who purchase Green Power or otherwise use renewable energy to power their vehicles. This will encourage zero emission driving and support customer acceptance of EVs.

Time of Use pricing.
Consumers have historically paid a flat rate for electricity. Under Time of Use pricing, electricity can be priced according to demand throughout the day and year, resulting in significant savings for consumers who opt to charge their EVs at off-peak times, and reduced impacts on electricity supply infrastructure.

Upfront EV cost reductions and fuel economy based fee.
Charging a fee to consumers based on the fuel economy of the vehicle at the time of purchase will push the market towards vehicles that are more fuel-efficient. Providing cost reductions or exemptions for EVs at the time of purchase, including sales tax waivers, income tax deduction or cash back rebates, will pull the market towards greater uptake of EVs. Together these “feebate” policies can offer a ‘budget neutral’ strategy.

This research has been conducted by the Institute for Sustainable Futures (ISF) for the CSIRO Electric Driveway (ED) project. The ED project is a three-year comprehensive assessment of potential EV use and adoption under Australian conditions, exploring potential synergies between the different components of Australia’s electricity and transport sectors and barriers to change. The research project is hosted by CSIRO’s Energy Transformed Flagship and draws on the strengths of CSIRO, universities and industry in a creative and effective partnership.

This report sits within one of the key areas of the ED project: task 1.3 – A3, which focuses on technical, economic, environmental and institutional assessments of widespread EV adoption. The analysis completed in this report will be continued with future work under the ED project including expanded policy options and modelling of the impact of policies on EV adoption.

This report does not represent in any way a political endorsement by any political body.
1. INTRODUCTION

Energy use by households and, in particular, electricity use in the home and petrol use in vehicles constitutes a large share of greenhouse gas emissions both nationally and internationally. Emissions from these two sources must be significantly curtailed if emission targets are to be met. While there has been much separate research into emissions reduction for either homes or for vehicles, the potential for emission reduction via synergies between these two areas warrants greater attention. Such synergies are the focus of the Electric Driveway (ED) Project.

The Electric Driveway Project is a three-year comprehensive assessment of potential electric vehicle (EV) use under Australian conditions, exploring potential synergies between the different components of Australia’s electricity and transport sectors and barriers to change. The research project is hosted by CSIRO’s Energy Transformed Flagship and draws on the strengths of CSIRO, universities and industry in a creative and effective partnership.

This report addresses one of the Electric Driveway Project aims to focus on institutional, technical and regulatory barriers to EV adoption and integration with buildings and the grid.

This is the second research report by the Institute for Sustainable Futures (ISF) for the Electric Driveway Project. The previous report contains pertinent background information including an overview of EV technology and an analysis of state and local electricity impacts of various EV charging and vehicle to grid (V2G) scenarios.

This report first explores key barriers to the widespread adoption of EV and points of possible government intervention. These barriers and solutions are then shown in a matrix presenting the areas of impact of each potential policy solution. A status review of domestic and international policy is then presented and summarised in a second set of matrices. Lastly, a summary section on priority policy options for Australia is provided.

This report focuses on EVs, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) and does not directly address hybrid electric vehicles (HEVs) or internal combustion engine vehicles (ICEVs) as only the vehicles that plug-in will have impacts on homes and electricity systems which are the focus of the Electric Driveway Project. The differences between these vehicles are outlined in Table 1-1 below.1

This work, combined with the other work in the Technical, Economic, Environmental & Institutional Assessment area of the Electric Driveway Project, will lead ultimately to a policy and technology options report to inform a strategy for optimal uptake of EV technologies.

---

1 Notes taken from Phase 1 report.
Table 1-1: Vehicle configurations

<table>
<thead>
<tr>
<th></th>
<th>ICEV</th>
<th>HEV / Motor</th>
<th>PHEV</th>
<th>BEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Train</td>
<td>Engine</td>
<td>Engine / Motor</td>
<td>Engine / Motor</td>
<td>Motor</td>
</tr>
<tr>
<td>Energy Source</td>
<td>Liquid fuel</td>
<td>Liquid fuel</td>
<td>Liquid fuel / electricity</td>
<td>Electricity</td>
</tr>
<tr>
<td>Net Efficiency (approx) – (Ornelas 2008)</td>
<td>12-15%</td>
<td>18-30%</td>
<td>33-77% (depending on EV distance driven)</td>
<td>62-77%</td>
</tr>
<tr>
<td>Benefits</td>
<td>Low relative capital cost</td>
<td>Reduced fuel costs</td>
<td>Significantly reduced fuel costs</td>
<td>Largest CO₂ reduction when compared to all others if charged with Green Power</td>
</tr>
<tr>
<td></td>
<td>Quick to refuel</td>
<td>Quick to refuel</td>
<td>Quick to refuel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO₂ reduction compared to ICEV (by ~30%)</td>
<td>Can travel short distances with electricity alone</td>
<td>CO₂ reduction from ICEV and HEV</td>
<td></td>
</tr>
<tr>
<td>Drawbacks</td>
<td>Reliance on non-renewable fuel source</td>
<td>Reliance on non-renewable fuel source</td>
<td>Higher relative capital cost than HEV</td>
<td>Potentially limited range</td>
</tr>
<tr>
<td></td>
<td>High running cost</td>
<td>Higher relative capital cost than ICEV</td>
<td>High capital costs with current battery prices</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High CO₂ output</td>
<td></td>
<td>Charging can be slow (potentially overnight)</td>
<td></td>
</tr>
</tbody>
</table>

1.1 Framework for analysis

The current industry consensus has been summarised as: “electric vehicles are coming – again – but this time it is different” (Hyde, 2010). New technology and support from all the major automakers, including introductions over the past few years of several new EVs, has convinced many people that, this time, EVs are here to stay. With several pieces of research (Albrecht, 2009a and Simpson, 2009) concluding that EVs will bring substantial environmental benefits, many stakeholders are looking for strategies that will increase vehicle adoption. However, numerous interrelated barriers exist that will inhibit the rapid transition of vehicle fuel from petrol to electricity. These barriers span multiple agencies, sectors and levels of government. Overcoming these barriers will therefore require a significant and coordinated response from Governments at all levels. These barriers and a suite of proposed solutions are the focus of this report.

In order to systematically address the various barriers, they must first be identified through an examination of the major aspects influencing EV adoption in Australia. This report not only draws on the research of experts from within Australia, but also uses international research to ensure that all key barriers are identified.

Once identified, barriers to EV adoption can be analysed and classified in numerous ways. The classification of barriers should seek to include categories that are mutually exclusive and collectively exhaustive. For this paper we have adopted the “barrier mapping” tool developed by ISF as part of CSIRO Intelligent Grid Research Program (Dunstan and Daly, 2009) (Figure 1-1). While this tool focuses on institutional barriers rather than technical barriers, it provides a systematic structure for classifying barriers and illustrating the relationship between them. It also allows a direct mapping of barriers against potential policy instruments to address these barriers using the Policy Palette (Figure 1-3).
The barriers can be fundamentally classified as either technical barriers or institutional barriers. The following, as described by the Intelligent Grid (iGrid) Research Program, sums up the distinction: technical barriers relate to the technological characteristics and limits; and costs associated with the technology – meaning ‘what they do’ and ‘what they cost’. Institutional barriers are those created as a result of how humans relate to the EVs, through laws, regulations, values and culture.

Figure 1-1: Barriers to changing practice

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Technical</th>
<th>Institutional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Technology</td>
<td>Current Costs</td>
<td>Regulatory Barriers</td>
</tr>
</tbody>
</table>

The figure below describes conceptually the distinction between technical barriers and institutional barriers. Overcoming both types of barriers will lead to different economic, social and environmental outcomes. Technical barriers form the limit of optimum outcomes, e.g. outcomes that are both technologically possible and economically feasible. If we relax the institutional barriers, we are able to move current practice closer to attaining wide-scale “best practice”.

Figure 1-2: Conceptual Framework of Technical and Institutional Barriers to EVs

In an emerging area of rapid technological change, such as EVs and associated infrastructure and components, it can be tempting to focus on the technical barriers to increase the use of the technology. From a global perspective this is probably appropriate. However, as technological improvement can quickly diffuse around the world, the relative success of different countries in taking advantage of these technological changes depends crucially on reducing and removing the institutional barriers to their adoption. So while policy
measures to support technological innovation in EV in Australia are important, it is equally important to understand and address the institutional barriers that can retard the growth of a receptive market for this technology in Australia.

The classification for institutional barriers is more complex than technical barriers (function and cost), and can be described as follows:

1. Regulatory barriers: regulation biased against the technology;
2. Externalities and price structures: failure to reflect costs (including environmental costs) accurately in prices;
3. Payback gap: the gap in acceptable payback periods between stakeholders, and in particular between infrastructure providers and consumers;
4. Split incentives: the challenge of capturing benefits spread across numerous stakeholders;
5. Lack of information: absence of or difficulty in accessing relevant, reliable information;
6. Cultural values: insufficient attention given by individuals and organisations to new opportunities and technologies; and
7. Confusion: the additional barriers created by the interaction of these barriers.

These categories of institutional barriers (in grey, and categories of possible policy response - in black) are illustrated in Figure 1-3 and discussed below.
The purpose of analysing barriers is to aid in the creation of effective policy options to address these barriers. The key objective in creating good policy in this context is to increase the rate of EV uptake in a setting where many of the drivers such as peak oil, climate change and industry competitiveness require urgent responses. Therefore, in this context, the test of effective policies will be the level of EV uptake. That is to say that there are issues with both supply and demand; and analogously barriers to achieving both availability and uptake.

According to the general principles of supply and demand, if demand for a good increases or the cost of supply decreases (while the other aspect is constant) then consumption, or adoption, of that good will increase. Therefore, policy options can increase adoption by either lowering the cost of supply, by for example, manufacturing subsidies or supporting technological innovation, or they can work to increase actual or effective demand by reducing transaction costs or other barriers.

In an ideal market, participants would be able to respond instantaneously to new information and new policies. However, in practice, policies are created in a context of shifting consumer preferences and technological change. While the dynamic element of both markets and government policy is considered below, the detailed analysis of diffusion of technologies and policy impacts is outside the scope of this report.

The analysis of policy options is further developed in this report using the framework developed under the Intelligent Grid Research Program – Project 4 (Dunstan et al., 2009) to classify options using the following seven categories:
1. Regulation: ‘establish laws and rules’ to require desirable outcomes and discourage undesirable outcomes
2. Pricing: reflect true costs and benefits (including environmental) in fuel and vehicle purchases
3. Enticement (or Incentives): reduce payback periods to levels acceptable to consumers by offering financial or other rewards
4. Facilitation: ensure that benefits spread across numerous stakeholders are adequately captured and distributed
5. Information: provide accessible, timely and relevant information to all stakeholders
6. Targets: generate attention and interest by individuals and organisations by ‘generating specific objectives and measuring performance against these objectives’.
7. Coordination: ensure policies work together to not only address specific barriers, but also barriers created by their interaction.

It should be noted that while there are analogous policy option and barrier categories, a policy option in one category may be designed to address a barrier in a category that is not its direct analogue. This is described in more detail in Section 2.2.7 of the report.

1.2 Prioritising policies for Australia

1.2.1 Why prioritising policy options is important

There is a virtually unlimited set of policy options that could be designed to increase EV adoption in Australia. However, implementing such an enormous set of options would require virtually unlimited resources. Furthermore, coordination between policies is often as important as the individual policies themselves. Therefore, it is prudent to prioritise options and implement a set of harmonised policies that will maximise the impact in terms of increased EV uptake in the shortest possible time at least cost to individuals, industry and government.

1.2.2 Criteria to prioritise options

To ensure that government resources are maximised in facilitating the widespread adoption of EVs, appropriate criteria by which to prioritise policy options need to be articulated and used. When selecting policy options, the government should prioritise options against internal criteria as well as external criteria.

Internal criteria, particularly in relation to EV policy development, means that government should ensure that the policy options appropriately harmonise with the role of government in technical change and generally fall within the government’s mandate.

The role of government in technological change was originally thought best to be a linear model, where the role of government is limited to the funding of basic R&D and sometimes applied R&D in the public interest (Freeman, 1995). With the inherent uncertainty involved in technological development, a more complex process oriented model should replace the linear model where interaction and learning processes are at the core. A process oriented model of policies to support technical change could include:

- Policies that acknowledge the key features of technical change, such as uncertainty, learning, path dependence and accumulation of knowledge (Soete and Arundel, 1995 ad Kemp et al., 1998 in Ahman, 2004)
- Policies that modulate the market by for example taxes, legislation and “niche-market management”, thereby allowing government to act as strategic niche market organisers
INTRODUCTION

- Policies that provide support, to some extent, in all development phases at the same time and not in a sequential order (Ahman, 2004).

Therefore, the internal criteria selected for this policy analysis incorporate the following considerations:

- Does the suite of policies provide support for development in all, or the majority of, phases?
- Do the policies fall within government’s mandate?
- Do the policies allow for the key features of technical change, including uncertainty, learning, path dependence and accumulation of knowledge?

Policy options also need to be considered in relation to one another and the broader socio-economic-political context. Therefore, the external criteria selected for this policy analysis include:

- How effective would this policy be at increasing adoption of EVs in Australia, in comparison to other options?
- How much would the option cost government to implement?
- How much would the option cost industry to implement?
- What level of public support would this policy option be expected to have, in comparison to other options?
- How urgent is this reform option (e.g. when should this reform option be implemented?)
- How important are the additional, or secondary, benefits of this policy (e.g. benefits related to air quality, greenhouse gases, job creation and economic stimulus)?
2. KEY BARRIERS AND POSSIBLE POLICY SOLUTIONS

Barriers to the adoption of EVs can be broadly classified as either technical barriers or institutional barriers. Section 2.1 focuses on technical barriers, or in other words, barriers that relate to the technological characteristics and financial characteristics of the EVs themselves – meaning ‘what they do’ and ‘what they cost’. Section 2.2 introduces institutional barriers, or those barriers that are created as a result of how humans relate to EVs, through laws, regulations, values and culture.

2.1 Technical Barriers and Solutions

Electric vehicle technology has come a long way since the 1996 release of the first modern consumer BEV: the GM EV1. Shortly after the first few customer deliveries of the EV1, most major automotive manufacturers either released their own EVs or were on the verge of doing so. However, today, not a single one of these vehicles are in production, and less than 1,000 were sold or leased. As was depicted in the movie, ‘Who Killed the Electric Car’, most of the original EV1s were recalled and crushed. A significant reason for the collective failure of this generation of EVs in the 1990s were the technical barriers with the components which did not enable the performance, reliability, and low purchasing price that consumers required.

However, since the release of the Toyota Prius in 1997, the electrification of passenger cars has embarked on a steady incremental path towards a zero emissions future. The advent of hybrid electric vehicles (HEVs) has enabled a flourishing electric drivetrain and automotive energy storage industry. As of August 2, 2010 Toyota had sold more than 2.5 million hybrid vehicles (Loveday, 2010b). In addition to significant electric drivetrain and battery technology improvements since the 1990s, there is now a clear precedent that consumers are comfortable, and in many cases prefer, vehicles with greater fuel economy enabled by electrification and electrochemical energy storage.

HEVs now provide a convenient platform upon which many advanced EV technologies can be proven and subsequently implemented in PHEVs and BEVs. For all but a small handful of production HEVs, sufficient energy storage has been achieved using nickel metal hydride batteries, a relatively old and mature battery technology. Meanwhile, two or three generations of significantly more advanced lithium ion batteries have made it out of the laboratories and into the manufacturing plants. Substantial progress on energy storage and drivetrain components has been made, but many technical barriers remain for EVs. These barriers have the potential to substantially reduce the rate of vehicle uptake.

A technical barrier is a relative shortcoming when comparing an incumbent technology to a competing new technology. For this comparison, ICEVs are the incumbents and EVs are the challengers. EVs have many attractive features that ICEVs generally do not offer such as peak baseline torque, home charging, low noise, low or zero emissions, and low maintenance. Despite all these attractive qualities and the recent progress with EV technology some shortcomings persist. A reduction or elimination of these shortcomings will increase consumer desirability and increase the rate of EV uptake. A useful and forward-looking basis for comparison is the gap between “nearly commercialized” EV technology and the most advanced commercially available ICEVs.

The critical technical EV attributes that affect consumer desirability are range, charge time, reliability, cycle life, calendar life, climate/temperature compatibility, safety, and cost. For each of these attributes, there may be several underlying technical gaps that are responsible for the perceived barrier.

2 Encompassing components such as EV specific transmissions, motors and motor controllers.
Barriers can also be explained in the context of tradeoffs. When one attribute of a technology is improved or scaled up, other attributes may suffer. A classic example is the relationship between range and cost for BEVs. A battery pack can be made much larger thus enabling an excellent range, however the cost and weight of this pack will rise dramatically and acceleration will suffer. It is therefore simplistic to say that “poor range is the largest barrier to EV adoption” unless it is put into context with battery pack costs and vehicle performance.

2.1.1 Technology characteristics

2.1.1.1 Charge time

Some motorists may choose to charge exclusively at home due to the added convenience of avoiding a detour in their driving route to recharge. However, many EV owners with irregular or demanding driving schedules may require the ability to rapid charge. For consumers who do require rapid charging, it is unclear what recharge time will be acceptable; however ICEVs can be used as a basis for comparison. The Nissan Leaf, for example, has a range of 160 km and can be charged to 80 percent in 30 minutes using 60 kW “level 3” charging (Squatriglia, 2009). By comparison, the 2010 Toyota Prius, has an 800 km range and can be “recharged” (i.e. refuelled) in approximately 2 minutes at a standard Australian petrol station. In terms of energy being transferred into the vehicle, this is equivalent to a 15,000 kW “charger”. Therefore, 250 units of energy are being pumped into the Prius for every unit of energy being charged back into the Leaf’s battery. While some consumers may be willing to accept a 30-minute recharge time, it is certainly not what they are used to. The barrier here can be framed simply as: how can that much electricity be put back into the battery pack in a short period of time?

Fortunately there are two areas of research that hold substantial promise: quick charge and battery swapping. One example of a commercially available EV with a rapid recharge time is the BYD e6. Using a 38 kW charger, BYD claims the e6 can be recharged to 50% capacity in less than 10 minutes. Furthermore, a lithium nickel manganese oxide battery created at MIT was shown to be capable of a sub 10-minute recharge (Hanlon, 2010). The clear leader in battery swapping is Project Better Place. Battery swapping has been demonstrated to take less than 2 minutes, and can be done safely by a robotic service station (Better Place, 2010).

Another common strategy for addressing long charge times is through the use of petrol-based “range extenders” as applied in Plug-in Hybrid Electric Vehicles (PHEVs). By providing the options of reverting to petrol as a source of either on board power generation or direct motive power, the drawbacks of long charge time where this is inconvenient can be avoided.

2.1.1.2 Range

BEV Range is defined as the distance the vehicle can travel on a single charge, and no single international standard exists for its measurement. Vehicle range is determined by drivetrain efficiency, aerodynamics, rolling resistance, driver behaviour, accessory loads and energy capacity. Thus an improvement in any of these vehicle attributes will result in an improvement in range. For BEVs, drivetrain efficiencies are already very efficient, and further gains may not result in significant improvements to range. Larger gains could be made by reducing vehicle weight and thus decreasing rolling resistance and breaking losses. Likewise, EV aerodynamics have not yet been perfected. However, the largest technical barrier to achieving greater BEV range is the energy capacity of the battery pack. Figure Table 2-1 below shows the number of daily journeys in Australia versus journey distance for all motorized travel. From this data we can see that the vast majority of journeys are less than 100km, and as such it would seem that EVs would be suitable for the mass market with this relatively modest range. However, EV range can be reduced by up to 50% or more due to real world driving conditions and user specific variations on the vehicles drive cycle. These variables include temperature, wind, rain, snow, aggressive driving, high cargo loads, and internal accessories. For example, if
an EV’s range is normally 120 km, and while packed with four passengers and camping gear on a hot summer day it drops to 60km unexpectedly, this will be a serious inconvenience to the motorist. In comparison, if an ICEV range is cut from 500 km to 250 km, it might be a more expensive trip, but the inconvenience to the motorist is minimal. Not only does the ICEV has plenty of range to spare, but the refuelling time is short and there are many places to refuel. ICEVs have proven that there is strong consumer demand for vehicle ranges far greater than 100km. Increased range enables longer infrequent trips and reduces range anxiety.

Table 2-1: Daily Travel Distance (Albrecht et al. 2009b)

Table 2-2 below shows a range of vehicles and their reported range for a single charge. The largest differentiator between these vehicles is pack size. Tesla stands out with the largest range, and there are 8 vehicles with a range of 150 km or greater.

Table 2-2: Vehicle Range on a Single Charge (Albrecht et al. 2009b)
2.1.1.3 Batteries

*Energy and Power Density*

In the past, EVs were perceived to be underpowered and have poor range. The two most influential figures of merit for these discrepancies are energy and power density. Relative to both volume and weight, these figures of merit help scientists and engineers compare battery packs of different sizes in a systematic and direct manner. Both power densities and energy densities for a wide variety of lithium ion chemistries have increased dramatically in the past fifteen years.

A123 Systems have a commercially available cell that has demonstrated a power density of 3 kW/kg (A123, 2010a). This is more than 10 times the typical power density of a lithium ion battery. Power densities have increased sufficiently high as to no longer be a barrier to commercialization.

A typical high quality lithium ion cell can have a gravimetric energy density of 150 Wh/kg. In comparison, petroleum has an energy density of approximately 12,500 Wh/kg or roughly 80 times the energy density. Fortunately EVs are roughly 3 times more efficient than ICEVs, but by comparing the two it becomes apparent why it is difficult to achieve a very high capacity battery pack in an EV.

Therefore, unlike power density, much remains to be desired with energy density. Despite excellent progress, energy density of available battery technologies remain a limiting factor in the widespread adoption of EVs (AA2020, 2010). In the current early commercialization phase, manufacturers such as BYD and Tesla are using larger, heavier battery packs in order to achieve sufficient range. An example is the BYD e6 that has a range of 300 km. Rather than use a high energy density pack, BYD has opted to use a chemistry that is sufficiently cheap that they can simply add more batteries at the expense of weight (BYD, 2010).

Table 2-3 below shows the forecasted weight for a typical EV battery pack. If the current rate of progress continues, it is predicted that a 160 km range battery pack will weight 55 kg.

Table 2-3: Forecasted Weight of a Typical Electric-Vehicle Battery. This assumes 3 miles (4.8km) per kilowatt-hour and 160 km range (US DOE 2010).

![Graph showing forecasted weight of a typical EV battery pack](image)

*Cycle and Calendar Life*
KEY BARRIERS AND POSSIBLE POLICY SOLUTIONS

Batteries degrade both due to use, as well as when not in use. Battery cycle life is defined as the number of complete discharge cycles a pack can handle before reaching 80% of its original capacity. Shallow cycles also cause degradation, however notably less than deep cycles. Calendar life differs from cycle life in that it is time it takes a pack to degrade to 80% of its original capacity when not in use. For example, if a battery pack has a 10 year calendar life and is being used regularly, it will have lost 20% of its original capacity after 10 years.

For most chemical variants of lithium ion batteries, such as lithium cobalt, lithium nickel cobalt manganese (NCM), and lithium manganese, a typical cycle life is 800 cycles. This translates to a useful life inside an EV of 4 to 8 years depending on usage, pack size and driving habits. Some variants, such as lithium iron phosphate (LiFePO4), experience less degradation per cycle. An example is the M1 cell from A123 Systems that has been shown to withstand 7,000 cycles at 25 degrees Celsius for a 1 hour discharge time.

Calendar life is unfortunately difficult to predict. The length of duration for state of the art cells being manufactured today will not be known for many years from now. However, accelerated tests can be used to simulate the effects of cell degradation over time with no external load on the cell. Additionally, there are examples of lithium ion batteries that have been used in the radio controlled toy racing industry for the past ten years with a proven track record for calendar life. For example, Dow Kokam produces a commercially available cell, which they claim has a 10+ year calendar life (Dow Kokam, 2010).

Safety and Temperature Considerations

The technical aspects of EV design that ensure the safety of the passengers are of the utmost importance. While EVs have the potential to be considerably safer than ICEVs due to the lack of a gas tank, at present they remain unproven in this regard in the mainstream commercial market space. No breakthrough is required to make EVs safe, however their remain technical barriers in the sense that battery packs and surrounding systems must be engineered and manufactured such that they can handle high heat, vibrations, collisions and abuse. The necessity of extra fuses, automatic disconnects, thermal management systems, and in some cases firewalls adds to the cost of the battery pack. Any highly publicized safety incident with EVs could have severe and long lasting effects on the perception of EVs in the eyes of consumers.

A near disaster occurred in June of 2008 when a converted Toyota Prius built by Hybrids Plus experienced a fire resulting from an assembly error. A washer was placed on the wrong side of a piece of plastic that resulted in a high electrical resistance. When the bolt came loose arcing occurred and started a fire that was completely independent from the cells themselves aside from the proximity of said bolt to the cells (Beauregard, 2008). This vehicle was a prototype and the incident does not seem to have irreparably harmed the EV industry, however if a commercially available vehicle such as the Tesla Roadster were to have such an incident, it is conceivable that it could have significant impacts on the whole industry.

The safety of a battery pack is highly influenced by thermal management. High temperature events pose the risk of causing thermal runway, which would lead to a fire or possibly an explosion inside the battery pack. While this is always a risk with gas tanks in ICEVs, considerable attention is being paid to ensure that EVs are even safer than what the consumers have come to expect. Most lithium ion batteries require monitoring and control to prevent cell failures. As such, temperature sensors are almost always included in EV battery management systems (BMS). A well-designed BMS will limit or even cut-off the current from the battery pack if a cell, or multiple cells, exceed the specified cut-off temperature. In order to prevent a high temperature warning or cut-off event from occurring, EVs will often include a thermal management system that utilizes either liquid or air to cool the battery pack. Liquid cooled systems can be used to cool the pack quickly, however they are often more expensive and more complex than air-cooled systems.
A notable example of an EV that uses air-cooling is the Nissan Leaf. It is speculated that the current draw from the Leaf’s pack is sufficiently low such that air-cooling is sufficient to avoid thermal incidents. In contrast, the Tesla Roadster uses liquid cooling for its much larger battery pack. While Tesla representatives claim liquid cooling to be superior, it is worth noting that the Roadster’s pack uses cobalt in their cells, and it is likely that their cell chemistry is intrinsically less safe than the Lithium Manganese cells used in the Nissan Leaf.

In addition to drivetrain and battery pack thermal management systems, most BEVs have air conditioning systems that rely on the energy stored in the battery pack. At higher temperatures the cooling systems can use a substantial portion of available energy and as such decrease vehicle range. For ICEVs this is less of a problem since the portion of energy devoted to cooling is small in comparison to the amount of energy used by the powertrain.

**Possible Policy Solutions**

While there are many EV components that are not yet optimized, there remain only a few which are far from optimal when compared to the ICEV equivalent. The largest technical gaps exist for battery technology and charging infrastructure. As such the following incentives and funding arrangements are recommended to address the most challenging technical barriers. Many of these recommendations are in alignment with the Australian Automotive 2020 Technology Roadmap (AA2020 2010).

**Research Funding**

**Tech1.** Initiate funds for centres of excellence for advanced manufacturing and battery pack development.

**Tech2.** Establish research partnerships between Australian centres of excellence and counterparts in Asia.

**Tech3.** Increase cell chemistry research funding for next-level high energy density batteries with a focus on increasing lifetime, reliability and reducing the cost of production.

**Demonstration Projects**

**Tech4.** Initiate, encourage and fund charging station and infrastructure demonstration programs. Preference should be given to research that is pursuing high power, lower cost, and higher reliability charging stations.

**Tech5.** Fund government EV fleet vehicle purchases with preference given to vehicles that are driven by commuters. Critical information from these vehicles such as power usage, state of charge and distance travelled should be fully monitored with GPS data acquisition. In addition the motorist’s qualitative experience should be recorded as well. Factors such driving enjoyment, range anxiety, and sense of safety should be included. This will enable further study of commuter habits and the ability of EVs to meet commuter demands.

**Tech6.** Demonstration projects that include advanced, high energy density battery packs. Preference for funding projects should go to EVs that hold promising battery technologies in the areas of high cycle life, high energy and power densities with low cell material costs.

**Tech7.** Fund or subsidize battery swapping stations for high daily use fleet applications such as taxis and delivery vehicles.
2.1.2 Technology costs

Battery Costs and Manufacturing Capacity

The single highest component cost for EVs is currently the battery pack. For the Tesla roadster, for example, the battery pack cost is estimated to be $33,000. To reduce costs, engineers could choose to design vehicles with substantially smaller packs, but consumers are used to ranges in excess of 400km. To achieve this range, an approximately 60kWh battery pack is required. At an aggressive price target of $200/kWh, this equates to $12,000 per battery pack.

Table 2-4 below shows the forecasted cost of a typical EV battery. Economies of scale will be largely responsible for a pack cost of approximately $5,000 by 2020.

Table 2-4: Forecasted Cost of Typical EV Battery. Assumes 3 miles (4.8 km) for ever kilowatt hour and a 160 km range (US DOE 2010)

To achieve these cost targets, very large factories must be built and production volumes must increase dramatically. Some progress has been made in this regard. A123 Systems for example has opened a new 91,000 square-foot manufacturing facility in Livonia, MI, USA. This new facility is expected to expand A123’s manufacturing capacity by 600MW, or approximately 20,000 vehicles worth of cells (A123 2010b). Another example is a joint venture between Thundersky and RUSNANO with enough capacity to build 15,000 cars per year (Nanowerk, 2010).

One concern with the long-term cost of battery packs is the availability of lithium and other metals used by lithium ion batteries. Despite lithium being found in abundance in salt flats and in the ocean, the number of high concentration mineable locations is relatively few. However, several studies have demonstrated that this will not be a limiting factor in the rollout of EVs. Furthermore, with an annual production exceeding 6,000 tonnes, Australia is the second largest producer of lithium in the world. Australian lithium reserves are estimated to be 580,000 tonnes (AA2020, 2010). Currently cobalt, lithium and nickel are the only battery materials that are recovered in significant quantity from common smelting processes. Also, recovering battery aluminium and copper may very well be economical in the near future. An example of a battery recycling company that recovers both lithium and cobalt is Toxco Inc in British Columbia (Toxco, 2010).
Manufacturing Assistance

Tech8. Enact an investment tax credit for domestic battery production facilities that encouraged local manufacturing of low cost, high energy and power density batteries.

2.2 Institutional Barriers and Solutions

Even if all technical barriers were removed, the uptake of EVs may be limited by the habits and conventions that have been established during the past century of dominance of ICEVs. This section introduces these “institutional barriers”, created as a result of how people relate to EVs, through market and government structures, laws, regulations, values and culture.

2.2.1 Regulatory Barriers - Regulatory Reform

Regulatory barriers generally refer to those barriers created by the operation of laws and regulations. In relation to EVs, a relatively rapidly emerging technology, regulatory barriers may more frequently arise due to a lack of regulation needed to support widespread adoption.

Laws and regulations in relation to EVs that are needed, but are commonly lacking due to the new nature of this market, include:

- Standards for technology (e.g. batteries and charging systems) and safety
- Interoperability between cars and chargers
- Guidance on how and where to install charging equipment, and when this equipment can be used
- Registration and insurance
- Manufacturing and sales
- Maintenance and servicing
- Consumer protection including performance claims and warranties
- Battery shipping and handling including recycling.

Regulation can also play an important role supporting the market development of EVs; however this regulation has been slow to develop to date. Examples include:

- Strict exhaust emissions standards
- Requirements for EV acquisition for government fleets.

Some specific areas where regulatory barriers are more acute are discussed below.

Electricity System Infrastructure Regulation

As stated in the Phase 1 report, EVs have the potential to be either a costly new electrical load or a new system resource depending primarily on the level of control utilities may have over the vehicles in their service area and timing of charging. If these issues are not addressed soon, there may be significant opposition to EVs from taxpayers who may end up paying higher electricity costs because of the additional peak system load. This could act as a significant barrier to widespread adoption of EVs.
There are significant challenges that need to be solved in order to maximise the utility of EVs as a distributed energy (DE) resource and simultaneously eliminate any negative impacts related to the electricity system associated with mass EV adoption. Several of the regulatory barriers associated with this are outlined in the iGrid Working Paper 4.1 report including “coupling” regulated utility revenue and profits to electricity sales volumes. This approach can mean that utilities have strong incentives to supply power but few incentives to purchase it back through vehicle to grid (V2G) applications.

A particular area of relevance for EVs is regulation pertaining to peak demand and network augmentation. Several specific recommendations have been made within this context in the iGrid Working Paper 4.2 including decoupling of network business profits from electricity sales, fair treatments of DE in the national electricity rules and streamlining of licensing requirements for DE.

**Vehicle Clustering**

Is it expected that, as with hybrids, uptake of EVs will group or cluster together in particular neighbourhoods (Packard 2010). This will cause loads on particular transformers, feeders and substations to increase faster than average as EV adoption rates increase. This increases the urgency of regulatory reform. While EV penetration rates may not have significant near-term impacts on many network assets, particular areas are likely to experience grid capacity stresses at relatively low levels of overall EV uptake.

**Controlled Charging**

EV companies anticipate customer demand for charging in under an hour for vehicles that are either being used for longer trips, do not have a convenient place to charge at home, or for people who do not to or are not able to wait. Level 3 fast charging can meet this demand by cutting charge times by more than half. However, there is no specific global standard for this type of charging and a variety of terms (e.g. Level 3 charging, Super-Charging, etc) for this type of charging is creating confusion and frustration within the industry.

**Home Upgrades and Permitting**

Many individuals who purchase EVs will install home charging electric vehicle supply equipment (EVSE). This will often require upgrades and permits, especially if there is no spare capacity in the main electrical service panel. Furthermore, for those who want to be able to feed energy back to the grid, additional permits and potentially new regulations will be required, similar to solar PV home installations.

**Vehicle Standards**

As discussed earlier, standards for technology and safety are an important aspect of EV regulation that needs to be developed rapidly in order to maximise adoption of EVs. The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) have already begun the process of setting standards related to various aspects of EVs. These international standards include the newly revised ISO 6469, a two-part standard intended to help manufacturers design fail-safe electrically propelled vehicles, and 9 different standards documents have already been published under IEC TC69—Electric Road Vehicles and Electric Industrial Trucks (Brown et al, 2010). If Australia adopts standards reflecting other national and international standards as much as practicable, it will increase EV adoption both by encouraging automakers to offer products in Australia and by maximizing safety and environmental outcomes. In order for standards to become useful, they must also be adopted by regulatory agencies in documents such as the Australian Design Rules (ADR). These rules were created without consideration for EVs and require revision.
Charging Infrastructure

EV charging both in the home in the public realm is an area that requires careful consideration with regards to regulation. A number of current international standards exist relevant to EV battery charging infrastructure and provide the basic electrical safety framework for the provisions of vehicle charging facilities at shopping malls, parking buildings, parking lots and other such facilities. The SAE Electric Vehicle Conductive Charge Coupler (J1772) for example covers the general physical, electrical, and performance requirements of one type of electric vehicle conductive charge system and coupler. The area of interoperability, or which vehicles will be able to charge at which stations, is an area where regulation is needed more urgently as there are currently several competing local and international initiatives. There is also a need for standardisation of how charging provider plans are communicated to the public especially if multiple business models emerge.

Vehicle Categories/Classifications

Australia is being denied many of the EVs products available globally because suitable regulatory classifications/categories for these vehicles do not currently exist. These include the multitude of mini-cars, 3-wheelers, NEVs and other “sub-car” products. A prominent example is Reva G-Wiz that was not eligible for registration as a regular vehicle and Australia, unlike many other countries, does not have a “quadracycle” vehicle category.

Battery Lifecycle

New regulations are needed for the manufacturing, shipment and recycling or disposal of EV batteries. This regulation is required both to ensure safety as well as efficiency in the industry. Ongoing work related to larger-scale battery packs includes a number of IEC initiatives and working groups related to developing standards for lithium-ion batteries, lead-acid, and nickel batteries for automotive applications (Brown et al, 2010).

Environmental Performance

The environmental performance with regards to resource use, local air quality and GHG emissions is a complex area of research. Regulations are needed to determine standards for consistent calculation of these effects between vehicle types including EVs and ICEVs. One of the main challenges in this is the determination of system boundaries.

Possible Policy Solutions

Given a significant requirement for either new regulation or regulatory reform in these areas, possible policy options include:

**R1. Develop standards for EVs and charging equipment in high priority areas**

Lazar and McKenzie (2009) suggested that there are several areas related to EVs where standards development is either progressing too slowly or not at all. This work was later revised (Lazar & McKenzie 2010) to include a work plan. The areas of highest priority identified in the report included standards for: occupant safety, aftermarket installations, recharging interface, and vehicle labelling. All of these fell under the ‘market protection’ classification used in the report. Where possible, these new standards should attempt to align with existing or upcoming international standards such as ISO 6469 on safety specifications.

**R2. Streamline EVSE code and permit requirements**

This will reduce application and waiting times, reducing purchase barriers of new EVs from
consumers requiring home upgrades. This is also important for businesses installing EVSE for commercial public charging.

R3. **Implement mandatory fuel economy standards**
Voluntary standards are unlikely to sway manufacturers towards offering more efficient vehicles, including EVs, as can be seen by relative fuel consumption in Australia versus many countries in Europe. Several countries have implemented mandatory fuel standards with additional credits for manufacturers that offer vehicles significantly below the mandated standards. These additional credits in addition to aggressive mandatory fuel economy standards would be required to increase the rate of EV uptake in a significant manner.

R4. **Develop mandatory low and zero emission vehicle requirements**
As with legislation developed by the California Air Resources Board (CARB), regulation requiring manufacturers to sell a minimum number of low and zero emission vehicles would ensure that potential purchasers have access to vehicles.

R5. **Ensure building codes for new or renovated sites to support EVs by requiring dedicated electrical capacity and parking spaces**
New buildings or renovations could be required to have the capacity to deal with the additional load of an EV and have EV specific parking allocations. Many homes, and particularly apartments, may have little or no spare electrical supply capacity. This also needs to happen at the community level to ensure there is sufficient capacity for EV charging in the network. There are international examples outlined in this report where jurisdictions have implemented a minimum number of service points for new apartment buildings as an example.

R6. **Regulation to allow emergency load curtailment of EV charging**
This would ensure that EVs do not threaten the integrity of the grid by allowing utilities to stop EV charging in certain circumstances to prevent potential damage to network assets or prevent a power outage.

R7. **Require utilities to develop an EV infrastructure plan**
This would ensure EV interoperability with the grid and address requirements and strategies for infrastructure, cost recovery, smart grid integration, time of use (TOU) pricing, and billing issues, an analysis of the types of power plants operating at different times of the day and year so there is a clearer picture of the best times for EV charging to maximize GHG reductions and an analysis of each utilities distribution system to identify areas where homes and/or the distribution system will need to be improved in order to handle increased EV charging.

R8. **Revision of ADRs to include new and converted EVs**
The Australia Design Rules (ADRs), administered by the Department of Infrastructure and Transport, are national standards that include vehicle safety and emissions for new and second hand vehicles. The Third Edition ADRs were re-made as national vehicles standards in September 2006 and have been created without consideration for EVs.

R9. **Regulation for charger to vehicle interoperability**
There are a growing number of international options for vehicle charging that include various housings, pin configurations and communications protocols. While each technology may have different merits, it would be advantageous to adopt and regulate a single standard as the US has done with J1772 for Level 2 charging. This would allow any EV to charge at any station and would therefore maximise the benefit of public charging infrastructure.

R10. **Require municipalities to plan and prepare for EVs**
Municipal planning and regulation at the suburb level is required to increase the rate of EV
adoption. In addition to residential premises, this would need to include commercial premises and public infrastructure like public transport facilities and curb-side parking.

R11. **Expansion of vehicle categories**
Several EVs currently available internationally do not easily fit in to the four categories in the ADRs. A logical addition would be what several other countries call a quadracycle or low speed compact vehicle that is not licensed to drive on highways.

### 2.2.2 Inefficient Pricing – Price Reform

There are two aspects to inefficient pricing that represent barriers to wide-spread adoption of EVs. These are: unpriced ‘external costs’ and the structure of prices. External costs are those costs that are caused by the supply of a good but are not included in the price of that good (e.g. the costs associated with greenhouse gas emissions).

The most obvious external cost of electricity supply is the cost of climate change caused by burning of fossil fuels to generate electricity. This means that the average price of fossil fuel-based centralised electricity is set below the true cost of supply, thus leading to excessive consumption and reducing the uptake of low emission sources, such EVs.

Generally, efforts to mitigate climate change and improve energy security will be a major catalyst for EVs (Brown et al., 2010). The current lack of a carbon price is a barrier to EV investment. Furthermore, any future climate change legislation that increased the cost of electricity generation, but did not affect the cost of petrol as with the proposed Carbon Pollution Reduction Scheme (CPRS) at the end of 2009, would act as a double pricing bias against EVs.

A second component of inefficient price structures is that of undervaluing the demand management resource that EVs offer. In Australia, there are very few, if any, utilities that offer net-metering tariffs for EVs as a source of energy when the car is plugged in and the grid can draw energy from the car’s battery pack.

**Possible pricing policy options include:**

**P1. Introduce a Price on Carbon Emissions**
A price on carbon, specifically including emissions from petrol would both encourage individuals to purchase EVs due to the higher relative cost of transport fuels as well as encourage adopters to purchase green electricity for their EVs.

**P2. Time of use pricing**
To both encourage prospective buyers to purchase EVs based on low overnight tariffs and to encourage charging in off peak periods, reducing electricity network stress. This could include as well critical peak pricing where the prices are more closely aligned with the pool price on days of high distribution system stress which normally correspond to days of high electricity demand.

**P3. Net-metering with feed-in tariffs**
To encourage EV owners to sell energy back through V2G. This would work best with a dynamic time of use tariff structure.

**P4. New or increased environmental, fuel or congestion charges or taxes**
Bringing existing transport options in alignment with true costs including those of air pollution and greenhouse gas emissions through the use of charges or taxes would allow EVs
to compete on a more equitable basis. This could include policies such as a minimum price for petrol (Lidicker et al., 2010) or an economy wide carbon tax that served to increase the cost of carbon intensive fuels. These charges or taxes could be used to fund EV development or other programs.

**P5. Reduce or eliminate subsides for existing ICEV purchases, especially in fleets with fringe benefit taxes**

This would work in much the same way as the increased fees or taxes on existing ICEVs, but would allow governments to simply remove ‘environmental loopholes’. (Riedy, 2003; & Bracks, 2008).

**P6. Reduce or eliminate subsides for oil and petrol such as credits for oil exploration**

This would work in the same manner as a reduction in subsidies for ICEV purchases. (Diesendorf et al., 2008).

**P7. Default network support payments**

To be paid at no disadvantage to the network businesses to EV owners exporting power to the grid. This should include the often significant value of avoided network system augmentation and should allow utilities cost recovery authority for any distribution system upgrades needed to facilitate EVs.

**P8. Green Registration Discounts**

This could be a requirement on the owner, manufacturer or seller or could be also be introduced as a reduction in cost of Green Power for new EV owners or tied to the provision of incentives such as rebates or discounts on registration fees etc. Governments or car dealers can promote the voluntary purchase of green electricity by electric car owners while electricity suppliers, local governments and companies that own and operate charging points can ensure that renewable electricity is used for the charging points for these cars; national governments could support these developments, for example through fiscal policies (Kampman et al., 2010).

**P9. Fuel-economy based fee at the time of purchasing a car**

Research suggests that ‘‘feebate’’ programs, where consumers pay a fuel-economy based fee at the time of purchase may be more effective at encouraging the purchase of high fuel-economy vehicles than fuel-economy based registration or emissions testing fees. Moreover, unlike a sales tax waiver, a feebate could be designed to be revenue neutral (Gallagher and Muehlegger, 2010).

### 2.2.3 Payback Gap – Enticement (Incentives)

Payback gap refers to the idea that customers require a comparable payback period for EVs as compared to ICEVs before they invest in EVs. Furthermore, the payback gap also refers to the differing expectations of individuals with regards to rate of return on capital purchases versus other investments. For example, many people hold cash in their bank accounts at interest rates of less than 5% while they are unwilling to invest in efficient appliances for their home with payback periods of less than 4 years or equivalent compounded rate of return on capital of greater than 19%. The payback gap also refers to the costs and slow return on investment for installing infrastructure, developing EVs and components, and manufacturing EVs and components.

Electric vehicle proliferation requires EVs to be cheaper to operate than ICEVs (Hensley et al, 2009). Some individuals and organisations will also be influenced in their purchase of EVs by desire to ‘be green.’ Looking at factors that influence adoption, Kahn (2007) found that environmentalism was associated with
hybrid ownership. However, Heffner et al. (2005) conducted detailed interviews with households in Northern California that own HEVs, and determined that both anticipated cost savings and the ‘‘green image’’ of hybrids influence purchase decisions. McManus and Berman (2005) also found that hybrid owners and potential owners identified the desire to save money on gas and reduce pollution as significant motivating factors for purchasing a hybrid. A 2004 marketing survey by ChangeWave Research concluded that hybrid owners tend to be in the highest income demographics and are more sensitive to gas prices than environmental benefits in purchasing their vehicles (Diamond, 2008a). This research shows that those currently buying cars have money or other values that are motivating them to do so. For consumers who take the lifetime ownership costs in to account in their purchase decision, addressing the payback gap will increase the EV adoption rate.

The payback gap can be addressed in several ways: offering incentives to decrease the price of EVs, creating ‘‘feebates’’ to increase the pricing of ICEVs (which is covered in the barrier discussion on inefficient pricing) or by supporting alternative or low cost financing options so that upfront costs are reduced in exchange for increased operating costs. To stimulate all parts of the market, these incentives should cover new vehicles as well as conversions, vehicles of different degrees of electrification (PHEVs and BEVs) and vehicles in different classes from neighbourhood EVs to electric trucks or buses. Incentives could be linked to other initiatives such as a bonus for EV manufacturers who purchase the Green Power equivalent to the average energy use of the vehicle or special incentives for individuals who trade in high fuel consumption vehicles (‘‘clunkers’’) at the time of purchase. Green Power should equate to less than $100 per year of ownership. Similar financial incentives could be developed for EV service providers and manufacturers.

Possible policy options include financial enticements such as:

E1. **Tax of fee reductions or exemptions or cash bonuses on EV or charging station purchases**
Reduce upfront purchase costs of EVs or related equipment through either reduced purchase taxes such as GST or through end of year tax rebates or accelerated depreciation for businesses or through cash back bonuses. These could be offered as variable credits depending on degree of electrification, reduction in GHGs, and/or by vehicle size and class. This could also come in the form of reduced insurance costs. Others have noted that BEVs should receive enhanced tax credits, exceeding those for hybrids (Fontaine, 2008). There should also be consideration for conversions from ICEVs to EVs.

E2. **Low interest loans or grant funds**
These could be used to both reduce financing costs and potentially to make EVs more accessible to lower income families. Loans could cover the vehicle, EVSE and installation costs.

E3. **Subsidised battery rental programs**
By removing the upfront capital costs of the batteries, many EVs would be cost competitive with ICEVs today. A government supported or partially financed program to do this would greatly increase adoption rates.

E4. **Fleet purchase incentives**
These could be structured in a variety of ways including accelerated asset depreciation or FBT exemptions.

E5. **Manufacturer subsidies or tax credits**
These could be given to vehicle or EV related equipment such as EVSE manufactures on a per unit basis to encourage rollout or to companies to encourage local manufacturing and R&D.
E6. **Incentives for battery second life programs**
Battery recycling program that would allow owners to sell vehicle batteries so they could be used for example by utilities after their first life in the vehicle.

E7. **Credits for low carbon fuels**
If electricity and other low carbon fuels are subsidised, it will decrease ongoing costs for vehicle owners.

E8. **Ability to quantify and monetize lifetime of CO₂ emission allowances**
This was suggested by Fontaine (2008) as a way to compensate EV owners for the future value of GHG reductions.

Other benefits that may encourage individuals to purchase EVs despite higher initial costs could include:

E9. **Access to High Occupancy Lanes and exemption from highway tolls or potential future congestion charges**
There are several international examples where policies of this nature have helped to encourage low emission vehicle adoption.

E10. **Creation of low or zero-emission zones near city centres**
This would reduce air pollution in select areas while creating an incentive for EV purchase.

E11. **Access to free or prime parking spaces**
This is another policy tool used in other jurisdictions that would encourage EV adoption. This could potentially be combined with free public charging.

E12. **Electricity rebate program**
This would equate to subsidising free electricity for a set period of time for charging EVs possibly in conjunction with the purchase of Green Power.

E13. **Special recognition of EVs**
This could be accomplished through for example special licence plates.

Finally, specific enticements that may bring down the costs of vehicles, increase availability or decrease the costs of grid integration include:

E14. **Grants/loans for R&D**
Primary research and development funding will help reduce production costs and increase vehicle performance. Funds should also be used for desktop research that helps better prepare governments and the public for the introduction of EVs.

E15. **Grants/loans or tax credits for manufactures**
Initiatives such as the Green Car Fund discussed later in this report can help manufactures of vehicles or EV related equipment to both create local jobs, help create growth in local industries and increase vehicle availability while reducing costs.

E16. **Grants/loans for EV pilot areas**
As with the Solar Cities program discussed in more detail later in this report, the grants or loans would help establish pilot areas where technical and institutional barriers could be examined at a more localised scale.

E17. **Funding to assist Utilities in planning/preparing for EV introduction**
Planning initiatives funded in the near term will help utilities maximise the benefit of EVs as a DE resource in the mid- to long- term.

E18. **Subsidies/programs to upgrade local circuits in homes/buildings to allow faster charging**
This will both encourage adoption of EVs as well as potentially be linked to emergency load
curtailment programs allowing utilities to slow or stop charging during times of high grid stress in exchange for providing Level 2 charging stations for homes.

2.2.4 Split Incentives - Facilitation

Split incentives refer to circumstances where the benefits and costs are shared unequally amongst a number of agents resulting in a less than optimal outcome. If the parties that benefit the least can somehow receive compensation from the parties that benefit the most, split incentives could be resolved. The greater the number of parties involved in decisions related to EVs, the greater the transaction costs associated with devising and negotiating a mutually acceptable outcome.

An example of this is rental car companies who are not responsible for the cost of fuel, but are exposed to the capital costs of purchasing the vehicle. In this circumstance, the company has less incentive to purchase fuel efficient or EVs while renters would prefer to drive a vehicle that has a lower cost of fuel.

Another example can be made with regards to building of infrastructure. Plug-in vehicles will require supporting general infrastructure to be developed as they come to market. Some of this infrastructure can be located within existing facilities, such as high voltage testing equipment and EV specific maintenance tools that will be required at auto mechanic shops, while other infrastructure, such as charging and battery swapping stations will require new sites. Much of this infrastructure has been the subject of a ‘chicken and egg’ debate of which should come first, the vehicles or the supporting infrastructure. Many international governments supportive of EVs have implied through financial support that lack of widespread infrastructure is one of the main barriers to widespread proliferation of EVs\(^3\) but manufactures or service providers are reluctant to invest in infrastructure during early market development without a guaranteed return on investment. As there will inevitably be individuals who will wait to purchase EVs until infrastructure is developed, policies that result in larger initial infrastructure build-outs will encourage more rapid adoption. Similarly, manufacturers will also be hesitant to develop EV manufacturing equipment or EV manufacturing components without proven demand.

The role of government to the barriers created by split incentives is one of facilitation between stakeholders. The following policy options could be deployed to create joint initiatives between government and industry:

**F1. Government fleet purchase guarantees**
Memorandum of agreement or understanding between governments and manufacturers to purchase minimum quantities of particular makes and models of EVs over a fixed period of time. Similar policies exist in other jurisdictions such as California. These could also be structured in terms of fleet targets or other mechanisms such as an Oil Savings Performance Contract as recommended by the Electric Drive Transportation Association (EDTA, 2009).

**F2. Joint infrastructure projects**
Public / private partnerships allow industry to deploy necessary infrastructure such as EVSE related projects. One example of this is targeted pilot programs including parallel examples in the DE space such as the Solar Cities program, discussed in more detail later in the report along with several international examples.

**F4. Funding of workforce training programs**
Training programs such as the new TAFE EV program will help create the skill base necessary to support the both vehicles and the corresponding infrastructure.

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\(^3\) Through, for example, the $99.8 million awarded by the US DOE to the EV Project to deploy charging infrastructure
F5. Connecting renewable energy targets to EV sales
This will ensure that future growth in electricity demand associated with EVs is linked to growth in low carbon energy resulting in low or zero carbon transportation outcomes.

F6. Government sponsored battery warranty program
This will help to reduce or spread the risks of advanced batteries. As stated by Fontaine (2008), warranties are a principle means to overcome the information imbalance regarding product quality between an informed manufacturer and an uninformed customer.

2.2.5 Imperfect information – Information Provision

Neoclassical economic theory states that for a market to be truly efficient, all actors must have access to perfect information. Furthermore, as stated by Jaffe and Stavins (1994), market failures can be caused by insufficient and incorrect information. This is especially relevant to EVs as the lack of available products has left many individuals, including policy makers, guessing as to the technical nature of the vehicles as well as impacts on electricity networks. To this point, there are several publically available resources devoted to ‘myth busting’ common misconceptions about EVs.

Typical prevalent myths, often based on previous eras of EVs, and corresponding explanations include:

*The range is extremely limited:* PHEV ranges normally match or exceed existing ICEV while BEV minimum range for existing vehicles varies from 100km for the Blade Electron produced in Australia to 393km for the Tesla Roadster while recently a converted Mira EV in Japan set an official record for an EV at over 1000km range on a single charge (Barry, 2010). Furthermore, range requirements for a typical daily driving cycle are much lower than these numbers with average distance travelled per person per day in Victoria at 33km (Vic DoT, 2010).

*Vehicles lack power and are slow:* Several racing cars, including some made by Porsche are now electric hybrids. Production BEVs including the Tesla Roadster and the Venturi Fetish have 0-60 mph acceleration times of less than 4 seconds, which is faster than only a few ICEVs. Furthermore, as early as 1994, a modified GM EV1 set the world speed record for an EV at 300 km/h. The Bukeye Bullet currently holds the official land-speed record for a BEV at 495 km/h with instantaneous power production of more than 600kW.

*Charge time is not quick enough:* Using a standard 15A wall outlet, a typical EV requiring 160Wh/km would require less than 2 hours of charge time to drive 33km. Several of the vehicles coming to market will also be equipped with Level 3 charging capabilities. The second generation Nissan Leaf will be able to recharge to 80% capacity in 30 minutes (Rowley, 2009). This is equivalent to being able to charge enough for a typical daily drive of 33km in about 7 minutes. Furthermore, consumer vehicles are typically parked for about 23 hours per day with a median travel time in Victoria of 78 minutes per day during the week (Vic DoT, 2010),leaving ample time for charging.

*EVs are more polluting:* EVs do not directly emit pollutants such as carcinogens, nitrogen oxides, hydrocarbons or carbon dioxide. However, some of these emissions are moved to power plants, which in states such as Victoria can have significant emission profiles. Using full fuel cycle emission factors in Victoria with estimated 160Wh/km BEV consumption, a typical BEV would emit approximately 216 gCO2-e/km. This can be compared to the new car average of 226 gCO2-e/km. However, this number is relatively high when compared to the 2010 Toyota Prius that under NRMA independent testing produced only 107 gCO2-e/km (Hudson, 2010). However, if Green Power is used for charging of BEVs, then emissions are reduced to effectively zero.
**EVs consume more resources:** This idea was first propagated by a CNW Marketing Research study in which they estimated that the lifetime energy costs of a Toyota Prius were greater than a Hummer. This was widely disputed and recently corrected in a recent update (CNW, 2010).

**Batteries are unreliable:** Experience with laptops and cell phones have led many consumers to believe that batteries are not capable of lasting as long as the average life of a vehicle. This concern has been widely resolved by recent warranty announcements on both the Nissan Leaf and the Holden Volt at 8 years or 160,000 km for the batteries and related components. Several hybrid car battery packs have warranties as long as 10 years, which is close to the average lifetime of a vehicle in Australia.

**EVs will cause the power to go out:** While impacts on the electricity grid from EV charging have the potential to trigger early investments in infrastructure if the majority of charging is not done overnight, the additional load from EVs will increase slowly allowing ample time for electricity utilities to plan future investments. Further information on electricity grid impacts can be found in the Phase 1 report.

In addition to common misconceptions, for informed stakeholders, there is still a lack of available information related to critical aspects of EV adoption and rollout. This includes information on potential current benefits of EVs compared to ICEVs. There are several circumstances in which this lack of access to relevant information may present a significant barrier.

Some of the following barriers have been adapted from the Institutional Barriers to Intelligent Grid Report (Dunstan and Daly, 2009):

- **EV purchase costs and rate of return:** Lack of reliable information on operating costs, creating difficulty in justifying higher purchase or capital costs
- **Benchmarks for performance:** Prospective consumers may not have information on low-emission vehicles alternatives including EVS
- **Lack of precedents and product information:** Information about EV driving and environmental performance may be difficult to access even as it becomes more widely available
- **Pricing and operating cost knowledge:** Lack of manufacturers suggested retail prices for upcoming EVs along with operating cost information may be unavailable
- **Network planning information:** As noted by Smith (2007), as with other potentially controllable loads, network planners need to estimate the location, timing and amount of the load caused by the introduction of EVs. The current lack of information both about EV adoption rates and charging locations as well as the lack of planning information of network constraints and opportunities for investment makes it difficult to assess both the problems and opportunities associated with EVs on the grid
- **Grid impacts:** Related to information on network planning is the current lack of reliable information related to the potential positive and negative impacts that EVs could have on the grid depending on how controllable and what the capabilities of their charging and possibly discharging systems are
- **Technology winners:** A lack of reliable information on the merits of various technology options, for example in battery packs, makes it difficult to predict which technologies will become dominant with time and what their associated implications are with regards for example to cost and impacts on the grid
- **Information on accessing infrastructure:** Information about the capacity of networks could be a very helpful tool to synergize, where appropriate and possible, the installation of EV networks, to best utilize the ‘spinning reserves’ offered by EV batteries.
Policy options to help overcome information related barriers include:

11. **Provision of a central hub for EV information**  
   This could include information on government programs and incentives, where to go for a test drive and vehicle performance. Both a physical location and a website would be beneficial.

12. **Consumer education initiative**  
   A centralised government sponsored initiative to help dispel EV myths and help individuals and businesses to understand the benefits of EVs could potentially be a strong driver for adoption.

13. **Requirements for separated EV electricity costs on utility bills**  
   This would allow consumers to better understand the operating costs of EVs and could potentially be accompanied by a comparison to what they would have paid in petrol.

14. **Require reporting of renewable energy used for vehicle charging**  
   Mandatory reporting of the energy mix used for charging would allow policy makers to calculate and better understand the environmental implications of EVs.

15. **Reports and case studies**  
   Specific national and international case studies of EV incentives, regulation, and vehicle characteristics will assist in good policy decision-making and help to keep stakeholders informed of recent developments.

16. **Common metric for lifetime cost comparison of ICEVs, HEVs and EVs**  
   Such as average cost per kilometre across all vehicles would help consumers make more informed purchase decisions.

### 2.2.6 Cultural Values - Targets

Institutional barriers include any form of constraint devised by humans to shape interaction with technology (Foxes, 2002). Whilst all institutional barriers are thus inherently embedded in cultural discourse, cultural barriers can be identified as the social conventions, values and behavioural norms that dictate consumer acceptance of technological innovation. Overcoming cultural barriers is crucial to encouraging the uptake of EVs as ultimately it is the consumer who will need to be convinced of the technology’s merits.

EVs represent the classic example of a ‘high learning product’, that is, an innovation that requires a considerable degree of behaviour change relative to existing behavioural norms (Kurani et al., 1994). Generally, the greater the deviation from established routines, the greater the resistance to the innovation. Innovation resistance is therefore the: “resistance offered by consumers to an innovation, either because it poses potential changes from a satisfactory status quo or because it conflicts with their belief structure” (Kurani et al., 1994).

Numerous frameworks have been proposed to explain the relationship between values, beliefs, attitudes and behaviour. Ajzen’s Theory of Planned Behaviour and the Values-Beliefs-Norms theory suggest consumer behaviour is subject to cultural norms, personal values and attitudes in addition to external information. This helps to explain why environmental concerns do not often translate into individual behavioural change. Lane and Potter (2007) describe this as the ‘attitude-action gap’, highlighting the role of conflicting values and social conventions in influencing the adoption of new technology (Land, 2007). Whilst not mutually exclusive, values and attitudes (shaped by social conventions) may be prioritised by the consumer in an order that favours the rejection of EVs (refer to Table 2-5).
### Table 2-5. Social Norms and the Implications for EV adoption

<table>
<thead>
<tr>
<th>Social norm</th>
<th>Values/attitudes</th>
<th>Behavioural implications</th>
<th>Implications for EV adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbolism and appearances</strong> (Sundareson and Sheth, 1989)</td>
<td>Social status Familyarity What is considered ‘acceptable’</td>
<td>Consideration of Image, brand, appearance, novelty</td>
<td>‘Novelty’ factor of EVs may facilitate early adoption but impede mainstreaming.</td>
</tr>
<tr>
<td><strong>Consumer culture</strong> (Sovacool, 2009)</td>
<td>Conceptions of abundance</td>
<td>Reflected in a disinterest in life-cycle costs. Australians have traditionally enjoyed low cost energy and increasingly affordable personal mobility.</td>
<td>EVs need to compete with ICVs on a cost basis.</td>
</tr>
<tr>
<td><strong>Conformity and scepticism of the unfamiliar/change</strong> (Sovacool and Hirsh, 2009)</td>
<td>Comfort, freedom of control, trust, social status, ritual, and habit</td>
<td>Psychological resistance to change: strong preferences for the status-quo mean familiar products attain higher values.</td>
<td>Unfamiliar products with high ‘disinterest’ factor at risk of consumer rejection. EVs and required behaviour change needs to be ‘sold’ appropriately.</td>
</tr>
<tr>
<td><strong>Convenience culture and leisure demands</strong> (Sovacool and Hirsh, 2009)</td>
<td>Leisure time Convenience Reliability</td>
<td>Preference for technology that allows for leisure and convenience.</td>
<td>Desire for reliable transport over long distances. Ease and convenience of use of conventional technology (ICVs) – require no behaviour change. Inadequate EV infrastructure may lead to slower uptake.</td>
</tr>
</tbody>
</table>

Social conventions ‘lock-in’ existing technologies and can potentially ‘lock-out’ the development of new technologies. Foxes (2002) suggests new sustainable technologies are especially at risk of lock-out as they have high unit costs and are yet to benefit from factors of increasing returns favouring incumbent technologies. Nonetheless, cultural attitudes have the ability to favour the adoption of new technologies. The novelty of EVs and environmental credentials for example offers the technology a clear point of difference in the vehicle market and will no doubt appeal to early adopters. However, the technology must overcome other cultural, institutional and technical barriers before becoming mainstream.

There is an obvious and inevitable link between imperfect information and reproduction of cultural values: the former perpetuates the latter, compounding the effects of both barriers. The section below, which discusses the interaction between EV barriers, explores this relationship in more detail, using examples of misinformation and cultural attitudes. Conversely, ‘correct’ information has the potential to **empower and enable** a shift in cultural values and consequently, foster sustainable behaviours.

A comparison of EV policies in the US and France, and the resulting outcomes, showed that stricter regulation in the US succeeded in the development of EVs and that the lack of public of awareness in France may have been the reason for the lack of success. The comparison also highlighted that individual cultures still have ‘standard operating procedures’ which reflect ‘deep-rooted national political and social cultures’ despite increasing globalization. It also suggests that governments should take into account the cultural dimension when promoting policy change (Calef and Goble, 2007).

The role of government in helping overcome cultural barriers is to draw the attention and interest of individuals and organisations by ‘generating specific objectives and measuring performance against these objectives’; in other words, by using **targets** at various scales (national, state, regional, local). Where
prevailing culture, habits or tradition are not delivering appropriate outcomes, targets can be an effective means of changing behaviour (Dunstan, et al., 2009). The Government also plays an important role in recognising the technology as viable. Currently, the Federal Government does not recognise electricity as an alternative transport fuel within its existing program (Australian Government, 2010).

T1. Firm national EV sales targets
Many Australian Government agencies and private organisations currently have targets for reducing the GHG intensity of their vehicle fleets, including the integration of HEVs. These targets could be modified to favour the adoption of EVs and PHEVs.

T2. Set government fleet targets for EVs
Many Australian government fleets have introduced targets for reducing the GHG intensity of their fleets. Such policy would favour the adoption of EVs.

T3. Recognise electricity as an alternative road transport fuel within existing programs
Currently, the government recognises biodiesel, ethanol, LPG, hydrogen and natural gas as alternative transport fuels. If electricity were also recognised, then the Department of the Environment, Water and Heritage would be involved in regulating and supporting electricity as a transport fuel, as well as improving the information available about this fuel, its use and its development in Australia.

Cultural barriers need to be targeted with the same level of scrutiny as technical barriers. As surmised by Sovacool and Hirsh (2009); “work to improve the technical performance of hardware must be coupled with attempts to overcome economic, behavioural, cultural, and infrastructural obstacles. These latter types of barriers do not fit neatly into the traditional R&D categories and remain deeply embedded in the social and institutional fabric. Overcoming them may require a substantial effort that currently eludes much discussion” (Sovacool, 2009).

2.2.7 Confusion and Interaction between Barriers - Coordination

Whilst the simplest approach to implementing policy options is to identify barriers and counteract each barrier specifically (known as a symmetric response, depicted in (Figure 2-1), in practice, this may be impractical due to resource or technical constraints (Dunstan et al., 2009). Further, institutional barriers are invariably inter-dependent—the overcoming of one barrier may actually require another to be addressed concurrently. Taking an asymmetric policy response approach (Figure 2-2) can help address these issues and involves prioritising actions perceived to be most achievable or cost effective. Stakeholder consultation will provide an opportunity to ensure the effectiveness of this prioritisation process.

An obvious example of interaction between barriers is the relationship between the reproduction of imperfect information and cultural attitudes. Misinformation can work to cement existing social conventions, and vice versa—examples of which are outlined in Table 2-6.

The implications of not addressing the issues of imperfect information and cultural barriers concurrently can be seen in the effect on further policy responses. Perpetuation of ‘EV myths’ in cultural discourse potentially gives way to flawed or wrongly prioritised fiscal policy responses in a context of limited time and resources.

Table 2-6. Example Interactions Between Imperfect Information and Cultural Values.

<table>
<thead>
<tr>
<th>Lack of or Misinformation</th>
<th>Cultural values/attitudes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived limited ranges</td>
<td>Desire for reliable transport over long</td>
<td>Several US studies have found values such as comfort, freedom, flexibility, and mobility are quantified into monetary terms and then surveyed drivers about their vehicle preferences, they found</td>
</tr>
<tr>
<td>Lack of or Misinformation</td>
<td>Cultural values/attitudes</td>
<td>Examples</td>
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<tr>
<td>of EVs</td>
<td>distances</td>
<td>that owners believed EVs had a disutility of between US$10,000 and $16,250 (Sovacool and Hirsh, 2009)</td>
</tr>
<tr>
<td>EV purchase costs and rate of return</td>
<td>Desire for affordable personal mobility</td>
<td>Lack of reliable information on operating costs, creating difficulty in justifying higher purchase or capital costs. A survey of Californian households found that not one factored in the present value of fuel savings as part of a decision to purchase a new vehicle (Green et al., 2007). A 2007 US study found that not one respondent tracked fuel costs over time and few considered transportation costs in household budgets (Sovacool and Hirsh, 2009).</td>
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<tr>
<td>Charge time not quick enough</td>
<td>Lifestyle demands – ‘on the go’, convenience, desire for technology that allows more leisure time</td>
<td>EV companies anticipate customer demand for charging in under an hour for vehicles that are either being used for longer trips, do not have a convenient place to charge at home, or for people who just do not like to wait.</td>
</tr>
</tbody>
</table>

Coordination of policy development is the critical directive for overcoming the compounding effects of interacting barriers. The following policy responses have been adapted from the iGrid Working Paper 4.2 for distributed energy.

**C1. Agency to coordinate EV technology development and deployment**
A key strategy often applied by government to address matters of major public interest is to appoint an appropriate agency to coordinate policy and development activities. This existing or new organisation must possess the appropriate skills, resources, commitment and authority for managing EV policy objectives, e.g. the Office for Low Emission Vehicles in the UK.

**C2. Development of Australian Standards for EV technology (in line with international coordination on standards)**
Victoria has taken the first steps in this regard by commissioning Standards Australia to undertake a scoping study into developing Australian standards for EV technology. The study identifies a list of recommendations for furthering the development of national EV standards.

**C4. Join international efforts and organisations**
For example, the Queensland, South Australian and Victorian State Governments have joined the EV20 Accord, an international accord between global cities, states and countries to collaborate in accelerating the development and deployment of EVs. This initiative is hosted by The Climate Group, an international, non-partisan, not-for-profit organisation working to advance climate change advocacy and the development of clean technology.

**C7. Coordination federal and state EV strategies**
This could include for example, a national strategy for EV development and deployment to identify priority actions and outline strategic direction and implications for all stakeholders.
### Key Barriers and Possible Policy Solutions

Barriers to and Policy Solutions for EV Adoption in Australia

#### Figure 2-1. Symmetric Policy Response Approach.

<table>
<thead>
<tr>
<th>Institutional Barriers</th>
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<tbody>
<tr>
<td>Regulatory Failure</td>
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<tr>
<td>Inefficient Pricing</td>
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<tr>
<td>Payback Gap</td>
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<tr>
<td>Split Incentives</td>
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<tr>
<td>Lack of Information</td>
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<td>Cultural Barriers</td>
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</table>

#### Policy Measures to Address Barriers

#### Figure 2-2. Asymmetric Policy Response Approach.

<table>
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<tr>
<th>Institutional Barriers</th>
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<td>Regulatory Failure</td>
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<td>Inefficient Pricing</td>
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<td>Cultural Barriers</td>
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#### Policy Measures to Address Barriers
### 2.3 Solutions Matrix

The matrix below categorises specific policy solutions by the category of policy response within which it fits (e.g. regulation, pricing, facilitation, etc) and the focus of the policy (e.g. batteries, vehicles, EV supply equipment, electricity networks). Additionally, sometimes a single policy solution can have implications on several or all aspects of EV adoption and integration. These broad-reaching policies are grouped and presented at the bottom of the matrix. Furthermore, sometimes a single policy solution can be developed to fit within several categories of policy responses, as can be seen below for solutions with check marks in multiple columns. These two aspects demonstrate the challenge in classifying and categorising policy barriers and solutions.

Table 2-7. Summary Matrix of Policy Solutions by Policy Category and Policy Focus

<table>
<thead>
<tr>
<th>Policy Solution Class and Summary:</th>
<th>Policy Category:</th>
<th>Technology Characteristics</th>
<th>Technology Costs</th>
<th>Regulation</th>
<th>Pricing</th>
<th>Incentives</th>
<th>Facilitation</th>
<th>Information</th>
<th>Targets</th>
<th>Coordination</th>
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<tr>
<td>Batteries</td>
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<td>- Subsidised battery rental programs</td>
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<td>- Incentives for battery second life programs</td>
<td>Battery</td>
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<td>- Government sponsored battery warranty program</td>
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<td>- Initiate and fund charging station and infrastructure demonstration programs including battery swapping</td>
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<td>Vehicles</td>
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<td>- Credits for low carbon fuels</td>
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<td>- Implement mandatory fuel economy standards</td>
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<tr>
<td>- Develop standards for EVs and charging equipment in high priority areas</td>
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<td>- Mandate the purchase of EVs in government fleets</td>
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<td>- Develop mandatory low and zero emission vehicle requirements</td>
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<td>- Fleet purchase incentives including through fleet specific tax exemptions</td>
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<td>- New or increased environmental, fuel or congestions charges or taxes</td>
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<tr>
<td>- Reduce or eliminate subsides for existing ICEV purchases, especially in fleets with fringe benefit taxes</td>
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<td>- Reduce or eliminate subsides for oil and petrol such as credits for oil exploration</td>
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<td>- Green registration discounts</td>
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<tr>
<td>- Ability to quantify and monetize lifetime of CO$_2$ emission allowances</td>
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<td>- Access to High Occupancy Lanes and exemption from</td>
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</tbody>
</table>
### Policy Solution Class and Summary:

**Policy Category:**

- Technology Characteristics
- Technology Costs
- Regulation
- Pricing
- Incentives
- Facilitation
- Information
- Targets
- Coordination

#### Key Barriers and Possible Policy Solutions

- **Barriers to and Policy Solutions for EV Adoption in Australia**
  - **March 2011**

<table>
<thead>
<tr>
<th>Policy Solution Class and Summary:</th>
<th>Policy Category:</th>
</tr>
</thead>
<tbody>
<tr>
<td>high-traffic tolls or potential future congestion charges</td>
<td>Technology Costs</td>
</tr>
<tr>
<td>- Access to free or prime parking spaces</td>
<td>✓</td>
</tr>
<tr>
<td>- Special recognition of EVs</td>
<td>✓</td>
</tr>
<tr>
<td>- A common metric for comparison between lifetime costs of all vehicles including ICEVs, HEVs and EVs</td>
<td>✓</td>
</tr>
<tr>
<td>- Firm national EV sales targets</td>
<td>✓</td>
</tr>
<tr>
<td>- Development of Australian Standards for EV technology in line with international coordination on standards</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>- Revision of ADRs to include new and converted EVs</td>
<td>✓</td>
</tr>
<tr>
<td>- Expansion of vehicle categories</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EV Supply Equipment and Other Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Streamline EVSE code and permit requirements</td>
</tr>
<tr>
<td>- Ensure building codes for new or renovated sites support EVs by requiring dedicated electrical capacity and parking spaces</td>
</tr>
<tr>
<td>- Subsidies/programs to upgrade local circuits in homes/buildings to allow faster charging</td>
</tr>
<tr>
<td>- Coordinate vehicle purchase and home charging station installation</td>
</tr>
<tr>
<td>- Regulation for charger to vehicle interoperability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electricity Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Streamlined network connection agreements</td>
</tr>
<tr>
<td>- Regulation to allow emergency load curtailment of EV charging</td>
</tr>
<tr>
<td>- Require utilities to develop an EV infrastructure plan</td>
</tr>
<tr>
<td>- Time of use pricing</td>
</tr>
<tr>
<td>- Net-metering tariffs</td>
</tr>
<tr>
<td>- Default network support payments</td>
</tr>
<tr>
<td>- Electricity rebate program</td>
</tr>
<tr>
<td>- Funding to assist Utilities in planning/preparing for EV introduction</td>
</tr>
<tr>
<td>- Connecting renewable energy targets to EV sales</td>
</tr>
<tr>
<td>- Requirements for separated EV electricity costs on utility bills</td>
</tr>
<tr>
<td>- Require reporting of renewable energy used for vehicle charging</td>
</tr>
<tr>
<td>- Green registration discounts</td>
</tr>
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</table>

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<table>
<thead>
<tr>
<th>Policy Solution Class and Summary:</th>
<th>Technology Characteristics</th>
<th>Technology Costs</th>
<th>Regulation</th>
<th>Pricing</th>
<th>Incentives</th>
<th>Facilitation</th>
<th>Information</th>
<th>Targets</th>
<th>Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Use electricity rate base to lower cost of EV batteries</td>
<td>✓</td>
<td></td>
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<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>- Subsidies or programs to upgrade local circuits in homes or buildings to allow faster charging</td>
<td></td>
<td></td>
<td>✓</td>
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</tbody>
</table>

**Impacts Across Multiple Areas**

- Tax of fee reductions or exemptions or cash bonuses on EV or charging station purchases
  -  ✓
- Establish research partnerships between Australian centres of excellence and counterparts in Asia
  -  ✓
- Grants, loans or tax credits for R&D in battery, vehicle, EVSE and grid integration technology
  -  ✓
- Grants, loans or tax credits for EV, battery and charge station manufacturers
  -  ✓
- Low interest loans or grant funds for vehicle, battery or related equipment purchase
  -  ✓
- Creation of dedicated electric transportation government agency to coordinate all EV related government activities
  -  ✓
- Join international efforts and organisations
  -  ✓
- Creation of low or zero-emission zones near city centres
  -  ✓
- Provision of a central hub for EV information
  -  ✓
- Grants or loans for energy hubs that include EVs
  -  ✓
- Consumer education initiative
  -  ✓
- Development of federal and state strategies and plans
  -  ✓
- Funding of workforce training programs
  -  ✓
- Joint infrastructure projects
  -  ✓
- Reports and Case studies
  -  ✓
- Require municipalities to plan and prepare for EVs
  -  ✓
- Recognise electricity as an alternative road transport fuel within existing programs
  -  ✓
3. AUSTRALIAN INITIATIVES

The adoption of EV policy has, until recently, been slow across all Australian jurisdictions in comparison to overseas experience. Nonetheless, current initiatives now appear timely in the wake of the first delivery of affordable, mass manufactured EVs in Australia (Mitsubishi iMiEVs). Current Australian initiatives concerned with facilitating the adoption of EV technology are largely focused on capacity building, that is, facilitation, information and coordination. To date, Queensland and the Australian Capital Territory are the only jurisdictions to provide incentives for the purchase of low emission vehicles. Whilst these are not directed towards EVs or even PHEVs specifically, they have stimulated consumer preference for HEVs and offer a policy response model that could be adapted to incentivise the adoption of EVs and PHEVs.

The Federal Government has focused on stimulating R&D in the automotive sector (Green Car Innovation Fund) and investment in broader strategies with positive implications for EV technology, including the Solar Cities and Smart Grid, Smart City programs. Similar to air conditioners, a national Demand Response standardisation is on the horizon for EV charging. A 2009 study of the Australian Standards in relation to EVs, recommended standard development around five focus areas: vehicle design; power systems; recharging; rescue, repair and recovery; and miscellaneous (GHG performance and use information) (Lazar and McKenzie, 2009). A more recent draft of the Standards Australia Workplan suggested the focus should be on stipulating minimum requirements in relation to product safety, public safety and consumer protection in order to minimise the risks of market development and public safety (Lazar and McKenzie, 2010).

Victoria appears to be leading the charge with EV policy initiatives, having commissioned Standards Australia to undertake a scoping study into developing Australian standards for EV technology and infrastructure. The State Government has also committed $5m to a state-wide passenger EV trial, is undertaking a hybrid-electric bus trial and has identified opportunities for the integration of EV policy into existing policies including land use planning and R&D.

Queensland has similarly taken a progressive stance. The Queensland EV Roadmap gives industry and the community a clear indication of the Queensland Government’s position on EVs and provides a tool to guide further policy responses.

Melbourne University have partnered with Better Place and Senergy Econnect Australia to investigate: the effect of mass adoption of electric vehicles on the grid; the management of electricity distribution by developing a smart grid; and meeting the challenge of transportation over Australia’s long distances by placement of charging stations.
Appendix 6 provides more detail on each of the policy responses summarised in Table 3-1 below.

Table 3-1. Summary of Australian Initiatives.

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Policy responses</th>
<th>Jurisdiction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Green Car Innovation Fund</td>
<td>Facilitation</td>
<td>Federal; Nation-wide</td>
</tr>
<tr>
<td>Smart Grid, Smart City</td>
<td>Facilitation, Information, Coordination</td>
<td>Federally sponsored; Sydney and Hunter region trials</td>
</tr>
<tr>
<td>Solar Cities</td>
<td>Facilitation, Information</td>
<td>Federally sponsored; with seven “solar cities”.</td>
</tr>
<tr>
<td>Victoria EV initiatives</td>
<td>Facilitation, Information, Coordination</td>
<td>Victoria; (EV standards scoping study for the national level)</td>
</tr>
<tr>
<td>Queensland EV Roadmap and Green Taxis Scheme</td>
<td>Coordination, Incentives, Regulation</td>
<td>Queensland</td>
</tr>
<tr>
<td>ACT Green Vehicles Duty Scheme</td>
<td>Information, Incentives, Regulation</td>
<td>ACT</td>
</tr>
<tr>
<td>UWA Australia Renewable Energy Vehicle (REV) Trial</td>
<td>Facilitation, Coordination</td>
<td>Perth; WA</td>
</tr>
<tr>
<td>Australian Standards for EVs</td>
<td>Regulation</td>
<td>Federal</td>
</tr>
<tr>
<td>CSIRO Electric Driveway</td>
<td>Information</td>
<td>Nation-wide</td>
</tr>
<tr>
<td>Melbourne Uni and Industry Partnership – Study of impact of mass-adoption of EVs on the Australian Grid</td>
<td>Information</td>
<td>Nation-wide</td>
</tr>
<tr>
<td>Government agency GHG/HEV targets</td>
<td>Facilitation, Information</td>
<td>Various Federal, State, and Local Governments throughout Australia</td>
</tr>
</tbody>
</table>
4. A SNAPSHOT OF INTERNATIONAL EV POLICIES AND INITIATIVES

The sections below summarize the electric vehicle initiatives and current policies for several countries and regions, including Canada, United States, Europe, Japan and China. The list of policies presented is not exhaustive, but rather representative of the trends in each country. For example, there have been hundreds of international studies and trials, both government and private, that have taken place but could not exhaustively be covered in this report.

4.1 Canada

In Canada, HEV annual sales continue to grow both in numbers and as a proportion of the total light-duty vehicle sales. In 2000, HEV sales represented only 0.03% of total light vehicle sales in Canada; by 2007 this proportion had risen dramatically to 0.88%, e.g. from 426 cars sold in 2000 to 14,828 cars sold in 2007 (Chandra et al., 2010). In terms of EV availability, two models were available in 2000 (Honda Insight and Toyota Prius) and 13 were available in 2007 (Chandra et al., 2010).

Canada has safety and technical standards for EVs, as well as specific regulation for Low Speed Vehicles, which are entirely electric and travel up to 40km/h.

Since 2009 Vancouver has required new multi-family developments to provide charging ports in 20% of the parking stalls. The province now requires one- and two-family dwellings to have plug-in vehicle charging capability.

Within Canada’s Electric Vehicle Technology Roadmap the Government lays out their plan to reach, by 2018 at least 500,000 highway-capable PHEVs.

The national ecoTechnology for Vehicles program conducts outreach activities across Canada. This program also works with manufacturers to acquire and test new EV technology, as well as address barriers to the introduction of these new technologies into Canada.

Five provinces offer sales tax rebates, with the largest rebate offered in Ontario ($8,500 CAD).

For more details, see Appendix 1. Summary of Canadian Policies.

4.2 United States

Sales of hybrids grew from less than 10,000 cars in 2000 to about 346,000 in 2007. It is expected the market for plug-in hybrid and battery electric passenger cars and light duty trucks will grow at a compound annual growth rate of 106% between 2010 and 2015, resulting in sales of more than 3.24 million vehicles during that period (Pike Research, 2010). President Obama has announced a goal of 1 million EVs on the road by 2015, while 8 states have their own targets related to EVs.

The US has national technical standards for EVs. According to the National Conference of State Legislatures (NCSL), 68 bills from 25 different States were introduced in 2009 that
involved electric vehicles (12 have been enacted). The leadership shown in California has paved the way for the US, in terms of EV policies and developments. In 1990, the introduction by General Motors (GM) of its concept electric car, the Impact, inspired the California Air Resources Board (CARB) to mandate that two percent of all new vehicles for sale in California in 1998 and ten percent by 2003 be all-electrics. Policymakers chose a technology-forcing approach, setting ambitious goals (e.g., zero emission vehicles), establishing strict deadlines and issuing penalties for non-compliance. The policy process in California called for substantial participation from the public, the media, the academic community and the interest groups affected by the regulation (Calef and Goble, 2007).

In 2009, in the latest revision of its Zero Emission Vehicle (ZEV) standards, California indirectly mandated the introduction of more than 50,000 PHEVs in the 2012-2014 timeframe by implementing requirements for each manufacturer to produce a minimum percentage of zero emission vehicles each year (e.g. 11% in 2010/2011) (EERE, 2010). To put this regulation into perspective, California has about 20 percent of the U.S. automobile market. California Air Resources Board (CARB) has directed its staff to begin developing new rules known as "ZEV 2.0" that will likely return the ZEV program to its original focus of pushing the envelope on pure EV technology expansion. Ten other states have adopted California's ZEV rules.

To incentivise the production of EVs, national CO₂ tailpipe (exhaust) standards have been developed for cars and light trucks. Vehicles must emit less than 250g CO₂/mi. PHEVs will be counted as zero emission vehicles, even when operating on grid electricity (up to the first 200,000 vehicles produced by each manufacturer).

States are quickly developing regulations on where and how to install charging systems, as well as requirements on when to use charging systems. An increasing majority of States have EV coordination bodies, strategic partnerships, policy evaluation bodies, guidelines, resolutions or roadmaps to support the widespread adoption of EVs.

In 2006, four States had EV purchasing requirements for government fleets. Currently, 29 States have Alternative Fuel Vehicle purchasing requirements.

In the US, electrified cars will be less expensive on a total-cost-of-ownership basis only if the price of gasoline exceeds $4 a gallon and electric batteries can travel 40 miles before a recharge, or if the government gives manufacturers incentives that subsidize the cost of production (Hensley et al, 2009). To offset these costs, the federal government is providing tax credits up to $7,500. Most of the State governments are providing tax incentives, grants, loans, rebates and other ownership benefits to encourage wide-spread adoption of EVs.

A nation-wide training program has been developed to help fire-fighters and other first responders prepare for the growing number of EVs on the road in the US. Other training and education programs continue to grow for technicians and engineering students. For more information, see Appendix 2. Summary of US Policies.

4.3 Europe

Most stakeholders within the EU assume a realistic market share for new, electrically chargeable vehicles in the range of 3 to 10% by 2020 to 2025, or between 450,000 and
1,500,000 units based on today’s market, depending on how quickly some of the immediate challenges can be addressed. The market share will increase progressively with every year that passes (ACEA, 2010a). In 2009, the market share of cars emitting 120 gCO₂/km had risen to 25%. Cars with emission above 160 gCO₂/km accounted for 23% of the market, compared to 39% in 2006 and to 80% in 1995 (ACEA, 2010b).

More optimistically, the head of the Centre of Automotive Research at the University of Applied Sciences in Gelsenkirchen, Germany, has forecasted: “By 2025, all passenger cars sold in Europe will be electric or hybrid.” Also optimistically, the Norwegian Finance Minister announced a plan to ban the sales of petrol vehicles by 2015, however the plan has not been implemented.

The European Union have set their 2012 exhaust emission goals for new vehicles at 130 grams per kilometre. Beyond this, the European Union is proposing even tougher standards of 80 g/km by 2020 and 60 g/km by 2025. To achieve this, the majority of the European light duty vehicle fleet will have to be almost entirely electrically (including hydrogen fuel cells) or carbon-neutral biofuel-powered. The EU is proposing stringent fines for non-compliance, e.g. fining carmakers €95 (US$120) per gram per model over the limit (EV World, 2010).

Many European countries are announcing their own targets for the number of EVs on the road. For example, France committed $2.2 billion to put 2 million electric cars on the road by 2020.

Several European countries have also developed relationships with car-makers to develop new plants, invest in charging networks and conduct wide-scale pilot projects.

As a member of the UN Economic Commission for Europe, most European countries will have international safety standards for EVs imposed on them by 2010.

The incentives in Europe to purchase an EV are widespread. National and regional governments of 15 EU member states have introduced incentives, including tax reductions and exemptions, bonus payments and discounts.

Importantly, the European Commission published their strategy for clean and energy efficient vehicles in April 2010.

Environmental groups in the EU are calling for all electric cars sold on the EU market to be equipped with small metering technology that allows vehicles to be charged only when surplus electricity is available on the power grid, which requires technology standardization, enforcement through EU legislation and for member states to raise their renewable energy targets, and policies to ensure that the additional electricity production for these vehicles is zero emission (Kampman et al., 2010).

For more information, see Appendix 3. Summary of European Policies.

4.4 Japan

In 2001, over 50,000 HEVs were in use in Japan, and several new models of HEVs were being introduced onto the market, e.g. the Toyota Estima, the Crown, and the second generation of the
Toyota Prius. HEVs are now established as a commercial option to ICEVs in Japan (Ahman, 2004). Despite the success of the Prius and the Insight, HEVs only accounted for 1% of the newly registered passenger cars in Japan in 2004 (Ahman, 2004). To date, Toyota has sold over one million Prius hybrids in Japan, and in 2009, the Prius was the best-selling vehicle in Japan (McGlaun, 2010).

Toyota is also currently testing smart-grid technology capabilities in conjunction with EVs in Rokkasho, northern Japan. The new smart-grid technology is called the Toyota Smart Centre and it allows the user of a Toyota plug-in hybrid to access information about their use of energy in their home and by the hybrid from a mobile phone or a TV in the home. The Smart Centre provides information on the amount of power consumed by the home, how much a hybrid vehicle has charged, and how much power has been stored at the home. The Smart Centre will then calculate the most efficient way to use the energy that is available to save power and reduce pollution. It will be able to turn things off that are charging and use power when rates are the lowest. Toyota believes that the Smart Centre could help reduce the power used in a home by 75% (Kageyama, 2010).

The Japanese Government was early in identifying technical innovation as a way to mitigate the environmental and energy problems associated with transport. In 1971, the government identified electric vehicles as a long-term target for vehicle development and began to guide the long-term development of vehicles (Ahman, 2004).

Ahman (2004) details the whole of government support in Japan, since the 1970s. He describes the main role of government as a conductor in the development process supplying both R&D support and artificially created niche markets, and easing the way for targeted technologies by means of legislation and standards. He found that the recent market success of the HEV can partly be attributed to the government support of the BEV technology.

Japan maintains their commitment to develop the EV market. The Ministry of Economy, Trade and Industry (METI) issued a goal for EVs to account for 50% of new car sales by 2020. To facilitate this, the government is spending US$135 million in 2010 to build country-wide charging stations (Loveday, 2010a).

In mid-2010, Japan’s METI began financing a three-month trial of a battery-swapping scheme for EVs in partnership with Better Place and EV taxis in Tokyo, in 2010, the world’s first battery replacement station for EVs (O’Connor, 2010). The project includes the recharging and rapid battery replacement stations developed by Better Place (Ben-Gedalyahu, 2010).

Within Japan, the Electric Vehicle Association publishes the standards specific to EVs.

For more details, see Appendix 4. Summary of Japanese Policies.

4.5 China

Pike Research’s EV market assessment report (2009) predicts that China will be the world leader in charging stations, selling nearly half of the global total of 1.5 million units expected to be sold in 2015.
The Chinese government intends to be the largest global manufacturer of EVs and had a goal of producing half a million EVs by 2011. Industry experts now predict that when China reaches this goal, other countries will follow the EV trend.

China revealed a category based standard as described by the US Commercial Service (2009):

*China’s MIIT unveiled new standards, which divides current alternative energy techs into three categories: Start-Up, Developing, and Mature. Only “mature” technologies will be permitted mass production, although “developing” technologies will be allowed limited sales. Currently, only hybrid & electric vehicles with NiMH or lead-acid batteries are classified as using mature technology. Government authorities are pushing for use of only NiMH in the next three years, which will then be replaced by lithium and/or fuel cells.*

The country is well on its way to achieving these goals. For example, the new energy vehicles and auto parts base in Jiading plans to have a production capacity of 10,000 new energy vehicles by 2010; 100,000 units by 2012; and 300,000 units by 2015 (US Commercial Service, 2009). Revised sales forecast 700,000 vehicle sales in 2010 due to increased government support.

One of the key barriers identified by China and the US to rapid EV development is the lack of international standards for EV products and testing. Therefore, China has launched a joint US-China Electric Vehicles Initiative to co-develop standards and testing procedures.

For more information please see Appendix 5. Summary of Chinese Policies.

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**The following example of wide-spread adoption of EVs is about two wheeled vehicles, but there are lessons to be learned for EV market support in the policies employed China.**

**The Effect of Bans:** China witnessed the world's most spectacular growth in electric vehicles since 1998. China's annual sales of electric two-wheeled vehicles (bikes and scooters) grew exponentially from **fifty six thousand vehicles** in 1998 to over **twenty one million** in 2008 (Yang, 2010). Before the late 1990s, there were sporadic attempts to commercialize electric bikes and scooters. Those attempts all failed. The electric bike market in China never took off until the late 1990s, facilitated by favourable local regulatory practices in the form of motorcycle bans and loose enforcement of electric bike standards (Weinert, et al 2007, Weinert et al 2009 in Yang, 2010). According to the motorcycle committee of the Society of Automotive Engineers of China, the use of motorcycles is now banned or restricted in over ninety major Chinese cities (Yang, 2010). The Taiwan Environmental Protection Administration (TEPA) started to promote and subsidize electric scooters in 1998. It spent tens of millions dollars (NT$ 1.8 billion) subsidizing electric scooters but without any restrictions on the use of petrol-fueled scooters. The subsidies included tax reductions for electric scooter manufacturers, subsidies for research and development, promotional activities, charging facilities, and rebates for consumers amounting to nearly half of the scooters' retail prices. With all of these subsidies, the cost of electric scooters was comparable to their petrol counterparts. Nevertheless, sales of electric scooters remained very low. The TEPA administrator eventually acknowledged this policy failure in 2002. Taiwan has so far been unsuccessful in establishing a sustained demand for electric scooters (Tang, 2004 in Yang, 2010). *Excerpt from Yang, 2010.*
5. SUMMARY OF INTERNATIONAL POLICIES

The sections below summarise the international EV policies and initiatives according to the type of policy.

5.1 Regulation

Regulation categories emerging from our research for EVs can be broadly described as those pertaining to:

- Technical and safety (batteries, charging system design, installation and connection)
- Emissions and fuel
- EV acquisition
- Manufacturers
- Charging systems
- EV specifics.

All of the countries investigated above have national standards, or are developing national standards for EVs and have some form of EV regulation. It is important to reiterate that the list below is not exhaustive, but rather representative of our findings and data reported in the Appendices.

Table 5-1. Summary of International Regulation

<table>
<thead>
<tr>
<th>REGULATION</th>
<th>AUS</th>
<th>CAN</th>
<th>US</th>
<th>EU</th>
<th>JP</th>
<th>CHN</th>
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<tbody>
<tr>
<td>NATIONAL STANDARDS</td>
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<td>National Technical Standards</td>
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<td>National Safety Standards</td>
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<tr>
<td>Emissions and fuel</td>
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<tr>
<td>Reduction in Exhaust Emissions</td>
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<td>x</td>
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<tr>
<td>Reduced Fuel Consumption in Federal Fleets</td>
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<tr>
<td>Increased Alternative Fuel Consumption in Federal Fleets</td>
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<tr>
<td>Reduction of Carbon Intensity of Transport Fuels</td>
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<tr>
<td>Alternate fuels for Transport Corporations</td>
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<tr>
<td>EV Acquisition</td>
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<tr>
<td>Acquisition of EVs in State and Federal Fleets</td>
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<tr>
<td>EV Acquisition for Taxi Fleets</td>
<td>x</td>
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<tr>
<td>Authority to require EVs in fleet procurement contracts</td>
<td>x</td>
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<tr>
<td>Manufacturers</td>
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<tr>
<td>Manufacturer Production Requirements for ZEVs</td>
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<tr>
<td>Which Enterprises can Manufacture an EV</td>
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<tr>
<td>Obtaining Product Permission to Produce EVs</td>
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<tr>
<td>Regulation for Low Speed EVs</td>
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<tr>
<td>Charging Systems</td>
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<tr>
<td>Where to Install Charging Systems</td>
<td>x</td>
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</table>
SUMMARY OF INTERNATIONAL POLICIES

<table>
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<tr>
<th>When to Use Charging Systems</th>
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<th>US</th>
<th>EU</th>
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<tbody>
<tr>
<td>Charging Infrastructure in Residential Developments</td>
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<thead>
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<th>EV Specifics</th>
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<th>CHN</th>
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<tbody>
<tr>
<td>Registration and insurance of EVs</td>
<td>x</td>
<td></td>
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</tr>
<tr>
<td>No and Protection of EV Parking Spaces</td>
<td>x</td>
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</tr>
</tbody>
</table>

**Outcomes of Regulatory Policy**

California’s Zero Emissions Vehicle (ZEV) mandate resulted in:

- Heavy investment in BEV technology by manufacturers, as seen by Toyota, Nissan and Honda (Mauro, 2000; Patchell, 1999 in Ahman, 2004).
- Greater than 5,500 electric vehicles onto California's roads.
- Spurring the development of innovative hybrid and fuel cell vehicles (Calef and Goble, 2007).

California’s Low Carbon Fuel Standard is expected to:

- Achieve a growth of 4.1 million EVs (Bailey and Morris, 2009).

China’s ban on motorbikes resulted in:

- Exponential growth in 2-wheeled electric vehicles from fifty six thousand vehicles in 1998 to over twenty one million in 2008 (Yang, 2010).

### 5.2 Pricing

Pricing policies mainly consisted of electricity tariffs approved by State agencies that are specifically for EV charging. Another important aspect of pricing policies are taxes used to equalize the costs of EVs versus ICEVs and/or taxes used to place a value on the environmental footprint caused by ICEVs.

Table 5-2. Summary of International Pricing Policies

<table>
<thead>
<tr>
<th>PRICING</th>
<th>AUS</th>
<th>CAN</th>
<th>US</th>
<th>EU</th>
<th>JP</th>
<th>CHN</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV ELECTRICITY TARIFFS, (e.g.):</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Net-metering</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rebates to stations providing off-peak EV charging</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Time of use</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat monthly fee</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>TAXES, (e.g.):</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fuel TaxCO₂ Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestion Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car Consumption Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST ALLOCATION of incremental costs across all fleets</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Outcome of Pricing Policies

One could argue that in order to promote electric vehicle use, governments should “buy-down” the PHEV technology by offering incentives. Richard Duke proposed several criteria for technologies that are appropriate for a buy-down strategy (Duke, 2002 in Yang, 2010). The criteria include:

1. Competitive market structure
2. Strong experience curve with a low floor price
3. Low current sales but strong market acceleration with subsidies
4. Low market risk from substitutes, and
5. Public benefits.

According to Yang (2010), three issues arise from these criteria. Due to the lack of empirical data, the experience curve for PHEV batteries is virtually unknown. The Taiwanese experience in electric scooters suggests that subsidies may not be effective in accelerating market penetration (referenced in Section 4.5). Also, there is a high risk from substitutes (i.e. conventional vehicles and regular hybrid vehicles). These features suggest that a government subsidized buy-down strategy may be an unreliable approach for launching PHEVs and EVs. The technological buy-down for EVs and PHEVs could require a significant budget and long time span. Therefore, there is a risk that the political support for the subsidy may wear off before the electric vehicle technology can prevail (Yang, 2010).

Limiting the fossil-fuelled alternatives may be a more effective launching strategy for electric vehicles. The reverse subsidy approach offers the advantage of not draining the government budget and therefore may be more financially sustainable than a direct buy-down approach.

Whether governments will adopt restrictive policies on conventional fossil-fuelled vehicles may a crucial determinant in the future of electric vehicles. Restrictive policies on conventional fossil-fuelled vehicles deserve more serious consideration if policymakers wish to create stable demand for clean vehicles. Subsidies resulting in comparable price and superior environmental performance may be insufficient to make electric vehicles a commercial success, while limiting the fossil-fuelled alternatives could be highly effective in forcing the market penetration of electric vehicles (Yang, 2010).

Research suggests that “feebate” programs, where consumers pay a fuel-economy based fee at the time of purchase may be more effective at encouraging the purchase of high fuel-economy vehicles than fuel-economy based registration or emissions testing fees. Moreover, unlike a sales tax waiver, a feebate could be designed to be revenue neutral (Gallagher and Muehlegger, 2010).

Since London introduced its stringent congestion fees, alternative cars that are exempted from the charges are booming (Grunweg, 2008 in Yang, 2010). According to John Mason, head of enforcement at Transport for London's Congestion Charge, the number of electric cars in London increased from 90 in February 2003 to over 1600 in June 2008. Other eco-friendly cars, such as hybrids, also rose from 1000 vehicles in 2003 to more than 20,000 in 2008.
5.3 Incentives

A wide variety and large number of incentives were available in the countries researched. The emerging categories, as summarised in Table 5-3, include incentives to:

- Purchase and own an EV and infrastructure
- Convert an EV
- Install infrastructure
- Develop EV and component
- Manufacture EV and battery.

Table 5-3. Summary of International Incentives to Purchase an EV and EV Infrastructure

<table>
<thead>
<tr>
<th>INCENTIVES</th>
<th>AUS</th>
<th>CAN</th>
<th>US</th>
<th>EU</th>
<th>JP</th>
<th>CHN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal Tax Incentives for Consumers (e.g.):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income tax credit for EV and infrastructure purchase</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Fuel consumption tax reduction</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Exemption from monthly vehicle tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road tax reduction or exemption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registration tax reduction or exemption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reduction or exemption from company car tax</td>
<td></td>
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<tr>
<td>Reduction or exemption from special pollution tax</td>
<td></td>
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<tr>
<td><strong>Federal Funding for Cities and States (e.g.):</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>City purchases of EV and infrastructure</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Department of Transport purchase of EV and infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parks and Public Lands purchase of EV and infrastructure</td>
<td></td>
<td></td>
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<tr>
<td>Bonus for cars emitting zero or little carbon emissions</td>
<td></td>
<td></td>
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<tr>
<td><strong>State/Local Tax Incentives for Consumers (e.g.):</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Income tax credit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Sales tax reduction or exemption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excise tax exemption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle license tax reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Congestion tax exemption</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>State Funds for Consumers &amp; Governments (e.g.):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rebates, Vouchers and Bonuses</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funds (grants and low interest loans)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>State Funds for Fleets and Transit Providers</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Local Funds for Fleets, Government and/or Consumers</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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</tr>
</tbody>
</table>
More incentives are summarized in the following table, specifically, owner incentives that are less focused on direct financial benefit as well as incentives to develop and manufacture EVs.

Table 5.4. Summary of International Incentives to Own, Develop and Manufacture EVs

<table>
<thead>
<tr>
<th>INCENTIVES</th>
<th>Benefits for Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner Benefits</td>
<td>• Access to High Occupancy Vehicle (HOV) lanes</td>
</tr>
<tr>
<td></td>
<td>• Dedicated Green Lanes for EVs</td>
</tr>
<tr>
<td></td>
<td>• Vehicle Emission Test Exemptions</td>
</tr>
<tr>
<td></td>
<td>• Insurance for loan payments</td>
</tr>
<tr>
<td></td>
<td>• Access to prime parking spots</td>
</tr>
<tr>
<td></td>
<td>• Exemptions from time-of-day and day-of week restrictions</td>
</tr>
<tr>
<td></td>
<td>• Parking fee reduction or exemption</td>
</tr>
<tr>
<td></td>
<td>• Credits against ground transport fees</td>
</tr>
<tr>
<td></td>
<td>• Free battery charging</td>
</tr>
<tr>
<td>Development</td>
<td>• Extension of taxicab registration for those with EVs</td>
</tr>
<tr>
<td></td>
<td>• Low interest loans</td>
</tr>
<tr>
<td></td>
<td>• Payroll income tax credit</td>
</tr>
<tr>
<td></td>
<td>• Investment tax credits</td>
</tr>
<tr>
<td></td>
<td>• High-tech growth tax credits</td>
</tr>
<tr>
<td></td>
<td>• Property tax exemptions</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>• Approval for tax increment financing</td>
</tr>
<tr>
<td></td>
<td>• Funds and tax incentives to encourage:</td>
</tr>
<tr>
<td></td>
<td>• To transform factories to produce EVs</td>
</tr>
<tr>
<td></td>
<td>• To develop EVs</td>
</tr>
<tr>
<td></td>
<td>• To sell EVs</td>
</tr>
</tbody>
</table>

Outcomes of Incentive Policies

State incentives, as well as average income and social preference have been found to be significant in explaining state market shares of EVs in the US (Diamond, 2008a). More specifically, a one-standard deviation increase in per-capita income is associated with a 32% increase in hybrid sales (Gallagher and Muehlegger, 2010).

The positive relationship between income and hybrid adoption suggests that financial incentives may disproportionately benefit higher income consumers who are more likely to purchase hybrids in the first place. Lower income consumers are less able to afford the higher up-front premium for a hybrid. Given the apparent weak or negligible effect of monetary incentives, this could mean current monetary incentives for hybrids may be rewarding those who need the incentive the least for a purchase they were likely to have made anyway (Diamond, 2008a).

The results of analyses on impacts of government incentives for hybrid-electric vehicles in the US suggest a strong relationship between petrol prices and hybrid adoption, but a much weaker
SUMMARY OF INTERNATIONAL POLICIES

relationship between incentive policies and hybrid adoption. Beresteanu and Li (2008) concluded that hybrid vehicle sales in 2006 would have been 37 percent lower had petrol prices stayed at the 1999 levels, whereas federal income tax deductions explained less than 5 percent of hybrid vehicle sales from 2001 to 2005. They did find that the more generous income tax credits in 2006 accounted for about 20 percent of hybrid vehicles sales.

For high fuel-economy hybrids, a 10% increase in petrol price has led to an 8.6% increase in per-capita sales of high fuel-economy hybrid vehicles; additionally, a $100 increase in annual fuel savings relative to comparable non-hybrid vehicles is associated with a 13% increase in sales (Gallagher and Muehlegger, 2010).

Regardless of the type of incentive, the disproportionate influence of fuel prices on market share suggests that market-driven spikes in petrol prices are likely to crowd out any modest effects from incentives or petrol taxes at current US levels (Diamond, 2008a).

A study in Canada also found that tax incentives may not be the most effective way to encourage people to switch away from fuel inefficient vehicles, at least in the short or medium run (Chandra et al., 2010). Specifically, the study found:

- 26% of the electric vehicles sold during the rebate programs can be attributed to the rebate
- The rebate programs subsidized many consumers who would have bought electric vehicles in any case
- The average cost of reducing carbon emissions from these programs is estimated to be $195 per tonne
- CAD$1000 increase in the sales tax rebate increases the market share of hybrid cars by 31–38%.

If the decision is made to offer incentives, providing incentives to consumers up-front might be the most efficient use of government funds (Diamond, 2008a). Up-front excise or sales tax waivers are more effective than delayed rebates or tax credits in influencing adoption (Diamond, 2008a). A comparison of the current income tax credit program with a rebate program found that the rebate program needs less government revenue to achieve the same level of average fuel-efficiency of new vehicles (Beresteanu and Li, 2008).

Similarly, Gallagher and Muehlegger (2010) found that the form of incentives is as important a factor in consumption adoption as incentive generosity. Specifically:

- Sales tax waiver of mean value is associated with over three times the effect of an income tax credit of mean value
- Conditional on the value of the incentive, sales tax waivers have more than a ten-fold greater impact on hybrid vehicle sales that income tax credits
- Sales tax waiver equal to 1% of the retail price is associated with an 8.3% increase in sales—a comparable income tax credit is associated with a 0.6% increase in retail sales.

In Virginia, **HOV lane incentives**, along with income and environmentalism, were significant predictors of market share, but that the HOV lane effect was highly dependent on local
conditions (Diamond, 2008b). Analysis by Gallagher and Muehlegger (2010) concur. They found the effects of HOV access vary significantly by state; there is little evidence that single-occupancy access to car pool lanes is correlated with adoption and only the State of Virginia had a positive and significant coefficient, e.g. a 92% increase in sales as a result of unrestricted access (most likely due to the extensive use to travel to and from Washington DC).

Many of the small incentives have been found to be of insufficient magnitude or generosity to affect state-level sales, including (Gallagher and Muehlegger, 2010):

- Exemptions from vehicle emissions tests
- Parking fee reductions or exemptions
- Exemptions from registration fees, excise taxes and annual license fees.

In terms of incentives for manufacturers, Michigan's aggressive effort to develop a home-grown advanced-battery industry via property tax exemptions resulted in four companies announcing plans to invest more than $1.7 billion in advanced-battery manufacturing facilities in Michigan. The projects created 6,683 new jobs in Michigan and were awarded state refundable tax credits that helped the companies in their quest for some of the $2 billion in federal grants for advanced-battery research and development.

Another conclusion is that market support, even in the early phases of development, is an important complement to R&D for gaining experience and building markets (Ahman, 2004).

### 5.4 Facilitation

Each of the countries also had many similar facilitation policies in place.

Table 5-5. Summary of International Facilitation Policies

<table>
<thead>
<tr>
<th>FACILITATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Partnerships</td>
<td>Partnership with manufacturers for testing and development</td>
</tr>
<tr>
<td></td>
<td>Bringing industry and stakeholders together</td>
</tr>
<tr>
<td>Funding</td>
<td>Funding for technology development</td>
</tr>
<tr>
<td></td>
<td>Support for academic research</td>
</tr>
<tr>
<td>Hardware</td>
<td>Wide-spread infrastructure commissioned by the government</td>
</tr>
<tr>
<td></td>
<td>Investigations into bulk purchasing for State agencies</td>
</tr>
<tr>
<td>Resolutions</td>
<td>State resolutions for federal action</td>
</tr>
<tr>
<td></td>
<td>State resolutions for manufacturer production of EVs</td>
</tr>
</tbody>
</table>

**Outcomes of Facilitation Policy**

The influence of the Memorandum of Agreement between the vehicle manufacturers and the Californian state, in regards to EVs that the government would purchase led to:

- Rise in production of BEVs in 1998 and 1999 to approximately 500–550 units/year.
- However, production fell directly after the agreement was fulfilled (Ahman, 2004).
A lithium battery project, support by the Japanese government resulted in:

- The development of a Li-ion battery by Shin-Kobe Electric machinery and currently used in the Nissan Hypermini (Terada et al., 2001 in Ahman, 2004).

Since China’s technology development pilot projects were initiated, significant progress had been achieved between 2001 – 2005, including:

- 26 national standards were established,
- 796 patents in and out of China (including 413 invention patents) were granted (Zhang et al, 2009).

During the Beijing Olympics, four auto manufacturers joined with three institutes to provide their independently developed lithium-ion battery bus, 25 hybrid buses, 77 hybrid sedans, 20 fuel battery sedans, 3 fuel battery city buses, 415 electric terrain and application vehicles. All of the 598 new energy vehicles formed the largest energy conservation and new energy vehicle demonstration and application team in the history of Olympics, and realized zero emission of automotive greenhouse gases in the central transportation zone of Beijing Olympics Park (Zhang et al, 2009).

5.5 Information

All of the countries researched had an Electric Vehicle Association that acts as an important information source. Other established and utilized sources of information available internationally are summarised below.

Table 5-6. Summary of International Information Sources

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>INFORMATION RESOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>Government and association websites and newsletters</td>
</tr>
<tr>
<td></td>
<td>Information sharing networks</td>
</tr>
<tr>
<td></td>
<td>Guidance on EV infrastructure</td>
</tr>
<tr>
<td>Tools</td>
<td>Decision-making tools for fleet managers</td>
</tr>
<tr>
<td></td>
<td>Installation guides for EV charging stations</td>
</tr>
<tr>
<td>Training</td>
<td>For fire-fighters and first responders</td>
</tr>
<tr>
<td></td>
<td>For mechanics</td>
</tr>
<tr>
<td></td>
<td>For engineering students</td>
</tr>
<tr>
<td></td>
<td>For fleet managers</td>
</tr>
<tr>
<td>Regulation</td>
<td>Labelling requirements for EVs and charging stations</td>
</tr>
<tr>
<td></td>
<td>Requiring dealers to provide EV info</td>
</tr>
<tr>
<td></td>
<td>GHG reporting requirements for vehicle manufacturers</td>
</tr>
</tbody>
</table>
INFORMATION

<table>
<thead>
<tr>
<th>Reports</th>
<th>Funding for studies and studies completed, e.g.:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Public opinion trials and research</td>
</tr>
<tr>
<td></td>
<td>• EV impacts on roadway funding</td>
</tr>
<tr>
<td></td>
<td>• EV impacts on CO2 emissions</td>
</tr>
<tr>
<td></td>
<td>• Costs for charging infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Monitoring transport fuel trends</td>
</tr>
<tr>
<td></td>
<td>• State-specific barriers to widespread EV adoption</td>
</tr>
</tbody>
</table>

Studies verifying the impacts of these information policies were not investigated.

5.6 Targets

All of the countries reviewed have some form of national EV target, as well as several regional and local targets, which strive for:

- Specific numbers or percentages of vehicles manufactured or sold or purchased by government
- Replacement or reductions in fossil fuels
- Specific numbers or percentages of EV parking spaces or charging stations.

Table 5.7: Summary of International Targets

<table>
<thead>
<tr>
<th>TARGETS</th>
<th>AUS</th>
<th>CAN</th>
<th>US</th>
<th>EU</th>
<th>JP</th>
<th>CHN</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Targets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of EVs on the road</td>
<td>X</td>
<td>X</td>
<td>500,000 by 2018</td>
<td>1,000,000 by 2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of EVs on the road</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10% by 2020 (Ireland)</td>
<td>100% of gov’t vehicles by 2004</td>
</tr>
<tr>
<td>Production of EVs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,000,000 by 2011</td>
<td></td>
</tr>
<tr>
<td>No of EVs sold</td>
<td>X</td>
<td></td>
<td>5,000,000 by 2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of EVs as new car sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50% by 2010</td>
<td></td>
</tr>
<tr>
<td>State and City Targets</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No or % of EVs on the road</td>
<td>5% by 2020 (Ontario)</td>
<td></td>
<td>1,000,000 by 2015 (London)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>% Reduction in gasoline, petroleum, and diesel fuel</td>
<td>• 20% reduction by 2012, from 2008 levels (IL);</td>
<td></td>
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</tr>
</tbody>
</table>
5.7 Coordination

Coordination policies have been developed at all levels within these countries, from international initiatives to local resolutions.

Table 5-8. Summary of International Coordination

<table>
<thead>
<tr>
<th>COORDINATION</th>
<th>AUS</th>
<th>CAN</th>
<th>US</th>
<th>EU</th>
<th>JP</th>
<th>CHN</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Coordination on Standards</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Coordination Bodies and Partnerships</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Roadmaps and joint policy evaluation</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>EU</td>
<td>National</td>
</tr>
<tr>
<td>Guidelines, definitions and resolutions</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Japan had an ambitious goal to replace 100% of all government vehicles by 2004. This first program did not meet targets because of the more turbulent economy during the 1990s made the more expensive vehicles unaffordable for government agencies (Ahman, 2004).

Spain, United States, China and London are all racing towards the goal of 1 million EVs on the road. France has set their sights set to reach 2 million, EVs by 2020.
6. SUGGESTED POLICIES FOR AUSTRALIA

6.1 Introduction

As described in Section 1.2, several filters and processes have been used to determine a list of potentially effective and appropriate policies for Australia, including:

1. Researcher review of policies against policy criteria
2. Survey among Electric Driveway stakeholders
3. Prioritisation at an Electric Driveway workshop
4. Final researcher review

Firstly, to narrow down the 50+ policy options presented in Section 2, four ISF researchers independently applied key questions and considerations (listed below) to select 20 policy options that would be appropriate for Electric Driveway stakeholders to review in a survey (any more than 20 would have been ineffective for the survey process). The key questions developed to select these 20 policy options included:

- Do the policies fall within government’s mandate?
- Do the policies allow for the key features of technical change, including uncertainty, learning, path dependence and accumulation of knowledge?
- Do the suite of policies provide for progress in all, or the majority of, technology development phases?

Other key considerations of the policy options included:

- Effectiveness at increasing adoption
- Cost to both government and industry
- Difficulty of implementation
- Urgency (e.g. when should these policies be implemented)
- Additional policy benefits and implications

The four independent analyses resulted in nearly 75% concurrence over the list of 20 policy options. The remaining policy options were selected through discussions in order to address any policies that overlapped and to fill any gaps. The top 20 policy instruments that were selected by ISF based on these questions and considerations are presented in Table 6-1. It is neither feasible nor appropriate at this stage to investigate each of these 20 options within the scope of this report. Therefore, to further refine our list of policy options to investigate, ISF developed and circulated a survey among stakeholders.

Based on the survey results, the policy options were narrowed down to 13 options (Note: the 13 italicised policy options in Table 6-1 are the priority options selected via the survey). ISF then held an EV policy workshop with stakeholders, where the 13 policy options were discussed. Based on the workshop discussions, ISF selected five policy options to research in more detail.
(Note: the five bolded and italicised policies in Table 6-1 are those that ISF has researched in more detail). These five policy instruments are discussed in more detail in this section, with a summary of their unique considerations and how each policy could be structured.

Table 6-1. Priority policy options

**Technology Policies**

Tech 1. Establish Australian centres of excellence through the provision of grants or loans for research, development and deployment of lower cost, longer lifetime batteries and vehicles and connect these centres with international equivalents

Tech 4. Initiate, encourage and fund charging station and infrastructure demonstration programs including battery swapping

**Regulation Policies**

R2 Creation of streamlined network connection agreements for electric vehicle supply equipment

R3/R4 Implement mandatory fuel economy standards and/or low and zero emission vehicle requirements

R5 Ensure building codes for new or renovated sites (residential, commercial, industrial) support EVs by requiring dedicated electrical capacity and parking spaces

**Pricing Reform**

P2 Time of use electricity pricing

P4 New or increased environmental, fuel or congestion charges or taxes on ICEVs

P5 Reduce or eliminate subsides for existing ICEV purchases, e.g. in fleets with fringe benefit taxes

**Incentives / Enticement**

E11 Access to free or prime parking spaces

E15 Grants/loans or tax credits for manufacturers

E17/R17 Funding and/or requirements for utilities in planning and preparing for EV introduction

E1/P9 Tax reductions or exemptions for EV and charging station purchases and implement a fuel-economy based fee at the time of purchasing a car including specific programs for fleets

**Facilitation**

F1 Mandated purchase of and an increasing percentage of EVs in government fleets and/or Memorandum of Agreement between government and manufacturers (e.g. California’s successful MOA)

F4 Funding of workforce training programs

F5 Connecting renewable energy targets to EV sales
6.2 Policy Selection

As mentioned above, ISF narrowed down the list of 50+ policy options presented in Section 2 to 20 options. ISF further refined the list of appropriate policy options via a survey circulated among stakeholders. Stakeholders were also sent a copy of this report, as a draft, in order to provide background and contextual information about these policy options\(^4\). The survey asked each respondent to rank the 20 policy options above from Very Important (1) to Not Important (5). The survey then asked each respondent to select their top 5 options from the list of 20 above and order them from 1 (Most Important) to 5 (5\(^{th}\) Most Important). The results are presented in the table below.

\(^4\) Note: the process to narrow the policy options from 50+ to 5 was not designed to be exhaustive, but rather representative. One vulnerability of this policy screening methodology includes prioritisation potentially based on imperfect knowledge. Circulating the draft report with the survey and before the workshop to stakeholders helped to address this vulnerability. Another potential vulnerability is that the initial reduction from 50+ to 20 policy options may have excluded policy options that would have been preferred by stakeholders. However, stakeholders were encouraged to provide their alternatives during the survey process, to be incorporated into the workshop.
Table 6-2. Survey Results: Scoring for each policy option

<table>
<thead>
<tr>
<th>Rank for Most Important</th>
<th>Policy Description</th>
<th>1st Rank</th>
<th>2nd Rank</th>
<th>3rd Rank</th>
<th>4th Rank</th>
<th>5th Rank</th>
<th>Total Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4</td>
<td>Fund charging stations</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>R3/4</td>
<td>Fuel and emission standards</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>R5</td>
<td>Building codes</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>C7</td>
<td>Government strategies</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>R2</td>
<td>Network connections</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>I6</td>
<td>Common metric</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>F1</td>
<td>Mandated government purchase</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>F5</td>
<td>Connect RE targets and EV sales</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>P2</td>
<td>Time of Use (ToU) pricing</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>T1</td>
<td>Centres of excellence</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>P4</td>
<td>Fuel or environmental charges</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>P5</td>
<td>Reduce subsidies for ICEVs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E1/P9</td>
<td>Incentives for EVs/Fee-bates</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>I1</td>
<td>Central hub of EV info</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>F4</td>
<td>Funding of workforce training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E11</td>
<td>Access to free or prime parking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>T1</td>
<td>Firm EV sales targets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

The survey respondents were then asked to classify the five policy options in relation to the following comparative attributes (these questions were also revisited at the workshop and therefore the results have not been provided):

5 Several respondents replied to the survey on the day of the workshop or several days after. These survey results presented in Table 6-2 were compiled after the workshop, therefore, the results do not reflect the survey results compiled the day before the workshop. The main differences are: the post-workshop survey data analysis showed T4 (Funding charging stations), R2 (Streamlining network connections) and P4 (Fuel or environmental charges) as being within the top 12 policy options, but they were not discussed at the workshop (as the pre-workshop survey analysis did not rank these policies in the top 12). Additionally, E11 (Access to free or prime parking) and I1 (central hub of EV info) were ranked in the top 12 in the pre-workshop survey, but were not ranked in the top 12 in the post-workshop survey analysis.  

6 To calculate the total scoring for each policy option, a weighted score was used. Each rank was worth the following points: most important (5pts), 2nd most important (4pts), 3rd most important (3pts), 4th most important (2pts), 5th most important (1pt).
• How effective would these options be at increasing adoption of EVs in Australia? (pre-requisite for mass adoption, very effective, quite effective, moderately effective)
• How much would the options cost government to implement? (Very expensive, expensive, moderately expensive, not expensive)
• How much would the options cost industry to implement? (Very expensive, expensive, moderately expensive, not expensive)
• What level of public support would you expect these measures to have? (Very challenging, moderately challenging, somewhat challenging, easy)
• How urgent is it for these reforms or options to be implemented (i.e. when should they be implemented)? (Right away, in the next 1-2 years, within 3-5 years, sometime in the next 10 years)
• How important are the additional benefits of the options not related directly to EV adoption (e.g. benefits related to air quality, greenhouse gases, job creation or economic stimulus)? (Very important, important, somewhat important, not important).

Respondents were also asked if they had any specific concerns regarding their top 5 options, if there were any other important policy options that were not in the list of 20 and if there were any topics or considerations with regards to process that they would like to have incorporated into the workshop (responses are presented below with workshop discussion points).

The top 12 policy options from the survey (italicised in Table 6-1) were selected to discuss in greater detail at a stakeholder workshop. ISF also added T1 Firm national EV sales targets to the list of policy options because of the role Targets have in creating a national vision for new technology and in order to have representation from each area of the Policy Palette at the workshop.

The workshop process included:

1. Presentation and discussion on barriers to widespread EV adoptions
2. Presentation and discussion on policies to support widespread EV adoption
3. Group ranking of activity of 13 policy options based on: Cost to government verses cost to industry; Efficiency verses industry; and Public support.

The following points around barriers to EVs were mentioned at the workshop (and in the survey). Note: the discussion points listed below are not representative of any specific stakeholder, nor are the discussion points an exhaustive summary of EV barriers from the perspective of all stakeholders:

• Questions around whether the motor vehicle industry has the capacity and skills to facilitate EV manufacturing
• Lack of incentives for companies to position themselves in this new market
• Disincentives exist for one manufacturer in particular to sell EVs, until existing previous models of cars have sold.
• Policy options to address negative influences, such as those lobbying against the EV industry
SUGGESTED POLICIES FOR AUSTRALIA

- Costs associated for EV manufacturers and service providers to be first adopters is a big barrier. Companies will wait until the next generation of technology, as they perceive this to be safer.

- How can we partner EV measures with carbon measures? E.g., what types of barriers to EVs would exist in Australia, where a carbon price also exists? How could EV purchasing and renewable energy charging be linked to avoid any potential, although unlikely, increase in carbon emissions in Victoria, because of the higher carbon intensity of electricity? What are the business models to achieve this outcome? The development and implementation of carbon policies and EV policies, their timeframe and linkages, could have a big positive or negative impact on carbon emissions and EV incentives.

- The additional benefit of EVs and reduced air pollution could play a very important role in Victoria. The deaths, per annum, in Victoria from air pollution are around 300 to 400. How could the externality of dirty fuel sources be costed and benefited to EVs?

- The lack of noise for EVs could be a barrier to EV in some respects, e.g., the impacts for the visually impaired.

- The flow-on effects for the electricity industry will also need to be researched and quantified. Currently, people do have any disincentive to not charge their vehicle at 6pm. How could charging EVs result in increased energy prices? Could this be a barrier? Residential customers will be required to put in a separate charge point for the vehicle (as residential customers do not have 10amp access), so essentially they will have to notify their utility that they have an EV and an electrician will have to be involved. Trials are being conducted in South Australia regarding peak power tariffs, e.g., a customer is allocated with a 6 kW demand limit, and it is up to the customer as to how they would like to allocate their power. Would this type of tariff have any applicability? This tariff has been considered, but the meters need to be capable of capturing both kW and kWh.

- Management of grid impacts/minimisation of electricity infrastructure investment is a major issue/externality that may arise from unfettered adoption of EVs - key considerations related to this issue include implementation of advanced metering infrastructure and time-of-use tariff charging, and the market frameworks for metering (specification, installation costs, accreditation) and re-selling of electricity.

- The focus on locked in charge point and energy supply is not in the best interests of the consumer (driver) and is driven by commercial interests. The use (charging) of EVs should not be linked to metering/ToU pricing as this is a sensitive area that is causing problems in the Smart meter deployment.

- Government needs to be taking action in this area in the right location, e.g., government must have proof of a market failure for government to intervene. It is also important to remember that government is not limited to intervening only where a barrier exists.

- Oil Company response needs to be considered - they will cut prices to stay competitive and potentially delay mass adoption.

The wide-ranging discussion topics around policy options at the workshop (and in the survey) included. *Note: the discussion points listed below are not representative of any specific*
stakeholder, nor are the discussion points an exhaustive summary of EV barriers from the perspective of all stakeholders:

- ToU tariffs will be a significant incentive because off-peak charging will be much cheaper
- How could registration of vehicles be linked to providing EV incentives? Registration seems to be one of the levers that a State government has
- Separate itemisation on utility bills (for EV usage)
- Opportunities to link renewable energy with EV targets
- Developing innovative finance options and/or identifying third party providers
- Potential restrictions or disincentives for peak recharging of EVs
- Revamp fringe benefit tax (FBT) for EVs (and encourage less kilometres travelled not more)
- Scalability of Electricity Distribution Company response to EV load
- Electricity market reforms may be required to cater for “re-selling” of electricity by charging infrastructure operators
- Workplace charging may be a key enabler for would-be EV operators unable to charge at home - this may require reforms to fringe benefit tax (FBT) calculations, incentives for workplaces to provide infrastructure etc
- EVs should not be connected (for commercial or other reasons) to ToU pricing initiatives, smart meter deployments or any other charge point requirements (battery exchange, fixed vendor for charging energy)
- Some standardisation of how charging provider plans are communicated will likely be required should no clear business model emerge initially
- The whole area of energy supply for charging vehicles needs to be reviewed both from an Australian Energy Regulator point of view and a State policy point of view to ensure synchronisation of drivers for consumers and EV uptake.

In the last 45 minutes of the workshop, a ranking exercise was completed, in order to create a composite analysis of policy options across multiple criteria. The participants collectively analysed the policy options using 2x2 matrices on a sticky wall (see below).
To complete the exercise, each participant was handed an envelope containing 13 squares of paper. Each piece of paper had one of the italicised policy options from Table 7-1. The participants were divided up into two smaller groups. One group ranked the 13 policy options according to their Costs and the second group ranked the 13 policy options according to their Benefits. The Costs matrix (on the left hand side) allowed participants to compare the costs of each policy option: the x-axis represented ‘Cost to Government’ (More Expensive, Less Expensive) and the y-axis represented ‘Cost to Industry’ (More Expensive, Less Expensive). The matrix on the right hand side allowed participants to compare the benefits of each policy option: the x-axis represented Effectiveness (Less Effective, More Effective) and the y-axis represented Urgency (5-10 years, Immediately).

The activity began with both groups placing the Regulatory policy options on the matrix all at once. After each person placed his or her Regulatory policies on the matrix, one member of each group would find the ‘centre of mass’ for each policy and place a collective ‘Group’ marker on the matrix in the centre of mass. This group ‘rank’ for each Regulatory policy option stayed on the wall, and all of the individual votes were removed. This process continued for Pricing, Incentives, Facilitation, Information, Targets, Coordination and Technology policy options, until all that was left on the two matrices, were collective group rankings for each of the policy options.
A summary of results from the analysis exercise are presented below. Note: the summaries below are not representative of any specific stakeholder, nor do they represent a thorough analysis from the perspective of all stakeholders.

Table 6-3. Costs: Cost to government versus cost to industry

<table>
<thead>
<tr>
<th>Cost to Industry</th>
<th>Low cost to industry, high cost to government:</th>
<th>Low cost to industry, low cost to government:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Mandated purchase of EVs in government fleets (F1)</td>
<td>• ToU electricity pricing (P2)</td>
</tr>
<tr>
<td></td>
<td>• Access to parking spaces (E11)</td>
<td>• Common metric for lifetime cost comparison of ICEVs, HEVs and EVs (I6)</td>
</tr>
<tr>
<td></td>
<td>• National EV sales target (T1)</td>
<td>• Coordinating federal and state EV strategies (C7)</td>
</tr>
<tr>
<td></td>
<td>• Central Hub for EV info (I1)</td>
<td>• Building codes that require dedicated electrical capacity and parking spaces for EVs (R5)</td>
</tr>
<tr>
<td></td>
<td>• Australian Centres of Excellence (Tech 1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost to Government</th>
<th>High cost to industry, high cost to government:</th>
<th>High cost to industry, low cost to government:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Tax benefits for EV purchases and fuel-economy based fee at the time of car purchases (E1/P9)</td>
<td>• Mandatory fuel economy standards and/or low and zero emission vehicle requirements (R3/R4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Connect RE targets to EV sales (F5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reduce subsidies for ICEV purchases (P5)</td>
</tr>
</tbody>
</table>

Table 6-4. Benefits: Efficiency versus urgency

<table>
<thead>
<tr>
<th>Urgency</th>
<th>More urgent, less efficient:</th>
<th>More efficient, more urgent:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Central Hub for EV info (I1)</td>
<td>• ToU electricity pricing (P2)</td>
</tr>
<tr>
<td></td>
<td>• Australian Centres of Excellence (Tech 1)</td>
<td>• Connect RE targets to EV sales (F5)</td>
</tr>
<tr>
<td></td>
<td>• Access to parking spaces (E11)</td>
<td>• Common metric for lifetime cost comparison of ICEVs, HEVs and EVs (I6)</td>
</tr>
<tr>
<td></td>
<td>• National EV sales target (T1)</td>
<td>• Federal and state strategies and roadmaps for EVS (C7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urgency</th>
<th>Less urgent, less efficient:</th>
<th>Less urgent, more efficient:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Reduce subsidies for ICEV purchases (P5)</td>
<td>• Mandatory fuel economy standards and/or low and zero emission vehicle requirements (R3/R4)</td>
</tr>
<tr>
<td></td>
<td>• Mandated purchase of EVs in government fleets (F1)</td>
<td>• Tax benefits for EV purchases and fuel-economy based fee at the time of car purchases (E1/P9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Building codes that require dedicated electrical capacity and parking spaces for EVs (R5)</td>
</tr>
</tbody>
</table>
After a group rank had been placed on both matrices for each policy option, the outcomes of the process were summarised by ranking the policies in a linear fashion. The linear composite was created by writing each policy option on the 45 degree line at its perpendicular angle of intersection with the 45 degree line (demonstrated below with Policy R3/R4).

Figure 6-1. Costs: Cost to government versus cost to industry

![Figure 6-1 Costs](image1)

![Figure 6-2 Benefits](image2)

Figure 6-2. Benefits: Efficiency verses effectiveness
A third matrix was then created to compare the ranking of the policy options in terms of Costs versus Benefits. In the third matrix, the coordinates for each policy option were a sum of each policy option’s rankings from the first and second matrix. The policy options that the stakeholders expected to have the greatest level of public support were then marked with a pink piece of paper.

The above photo of the composite matrix (e.g. of mapping of the results of Costs versus Benefits) has been translated into a summary chart, shown below in Figure 6-3. The four policies with public support are noted with a border.
Please note: the strength of the workshop process is that it provides an analytical tool for further investigation and prioritisation of policy options. We do not consider the analysis described above to be exhaustive, nor final. Rather we consider this analysis to be introductory and a starting point, and we consider the process a valuable tool for future discussions.

ISF’s initial analysis of the policy options, the results of the survey and the discussions at the stakeholder workshop were all helpful stages to select five specific policy options to research further. Our final considerations for selecting the options to research in more detail include:

- Selecting the policy options that require a more detailed explanation (e.g. “Provision of a Central Hub for EV information does not require much greater exploration in terms of costs, benefits and potential implementation structures).

- Selecting the policies that are more appropriately matched to the current stage of the EV market in Australia (e.g. which policies should be investigated in the short-term)

ISF has selected the following policy options to research in greater detail:

- I6: Common metric for lifetime cost comparison
• C7: Coordination federal and state EV strategies
• F5: Connecting renewable energy targets to EV sales
• P8: Green registration discounts
• P2: Time of use pricing
• E1/P9: Upfront EV cost reductions and fuel economy based fee.

6.3 Policy Option Summaries

Below we present a brief summary on each of these policy options, their specific considerations and potential outcomes, including:

• A general description, an explanation of why the policy is needed and the barriers the policy addresses
• The financial and non-financial benefits. Note: We have not quantified the financial and non-financial implications, but we have given a summary of the potential direction and magnitude of these implications
• The steps required to implement the policy. Note: these steps for implementation are not prescriptive or definitive but rather are meant to facilitate discussion
• A brief description of how the policy relates to other EV policies
• The potential obstacles and risks
• A reference of national and international examples.

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7 In the next phase of the Electric Driveway project, several of these policies will be further analysed and recommendations for key inputs for CSIRO’s Diffusion Model will be provided. Specifically, a short list of 2-3 policies will be analysed to determine their impact on facilitating EV adoption. The Diffusion Model will analyse parameters such as: size ($) of the policy; conditions for the policy (e.g. means test, amount for each vehicle type); timing of introduction; projected vehicle and battery costs, etc. Additionally, the model can test several scenarios of project costs (e.g. best, average, worst).
## I6: Common metric for lifetime cost comparison

### Context

**General Description:**
The creation of a common metric for comparing the lifetime costs of vehicle ownership would provide a simple source of information to consumers when comparing ICEVs and HEVs to EVs. Consumer guides for automobiles have existed, vehicle metrics such as fuel efficiency, and a rough estimate for projected maintenance costs. However, with the exception of fleet vehicle customers, it is unlikely that consumers will do a full lifetime cost of ownership comparison when making a purchase decision. The need for such a metric may have been limited in the past since ICEVs can be compared to one another with each aspect of performance and cost compared side by side. In contrast, EVs fundamentally change the cost structure since the initial costs are high, but the operating costs are far lower. An easier comparison of the total cost of ownership of an EV to an ICEV of a similar vehicle class may make EVs more attractive to consumers.

The creation of a national standard for evaluating the average cost per kilometre for all vehicles (ICEV, HEV, PHEV and EVs), would help consumers make more informed purchase decisions. Such a metric would take into account:

- Vehicle purchase price
- Vehicle purchase consumer tax/incentive
- Cost of fuel
- Fuel tax
- Insurance
- Schedule maintenance
- Unscheduled maintenance
- Scrap value
- Discount rate
- Depreciation
- Cost of a replacement battery pack
- Battery pack lifetime
- Cost of electricity
- Cost of home charging infrastructure.

Further factors that may play a greater role in the future:

- Carbon taxes and incentives
- Second life of battery pack
- Electricity rebates.
### Need:
There is a lack of reliable information about the costs of PHEVs and EVs relative to ICEVs. Adoption rates will depend in part on the consumer’s perception of cost. There are several circumstances in which this lack of access to relevant cost information may present a significant barrier. An example is the common lack of understanding for the difference in purchase price between ICEVs and EVs. For EVs, the battery pack cost is high, but the operating costs (for a reliable battery) will be much lower. There is also a lack of reliable information on maintenance costs, creating difficulty in justifying higher purchase or capital costs.

There are very few standards for understanding long term battery pack related costs. Many consumers fear that if they were to buy an EV, they may have to buy a very expensive replacement battery pack. In general, there is a lack of information regarding these types of costs. A single lifetime cost estimate would reduce the confusion and perceived cost related risks of EV ownership.

### Barriers addressed:
The barrier addressed is ‘Imperfect information’ concerning the total cost of vehicle ownership.

### EXPECTED OUTCOMES

<table>
<thead>
<tr>
<th>Upfront costs and on-going costs to consumer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>This policy is not expected to have an impact on direct upfront costs or ongoing costs to the consumer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefits in terms of convenience, decreased risk and appeal:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is expected that a common cost metric would provide substantial convenience to consumers who might otherwise not be able to make such a cost comparison. There is a decreased risk to the consumer since they will have a greater visibility of the true cost of ownership. The appeal of EVs is also expected to increase when compared to other vehicles on a total cost of ownership basis.</td>
</tr>
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<table>
<thead>
<tr>
<th>General outcomes for EV market:</th>
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<tbody>
<tr>
<td>The metric effectively unlocks a great deal of hidden value that would otherwise be overlooked by the consumer. With the use of a common cost metric, it is likely that more EVs will be sold. Furthermore, automotive OEMs will be further incentivised to keep maintenance, refuelling, and other ongoing operating costs to a minimum.</td>
</tr>
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### IMPLEMENTATION

<table>
<thead>
<tr>
<th>Steps to implement and level of government and potential department:</th>
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<tbody>
<tr>
<td>As the lead department in the creation and administration of the Green Vehicle Guide (GVG), the Department of Infrastructure and Transport, would be well placed to lead the development of this common cost metric. Stakeholder consultation would be important in determining the weighting placed on various factors. The rollout could be implemented in stages with the first stage being a voluntary or optional metric being applied to the vehicle, with a national requirement for all vehicle classes being implemented at a later date.</td>
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<tr>
<th>Cost:</th>
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<tr>
<td>The largest cost to implement such a metric will likely be incurred during the stakeholder consultation phase and would be affected by the method for calculating the metric. An inclusive and collaborative process would need to be used to ensure stakeholders are treated fairly. There will also be a cost associated with the ongoing acquisition of reliable performance data that is needed as an input to calculate the metric for each vehicle. Further, there will be a likely small cost for distributing the information to the consumers.</td>
</tr>
</tbody>
</table>
Variants:
There are many ways to implement a cost metric including:

- Voluntary submission of data by the automotive manufacturers
- Third party regulation and standardisation, an annual consumer guide
- Mandatory stickers and figures on new vehicles and/or in user manuals
- Regulation on operating cost claims in car advertisements.

RELATIONSHIP TO OTHER POLICY OPTIONS
The creation of regional financial incentives, taxes and charges will affect the variability in the costs of vehicle ownership and thus will affect the creation of a common metric for cost comparison. For example, if a the common cost metric is applied nationally and there is a large difference in operating costs and subsidies from state to state, the utility of such a metric will be diminished. If the variability of lifetime cost for an EV varies widely enough from region to region, it may prove to be too complicated to warrant the creation and implementation of a common cost metric. Examples of region specific changes that could affect the creation of a common cost metric are:

- P2. Time of use electricity pricing
- P4. New or increased environmental, fuel or congestion charges or taxes on ICEVs
- E1/P9 Purchase incentives and fee-bates
- E11. Access to free or prime parking spaces.

OBSTACLES AND RISKS
There are many ways to compare the cost of EVs to ICEVs, and some methods will make EVs seem more appealing than others. Likewise the interests of manufacturers, replacement parts companies, financing companies, and others will likely be affected by the way in which this metric is implemented.

Another risk is that the metric is made to be too simple or too complex. If made too simple, it may appear easy for the consumer to use but ultimately it will mislead the consumer since it does not contain enough information to make an educated decision. If made too complex, the consumer may simply avoid using the metric.

PRECEDE rENTS
National examples:
Green Vehicle Guide (GVG):
The Department of Infrastructure and Transport (DoIT) has developed a consumer guide for evaluating vehicles when making purchasing decisions. The DoIT GVG will be updated to account for EVs and how to rate and compare them to ICEVs in a meaningful way. The challenges are evident from their Electric Vehicle Information page where they state:

>[W]e would expect that “pure” EVs would rate as zero emission vehicles for the purposes of the Greenhouse Rating and the Air Pollution Ratings and thus score 10/10 on these ratings (and achieve a 5 star overall rating). Plug in-hybrids would be rated on the basis of the CO2 emissions value from the standard test for Greenhouse Ratings and on the basis of the standard to which the vehicle is certified.

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8Green Vehicle Guide Electric Vehicle Information:
(accessed 23 November 2010)
under ADR79/02 for the Air Pollution Ratings. However, in recognition of the particular and unique aspects of EV operations, we will also aim to provide more detailed information on the GVG regarding the CO₂ emissions aspects of vehicle recharging, highlighting the capacity to deliver a zero vehicle emissions outcome, but also noting the potential for a range of overall CO₂ emissions outcomes.

The DoIT also creates fuel consumption labeling standards and as such are a likely candidate for the development of a common cost metric for Australia⁹.

**International case studies:**

**USA:**
There are several international precedents for making fuel efficiency and operating cost information available to the consumer. A good example is the EPA/DOT Fuel Economy labels and the recently proposed EV versions of those labels. While guides and calculators are useful, they are not ubiquitous or as easy to understand as a single label that must be placed on all new vehicles prior to sale.

**EPA/DOT Fuel Economy label (proposed)¹⁰:**
The EPA and the National Highway Traffic Safety Administration (NHTSA) have created a new vehicle comparison label that is required on all new vehicles. There are two primary label designs under consideration.

**EPA/DOT Advanced Technology Vehicles Label (proposed)¹¹:**
Similar to the Fuel Economy label for ICEVs, the Advanced Technology label will enable consumers to make a fair comparison with between ICEVs, BEVs and PHEVs:

**EPA/DOT Electric Vehicle Label (proposed)¹²:**
This label is specific to BEVs. It displays:

- Vehicle efficiency in kWh/100miles
- MPGe (miles per gallon equivalent) and amount saved over a 5 year period.
- Annual “fuel” cost
- Amount of money saved over 5 years in comparison to the average car.

**EPA Green Vehicle Guide¹³:**
This guide allows consumers to compare vehicles for basic information, but it contains no cost evaluation.

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¹⁰ US Environmental Protection Agency Fuel Economy Label, Gas and Diesel Vehicles: [http://www.epa.gov/fueleconomy/label.htm](http://www.epa.gov/fueleconomy/label.htm) (accessed 23 November 2010)


Canada:

NRCan EnerGuide label\textsuperscript{14}:
This label is intended to remain on cars up to the time of sale. This label does not take into account driving habits, and does not factor in maintenance. It only allows for a cost comparison for fuel. This label shows:

- Annual Fuel Cost
- Annual Fuel Use
- CO\textsubscript{2} Emissions/yr
- City/Hwy Fuel Consumption.

NRCan Cost comparison tool\textsuperscript{15}:
This tool allows the consumer to compare two vehicles side by side for cost of fuel, CO\textsubscript{2} emissions, and fuel efficiency.

Non Profits:
Several cost of ownership calculators have been developed by non-profit organizations as well as through government initiatives. However, none of them have outputted a standardized metric that allows for an easy comparison.

Be Frugal EV Calculator\textsuperscript{16}:
Author: BeFrugal.com
Outputs: Cost Equivalent MPG, total CO\textsubscript{2} emissions

Project Get Ready\textsuperscript{17}:
Author: Rocky Mountain Institute
Outputs: lifetime cost of vehicle, lifetime cost of fuel, equivalent barrels of oil used, CO\textsubscript{2} equivalent emitted

\textsuperscript{15} NRCan Cost Comparison Tool: http://oee.nrcan.gc.ca/transportation/tools/compare/compare-search-one.cfm (accessed 23 November 2010).
C7: Coordinating federal and state EV strategies

## Coordination

### CONTEXT

**General Description:**
The federal government along with several of the state governments lack a coordinated strategy on the adoption of EVs. Potential for greater coordination could relate to:

- Information about how existing programs relate to EVs
- Areas of priority policy reform
- Analysis of the impacts and benefits of EVs specifically with regards to the environment, electricity grid, standards, EV consumers and local industry development
- Programs and program timelines, including specific incentives, that aim to increase broad adoption and may specifically address:
  - Vehicle demonstration
  - Charging infrastructure
  - Government fleet purchases
  - Emission standards
  - Industry collaboration.
- Plans to integrate strategies of associated industries such as manufacturing and electricity production
- Adoption targets
- Participation in national or international initiatives
- Delegation of implementation responsibilities to specific teams or departments with regular reporting and benchmarks.

### Need:

Strategies are needed at the federal and state levels to determine how government can best work with industry and the public to ensure a smooth and rapid transition from ICEVs to EVs. Governments can use these strategies and roadmaps to play a coordinating role that will result in increased social, environmental and economic sustainability outcomes. These strategies are also needed to guide various stakeholders, such as automotive manufacturers, in their decisions as well to create transparency in EV policy.

In addition, federal and state governments are significant vehicle purchasers and could therefore have a large influence through fleet EV purchases.
Barriers addressed:
Federal and state strategies address the barrier of ‘confusion’ which is described as the interactions created by other barriers. For example, strategies can provide good information about EV technology and performance as well as information about policy direction and targets that will help to address barriers around cultural values. Governments can also bring together various stakeholders in the strategy development such as fleet managers, vehicle manufacturers and research institutions in a process that will facilitate maximising common benefits of EV adoption and determine which barriers to prioritise.

EXPECTED OUTCOMES

Upfront costs and on-going costs to consumer:
The strategies themselves are unlikely to change the financial factors associated with EVs. However, better coordination could potentially lead to greater economic efficiency which may translate to lower sales prices. The magnitude of this reduction is too complex to calculate and therefore further research would be needed to determine an approximate value.

Furthermore, policies contained within the strategies may relate directly to EV economics, but need be addressed separately from the strategies themselves.

Benefits in terms of convenience, decreased risk and appeal:
Federal and state strategies would likely decrease risk to potential EV buyers though both the information provided in the documents as well as the perceived increase in government commitment to EVs.

Convenience for the consumer would not be affected by the strategy, however, appeal would likely increase dependent partially on the level of promotion and distribution of the strategies.

General outcomes for EV market:
The expected general outcomes are:

- Improved communication between stakeholders as a result of the strategy development process
- Further greenhouse gas reductions
- Better publically available information on EV technology and performance characteristics
- Harmonisation of standards, policies and regulations to support EVs
- EV automakers would be more receptive to entering the Australian market, because a coordinated local strategy would reduce their risks. This would result is an increased range of models available as increased competition.

IMPLEMENTATION

Steps required to implement and level of government and potential department:
Strategy development could take a variety of different forms. However, the following steps should be considered:

- Determine purpose and vision of strategy
- Decide on methodology and process including which stakeholders will be involved and how
- Establish links with other strategies and planning processes
- Analysis of:
  - EV technology
Barriers to and Policy Solutions for EV Adoption in Australia

- Related government programs and departmental responsibilities
- Barriers to adoption.

- Identify key results strategy will aim to achieve
- Selection of programs to fulfil key results
- Determine work plan with program costings and implementation responsibilities
- Set implementation timeline
- Plan for and execute a plan to promote and distribute the strategy
- Monitor and report on progress
- Revise strategy periodically.

The policies at the state level would likely be suited to relevant departments of energy or transportation such as the Department of Energy and Resource Management in Queensland. At the federal level, the two departments that could lead the strategy would be the Department of Climate Change and Energy Efficiency or the Department of Resources, Energy and Tourism.

Cost:
The cost of developing a strategy would vary significantly depending on the degree of analysis and engagement. However, it is the authors estimate from costings of related strategy work that a viable state strategy would cost between $150K and $300K while a federal strategy would cost between $250K and $500K.

Variants:
EV strategies could be included as a part of a larger transport and/or energy strategy. However, it is recommended that at least an independent section of the plan or strategy is devoted to EVs in this case.

RELATIONSHIP TO OTHER POLICY OPTIONS
The primary relationship between this and other policy options discussed in this report is that the strategies could present and discuss the other options in one document in much the same way as this report but in a government endorsed plan. For example, the strategy would be the logical place to discuss the government’s current and planned initiatives in the areas of regulation, targets, information, facilitation, incentives and pricing.

OBSTACLES AND RISKS
The primary risk in developing a state or federal EV strategy is the lack of a good process for stakeholder engagement. An effective plan will need to draw on the experience and needs of research organisations, industry, government and consumers.

PRECEDENTS
National examples:
There is currently only one precedent in Australia with the QLD Government. The issue paper for public discussion “outlines what Queensland will do to support the uptake of electric vehicles (EVs) when they come onto the Australian market over the next few years”. The stated key drivers for the strategy include the needs to:

- *Position Queensland to optimise the greenhouse reduction potential of EVs*
SUGGESTED POLICIES FOR AUSTRALIA

- Investigate, and where appropriate, plan for future infrastructure needs to support EVs and improve how the electricity network is used
- Support Queensland industry, businesses, electricity distributors, and the community during the transition to EVs
- Factor EVs into land use planning to build community and industry resilience to potential increases in fuel prices and possible shortages
- Work with other governments and industry to harmonise standards, policies and regulations to support EVs.

However, the SA state government also recently committed to the development of a ‘Low Emission Vehicle Strategy’. This strategy will:

Complement the South Australian Government’s investment in the public transport system and the implementation of South Australia’s new planning strategy. It will outline the roles and future actions of the South Australian Government in relation to the advancement of low emission passenger vehicles, and be informed by international efforts including the Climate Group’s EV2O initiative. The strategy will not favour any particular technology but will aim to create a supportive environment that reduces or eliminates barriers to change. The strategy will also include development and establishment of a new emissions reduction target for the State Government fleet.

Other states include EV related strategies as portions of broader overarching transport plans such as the Victoria Transport Plan. However, there is currently no federal EV strategy in Australia which makes it more difficult for states to create individual strategies without knowing the general direction of EV policy in Australia.

International case studies:

Several states, countries and regions have developed EV strategies. Several of these are summarised briefly below.

**Japan**

MITI created one of the first commercialisation plans in the world for EVs in 1976 (Ahman 2004). The current plan developed in 2010 is called the Next-Generation Vehicle Plan and includes HEVs as well as EVs. The current plan includes separate roadmaps for international standardisation, resource strategy and infrastructure development.

**EU**

The European Commission earlier this year release “A European strategy on clean and energy efficient vehicles” focused on heavy and light duty vehicles. A specific section on EVs deals with the issues of market placement, standardisation, charging infrastructure, energy generation and distribution and battery recycling.

**Canada**

The Electric Vehicle Technology Roadmap for Canada is “intended to provide the strategic direction to ensure the development and adoption of EVs in Canada, while building a robust industry.” The topics covered in the strategy include “energy storage, components for EVs, vehicle integration, business models and opportunities for EVs, government policies, regulatory and human resource issues, and public awareness and education.”
US
While the US government has not created an EV strategy, several national organisations have including the Electrification Coalition with their roadmap in 2009 and the Electric Drive Transportation Association (EDTA) with their 2009 Road Map for Energy Security.

IEA
The IEA Electric and Plug-in Hybrid Electric Vehicles Roadmap was developed in collaboration with government, industry and NGOs and addresses BEVs and PHEVs. The vision of the Roadmap is to achieve a 50% sales share of light duty vehicles with EVs and PHEVs by 2050.
## F5: Connecting renewable energy targets to EV sales

### CONTEXT

**General Description:**
Connecting renewable energy targets (RETs) to national EV sales will ensure that future growth in electricity demand associated with EVs is linked to growth in low carbon energy resulting in low or zero carbon transportation outcomes. The electricity consumption of EVs could be estimated based on the type of EV sold or the vehicles could be separately metered at homes and public charge stations. The RETs could be adjusted annually based on the EV electricity consumption. The current national targets are fixed out to 2020 and include an expansion from the 2011 target of 12,500 GWh to the 2020 target of 45,000 GWh and are split between the large-scale renewable energy target and the small-scale renewable energy scheme. Smart grid technologies will also allow EV charging to more closely align with times of high intermittent renewable generation. This will reduce the system costs of intermittent renewable generation and will allow the federal government to implement the RET more efficiently.

### Need:
This policy is needed to ensure that the transition of vehicles from ICEVs to EVs results in the best possible environmentally sustainable outcome. As Australia has one of the most carbon intensive electricity generation systems in the world, EVs will need be charged from renewable energy to have a significant direct greenhouse gas reduction.

### Barriers addressed:
The barriers addressed are primarily related to split incentives but also cover cultural barriers. With regards to split incentives, the main issue is the effectiveness of other government policies related to EV adoption in reducing GHGs if the majority of the EVs charge using conventional grid electricity. This is especially important in the State of Victoria due to the use of lignite as a fuel source. The cultural barrier is related to the concern that EVs will not be less polluting than ICEVs or HEVs which can be alleviated through ensuring the EVs energy comes from zero emission sources.

### EXPECTED OUTCOMES

**Upfront costs and on-going costs to consumer:**
The expected cost outcomes are likely to be small. The only direct benefit would be that consumers would not need to purchase Green Power to ensure zero emissions.

**Benefits in terms of convenience, decreased risk and appeal:**
The knowledge that no emissions would be generated from recharging would increase the appeal of EVs. Convenience and risk would likely be unchanged by this policy.

**General outcomes for EV market:**
The expected outcomes for the overall EV market are increased adoption as a result of the assurance that all consumers will be driving the most sustainable vehicle option available. There is also the potential for more automakers to introduce EV models in Australia. Some companies, such as Toyota, have cited high electricity emission intensity as a reason for not launching EVs in Australia in the past, although have later gone on to announce that their EVs will be sold in Australia.

### IMPLEMENTATION
### Steps to implement and level of government and potential department:

The key factor to consider in the implementation of this policy is the method for determining the additional energy used by the EVs. While it is possible to estimate the energy used by each vehicle based on a combination of trials, case studies and individual vehicle characteristics, it would be significantly more accurate to separately meter EVs. This would have the additional benefits of allowing for potential demand management policies to be implemented at a later date and for electricity retailers to be able to offer pricing plans that incentivise off-peak charging. If EVs are separately metered, total energy use from each vehicle can be aggregated by each utility and reported to the government annually to allow for revision of RETs.

The Renewable Energy Regulator would monitor the scheme to ensure adequate reporting and compliance by utilities. The Department of Climate Change and Energy Efficiency would be the likely lead department in initiating and crafting the legislation given their current responsibility for the existing RET.

### Cost:

According to modelling from McLennan Magasanik Associates (MMA, 2010), the current enhanced RET will have an impact on retail electricity prices on $4.62 from 2010 to 2015, $7.28 from 2015 to 2020 and $5.42 per MWh from 2021 to 2030. These represent increases in electricity prices of less than 5%. However, the best way to estimate the additional cost for liable parties (those making wholesale acquisitions of electricity), is to multiply the average renewable energy certificate (REC) price by the additional load created by EVs. From the Phase 1 ED Report, each vehicle will require approximately 5kWh per day or 1.8MWh per year, decreasing with technology improvements. The average REC price for the past year was approximately $37 so therefore, the cost per vehicle is approximately $67 per year. More detailed modelling by CSIRO under the ED project will estimate the number of vehicles sold in a given year, which can be used to calculate the total cost to liable parties which would be passed on as an incremental increase in retail electricity price. However, if 5% of vehicles in Australia were electric, which is not expected to happen until sometime after 2020, then the total increase in the RET target would be from 45,000 GWh to 46,350 GWh. If the additional cost of the RET scheme after 2020 was the stated $5.42 per MWh, then EVs would contribute an additional $0.16 per MWh or an increase of 0.09% on 2020 electricity prices.

### Variants:

Another way to calculate the increased costs to the federal government of increasing the RET is by estimating the renewable technology mix and the average price per MWh including amortized capital, fixed and variable operation and maintenance and incremental network costs.

One method to recover the costs of the program is to require participating drivers to take part in demand response programs whereby the charging rate could be reduced during times of peak demand. The potential cost savings to the electricity utility companies from this activity have the potential to recover a substantial portion cost of the reduced registration revenue.

Another related possibility is to require that participating vehicles use smart charging technology that maximises the use of renewable generation by charging faster at times of maximum intermittent renewable energy generation and minimum total system demand.

Another variant is to pass the obligation on to car manufactures who want to continue to sell vehicles.

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18 $37 times 1.8 equals $67
with high levels of emissions to purchase RECs equivalent to lifetime energy consumption, instead of requiring the federal government to increase the RET.

### RELATIONSHIP TO OTHER POLICY OPTIONS
There is a clear relationship between this policy and the firm national EV sales targets. A sales target would allow the RET adjustments to be made in advance without the assistance of EV distribution modelling.

### OBSTACLES AND RISKS
There is a risk of lack of public acceptance for the costs of Green Power for EV drivers to be divided across the whole electorate. However, several state and federal policies are tied to particular consumer segments and draw from the tax base of the entire population. Furthermore, it can be argued that increases to the RET do not actually benefit the drivers of EV directly, but are of national and international interest.

### PRECEDENTS

#### National examples:
The expanded RET includes the Small-scale Renewable Energy Scheme (SRES) as part of the overall target. The 2020 target for this category which includes small scale technologies such as solar panels and solar hot water systems is set at 4,000 GWh, but had been left uncapped. This means that any additional energy generated above this cap will serve to increase the total RET. This could be applied in the same way to EVs or alternatively EVs could be included in the SRES as triggering increases in the target.

Better Place in Australia has partnered with AGL to provide all the energy required for its charging and battery swap stations from 100% Green Power. This links EV driving to renewable energy in the same manner as an increase in the RET would.

#### International case studies:
Better Place has also implemented programs internationally that ensure that all energy used to charge EVs as their charge and swap stations is sourced from renewable energy.\(^\text{19}\)

A study by Transport & Environment, Friends of the Earth Europe and Greenpeace European, *Green Power for Electric Cars*, contained a similar recommendation for European countries to increase renewable energy production by an equal amount to the energy consumed in powering EVs over and above their national targets.

### P8: Green registration discounts

**Price Reform**

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<td><strong>General Description:</strong></td>
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<tr>
<td>Allowing discounts on annual vehicle registration costs for EV drivers who purchase Green Power or otherwise use renewable energy to power their vehicles will encourage zero emission driving and result in potentially substantial greenhouse gas emission reductions. This policy could be implemented at a state or federal level and could either be structured as a rebate on registration or on compulsory third party insurance (provided through the Transport Accident Commission in Victoria).</td>
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<tr>
<th>Need:</th>
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<td>This policy is needed because while EVs charging from grid power will produce fewer emissions than the current average of new vehicles sold, the reductions will be minimal in some states due to the relatively higher emissions intensity of the grid-supplied electricity. Furthermore, some new vehicles such as those listed in the top 20 of the Green Vehicle Guide[^20] would produce substantially less emissions than a typical EV drawing power from the grid in the highest emission intensity states such as Victoria.</td>
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A policy is needed to encourage owners of EVs to switch over to Green Power and reduce vehicle emission down to near zero.

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<th>Barriers addressed:</th>
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<td>The barriers addressed are primarily related to price reform, information and incentives.</td>
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From the price reform perspective, this policy allows for economic benefit to the consumer for environmental leadership.

With respect to information, several organisations have concluded that EV emissions will be higher than an average vehicle in Victoria. An example of this is the statement on the Royal Automobile Club of Victoria (RACV) website:[^21]

> Based on manufacturers’ data and desktop analysis, electric vehicles powered by Victorian-produced coal-fired electricity produce slightly more greenhouse gas emissions than comparable petrol vehicles.

Analysis within the ED project in the Technical, Economic, Environmental & Institutional Assessments Phase 1 Report concludes otherwise, however, it is clear to all stakeholders that EVs running on Green Power will produce near zero emissions.

In terms of incentives, it is expected that many individuals who purchase EVs will be motivated by environmental concerns and therefore may independently purchase Green Power. However, there will inevitably be individuals who don’t feel that they can afford Green Power or are adverse to the hassle of


switching to Green Power and will therefore require an additional incentive to purchase it for their homes, especially with the additional electrical load of an EV.

EXPECTED OUTCOMES

**Upfront costs and on-going costs to consumer:**
The expected outcomes are reduced upfront costs for consumers that decide to participate. This would depend on the amount of registration reduction. Registration in Victoria currently costs $187.40. The additional cost of Green Power to run a vehicle for a year can be calculated from the ED Phase 1 ISF Report estimate of 1,800 kWh used per vehicle per year. At an approximate additional cost for 100% Green Power at $0.05/kWh, this represents an additional $90 per year. Therefore, consumers who opted for green registration could save up to $97 per year and have the added benefit of knowing that their vehicle produces near zero emissions.

**Benefits in terms of convenience, decreased risk and appeal:**
This policy would detract slightly from convenience, depending on how it was implemented, as users would need to sign up for Green Power either at the time of registration or afterwards.

However, the appeal of EVs would increase significantly with the knowledge that emissions were reduced to near zero. Special licence plates associated with green registration would add even more to this appeal.

There would likely be no change in the risk of purchasing an EV through this initiative.

**General outcomes for EV market:**
This initiative would help to increase adoption of EVs through both the potential cost reductions and more generally through the perception that EVs were truly the most sustainable passenger vehicle choice on the market.

IMPLEMENTATION

**Steps required to implement and level of government and potential department:**
There are several possible ways to implement this policy. Key pieces of information that would need to be either estimated or provided to the relevant state authority (for e.g. VicRoads in Victoria under the Department of Transport) include the amount of energy used by the EV and the amount of Green Power purchased. The energy used could either be estimated based on the kilometres driven (from the odometer reading at the time of registration) and the expected energy consumption per kilometre of the make and model of EV or based on electricity meter data for the EV. Also, the evidence of Green Power purchase could either be presented at the time of registration renewal or provided directly to the appropriate agency by the energy retailer. This second option would reduce the hassle for the user and may be as simple as checking a box on the initial registration form.

**Cost:**
The cost to a given state government would depend on the amount of registration fee waived. If, for example, the full fee were to be waived in Victoria and 5% of vehicles in the state were electric and subscribed to the green registration plan, then the cost would be approximately $37M per year for 200,000 EVs. This would of course also lead to a significant decrease in greenhouse gas emissions from personal transportation and would become cheaper as renewable generation costs continue to decline.
### Variants:

The addition of a green licence plate in conjunction with green registration would not only serve to increase the appeal of EVs, but could be done at very little cost.

A similar approach could also be used for businesses with a demonstration that an equivalent number of RECs or Green Power was purchased to account for the energy used in driving their EVs.

Another variant would be to link registration costs to CO\(_2\) output per km for all vehicles. EVs using Green Power would then have a well-to-wheel CO\(_2\) output of zero.

### RELATIONSHIP TO OTHER POLICY OPTIONS

This policy achieves related outcomes to others that aim to reduce the ongoing or upfront costs of EVs or increase the effective ongoing or upfront costs of ICEVs. There are also similarities to other policies that attempt to increase the recognition of EVs as low emission vehicles.

### OBSTACLES AND RISKS

Initial challenges in setting up the scheme may lead to increased hassle for the consumer and higher administrative costs for the government. However, it is expected that once a streamline system is developed for both accurately estimating energy used by the EVs and the amount of Green Power purchased, the administrative costs and hassle will decrease to a small proportion of the overall costs.

### PRECEDENTS

#### National examples:

From the perspective of reduced ongoing charges for vehicles, a precedent currently exists across Australia for reduced insurance premiums based on safe driving history. This could easily be extended to reduced insurance or registration based as well on ‘green’ driving.

The state of Victoria began offering a registration discounts for HEVs in 2007. The text from the VicRoad website states:  

> All hybrid vehicles receive a $100 registration discount. This discount is automatically deducted and will appear on your registration renewal notice. A hybrid vehicle is powered by both electricity and fuel. Fully electric vehicles do not receive this discount.

Despite the wording, a recent announcement stated that the Government has “has also made electric vehicles eligible for the discount.”

Furthermore, HEVs and PHEVs are given a green diamond shaped “hybrid” sticker to differentiate their licence plate.

Another related Victorian initiative is the Vehicle Registration Offset Program. This program will be available from July 2011 and will enable road users to offset their emissions as part of the VicRoads registration process using a carbon calculator. The estimated voluntary cost for an ICEV will be between $80 and $120 per annum. It would be simple for the government to waive these costs for EV

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24 Ibid.
drivers as an alternative to reduced registration fees.

A final related Victorian initiative is the procurement of 100% Green Power for the vehicles used in the Victorian EV Trial. Similar methodologies used to calculate the amount of Green Power required for the trial vehicles could be used for the calculation of energy required in other EVs not participating in the trial.

Another up-front incentive is the ACT Green Vehicles Duty Scheme, which is discussed in more detail in policy E1/P9, EV Cost Reductions and Fuel Economy Base Fee at the Time of Vehicle Purchase.

**International case studies:**

Sweden waives the annual circulation tax for five years for EVs with energy consumption less than 37 kWh per 100 km (which is achievable by virtually all passenger EVs). This is equivalent to a premium of SEK 10,000 ($1,478 AUD). Similar policies exist in other European countries.

Ireland is one of several countries where rebates on initial vehicle registration charges have been reduced or eliminated for EVs. This can equate to substantial savings as Vehicle Registration Tax (VRT) can be up to 36% of the Open Market Selling Price and is linked to the CO₂ emissions per kilometre travelled. This charge can be higher than €23,000 ($31,800 AUD) on some vehicles. In addition to the savings of having a low emission (less than 120 gCO₂ per km) vehicle, HEVs, PHEVs and BEVs get an additional €2,500 ($3,465 AUD) discount on registration.

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27 www.revenue.ie/en/tax/vrt/faqs-co2.html#section7
### P2: Time of use pricing

<table>
<thead>
<tr>
<th>Context</th>
<th>Price Reform</th>
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<tbody>
<tr>
<td><strong>General Description:</strong></td>
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| Need: | | Requirements for new power station and grid upgrades are generally dictated by the annual peak power demand on the grid. On such days, heating (in winter) or air conditioning (in summer) in combination with all other electrical loads can add up to being more than three times as high as the lowest loads on a mild night. This large spread contributes to the long term costs and environmental impact of electricity production. The addition of uncontrolled EV charging, typically at the end of the workday is likely to exacerbate peak demand. ToU pricing has the potential to moderate this impact on peak demand, allowing power suppliers and network companies to avoid unnecessary high capital costs which would otherwise ultimately trickle down to the consumers. By creating standard ToU pricing for EVs, it both encourages prospective buyers to purchase EVs based on low overnight tariffs and encourages charging in off-peak periods, reducing electricity network stress. This could include critical peak pricing where the prices are significantly higher for short periods of the highest peak demand. |

| Barriers addressed: | | It is unlikely that the average cost of electricity will be a large barrier to EV adoption. However, without time of use pricing structures, EV owners will likely charge at all times of the day without discretion thus burdening the grid far more than necessary. Ultimately, this will result in unnecessarily high electricity prices, thus potentially affecting the long term desirability of EVs. |

| Expected Outcomes | | **Upfront costs and on-going costs to consumer:** ToU pricing may prove to be expensive for consumers who have no alternative but to charge their EVs during the day or during peak hours. For these customers, their electricity bill will likely be higher than it would if variable pricing were not implemented. |
Benefits in terms of convenience, decreased risk and appeal:
In some cases, charging at night may be less convenient than a charge during peak hours. Regardless, ToU pricing can provide consumers a safeguard against rising prices given that they are able to charge mostly at off-peak times. As such, there may be a decreased price risk to the consumer in this regard.

General outcomes for EV market:
ToU pricing can act as an incentive for people to charge at off-peak times, thus decreasing the cost to recharge and lowering the overall cost of EV ownership. Furthermore, it can help avoid additional infrastructure expenditure and, as a result, keep electricity price increases to a minimum.

IMPLEMENTATION

Steps required to implement and level of government and potential department:
Firstly, government, utilities and consumer groups work together to provide smart meters at no extra cost to the consumer regardless of EV ownership. Ideally, prices would be kept the same for a certain grace period to avoid consumer backlash. Within this time period, consumers will be able to observe their own power usage and will become acquainted with time of use information. Consumers can also be informed by how much they have reduced their electricity usage during peak-hours thus familiarizing the consumer. During this period, time of use billing can be made available as an option to the consumer; however it would not be mandatory until after the specified grace period. Once this base of smart meters is installed, it will be far easier for utilities to offer EV owners time of use billing for EV charging.

The specific details of EV charging in combination with time of use billing can be addressed in a contract between the electricity provider and the consumer. The consumer’s electricity consumption would be recorded over short intervals by the smart meter and the price would be calculated based on the time of use and the day of the week.

Cost:
The cost to implement ToU will likely be incurred by consumers who currently use electricity at peak hours, but are unable to shift or reduce this load. An example of this is consumers who work from home and those who use lots of air conditioning.

Variants:
Rather than mandating, one variant is to allow consumers to choose this type of billing as an option. Users who feel that they would not benefit from such a measure could opt out. Another possibility is the introduction of a second smart meter in the home that is used exclusively for vehicle charging. The rates on this meter could be tiered aggressively for time of use, while the rest of the home remains the status quo.

RELATIONSHIP TO OTHER POLICY OPTIONS
If time of use billing for EV charging becomes widespread, it could affect the effort to initiate, encourage and fund charging station infrastructure (T4). Fast charging stations that are primarily used during the day, for example, may be faced with much higher electricity rates.

OBSTACLES AND RISKS
A key obstacle to ToU billing is the lack of installed ToU meters. ToU meters are required in order to implement ToU pricing for EVs. Part of the reason for this obstacle is the confusion and backlash that has resulted from previous attempts to roll out ToU meters and ToU billing at the same time. Another risk is that if ToU billing for EVs is mandated, it may ultimately become a barrier to purchase an EV if
potential buyers are concerned that the cost to recharge will increase as a result of the policy.

### PRECEDENTS

**National examples:**

**Victoria**

**Department of Primary Industries**

The Smart Meter project was initiated by the Victorian Government through legislative changes in 2006. Now the ongoing roll-out of Victoria’s advanced metering infrastructure involves government, electricity businesses, and consumer groups. The goal is to replace all residential and small business meters in Victoria with 2.5 million Smart Meters by the end of 2013. Smart meters will be installed and managed by electricity distribution businesses. These companies are regulated monopolies, and their spending is monitored by the independent Australian Energy Regulator to ensure value to the consumer. While more than 200,000 smart meters have been installed in Victoria, considerable resistance has been encountered.

EnergyAustralia has also introduced PowerSmart and LoadSmart time-based pricing where time of use pricing within 30 minute intervals available for business use only.

**International case studies:**

**California**

Including low speed electric vehicles, the state of California has more than 25,000 electric vehicles on the roads. Furthermore Californian utilities continue to roll out smart meters by the hundreds of thousands.

**Southern California Edison:**

SCE has rolled out more than 1 million smart meters. In combination, there are many EV owners who have experienced “off-peak” charging of their EVs. With this large installed base of smart meters, SCE can offer several different plans to EV ownership with less government regulation. SCE offers three plans to EV owners:

- **Residential Plan (Schedule D):** The standard residential rate plan where the price per kilowatt-hour is tiered and increases as the amount of energy usage increases. This choice is the status-quo, but is not the cost-effective choice for EV owners who charge at night.

- **Home & Electric Vehicle Plan (ToU-TEV):** A tiered structure similar to the standard residential rate, but provides lower electricity rates at night. This rate may be ideal for customers who have low usage during peak daytime hours of 10 a.m. to 6 p.m.

- **Electric Vehicle Plan (ToU-EV-1):** This rate uses a second meter to measure the electricity used...

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to charge the customers vehicle, and thus can be billed at a separate rate from the rest of the home. Due to the possibility of off-peak charging, this option potentially gives customers the lowest rates for electric vehicle charging, but also involves more initial set-up cost and time\(^\text{33}\).

**San Diego Gas & Electric:**
The California Public Utilities Commission (CPUC) and SDG&E have started a two-year ToU for EVs pricing study for 1,000 SDG&E customers. The first 1,000 SDG&E customers who buy a Nissan LEAF will receive free home charging equipment, courtesy of ECOtality, and will be able to take advantage of lower electricity rates during off peak hours\(^\text{34}\).

**Pacific Gas and Electric Company (PG&E):**
Mainly as a result of poor communication with utility customers, considerable backlash against time-of-use billing and smart metering has been experienced in California as well. Some consumers feared their utility bills would rise and others were simply disturbed by the abruptness that smart meters were “imposed” upon them. To counter this backlash, the Silicon Valley Leadership Group, the City of San Jose and PG&E partnered to create the “Smart Grid Task Force”. Members of this task force include Oracle, Cisco, Nanosolar, Control4, Coulomb Technologies, Silver Spring Networks and OPower\(^\text{35}\).

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E1/P9: EV cost reductions and fuel economy based fee at the time of vehicle purchase

**CONTEXT**

**General Description:**
Charging a fee to consumers based on the fuel economy of the vehicle at the time of purchase, otherwise known as charging a fee rebate, will push the market towards vehicles that are more fuel-efficient\(^{36}\). Additionally, providing cost reductions or exemptions for EVs at the time of purchase, including sales waiver, income tax reduction or cash back rebates, will pull the market towards greater uptake of EVs. Together these policies could potentially offer a ‘budget neutral’ strategy.

**Need:**
Most consumers have a poor understanding of the time value of money and typically demand very quick payback periods. EV proliferation requires customers to perceive or understand (depending on the type of customer) that EVs are cheaper, over the lifetime of the vehicle, than ICEVs\(^{37}\). While individuals have purchased EVs in the past because of anticipated cost savings and desire to save money on gas\(^{38-39}\) most consumers focus on the upfront costs to purchase a vehicle rather than any potential on-going savings. Since EVs are currently anticipated to have a greater upfront cost, as EVs become more widely available consumers are likely to continue to opt to purchase ICEVs. A reduction in upfront cost should spur the EV market. Additionally, several studies also suggest that the uptake of EVs is much more heavily influenced by the cost of fuel rather than incentives.\(^{40-42}\) Therefore, instituting a fuel economy based fee, e.g. artificially increasing the cost of fuel, can influence the EV market in a way similar to the influences seen during market-driven spikes in petrol prices.

**Barriers addressed:**
The barriers primarily addressed via incentives and fee rebates at the time of purchase are the ‘payback gap’ and ‘inefficient pricing’. The payback gap refers to the fact that consumers need to perceive that lifetime costs between EVs and ICEVs are comparable and that the discount rate for EVs is higher than their average time-value of money. Inefficient pricing refers to unpriced ‘external costs’, e.g. costs resulting from the supply of the good, which are not recovered in the sale of the good. By providing a fuel economy based fee, vehicles that emit a greater amount of greenhouse gases are penalised, effectively incorporating the costs for carbon emissions. These costs, or revenue, can be used to incentivise consumer purchasing of EVs that have less greenhouse gas emissions.

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EXPECTED OUTCOMES

Upfront costs and on-going costs to consumer:
Incentives will decrease the upfront EV cost to the consumer, but the impact will depend on the level of the incentive selected by state or federal government. The average range for tax rebates internationally are:

- <$2000 (e.g. Utah, South Carolina)
- $2000 - $8000 (e.g. 5 Canadian provinces, US Government, 8 US States, Netherlands, Spain)
- >$8000 (e.g. New Jersey, Belgium, Sweden).

Additionally, the EV consumer will have the added benefit of avoided feebate costs, which could range from $1000 - $3000, to be more publically acceptable.

On-going costs will not be impacted.

Benefits in terms of convenience, decreased risk and appeal:
The decreased cost of EVs and increased cost of ICEVs will certainly increase the appeal of EVs. These policies will not significantly impact on risk or convenience.

General outcomes for EV market:
Future work could quantify more accurate outcomes for the EV market, however several studies from the US offer relevant insight into the potential magnitude of the outcomes as a result of these policies. Gallagher and Muehlegger (2010) found that a tax incentive of US$1000 is associated with a 5% increase in hybrid sales and when measured relative to model Manufacturer’s Suggested Retail Price (MSRP), increasing a tax incentive by 1% of a vehicle’s MSRP is associated with a 1.2% increase in sales\textsuperscript{43}. In relation to a feebate, a $100 increase in annual fuel savings is associated with a 13% increase in sales. Additionally in the US, a 10% increase in petrol price has led to an 8.6% increase in per-capita sales of hybrid vehicles. Interestingly, Gallagher and Muelegger (2010) also found that by increasing the average petrol price in a state by 20% over a 6 year period (2001 – 2006, e.g. equal to an average fuel economy savings from driving a hybrid of $85 per year), would increase hybrid sales an equivalent amount to $330 sales tax waiver.

In Connecticut, a sales tax exemption for EVs lead to a increase in state market share of EVs, in comparison to the US average market share (from -9% to +13%)\textsuperscript{44}.

Keeping in mind that the share of hybrid vehicle sales in Canada for 2005 was 0.35%, Chandra et al. (2010) found that a $1000 increase in provincial sales tax rebate increases the market share of hybrid cars by 31-38%\textsuperscript{45}.

IMPLEMENTATION

Steps required to implement and level of government and potential department:
If the decision is made to offer incentives, providing them to consumers up-front will be a more efficient use of government funds as up-front excise or sales tax waivers are more effective than delayed rebates or tax credits in influencing adoption.\textsuperscript{46} A comparison of the income tax credit programs with rebate


\textsuperscript{44} Diamond, 2008.

\textsuperscript{45} Chandra et al, 2010.

\textsuperscript{46} Diamond, 2008.
programs found that the rebate program needs less government revenue to achieve the same level of average fuel-efficiency of new vehicles.\footnote{Beresteanu, A, Li, S. 2008.}

Gallagher and Muehlegger (2010)\footnote{Gallagher, K, Muehlegger, E., 2010.} found that the form of incentives is as important a factor in consumption adoption as incentive generosity. Specifically:

- A sales tax waiver of mean value is associated with over three times the effect of an income tax credit of mean value
- Conditional on the value of the incentive, sales tax waivers have more than a ten-fold greater impact on hybrid vehicle sales that income tax credits
- A sales tax waiver equal to 1% of the retail price is associated with an 8.3% increase in sales—a comparable income tax credit is associated with a 0.6% increase in retail sales.

**Cost:**
The cost to government to implement should be relatively low, as noted by workshop participants during the Electric Driveway Policy Options workshop. Together these policies could potentially offer a ‘budget neutral’ strategy.

**Variants:**
An alternative to a feebate on ICEVs would be an increase in the cost to register the vehicle. By decoupling the feebate from the sale of the car, it may allow for greater flexibility in the size of the feebate with less resistance from OEMs and dealerships. In this variant, the feebate would simply be incorporated into the registration fees. Likewise, registration fees for EVs could be reduced or eliminated.

Means testing incentives may also make for more fair policies and would potentially allow for greater incentives for individuals with lower incomes. Arguably, consumers with lower incomes will also be more affected by increases in fuel prices as they are likely to commute further and spend a larger portion of their income on fuel and therefore will benefit more from using an EV.

**RELATIONSHIP TO OTHER POLICY OPTIONS**
As these policies are intended to significantly shift the sales and use of Electric Vehicles, it would be prudent to link the development of these policies with F5 Connecting renewable energy targets to EV sales and Green Registration Discounts.

If consumers had a Common Metric (16) for comparing lifetime costs of all vehicles, the consumer would understand and value the cost-savings offered by an EV, meaning the upfront incentive would not have to be as high to motivate consumers past the current ‘sticker shock’ of an EV.

**OBSTACLES AND RISKS**
One study has found that a one-standard deviation increase in per-capita income is associated with a 32% increase in hybrid sales.\footnote{Gallagher, K, Muehlegger, E., 2010.} The positive relationship between income and hybrid adoption suggests that financial incentives may disproportionately benefit higher income consumers who are more likely to purchase hybrids in the first place. Lower income consumers are less able to afford the higher up-front

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\footnote{Beresteanu, A, Li, S. 2008.}
\footnote{Gallagher, K, Muehlegger, E., 2010.}
\footnote{Gallagher, K, Muehlegger, E., 2010.}
premium for a hybrid. Given the apparent weak or negligible effect of monetary incentives, this could mean current monetary incentives for hybrids may be rewarding those who need the incentive the least for a purchase they were likely to have made anyway.\textsuperscript{50} Resistance from other stakeholders will also need to be considered, e.g. OEMs, car dealerships, low and mid-income consumers.

Dealers could potentially factor incentives into their pricing structure and charge consumers more for the vehicle.

### PRECEDENTS

#### National examples:

The main Australian example is the ACT Green Vehicles Duty Scheme. The Green Vehicles Duty Scheme does not target EVs specifically, but provides an incentive for consumers to purchase environmentally leading edge vehicles by subsidising stamp duty costs of low emission models. Similar to the recommendations above of partnering an incentive and a fee-bate, the Scheme penalises poor performing vehicles via an increase in stamp duty.

In the Scheme, vehicles are rated based on their carbon and air pollution emissions, which are collated by the Commonwealth Government’s Green Vehicle Guide (GVG). Vehicles with the top rating attract nil stamp duty. Purchasers of a Toyota Prius for example, will save around $1122 (Department of Territory and Municipal Services, 2008).\textsuperscript{51} Purchasers of vehicles in the lowest category face higher stamp duty costs than what was incurred prior to the scheme.

The ACT Government argues incentivising better environmentally performing vehicles via stamp duty is more appropriate at influencing consumer behaviour than a registration concession because the scheme targets people at the time of vehicle purchase and does not adversely impact on lower income earners more likely to own second hand, poorer performing vehicles.

Being tied to the Commonwealth’s GVG, the scheme is also flexible in that it can accommodate PHEVs and EVs as they become available. The GVG ratings are reviewed periodically. There is also potential for the scheme to complement plans by EV services provider, Better Place Australia, to begin installing EV recharging infrastructure in Canberra in 2011.

#### International case studies:

##### United States

*Incentives:* The US federal government offers US$7,500 as a tax credit for EV purchases and infrastructure. In addition to this, there are over 30 other financial incentives across state and local jurisdictions (funding, rebates, vouchers, bonuses, tax credits and reductions or exemptions on sales tax, excise tax, vehicle license tax). To see the most current and comprehensive list visit, the US Energy Efficiency and Renewable Energy’s Alternative Fuels and Advanced Vehicles Data Center.\textsuperscript{52}

##### Canada

*Incentives:* Five Canadian provinces offer sales tax rebates up to maximums of $2000 (4) and $3000 (1). The Ontario Government offers are rebate of US $5,000 - $8,500.

\textsuperscript{50} Diamond, 2008.


Europe

Incentives: National and regional governments of 15 EU member states have introduced incentives for buying electric vehicles, consisting of tax reductions and exemptions, as well as bonus payments for the buyers of electric vehicles, e.g. all western European countries with the exception of Italy and Luxembourg. Three notable incentives are from Denmark, Belgium and the UK. EVs weighing less than 2,000 kg are exempt from the Danish registration tax, which is based on the price of the vehicle. This tax is calculated as follows: \((105\% \times \text{vehicle price up to DKK 79,000}) + (180\% \times \text{vehicle price above DKK 79,000})\); e.g. a car costing DKK 80,000 would have a registration tax of DKK 144,000. Belgium offers a personal income tax reduction of 30% (maximum of $9000 EUR). As from 2011, purchasers of electric vehicles (including plug-in hybrids) will receive a discount of 25% of the vehicle’s list price up to a maximum of £ 5,000. The government has set aside £ 230m for this incentive programme.

Feebate: Seventeen EU Member States levy CO\(_2\)-related taxes on passenger cars. In Romania, electric and hybrid cars are exempt from the special pollution tax, which is based on CO\(_2\) emissions, cylinder capacity and compliance with Euro emission standards. UK exempts electric vehicles from the annual circulation tax. This tax is based on CO\(_2\) emissions and all vehicles with emissions below 100 g/km are exempt from it. In Sweden, hybrid vehicles with CO\(_2\) emissions of 120 g/km or less and electric cars with an energy consumption of 37 kWh per 100 km or less are exempt from the annual circulation tax for a period of five years from the date of their first registration. In Austria, cars emitting less than 120g/km receive a maximum bonus of $300 EUR, and alternate fuel vehicles have an additional maximum bonus of $500 EUR.

*For more detail on international examples of incentives, please see the summaries provided in the Appendices of this report.
### APPENDIXES

#### Appendix 1. Summary of Canadian Policies

<table>
<thead>
<tr>
<th>Regulation - Canada</th>
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<tr>
<td><strong>National Technical Standards</strong></td>
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<tr>
<td>Canadian Standards Association (CSA) has standards for battery chargers related to general use power supplies, as well as design and installation requirements for EV charging systems (e.g., CSA C22.1 Section 17 and Section 86).</td>
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<thead>
<tr>
<th>National Safety Standards</th>
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<tr>
<td>The <em>Motor Vehicle Safety Act</em> was amended in 2001 to require a series of crash tests to protect occupants from the hazards that are unique to electric vehicles, e.g. electric shock, electrolyte spills from batteries and the potential injury arising from the battery assembly entering the passenger compartment (Canada Gazette, 2001). Electric passenger cars are required to meet the standards required by the <em>Motor Vehicle Safety Act</em> that apply to all passenger cars.</td>
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<tr>
<th>National Regulation for Low Speed Vehicles</th>
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<tbody>
<tr>
<td>Different to the legal status of a passenger car, the <em>Motor Vehicle Safety Regulations</em> define Low-Speed Vehicles as vehicles that:</td>
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<tr>
<td>• Are designed for use primarily on streets where access of other classes of vehicles are controlled</td>
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<tr>
<td>• Travel on four wheels</td>
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<tr>
<td>• That are entirely electric and travel up to 40 km/h</td>
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<tr>
<td>• Have a gross vehicle weight rating of less than 1 361 kg.</td>
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In 2008, Transport Canada amended the legislation to add small trucks to the LSV class. Canada’s LSV class was created to allow companies to manufacture, import and sell these small, lightweight limited purpose electric vehicles that could not meet the safety standards applied to larger and heavier mainstream vehicles that operate on public roads. However the 2008 guideline also recommended limiting LSV speeds to 40 km/h roads, which significantly impacts city use. According to Transport Canada, such vehicles would instead be appropriate for university campuses, parks, gated communities and military bases.

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<th>City Codes</th>
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<tr>
<td>In 2009, Vancouver passed requirement for charging ports in 20% of parking stalls in new multi-family developments (Bailey and Morris, 2010). The outlets would be 240V – similar to those used by household dryers or stove – and charge EVs about four times faster than standard 110V outlets. The city expects the move will add 0.5 percent to the cost of an average building. Vancouver also requires one and two-family dwellings to have plug-in vehicle charging capabilities.</td>
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### Targets - Canada

**National Targets**
The Government of Canada has a target to reach, by 2018, at least 500,000 highway-capable plug-in electric-drive vehicles on Canadian roads, as well as what may be a larger number of hybrid-electric vehicles. All these vehicles will have more Canadian content in parts and manufacture than vehicles on the road in Canada in 2008 (GoC, 2010).

**State Targets**
Ontario is striving to have EVs represent 5% of the vehicles on the road in 2020.

### Information - Canada

**National Portals**
Canada’s Electric Vehicle Technology Roadmap has its own dedicated webpage with updates on progress and upcoming workshops: [www.evtrm.gc.ca](http://www.evtrm.gc.ca)

Transport Canada has an online Urban Transportation Emissions Calculator for estimating annual emissions from personal, commercial and public transit vehicles.

**National Education Programs**
The ecoTechnology for Vehicles program, mentioned above, conducts outreach activities across Canada in order to provide hands-on experiences and information about advanced vehicle technologies, as well as circulates their *Green Wheels* newsletter.

**Provincial Programs**
With funding from Transport Canada, the Centre for Electric Vehicle Experimentation in Quebec (CEVEQ) initiated and managed an Assessment of Low Speed Electric Vehicles in Urban Communities, for which four EV manufacturers provided seven LSVs. The study was used to gather public opinion on the risks related to using these vehicles in normal city traffic (CEVEQ, 2002).

**Arising policy suggestions included:**

- Authorize the use of LSVs in areas with 50 km/h and lower speed limits, except in areas where actual known speeds are higher than authorized speeds (e.g., major arterial roads)
- Have municipalities participate in each phase leading up to the government’s possible authorization of LSV use on municipal roads
- Prepare a guide for municipalities to help them facilitate the introduction of LSVs in municipal areas.

### Facilitation - Canada

**Federal Programs**
Transport Canada’s ecoTechnology for Vehicles (eTV) program works with manufacturers to acquire and test and to address barriers to the introduction of new passenger vehicle technologies in Canada. eTV’s test results also inform the development of regulations, codes and standards for EVs and PHEVs (TC, 2010): [www.tc.gc.ca/eTV](http://www.tc.gc.ca/eTV).
### Incentives – Canada

**Provincial Sales Tax Rebates**

Five Canadian provinces offer sales tax rebates up to maximums of $2,000 (4) and $3,000 (1). The Ontario Government offers are rebate of US $5,000 - $8,500.

### Pricing - Canada

Unknown

### Coordination - Canada

**Federal Coordination**

The Canadian Electronic Vehicle Roadmap (evTRM) is led by industry and coordinated by a federal government secretariat. The evTRM identifies critical gaps, requirements and milestones needed to advance EVs in Canada. (GoC, 2010)
## Appendix 2. Summary of US Policies

### Federal Regulation – United States

#### National Technical Standards

In the US, EV-related standards have been developed by UL since 1998, e.g. standards for EV charging systems and related equipment. UL intends to release a new set of requirements for large batteries in EV that will focus on the mitigation of the risk of fire, electrical hazards, and enhancement of the overall safety of the EV (Anon, 2009 in Brown et al., 2010).

Importantly, the Society of Automotive Engineers (SAE) Standard J1772 standardizes the connection between the EV and charging station, as well as 14 other standards.

The United States Advanced Battery Consortium (USABC) has begun formative work to develop and establish standards for performance and abuse tolerance of ultracapacitors (UL, 2009 in Brown et al., 2010).

#### National Emissions Regulation

In 2010, the Environmental Protection Agency (EPA) developed CO₂ tailpipe (exhaust) standards for cars and light trucks. The standards require these vehicles to meet an estimated combined average emissions level of 250 grams of carbon dioxide per mile, nearly 30% less than the emissions produced by today’s average new vehicle. Together, these standards will cut greenhouse gas emissions by an estimated 960 million metric tons and 1.8 billion barrels of oil over the lifetime of the vehicles sold under the program (model years 2012-2016) (EPA 2010). To incentivize automakers to produce EVs and PHEVs, the EPA will count vehicle emissions as zero grams per mile for plug-in electric vehicles when operating on grid electricity but the agency is limiting this scoring to the first 200,000 vehicles produced by each manufacturer. For automakers that produce 25,000 advanced technology vehicles in 2012, EPA will expand their manufacturer production cap to 300,000. If a manufacturer exceeds their cumulative 200,000 or 300,000 vehicle production cap, the global warming emissions scoring for grid-electricity miles for EVs and PHEVs will include the power plant emissions associated with the electricity production and delivery to the vehicle.

#### National Vehicle Acquisition and Fuel Use Requirements

**Federal fleets**

Under the Energy Policy Act (EPAct) of 1992, 75% of new light-duty vehicles acquired by certain federal fleets must be alternative fuel vehicles (AFVs), including hybrid electric vehicles. Additionally, federal agencies with 20 vehicles or more in their U.S. fleet to decrease petroleum consumption by 2% per year, relative to their Fiscal Year (FY) 2005 baseline, through FY 2015. Agencies must also continue to increase their alternative fuel use by 10% per year, relative to the previous year. Executive Order 13514, issued in October 2009, requires federal agencies to establish reduction targets for greenhouse gas (GHG) emissions by FY 2020, relative to a 2008 baseline. Reductions may be achieved through a variety of measures including reduced petroleum consumption, use of AFVs, and fleet optimization efforts. (42 U.S. Code 13212, Executive Order 13423 (PDF 105 KB) and Executive Order 13514).

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53 http://www1.eere.energy.gov/femp/about/fleet_mgmt.html
### Federal Regulation – United States

The U.S. Department of Defense (DOD) is required to exhibit a preference for the lease or procurement of motor vehicles with electric or hybrid electric propulsion systems, including plug-in hybrid systems. The Secretary of Defense must establish regulations to implement the electric vehicle preference by October 28, 2010. (10 U.S. Code 2922g, and Public Law 111-84, Section 2844)

### State and Alternative Fuel Provider Fleets

Under the Energy Policy Act of 1992, certain state government and alternative fuel provider fleets are required to acquire alternative fuel vehicles (AFVs). Compliance is required by fleets that operate, lease, or control 50 or more light-duty vehicles within the U.S.

### Battery Disposal Regulations

The US has federal regulations such as Resource Conservation and Recovery Act (RCRA) and Characteristics of Hazardous Waste—Title 40 of Code of Federal Regulations (CFR) which provides the basis for managing the disposal and recycling of battery wastes.

### State Regulation – United States

#### Specifications for Electric Vehicle Compatibility

In California, new EVs and PHEVs must be equipped with a conductive charger inlet port that meets the specifications contained in Society of Automotive Engineers (SAE) standard J1772 in order to qualify for state rebates (California Code of Regulations Title 13, Section 1962.2).

#### Requirements Where to Install Charging Systems

The Oklahoma Department of Central Services Fleet Management Division may construct, install, acquire, operate, and provide alternative fuelling infrastructure for state agencies and local government use as well as the public in areas of the state where public access to alternative fuel infrastructure is not readily available (Oklahoma Statutes 74-78v1).

Contingent upon funding, the Washington state must install electrical outlets suitable for charging EVs in each of the state's fleet parking and maintenance facilities as well as every state-operated highway rest stop by December 31, 2015. (Revised Code of Washington 43.01.250, 43.19.648, and 47.38.075)

State and local governments in Washington may lease land for installing, maintaining, and operating EV charging stations or battery exchange stations for up to 50 years.

Also in Washington, certain jurisdictions must develop regulations to allow the use of EV infrastructure and battery charging stations in all areas except critical areas or areas zoned for residential or resource use. These regulations must be developed six months after the Washington Department of Commerce distributes model ordinances, development regulations, and guidance for local governments for site assessment and installing EV infrastructure, or by July 1, 2010, whichever is later. Additionally, cities or municipalities may adopt incentive programs to encourage retrofitting of existing structures capable of charging EVs (Revised Code of Washington 35.63.126-35.63.127, 35A.63.107, 36.70.695, and 36.70A.695).

#### Requirements on How to Install Charging Systems

A multi-family residential dwelling or townhouse owner, in Hawaii, may install an EV charging
**State Regulation – United States**

- System at a parking stall at the dwelling as long as the system is in compliance with applicable rules and the homeowner receives consent from the private entity if the system is placed in a common area (Senate Bill 2231, 2010, and Hawaii Revised Statutes 196) (EERE, 2010).

Without requiring significant upgrades, EV infrastructure installed in Minnesota must: 1) be able to be used by any make, model, or type of EV; 2) comply with state safety standards and standards set by the Society of Automotive Engineers; and 3) be capable of bidirectional charging once electrical utilities achieve a cost-effective ability to draw electricity from EVs connected to the utility grid (Minnesota Statutes 325F.185).

**Requirements When to Use Charging Systems**

- Publicly and privately owned EVs may be charged at Washington state office locations where the vehicles are used for state business, commuter vehicles, or conducting business with the state.

- The Oklahoma Department of Central Services must discontinue public access to their fuelling stations if a privately owned alternative fuelling station opens within a five-mile radius (Oklahoma Statutes 74-78v1).

- Oklahoma’s Alternative Fuels Conversion Act requires all school and government vehicles capable of operating on an alternative fuel to use the fuel whenever a fuelling station is located within a five-mile radius of the respective department or district and the price of the alternative fuel is cost competitive. If school and government vehicles must be fuelled outside the five-mile radius and no fuelling station is reasonably available, the school and government vehicles are exempt from this requirement.

**Emissions Regulations**

- The California Low Carbon Fuel Standard (LCFS), overseen by the California Air Resources Board (CARB) requires a 10% reduction in overall carbon intensity of transportation fuels in the state by 2020.

- California’s Low Emission Vehicle II regulations specify maximum exhaust and GHG emissions for LEVs, as well as amend the vehicle test procedures for zero-emission and hybrid electric vehicle (California Code of Regulations Title 13, Section 1961-1961.1) (EERE, 2010).

- As part of Colorado’s GHG reduction goals, the Colorado Department of Public Health and Environment (CDPHE) is directed to develop regulations to submit to its Air Quality Control Commission that mandate reporting of GHG emissions from all major sources. CDPHE must identify and evaluate the benefits and impediments to measures designed to reduce tailpipe emissions, including the utility and availability of alternative fuel vehicles. Additionally, CDPHE must develop a proposal for reducing net GHG emissions from the state’s transportation sector (Executive Order D004 08) (EERE, 2010).

**Manufacturer Production Requirements**

- Manufacturers must produce and deliver for sale in California a minimum percentage of ZEVs for each model year, e.g. 11% in 2010-2011; 16% in 2018 and on (California Code of Regulations Title 13, Section 1962.1).
### State Regulation – United States

#### Government Acquisition Requirements

Between 2000-2006, *four* states had government EV purchasing requirements. Currently, 29 states have green fleet purchasing requirements. Notably, Hawaii’s Alternative Fuel and Advanced Vehicle Acquisition Requirements prioritises EV and PHEVs.

Arizona requires:

- Federal fleets operating in certain Arizona counties to be comprised of at least 90% alternative fuel vehicles
- Certain local governments to develop and implement vehicle fleet plans. At least 75% of the total government fleet must operate on alternate fuels
- School districts with an average student population of more than 3,000 students to ensure that 50% of the fleet operates on alternative fuels.

Under Oklahoma’s Alternative Fuels Conversion Act, all school and government fleets may convert their vehicles to operate on an alternative fuel, and all school districts should consider only purchasing school vehicles, which have the capability to operate on an alternative fuel.

#### Requirements for Transportation Corporations

All buses purchased by the New Jersey Transit Corporation (NJTC) must be: 1) equipped with improved pollution controls that reduce particulate emissions; or 2) powered by a fuel other than conventional diesel. Qualifying vehicles include compressed natural gas vehicles, hybrid electric vehicles, fuel cell vehicles, vehicles operating on biodiesel or ultra low sulphur fuel, or vehicles operating on any other bus fuel approved by the U.S. Environmental Protection Agency. If the NJTC is unable to meet the bus purchase requirement, a report must be submitted to the New Jersey Senate and General Assembly detailing the reasons and an exemption may be granted by the state legislature (New Jersey Statutes 27:1B-22).

#### Registration

In Arizona, a registered Alternate Fuel Vehicle must display an AFV license plate. In Iowa, owner’s who modify vehicles to use a different type of fuel are required to register the conversion within 30 days (Iowa Code 321.116 and EERE, 2010).

#### Insurance

In Florida, insurance companies may not impose surcharges on EVs based on factors such as new technology, passenger payload, weight-to-horsepower ratio, and the types of material used to manufacture the vehicle, unless the Florida Office of Insurance Regulation receives actuarial data that determines the surcharges are justified (Florida Statutes 627.06535 and EERE, 2010).

An insurer in Maine may credit or refund any portion of the premium charged for an insurance policy on a clean fuel vehicle in order to encourage its policyholders to use clean fuel vehicles, as long as insurance premiums on other vehicles are not increased to fund these credits or refunds (Maine Revised Statutes Title 24-A, Section 2303-B).
## State Regulation – United States

### EV Parking Spaces
In Arizona, an individual is not allowed to stop, stand, or park a motor vehicle within any parking space specially designated for parking and charging EVs unless the motor vehicle is an EV and has been issued an alternative fuel vehicle special plate or sticker.

All public, private, and government parking facilities in Hawaii with at least one hundred parking spaces must designate at least 1% of the spaces specifically for EVs by December 31, 2011. The spaces designated for EVs will continue to increase by 1% for each additional 5,000 registered EVs until the percentage reaches 10%. (Hawaii Revised Statutes 226-10, 291-71, and 291-72) (EERE, 2010).

### Provision of Authority for Requiring Energy Efficient Vehicles
When awarding a vehicle procurement contract, every city, county, and special district, including school and community college districts, is authorized to require that 75% of the passenger cars and/or light-duty trucks acquired be energy-efficient vehicles (California Public Resources Code 25725-25726) (EERE, 2010).

## Local Regulation – United States

### Taxicab Acquisition Requirements
Chicago taxi companies with 50 or more vehicles in their fleet must operate at least one alternative fuel taxi (City of Chicago Rules and Regulations for Taxicab Medallion License Holders Rule 5.0) (EERE, 2010).

## Targets – United States

### National Target for Vehicles
US government intends to have one million EVs on the road by 2015 (Anon, 2009 in Brown et al, 2010).

In 2007, the US Department of Energy issued the Replacement Fuel Goal, which is to replace 30% of the U.S. motor fuel consumption, via a domestic production capacity for replacement fuels by 2030.

### State Targets for EVs and EV Infrastructure
To help achieve Illinois’ goal of reducing petroleum use by 20% by July 1, 2012, as compared to 2008 levels, Illinois state agencies must work towards:

- By 2015, at least 20% of new passenger vehicles purchased must be HEVs and 5% must be BEVs
- By 2025, at least 60% of new passenger vehicles purchased must be HEVs and 15% must be BEVs (Executive Order 11, 2009).

By 2010, 100% of all light-duty vehicles for New York state agencies must be alternate fuel vehicles, including EVs (Executive Order 9, 2008, Executive Order 142, 2005, and Executive Order 111, 2001).

By 2018, Washington plans for each county to have 10% of public and private parking spaces
ready for EV charging. Hawaii plans to build as many as 100,000 charging stations for EVs by 2012 (Hensley et al., 2009).

State Targets for Fuel
Minnesota required government agencies to reduce petrol by 50% and petroleum-based diesel fuel by 25% by 2015 (Executive Orders 04-08 and 04-10, 2004, and Minnesota Statutes 16C.137).

The PennSecurity Fuels Initiative aims to replace 900 million gallons of the Commonwealth's transportation fuels with alternative sources by 2020.

By 2015, all Washington state and local government agencies must use 100% biofuels or electricity to operate all publicly owned vehicles. All state agencies must achieve 40% biofuel or electricity use by 2013 (Revised Code of Washington 43.19.647-43.19.648).

The Wisconsin Department of Administration is directed to require, through its fleet management policy, that all state agencies reduce the use of petroleum-based petrol in state-owned vehicles by 20% by 2010 and 50% by 2015.

Information at a National Level – United States

Resources and Training
The Alternative Fuels and Advanced Vehicle Data Center summarizes laws, regulations and funding opportunities by jurisdiction: www.afdc.energy.gov/afdc/laws

The US Commercial Service offers updated EV Developments and News on their Global Automotive Team website: www.buyusa.gov/auto/evnews.html

Fire-fighters and first responders
A nation-wide Electric Vehicle Safety Training program helps fire-fighters and other first responders prepare for the growing number of electric vehicles on the road in the United States. The project, funded by a $4.4 million grant from the U.S. Department of Energy, and run by the National Fire Protection Agency provides first responders with information they need to most effectively deal with potential emergency situations involving electric vehicles: www.evsafetytraining.org

Vehicle Labelling Requirements
Alternative fuel vehicles (AFVs) and fuel dispensers must be labelled with information to help consumers make informed decisions about buying or fuelling a vehicle. All new and used AFVs, including vehicles with an aftermarket conversion system installed, must be clearly labelled with the vehicle’s cruising range as estimated by the manufacturer, as well as other descriptive information. The labelling requirements do not apply to HEVs. Electricity charging stations must also be clearly labelled with the rating (16 CFR 306 and 309).

Greenhouse Gas Reporting Requirement
Beginning 2010, vehicle and engine manufacturers are required to report annual greenhouse gas (GHG) emissions to the U.S. Environmental Protection Agency (EPA) (see EPA’s Mandatory Reporting of Greenhouse Gases Web site).
### Information at a State Level – United States

#### Information Networks
The New York State Clean Cities Sharing Network, which provides technical, policy, and program information about AFVs, is managed by the New York State Energy Research and Development Authority (NYSERDA). Members are notified about upcoming funding opportunities and events. The Network publishes information about tax incentives, fuelling stations, case studies, and contact information for the Clean Cities program and other industry leaders. The Network also organizes and sponsors technical workshops.

#### State Reports

**EV Impacts on Roadway Funding**
Minnesota Department of Transportation conducted a study in 2009 that addressed, in part, the impact that EVs might have on the current funding mechanisms for the state’s roadways and provided suggestions on how to mitigate any impacts.

**EV Impacts on greenhouse gases**
- Minnesota: Minnesota Pollution Control Agency in 2007
- Illinois: Argonne National Laboratory in 2009

**Costs for Charging Infrastructure**
- Idaho National Engineering Laboratory in 2008

**Monitoring Transport Fuel Trends**
The California Energy Commission is required to prepare and provide an Integrated Energy Policy Report to the governor on a biannual basis. The IEPR provides an overview of major energy trends and issues facing the state, including those related to transportation fuels, technologies, and infrastructure (California Public Resources Code 25302).

#### Information Dissemination Requirement
New motor vehicle dealers must make information about AFVs and Arizona-based incentives for purchasing or leasing AFVs available to the public.

#### Training, Education and Manuals

**Technicians**
Oklahoma’s Alternative Fuels Technician Certification Act regulates the training, testing, and certification of technicians who install, modify, repair, or renovate equipment used in fuelling alternative fuel vehicles and in the conversion of any engine to operate on an alternative fuel. This includes EVs, EV charging infrastructure, and EV technicians (Oklahoma Statutes 74-130.11 through 74-130.24).

The New York State Energy Research and Development Authority’s (NYSERDA) Flexible Technical (Flex-Tech) Assistance Program provides assistance to fleet managers who want to evaluate the feasibility and cost of adding AFVs and fuelling facilities to their operations. Low-cost training for vehicle mechanics is also available through certified institutions.
**Engineering students**

As part of the Michigan Green Jobs Initiative, the Michigan Department of Energy, Labor and Economic Growth is partnering with two universities to provide training of automotive engineers for advanced vehicles through the Michigan Academy for Green Mobility. The courses will be focused on developing engineering skills that apply to next-generation hybrid and electric vehicles with an emphasis on battery design and hands-on learning.

**General**

The Iowa Department of Natural Resources conducts marketing and education outreach to encourage the use of alternative fuel vehicles.

The State of Oregon has published an installation guide for installing EV charging stations.

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**Information at a City Level – United States**

Los Angeles Department of Water and Power (LADWP) provides guidance on EV infrastructure to help customers determine applications for EVs in their fleet operations, EV maintenance services, and training.

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**Federal Facilitation – United States**

In 2009, the US Department of Energy (DOE) awarded grants to 48 new advanced battery and electric drive projects that will receive $2.4 billion in American Recovery and Reinvestment Act (ARRA) funding. More than half of the funding went to companies in the state of Michigan.

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**State Facilitation – United States**

**Charging Infrastructure**

The Alternative Fuelled Vehicles Program was developed within the New York State Office of General Services to:

- Assist New York State agencies, authorities, state universities and community colleges in acquiring and utilizing alternative 104 fuelled vehicles
- Satisfy federal and state requirements for purchasing such vehicles
- Develop a comprehensive, conveniently accessible state-wide network of fuelling stations to support the vehicles.

Upon agreement of standards for EVSE, Oregon will re-issue a request for proposal for building a state-wide EV charging network (EERE, 2010).

Hawaii government is working with Better Place to roll out as many as 100,000 charging stations by 2012.

The California government and local governments within California are working closely with Coulomb Technologies, a company facilitating and installing electric vehicle (EV) charging station infrastructure. The group organised a “Plant a Station” campaign. Coulomb’s website has an easy way for consumers and businesses to suggest locations for ChargePoint® Networked Charging Stations in their community to best serve the demand EV charging. Additionally, Coulomb announced that their newly released ChargePoint App for the iPhone
### State Facilitation – United States
and iTouch has reached nearly 30,000 downloads. The free App locates ChargePoint Networked Charging Stations for EV anywhere in North America, and displays in real time if a charging station is currently available or in use. With the ChargePoint App, drivers can start and stop charging sessions, be notified when their vehicle is fully charged, and get directions to stations (Coulomb Technologies, 2010).

### Purchasing Systems
A committee lead by the Operational Services Division and made up of other state and regional agency representatives was tasked with studying the feasibility of developing and implementing a system to facilitate the bulk purchase of AFVs by the Commonwealth and its political subdivisions. The study should include the associated cost savings of a bulk purchase system, as well the cost of the system administration, the appropriate entities to participate in the system, and the probability that the system would be utilized by these entities. The study results, relevant recommendations for moving forward, and drafts of legislation necessary to put these recommendations into effect should be presented to the Massachusetts legislature (Massachusetts Session Law 169, 2008).

### State-supported Industry Partnership
As part of a $5-million Michigan Energy Efficiency Grant Program, General Motors, Pacific Northwest Laboratory, DTE Energy, Michigan Transportation Research Institute (UMTRI) and others are studying the impact of PHEVs in Michigan.

The Minnesota Department of Commerce and the University of Minnesota are collaborating to engage stakeholders on issues related to Smart Grid development in Minnesota. Michigan’s Public Service Commission established a smart grid collaborative, which is now studying various aspects of PHEVs.

Oregon’s largest utility Portland General Electric partnered with NEC Corporation to open the US’s first public-use, quick-charge station for electric vehicles. The Takasago Rapid Charging Station can recharge electric vehicles with lithium-ion batteries to 80% of full strength in only 20-30 minutes. The Governor of Oregon opened the charging station, in August 2010, by charging an all-electric Nissan Leaf. Importantly, he reiterated, “By making charging convenient and available for public use, we are telling car manufacturers that Oregon is ready for the next generation of electric vehicles – and we want our state to be a leader in introducing these cars to the rest of the country” (EE News, 2010).

### State-supported Academic Research
In 2009, $3 million of Ohio’s technological innovation fund was granted to the Center For Automotive Research (CAR) at The Ohio State University to develop electric vehicle technology.

### Resolutions
**For Federal Action**
The Nevada legislature recommends that the U.S. Congress enact legislation authorizing HEVs to qualify for compliance under the Energy Policy Act of 1992 as a practical and economic way to reduce emissions and lessen the use of foreign oil (Senate Joint Resolution 9, 2009).
### State Facilitation – United States

**State Resolutions for Manufacturer Behaviour**
The New Jersey Senate urges automobile manufacturers to use available technology to begin manufacturing PHEVs for purchase and use by the general public, recognizing that the reliance of PHEVs on electricity as the primary fuel source can reduce petrol consumption in the U.S. (Senate Resolution 108, 2007)

The Commonwealth of Pennsylvania urges auto manufacturers to develop and produce PHEVs for consumer use. (Reference House Resolution 106, 2007)

### Federal Incentives for the Buyer – United States

**Federal Income Tax Credit for Consumers**
Following the National Energy Policy Report (2001), the U.S. government has been supporting consumer purchase of hybrid vehicles via federal income tax deductions before 2006 and federal income tax credits of $7,500 since then. Consumers who purchase residential fuelling equipment may receive a tax credit of up to $2,000.

**Federal Funds for Cities and State Agencies**
In August 2009, DOE announced the recipients of $300 million in Clean Cities program funding. These projects aim to speed the transformation of the nation’s vehicle fleet, putting more than 9,000 alternative fuel, electrified and energy efficient vehicles on the road, establishing 542 refuelling locations across the country and displacing approximately 38 million gallons of petroleum per year.

The Congestion Mitigation and Air Quality Improvement Program provides funding to state departments of transportation (DOTs), municipal planning organizations (MPOs), and transit agencies for projects and programs in air quality non-attainment and maintenance areas that reduce transportation-related emissions. Eligible activities include travel demand management strategies, development of alternative fuelling infrastructure, conversion of public fleet vehicles to operate on cleaner fuels, and outreach activities that provide assistance to diesel equipment and vehicle owners and operators regarding the purchase and installation of diesel retrofits. State DOTs and MPOs must give priority to projects and programs to include diesel retrofits and other cost-effective emissions reduction activities, and cost-effective congestion mitigation activities that provide air quality benefits.

The Alternative Transportation in the Parks and Public Lands Program provides funding to support public transportation projects in parks and on public lands. The goals of the program include conservation of natural, historical, and cultural resources, and reduced congestion and pollution. The Federal Transit Administration administers the program while partnering with the Department of the Interior and the Forest Service to provide for technical assistance in alternative transportation options. Eligible projects include capital and planning expenses for alternative transportation systems such as clean fuel shuttle vehicles (49 U.S. Code 5320).
# State Incentives for the Buyer – United States

## Tax Incentives

*Income and Sales Tax*

From 2000-2006, eight states offered an income tax credit and four states waived sales taxes on hybrid vehicle purchases. Colorado currently offers income tax credits for vehicles that use or are converted to use an alternative fuel. The tax credit is capped at $6000, but will increase the cap to $7,500 between 2012 and 2016 (House Bill 1331, 2009, and Colorado Revised Statutes 39-33-101 to 39-33-106) (EERE, 2010).

Georgia offers a maximum income tax credit for 10% or $2,500 for Alternative Fuel Vehicles and 20% or $5,000 for Zero Emission Vehicles (EERE, 2010). Others include:

- Kansas: 50% credit for conversion costs, 50% for purchase costs
- Maryland: maximum of 50% tax credit for the purchase of a PHEV
- Montana: tax credit up to 50% for conversion
- Oklahoma: 50% tax credit for purchasing or conversion
- South Carolina: tax credit equal to 20% of the federal credit
- Utah: tax credit of 35% or $2,500, whichever is less for purchasing and 50% credit for converting, up to $2,500

*Exemption of Registration Fees, Excise Tax and Annual License Tax*

From 2000-2006, 4 states enacted registration or excise tax exemptions. Other current policies include:

- Arizona’s initial annual vehicle license tax on an Alternative Fuel Vehicle is lower than the tax on a conventional vehicle
- Arkansas imposes excise taxes on alternative fuels based on a gasoline gallon equivalent basis. DC offers exemptions for alternative fuel vehicles on excise tax
- No county, city, village, town, or other political subdivision in Wisconsin is allowed to levy or collect any excise, license, privilege, or occupational tax on motor vehicle fuel or alternative fuels, or on the purchase, sale, handling, or consumption of motor vehicle fuel or alternative fuels (Wisconsin Statutes 78.82)
- Zero Emission Vehicles sold, rented or leased in New Jersey are exempt from state sales and use tax.

## Rebates

- Illinois offers rebates up to $4,000 or 80% of the cost of purchasing or converting an electric powered vehicle
- In California, rebates are available through the Clean Vehicle Rebate Project for the purchase or lease of qualified clean vehicles. The rebates offer up to $5,000 for light-duty zero emission and plug-in hybrid vehicles and up to $20,000 for zero emission
State Incentives for the Buyer – United States

commercial vehicles

- The Colorado Department of Revenue offers a rebate for the purchase of an AFV, HEV, or for the conversion of a vehicle to operate using an alternative fuel. Vehicles must be owned by the State of Colorado, a political subdivision of the state, or a tax-exempt organization, and be used in connection with the official activities of the entity. Each qualified entity is limited to $350,000 per state fiscal year in total rebates paid (Reference House Bill 1331, 2009, and Colorado Revised Statutes 39-33-101 through 39-33-106) (EERE, 2010)

- New Jersey’s rebate up to $12,000 for purchasing and conversions of EVs, and 50% rebate for the cost of purchasing or installing infrastructure.

Fund, Grant and Loan Programs
The Illinois Alternative Fuel Vehicle Grant Program offers grants, up to $2,000 to counties, cities, towns, townships, or school corporations to purchase OEM alternate fuel vehicles and for the cost of conversions (Indiana Code 4-4-32.3) (EERE, 2010).

Maine’s Transportation Efficiency Fund is a non-lapsing fund managed by the Department of Transportation for zero-emission vehicles, biofuel and other alternative fuel vehicles, congestion mitigation and air quality initiatives, rail, public transit, and car or van pooling (Legislative Document 1786, 2010 and Maine Revised Statutes Title 23, Section 4210-E) (EERE, 2010).

The Louisiana Department of Natural Resources administers the Alternative Fuel Vehicle Revolving Loan Fund Program to provide loan assistance to local government entities for the cost of converting conventional vehicles to operate on alternative fuels, or the incremental cost of new AFVs (Senate Bill 103, 2010, and Louisiana Revised Statutes 33:1419.5-33:1419.10) (EERE, 2010).

The Alternative and Renewable Fuel and Vehicle Technology Program, established by Assembly Bill 118 and administered by the California Energy Commission, aims to increase the use of alternative and renewable fuels and innovative technologies through grants and loans.

The Hawaii Department of Business, Economic Development, and Tourism established the Hawaii Transportation Energy Transformation Grant Fund to provide grants through the Transportation Energy Diversification Project for the acquisition of EVs, the installation of EV charging infrastructure, and the development of innovative programs or the coordination of activities that diversify transportation energy sources. The Department will review all applications and will provide annual statistical information regarding program participation to the governor and state legislature (Hawaii Revised Statutes 201) (EERE, 2010).

Others include:

- In Florida, property owners may apply to their local government for funding to help finance installations of EV charging equipment at their property or enter into a financing agreement with the local government for the same purpose (House Bill 7179, 2010, and Florida Statutes 163.08) (EERE, 2010)
State Incentives for the Buyer – United States

- Maine: Clean Fuel Vehicle Fund (grants and loans) administered by the Finance Authority of Maine
- Nebraska: The Dollar and Energy Saving Loan program (purchase and conversion of EVs and purchase of charging station equipment) with a maximum loan up to $150,000 and interest rate of 5% or less
- New Hampshire: EV purchasing and infrastructure fund
- New Mexico: acquisition loans, up to $3,000
- New York: Clean City Challenge funds, which can be used to cost-share up to 75% of the acquisition or infrastructure project
- North Carolina: Loan program, where state and local government credit unions offer green vehicle loans to purchase new HEVs. The loans are offered at a 1% interest rate discount as compared to traditional new vehicle loan rates
- Oklahoma: The Oklahoma Department of Central Services’ Alternative Fuels Conversion Loan program provides 0% interest loans to government fleets for converting vehicles to operate on alternative fuels, the construction of AFV fuelling infrastructure, and the incremental cost associated with the purchase of an original equipment manufacturer AFV. The program provides up to $10,000 per converted or newly purchased AFV and up to $150,000 for the development or installation of fuelling infrastructure (Oklahoma Statutes 74-130.4 and 74-130.5)
- Oregon: credits up to $1,500 for the purchase of an HEV for residents and 35% tax credit for businesses
- Pennsylvania: financial assistance for HEVs and PHEVs
- Texas: The Texas Emissions Reduction Plan provides grants for purchasing and converting EVs
- Utah: the Clean Fuels and Vehicle Technology Grant and Loan Program provides grants and loans to businesses to cover costs associated with conversion and purchasing EVs.

Grants for fleets
Beginning in 2010, the Texas Commission on Environmental Quality will administer the Texas Clean Fleet Program, which encourages owners of fleets containing diesel vehicles to permanently remove the vehicles from the road and replace them with alternative fuel or hybrid electric vehicles. Grants will be available to fleets to offset the incremental cost of such replacement projects (Senate Bill 1759, 2009, and Texas Statutes, Health and Safety Code 391).

Vouchers for fleets
Through the Hybrid Truck and Bus Voucher Incentive Project (HVIP), the California Air Resources Board provides vouchers to eligible fleets in order to reduce the incremental cost of qualified medium- and heavy-duty hybrid electric vehicles at the time of purchase. Vouchers are available on a first-come, first-served basis and range from $10,000 to $45,000.
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**Funds for buses**
The Clean Fuelled Bus Program, administered by the New York State Energy Research and Development Authority (NYSERDA), provides funds to state and local transit agencies, municipalities, and schools for up to 100% of the incremental cost of purchasing new alternative fuel buses and associated infrastructure (e.g. uses electricity as a primary motive force) (EERE, 2010).

**Access to High Occupancy Vehicle Lanes (HOV)**
Five states allowed single-occupancy hybrid vehicles to drive in high-occupancy vehicle (“HOV”) lanes. Currently there are nine.

**Green Lanes**
Phase Two of the Illinois Tollway Congestion-Relief Program (PDF 840 KB) includes a Dedicated Green Lanes Plan that will provide access to qualified hybrid electric vehicles at premium prices (EERE, 2010).

**Vehicle Emission Test Exemptions**
From 2000 – 2006, 3 states enacted vehicle emission test exemptions for hybrid vehicles. Currently there are two.

**Insurance for Loans**
The Finance Authority of Maine may insure up to 100% of mortgage payments with respect to mortgage loans for clean fuel vehicle projects (Maine Revised Statutes Title 10, Sections 1023-K and 1026-A).

**Parking Incentives**
Arizona allows individuals driving Alternate Fuel Vehicles to park, without penalty in areas that are designated for carpool operators.

**State Exemptions for Driving Restrictions**
In DC, certified clean fuel vehicles are exempt from time-of-day and day-of-week restrictions and commercial vehicle bans (District of Columbia Code 50-702 and 50-714) (EERE, 2010).

**Registration incentives**
HEVs operating as taxicabs in Nevada may remain in operation for an additional 24 months beyond the existing limits. Existing limits restrict vehicles used as taxicabs to operate for a period of up to 67 months for new vehicles or 55 months for used vehicles with less than 30,000 miles on the odometer (Senate Bill 9, 2009, and Nevada Revised Statutes 706.8834).

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**Reduction of Fees and Charges**
From 2000-2006, 13 cities enacted parking fee reduction or exemptions. The Los Angeles Airport (LAX) offers free parking and charging for EVs in the lower/arrivals level of Parking Structures 1 and 6.
The Salt Lake City Department of Airports provides incentives to commercial ground transportation providers who purchase and operate clean fuel vehicles that exclusively operate on approved clean fuels, including electricity, or hybrid electric vehicles. The incentives are in the form of a credit against ground transportation fees. Incentive credit amounts are $2,500 for each original equipment manufacturer vehicle or certified vehicle converted to operate on an alternative fuel.

**Funds for Private Fleets**

New York City’s Private Fleet Alternative Fuel/Electric Vehicle Program will award funds up to 50% of the purchase cost for light duty vehicles, 80% of the purchase or converting costs for medium to heavy EVs, and 50% for EV charging stations.

**Funds for Local Government**

Congestion Mitigation and Air Quality program grants are available from the Houston-Galveston Area Council for up to 75% of the incremental cost of purchasing EVs or establishing publicly accessible alternative charging infrastructure (EERE, 2010).

**Incentives Specifically for Infrastructure – United States**

**Federal Tax Credit for Infrastructure**

A tax credit is available for the cost of installing alternative fuelling equipment, including, electricity. The credit amount is up to 50% not to exceed $50,000. Fuelling station owners who install qualified equipment at multiple sites are allowed to use the credit towards each location (Public Law 111-5, Section 1123, and 26 U.S. Code 30C and 38B).

**Electric Vehicle Charging Infrastructure Grants**

San Francisco: The San Francisco Bay Area is to get $5 million to install 5000 electric vehicles across the region. The funds from the Bay Area Air Quality Management District, the agency responsible for air quality in the region, will support the development of 3000 home chargers, 2000 public chargers in car parks and at local companies and 50 fast charging stations near highways. The programme is part of the region’s ‘Spare the Air’ initiative aimed at tackling air pollution, over 50% of which comes from transport.

Colorado: grants are available to local governments for the installation of EV charging stations. Grants are prioritized based on the local government's commitment to energy efficiency (Reference Senate Bill 075, 2009 and Colorado Revised Statutes 24-38.5-102 and 24-38.5-103) (EERE, 2010).

**Alternative Fuel Infrastructure Tax Credits**

The Colorado Department of Revenue offers an income tax credit for the cost of construction, reconstruction, or acquisition of an alternative fuelling facility for motor vehicles. For an alternative fuelling facility that will be generally accessible for use by the public or if at least 70% of the alternative fuel dispensed annually is derived from a renewable energy source for a period of 10 years, the allowable credit increases. The credit has a maximum value of $400,000 (Colorado Revised Statutes 39-22-516) (EERE, 2010).
In Georgia, an eligible business enterprise may claim an income tax credit for the purchase or lease of qualified EVSE (maximum of 10% of the cost of the EVSE or $2,500) (EERE, 2010).

Others include:

- Kansas: 50% tax credit on the construction costs of an alternative fuelling station
- New York: 50% tax credit for the installation of infrastructure to charge electric vehicles (New York Tax Law 187-b)
- Oklahoma: 75% tax credit for the installation of electricity charging stations
- Oregon: 50% tax credit for infrastructure projects.

**Incentives for the Developer – United States**

**Federal Loans**

DOE offered a conditional loan of $528.7 million to manufacturer Fisker Automotive for the development of two versions of PHEVs with the intent of assembly line production beginning in late 2012. DOE has also offered conditional loans of $1.6 billion to Nissan North America, Inc. and $465 million to Tesla Motors.

**Business Tax Credits**

A taxpayer engaged in research and development of a qualified hybrid system that has the primary purpose of propelling a motor vehicle may claim a tax credit under the Michigan Business Tax equal to 3.9% of all wages or other payments. The maximum amount of credit allowed for any one taxpayer is $2 million per tax year (Michigan Compiled Laws 208.1101-208.1601).

Taxpayers certified by the Michigan NextEnergy Authority (MNEA) may claim a non-refundable credit for tax liability attributable to research, development, or manufacturing of qualified alternative fuel vehicles (AFVs) and renewable fuel. Additionally, businesses located within the designated Alternative Energy Zone that are engaged in qualified activities may claim a credit for the taxpayer's qualified payroll amount (Michigan Compiled Laws 207.821-207.827 and 208.1429).

In Wisconsin, the Vehicle Battery and Engine Research Tax Credits provide automobile developers with a tax credit equal to 10% of electric vehicle research costs.

Vermont: High-tech businesses involved exclusively in the design, development, and manufacture of hybrid electric vehicles, electric vehicles are eligible for up to three of the following tax credits: 1) payroll income tax credit; 2) qualified research and development income tax credit; 3) export tax incentive; 4) small business investment tax credit; and 5) high-tech growth tax credit (Vermont Statutes Title 32, Chapter 151, Section 5930a, c, f, g, and k).

**Property Tax Exemptions**

A tax exemption may apply to industrial property, which is used for, among other purposes, high-technology activities, including electric and hybrid vehicles and their components. In order to qualify for the tax exemptions, an industrial facility must obtain an exemption certificate for the property from the State Tax Commission (Michigan Compiled Laws 207.552 and 207.803).
Eligibility for Financing
Michigan’s Local Development Financing Act allows qualified advanced vehicle research and development projects to be eligible for financing. A municipality is authorized to create a local development financing authority that may borrow against future tax increment financing to pay for public infrastructure improvements that will attract economic development projects. The Michigan Economic Development Corporation (MEDC) may designate all or part of a local development financing authority district a “certified alternative energy park” to attract businesses engaged in alternative energy projects, including research and development of alternative energy vehicles (Senate Bill 0428, 2009, and Michigan Compiled Laws 125.2152-125.2162c) (EERE, 2010).

Federal Incentives for the Manufacturer – United States
Loans for Transforming Factories
Through the Advanced Technology Vehicles Manufacturing Loan Program, ATV and ATV components manufacturers may be eligible for direct loans for up to 30% of the cost of re-equipping, expanding, or establishing manufacturing facilities in the U.S. used to produce qualified ATVs or ATV components, including EVs (Public Law 111-85, Section 312; Public Law 110-140, Section 136; and 42 U.S. Code 17013).

In 2009, DOE announced a $5.9 billion Advanced Technology Vehicles Manufacturing program loan to Ford Motor Company to transform factories across five states to produce more fuel-efficient models, including plug-in electric vehicles.

State Incentives for the Manufacturer – United States
Business Tax Exemption or Credits
Manufacturers of traction battery packs for use in vehicles may be eligible for a tax credit from the Michigan Economic Growth Authority. The amount of the credit is based on kilowatt hours of battery capacity. Beginning on or after January 1, 2012, a manufacturer may claim a tax credit of up to 75% of the qualified expenses for vehicle engineering to support battery integration, prototyping, and launching. The same credit is available to a manufacturer that increases its engineering activities for advanced automotive battery technologies. Taxpayers that have received federal loan guarantees may claim a credit equal to 25% of the capital investment expenses for the construction of a facility that will produce large-scale batteries and manufacture integrated power management, smart control, and storage systems, if the project creates at least 500 new jobs in the state (Senate Bill 777, 2009, and Michigan Compiled Laws 208.1434).

In South Carolina, manufacturing machinery and equipment purchased for use in manufacturing batteries for hybrid electric vehicles may be reduced by 20% of the original cost. Qualified facilities must invest at least $100 million in the project and create at least 200 new full-time jobs with an average compensation level of 150% of the annual per capita income in South Carolina or the county where the facility is located, whichever is less (House Bill 4478, 2010, and South Carolina Code of Laws).

The Indiana Economic Development Corporation (IEDC) may award tax credits businesses for the manufacture or assembly of alternate fuel vehicles in Indiana; up to 15% of the qualified
APPENDICES

investment (Indiana Code 6-3.1-31.9) (EERE, 2010).

Others include:

- Louisiana’s Green Jobs Tax Credit, including the advanced drive train vehicle industry
- New Mexico’s Alternative Energy Product Manufacturers Tax Credit, which provides a maximum 5% credit of qualifying expenditures for manufacturing alternative energy products, which include electric and hybrid electric vehicles (New Mexico Statutes 7-9)
- Oklahoma’s EV Manufacturing Tax Credit, up to $2000 credit per vehicle.
- In Virginia, businesses involved with the manufacture of components for alternative fuel vehicles (AFVs), AFV conversions, or the production, storage, or dispensing of hydrogen as a vehicle fuel are eligible for a job creation tax credit for up to $700 per full-time employee (Virginia Code 58.1-439.1).

Pricing – United States

Federal Policy
The U.S. General Services Administration (GSA) is required to allocate the incremental cost of purchasing alternative fuel vehicles across the entire fleet of vehicles distributed by GSA. This mandate also applies to other federal agencies that procure vehicles for federal fleets (Reference 42 U.S. Code 13212 (c)).

Utility Pricing
Many utilities offer tariffs specifically for EV, e.g.:

- In 2009, Delaware became the first to allow EV owners to be eligible for a type of net metering with their utility. Retail electricity customers with one or more grid-integrated EVs will be credited in kilowatt-hours for energy discharged to the grid from the EV’s battery at the same rate that the customer pays to charge the battery (Senate Bill 153, 2009) (EERE, 2010).
- Minnesota’s Great River Energy Off-Peak Charging Program provides rebates to charging stations that provide off-peak (11pm-7am) electric vehicle charging
- PG&E’s Time-of-Use (ToU) Low Emission Vehicle rate, known as the “E-9 rate” (Schedule E-9). The E-9 rate is mandatory for those customers that are currently on a residential electric rate and who plan on refuelling an EV on their premises. The rate is as low as 5 cents/kWh and as high as 28 cents/kWh depending on the time of day, day of the week and time of year. The E-9 rate has two basic options, metering the whole house or just the EV charger (Bailey and Morris, 2010)
- The Sacramento Municipal Utility District (SMUD) offers a discounted rate of approximately 50% as compared to the regular residential rate for electricity used by residential customers to charge EVs. EV drivers must sign up for the appropriate residential time-of-use rate. SMUD also offers lower off-peak time-of-use rates for EV charging by commercial customers
The Los Angeles Department of Water and Power (LADWP) offers a discounted rate of $0.025/kWh for electricity used to charge EVs during off-peak times.

In Michigan, the Detroit Edison utility is trialling two options of vehicle charging systems for consumers: a $40/month/vehicle flat fee and a low rate for off-peak charging. Peak hours are defined as falling between 9 a.m. and 11 p.m. on weekdays. The Michigan Public Service Commission approved Detroit Edison’s plan yesterday, making it the first company in Michigan to develop a plan for EV charging. The rate system is designed as an experiment to run through 2012. Most customers will need to equip their homes with a second meter, to be dedicated specifically to vehicle charging. Detroit Edison will offer up to $2,500 of funding per home to deter costs of the system (MPSC, 2010).

**Coordination – United States**

**International Standards Coordination**

The US and China have launched a joint US–China Electric Vehicles Initiative because joint standards development for EV products and testing was identified as key to facilitating rapid deployment of EVs in both countries (Anon, 2009 in Brown et al, 2010).

**State Coordination Bodies**

In Connecticut, the EV Infrastructure Council (Council) must coordinate interagency strategies to prepare for the adoption of EVs, including establishing performance measures for meeting infrastructure, funding, environmental, and regulatory goals, due September 1, 2010 (Executive Order 34, 2009) (EERE, 2010).

The Alternate Fuels Commission was established within the Illinois Department of Commerce and Economic Opportunity to identify and recommend strategies for implementing and promoting the use of alternative fuels and alternative fuel vehicles. The Commission will also identify ways to improve stakeholder communication and coordination regarding the research and promotion of alternative fuels (House Bill 4245, 2009, and 415 Illinois Compiled Statutes 120/23) (EERE, 2010).

The Missouri Alternative Fuels Commission promotes the continued production and use of alternative and renewable transportation fuels in Missouri. The commission submits a report annually to the Governor and general assembly and provides recommendations on changes to state law to facilitate the sale and distribution of alternative fuels and alternative fuel vehicles; promote the development, sale, distribution, and consumption of alternative fuels; promote the development and use of alternative fuel vehicles and technology that will enhance the use of alternative and renewable transportation fuels; educate consumers about alternative fuels; and develop a long-range plan for the state to reduce consumption of petroleum fuels (Missouri Revised Statutes 414.420).

The Vermont Agency of Administration developed, and is responsible for overseeing the implementation of the State Agency Energy Plan. The Agency of Administration must modify the Plan as necessary and readopt it on or before January 15 of each fifth year. As specified in the 2010 Plan, the Vermont Agency of Transportation must continue to use 5% biodiesel (B5) in its fleet of heavy-duty vehicles. The Vermont Department of Buildings and General Services
Coordination – United States

must continue to use hybrid electric vehicles and Partial Zero Emission Vehicles in its fleet, while adjusting purchases based on annual fleet selection monitoring and available vehicle technology. All state agencies must investigate the use of additional alternative fuel and advanced technology vehicles, as well as the necessary fuelling infrastructure, such as incorporating electric vehicle supply equipment at appropriate state facilities. Additionally, the Climate Neutral Working Group must expand education and tracking related to anti-idling campaigns for state fleet vehicles and private sector vehicles operating on state owned property, and conduct a survey to determine the level of government employee participating in carpooling, vanpooling, and other commuting options (Vermont Statutes Title 3, Chapter 45, Section 2291).

State Partnerships to Achieve Coordination

The Washington Department of Ecology must work with the Washington Departments of Commerce and Transportation to assess whether California’s low carbon fuel standard or other state standards would help Washington meet its greenhouse gas emissions reduction target of 1990 levels by 2020. The Department of Transportation must also work in consultation with the Departments of Ecology and Commerce and other interest groups to address low or zero emission vehicles. Additionally, the Office of the Governor will work with state agencies to seek funding to implement a project for the electrification of the West Coast interstate highway and associated metropolitan centres and to purchase electric vehicles and install public fuelling and/or charging infrastructure for electric and other high-efficiency, zero, or low carbon vehicles (Executive Order 09-05, 2009).

In Washington, certain regional transportation planning organizations must collaborate with state and local governments to promote EV use, invest in EV infrastructure, and seek funding for these efforts. Collaborative planning efforts may include: 1) developing short- and long-term plans outlining how state, regional, and local governments may construct EV charging locations and ensure that the infrastructure can be electrically supported; 2) supporting public education and training programs on EVs; 3) developing an implementation plan for counties to have 10% of public and private parking spaces ready for EV charging by December 31, 2018; and 4) developing model ordinances and guidance for local governments for site assessment and installing EV infrastructure (Revised Code of Washington 47.80.090).

In an effort to promote best practices for public transportation services in Michigan, the Michigan Department of Transportation is directed to coordinate with the Michigan Economic Development Corporation to promote the transition of transit bus fleets to hybrid vehicles with improved fuel economy (Reference Senate Bill 254, 2009).

The Southern California Regional Plug-in Electric Vehicle Plan is a collaboration between cities, utilities, automakers and other key stakeholders who are working actively to support and build the commercial launch or EVs.

State Roadmaps

A committee led by the Commissioner of Energy Resources and made up of other state and regional agency representatives is required to develop a Massachusetts-wide plan for the advancement of hybrid electric and alternative fuel vehicles. The plan should cover a 10 year period, beginning in 2010, and take into account geographic diversity, demographics,
Coordination – United States

transportation needs, infrastructure, and the current and emerging alternative fuel and advanced vehicle technologies. Goals set forth in this plan may include the purchase of alternative fuel or advanced vehicles and the production or distribution of alternative fuels. The plan should include strategies and methods for achieving these goals (Massachusetts Session Law 169, 2008) (EERE, 2010).

The California Department of Transportation (Caltrans) is required to update the California Transportation Plan by December 31, 2015, and every five years thereafter. The Plan must address how the State will achieve maximum feasible emissions reductions, taking into consideration the use of alternative fuels, new vehicle technology, and tailpipe emissions reductions (Reference Senate Bill 391, 2009, and California Government Code 65071-65073) (EERE, 2010).

Mayors of San Francisco, San Jose, and Oakland will follow a policy plan to develop and expand the infrastructure needed to promote the use of EVs. Policy steps include: expediting the permit and installation processes for charging outlets; providing incentives for employers and other organizations who install charging infrastructure at the workplace and other parking facilities; developing standard regulations governing EV infrastructure across the region; and establishing programs to purchase EVs for use by city and state employees. The mayors will work with other cities in the Bay Area as well as regional government organizations and private sector partners (EERE, 2010).

State Joint Policy Evaluation
The California Public Utilities Commission (Commission), in consultation with the California Energy Commission, California Air Resources Board, electrical corporations, and the motor vehicle industry, must evaluate policies in an effort to develop infrastructure sufficient to overcome any barriers to the widespread deployment and use of EVs and PHEVs. By July 1, 2011, the Commission is required to adopt rules to address the following (Senate Bill 626, 2009, and California Public Utilities Code 740.2):

- The impacts on electrical infrastructure and any infrastructure upgrades necessary for widespread use of EVs and PHEVs, including the role and development of public charging infrastructure
- The impact of EVs and PHEVs on grid stability and the integration of renewable energy resources
- The technological advances necessary to ensure the widespread use of EVs and PHEVs and what role the state should take to support the development of this technology
- The existing code and permit requirements that will impact the widespread use of EVs and PHEVs and any recommended changes to existing policies that may be a barrier to the widespread use of EVs and PHEVs
- Expand fuel infrastructure, fuelling stations, and equipment
- The role the State should take to ensure that technologies employed in EVs and PHEVs work harmoniously and across service territories
- The impact of widespread use of EVs and PHEVs on achieving the state’s greenhouse gas emissions reductions goals and renewables portfolio standard program, and what
### Coordination – United States

Steps should be taken to address the possibility of shifting emissions reductions responsibilities from the transportation sector to the electrical industry.

Maine has adopted a policy to promote the development, implementation, availability and use of smart grid technology, including integrating advanced electric storage and peak-reduction technologies into the electric system through plug-in electric and hybrid electric vehicles (Legislative Document 1535, 2010, and Maine Revised Statutes Title 35-A, Section 3143) (EERE, 2010).

#### State Guidelines for EV Policy Development

The state of Montana encourages the use of alternative fuels and fuel blends to the extent that doing so produces environmental and economic benefits to the citizens of Montana. The state legislature recommends several guidelines for the development of a state alternative fuels policy, including the following: 1) encourage the use of self-sufficient markets; 2) any state alternative fuels program should have measurable benefits and state agencies must communicate these benefits to the public; 3) state and local governments are encouraged to set an example with their vehicle fleets by using alternative fuels and fuel blends (Montana Code Annotated 90-4-1011).

#### State EV Definitions

EV infrastructure is defined as structures, machinery, and equipment necessary and integral to support an EV, including battery charging stations, rapid charging stations, and battery exchange stations. A battery charging station is defined as an electrical component assembly or cluster of component assemblies designed specifically to charge batteries within an EV. A rapid charging station is defined as an industrial grade electrical outlet that allows for faster recharging of EV batteries through higher power levels. A battery exchange station is defined as a fully automated facility that will enable an EV with a swappable battery to enter a drive lane and exchange the depleted battery with a fully charged battery through a fully automated process. Infrastructure must meet or exceed any applicable state building standards, codes, and regulations (Revised Code of Washington 74.80.090).

#### State Resolutions

To achieve Hawaii’s transportation efficiency goals and to create jobs, foster economic growth, and reduce greenhouse gas emissions, the Hawaii Senate encourages the promotion of EV use in the state. As a first step, EV charging infrastructure must be developed. Also, stakeholders should work together to expedite the use of EVs in Hawaii. Additionally, the Hawaii House of Representatives urges the Hawaii Clean Energy Initiative End-Use Efficiency Work Group to address the challenges related to EV charging stations and access to electrical outlets to facilitate the use of EVs and plug-in hybrid electric vehicles (House Concurrent Resolution 230, 2010, and Senate Concurrent Resolution 126, 2009) (EERE, 2010).
Appendix 3. Summary of European Policies

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<tr>
<th>Regulation - Europe</th>
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<tr>
<td><strong>UN Technical Standards</strong></td>
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<tr>
<td>Countries included in the UN Economic Commission for Europe (UNECE), including most European Countries, will have new regulations imposed by the end of 2010 by the vehicle regulatory body of the UNECE, the Vehicle Regulations and Transport Innovations Section. New rules in these international safety standards were adopted at the World Forum for Harmonization of Vehicle Regulations and include protections against electric shock, high temperatures and gas exposure.</td>
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<tr>
<td><strong>Enforced Union-wide Standards</strong></td>
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<tr>
<td>Europe has also developed a range of EV-related standards, as published by the European Committee for Electrotechnical Standardization (Brown et al, 2010). The EEC Directive 91/157 (batteries and accumulators containing certain dangerous substances) regulates the disposal and management of EV batteries and is currently in revision (Brown et al, 2010).</td>
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<tr>
<td>The EU’s Competitiveness Council declared that by mid-2011, EU standards for car-charging interfaces will be finalised to ensure that EVs can be recharged anywhere within the EU, with any model of charger. The Council argued that interoperability between EVs and the charging infrastructure is crucial to winning consumers' acceptance and thus creating a mass market for the new vehicles.</td>
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<tr>
<td><strong>Emission Standards</strong></td>
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<tr>
<td>The European Commission is legislating to force manufacturers to cut their average CO₂ emissions by about one-quarter by 2012.</td>
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<tr>
<td><strong>Exhaust Emission Standards</strong></td>
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<tr>
<td>The European Union (EU) is setting new car fleet emissions targets of about 152 g/mile of CO₂ by 2020.</td>
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<tr>
<td><strong>Ban on petrol cars</strong></td>
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<tr>
<td>In 2009, the Norwegian Finance Minister announce a plan to ban the sales petrol cars by 2015, which would require carmakers to sell only vehicles that ran fully or partly on fuels such as electricity, biofuels or hydrogen although the plan as not progressed since 2009.</td>
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<tr>
<td>In Firenze, Italy, cars running on petrol cannot enter the centre of the city, but electric cars can.</td>
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<th>Targets - Europe</th>
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<tr>
<td><strong>European Union Targets</strong></td>
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<td>The European Union have set their 2012 exhaust emission goals at 130 grams per kilometre. Beyond this, the European Union is proposing even tougher standards of 80 g/km by 2020 and 60 g/km by 2025. To achieve this, the majority of the European light duty vehicle fleet will have to be almost entirely electrically (including hydrogen fuel cells) or carbon-neutral biofuel-powered. The EU is proposing serious fines for non-compliance, e.g. fining carmakers €95</td>
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(US$120) per gram per model over the limit (EV World, 2010).

**Country Targets**
1. The Spanish government aims to have 1 million electric vehicles in Spain by 2014
2. France announces in October 2009 it will commit $2.2 billion to put 2 million electric cars on the road by 2020
3. Ireland announced a goal to have 10% of all cars running on electricity by 2020.

**City Targets**
London expects to take the lead as the world’s most electric vehicle friendly city with plans to have 25,000 charge stations available by 2015 and 1 million electric vehicles in its fleet by 2015.

**Information - Europe**
Undetermined at this time.

**Facilitation – Europe**

**Partnerships with Industry**
In Portugal, the government has linked up with car-makers to further the use of electric cars by investing in setting up electric charging stations across the country and in raising awareness of the vehicle's benefits.

Britain is trying to persuade Japanese automaker Nissan to make its Sunderland plant the European base for its new electric car the Leaf.

In Denmark, the Island of Bornholm is striving to replace all petrol cars with EVs as part of the EDISON project. By using smart grid technology, an all-electric fleet will use V2G to allow more turbines to be built and provide up to 50% of the island's supply. The project is run in partnership with Danish Energy Association and Siemens and Dong.

**Regional Partnership**
France and Germany have started a cross-border electric vehicle pilot project in the Strasbourg-Stuttgart region.

**Research**
The European Green Cars Initiative supports the development of sustainable forms of road transport, including research on high density batteries, electric engines, and smart electricity grids and their vehicle interfaces.

**Incentives - Europe**

**Summary of Country Incentives for Consumers**
National and regional governments of 15 EU member states have introduced incentives for buying electric vehicles, consisting of tax reductions and exemptions, as well as bonus payments for the buyers of electric vehicles, e.g. all western European countries with the exception of Italy and Luxembourg.
Incentives - Europe

**Fuel Consumption Tax Reductions or Exemptions**
- **Austria**: levies a fuel consumption tax on the first registration of a passenger car, equal to 2% of the purchase price multiplied by a factor of the fuel consumption in litres. EVs are exempt from Austrian fuel consumption tax.

**Monthly Vehicle Tax Exemption**
- Austria: EVs are exempt from a monthly vehicle tax.

**Road Tax Exemption**
- EVs and other alternate fuel vehicles are exempt from road tax in the **Czech Republic**
- **Germany**: EVs are exempt from annual circulation tax for five years
- **Sweden**: Hybrid vehicles with CO\(_2\) emissions of 120 g/km or less and electric cars with an energy consumption of 37 kWh per 100 km or less are exempt from the annual circulation tax for a period of five years from the date of their first registration.

**Registration Tax Reduction or Exemptions**
- EVs weighing less than 2,000 kg are exempt from the **Danish** registration tax, which is based on the price of the vehicle. This tax is calculated as follows: \((105\% \times \text{vehicle price up to DKK 79,000}) + (180\% \times \text{vehicle price above DKK 79,000})\); *e.g. a car costing DKK 80,000 would have a registration tax of DKK 144,000*
- **Greece**: EVs and hybrids are exempt from registration tax
- **Portugal**: Electric vehicles are totally exempt from the registration tax. Hybrid vehicles benefit from a 50% reduction of the registration tax. This registration tax is based on engine capacity and CO\(_2\) emissions
- **The Netherlands**: Hybrid vehicles with an energy efficiency label A benefit from a maximum reduction of EUR $6,400 of the registration tax. For hybrid vehicles with a B label, the maximum bonus is EUR $3,200. The registration tax is based on price and CO\(_2\) emissions
- **Ireland**: Electric and hybrid vehicles benefit from a reduction of maximum EUR $2,500 of the registration tax.

**Income Tax Reduction**
- **Belgium**: Personal income tax reduction of 30%, maximum of EUR $9,000.
- **Spain**: 9 regional governments grant tax incentives of EUR $6,000 for EVs and EUR $2,000 for hybrids. One regional government offers incentives up to 70% of the investment.

**Company Car Taxation**
- For electric and hybrid vehicles in Sweden, the taxable value of the car for the purposes of company car taxation is reduced by 40% compared with the corresponding or comparable petrol or diesel car. The maximum reduction of the taxable value is SEK 16,000 per year
- **UK**: electric cars receive a five-year exemption from company car tax and electric vans a five-year exemption from the van benefit charge (£3,000).

**Congestion Tax Exemption**
- London provides EVs with exemptions for the congestion charge (savings of £8 a day). The congestion tax in London imposes costs on conventional fossil-fuelled vehicles but does not...
**Incentives - Europe**

entirely remove them as an option.

**Emission Rewards**
In Austria, cars emitting less than 120g/km receive a maximum bonus of EUR $300, and alternate fuel vehicles have an additional maximum bonus of EUR $500.

**Emission Tax Reduction or Exemption**
Seventeen EU Member States levy CO₂-related taxes on passenger cars.

- In Romania, electric and hybrid cars are exempt from the special pollution tax, which is based on CO₂ emissions, cylinder capacity and compliance with Euro emission standards
- **UK**: Electric vehicles are exempt from the annual circulation tax. This tax is based on CO₂ emissions and all vehicles with emissions below 100 g/km are exempt from it.

**Bonuses and Discounts**

- **Cyprus**: A premium of EUR $700 is granted for the purchase of an EV
- **France**: under a “bonus-malus” system, a premium is granted for the purchase of a new car when its CO₂ emissions are 125 g/km or less. The maximum premium is EUR $5,000 for vehicles emitting 60 g/km or less. The incentive cannot exceed 20% of the vehicle purchase price. Hybrid vehicles emitting 135 g/km or less receive an incentive of EUR $2,000
- **UK**: As from 2011, purchasers of electric vehicles (including plug-in hybrids) will receive a discount of 25% of the vehicle’s list price up to a maximum of £5,000. The government has set aside £230m for this incentive programme.

**Free Parking**
- EV drivers receive free parking in downtown Copenhagen and London (savings on average of £25 per day).

**Infrastructure**
In 2010, London’s mayor confirmed up to £17 million (US$26 million) for electric vehicle infrastructure.

**EU Incentives for Manufacturers**
EU policy allows manufacturers to gain “super credits” for the sale of electric vehicles. However, critiques point out that by allowing each EV sold to be counted 3.5 times as part of a manufacturer’s calculations towards their overall fleet limit, allows them to sell 3.5 high emission cars with no effect on emissions targets.

**Pricing - Europe**
Seventeen EU Member States levy CO₂-related taxes on passenger cars.

**Coordination - Europe**
The European Parliament resolution on EVs supports the Competitiveness Council’s invite for the Commission to set up an action plan for clean and energy efficient vehicles and calls on the
The European Commission published their strategy for clean and energy-efficient vehicles in April 2010.

In 2009, the Spanish Minister for Industry announced the Movele Plan (Electric Mobility Plan), which subsidises the purchase of EVs up to 15-20% of its cost and for the immediate purchase of 2,000 electric cars and installation of 500 charge points for the municipalities of Seville, Barcelona and Madrid (IDAE, 2008).
Appendix 4. Summary of Japanese Policies

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<th>Regulation - Japan</th>
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<td>Enforced National Standards</td>
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<tr>
<td>Japan, being the world’s predominant producer of hybrids and many battery technologies, has established the Japanese Electric Vehicle Association, which in turn publishes a series of standards specific to the EV (Brown et al., 2010).</td>
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<th>Targets - Japan</th>
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<tr>
<td>Vehicle targets for general market</td>
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<td>In 1991, the goal was then to have 200,000 BEVs on the road by the year 2000 (MITI, 1990 in Ahman 2004). In 1997, the inclusion of HEVs can be seen in the light of the new CO₂ reduction target for 2008–2012 under the Kyoto protocol.</td>
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Japan maintains their commitment to develop the EV market. The Ministry of Economy, Trade and Industry (METI) issued a goal, in 2010, for EVs to account for 50% of new car sales by 2020.

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<th>Vehicle targets for government fleets</th>
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<tr>
<td>Under the Environment Conservation Programme (1995), the Government announced that it would replace 10% of their public vehicles with low emission vehicles (LEVs) by 2000 in a procurement programme.</td>
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In 2001, the central Government took a new initiative to replace all vehicles used by government with LEVs by the year 2004. Of these vehicles, 60% was expected to be HEVs, according to the Environmental Ministry, which corresponds to roughly 4000 vehicles (EVAAP, 2002 in Ahman, 2004). The rest will mainly be replaced by compressed natural gas vehicles and some BEVs.

<table>
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<th>Prefecture goals</th>
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<tr>
<td>Kanagawa prefecture has a plan to ensure that there are 3000 EVs on local streets by fiscal year 2014 and aiming for 1,000 charging outlets of 100 and 200 volts within the prefecture by 2014.</td>
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<th>Information - Japan</th>
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<td>Undetermined at this time.</td>
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<th>Facilitation - Japan</th>
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<td>Research and Development</td>
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<td>The Ministry of International Trade and Industry (MITI) has promoted BEVs since 1971, launching a 5-year government-industry R&amp;D programme. The MITI also funded company R&amp;D between 1978 and 1996 supporting leasing projects (MITI, 1990 in Ahman, 2004). The idea of the MITI’s R&amp;D support is to create R&amp;D consortia including companies from different sectors and universities by adding a limited amount of government funding and strategic guidance in line with the “National Vision”. The idea is to induce more company funded R&amp;D by this way and to stimulate inter-firm technology spill over (Ahman, 2004). In 1995 BEV field</td>
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tests were launched by the MITI but these were replaced by several BEV-ITS programs starting in 1998, demonstrating the feasibility of BEVs in combination with Intelligent Transportation Systems (ITS). Research is also conducted under the same programme on lithium batteries (through the organisation LIBES) since 1992. In 1997 the MITI initiated the Advanced Clean Energy (ACE) vehicle programme. This is an R&D programme extending from 1997 to 2003 with the objective of developing different high-energy efficient hybrid vehicles.

The MITI funded programmes are usually long (>10 years) and divided into three phases starting with (i) R&D on basic technologies, then (ii) demonstration and prototype, and the last phase (iii) production and early deployment. All three phases receive government funding. However, companies and other interested parties are expected to increase their share of responsibility as the technology comes closer to commercialisation. Generally, the MITI funds company research on technologies that are in the public interest with 100% funding at the early stage of development and between 50 and 67% as the technology comes closer to commercialisation. Standardisation projects receive 100% funding from the MITI (Daito, 2002 in Ahman, 2004).

**Market Trials**

Tsukuba City Solar-to-Electric Test is a partnership between government and auto manufacturers to test cars that rely on solar electricity for the batteries, which will be rapidly-charged at local FamilyMart stores.

**Support for Infrastructure**

The ECO-Station Project was initiated in 1993 with the aim of establishing 2000 fuelling stations for clean-energy vehicles by the year 2000. Approximately 50% of these were intended as BPEV charging stations (Hayashi et al., 1994 in Ahman, 2004). Quick-charging facilities for BPEVs with night-time energy storage systems for load levelling were targeted (Ahman, 2004).

To facilitate the government’s goals for EV sales, the government is spending US $135 million in 2010 alone to build country-wide charging stations (Loveday, 2010a).

In mid-2010, Japan’s METI began financing a three-month trial of a battery-swapping scheme for EVs in partnership with Better Place and EV taxis in Tokyo, in 2010 (O’Connor, 2010), the first of its kind. The project includes the recharging and rapid battery replacement stations developed by Better Place (Ben-Gedalyahu, 2010).

**Battery facilitation**

The MITI identified the battery as the crucial part in need of government support for the successful introduction of BPEVs onto the market. The lithium battery project (LIBES) that started in 1992 presented in 2001 a BPEV battery that meets most of the criteria set and that is now ready for field tests.

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**Incentives - Japan**


**Summary**

From 1978 to 1996 the Japanese Electric Vehicle Association (JEVA) conducted various leasing and purchasing incentive programmes. These programmes included relief from commodity and acquisition tax in 1975 and 1976, leasing services directed towards private enterprises, the collection of field data for further research, feasibility studies and subsidies to local governments to buy BPEVs (Iguchi, 1992 in Ahman, 2004). In 1996, a BPEV Purchasing Incentive Programme was introduced which replaced existing leasing and purchasing incentive programmes that had been in operation since 1976. Fifty percent of the extra incremental vehicle price was subsidized (Ahman, 2004). In 1998, the programme was integrated into the Clean-Energy Vehicles Introduction Programme (CEV) together with other promotional programmes for methanol-fuelled vehicles and CNG vehicles. Previous programmes for the promotion of CEVs had been running since 1993 and primarily targeted infrastructure issues for BPEVs, CNG and methanol-fuelled vehicles. The Clean Energy Vehicle Programme of 1998 had an improved budget and included for the first time HEVs.

**National Subsidies**

When it comes to direct market support, the Ministry of International Trade and Industry (MITI) takes half of the financial risk of a new technology, e.g. subsidizes half of the extra cost compared to a comparable ICEV (Daito, 2002 in Ahman, 2004).

**Local funding**

Local governments and other agencies can supply further funding within their area jurisdiction (Ahman, 2004). One of the most generous prefectures in Japan is Kanagawa, which in March 2009 started providing a subsidy of about half that of the national government (i.e., ¥300,000). This includes a range of measures to promote EVs, such as subsidies, lower taxes, plus reduced parking fees and expressway tolls. The electric charging infrastructure will be further developed with “quick chargers” installed in 30 locations by 2010, aiming for 1,000 charging outlets of 100 and 200 volts within the prefecture by 2014.

**Pricing - Japan**

Undetermined at this time.

**Coordination - Japan**

**National Plan**

MITI established a basic market expansion and commercialisation plan for BPEVs in 1976 and has since updated and reissued in 1983 and 1991 (Ahman, 2004). The comprehensive plan sought to coordinate government agencies, companies and municipalities in their efforts to expand BPEV and HEVs development. Barriers were identified and the relevant actors were called upon to make efforts to remove these barriers through technical development, amending laws and taxes, creating new standards and building a fuel infrastructure (Iguchi, 1992 in Ahman, 2004). Market expansion plans present comprehensive plans for the development and commercialisation of the targeted technologies. The plans include all the relevant actors identified by the MITI, including industry, universities, local governments and government agencies. The aim of these plans is to induce a common vision among the actors and coordinate industry and government policy. The efforts and the process of the relevant actors are coordinated and supervised by the MITI. Little formal pressure exists according to the MITI and
the plan rests on a vision in which all actors, including the Government, are expected to play their part (Watanabe, 2000 in Ahman, 2004).

The market expansion plans should also be seen in the context of the visions of the MITI for Japanese industry, including strategic goals such as future competitiveness, as well as energy and technology independence (Ahman, 2004). In 1996, the perceived market outlook was thus bleak. Based on these reactions the marketing efforts for BPEVs shifted from R&D on advanced batteries to finding applications (e.g. rental, sharing or ITS systems) where a state-of-the-art BPEV can function rather than trying to force the technology to produce a vehicle with features comparable to those of conventional vehicles.

**Regional/local government plans**

Larger prefecture governments (Tokyo, Chiba, Kanagawa, Osaka and Hyogo) laid out aggressive market plans in 1993 for introducing BPEVs in order to reduce NOx emissions in accordance with the Auto-NOx Law. The plans included a total number of almost 100,000 BPEVs and 170,000 LPGVs in the year 2000 (JEVA, 1998 in Ahman, 2004).
## Appendix 5. Summary of Chinese Policies

### Regulation - China

#### Enforced National Standards

China appears to largely rely on adaptations of SAE standards for the EV (Brown et al, 2010).

#### Qualification of Manufactures

In 2007, China's National Development and Reform Commission implemented the Administration Rules on Access to the Production of New Energy Vehicles, which was administered by the New Energy Vehicle Expert Committee, in order to significantly streamline the development of new energy vehicles. The New Energy Production Entrance Guidelines regulate the qualifications of enterprises that are going to produce new energy vehicles or components and requires that these enterprises to obtain the production permission from the National Development and Reform Commission.

### Targets - China

#### Federal Target for Industry

The government has made known its intent to position its auto manufacturing sector to be the largest global producer of EVs (Bradsher, 2009 in Brown et al., 2010), with a goal of producing half a million EVs by 2011 (Hensley et al., 2009).

### Information - China

Undetermined at this time.

### Facilitation - China

#### Infrastructure

China’s State Grid is building charging facilities in at least three of the country’s largest cities by 2011.

#### Research and Development

Under the, China Auto Industry Rejuvenation Plan, the central government will appropriate RMB 10 billion in a special fund to support technical innovation and renovation and development of new energy vehicles and its spare parts by enterprises in the next three years.

#### Pilot Projects

In 2001, the Ministry of Science and Technology of China initiated the Electric Automotive Projects. Enterprises, institutes and universities are all involved in key projects under the support of local governments. In 2009, the Ministry of Finance and the Ministry of Science and Technology jointly issued the "Circular on Carrying out Energy Conservation and New Energy Vehicle Demonstration and Popularizing Pilot Programs" which listed thirteen China cities as pilot cities for demonstration and popularization of energy conservation and new energy vehicle development. The central government offered one-time fixed-amount subsidies for the purchase of energy conservation and new energy vehicles in the pilot cities. It was reported that each hybrid vehicle would receive up to RMB 50,000 in subsidies and electric cars would receive RMB 60,000. The circular required the local governments to allocate funding for other
relevant expenses including the construction of auxiliary facilities and the maintenance of the new energy vehicles to guarantee the smooth operation of the pilot programs.

In order to promote the development and commercialization of new energy vehicles in China, the Chinese Olympic Committee decided to use new energy buses and cars serving for Beijing Olympic Games. The government purchase bid required 1,000 new energy vehicles.

### Incentives - China

#### National subsidies
Under the China Auto Industry Rejuvenation Plan, subsidies from the central budget will be appropriated to support the spread of new energy vehicles in large size and medium size cities. China government will cover $8,800 of the cost of each EV purchased by large-city governments and taxi fleets.

#### Local Government Discounts
Some cities in China are offering incentives for residents to buy cars locally. Shenzhen is offering the discounts up to 60 percent of the car's value (RMB 50,000 when buying a hybrid vehicle and RMB 60,000 if the vehicle is all-electric.) Chongqing city is also offering the incentives of RMB 36,000 in subsidies and an exemption in the bridge tolls of RMB 7,000 when buying a locally-made Jiexun hybrid MPV, which costs RMB 140,000. The Shanghai municipal government plans to offer up to a 20 percent one-time subsidy to people who buy the new energy vehicles from 2010 through the end of 2011. The maximum compensation for a passenger car will be RMB 60,000. The hybrid electric cars in China now can cost more than RMB 250,000. (Zhang, et al., 2009).

#### Road Tax Exemptions
The buyers of hybrids, all-electric or fuel-cell vehicles will also get a break on some road taxes.

#### Registration incentives
Other promotional measures include easier registration.

### Pricing - China

#### National Car Consumption Tax Rate
China's Auto Industry Rejuvenation Plan ensures the Car Consumption tax rate of 3.0L to 4.0L vehicles will increase to 25% from 15%, and the tax rate of 4.0L and above vehicles will rise to 40% from the current 20% (Zhang, et al., 2009). In contrast, the consumption tax rate on passenger vehicles with an engine size of 1 litre or lower will fall to 1% from the current 3%.

#### National Fuel Taxation Scheme
China’s Auto Industry Rejuvenation Plan also raises the petrol tax from the current RMB 0.2 yuan per litre to RMB one yuan and the diesel tax from RMB 0.1 yuan per litre to RMB 0.8 yuan.
### Coordination - China

**International Standards Coordination**

The US and China have launched a joint US–China Electric Vehicles Initiative because joint standards development for EV products and testing was identified as key to facilitating rapid deployment of EVs in both countries (Anon, 2009 in Brown et al., 2010).

**National Guidelines**

“New Energy Vehicle Production Entrance Guideline” has been issued and actioned since 2007. Aside from setting regulations, it defines and classifies new energy vehicles and ensures that all new energy vehicle manufacturers and products are included in the “Announcement of Vehicle Manufacturers and Products” (Chen et al., 2008).
Appendix 6. SUMMARY OF AUSTRALIAN INITIATIVES

6.1 Australian Green Car Innovation Fund

Part of the Commonwealth’s *New Car Plan for a Greener Future*, the $1.3 billion Australian Green Car Innovation Fund (GCIF) provides grants on a competitive basis to eligible Australian companies, research organisations, industry associations and individual researchers to help improve the environmental performance of the automotive industry. Specifically, the program seeks to “enhance the research and development and commercialisation of Australian technologies that significantly reduce fuel consumption and/or greenhouse gas emissions of passenger motor vehicles”. Under the scheme, $1 of government funding is provided for every $3 of the applicant’s. The program is set to run for ten years.

**Eligibility**

Applicants fall under one of two funding streams. Stream A is limited to motor vehicle producers (MVPs) registered under the Australian Government’s *Automotive Competitiveness and Investment Scheme* (ACIS) or the *Automotive Transformation Scheme* (ATS). MVPs can apply for $5 million (minimum). However the cumulative total of grants must not exceed $300 million. Stream B is open to non-tax exempt companies incorporated under the *Corporations Act 2001*, or consortia led by a non-tax exempt company. Stream B applicants may apply for grants of $100,000 or more, with the cumulative total of grants not exceeding $100 million.

Successful applicant of both streams must meet the following key assessment criteria and demonstrate an ability to fund the costs of the project not covered by the grant, in addition to access to and rights in all intellectual property necessary to carry out and commercialise the project:

- Extent of the reduction in passenger motor vehicle fuel consumption and/or greenhouse gas emissions
- Technical merit, extent and calibre of innovation
- Capacity and capability of applicant to undertake the project
- Commercialisation potential

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• How the project will contribute to a sustainable and competitive Australian automotive industry and the broader Australian economy.\textsuperscript{58}

Projects can be up to three years in duration (four years in special circumstances). Table 0-1 summarises the eligible activities available for funding. Expenditure may include costs of labour, contractors, plant and equipment (capped at 50\%), acquisition and adaptation of new leading-edge technologies (capped at 10\%), prototypes, IP protection (capped at 10\%), collaborative costs and other eligible miscellaneous costs.\textsuperscript{59}

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and development</td>
<td>Systematic, investigative activities that involve innovation, technology transfer into Australia or technical risk and result in new knowledge or new improved materials, products, devices or services.</td>
</tr>
<tr>
<td>Proof of concept</td>
<td>Work necessary to establish the commercial and technical viability of a product or process.</td>
</tr>
<tr>
<td>Early stage commercialisation activities</td>
<td>Includes related product development (work undertaken to improve the performance or reduce the cost of a product, process or service) and IP protection and management.</td>
</tr>
<tr>
<td>Pre-production development activities</td>
<td>Late stage activity generally focused on enabling a new product of process to progress to production phase, e.g. retooling, technology development, product testing, and demonstration and process improvement. Does not include mass production of components.</td>
</tr>
</tbody>
</table>

### 6.2 Smart Grid, Smart City

Smart or intelligent grids provide the missing link between battery charging infrastructure and EVs, and are therefore crucial to realising an EV and distributed energy future. Smart grids have several advantages over conventional electricity grids. Using advanced communication, sensing and metering infrastructure, smart grids can better manage energy loads and identify infrastructure that requires maintenance. This enables more efficient energy distribution and vastly improves the reliability of the electricity network. With this ‘intelligent’ infrastructure, smart grids are thus inherently capable of greatly improving the efficiency and reliability of the electricity network by “identifying and resolving faults, better managing voltage and identifying infrastructure that requires maintenance”.\textsuperscript{61} By design, smart grids can also aid consumers

\textsuperscript{58}Department of Innovation, Industry, Science and Research, 2008, \textit{Green Car Innovation Fund: Fact Sheet}, Canberra, accessed 15 September 2010


\textsuperscript{60}Department of Innovation, Industry, Science and Research, 2008, \textit{Green Car Innovation Fund: Expenditure Guidelines}, Canberra

manage their electricity consumption and, critical to the deployment of EV technology, “enable the use of energy efficient smart appliances that can be programmed to run on off-peak power”\(^\text{62}\). As such, smart grids have the potential to coordinate the storage of renewable energy in EVs.

In July 2010, the Australian government announced $100m in funding for the demonstration of Australia’s first commercial-scale smart grid in the Newcastle area, with parts of the trial also to be conducted in Newington, Sydney CBD, Ku-ring-gai and Scone to reflect urban, suburban and rural conditions and diverse network, geographic, climatic and customer characteristics\(^\text{63}\). The ‘Smart Grid, Smart City’ project will be managed by the Department of Climate Change and Energy Efficiency and aims to gather “robust information about the costs and benefits of smart grids”\(^\text{64}\). The objective of the program is to demonstrate the potential applications and benefits of smart grids, and provide baseline data on network efficiency improvements and behaviour change implicated with having more information about individual energy consumption. For example, households and businesses participating in the trial will be able to monitor real time electricity use through in-house displays.

The project will also involve an extensive EV trial, with two fleets of 10 to 20 vehicles to be trialled in the Hunter region and by Sydney City Council. The consortium led by EnergyAustralia which successfully won the Smart Grid Smart City bid includes EV recharging infrastructure provider Better Place Australia, who will supply a trial EV recharging network as part of the project\(^\text{65}\). The trial will explore V2G technology, including central systems to manage large power loads when many EVs are charging simultaneously.

Targeted rollouts of smart grid and EV infrastructure such as in the Smart Grid Smart City project will allow the community, the private sector and governments to “gain early experience with charge station infrastructure at a level of penetration required to encourage significant adoption in a specific area. This will inform larger future rollouts”.


6.3 Solar Cities

The Solar Cities program is a nine year $75 million Federal Government initiative aimed at providing opportunities for realising the potential of solar power, energy efficiency, intelligent grid and electric vehicle technology\(^{66}\). The critical objectives of the program are to:

- Demonstrate the economic and environmental impacts of integrating cost-reflective pricing with the uptake of solar, energy efficiency and smart metering technologies; and
- Identify and address barriers to distributed solar generation and electricity demand management.\(^{67}\)

Set to run until mid 2013, the program is administered by the Department of Climate Change and Energy Efficiency, in partnership with local and state governments, industry, business and local communities.\(^{68}\) Funding has been allocated on competitive grounds. Between August 2006 and August 2008 the seven cities of Adelaide, Alice Springs, Blacktown, Central Victoria, Moreland, Perth and Townsville were awarded funding under the scheme.

As the program involves the trailing of smart metering and development of distributed energy infrastructure, its outcomes are inherently related to the future advancement and deployment of EV technology. In the case of Adelaide, these technologies have been directly combined to deliver Australia’s first solar powered electric bus service (See Box 1).


Box 1. Tindo – Adelaide’s solar powered community bus

Jointly funded by the Federal Government under its Solar Cities program and Adelaide City Council, a 50 kW solar photovoltaic (PV) system was installed on the roof of Adelaide Central Bus Station. The PV system provides enough electricity to charge ‘Tindo’ – Adelaide’s electric community bus launched in 2007. Tindo has a range of 200km between recharging under typical urban conditions, is air-conditioned and has a capacity of 40 people. An additional fast charge station located outside the Central Bus Station provides a range of 1km per one minute of charge.

The bus draws on solar energy stored in its 11 Zebra sodium/nickel chloride battery modules and recycles wasted energy using regenerative braking to save up to 30% of energy consumption. In its first year of operation, Tindo has saved over 14,000 litres of diesel and 70,000 kg of CO₂-e.

(Source: Adelaide City Council 2010).  

6.4 Victorian EV trial

In its State Transport Plan the Victorian Department of Transport outlined its support for increasing the use of low emission vehicles and advancing EV technology. The Department has now committed itself to the following projects:

1. A passenger EV trial
2. A scoping study into EV standards for Australia
3. A hybrid-electric bus trial
4. Complementary levers to facilitate the transition to EVs.

The State’s broad policy and program objectives are outlined in Appendix Table 1 and the above initiatives discussed in more detail below.
### Appendix Table 1. Policy Initiatives of the Victorian Government

<table>
<thead>
<tr>
<th>Government policy</th>
<th>Program Objective</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourage the use of low emission vehicles</td>
<td>Identify market development barriers/enablers</td>
<td>Quantify life-cycle costs of a range of alternative fuel vehicle technologies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identify and facilitate development of investment risk mitigation measures for end-users (insurance, service network, disposal mechanisms)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Address information barriers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identify regulatory barriers to EV adoption</td>
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<tr>
<td></td>
<td></td>
<td>Identify early adopter market segment and run pilot programs in these areas, inc. tailored communication strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identify linkages with existing transport infrastructure to address technological deficiencies</td>
</tr>
<tr>
<td>Design industry development framework for low emission outcomes</td>
<td>Analyse energy supply infrastructure and design renewable energy supply mechanisms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apply life-cycle analysis to conventional transport and EV technologies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identify end of life disposal mechanisms for batteries and other unique EV components</td>
<td></td>
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<tr>
<td>Address barriers to industry development; and incentivise local manufacture and/or assembly of EV technologies</td>
<td>Identify and address any regulatory impediments</td>
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<tr>
<td></td>
<td>Create a narrative for Vic around EV technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design a tailored/targeted communications campaign</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Survey the range of applicable industry assistance mechanisms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Create info provision mechanism to inform local industry forward investment decisions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Include local content clause in procurement activities</td>
<td></td>
</tr>
<tr>
<td>Promote innovation, economic development and employment</td>
<td>Create EV technology (vehicles, infrastructure) innovation opportunities</td>
<td>Build linkages between existing Vic Govt program participants and researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Investigate local industry program participation opportunities</td>
</tr>
<tr>
<td>Design policy measures to promote EV adoption</td>
<td>Analyse 'sweet-spots' and design tailored policy measures to promote uptake</td>
<td></td>
</tr>
<tr>
<td>Promote energy security for</td>
<td>Understand the effects, risks and opportunities of</td>
<td>Benchmark the range of recharge infrastructure models</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Investigate regulatory, metering implications for grid energy exchange by entities, individuals</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Government policy</th>
<th>Program Objective</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victoria</td>
<td>various recharge infrastructure models on existing energy supply infrastructure</td>
<td>Investigate linkages into VRET/MRET and Green Power</td>
</tr>
<tr>
<td>Information provision and collection of data</td>
<td>Ensure market settings are most appropriate to allow collection of data</td>
<td>Develop better-informed drive cycle for Australian conditions, based on driving in actual conditions</td>
</tr>
</tbody>
</table>

**Passenger EV trial**

The Victorian EV trial is the largest of its kinds currently underway in Australia, with $5 million over a five year period being allocated by the Victorian Government[^69]. The overall objective of the program is to “inform an easier and quicker transition to an environment where Victorians increasingly opt for clean electric vehicles”. The trial will provide an opportunity to collect ‘real world’ information on the use of EVs in Victorian conditions, including identifying:

- The market for EVs over time
- How the use of EVs affects driver behaviour
- Impacts of recharging, vehicle performance and efficiency, and
- Implications for electricity consumption and demand management, greenhouse gas emissions and air pollution[^70].

The trial aims to replicate real world conditions as closely as possible and in doing so “will assess how a range of electricity providers will interact, reflecting the variety of providers likely to develop in the market”. Participants include:

- Members of the public
- Private and government fleets
- Recharge infrastructure providers
- Electricity suppliers, distributors and retailer, and
- Technology providers to assist in data collection.

The Department of Transport will work with the Royal Automotive Club of Victoria (RACV) to find 180 households to take part in the trial, with successful applicants being able to trial the car for 3 months. Around 60 EVs (Mitsubishi i-MiEVs) will be rotated between different households and various private and government fleets.

**EV Standards Scoping Study**

In 2009 the Victorian Government commissioned Standards Australia to undertake a scoping study for EV standards in Australia\(^\text{72}\). The findings of this study are outlined in Appendix Table 2. The 2010 final report recommends three priority areas for standards development in relation in EVs in Australia:

- Development of standards for aftermarket conversions to ensure EVs deliver the same level of safety as original equipment manufacturer (OEM)
- Development of standards for Level 2 recharging to ensure interoperability
- Standards relating to the provision of vehicle user and GHG information (overcoming market unfamiliarity, e.g. vehicle labelling and standardised information of relative energy efficiency and GHG performance)\(^\text{73}\).

The study also found a “complete absence of a national industry dialogue addressing the key issues associated with the introduction of electric vehicles in Australia”. Consequently, the report also recommends the need to maintain a comprehensive stakeholder dialogue that had been initiated by the scoping study\(^\text{74}\).

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\(^{73}\)http://www.standards.org.au/LinkClick.aspx?fileticket=32lAegzIvLk%%3d&tabid=94&mid=423

\(^{74}\)http://www.standards.org.au/LinkClick.aspx?fileticket=32lAegzIvLk%%3d&tabid=94&mid=423
Appendix Table 2. Key strategic insights from the study, Electric Vehicle Standards in Australia, 2010\textsuperscript{75}

<table>
<thead>
<tr>
<th>Issue</th>
<th>Finding</th>
</tr>
</thead>
</table>
| EV transition timeframe              | Lack of consensus with respect to the likely development (nature and timing) of the domestic EV market. Development of the domestic EV market is likely to occur in three distinct stages:  
Stage 1 – Market infancy  
Stage 2 – Market establishment  
Stage 3 – Market maturation       |
| Standards approach                   | Industry characterised by a high level of technology dynamism, suggesting the use of performance-based standards over prescriptive standards |
| Cost                                 | High cost of new OEM electric vehicles will likely create market demand for aftermarket vehicles in the medium to short term |
| Emissions standards                  | GHG performance will vary according to the GHG intensity of the electricity supplied to the vehicle |
| Recharging and the national electricity grid | Provision of feed-in (V2G) capability for recharging infrastructure may create challenges and opportunities for the operation of the national electricity grid |
| Home-based recharging                | May create challenges, most notably associated with the operation of level II recharge systems |
| International standardisation        | Need to harmonise Australian vehicle standards with international vehicle standards |
| Consumer operability                 | New and unfamiliar operating paradigm for road users, the vehicle repair industry and rescue authorities |

**HEV Bus Trial**

The Victorian Government is currently trialling two hybrid-electric bus technologies. The $750,000 project involves two HEV buses, using in series and parallel technologies\textsuperscript{76}. The purpose of the project is to identify barriers to investment in each technology and gain a better understanding of vehicle performance under Victorian road conditions. A similar trial is soon to begin in Queensland.

**Complementing policies and programs**

The Department of Transport has identified the following policies and programs designed to directly or indirectly facilitate the uptake of EV technology in Victoria.

\textsuperscript{75} http://www.standards.org.au/LinkClick.aspx?fileticket=32IAegzIvLk%3d&tabid=94&mid=423

Appendix Table 3. Levers to facilitate the uptake of EVs in Victoria

<table>
<thead>
<tr>
<th>Domain</th>
<th>Example policies, projects and initiatives as at March 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land-use planning</td>
<td>Melbourne@5million, Victorian Transport Plan&lt;br&gt;Identifies overarching land-use, transport network and employment planning strategies to allow for systematic and targeted design of EV roll out.&lt;br&gt;Precinct Structure Plans (PSPs)&lt;br&gt;Promote sustainable transport options including EVs, among other ‘liveability’ objectives.&lt;br&gt;Zero Emission Neighbourhood program&lt;br&gt;Grant program targeted at sustainable residential development including consideration of EV technology options.</td>
</tr>
<tr>
<td>Transport infrastructure and vehicles</td>
<td>Transport Integration Act 2010&lt;br&gt;Integration of sustainability objectives into transport planning, thereby encouraging preference of sustainable transport options such as EVs.&lt;br&gt;Smart Meter Roll-out&lt;br&gt;State-wide roll-out of smart meters. Commenced in September 2009 and to be completed by the end of 2013. Smart meters are a key enabling technology for EV adoption.&lt;br&gt;IPv6 Virtual Test Bed&lt;br&gt;An IPv6 Virtual Test Bed for use by EV technology suppliers in verifying their latest ICT systems showcases leading edge product features and establish advanced data management systems for development projects.&lt;br&gt;Government Fleet Target&lt;br&gt;Strategy to reduce GHG burden of government fleet. Preference for low emission vehicles.</td>
</tr>
<tr>
<td>Industry support/research</td>
<td>Automotive Australia 2020 vision project&lt;br&gt;Technology roadmap for the local automotive industry. EV technology has been identified as a priority and an action plan will be delivered in 2010.&lt;br&gt;Victorian EV Trial / Nissan EV Memorandum of Understanding (MoU)&lt;br&gt;Memorandum of Understanding between Victorian Government and Nissan to work collaboratively on investigating options for EV roll-out in Victoria (e.g. Victorian EV Trial)</td>
</tr>
<tr>
<td>Education and training</td>
<td>Victorian EV Trial&lt;br&gt;$5 million/5 year trial to provide baseline data on the potential EV market, consumer behaviour, vehicle performance and market responses.&lt;br&gt;Hybrid-electric Bus Trial&lt;br&gt;Launched in June 2009, involves the trialling of two hybrid-electric buses</td>
</tr>
</tbody>
</table>

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6.5 Queensland EV Roadmap and Green Taxis Scheme

Queensland EV Roadmap

The Queensland EV Roadmap was developed by the Queensland State Government to “develop an EV policy position for Queensland to take advantage of the potential of EVs in helping reduce GHG emissions”. Other key drivers include:

- Planning for EV infrastructure needs
- Supporting the transition to EV technology
- Energy security
- Help coordinate EV standardisation and regulations across government.

The Roadmap also notes that without policy and infrastructural preparation, uncontrolled EV charging “could adversely affect the existing electricity grid, electricity pricing and household energy use”\(^78\). In this light, the Queensland Government has identified five key policy ‘work areas’ to aid the transition to an EV future (summarised in the Table below). The Roadmap also identifies opportunities for public consultation and discussion, and current initiatives to further research and policy development concerning EV technology, such as

- The EV20 Accord, an international accord instigated by the Climate Group to fast-track the development and deployment of EVs
- Ergon Energy EV technology pilot program, and
- The Queensland Sustainable Energy Innovation Fund.

The Roadmap gives industry and the community a clear indication of the Queensland Government’s position on EVs and provides a useful model for other jurisdictions.

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<table>
<thead>
<tr>
<th>Domain</th>
<th>Example policies, projects and initiatives as at March 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>Example policies, projects and initiatives as at March 2010</td>
</tr>
<tr>
<td></td>
<td>(series and parallel technologies) to collect data on vehicle performance and identify barriers to investment in these technologies. Swinburne Short-course on EVs First Australian publicly accredited short course developed for retrofitting conventional vehicles to EVs and for servicing EVs; begun in 2010. National Standards for EVs 2010 scoping study to investigate regulatory barriers and compliance issues associated with EV adoption.</td>
</tr>
</tbody>
</table>

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Appendix Table 4. Summary of policy work areas identified by the Queensland EV Roadmap

<table>
<thead>
<tr>
<th>Policy work area</th>
<th>Actions</th>
</tr>
</thead>
</table>
| Environmental and resource impacts    | Reduce GHG emissions from passenger transport  
Ensure domestic energy security and preparing for the use of alternatives to fossil fuels  
Minimise environmental impacts of EV development, e.g. battery recycling |
| Recharging and electricity grid impacts | Support electricity needs (reducing peak demand vulnerability)  
Increase network efficiency  
Maintain electricity affordability  
Encourage deployment of intelligent systems to save costs over time |
| Standards, planning and regulation    | Maintain competitiveness by offering consumers high quality, safe new vehicles  
Ensure motorist safety through education about the functionality of new technologies  
Prepare for new infrastructure systems through policy and in relation to land-use planning |
| Consumer uptake and behaviour change  | Develop strategies and policies to meet the needs of motorist behaviour  
Understand motivations for EV adoption and about decisions made about vehicle purchases  
Raise awareness about benefits of alternative (cleaner) motoring (inc. EVs) |
| Industry development and growth       | Promote growth in sectors where enterprise strengths exist  
Encourage growth in clean technology and renewable energy market sectors |

Queensland 15% Preference Rule for Green Taxis

The Queensland Government has introduced a 15% preference rule for taxis with a greenhouse gas rating of 8 or above under the Commonwealth’s Green Vehicle Guide (GVG) rating scheme. Insofar preference has been for HEVs, primarily the Toyota Prius. The scheme was introduced to target greenhouse gas emission reduction in the Queensland taxi fleet. On average, a Queensland taxi will travel approximately nine times the distance travelled by the average motorist⁷⁹. The industry is responsible for 100,000 tonnes of GHG emissions. Box 2 outlines how the scheme will work.

In the future, and with the appropriate level of infrastructure, green taxi policies such as the Queensland scheme could be extended to include EVs.

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Box 2. 15% mark-up on tender bids (Queensland DOT, 2009)

Preference is given by applying a 15% mark-up on their tender bid, giving an advantage in the tender process, e.g. Person A has a Green Vehicle and bids $280,000 while Person B has a Regular Vehicle and bids $300,000. A bid from Person A would attract a 15% mark-up on their bid which would increase their bid by $42,000 to $322,000, thereby making Person A the highest bidder.

6.6 ACT Green Vehicles Duty Scheme

The Green Vehicles Duty Scheme does not target HEVs, PHEVs or EVs specifically, but provides an incentive for consumers to purchase environmentally leading edge vehicles by subsidising stamp duty costs of low emission models. It also works to discourage poor performing vehicles by increasing stamp duty costs on these vehicles. New light vehicles are given a Green Vehicle Rating of A, B, C or D, based on the vehicle’s carbon dioxide and air pollution emissions. This data is currently collated by the Commonwealth Government’s for its Green Vehicle Guide (GVG)—an online, regularly updated registry that allows consumers to compare the environmental performance of vehicles.

Vehicles with an A rating attract nil stamp duty. Purchasers of a Toyota Prius for example, will save around $1122. This category includes current HEVs on the market, including the Prius, Toyota Camry Hybrid, and the Lexus RX450h. However, it does not include all HEVs with the Honda Civic hybrid falling within category B. Category B vehicles receive a reduced subsidy. Stamp duty on category C vehicles generally remains unchanged, whilst purchasers of category D vehicles face higher stamp duty costs than what was incurred prior to the scheme.

The ACT Government argues incentivising better environmentally performing vehicles via stamp duty is more appropriate at influencing consumer behaviour than a registration concession because the scheme targets people at the time of vehicle purchase and does not adversely impact on lower income earners more likely to own second hand, poorer performing vehicles.

Being tied to the Commonwealth’s GVG, the scheme is also flexible in that it can accommodate PHEVs and EVs as they become available. The GVG ratings are reviewed periodically. There is also potential for the scheme to complement plans by EV services provider, Better Place Australia, to begin installing EV recharging infrastructure in Canberra in 2011.

81 ACT Government, 2008,
6.7 UWA Australia Renewable Energy Vehicle (REV) Trial

Launched in March 2010 this 2 year trial will see 10 converted ICEVs-EVs incorporated into the fleets of government agencies and key industry stakeholders\(^\text{83}\). Funding is primarily provided by the University of Western Australia (UWA) and the West Australian Department of Planning and Infrastructure. Cash and in-kind support has also been sought from industry sponsors\(^\text{84}\).

The Perth EV trial is being conducted in conjunction with the first Australian fast-charging network trial. A consortium led by UWA and Murdoch University received $229,000 in funding under the Australian Research Council’s Linkage grant scheme. The project will involve the installation of 10 fast-recharge stations around Perth, with data collection via wireless 3G broadband and from vehicles via black-box recorders\(^\text{85}\).

The REV Trial includes a comprehensive research program, the objectives of which are outlined in Box 3 below.

Box 3. WA EV Trial Objectives

- Test realistic fleet usability, given distance, behavioural and range factors
- Full comparative economic study electric vehicles versus fuel vehicles
- Testing of the first integrated recharging network (smart grid/V2G elements) – generate alternative infrastructure scenarios based on usability and economic analysis
- Testing to what extent distributed high capacity recharging required and the potential grid impacts thereof
- Provide data points for initial findings on energy policy, transport regulation and vehicle taxation

(Source: http://www.co2smart.com.au/)

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\(^{83}\) http://www.co2smart.com.au/

\(^{84}\) http://therevproject.com/

\(^{85}\) http://www.news.uwa.edu.au/200911021834/media-statements/perth-get-electric-vehicle-charging-stations-2010
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