27th October 2011

John Pierce
Chairman
Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

Dear Mr Pierce,

Review of Energy Market Arrangements for Electric and Natural Gas Vehicles

SP AusNet welcomes the opportunity to make this submission in response to the AEMC's Approach Paper.

The primary focus of this submission is on electric vehicles, which offer the prospect of an economically efficient and low emission alternative to the internal combustion engine. SP AusNet has been active in research into electric vehicles through its participation in the Electric Driveways program with CSIRO and the operation of a fleet of Plug-in Hybrid Electric Vehicles.

Economic efficiency

As the Approach Paper observes, the AEMC's role is to examine the role of energy markets *"to support the adoption of EVs and NGVs in the most economically efficient manner."* Critically, the Approach Paper appears to reject the promulgation of transport policy through inappropriate distortions to the energy market. SP AusNet's submission is that when EVs are connected to the electricity network they are no different in principle to a load or, if Vehicle to Grid (V2G) technology is enabled, an embedded generator. As such, special treatment should be avoided as far as possible.

This paper then largely mimics SP AusNet's earlier submission to the Power of Choice review in that:

- Price signals will be the most effective facilitator of efficient and orderly uptake of EVs;
- It is imperative that network service providers are not restricted from actively participating in this emerging market as they are well placed to assess, optimise and manage risks and opportunities arising from EV integration; and
- Rules implementing stronger incentive frameworks for demand side participation should be revisited as it is questionable whether current incentives provide sufficient rewards for pursuing, for example, controlled charging or V2G that generates benefits to society as a whole through reduced carbon emissions or lower built capacity.

Likely uptake

Attachment 1 to this submission collates some perspectives on factors affecting the likely uptake of EVs in Victoria, their impacts and detailed market arrangements, with

Attachment 2 canvasing NGVs. SP AusNet concurs with the AEMC that there are inherent uncertainties in forecasting potential EV penetration rates. While a scenario based approach has considerable merit, the AEMC may also wish to consider factors that could lead to a sudden acceleration in the uptake of electric vehicles (for example, a step change in transport policy or taxation, economic collapse in a target EV market leading to 'dumping' in Australia or an oil price shock uncorrelated with electricity prices) such as has been seen for PV solar. In particular, this will inform the AEMC on the risk that a surprisingly high uptake, inadequately anticipated in a five yearly price setting process, will run the risk of either commercial harm to NSPs or a diminution of service to other customers.

Network impacts

If EV uptake were substantial, our preliminary analysis indicates that it would likely necessitate substantial augmentation to existing networks to meet system peak, as might be expected, but also potentially to manage increased asset utilisation. In this regard, it is worth noting that the average expected EV charger would take the peak capacity of an average household from 3kW to 6.6kW. Nonetheless, the existing regulatory framework could be expected to manage this investment, subject to economic network planning and effective price signals to facilitate efficient consumer decisions.

Research indicates that many consumers have questions about EVs. It would be unfortunate if unjustified barriers to entry or energy market complexity uneconomically inhibited their uptake. Rather, the primary lessons from rapid air conditioning and PV solar penetration are the importance of accurate price signals (including simple, reliable consumer information on operating costs at the point of sale), ensuring that NSPs have effective processes and delivery capability to respond to consumer demand and maintaining satisfactory service and prices to other customers.

If you wish to discuss this submission further, please contact Tom Hallam, Manager Economic Regulation on 9695 6617.

Yours sincerely,

Alistair Parker
Director Regulation and Network Strategy

Attachment 1 Uptake and impacts of electric vehicles

Potential Uptake of EVs

The most significant factor in the initial uptake for EV's will be the availability of compelling EV products in each car market class.

Immediately after this will be the cost benefit to the customer compared to Internal Combustion Engines (ICE) taking into account:

- Relative capital and depreciation costs, recognizing that lease arrangements may predominate with EVs in an effort to mitigate high battery costs;
- Relative fueling costs, taking into account the potential for V2G; and
- Perhaps less importantly initially, relative maintenance costs which may well be lower for EVs compared to ICE vehicles due to simpler engine and transmission components.

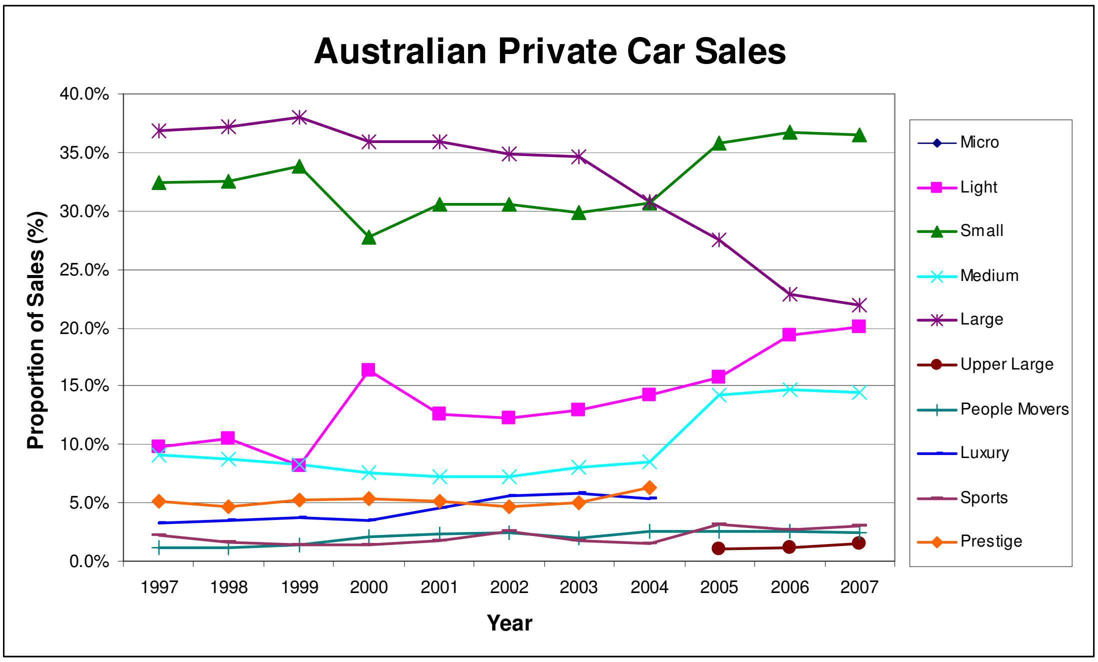
Vehicle Availability

Vehicle availability and model variation will play important roles in the uptake of EVs.

A report delivered to the NSW environment and climate change department in September 2009 estimated that the automotive industry is set to launch 30 new EVs and plug-in hybrid vehicles (PHEVs) in the next three-to-five years[1].

A global economic downturn overseas may also make Australia a more attractive market in the short to medium term and with less than 2% of world car sales a small change in focus could have a large impact on Australia.

EVs will enter the market at the lower size range, the most active part of the market[2], which may further facilitate uptake.



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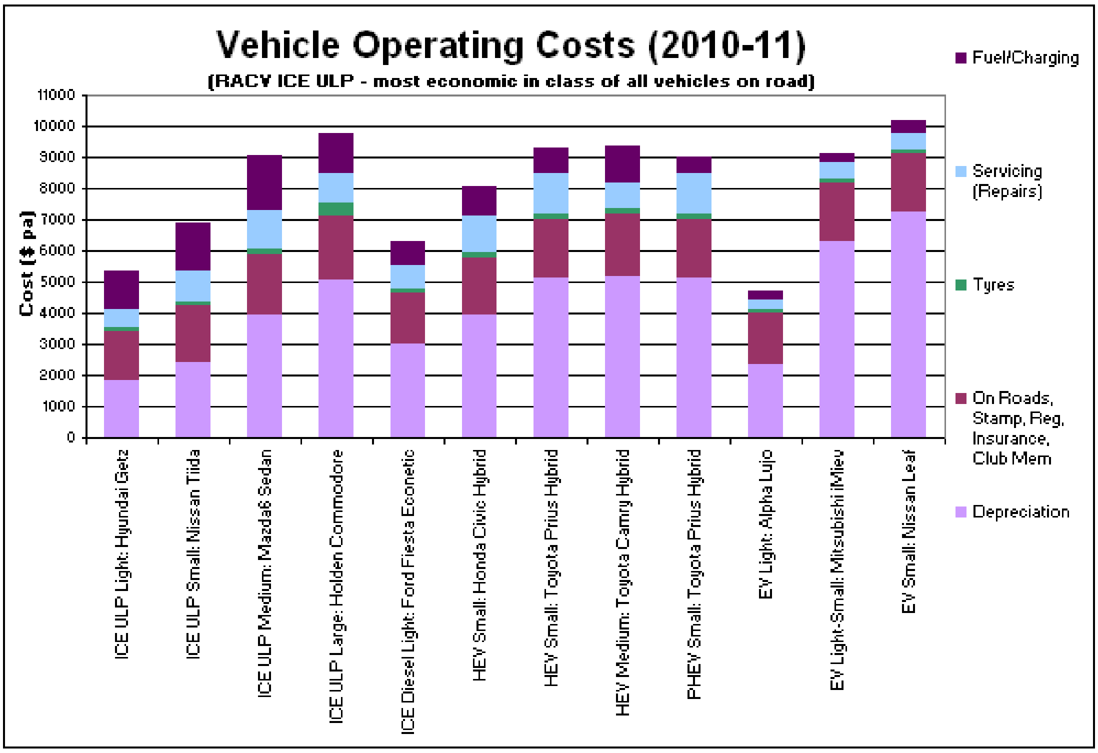
[1] RON HAMMERTON,1 February 2010, http://www.goauto.com.au/mellor/mellor.nsf/story2/0629B6F54CF9F876CA2576BC00823678

[2] http://www.arrb.com.au/admin/file/content13/c6/ARR371_New%20car%20fleet_fuel.pdf

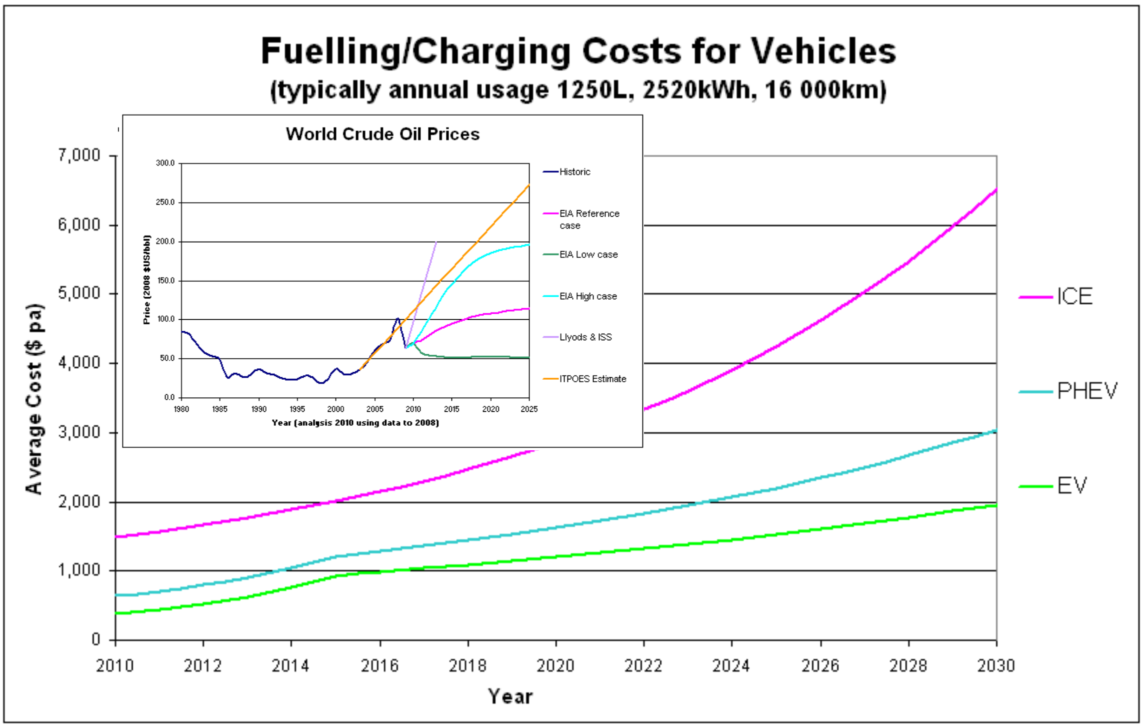
Cost Drivers

An SP AusNet comparison of existing vehicles and proposed costs of EVs based on the Royal Automobile Club of Victoria (RACV) methodology is provided below. Currently, battery costs contribute to high depreciation costs on the vehicles making them less attractive overall but this may improve over time as battery prices reduce, notwithstanding the potential impact on consumer confidence on resale value.

The Alpha Lujo (due Sept11) is typical of the claims of many new entrants with a very competitive initial price, however, there is a lack of delivery. If one of these new entrants did deliver at their proposed prices then this could have a significant impact on the small passenger vehicle market segment.



When considering just the fuelling/charging costs, the EV already represents the most attractive option and this is likely to continue into the future as oil prices increase, regardless of expected increases in electricity prices. Over time it would be expected that there would be a de-coupling of oil and electricity markets as renewable technologies supply greater generation capacity and oil scarcity increases. It should be noted that based on the current cost for refuelling, the price signal will need to be set at an appropriate level in the electricity network to minimise the impact on peak demand.



(Similar EIA high case assumption, AGL Fuel Poverty elect retail costs to 2015 (15%pa) then 5% pa increase)

Customer Demographics and preferences

In terms of customer demographics Australia represents a unique market which is likely to facilitate the uptake of EVs. A high proportion of Australian families have two cars and a garage, factors which are likely to encourage the uptake of EVs as a second vehicle. This may favour the adoption of EVs, at a lower overall cost, to be preferentially selected over a Plug-in Hybrid EV (PHEV), higher cost due to two systems incorporated in the vehicle. Studies from around the world currently favour the preferential uptake of PHEVs over EVs which would represent lower energy requirements from the grid.

Range anxiety may result in the EV being the vehicle which is used to make short range trips most likely the second vehicle used for school runs and the like. This vehicle may also have the greater share of car travel for a family as it does multiple shorter trips compared to a vehicle, which may be parked for most the day for day workers.

A prime requirement will be the effective education of consumers as initial negative experiences will deter further deployment. Some of the information is fairly complex and will need clear and transparent communication including:

- Network and site limitations if present
- Interaction with grid and home
- Safety issues
- Options for financing / leasing / purchasing
- PV implications
- Carbon emissions and associated taxation
- Charging options
- V2G options as developed

The EV sellers and specialised EV model operators will need to be responsible for providing consumers with the appropriate information upon which they can make an informed decision. There appears to be some misinformation already present in the market place, which needs to be corrected with EV sellers and others becoming better educated.

Transport policy

Government policy will play an important role in how and when EVs are taken up as illustrated overseas. There are rafts of different policies adopted to encourage EV uptake. These include:

- Transit lanes (green number plates) (Norway/Canada)
- Rebates and tax breaks (15 of 27 EU)
- Parking fee, Toll fee exemptions (Norway)
- Subsidies to automakers (50,000 cars) (China 2012)
- Infrastructure support (Denmark/Israel)
- Stimulus package – research batteries etc (US)
- Clean Vehicle Rebate Project (California/Germany)
- NSW government fleet purchases (5% by 2015)

In terms of stimulating demand for EVs, Norway probably has the most successful set of policies, leading to 5% of car sales being EV/PHEV. However, some policies in Norway may have generated a perverse outcome, increasing their overall car fleet and hence energy consumption. Adoption of policies such as Transit Lane Priorities have facilitated the adoption in Norway however this may have removed people from public transport and into new vehicles rather than changed the composition of the existing vehicle population by replacing existing vehicles with EVs.

Policy in Australia will need to consider the carbon impact in particular as adoption of EVs could potentially worsen our global carbon footprint by transferring a fuel load from a potentially more efficient system (ICE) to a more polluting technology (coal fired power stations). There have been diverse outcomes from the range of modelling work performed to estimate this impact.

The Garnaut Review modelling shows that based on the average emissions intensity of the Australian grids, an electric car today would generate about 30% more emissions than a similar petrol-fuelled car. The increase would be even higher (at 36%) if the car drew its power from the coal-dependent supplies of Victoria. However, to illustrate the importance of the electricity source, and the opportunity for long-term emissions reductions, the modelling also indicates that drawing on the power supplies of Tasmania (predominantly hydroelectricity) an electric car would generate about 85% fewer emissions than the equivalent petrol car[3].

However, subsequent work proposes a different scenario with EVs achieving a much better outcome in terms of emission reductions. RARE Consulting estimated that per kilometre travelled, a mid-sized electric vehicle requires 0.246 kWh of electricity to be generated. At the average emissions intensity of 860 g CO_2-e/kWh, this equates to 212 g CO_2-e per kilometre travelled, or about 20% less than an average Australian petrol-fuelled passenger car[4].

Another study[5] has indicated that a 24% emission reduction per vehicle is possible when recharged from the current national average grid and assuming a green power

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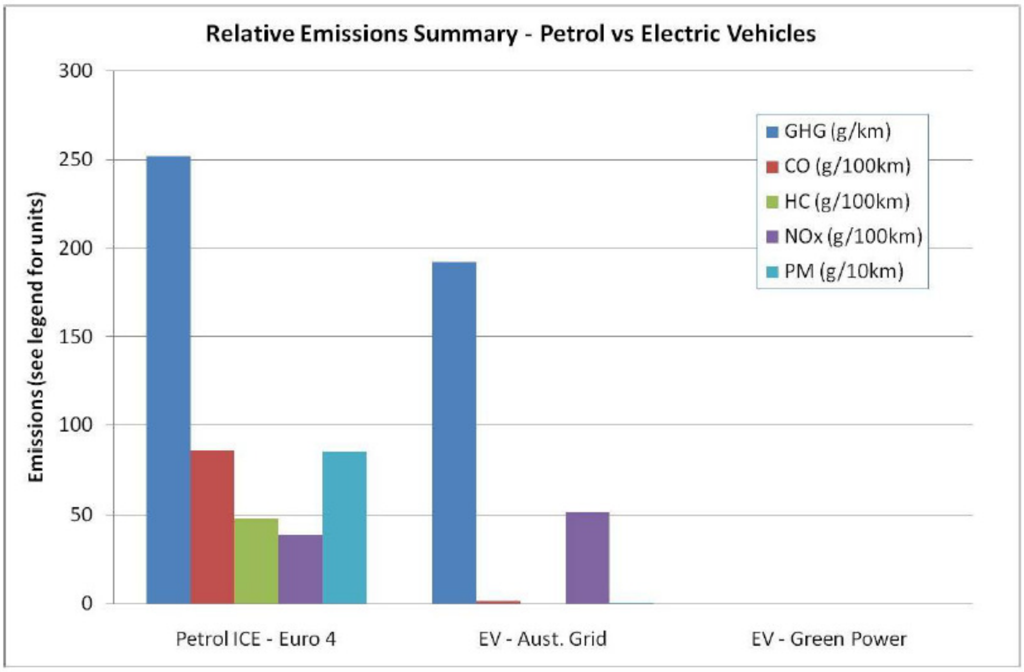
[3] Electric Vehicle Standards in Australia – A Scoping Study, Version: 1.0, September 2009

[4] http://www.rareconsulting.com.au/blog/post/life-cycle-analysis-what-lies-behind-the-modelling/

[5] Environmental Attributes of Electric Vehicles in Australia, Dr Andrew Simpson, Curtin University Sustainability Policy (CUSP) Institute – July 2009

source this increases to 100%. However, it is clear with the 100% outcome for the green scenario that this study lacks some of the carbon impacts included in the prior assessment. This study did also include an assessment of other contaminants which could be reduced with the uptake of EVs.



Network impacts of EVs

Potential network costs associated with EVs include the following:

- Network Augmentation driven by
  - Insufficient network capacity to supply significant penetration of EV loads,
  - Increased peak demand due to uncontrolled charging
  - Increased reliability or quality of supply events due to network constraints
  - Mitigation of network instability and increasing line losses due to voltage instability from EV loads
- Development of EV charge control systems to mitigate network constraints
- Administration - ensure safe connection of EV charging installations to grid
- Increasing complexity in the planning and operation of distribution networks
- Increased generation resources to supply EV loads
- Incremental generation cost increases due to increased peak demand
- Development of new infrastructure support including dedicated circuits, charge points, battery swap stations with associated new installers requiring additional safety and protection standards
- Customer installation costs to rectify existing circuitry, install dedicated circuits, enable increased speed of charging requirements, enable Vehicle to

Grid (V2G) options, enable home supply (off-grid) options, rectify safety issues

- Public/Commercial infrastructure to enable charging support

Potential energy market benefits associated with EVs include the following:

- Home power supply support (off-grid) as EV has a battery (or group of batteries) during grid outages for one or more houses
- Facilitate the incorporation of renewables
- Reduce peak demands and hence augmentation and incremental generation costs, however this may be limited given the majority of Australian network peaks occur in the late afternoon when substantial numbers of cars are in transit or arriving home in a depleted state
- Supply support in constrained areas of the network and hence moderate augmentation costs
- VAR support on the network (with appropriate inverter)
- Potential minimization of transmission losses (Direct Current (DC) charging) by neighboring generation sources

Potential consumer benefits associated with EVs include the following:

- Cheaper vehicle operating costs for owners
- Vehicular performance improvement – greater torque
- Lifestyle enhancement due to more convenient charging of PHEV/EVs at residential electrical outlets
- Owner status symbol / prestige / green image
- Moderate local pollution both noise and ICE vehicle emissions (Note majority of vehicle noise is from tyres). The quality of emissions from power stations are more controlled than those of ICE vehicles hence contaminants other than carbon are likely to be lower for EVs.

It is clear from the above list that only consumers can place an economic value on these benefits and as such transparent energy price signals will be critical for efficient uptake.

Network planning

The existing network has been planned based on historical average customer usage with few disruptive technologies such as EVs included. This has been progressive over time and hence different areas of the network will have different maximum load tolerances with more recent areas sized for higher loads such as air conditioners.

Currently a new individual premise has a deemed contract arrangement of a maximum of 40Amp (9.6kVA). An EV load may be around 3.6kW, or more for larger vehicles, compared with a rated maximum dwelling load of 9.6kW. In Victoria, the network is traditionally designed to accommodate a diversified demand of 3kVA and is not built to facilitate simultaneous 40Amp loads at every house.

EV penetration as low as 5% for some areas may require significant augmentation to the network. Many rural single-phase and SWER substations are of small capacity such as 10kVA with a typical SWER circuit capacity of 100kVA but sometimes less. Hence, rural customers and in particular those customers supplied by the SWER networks would need to be made aware that EVs are not a technology that they could adopt without significant costs to upgrade their supply or installation of alternative charging such as PV.

Network constraints will also play a part in the adoption of vehicles as increasing penetration levels would require heavy augmentation of the distribution network and these costs will ultimately be borne by customers. With charging capacities of 3-4kW per vehicle there are significant sections of the existing network that would not cope for example underground Low Voltage (LV) circuits in an urban subdivision which are also likely to experience higher EV uptake due to short journeys and multiple charging locations compared with rural areas where IC engines in farm machinery and farm produce transport are likely to prevail for longer periods. Also in rural areas where many Single Wire Earth Return (SWER) subs are 5kVA or less and would require significant costs to upgrade.

Domestic EV Charging

The expectation is that vehicles will require a 15Amp circuit as a minimum for charging whereas standard circuits in Australia are only 10Amps. If a vehicle was supplied to charge at 10Amps this could result in increased circuit overloads and protection operations, customer service calls or at worst, fires, as it competes with existing appliances on a circuit. Significant customer education would be required to ensure safe operation if this type of vehicle charging was made available.

To install a 15Amp circuit (such as for an electric stove, air conditioner or spas) a house owner will require an Registered Electrical Contractor (REC) who will need to make an assessment on whether the dwelling service line rating can support this service level. If appropriate the electrician will install the additional circuit ensuring safety requirements are met and will notify Energy Safe Victoria (ESV) of the installation to obtain a safety certificate.

There will be a choice as to whether an EV is metered (eg a sub-meter at an extra cost) separately to the overall dwelling consumption. If the EV is subject to the same tariffing arrangements as the dwelling then there would be little value unless the vehicle was participating in specific lease arrangements or V2G activities, which many of the first wave of vehicles may not be capable. If a meter is required this may become an issue if the resident moves house or the owner is a renter.

Tariffing arrangements should be independent of the type of load but provide a strong enough signal to incent a consumer to move discretionary loads (eg EVs) to low price periods. In all likelihood the tariff will need to be dynamic to ensure an on-going response over time, across seasons and across different network segments.

The simplest charging control would be a timer on the socket in which the EV is plugged. An alternative solution could be a home Energy Management System to control charging of an EV. Possibly the best solution would be enabling an EV as a Demand Response Enabling Device (DRED), with communications through a smart meter (a two-element meter can also provide a separate reading of consumption for the EV and control), allowing distributors to manage charging as they are best placed to understand the loads on their networks and the best time to enable charging. However, the current mistrust of distributors may limit uptake of this option.

Distributors have the right to interrupt customers' installations which do not comply with the Distribution Code requirements providing they follow the required process of notifying the tenant. However, currently this process does not provide adequate response times required due to the relative load size that an EV represents. This will create significant tensions with the customer with further complications due to the difficulty in technically assessing the source of power quality issues eg at the place of EV residence or on the adjacent network..

Alternatively price signals could be transmitted through the smart meter to enable a consumer response. The consumer then decides and programs charging to suit their personal circumstances. For example a full charge is required at certain times of certain days as EV usage varies with day, week and season, at other times when EV usage is lower the consumer may agree to enter the ancillary market.

It should be considered that EVs are not treated as a special case but as one of a number of devices which can be treated as discretionary loads with a consistent approach to improve energy management performance.

Customer/Operator Obligations

It will be important that owners and other market participants such as integrators understand their obligations and responsibilities involved in bringing EVs onto the grid as both a load and a generator. There will be a number of associated safety issues which will need to be clearly understood. Understanding the interaction with the grid will also require attention as this was a customer issue in relation to solar installations which created customer confusion and angst, increasing customer complaints. EVs have an even greater potential to generate consumer complaints due to the connection requirements, particularly the addition of 15Amp circuits, if required.

Asset Utilisation

It has been proposed that EVs will improve asset utilisation by charging at off peak times, predominantly at night. However, this is a relatively simplistic view given that some networks segments experience peaks at night eg rural networks with electric hot water heating.

Consideration will be required of the impact of increased utilisation on the life of assets, generation sources and maintenance windows which will have resulting cost implications.

Increasing asset utilisation will also result in higher electrical losses in the network, in particular in overhead lines.

Storage effectiveness and V2G charging rates

The effectiveness of EVs as a storage option in a V2G scenario is estimated to range around 70-80%[6, 7] conversion efficiencies. When compared to other storage technologies it is probably midrange of current battery technology efficiencies of around 60% (electrolytic-pump system operational performance) - 90% (Na-S for solar concentrating plants). Ultimately the customer will pay for energy losses in the system (the battery plus line) and hence the impact on customer bills will need to be considered in the adoption of a storage technology and its relative location to generation source and load requirement.

The first priority is to ensure the safe operation of EVs if used in a generation capacity similar to requirements for solar PV generation into the grid. If a fault has caused the failure in a grid then EVs must stop charging into the grid. If EVs are used to support outages in a grid then a process which ensures correct and safe operation will need to be determined for their use in this scenario. This has not been enacted to date with solar and will require more sophisticated infrastructure and process support.

The rate at which a vehicle battery can generate into the grid is likely to be governed by the rate at which it discharges during normal car operation otherwise it may damage the battery and contravene manufacturers' recommended operational guides and void warrantees. This would limit a car capacity to potentially 2kW as a generation source for the grid, a lower rating compared to its charging rate, for around 4-10 hours (depending upon the vehicle). If car manufacturers have a vested

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[6] EV grid-battery-grid efficiency 73%, http://www.iiasa.ac.at/Admin/PUB/Documents/IR-06-025.pdf

[7] Tesla around 80% (86% x 93% additional inverter), http://www.stanford.edu/group/greendorm/participate/cee124/TeslaReading.pdf

interest in the use of their vehicles as storage devices they may enable higher discharge rates to the grids. However, if higher discharge rates are used then battery deterioration will accelerate and less capacity will be available over time.

An important issue for consideration in controlled switching of aggregated loads will be the magnitude of the load at any point in time. Large rises and drops could have a significant impact on network causing outages and equipment damage (1% vehicle penetration in the NEM is the equivalent of either 0.6% (V2G charge back) or 1.2% (EV charging) of existing NEM generation capacity dependent upon available vehicles). Consideration will also need to be given to the impact on pricing in the NEM.

Impact on Demand

Some work has been done on correlating EV penetration levels on network demand. In the UK it is estimated that an increase of about 18% in maximum demand results from every 10% increase in houses with EVs[8]. In the US it is estimated that the addition of one "average" PHEV per household increases peak daily energy usage by about 40% and peak coincident summer demand by about 47%. The average American household has 1.8 vehicles meaning that full market penetration of PHEVs would have even more impact - a 75% increase in energy usage and a 93% increase in peak demand[9]. DONG estimate that 200,000 EVs (10% car sales) by 2020 will require "upgrading" of their complete network to support the extra load (2/3 Melbourne load)[10].

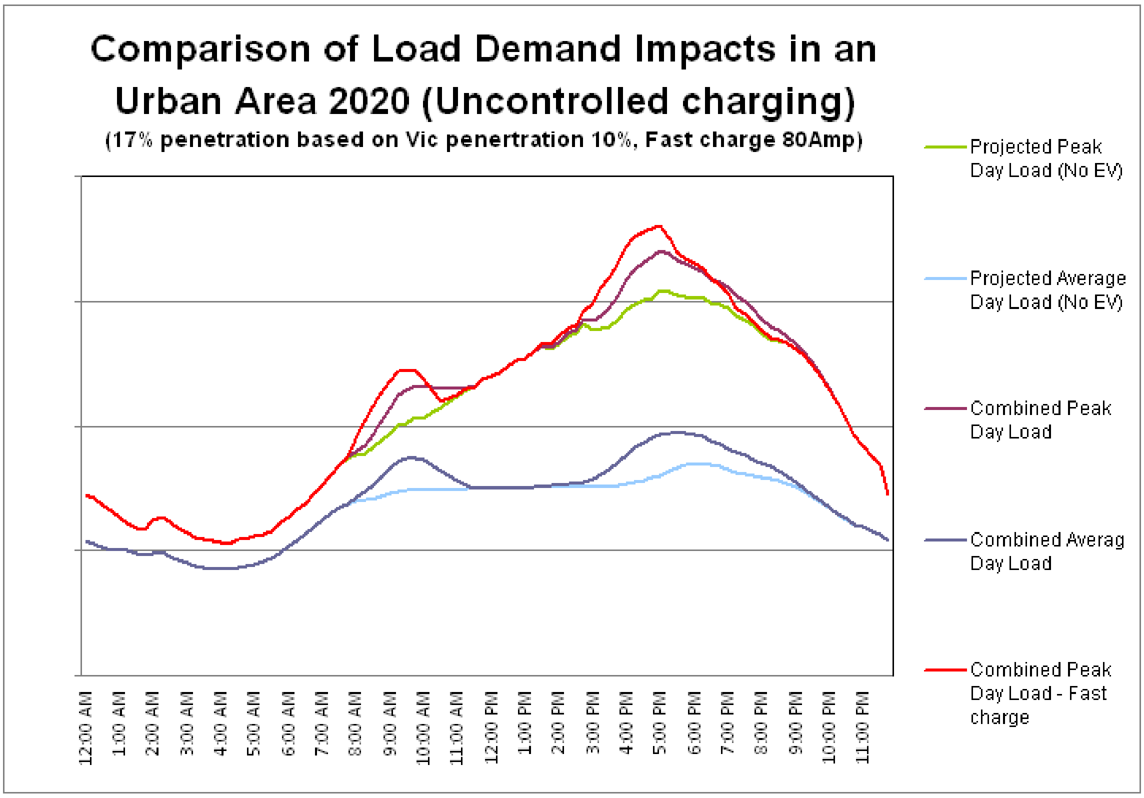
Modeling work performed by SP AusNet has estimated the impact of a 10% electric vehicle penetration in the Victorian car fleet on urban sections of its network. The following graph shows the impact on both a typical maximum demand day and an average demand day for uncontrolled charging.

Assuming urban areas will have a preferential uptake of EVs there will be a concentrating factor hence the effective 17% EV penetration rate used for the urban feeders. The impact for uncontrolled charging shows a 14% and 11% increase on the peak for average and peak days respectively with an 18% increase for fast charging on a peak day. There is some allowance for battery cooling, higher energy requirement, in the fast charging scenario (range of fast charging may be anything between 32Amps to 100's of Amps) however this may be underestimated. The overall load increase for an average day is estimated to be 5% but this may increase as vehicles with greater ranges become available, and range anxiety decreases, facilitating increased usage.

8 090701 Impact of Electric Vehicles on Power Distribution UK

9 090601 PHEV Impact on utility US Bartosz Wojszczyk

10 SPN discussions with DONG



Controlled Loads

One important aspect of controlling the load will be the scheduling of the load. A staggered approach to timing will be required such that there is no step change in the load both coming onto the network and also coming off the network as this has the potential to cause outages and damage assets. There will be a certain amount of randomness on when cars are plugged in however this may not be the most effective outcome. Currently these types of loads (eg off-peak hot water) are controlled on time clocks on a staggered timing arrangement.

Off-peak water services require a separate circuit for control however these systems are currently transitioning to more efficient solar services freeing up the circuit enabling them to assume another function. There is an opportunity to ensure the availability of this circuit for use by EVs as a future control option. Another opportunity is to ensure that all new premises have a two-element meter, which can also provide separate readings of consumption for both elements, to facilitate the uptake of EVs.

Development of commercial business models

A variety of new business models are likely to develop for the EV industry such as aggregators, integrators and on-sellers for both load and generation options. As a generation option, it is considered that individual EV owners participating in the NEM would be cost prohibitive and hence the best solution to promote effective use of this resource would potentially be in the form of an aggregator.

Currently aggregators are required to contract with a retailer to trade in the NEM. This introduces a “middle man” and reduces incentives for the development of an aggregated solution as the aggregator has reduced access to the benefits which their solution can accrue in the wholesale energy market. In addition the retailer will be in direct competition with the aggregated solution as many are “gentailers”. Facilitating aggregators in the market place will increase competition and may place downward pressure on generation prices.

Aggregators (for PV or EV etc) or any third party which operates in a way such that the network is impacted needs to be subject to regulatory scrutiny and obtain a license to operate. SP AusNet advocates that aggregators etc be allowed into the market as valid players subject to rules which ensure the safe operation of the network and protect both EV consumers and other electricity consumer interests. An example where security protections will be paramount is in the remote switching of loads to ensure communication systems are not vulnerable to cyber attack and hence customer loads are not switched without their authority.

While EVs are likely to require a majority of charging at home some charging may be required from other locations and vendors thus requiring a relationship between various parties. Also with the introduction of V2G options this may increase the options to charge and discharge at locations other than a home environment. To provide a competitive market allowing customers to choose their best option the various providers will need to develop systems with a high degree of interoperability. This needs to be secure and allow for smart ticketing and billing, and intelligent back office solutions.

A secure identification method will need to be employed which could be based on a telephone number or card system, in-line with existing operations in other industries. Roaming NMI's have been raised as a possible solution however this is likely to be problematic. NMIs are traditionally used in the electricity network for a set meter in a set location, with specific locational network billing, and hence may not be the most appropriate solution for an EV which could be potentially charged in various locations. An appropriate use of the NMI would be as an identifier for fixed location charging stations.

Other requirements for EV charging could include dual meters for residences and product registration.

EVs as Embedded Networks

One business model for aggregating EV loads / generation has included a multiple embedded network arrangement. SP AusNet has made a couple of submissions in which we have raised issues in relation to embedded networks which are also pertinent to this paper:

- AER Approach to Seller Exemptions
- AER Approach to Electricity Network Service Provider Exemptions

In brief, the points raised in these papers include:

- Emphasis of the importance to distributors of having visibility of embedded networks so that we can deal effectively and efficiently with the special aspects of embedded networks and the parties involved.
- All embedded networks should be registered, and that a self registration process through an internet based facility would be relatively simple to set up and to use and would provide visibility of the whole range of embedded networks.
- We consider that there are already a number of "issues arising in the market which call for greater transparency and accountability" and hence this is not a situation of waiting and seeing what issues arise as they are already being experienced.
- A Specialist External Provider (SEP) appears to be a party who has potentially no interest in the embedded network except to make money from onselling electricity. Whilst SP AusNet has no absolute adverse opinion of the concept of the SEP, it does introduce a party whose drivers may be less "altruistic" towards the customers on the embedded network and potentially less knowledgeable with respect to the specifics of these customers (eg life

support obligations). Hence placing obligations on the SEP for customer service matters may require tighter monitoring and regulation than those placed on the embedded network owner / operator who is generally providing a range of services including rental.

- Embedded networks represent an anomaly in the broader industry practices which require a disproportionate resource allocation by Participants and potentially increased customer risks. Embedded network owner and/or exempt parties should be obliged to provide a level of service and industry interfacing such that these resource impacts and risks are minimised.
- The limit of an embedded network premise is unclear in that onselling is not clearly limited to a single premise or site. This could lead to perverse outcomes where the embedded network extends to a number of properties and involves reticulation along and across public roads, or across "private easements". SP AusNet considers that these types of scenarios are outside the accepted scope of an embedded network and present a number of supply risks.

Embedded networks should only be allowed with no variations to the standard implementation. Currently there are relatively few embedded networks but some of these sites are very complex and difficult to manage and in some cases are managed using manual systems. If these types of sites increase then costs will increase for management of these types of systems. Some current billing systems may also not be able to cope with multiple complex systems.

Metering Arrangement Options

The majority of new participants in EV charging infrastructure (eg Ecotality, ChargePoint) are supplying charging infrastructure which incorporates a meter in their construction. This meter is currently not a market valid meter (no NMI) but can only be used for indicative sub metering purposes. Metering charges would be billed against the site meter which is registered in MSATS as part of the total load for that site. There is an opportunity to incorporate a billable meter, which meets regulatory requirements, in the infrastructure if this is a required feature of the business model for EVs, ie a separate bill option.

Note that if the EV load is subject to the same tariffing arrangements as the site (eg home residence) there will be little value in providing a metering alternative as this will only increase costs. Customers will need to be informed that if an EV (generation and battery storage capabilities) is registered to a premise with a solar installation then the Premium Feed-in-Tariff (FiT) will no longer be applicable. Distributors will need to be notified to make the appropriate adjustments. This will require a new process potentially through the retailer to notify the distributor.

An alternative metering solution is a multiple occupancy (not embedded network) option for separate billing of an EV. This option would enable separation of a PV system, if it exists, and the retention of a Premium Feed-in-Tariff (FiT) if this is in place. However this will incur dual meter service costs as there would be two meters in place of one. The incumbent distributor would be responsible for installation of this meter and would require a site shut down to install.

A multiple occupancy (embedded network) option for separate billing of an EV could be implemented if required. A contract arrangement (new Embedded Network agreement required) would be in place between the site owner and the incumbent distributor while downstream relationships would belong to the site owner (the exempt network service provider) and not the distributor. The site owner would be responsible for all the obligations which fall to the exempt network service provider including data to market systems, etc.

This option will incur a network charge at the parent meter but only a meter charge component at a child meter on the site. Any premium PV FiT tariff to the site would no longer be applicable.

In Victoria the incumbent distributor would be responsible for installation of this child meter (except if >160MWh or type 4 meter,) if it is used in an on-selling (ie market meter with retailer of choice) capacity. Note that it is the site owner who is responsible for the child meter and hence the relationship of supply, and not the distributor. If the (child meter) consumer has an issue with a loss of supply then the site owner needs to be contacted and not the distributor. Also if an EV is used as a generation source then the home owner (the Embedded Network Operator) needs to establish a Generator Connection Agreement with the licensed distributor.

In both cases of multiple occupancy the total site load cannot exceed the agreement which has been made between the distributor and site owner.

Attachment 2 Natural Gas Vehicle Uptake and Impacts

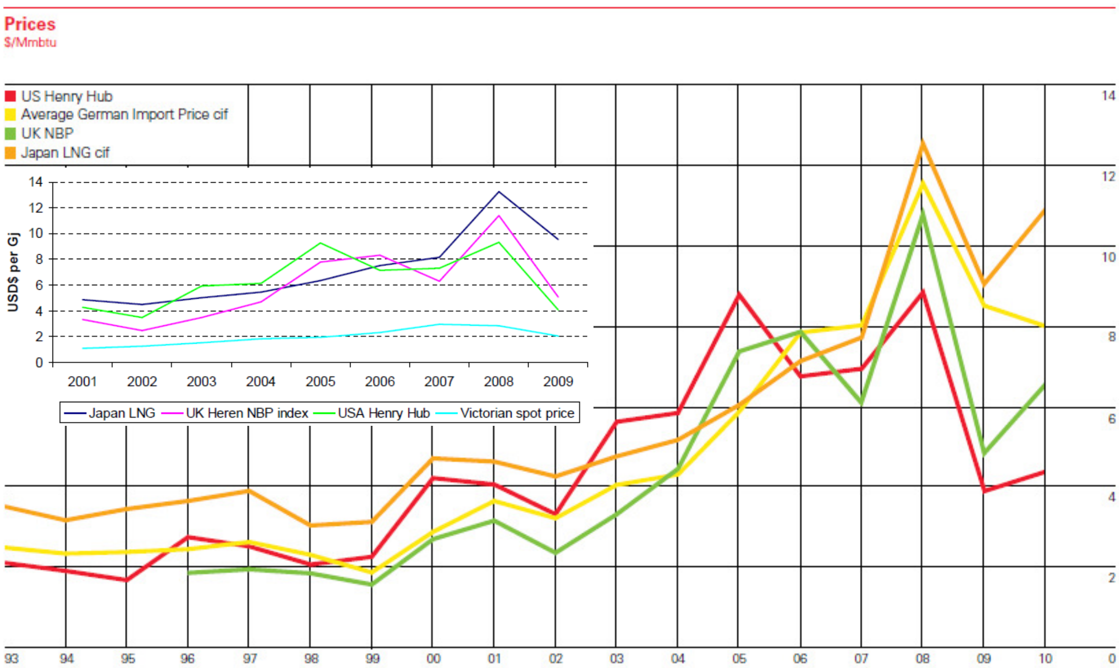
NGV market and uptake

Growth in the NGV market may be challenging in the current environment as Australian gas supplies will soon access the export markets which are trading at significantly higher prices to domestic markets, and will continue to do so due to the rapid growth in this sector.

The current framework facilitates investment and the market is well placed to meet demand over the next 5-10 years regardless of the penetration of Natural Gas Vehicles (NGVs) as it is expected that residential gas charging will not be a viable option at this current time. Hence there is unlikely to be any impact on residential tariffs as expansion of the NGV market is expected to be by major transport companies or NGV refueling stations, to supply multiple users, which would require these entities to provide the capital investment for augmentation of a gas line if required. The NGV market, especially the residential market, is unlikely to develop significantly due to competing export markets, gas peaker generators and safety concerns over NGVs.

There are government subsidies supporting the gas market in WA at present due to the difference in WA and export prices ($3 compared to $11 Japan market[11], Victoria market $2[12]) as shown in the graphs below. When this is removed it is likely that the market will undergo substantial changes such as increased charges for consumers.

World demand for gas is increasing substantially, and hence price also, as this is seen as a "greener" alternative. World natural gas production increased by 7.3% in 2010, the largest increase since 1984. Natural gas consumption increased by 7.4%, with above-average growth in all regions but the Middle East. The US recorded the world's largest gas consumption increment.

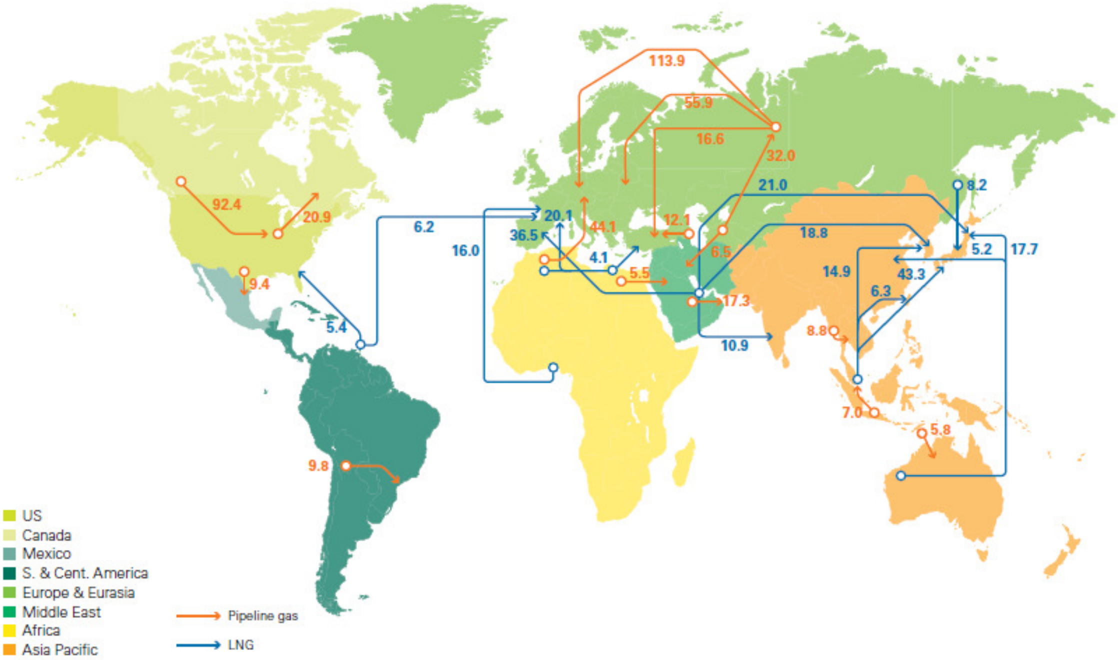


[11] BP Statistical Review of World EnergyJune 2011, bp.com/statisticalreview

[12] Energy shock: confronting higher prices, Australian Industry Group, February 2011

The eastern Australian market will be opened to the export market in 2015 due to the more than $50bn worth of LNG projects under way at Gladstone's Curtis Island, where BG Group and Santos are already in construction for plans to export Queensland's vast onshore Coal Seam Gas (CSG) reserves, and Origin Energy and ConocoPhillips are installing liquefied natural gas production trains[13]. The figure below shows how this links into the Japanese market[14].

Major trade movements
Trade flows worldwide (billion cubic metres)



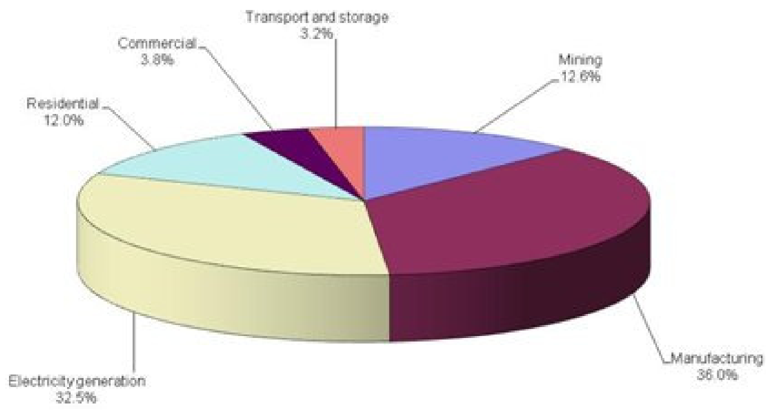
Gas consumption by sector

The figure below shows natural gas consumption by sector (2005-6)[15]. Consumption in the transport sector is mostly driven by commercial applications by buses and trucks.

[13] http://www.theaustralian.com.au/business/breaking-news/origin-energy-conocophillips-sign-off-us20bn-lng-project-in-queensland/story-e6frg90f-1226103429559

[14] BP Statistical Review of World EnergyJune 2011, bp.com/statisticalreview

[15] http://www.aph.gov.au/library/pubs/rp/2007-08/08rp25.htm



Vehicle Cost Comparison

The table below shows the savings of a dual fuel (CNG and diesel) vehicle compared to a diesel vehicle. Currently savings achieved are showing a maximum of 55% if fuel types were swapped but the example shows a 65% substitution which results in fuel savings of around 44%. Currently we are already exposed to world diesel prices hence any significant change which increases the CNG price more than 2.5x (ie 3-5x increase) will reverse the savings opportunities.

CNG Payback Model [16]			
Current Data		**Investment**	
Annual distance	85,000	Conversion	$23,000
Mileage (km/Lit)	4.5	Cylinders	$3,600
Diesel volume (Lit)	18,889	Less Govt Grant* (up to 50%)	$13,300
Diesel price	$1.00	Total investment	$13,300
CNG price	$0.450		

Summary			
CNG Dual Fuel Projections		Annual diesel cost	$18,889

[16] http://www.natural-gas.com.au/business/vehicles.html

Avg substitution rate	65%	Less Dual Fuel cost	$10,587
CNG volume (m ^{3})	12,278	Total savings	$8,302
Diesel volume (Lit)	6,611	Cents/km (Diesel)	$0.222
Cost	$12,136	Cents/km (Dual Fuel)	$0.125
CNG rebate ($0.12617)	$1,549	Payback (yrs)	1.60
Total Dual Fuel cost	$10,587	Payback (km)	136,174

* For more details please see 'Government Grants ' section

Overseas Examples

Global numbers of natural gas-powered vehicles are increasing by 17.8 per cent per year[17]. The largest users include Iran and Pakistan with more than two million natural gas vehicles (NGVs) on their roads.

CNG vehicles are common in South America, with a 35% share of the worldwide NGV fleet, where these vehicles are mainly used as taxicabs in main cities of Argentina and Brazil. Normally, standard gasoline vehicles are retrofitted in specialized shops, which involve installing the gas cylinder in the trunk and the CNG injection system and electronics. Almost 90% of NGVs have bi-fuel engines, allowing these vehicles to run on either gasoline or CNG. As of 2009 Argentina had 1,807,186 NGV's with 1,851 refueling stations across the nation, or 15% of all vehicles; and Brazil had 1,632,101 vehicles and 1,704 refueling stations, with a higher concentration in the cities of Rio de Janeiro and São Paulo[18].

NGVs were introduced to New Zealand in the 1980s, though their use has now declined. At the peak of New Zealand's natural gas use, 10% of the nation's cars were converted, around 110,000 vehicles[19].

Australian Car Market

The following tables show the current composition of the Australian vehicle market by fuel and vehicle type. Currently there is very little penetration by NGV (CNG or LNG) vehicles. Australia has fewer than 3000 NGV vehicles[20] (less than 0.02 per cent of the national vehicle fleet) – mainly buses and trucks (rigid in particular). The 30 year history of the LPG refuelling and car conversion industry in Australia has resulted in minimal development of the 'CNG car market', with only approximately 2,000 LPG refuelling sites by 2008[21].

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[17] 14 Oct 2011, Natural Gas Australia: An Automotive Perspective, ABMARC, 28 Sept 2011, http://www.goauto.com.au/mellor/mellor.nsf/story2/849B9C2A2CE9B093CA25792900058429

[18] http://en.wikipedia.org/wiki/Natural_gas_vehicle

[19] http://en.wikipedia.org/wiki/Natural_gas_vehicle

[20] 14 Oct 2011, Natural Gas Australia: An Automotive Perspective, ABMARC, 28 Sept 2011, http://www.goauto.com.au/mellor/mellor.nsf/story2/849B9C2A2CE9B093CA25792900058429

[21] Feb 2008, http://gastoday.com.au/news/the_australian_natural_gas_vehicle_industry/004426/

Australian Vehicles[22]	2006	2011
	%	%
Petrol	87.1	82.1
Diesel	10.6	14.7
Other (including NGV/CNG/LNG)	2.3	3.2

Compressed natural gas (CNG) and liquefied natural gas (LNG) are both composed primarily of natural gas, or methane (CH_4).

Australian Vehicles[23]	2011	2011	Average annual growth 06/11
	no.	%	%
Passenger vehicles	12,474,044	76.2%	2.3
Campervans	50,653	0.3%	4.2
Light commercial vehicles	2,530,630	15.5%	3.8
Light rigid trucks	119,539	0.7%	4.8
Heavy rigid trucks	318,223	1.9%	2.1
Articulated trucks	85,965	0.5%	3.8
Non-freight carrying trucks	22,656	0.1%	2.3
Buses	87,883	0.5%	3.2
Motor cycles	678,790	4.1%	8.2
Total motor vehicles	**16,368,383**	**100.0%**	**2.7**

CNG and LNG are predominantly used in Australia in the heavy vehicle market in specialist applications such as metropolitan bus fleets, garbage trucks and line haulage. LNG as a heavy duty vehicle fuel is a recent development; improvements in vehicle tanks, storage vessels and gas dispensers have all contributed to its adoption by heavy vehicle fleets and bus and locomotive operators. LNG-fuelled vehicles have ranges and refuelling times comparable to those of diesel-fuelled vehicles without any power to weight disadvantages[24].

The use of CNG as a transport fuel presents a number of practical impediments. For example CNG needs to be stored under pressure and requires specialised heavy-duty storage tanks on board the vehicle adding to its material cost and weight. These storage tanks affect the amount of fuel that a vehicle can carry and its operating range, therefore limiting its broader application within the Australian vehicle fleet.

[22] http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0/

[23] http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0/

[24] http://www.ret.gov.au/resources/fuels/alternative_transport_fuels/Pages/CNGandLNG.aspx

Further, natural gas fuels require abundant, appropriately placed, specialist refuelling facilities that are not readily adaptable to, or available across, Australia's petroleum distribution infrastructure[25].

Heavy-duty storage tank requirements also result in refueling stations being much more expensive to build than LPG. Refuelling with CNG takes approximately 3-4 minutes, about the same time as with conventional fuels[26].

It will be difficult to compete with existing technologies particularly with the ongoing improvements in diesel engine performances, Also NGV vehicles require more frequent filling and have a lower calorific value making it less convenient and limiting vehicle range particularly for smaller vehicles[27].

Residential Charging

NGV refuelling using gas from residential lines will require a pressurising device as the relative pressure delivered to dwellings is relatively low making it more effective for commercial installations which can also provide greater storage options. There is a residential device developed in Canada which can provide this functionality but there are concerns over safety aspects and potential noise pollution. One example is the required ongoing maintenance requirements which may not be sustained in a typical residence. Additional challenges include the relatively high cost of installing refuelling units and reducing refuelling time (most home based systems take about 6 hours to refill an average size car)[28].

The lack of sufficient infrastructure is limited for residential vehicles and will hamper adoption as drivers will suffer from range anxiety. There is also likely to be consumer resistance due to perceived additional safety issues on top of the typical concerns over gas devices.

Carbon Emissions

The table below shows the relative emissions of various fuel options. While CNG and LNG have lower energy contents than either petrol or diesel

CO_2 emissions from an NGV are between 20 per cent and 25 per cent lower when compared directly to the petrol engine it replaces[29,30]. NGVs also produce lower particulate emissions and are generally more fuel efficient. Carbon tax impacts may improve the competitive pricing of NGVs.

Emissions factor[31]	**Kg CO_2 -e/GJ CO_2**
CNG	51.2
LPG	59.6
Gasoline (petrol)	66.7
Diesel	69.2

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25 http://en.wikipedia.org/wiki/Natural_gas_vehicle

26 http://www.natural-gas.com.au/business/vehicles.html

27 http://www.natural-gas.com.au/business/vehicles.html

28 http://www.ret.gov.au/resources/fuels/alternative_transport_fuels/Pages/CNGandLNG.aspx

29 http://www.ret.gov.au/resources/fuels/alternative_transport_fuels/Pages/CNGandLNG.aspx

30 14 Oct 2011, Natural Gas Australia: An Automotive Perspective, ABMARC, 28 Sept 2011, http://www.goauto.com.au/mellor/mellor.nsf/story2/849B9C2A2CE9B093CA25792900058429

31 Department of Climate Change (2009) National Greenhouse Accounts (NGA) factors

Network Impact

Presently peak durations are of relatively short durations and hence the impact of NGV charging in residential areas is likely to only impact extended networks.

The growth in the NGV market will probably be concentrated in fleet vehicles rather than the residential market. These types of customers (eg Toll, Wesfarmers) are likely to install large charging facilities, with associated storage, requiring a reasonable capital allocation and hence any gas network augmentation requirements will need to be funded by the customer. This will ensure that residential customer tariffs are not impacted.