Developing a market for Natural Gas Vehicles in Australia

Discussion Paper June 2014

Energy Supply Association of Australia | info@esaa.com.au | www.esaa.com.au

Executive Summary

Consumer concerns about pollution and petrol price increases in recent years have put alternative fuel vehicles such as electric vehicles (EVs) and natural gas vehicles (NGVs) back in the spotlight. The esaa recently released a report on the prospects for EVs in Australia.[1] This report examines the prospects for Natural Gas vehicles.

Many Australian drivers are familiar with gas as a vehicle fuel source through the widespread use of liquefied petroleum gas (LPG); around 314,000 cars have been retrofitted with LPG since 2006 as part of the LPG Vehicle Scheme.[2] LPG is produced as a by-product of refining crude oil By contrast, natural gas vehicles use methane, which naturally occurs in various geological formations. As it is much less dense than LPG or conventional fuels it must either be compressed or liquefied to reduce its volume for use as a transport fuel. Vehicles fuelled by either liquefied natural gas (LNG) or compressed natural gas (CNG) – collectively referred to as NGVs in this report – offer two main advantages over conventional vehicles: lower running costs and lower pollution. Australia's abundance of natural gas could reduce the country's reliance on imported fuels and the risks of price vulnerability due to oil supply constraints.

Australia is currently a small player in the world NGV market. Worldwide there are almost 20 million NGVs.[3] In some countries, where natural gas has a strategic value, natural gas is the dominant fuel source for cars. In Australia, there are currently just 3,110 NGVs (0.02 per cent NGVs produce around 30 per cent less greenhouse gas emissions than equivalent petrol vehicles as well as lower levels of carbon monoxide and nitrogen oxides.[4] Heavy-duty NGVs produce far lower levels of particulate matter than diesel vehicles.[5]

Of course, fuel cost savings vary according to the difference between natural gas and petrol prices, but refuelling with natural gas is currently around 20 per cent cheaper than diesel.

The future uptake of NGVs will depend on many factors such as: gas and petrol prices, gas availability, vehicle availability, after-market conversions (for small vehicles), infrastructure and government policies.

In Australia, the commercial transport market is the most likely source of growth in the domestic EV market. This is based on the existing state of the market and the vehicles made available.

---

[1] esaa (2013), Sparking an Electric Vehicle Debate in Australia.
[2] AusIndustry, LPG Vehicle Scheme Statistics, retrieved 19/06/2014 from: http://www.ausindustry.gov.au/programs/energy-fuels/lpgvs/Pages/LPGVS-SchemeStatistics.aspx
[3] The Gas Vehicles Report, April 2014, Vol 13, No. 2, p. 25.
[4] NGVA Europe, Comparison of energy contents and CO2 emissions from different fuels, Retrieved 16/10/2013 from: http://www.ngvaeurope.eu/comparison-of-energy-contents-and-co2-emissions-from-different-fuels
[5] Beer et al. (2004). Life-Cycle Emissions Analysis of Fuels for Light Vehicles: Report to the Australian Greenhouse Office

The development of home refuelling facilities and affordable vehicle conversions could tilt car owners' preferences towards NGVs, particularly if petrol prices rise in comparison to gas prices. Certainly, the strong passenger NGV market in Italy shows that this this is possible. But so far, incentives for passenger vehicles to convert to gas have unfortunately been limited to LPG.

NGVs are often cost-effective over a vehicle's lifetime. Businesses that are heavily reliant on transport can benefit from shifting to NGVs. While trucking companies are the obvious beneficiaries of lower fuel costs, companies such as Coca Cola, Australia Post, Woolworths, and Coles which rely on road transport to distribute their products around the country could also gain from increasing penetration of NGVs.

If a larger NGV market is seen as a strategic advantage for Australia, a combined effort between the natural gas and automotive industries, transport-reliant industries as well as state and federal governments will be needed. Policies may need to be developed to address some of the barriers to NGV market development, in particular the lack of refuelling infrastructure.

Issues around accessing sufficient gas supplies also need to be resolved. Australia has sufficient gas resources to support projected domestic and export market growth to 2035 and beyond. But, the ability of domestic and export markets to access such resources largely depends on stable, balanced government policy at both the federal and state level.

Over the past few years, gas prices on the east coast of Australia have risen as an export market has developed. An expanding NGV market would further increase demand for natural gas and consequently put pressure on gas prices. Allowing access to more gas fields in Australia could help to ensure the supply demand balance stays in check and keeps gas prices at a competitive level.

Other policies used internationally to encourage development of an NGV industry include:

- Purchase price subsidies.
- Government purchasing programs for vehicles such as public transport buses and garbage trucks.
- Vehicle fleet emissions standards
- Fuel tax exemptions or reductions

Table of Contents

Executive Summary 2

1. Introducing natural gas vehicles 5
   - 1.1 How they work 5
   - 1.2 History of NGVs 6
   - 1.3 Market trends in NGV uptake 7
     - 1.3.1 USA 9
     - 1.3.2 Italy 10
     - 1.3.3 Rest of Europe 10
2. NGVs in Australia 13
   - 2.1 NGV forecasts 15
3. Pros and cons of NGVs 17
   - 3.1 Benefits of NGVs 17
     - 3.1.1 Fuel cost savings 17
     - 3.1.2 Greenhouse gas emissions and air quality 20
     - 3.1.3 More efficient use of energy networks 21
   - 3.2 Barriers to NGV uptake 21
     - 3.2.1 Lack of infrastructure 21
     - 3.2.2 Technology 22
     - 3.2.3 Safety concerns 23
     - 3.2.4 Shifting dynamics in Australian gas markets 23
     - 3.2.5 Up-front cost 23
     - 3.2.6 Fuel taxation 24
     - 3.2.7 Weight restrictions/charges 24
     - 3.2.8 Lack of clear policy 24
4. A role for government? – realising the strategic benefits of NGVs 26
   - 4.1 Pollution and greenhouse emissions 26
   - 4.2 Energy security and terms of trade 26
5. Policy Enablers 28
   - 5.1 Developing an NGV market in Australia 28
     - 5.1.1 Encouraging vehicle sales 28
     - 5.1.2 Infrastructure 29
     - 5.1.3 Informational barriers 30
     - 5.1.4 Gas prices and supply 30

1. Introducing natural gas vehicles

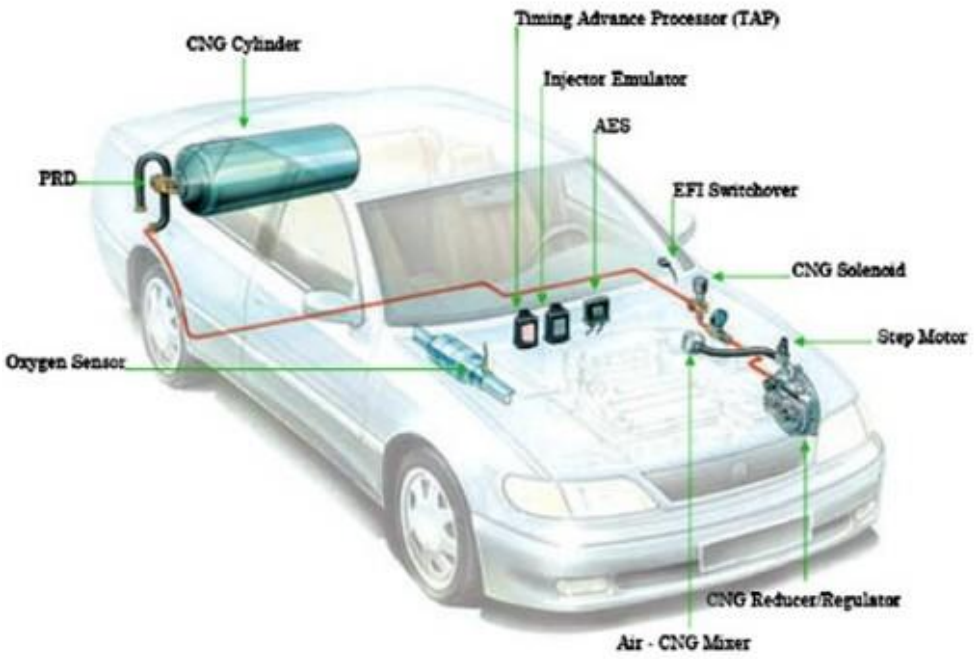
1.1 How they work

Many Australian drivers are familiar with gas as a vehicle fuel source through liquefied petroleum gas (LPG). These vehicles represent the largest amount of alternative fuel vehicles on Australian roads. Of the 16.6 million vehicles in Australia, 615,000 run on LPG.[6] Since 2006, more than 317,000 LPG vehicles have been added to the Australian fleet as part of the LPG Vehicle Scheme. The Scheme is due to end on 30 June 2014.[7]

Natural gas vehicles (NGV) differ from LPG in that the gas is primarily made up of methane, compared to a mixture of propane, propylene, butane, and butylene for LPG.

NGVs essentially operate on the same fundamental concepts as internal combustion engine (ICE) vehicles powered by petrol. Natural gas is mixed with air in the cylinder of a four-stroke engine and then ignited by a spark plug to move a piston up and down. Figure 1.1 shows the basic design of an NGV. But there are several key differences between LPG and CNG or LNG (see Box 1).

Figure 1.1 - A natural gas powered car[8]



[6] Shell Australia, Retrieved from: http://www.shell.com.au/products-services/on-the-road/fuels/lpg.html on 10 October 2013.
[7] AusIndustry, LPG Vehicle Scheme Statistics, retrieved 19/06/2014 from: http://www.ausindustry.gov.au/programs/energy-fuels/lpgvs/Pages/LPGVS-SchemeStatistics.aspx
[8] Sourced from http://3.bp.blogspot.com/-v2IF5u2wDWw/UNkOXxUM1DI/AAAAAAAAPk8/V_ciE6Gxaxk/s1600/NaturalGasVehicle1.jpg on 19/10/13

Box 1

Liquefied Natural Gas (LNG)/Compressed Natural Gas (CNG) vehicle – LNG and CNG vehicles are fuel combustion engines, drawing fuel from gas networks through highly pressurised pipeline systems. LNG and CNG require higher-density on-board storage tanks than traditional internal combustion vehicles.

CNG must be stored in a high pressure (around 20 MPa) cylinder that acts as the fuel tank. Tanks can be heavy and therefore affect performance but lighter (and consequently more expensive) tanks can be found.

In the case of LNG, the fuel tank is highly insulated in order to allow the fuel, which is liquefied at temperatures of below -162°C, to be kept cold. The advantage of LNG over CNG is that the fuel is at a higher density, meaning more energy is contained in the same space.

LPG vehicles - LPG is produced as a by-product of converting crude oil into petroleum and other oil products. It is not as clean as natural gas as an energy source and is somewhat less stable.

NGVs offer several advantages over petrol or LPG fuelled vehicles. Natural gas is cheaper and more efficient than LPG and cheaper than petrol or diesel. It produces lower levels of greenhouse gas emissions, particulate emissions and carbon monoxide than petrol and diesel.[9] Natural gas for vehicles can be transported using existing gas transmission pipelines.

It is possible to convert ICE vehicles so that they can be fuelled by natural gas. The cost to convert to natural gas varies depending on the type of vehicle. With such a small market for conversion in Australia it is difficult to provide a range. But figures from the US show that conversion costs around US$12,000–18,000 (A$13,300–20,000) for a passenger vehicle including the retrofit system, fuel tanks and related tubing/brackets, and the installation.[10] Due to the loss of storage space involved in retrofitting a car with a tank for natural gas, larger passenger vehicles such as sedans and stations wagons are better suited to conversions than small vehicles.[11]

1.2 History of NGVs

Natural gas as a vehicle fuel source has been in existence since the 1930s, although expansions in crude oil markets in subsequent decades caused substitution away from natural gas. Despite oil shocks in the 1960s and 1970s, natural gas was still very much considered an alternative fuel, and its application was not explored thoroughly. Since the

[9] Beer et al. (2004). Life-Cycle Emissions Analysis of Fuels for Light Vehicles: Report to the Australian Greenhouse Office

[10] NGV America, (2011) Fact Sheet: Converting light-duty vehicles to natural gas. Retrieved 14/11/2013 from: www.ngvc.org/pdfs/FAQs_Converting_to_NGVs.pdf.

[11] NGV Global, Vehicle types. Retrieved 19/06/2014 from: http://www.iangv.org/natural-gas-vehicles/vehicle-types/

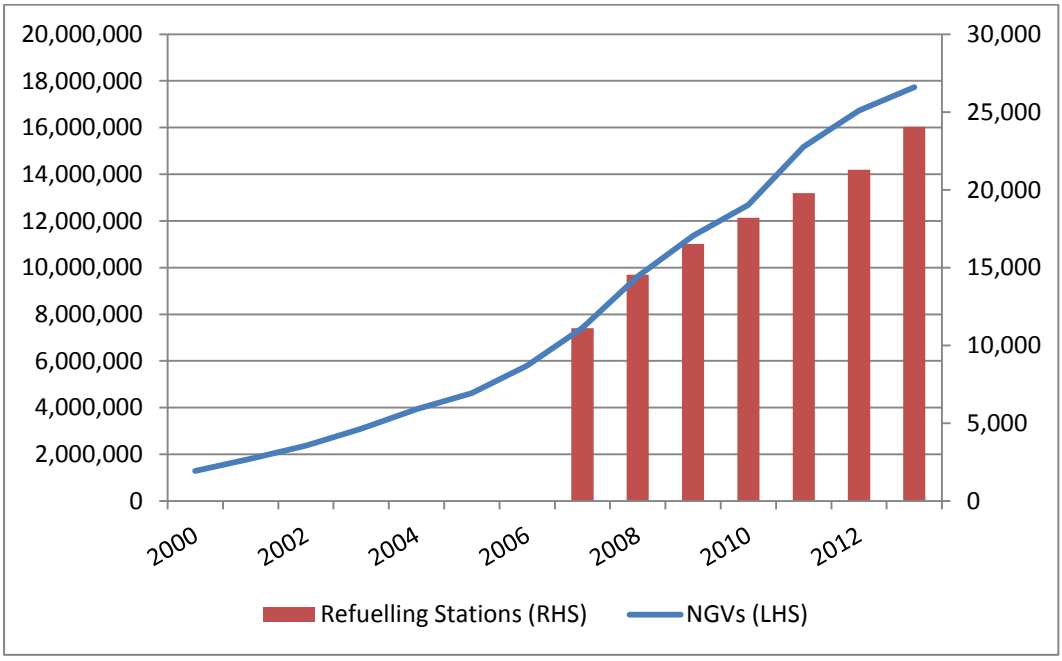
1970s, NGVs have been promoted in countries such as India, Brazil, and China as a relatively clean alternative fuel and to reduce dependence on oil imports.[12] Over time, NGVs have become more prominent, although largely in commercial and industrial sectors, as options for heavy road transportation, or as government fleet vehicles.[13]

1.3 Market trends in NGV uptake

The global NGV market is growing strongly. There are now almost 20 million NGVs and 25,000 refuelling stations worldwide.[14] Annual growth rates have averaged 19.3 per cent over the past decade. Figure 1.2 shows the growth in the number of NGVs and worldwide since 1995 and the number of refuelling stations since 2007 (refuelling station data prior to 2007 is not available).

Some forecasts suggest that this will almost double, to around 35 million NGVs worldwide by 2020 with annual sales of more than 3.3 million.[15]

Figure 1.2 Historical NGVs and refuelling stations, Worldwide



Source: IANGV and NGVA Europe

Internationally, NGV uptake has been largely concentrated in commercial vehicles, such as heavy vehicles used in road freight, or buses. Since 2009, buses have comprised the majority

[12] Yeh, S. 2007, 'An empirical analysis on the adoption of alternative fuel vehicles: The case of natural gas vehicles', Energy Policy, vol 35, pp 5965-5875

[13] USA Today (2011), *Natural-gas powered cars: Who even knows they exist?* Retrieved 30/5/2013 from: http://usatoday30.usatoday.com/money/autos/2007-05-08-natural-gas-usat_N.htm

[14] The Gas Vehicles Report, April 2014, Vol 13, No. 2, p. 25.

[15] Navigant Research, Market Data: Natural Gas Vehicles Global Natural Gas Vehicle Sales and Refueling Infrastructure Forecasts: 2013-2020

of total NGVs in the U.S. NGV buses are also popular in India, Argentina and Germany. Table 1.1 shows the top 10 countries by NGV penetration rate.

Uptake in many of the largest adopting countries has been driven by government support for the natural gas sector, including through taxing substitute fuel sources heavily and providing incentives for uptake of NGVs.

The vast majority (92 per cent) of NGVs are light duty vehicles, followed by buses (4.4 per cent), and trucks (2.1 per cent).

Despite these countries leading global NGV demand, NGVs represented less than 1.64 per cent of the total fleet in 2012 with more than 19.8 million vehicles worldwide.[16] There is strong uptake in markets which influence their automotive industries to make NGVs more attractive to commercial and small consumer purchasers, as can be seen in Iran, Pakistan, and Armenia.

Table 1.1 Top 10 NGV countries by penetration rate

Country	Total NGVs	Proportion of total fleet
Pakistan	2,790,000	79.67%
Bangladesh	208,304	62.12%
Armenia	244,000	55.45%
Bolivia	254,722	28.12%
Iran	3,300,000	27.09%
Uzbekistan	450,000	26.47%
Argentina	2,244,346	17.53%
Colombia	450,633	15.45%
Peru	157,973	10.49%
Myanmar	30,005	8.02%

Source: NGVA Europe.

As at 2013, 27 per cent of Iran's total vehicle fleet were NGVs. This is largely affected by state-imposed trade sanctions levied on petrol imports. In Pakistan, the growth in the NGV market has been the result of energy security concerns, with the government keen to reduce reliance on imported fuels.[17]

In Italy, the presence of a large network of natural gas refuelling stations as well as government incentives means that NGV owners are able to take advantage of the fuel cost savings that NGVs offer over conventional vehicles.

[16] The Gas Vehicles Report, April 2014, Vol 13, No. 2, p. 25.
[17] Daily Times Pakistan, 12 August 2005, HDIP asked to manufacture CNG equipment. Retrieved from: http://www.dailytimes.com.pk/default.asp?page=story_12-8-2005_pg5_4 on 5 August 2013.

1.3.1 USA

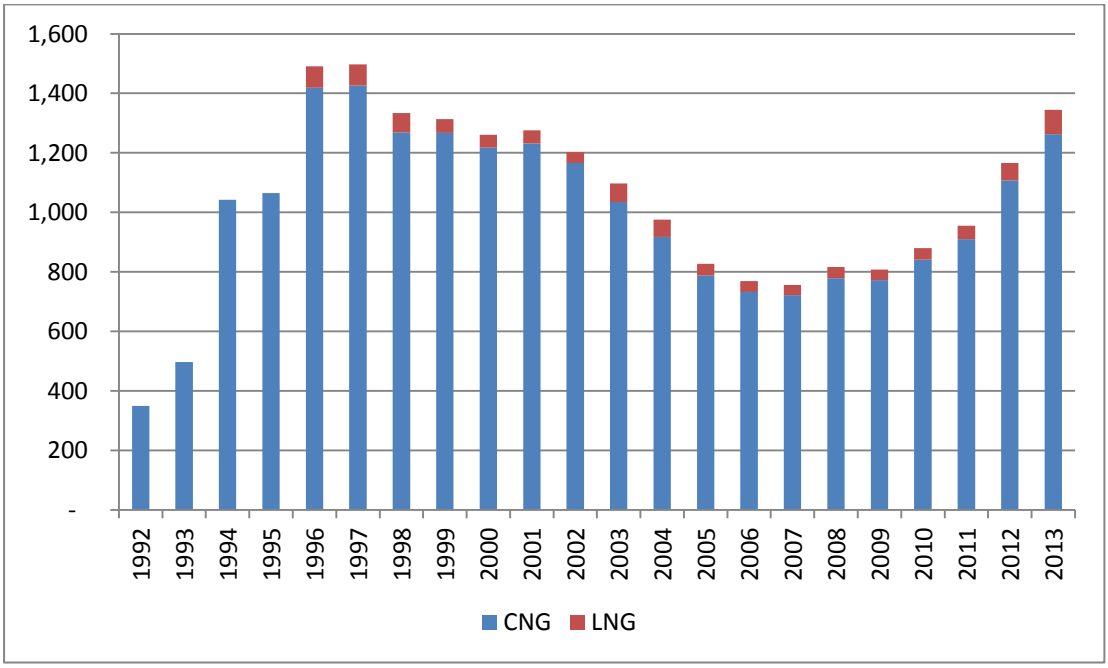
In the US, the number of refuelling stations has expanded over the past few years, coinciding with a petrol price spike in 2008. This follows a strong decline in the number of NGV refuelling stations from 1997 to 2008. Figure 1.3 shows the change in number of LNG and CNG refuelling stations since 1992.

NGVs are gradually being adopted by trucking companies and other heavy industries, as well as federal, state and municipal governments. 1,800 NGVs are to be manufactured in a 22-state government bid to stimulate public demand. And President Barack Obama used his 2014 State of the Union Address to call for more natural gas refuelling stations to be built to reduce America's reliance on imported oil.

There are a number of state-based incentives available to purchasers of NGVs in the U.S. In Texas NGV and Fuelling Infrastructure Grants are available, which provide funding for the replacement of medium and heavy-duty vehicles with new or converted NGVs. In California, public transit service operators who employ natural gas are exempt from state road taxes. South Coast residents in California may also be eligible for up to $2,000 for the purchase of a home fuelling appliance. The State of Pennsylvania also offers grants of up to $25,000 per vehicle for the purchase of natural gas by municipal and commercial fleets.[18]

There is significant private sector investment interest in improving home refuelling technology, to reduce the cost and improve the safety and capacity of NGV fuel tanks.

Figure 1.3 - US CNG and LNG Fuelling stations



[18] U.S. Department of Energy (2013). Retrieved 19/06/2014 from: http://www.afdc.energy.gov/laws/law/PA/10432

Source: US Department of Energy

1.3.2 Italy

There are approximately 846,000 NGVs in Italy.[19] This figure has almost doubled since 2007 (432,900 vehicles).[20] Approximately 7 per cent of new vehicle purchases in the country are NGVs.[21] Italy has 966 natural gas fuelling stations, and the CNG pump price is 50-60 per cent less expensive than traditional gasoline. Ongoing government support for the NGV industry in Italy has been credited as one of the major reasons for its success.[22] Buyers of alternative fuel vehicles, which include NGVs, currently receive incentives of up to €5,000 (A$7,600). The level of the incentive depends on the efficiency of the vehicle (gCO_2/km). Incentives are primarily aimed at fleets and businesses. The incentives will reduce to a maximum of €3,500 (A$5,300) in 2015.[23]

1.3.3 Rest of Europe

Aside from Italy, other important NGV markets in the EU include Germany (96,349), Bulgaria (61,270) and Sweden (44,321).[24] In contrast to Australia, the European EV market is dominated by light vehicles (98 per cent of the EU NGV fleet).

There are 2,969 CNG refuelling stations in Europe with just a handful of LNG stations. Surprisingly, despite having less than 100,000 NGVs, Germany has a wide network of CNG refuelling stations (915); only 50 fewer than Italy, which has nine times as many vehicles on the road.[25] In addition, there are almost 1,200 small vehicle refuelling appliances across Europe. These allow households to refuel their NGVs at home using their existing gas connection and therefore pay for it through their gas bill. Refuelling times are far longer than at a dedicated CNG refuelling station but this is offset by the convenience of home based charging. Prices for home refuelling can also be higher since gas prices for industrial users are typically lower than for households.[26]

NGV uptake in Europe has been encouraged through a range of support measures such as tax breaks, up front subsidies, incentives for creating biogas, and agreements with governments to adopt natural gas powered buses.

---

[19] NGVA Europe (2013), *European NGV Statistics,* retrieved 11/10/2013 from: http://www.ngvaeurope.eu/european-ngv-statistics
[20] NGV Global, Natural Gas Vehicle Statistics, NGVs by Year
[21] Southern California Gas Company, (2006), retrieved from: http://www.socalgas.com/documents/news-room/presentations/NGV_Allman_presentation.pdf
[22] Bloomberg (2012), *Gasoline Sticker Shock Fuels Fiat Natural-Gas Auto Sales,* retrieved from: http://www.bloomberg.com/news/2012-09-17/gasoline-sticker-shock-fuels-fiat-natural-gas-auto-sales.html
[23] NGV Global, Italian Alt-Fuel Incentive Start March 2013, retrieved 16/10/2013 from: http://www.ngvglobal.com/25704-0218#more-25704
[24] NGVA Europe (2013), *European NGV Statistics,* retrieved 11/10/2013 from: http://www.ngvaeurope.eu/european-ngv-statistics
[25] Ibid.
[26] esaa analysis based on Eurostat and NGVA Europe

The uptake of NGVs in Europe is being further encouraged by the adoption of stringent emissions standards for new vehicles in order to support the EU's emissions reduction targets. As NGVs produce lower levels of greenhouse gas emissions that petrol or diesel vehicles, they represent an immediate option for meeting the 95gCO_2-e/km target in 2020. The EU's biofuel targets could also support the use of biomethane as a fuel source providing yet another incentive for NGV uptake.

Vehicles manufacturers such as Fiat, VW, Audi and Opel are making passenger NGVs available in the European market. For large vehicles, IVECO, Mercedes-Daimler and Volvo have models available in Europe, while in Australia, Isuzu has four different NGV trucks available. Table 1.2 below shows some of the NGV models available.

Table 1.2 - Available NGV models

Manufacturer	Model	Vehicle Type
Fiat	Panda 1.4 8V Natural Power (bi-fuel)	Car
	500 L Natural Power (bi-fuel)	Car
	Punto Evo 1.4 8V Natural Power (bi-fuel)	Car
	Qubo 1.4 8V Natural Power (bi-fuel)	Car
	Fiorino 1,4 8V Natural Power (bi-fuel)	Car
	Doblo 1.4 T-Jet 16V Natural Power (bi-fuel)	Car
	Ducato Natural Power	Van
	Doblò Cargo Natural Power Turbo (bi-fuel)	Van
	Fiorino Natural Power (bi-fuel)	Van
Lancia	Ypsilon Ecochic Methane (bi-fuel)	Car
Mercedes-Benz	B 200 NGT (bi-fuel)	Car
	E 200 NGT	Car
	Sprinter NGT (bi-fuel)	Van
Opel	Zafira Tourer 1,6 CNG Turbo ecoFLEX	Car
	Zafira 1.6 CNG Turbo ecoFLEX	Car
	Combo 1,4 CNG ecoFLEX	Van
Seat	Mii CNG	Car
Skoda	Citigo CNG	Car
Volkswagen	Up! CNG (bi-fuel)	Car
	Golf VII 1.4 (bi-fuel)	Car
	Passat 1,4 TSI EcoFuel (bi-fuel)	Car
	Touran 1,4 TSI EcoFuel	Car
	Touran Cross 1,4 TSI EcoFuel	Car
	Caddy 2,0 EcoFuel	Van
	Caddy 2,0 Maxi EcoFuel	Van

	Caddy Tramper 2,0 EcoFuel	Car
	T5 2.0 BiFuel	Van
Audi	A3 1.4 TCNG (bi-fuel)	Car
	A4 TCNG (bi-fuel)	Car
Volvo	V70 CNG (bi-Fuel)	Car
	Dual Fuel (Methane / Diesel)	Truck
Saab	9-3 Sport Combi (Flex-Fuel)	Car
IVECO	Daily CNG	Van
	Stralis CNG	Truck
	Stralis LNG	Truck
Daimler	Econic CNG	Truck
	Econic LNG	Truck
Scania	CNG	Truck
Isuzu	NLR 200 CNG	Truck
	NPR 300 CNG	Truck
	FSR 700 CNG	Truck
	FSR 850 CNG	Truck

Source: NGVA Europe, Isuzu Australia

2. NGVs in Australia

Natural gas vehicles have been promoted for some time in Australia. In 2000, their uptake was encouraged through the Australian Greenhouse Office's Alternative Fuels Conversion Program (AFCP) which ran until 2004 and applied to commercial vehicle over 3.5 tonnes. The AFCP provided grants to cover the cost of up to 50 per cent of the additional cost of purchasing a CNG or LPG vehicle, converting existing vehicles to these fuels or upgrading conversions. The Compressed Natural Gas Infrastructure Program aimed to establish a network of publicly accessible compressed natural gas (CNG) refuelling stations.

NGVs have previously been hailed as a potential alternative to ICE vehicles for passenger vehicles in Australia, due to our significant gas infrastructure. Australia has large natural gas reserves, and nearly half of all Australian residential and commercial premises are connected to natural gas networks.

Governments at the state and national level have released reports and conducted inquiries to investigate the potential for using natural gas as a transport fuel source NGVs in Australia.[27, 28, 29]

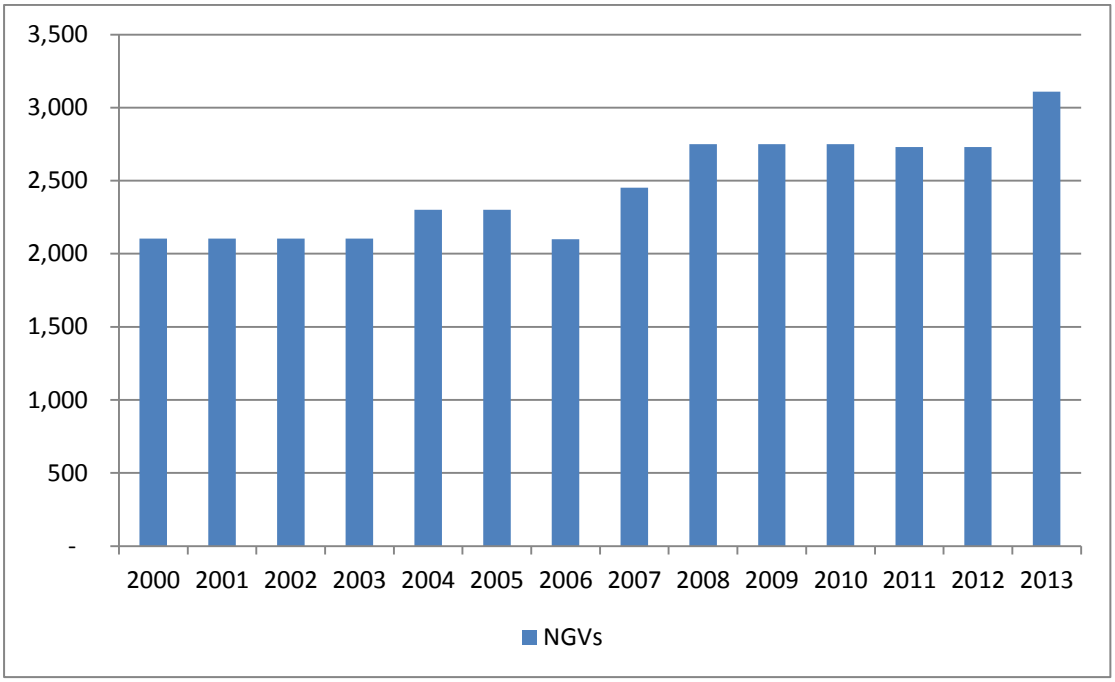
Despite this, NGV uptake is still very low, with most NGVs being sold as commercial fleet vehicles such as heavy road transport, or buses. As of December 2011, NGVs represented just 0.02 per cent of Australia's total vehicle fleet, though from 2000-2011, total NGV sales have grown at an average of 2.4 per cent each year.[30] Historical NGV uptake in Australia is shown in Figure 2.1 below.

On behalf of the esaa, Deloitte conducted interviews with a range of industry stakeholders on the potential for an NGV market to develop in Australia. Stakeholders suggested that the high costs of introducing NGVs into small consumer markets have hampered growth. Growth in commercial NGVs is expected to continue, especially if fuel prices rise, although industry expectations are that LNG and CNG offer little additional benefit to LPG vehicles. LPG vehicles have experienced little growth in Australia in the last decade, despite significant emissions savings and one of the largest infrastructure networks in the world. LPG vehicles also have comparable range and better vehicle torque than NGVs, and stakeholders doubted NGV uptake would be significant given LPG growth has been so constrained. Infrastructure and storage issues have also jeopardised uptake of passenger NGVs, and are expected to do so into the future.

[27] Parliament of Tasmania, 2003, Joint Standing Committee on Environment, Resources and Development, *The Use Of Compressed Natural Gas As A Vehicle Fuel In Tasmania*
[28] New South Wales Government, 2008, *NSW Cleaner Vehicles and Fuels Strategy*
[29] Department of Resources, Energy and Tourism, 2011, *Strategic Framework for Alternative Transport Fuels*.
[30] NGV Global (2012), *Current Natural Gas Vehicle Statistics,* retrieved 8/3/2013 from: http://www.iangv.org/current-ngv-stats

Although an NGV market is growing, refuelling infrastructure remains limited. There are just five public refuelling stations for CNG in Australia[31] including sites in Aspendale (Victoria), Fyshwick (ACT) and Moorebank (NSW). Private sites dominate Australia's natural gas refuelling infrastructure with sites such as bus depots having their own refuelling equipment using existing gas mains. According to the NGVA Europe there are 47 private CNG refuelling stations, 10 LNG refuelling stations and 130 small vehicle refuelling appliances in Australia.[32]

Figure 2.1 - Historical NGV Uptake, Australia



Source: NGV Global (2012)

Energy Developments Limited uses CNG to fuel the trucks it uses to transport CNG to the Yulara Power Station in the Northern Territory. The Yulara Power Station is used to supply electricity to the Uluru-Kata Tjuta National Park and the local community, which hosts more than 400,000 visitors from around the world each year. CNG is used to fuel the trucks for the entire 880 km return trip from Alice Springs.[33]

But the market is set to grow. BOC has already begun adding LNG refuelling stations along this transport corridor with the opening of a public LNG refuelling station in Tarcutta, NSW in December 2013.[34] This is in addition to existing stations in Preston (Victoria) and another planned outlet in Wetherill Park (NSW).

[31] NGVA Europe (2013), *Worldwide NGV Statistics,* retrieved 11/10/2013 from: http://www.ngvaeurope.eu/worldwide-ngv-statistics
[32] Ibid.
[33] Energy Developments Limited, Yulara Compressed Natural Gas Transport Project. Retrieved from: http://www.energydevelopments.com.au/01_cms/details.asp?ID=87 on 21/05/2014.
[34] Andrew Pearson (2013, December 7). Natural gas refueller opens at Tarcutta. *The Daily Advertiser*. Retrieved from: http://www.dailyadvertiser.com.au/story/1956238/natural-gas-refueller-opens-at-tarcutta/

AGL has recently announced plans to roll out CNG refuelling stations across the east coast of Australia, starting in Melbourne.[35] The public and on-site refuelling stations – designed to suit commercial trucks and vehicles – are planned to be located in areas that enable fleets to refuel without having to change their routes.

Wesfarmers is also moving into supplying LNG as a transport fuel with the recent opening of a refuelling station in Wodonga, with another planned to be built near Goulburn, in NSW.[36] Thanks to an $8.3 million Victorian Government program, another four LNG refuelling stations are planned to be added to the recently opened Wodonga station and the public LNG refuelling station in Deer Park, in Melbourne's western suburbs.[37] Conversely, Shell has recently shelved its plans to establish a gas corridor along the Hume Highway between Melbourne and Sydney.

2.1 NGV forecasts

Our research identified two key Australian NGV forecasts, developed by AECOM and Australian Treasury respectively.

AECOM has conducted brief studies into the market for NGVs, as has Treasury in its assessment of the impact of carbon policy on the broader Australian economy. As discussed in this section, the outlook for growth in NGVs in Australia looks weaker than the outlook for growth in EVs.

In 2012, AECOM contributed to the AEMC's *Power of Choice Review* with the report *Impact of EVs and NGVs on the energy markets*.[38] The NGV forecast separates the market into passenger vehicles and trucks and buses. AECOM found that CNG-fuelled trucks will continue to be a cheaper option than diesel until around 2030. For passenger vehicles, AECOM indicated that NGVs were only financially viable for large cars with high vehicle kilometers travelled.

AECOM forecasts that it is unlikely that NGV sales will increase significantly in coming decades. It is also a realistic possibility that NGV sales will be steadily eroded as electric and other alternative vehicle technologies begin to penetrate the market.

[35] AGL, AGL unveils alternative fuel vision at international truck show. 3 April 2014
[36] Matt Chambers (2013, June 24). Watch out diesel, LNG is on the Road. *The Australian*. Retrieved from: http://www.theaustralian.com.au/business/in-depth/watch-out-diesel-lng-is-on-the-road/story-fnhf3xc9-1226665035213#
[37] Victorian Government, (2013). LNG Refuelling Station Opens in Wodonga. Retrieved from: http://www.premier.vic.gov.au/media-centre/media-releases/6461-lng-refuelling-station-opens-in-wodonga.html
[38] AECOM (2012), *Impact of Electric Vehicles and Natural Gas Vehicles on the Energy Markets*

Australian Treasury forecasts suggest that NGVs are generally expected to increase their share of the heavy vehicles road transport sector, to approximately 2025.[39] NGVs are not expected to feature in the market for light vehicles at all, as shown in Figures 2.2 and 2.3.

Of note is the projected impact of biodiesels on demand for natural gas as a fuel source. Biodiesels are expected to take an increasing market share of heavy road vehicles from 2025 onwards as their cost-competitiveness with existing fuels improve and the impact of the NSW Biofuels mandate takes effect.[40] As such, heavy NGV sales are projected to experience some growth prior to 2025, but decline after this time.

Figure 2.2 - Australian Road Transport Fuel Mix, Heavy-duty vehicles

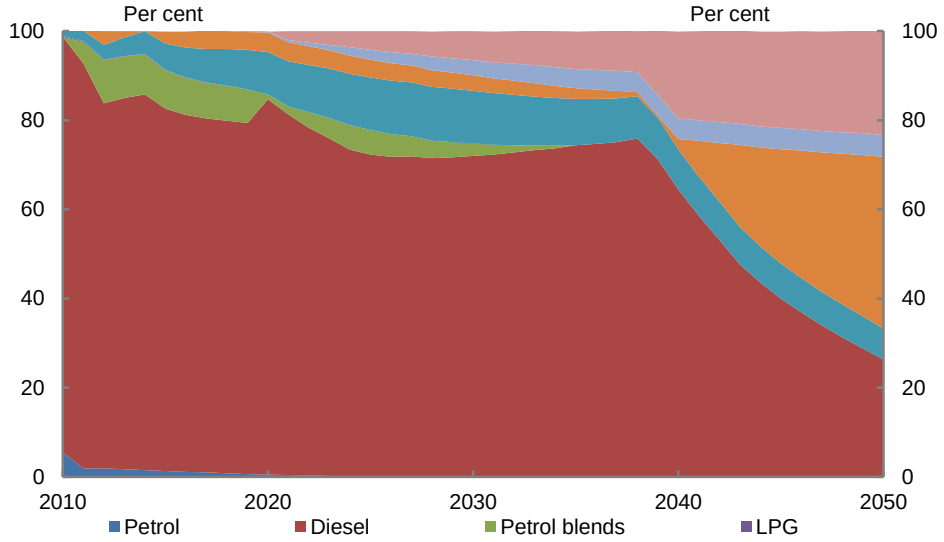
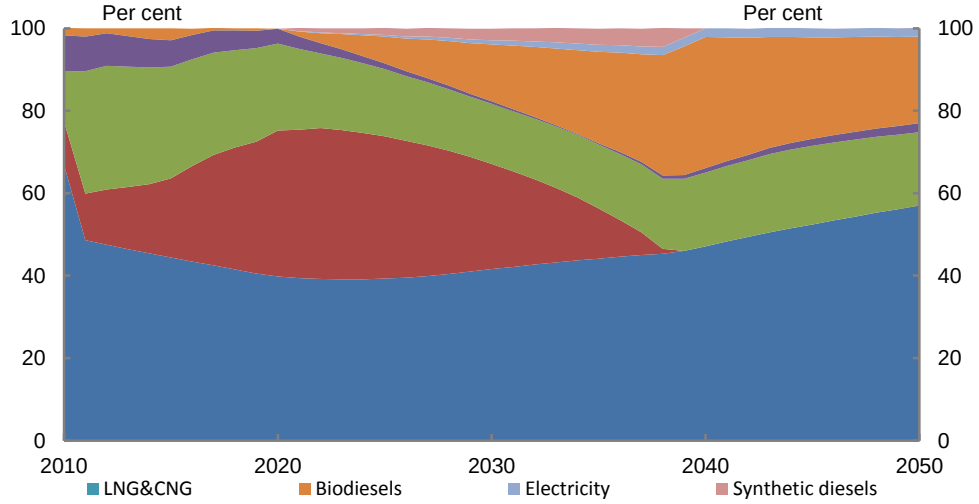


Figure 2.3 - Australian Road Transport Fuel Mix, Passenger Vehicles



Source: Commonwealth Treasury, Strong Growth Low Pollution

[39] Treasury, (2011), *Strong Growth, Low Pollution: Modelling a Carbon Price,* p 132
[40] Graham, P., and Reedman, L. (2011), Road Transport Sector Modelling, Report prepared for Department of the Treasury, CSIRO Report No. EP114249, July,

3. Pros and cons of NGVs

3.1 Benefits of NGVs

NGVs offer advantages over traditional ICE vehicles in terms of fuel costs and greenhouse gas emissions. NGVs produce around 20 per cent less greenhouse gas emissions than petrol.[41] The extent of the cost savings will depend on the amount of kilometres travelled, the cost premium for NGVs over ICE vehicles and the difference between natural gas and petrol prices.

Increasing the number of NGVs in Australia would benefit OEMs that manufacture and sell vehicles, gas suppliers, retailers and networks. There is great potential for benefits to spread wider. It would provide a lower-cost, lower emissions fuel system than the existing diesel and petrol fuel mix.

3.1.1 Fuel cost savings

There are significant fuel cost savings that can be made using natural gas. This is despite the perverse outcomes of the fuel excise regime that effectively penalises CNG on a per litre basis (see Section 3.2.6). Unfortunately, there is little data available on NGV fuel prices in Australia; AECOM's Final Advice to the AEMC on market arrangements for EVs and NGVs used $1.06/kg for CNG which represents a cost of $0.73 per litre of diesel equivalent.[42] Taking into account fuel tax rebates and the Road User Charge Net for heavy vehicles, net refuelling costs for LNG are around $0.95 cents per litre of diesel equivalent. This is around 20 per cent cheaper than the net cost of diesel.[43]

The NSW Government's Road and Maritime Service's Green Truck Partnership found that CNG vehicles reduced fuel costs by 10 per cent per km and 18 per cent per hour of operation.[44] LNG vehicles reduce fuel costs by 45 per cent per km.[45] Each study looked at a different class of vehicle so caution should be taken in interpreting these results.

Of course, the cost premium for NGVs means that the payback period is several years. AECOM found the cost premium for NGVs was around 45 per cent for both trucks and buses.[46]

---

[41] NGVA Europe, Comparison of energy contents and CO2 emissions from different fuels, Retrieved 16/10/2013 from: http://www.ngvaeurope.eu/comparison-of-energy-contents-and-co2-emissions-from-different-fuels

[42] 1 kg of CNG = 1.462 litres of diesel http://www.gowithnaturalgas.ca/getting-started/understanding-energy-equivalency/

[43] Confidential industry consultation.

[44] Roads and Maritime Services, Green Truck Partnership, LNG Case Study. Retrieved from: www.rms.nsw.gov.au/heavyvehicles/downloads/greentruck/case-study-cng.pdf on 11/12/2013.

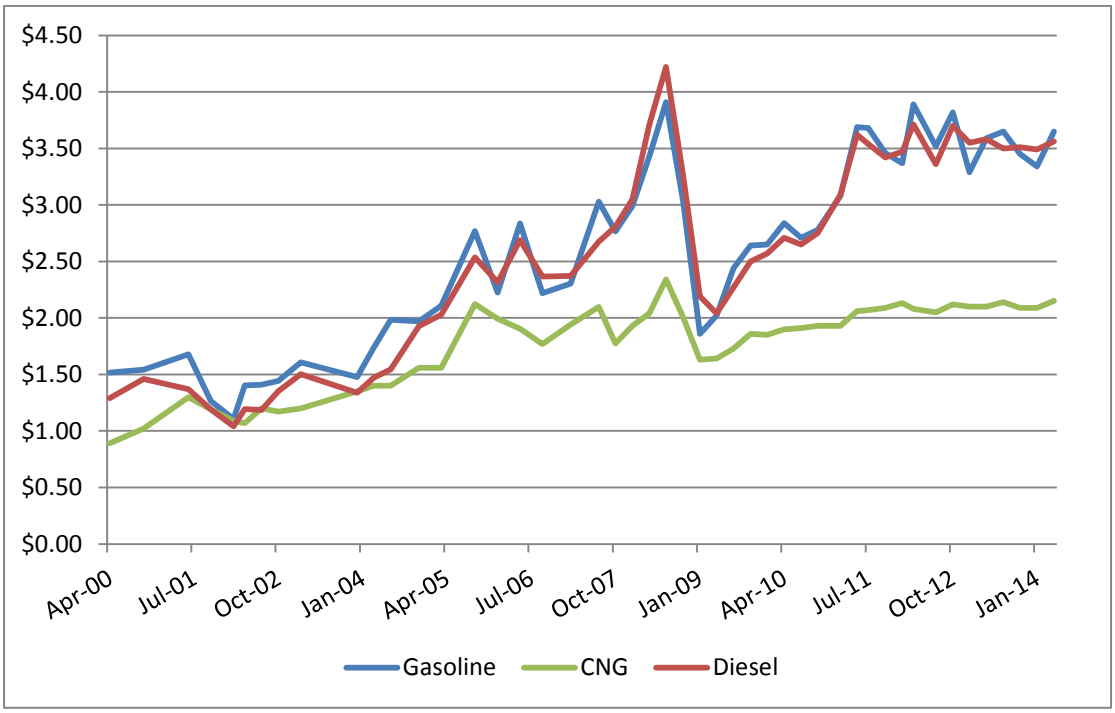
[45] Roads and Maritime Services, Green Truck Partnership, LNG Case Study. Retrieved from: www.rms.nsw.gov.au/heavyvehicles/downloads/greentruck/case-study-lng.pdf on 11/12/2013.

[46] AECOM (2012), *Impact of Electric Vehicles and Natural Gas Vehicles on the Energy Markets*

Fuel price data from the US and Europe is more widely available and clearly shows the cost advantage of natural gas over conventional fuels.

Data from the US Alternative Fuels Data Centre show that since 2000, CNG has been consistently cheaper than petrol or diesel fuel (see Figure 3.1). Since 2009, the gap has widened with CNG now 40 per cent cheaper than gasoline per gallon equivalent. Low gas prices in the US go some way to explaining this change over time. At retail natural gas prices of 40-50 per cent below petrol or diesel prices, the payback period for NGVs is kept to 3-4 years.[47] This may be a sufficient incentive to encourage some consumers to shift to an NGV.

Figure 3.1 - US Average Retail Fuel prices (USD per Gallon Gasoline Equivalent)[48]

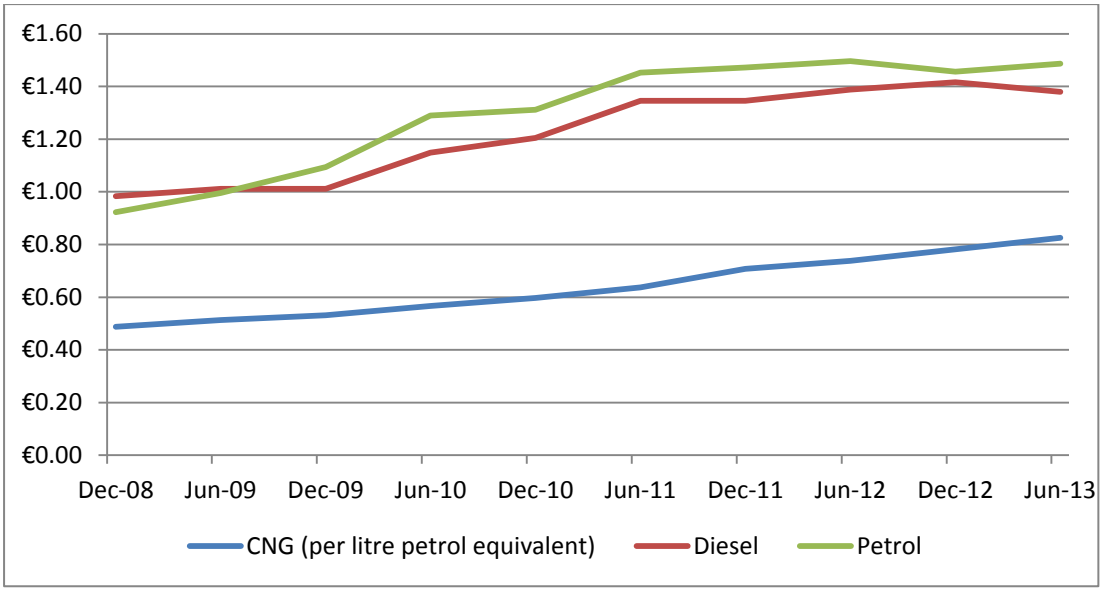


Source: Alternative Fuels Data Centre

The advantage of NGVs in terms of refuelling costs is also clear in Europe (see Figure 3.2) where refuelling with CNG is around half the cost of conventional fuels (diesel and petrol).

[47] Yeh, op.cit.
[48] Alternative Fuels Data Centre, Fuel Prices. Retrieved on 24/03/2014, from: http://www.afdc.energy.gov/fuels/prices.html

Figure 3.2 - European average retail fuel prices



Source: esaa, based on NGVA Europe, Eurostat

Gas prices in the USA are generally lower than in Australia; the price benefit of natural gas over diesel is therefore lower in Australia compared to the USA. But in Australia, commercial users can avoid fuel price risk, as fuel supply contracts run from 1-8 years with the ability to fix a price over the contract period.

With NGVs often cost-effective over a vehicle's lifetime, the fuel cost savings could be gained by businesses that are heavily reliant on transport. Trucking companies are the obvious beneficiaries of lower fuel costs, but companies such as Coca Cola, Australia Post, Woolworths, and Coles which rely on road transport to distribute their products around the country also stand to gain. Similarly, farmers could also benefit from lower transport costs to get agricultural products from farms to processors, abattoirs and distributors. For example, LNG trucks are a good option for milk trucks that collect milk from several dairy farms before returning to a central base.

In the US, NGVs are regularly used as part of waste collection. Local councils could therefore stand to benefit if garbage trucks are converted to run on CNG or LNG. This would likely lower fuel costs.

End consumers potentially stand to benefit from lower costs if these cost savings are passed through.

Box 2

UPS case study

Worldwide delivery firm UPS has begun to expand its fleet of NGVs. Currently, it operates 965 CNG-fuelled package delivery vehicles[49] and 112 LNG trucks.[50] In addition, UPS has announced plans to UPS also plans to purchase 1,000 LNG trucks and build 13 onsite fuelling facilities in Florida, Illinois, Indiana, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee and Texas. This is in addition to their existing LNG refuelling facilities in Las Vegas, Phoenix, Salt Lake City in Utah, and in Ontario, California.[51]

Their LNG trucks have a range of 600 miles (966 km) and use two 70 gallon (265 litre) LNG tanks combined with a 20 gallon (76 litre) diesel tank.[52]

3.1.2 Greenhouse gas emissions and air quality

Estimates of the reductions in emissions from using natural gas as a vehicle fuel instead of diesel or petrol vary. Replacing diesel fuel or petrol with CNG or LNG will reduce greenhouse gas emissions. CNG-fuelled buses can produce 15-20 per cent less greenhouse gas emissions than diesel buses.[53] For passenger vehicles, using CNG as a fuel source could potentially reduce emissions by almost 30 per cent compared to petrol (Table 3.1).[54]

Table 3.1 - Comparison of GHG emissions from petrol, diesel, LPG and CNG

Fuel Type	GHG emissions (gCO_2-e/km)	Emissions vs diesel	Emissions vs petrol
Petrol	235.1	+17.4%	0
Diesel	200.2	0	-14.8%
CNG	167.7	-16.2%	-28.7%
LPG	214.1	+6.9%	-8.9%

Source: Rare Consulting (2010), GHG life cycle assessment of passenger car technologies and fuels in Australia.

[49] UPS Fact Sheet, Saving Fuel: Alternative Fuels Drive UPS to Innovative Solutions
[50] UPS Fact Sheet, Alternative Fuel
[51] Ibid.
[52] Ibid.
[53] Lanni T, Frank BP, Tang S, Rosenblatt D, Lowell D. Performance and emissions evaluation of compressed natural gas and clean diesel buses at New York City's metropolitan transit authority. SAE Technical Paper Series, 2003-01-0300. Society of Automotive Engineers; 2003.
Clark NN, Gautam M, Rapp BL, Lyons DW, Graboski MS, McCormick RL, Alleman TL, Morton P. Diesel and CNG transit bus emissions characterization by two chassis dynamometer laboratories: results and issues. SAE Technical Paper Series, 1999-01- 1469. Society of Automotive Engineers; 1999.
Nylund N, Erkkila K, Lappi M, Ikonen M. Transit Bus Emission Study: comparison of emissions from diesel and natural gas buses. Research Report PRO3/P5150/04. Technical Research Centre. Finland: VTT Processes; 2004.
Ullman TL, Smith LR, Anthony JW, Slodowske WJ, Trestrail B, Cook AL, Bunn WB, Lapin CA, Wright KJ, Clark CR. Comparison of exhaust emissions, including toxic air contaminants, from school buses in compressed natural gas, low emitting diesel, and conventional diesel engine configurations. SAE Technical Paper Series, 2003-01-1381. Society of Automotive Engineers; 2003.
[54] Rare Consulting (2010), GHG life cycle assessment of passenger car technologies and fuels in Australia.

Assuming a 20 per cent reduction in greenhouse gas emissions through using natural gas and based on Australia's 2011 transport emissions, greenhouse gas emissions fall by approximately 36,400 tCO_2-e for each per cent of NGV penetration in the heavy-duty vehicle market. Given that since 1990, emissions from heavy-duty vehicles have on average grown by more than 2 per cent annually, the ability of NGVs to reduce emissions could make an important contribution to Australia's 2020 emissions target.

In addition, emissions of the small particles that primarily make up smog[55], known as PM_{10} are more than 99 per cent lower from natural gas fuelled vehicles than from diesel-fuelled vehicles.[56]

Compared with diesel buses or heavy-duty and light-duty diesel/gasoline vehicles, NGVs also have the potential to emit lower levels of other forms of air pollution such as nitrogen oxides (NOx) and carbon monoxide (CO).

3.1.3 More efficient use of energy networks

One of the benefits of using natural gas to power transport vehicles is that the distribution network and infrastructure already exists, and is widespread. The main initial additional cost is the provision of refuelling infrastructure.

More NGVs on the road would increase the usage of the existing infrastructure meaning it would be used more efficiently. This provides benefits to all gas users rather than just to NGV owners.

3.2 Barriers to NGV uptake

We have identified some major barriers to uptake in the market for NGVs in Australia including up-front costs, limited technology options, a lack of refuelling infrastructure and the absence of a clear policy direction. These barriers are discussed below.

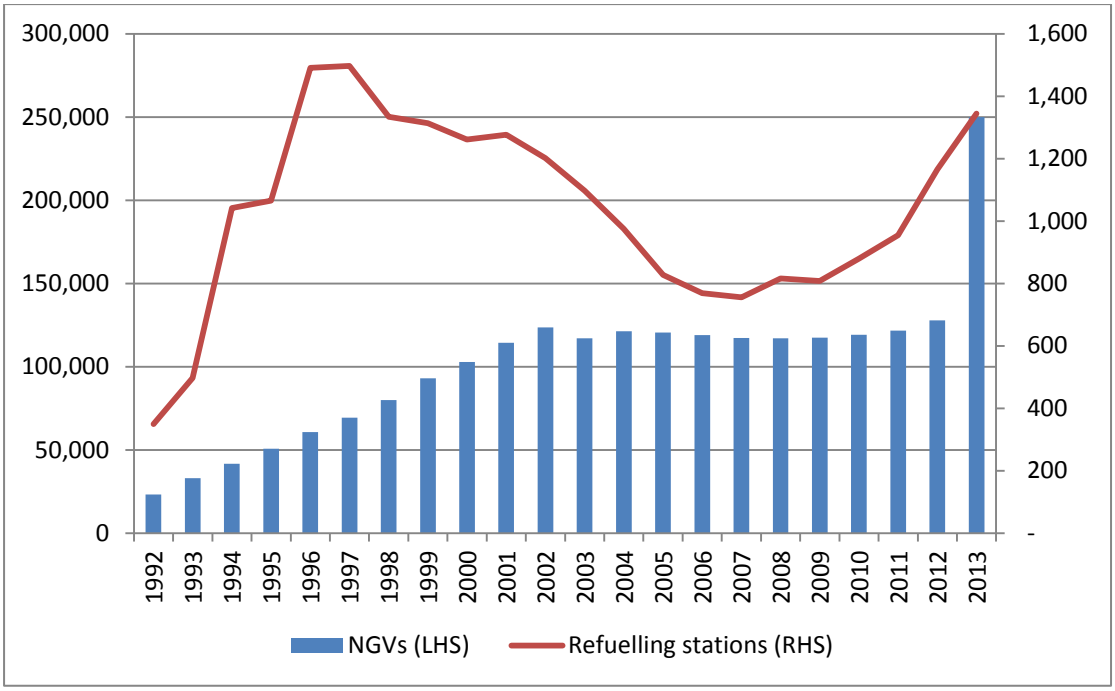
3.2.1 Lack of infrastructure

A reliable network of re-fuelling infrastructure is an important factor needed to facilitate NGV uptake.

In the U.S., there were less than 1000 CNG filling stations in 2011, which is a decline from over 1,400 in 1997. Growth in the US market for NGVs stagnated from 2002 following this decline in refuelling infrastructure, but has since recovered as shown in Figure 3.3.

[55] http://www.marlborough.govt.nz/Environment/Air-Quality/Smoke-and--Smog.aspx
[56] Jayaratne, E. R., et al. "Particle and gaseous emissions from compressed natural gas and ultralow sulphur diesel-fuelled buses at four steady engine loads." Science of the Total Environment 407.8 (2009): 2845-2852.

Figure 3.3 - NGVs and NGV Refuelling stations in the USA



Source: Alternative Fuels Data Centre, Gas Vehicles Report, NGV Global

Australia has experienced a similar decline in refuelling infrastructure over the last 15 years. Fuelling stations are largely being situated in strategic locations for commercial users, rather than dispersed across metropolitan areas to promote uptake in small consumer markets. In line with the availability of refuelling infrastructure, Australian NGV uptake has flattened in the last decade.

3.2.2 Technology

There is currently just one manufacturer making a dedicated LNG-fuelled engine available to the Australian market: Cummins-Westport. The limited choice in the market means that the variety of heavy-duty vehicles that could take advantage of natural gas as a transport fuel source is restricted.

Dual-fuel conversions provide another option, combining some of the cost savings of natural gas with the accessibility of diesel fuel. Of course, the full benefits of a dedicated CNG or LNG system are not fully realised under a dual-fuel system.

After-market conversions offer another opportunity for vehicles, passenger vehicles in particular, but their availability in Australia is limited. In contrast, NGVAmerica, an organisation which aims to develop a growing and profitable NGV market in America, lists hundreds of after-market conversion systems available for vehicles in the USA.[57]

[57] NGVAmerica, Available Vehicles and Engines. Retrieved 10/02/2014 from: http://www.ngvamerica.org/about_ngv/available_ngv.html

3.2.3 Safety concerns

An NGV requires a great deal of structural support to safely house its fuel tanks. These tanks are highly pressurised and must be reinforced if they are to meet Australian regulatory standards. This increases the weight of the vehicle, increasing braking time and distances, as well as reducing fuel efficiency and space available inside the vehicle itself, relative to a conventional ICE vehicle. The development of lightweight fuel tank technologies could mitigate these drawbacks.

Stakeholders suggested that consumers hold concerns about the safety of the fuel tank and its highly combustible contents, as well as range anxiety. In addition, the high purchase price of vehicles, relative to diesel and other petrol vehicles, is a major barrier which, when coupled with generally poor resale value, makes NGVs relatively less attractive to consumers.

3.2.4 Shifting dynamics in Australian gas markets

The scale of price advantage natural gas enjoys over petrol will be dependent on natural gas prices in Australia. For decades, the only market for gas produced in eastern Australia was the domestic one. This resulted in long-term contracts at prices significantly below world prices. These long-term contracts ensured large gas projects in places like the Cooper Basin, Bass Strait and North-West Shelf could be developed, allowing Australian customers to enjoy some of the lowest gas prices in the world.

Two emerging trends are causing shift in the supply and demand dynamics. Firstly, as some of the original reserves run low, production is moving up the cost curve to higher cost fields including unconventional gas sources. Secondly, a vibrant export market has developed, first on the west coast and now on the east, leading to an internationalisation of gas prices.

These trends will not necessarily wipe out the fuel cost advantage but it may reduce it. Notably, in Europe, where gas prices are significantly higher than Australia, there is still a fuel cost advantage.

3.2.5 Up-front cost

The high purchase price of vehicles, relative to diesel and other petrol vehicles, is a major barrier which, when coupled with generally poor resale value, makes NGVs relatively less attractive to consumers.

There is evidence to suggest that NGV buyers underestimate the economic benefits of their investment.[58] Most consumers appear to want a payback period of less than three years for investments in fuel economy.[59] This is generally shorter than the lifetime of a vehicle.

[58] Yeh, op. cit.
[59] Greene et al. 2005, Santini and Vyas 2005.

Existing incentives to move towards gas as a fuel source are directed almost entirely at LPG. The LPG Vehicle Scheme provides $1,000 for converting a vehicle to run on LPG, or $2,000 for the purchase of a new vehicle fitted with LPG before first registration, including vehicles fitted with LPG at the time of manufacture, and vehicles fitted with LPG after manufacture but before it has been registered for the first time. This scheme ends on 30 June 2014.[60]

Including CNG and LNG conversions in these schemes would provide a degree of technology neutrality around conversions rather than preferencing a specific fuel source. LPG may be the most readily accessible alternative vehicle for passenger vehicles in Australia, but that does not mean that it is the only relevant gas technology. The growth of CNG-fuelled passenger vehicles in Europe shows that CNG can be a viable fuel source for passenger cars in Australia.

3.2.6 Fuel taxation

There is also little in the way to encourage natural gas uptake in the heavy duty vehicle sector. Recent increases to fuel excise rates have eroded the price advantage of natural gas compared to diesel. These increases to fuel excise rates for CNG and LNG have been designed so that excise is applied at the same rate per MJ of fuel. Though this would not apply to home refuelling systems.

At first glance, this appears to be a reasonable approach, but not only does this not account for the broader benefits of natural gas as a fuel source – lower carbon monoxide, carbon dioxide, particulate matter and NOx emissions – but it also effectively penalises CNG on a per litre basis. This is because the low density of CNG means that a greater volume is needed to store the same amount of energy compared to using diesel.

3.2.7 Weight restrictions/charges

One of the key trade-offs that needs to be made when considering using an NGV, especially for trucks, is space. CNG and LNG require larger tanks than diesel vehicles. As a result, natural gas fuelled trucks generally have less space available to carry freight and are generally heavier than diesel-fuelled trucks. Due to regulations governing the length of trucks, NGV trucks have to carry less freight. This reduces the economic viability of NGV trucks despite the other benefits they bring.

3.2.8 Lack of clear policy

The lack of clear policy direction from governments at all levels has not allowed for a stable, long-term response from the industry and has provided no certainty to investors. Numerous reviews into subjects such as alternative fuels and fuel security have been conducted, but no coordinated or consistent approach has been developed.

[60] AusIndustry, LPG Vehicle Scheme

The lack of a genuine pathway was highlighted by industry participants in the consultation process for the Strategic Framework for Alternative Transport Fuels who argued that the "the lack of a clear statement of national intent for alternative transport along with apparently inconsistent policies and legislation was sending mixed messages to global providers of alternative transport technologies, the investment community and the general community".[61]

Continual changes to carbon policy, gas policy and fuel excise regimes over the past decade hardly inspire the required confidence for NGV manufacturers to invest in the Australian market. Businesses can manage economic risks such as fuel prices and exchange rates but not the risk of frequently changing government policies.

[61] Department of Resources Energy and Tourism (2011) Strategic Framework for Alternative Transport Fuels, p.44

4. A role for government? Realising the strategic benefits of NGVs

New technologies constantly evolve into consumer markets. The role of government is mostly prudential – to ensure that the safety of consumers is not compromised with the evolution of new technologies. In some cases there are broader, strategic benefits that governments may seek to capture by advancing or facilitating new technologies. The first mobile phone network was developed in Australia by a government owned business - Telecom Australia. Both major parties support government co-ordinating the provision of a national broadband network, they just disagree on the specific method.

This section discusses what strategic benefits would be delivered by an accelerated roll out of NGVs and NGV refuelling stations in Australia.

4.1 Pollution and greenhouse emissions

NGVs have the potential to lower greenhouse gas emissions from the transport sector. Emissions from transport make up around 17 per cent of Australia's total greenhouse gas emissions, with diesel responsible for around 40 per cent (30.4 $MtCO_2$-e) of road transport emissions.[62] The vast bulk of this is from commercial vehicles including trucks, buses and vans.

There are a number of ways that carbon policies could be oriented to recognise the lower emissions profile of NGVs, including economy-wide carbon pricing, vehicle fleet emissions standards differential fuel taxation rates, or qualification for an abatement auction such as the Government's Emissions Reduction Fund. In the latter case, the challenge will be how to aggregate activity such as conversions to LNG or CNG.

A shift to NGVs would also reduce levels of other pollutants such as carbon monoxide (CO), particulate matter and nitrogen oxides (NO_x). As governments seek to find ways to improve environmental outcomes NGVs may become an ideal option to reduce air pollution, especially if replacing diesel fuel.

4.2 Energy security and terms of trade

The value of Australia's imports of crude oil, automotive and diesel fuel totalled more than $32 billion in 2011-12, even though Australia is one of the biggest energy exporters in the world.[63] Over the past decade diesel imports have increased in volume by almost 800 per

[62] Australian National Greenhouse Gas Inventory, 2012 Road Transportation Emissions by fuel
[63] Bureau of Resources and Energy Economics, 2013, Australian Petroleum Statistics No 202.

cent. A shift to vehicles fuelled by a domestic fuel source such as natural gas would reduce this reliance on imported fuels and the risks of price vulnerability due to oil supply constraints.

Australia has substantial natural gas reserves which could be harnessed to provide a low-cost, domestically sourced fuel option for the transport sector through the expansion of the NGV market. In the short term, there are supply concerns as Australia's east coast gas market starts exporting gas and some unconventional gas reserves are locked up due to regulation. Over the longer term, as supply and demand stabilise, a shift to domestically-sourced natural gas presents a real opportunity for Australia.

5. Policy Enablers

Government and industry incentives are important enablers for NGV uptake, as international experience has shown. There are five major types of policy that can be used to encourage the uptake of NGVs (or other alternative fuels). These are:

- Outcome based regulation such as vehicle emissions standards
- Technology- or fuel-based regulation such as mandating catalytic converters, zero emissions vehicles or banning certain fuels.
- Incentive-based policies for consumers such as tax credits and rebates
- Incentive-based policies for suppliers such as research, development and demonstration funding.
- Market creation incentives such as investment in refuelling stations.

Countries that have witnessed strong NGV market growth, such as India, China, Brazil and Italy have offered financial incentives to consumers and equipment suppliers.[64]

Government support and partnership with private investors could help stimulate demand, as could improving home refuelling technology, to reduce the cost and improve the safety and capacity of NGV fuel tanks.

5.1 Developing an NGV market in Australia

With just 3,110 NGVs currently in the Australian market, NGVs are building from a very small base. But NGVs continue to gain market share, almost entirely in the heavy vehicles sector. Bus fleets in Melbourne, Canberra and Perth have CNG-fuelled buses. TransPerth alone operates 365 CNG-fuelled buses.[65] For commercial trucks, Isuzu has four different models of CNG-fuelled trucks on the market.

Expanding the number of NGVs on Australia's roads diversifies the fuel source for the Australian fleet. Reducing Australia's reliance on largely imported oil in favour of domestically sourced gas may have some benefits. It also allows for greater use of existing gas transmission (and distribution) infrastructure.

5.1.1 Encouraging vehicle sales

The fact that vehicle manufacturers are making NGVs available in other markets shows that they are not ignoring natural gas as a fuel source. Australia is currently not a priority market. Under the right economic and policy environment, manufacturers may be more willing to offer a range of NGVs to the Australian market.

[64] Yeh, op. cit.
[65] TransPerth, Buses: Connecting People with Places Fact Sheet

The supply of NGVs could also be boosted by the introduction of vehicle fleet emissions standards. Under such a mechanism, vehicle manufacturers would be compelled to ensure that the average emissions intensity (in g CO_2-e/km) of vehicles sold in a particular year is below a certain level. It could be possible to apply this separately to passenger vehicles and heavy-duty vehicles.

This strategy is being implemented in the European Union for cars and vans. Car manufacturers are obliged to ensure that their new car fleet does not emit more than an average of 130g CO_2/km by 2015 and 95g by 2020.[66]

For vans, the mandatory target is 175g CO_2/km by 2017 and 147g by 2020.[67] The fact that vehicle manufacturers like Volkswagen and Fiat are making natural gas fuelled vans available (see Aside from Italy, other important NGV markets in the EU include Germany (96,349), Bulgaria (61,270) and Sweden (44,321). In contrast to Australia, the European EV market is dominated by light vehicles (98 per cent of the EU NGV fleet).

There are 2,969 CNG refuelling stations in Europe with just a handful of LNG stations. Surprisingly, despite having less than 100,000 NGVs, Germany has a wide network of CNG refuelling stations (915); only 50 fewer than Italy, which has nine times as many vehicles on the road. In addition, there are almost 1,200 small vehicle refuelling appliances across Europe. These allow households to refuel their NGVs at home using their existing gas connection and therefore pay for it through their gas bill. Refuelling times are far longer than at a dedicated CNG refuelling station but this is offset by the convenience of home based charging. Prices for home refuelling can also be higher since gas prices for industrial users are typically lower than for households.

NGV uptake in Europe has been encouraged through a range of support measures such as tax breaks, up front subsidies, incentives for creating biogas, and agreements with governments to adopt natural gas powered buses.

The uptake of NGVs in Europe is being further encouraged by the adoption of stringent emissions standards for new vehicles in order to support the EU's emissions reduction targets. As NGVs produce lower levels of greenhouse gas emissions that petrol or diesel vehicles, they represent an immediate option for meeting the 95gCO_2-e/km target in 2020. The EU's biofuel targets could also support the use of biomethane as a fuel source providing yet another incentive for NGV uptake.

Vehicles manufacturers such as Fiat, VW, Audi and Opel are making passenger NGVs available in the European market. For large vehicles, IVECO, Mercedes-Daimler and Volvo

[66] European Commission, Road transport: Reducing CO_2 emissions from vehicles. Retrieved 18/11/2013 from: http://ec.europa.eu/clima/policies/transport/vehicles/index_en.htm
[67] Ibid.

have models available in Europe, while in Australia, Isuzu has four different NGV trucks available. Table 1.2 below shows some of the NGV models available.

Table 1 1.2) may be a response to these standards.

The European Commission has yet to define a standard for heavy duty vehicles, but is working on a strategy to reduce CO_2 emissions from heavy vehicles in both freight and passenger transport.[68]

Introducing this kind of policy in Australia may be one way to increase the supply of vehicles reaching the Australian market. If applied solely to vans and cars it may have the effect of boosting supply of a range of alternative fuel vehicles including electric vehicles.

Local and state governments may also be able to stimulate demand for vehicles and in turn help provide a market for private investment in refuelling infrastructure by purchasing NGVs. Local and state governments are sometimes for purchasing heavy-duty vehicles such as garbage trucks and buses which are readily able to use CNG or LNG. These are vehicles that use large amounts of fuel which helps to reduce the payback period.[69]

5.1.2 Infrastructure

One of the critical issues will be to expand refuelling infrastructure. There are currently only 5 public CNG refuelling stations around Australia.[70] The general lack of NGV refuelling infrastructure will continue to hamper the development of a wider NGV market. This is a similar 'chicken-and-egg' type situation to the market for electric vehicles: without adequate infrastructure, consumers are less likely to purchase the vehicles, but without enough vehicles on the roads, infrastructure providers are unlikely to provide the necessary investment required.

Accordingly, to support investment in natural gas refuelling infrastructure, government support for upfront capital or fixed revenue agreements could provide infrastructure providers with an incentive to expand in the Australian market.

5.1.3 Informational barriers

Identifying the reasons why businesses are not turning to natural gas as a fuel source, despite the cost savings it can bring, may be a first step towards better understanding what needs to be done to encourage uptake. Governments at both state and federal level can take a key role in studying these barriers. Addressing any informational barriers may also be necessary to encourage further uptake. Despite NGVs having a relatively short payback

[68] Ibid.
[69] Navigant Research, 2013, Medium and Heavy Duty Natural Gas Trucks and Buses, Natural Gas Supply, Refueling Infrastructure, CNG, and LNG: Global Market Analysis and Forecasts
[70] NGVA Europe, Worldwide NGVs & Refuelling Stations, September 2013 Statistics Update.

period, there is evidence that businesses tend to apply a high discount rate, expecting a payback period that is far shorter than the life of the vehicle.

Informational barriers aside, the cost premium of NGVs may also be hindering development of the market despite the lower fuel costs. A variety of policy measures could be used to stimulate demand for NGVs including:

- Purchase price subsidies for consumers, as was applied for diesel technology when it was a developing industry;
- Account for the difference in greenhouse gas emissions across fuel types when setting fuel excise rates, and;
- Discounts and rebates on registration and other taxes.

5.1.4 Gas prices and supply

The price advantage natural gas enjoys over petrol will be dependent on natural gas prices in Australia. As in any market price is a factor of supply and demand. Increasing NGV penetration will increase demand for natural gas so it is crucial that there is adequate supply and that domestic gas markets work effectively to bring the gas to end users.

To ensure gas resource development is sufficient to support both domestic and export demand in the future, it is critical that government policies relating to the exploration and production of unconventional gas resources are carefully considered. In particular, government policies should give adequate consideration to the concerns of local communities, but also focus on the key role that natural gas plays in the Australian economy, both in terms of value creation and as an essential service.

Additionally, the inconsistent treatment of alternative fuels under the fuel excise regime means that the cost of natural gas for transport is higher than for other alternative fuels. Changing excise rates so that the full benefits of natural gas as a fuel source – lower greenhouse gas emissions, particulate pollution and NO_x emissions – are better recognised would also help to improve the cost advantage of LNG.