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nationalgrid

The future of gas

Transport



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Foreword

by Richard Court

Head of UK RIIO Delivery

Did you know 25 per cent of the UK's total greenhouse gas emissions come from the transport sector? And around a quarter of that is directly attributable to road surface emissions from HGVs and buses?



Although emissions are gradually falling, (in 2013 levels dropped by 1.1 per cent thanks to the lower carbon intensity of cars and vans) as the UK economy begins to grow again, and therefore the demand for transport rises, any gains may be outweighed very quickly.

Given the huge impact that the HGV and bus sectors have on overall transport emissions, we need to explore all the options on how we could help this sector to make its contribution.

Here at National Grid we understand there is no silver bullet to achieve a significant reduction in emissions from HGVs and buses overnight. Providing clean, quiet and cheap alternatives to diesel sounds easy, but this is a complex commercial environment, where price sensitivities can be acute; so simply replacing vehicle fleets or retro-fitting engines can't be done without significant planning. However, we think natural gas has a fantastic potential to play a major role in the UK in a similar way to how it has driven benefits in other countries around the world.

The question is, how do we exploit this potential? Do we build new filling stations to ensure alternative fuels are more widely available, or build the vehicle fleet first? And how do we ensure we have enough engineers trained in new technologies to maintain those fleets?

This is a prime area where we need to work together as an end-to-end industry and National Grid is actively taking on some of the challenge of doing this. We are stimulating debate and driving the development of gas as an alternative, green fuel source for commercial vehicle fleets, and have also helped set up the Natural Gas Vehicle network with representatives and expertise from across the supply chain.

In addition, we have a gas transportation network well-placed to connect and create a national filling station infrastructure and are investing in trials because we believe this represents a huge opportunity to use the existing gas network infrastructure. Indeed, we have connected the first commercial compressed natural gas (CNG) refuelling station to our transmission system in Leyland, which is currently being used by the John Lewis Partnership to fuel their fleet of dedicated CNG heavy goods vehicles.

We are also working to raise awareness of other infrastructure that provides a capability for road use of CNG and liquefied natural gas (LNG) including National Grid's own Isle of Grain facility.

In this latest paper in the Future of Gas series, we consider the challenges and opportunities for the use of gas for the transport sector, as well as the investment required, how we tackle hearts and minds at the same time as technology and what the tipping point for take-up might be.

I hope this paper stimulates debate and offers some insight into how National Grid can help tackle transport emissions, because this isn't just our story to tell. I look forward to your feedback and ideas.

The challenge

National Grid's gas transmission network already ensures the safe and reliable transportation of gas to 23.2 million customers around Great Britain; providing millions of households with essential energy for heating and cooking. But could gas also be part of the solution for tackling the decarbonisation of the transport sector?

Currently, 25 per cent of total greenhouse gas (GHG) emissions comes from transport, and of that, around a quarter is produced by HGVs and buses. But because these vehicles actually account for only about 1.5 per cent of all road traffic in the UK, their emissions are disproportionately high. Of course, they are used much more intensively than the family saloon car and relied upon to help deliver the UK's tentative economic growth, so we need them to keep moving day and night, up and down the country.

And it's not just carbon we need to be mindful of; air and noise quality are major issues in most UK cities. Nearly 9,500 people die early each year in London due to long-term exposure to air pollution; and London, Birmingham and Leeds are among the UK cities that have breached EU safety limits on nitrogen dioxide (NO₂) for the last five years. In the USA, heavy-duty trucks comprise about 10 per cent of the total nitrogen oxide (NOx) pollutants.¹ This NOx contributes to the formation of ground level ozone, smog and fine particulates.

As such, the focus on renewable and low carbon energy sources is being taken very seriously by the freight sector. But while the use of CNG for HGVs and buses isn't new, it certainly hasn't reached its full potential. So why is this, and how can National Grid help facilitate and accelerate this decarbonisation?

Vehicles and infrastructure

Put simply, more vehicles and infrastructure – and the supporting supply chain – are needed. But the previous lack of available CNG vehicles is just one of the factors holding up gas as a viable alternative fuel option. Until recently, vehicles had to be retro-fitted to run on CNG, or run on a blend of diesel and CNG.

The current lack of national filling stations to support a bigger fleet of CNG vehicles is also a barrier, with only 15 dedicated sites currently in operation, five of which are public access. Where companies are investing in CNG fleets, they have tended to build their own support infrastructure to realise the benefits.

Finally, a supply chain needs training in new engine technologies to maintain the vehicles, and must be able to manage, supply and transport the fuel itself to support thousands of CNG HGVs and buses. It would also require a policy framework which supports operators who move to gas.

Efficiency and emissions

Natural gas engines produce fewer emissions, have a lower carbon footprint and are 50 per cent less noisy than diesel engines, so they're ideal for enabling night-time deliveries, for example. Tests show they outperform Euro VI diesel engines on NOx, Sulphur Oxide (SOx), Particulate Matter (PM) and CO₂ emissions.²

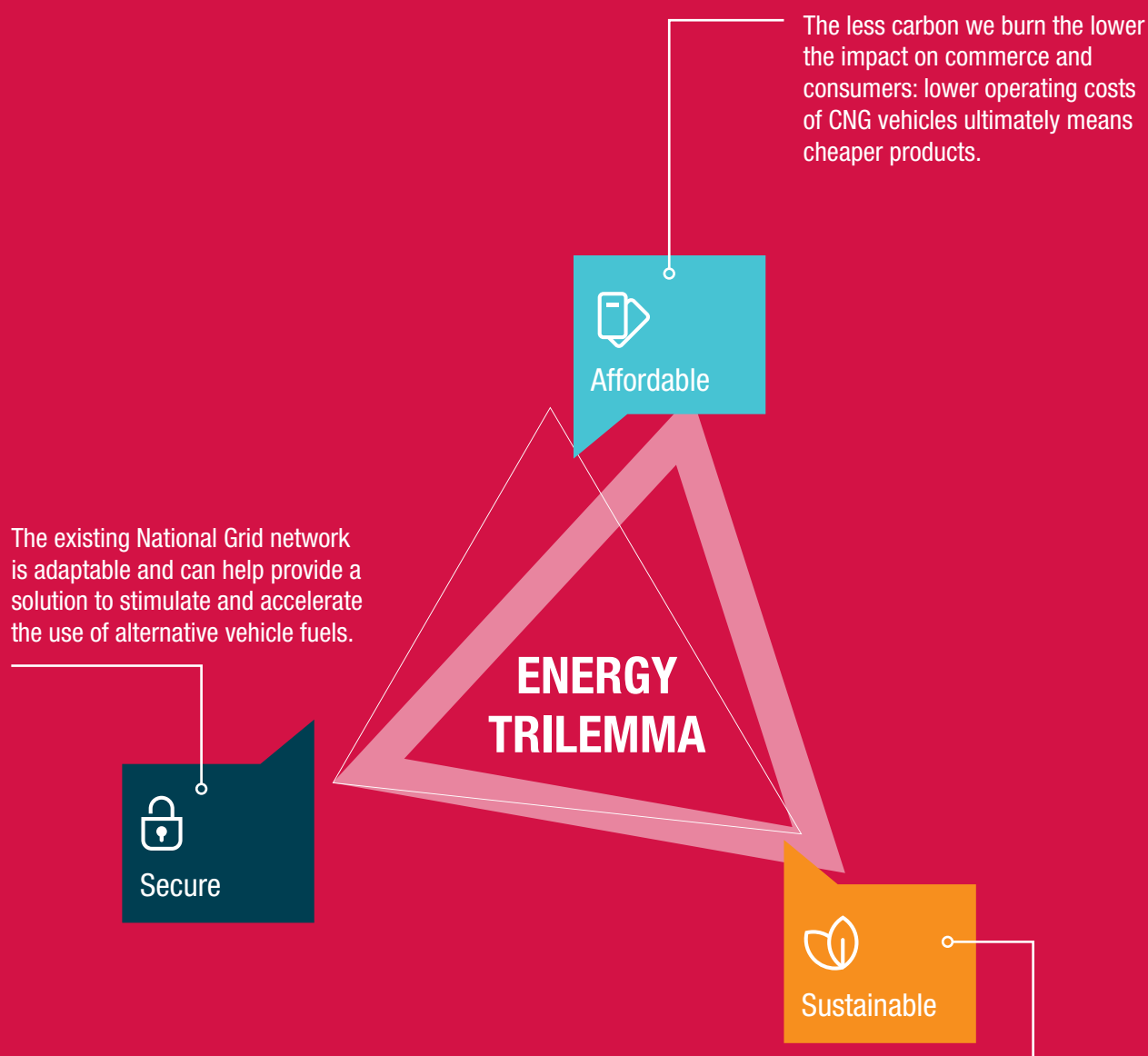
With retro-fitted vehicles, 'methane slip' could be an issue due to incomplete combustion of the methane in the engine, which escapes into the atmosphere. As methane itself is a significant greenhouse gas – more powerful than CO₂ even – any slippage might negate some of the benefits of using gas as a greener energy source for vehicles.

Analysis to date which aims to quantify CO₂ emissions in transport has been inconsistent and contains a number of uncertainties. To address this, the Department for Transport (DfT) has developed a consistent vehicles test protocol, with the Low Carbon Vehicle Partnership carrying out real world mission testing under controlled conditions at facilities including Millbrook Proving Ground. It is hoped that the results from these tests will strengthen the case for CNG for use with trucks and buses.

Driving change

The potential of gas as a road transport fuel is incorporated in the Low Carbon Vehicle Partnership's infrastructure road map to 2030. Having a clear policy framework could make a significant contribution to reducing transport emissions in the medium term.

But of course any move to CNG must work in commercial terms for fleet operators – providing the freight and bus sector with reliable returns on their investment. Getting this balance right between costs, noise and emissions as well as certainty of supply of CNG should attract more and more companies to opt for this lower carbon technology and away from diesel.



Gas: The fuel of choice for HGVs and buses

Of total GHG emissions

25%

are attributed to transport

c.24%

Road surface emissions from HGVs and buses

c.1.5%

of UK vehicles

National Grid believes that gas could and should be the fuel of choice for HGVs and buses in the UK

- Support UK CO₂ reductions and cleaner air in cities
- Thorough utilisation of the gas network into the future
- Gas network forming the backbone of a national filling station infrastructure

A clean, quiet and cheap alternative to diesel

Using compressed natural gas for long haul vehicles will act as a bridge to the low carbon economy by helping to decarbonise the sector and get us on the journey towards 2050. But HGVs could be powered by renewable gas for a hundred years or more and be a truly sustainable alternative.

The story so far

We need to balance an increased energy demand for transport globally with the desire to reduce our dependence on fossil fuels. This requires a mix of alternative fuels to become more readily available, and for vehicles to become more efficient. In this chapter, we look at how alternative fuels have been adopted around the world, in Europe and here in the UK. The question is, what more can the UK learn and do as we strive to meet our demanding emissions targets?

Global perspective

Almost 85 countries from all five continents use natural gas vehicles, and the growth opportunity, as shown in the graph below for China, is significant.

Despite the recent oil price crash, pump prices aren't likely to see any sustained dip and so the economic case for alternative fuels is recognised by more and more governments. Not only are they keen to promote natural gas as a key component in the energy mix, but many will want to break their dependence on imported liquefied

fuels. Even the big oil producing countries, such as Iran or Venezuela, encourage the use of natural gas in their domestic markets to ensure they can export as much of their oil as possible.

In Singapore, the Ministry of Transport passed a law back in 2005 requiring all public transport vehicles - buses, trucks and taxis - to run on CNG, with a green vehicle rebate offered to incentivise take-up. A grant was introduced as far back as 2001 for 40 per cent discounts on the open market value cost of newly registered green passenger vehicles in order to help reach a critical mass of CNG vehicles and then end the incentives.

The graphic illustrates that when there's an appetite, the market will respond very quickly. Beyond Europe there is clearly a mature market for natural gas powered vehicles using trusted technology.

North America

In the United States, CNG products and engine technology have been evolving since the 1980s, and the Natural Gas Vehicle (NGV) market for commercial trucks

and buses has become self-sustaining. Several of the large trucking companies have adopted CNG or LNG, including a major snack food producer. And since 2011, the buses in Los Angeles' transit system have run entirely on CNG.

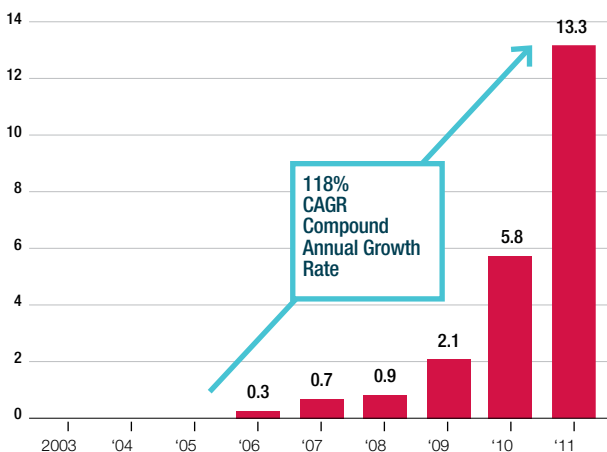
In the heavy-duty, long-haul trucking market, both CNG and LNG are being promoted in certain regions and refuelling infrastructure is being built along key corridors. The current US NGV population is 130,000 and by 2035 that number could increase to 16 million – quite a considerable growth rate!

Recently, Canada has seen significant investment in CNG and LNG vehicle fleets as well as natural gas fuelling stations. Natural gas vehicle adoption is spread across the country with 650 new vehicles in operation in British Columbia, Alberta, Manitoba, Ontario, and Quebec. Of these, 59 per cent are CNG vehicles and 41 per cent are LNG vehicles. Between 2012 and 2014 there has been significant investment with 23 new fuelling stations to serve return-to-base refuelling of transit buses, refuse and highway trucking fleets, as well as the regional trucking corridors.

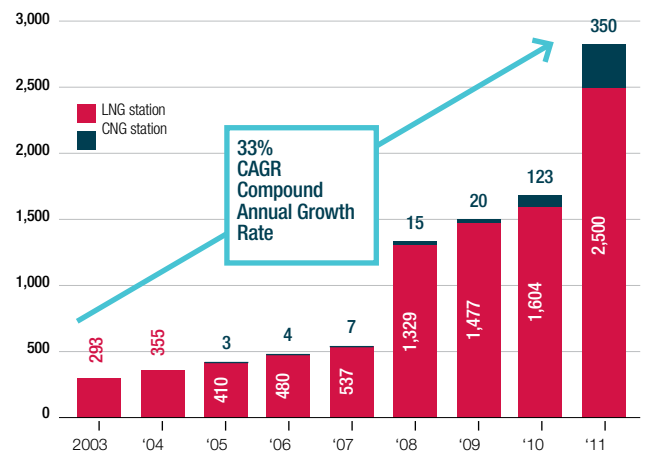
Global truck market opportunity³

The rate of vehicle growth in China is exponential and is supported by a network of filling station that has grown eight-fold.

China LNGV Population (Thousands)



Natural Gas stations in China



Europe

Across mainland Europe, 32 countries host a combined total of over 3,400 CNG/NGV filling stations.⁴ EU policy, supported by the Clean Power for Transport (CPT) package, is pushing for natural gas and biomethane to play a major part in road and maritime transportation. According to Directive 94/2014/EU, Member States will have to develop a National Policy Framework to establish a network of refuelling stations for natural gas vehicles in cities, ports and along the Trans-European-Network for Transport (TEN-T).

Member States have to provide refuelling points for:

- CNG in cities/densely populated areas by 2020
- CNG and LNG along the TEN-T core network by 2025
- LNG in sufficient TEN-T seaports by 2025
- LNG in sufficient TEN-T inland ports by 2030

UK

As we can see from the graphic below the growth of the NGV market around the world has taken off very quickly, but we as a country and indeed in Europe are lagging behind - not just in the HGV and bus sectors but across all vehicle types.

Here in the UK, there are over 700 gas-powered HGVs on the road network, operated by around 25 leading household brands. Additionally, a number of lighter gas powered delivery vehicles are also being used in urban areas and fleets of natural gas powered buses are operating in Reading and Sunderland⁵. This includes John Lewis Partnership, which is running one of the largest alternatively fuelled heavy truck fleets in the UK.

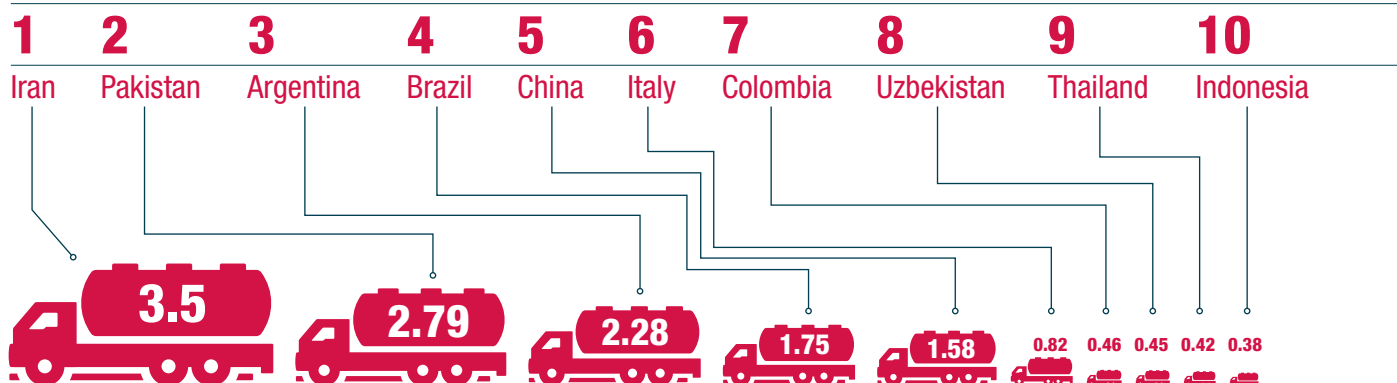
The business case for renewable gas in transport

For renewable methane (bio and synthetic natural gas) used in transport, incentives can be claimed through the Renewable Transport Fuel Certificates (RTFC), which is essentially a subsidy like the Renewable Heat Incentive (see Future of Gas - Domestic Heat chapter). The scheme is currently restricted to gas transported from the source of production straight to the vehicle being fuelled. However, this can place limitations on the use of biomethane, especially where the source of production is located away from the point of demand. This means the fuel would have to be transported by road tanker, diminishing its environmental benefits (the well-to-motion emissions footprint).

National Grid believes RTFCs should apply to bio gas injected into the distribution grid, with a certification scheme to authenticate the source of supply and use. This would remove the need for tankering fuel from production to vehicles, thereby realising the benefits of utilising the gas distribution network for delivering fuel. It would also decouple the geographic restriction of demand and supply, and act as a catalyst to incentivise the use of renewable gases in transport.

Top 10 countries with the largest NGV vehicle fleet – 2013

Registered fleet in millions



World total = 18.09 million NGV vehicles

The story so far

So, whilst the UK may be lagging behind some of our global competitors that certainly doesn't mean that no progress has been made. The Government has invested in testing and modelling and vehicle fleet operators have been working with the energy sector to develop the options and technology that will support us out to 2050.

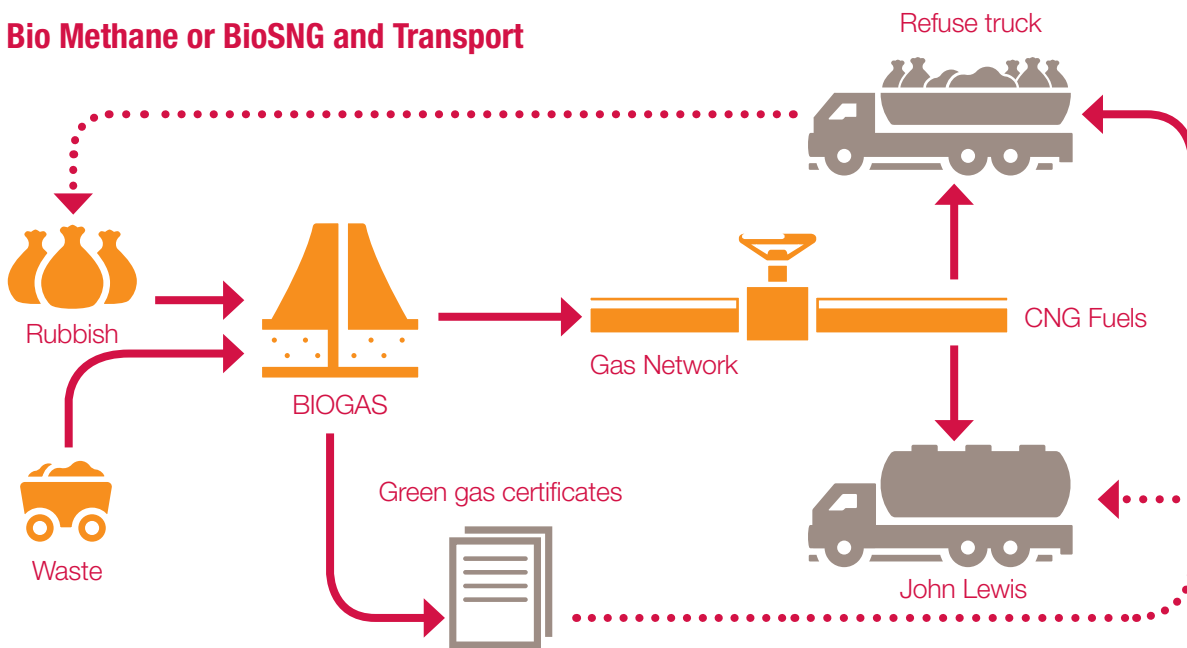
Bio methane or BioSNG and transport

Well-to-motion CO₂ emissions are reduced even further when renewable forms of gas are used as a transport fuel. This can work in the following way:

- Renewable gas made from waste and rubbish injected into the Local Transmission System (LTS), giving a low carbon footprint for the delivery of fuel

- Producers of renewable gasses from waste trade 'green gas certificates' with those wishing to buy 'green gas', thereby authenticating its validity
- Support a circular economy where refuse trucks run on gas from rubbish and supermarkets run delivery trucks on fuel made from waste food.

Bio Methane or BioSNG and Transport



Testing and modelling

The DfT has invested in testing to better understand the benefits of gas versus diesel. The Low Carbon Vehicle Partnership is in the process of carrying out tailpipe emissions testing to compare CO₂ and particulate matter emissions and the efficiency of comparative vehicles fuelled by methane, diesel, and dual fuel.

The Energy Technologies Institute (ETI) has also been working to develop a well to motion model that predicts the carbon intensity of diesel, CNG and LNG from varying sources, through to use on the vehicle.

It is expected that results from the DfT's real-world emissions testing, coupled with the ETI's well-to-motion modelling study, will create a compelling environmental case

for using CNG as a vehicle fuel for trucks and buses, especially if the source of gas is from low leakage, higher pressure gas distribution mains. Indeed, it is thought that vehicles fuelled with CNG from National Grid's LTS will have the lowest carbon footprint of any fossil fuel.

The pros and cons of alternative fuels:

Fuel	Mode and range of transport					
	Road passenger			Road freight		
	short	medium	long	short	medium	long
Electricity	■			■		
CNG	■	■	■	■	■	
Hydrogen	■	■	■	■	■	
LPG	■	■	■	■	■	■
LNG	■	■	■	■	■	■
Biofuels (Liquid)	■	■	■	■	■	■





■ All possibilities ■ Target areas for CNG in UK

Coverage of transport modes and travel range by the main alternative fuels (COM (2013) 17)

Fuel	Mode of Transport (Passenger and Goods)				
	Car: Urban	Car: Long Distance	LCV 20 Delivery	Truck/Bus: Long Distance	Bus: Urban
Today/Future ●/●					
Gasoline	●/●	●/●	●/●	/●	/●
Diesel / Kerosene	●/●	●/●	●/●	●/●	●/●
CNG	●/●	●/●	●/●	●/●	●/●
LPG	●/●	●/●	●/●		
LNG			/●	●/●	●/●
Biodiesel Fatty Acid Methyl Esters (FAME)	●/●	●/●	●/●	●/●	●/●
Advanced gasoline (cell ethanol. butanol)	●/●	●/●	●/●	/●	/●
Hydrogen	/●	/●	/●		/●
Electricity	●/●	/●	/●	/●	/●

Transport modes and technical possible energy carriers for today and in future. European Road Transport Research Advisory Council (ERTRAC 2014)

West Midlands

-  Local Transmission Mains
-  Intermediate Pressure Main
-  Motorway Network Freight Site
-  Distribution depots

Major distribution depots are in close proximity to the existing gas network and the motorway network



How competitive is methane as a fuel

- Industry tells us the payback period for additional cost of natural gas vehicles (dedicated or dual-fuel) has to be less than two and a half years
- The adoption rate surged in North America when the payback period was two years maximum
- Simple calculation:
 - Additional cost of dedicated gas truck = **£30,000** (CNG Fuels estimate)
 - Prevailing diesel price = **£0.85/litre** (Freight Transport Association (FTA) bulk diesel website fuel price)
 - Annual mileage = **100,000 miles**
 - MPG = **9.0**
 - Annual fuel cost = **£42,935**
 - Fuel savings per year for two-year payback = **£15,000, or 35%** below current cost of diesel
- However, a dedicated gas engine is currently around 10 per cent less efficient compared to a diesel engine, so the fuel cost saving has to be closer to 40 per cent to achieve a two-year payback period.

Compressed natural gas

What is CNG?

Compressed natural gas is made by compressing natural gas (mainly methane), to less than 1 per cent of the volume it occupies at standard atmospheric pressure. It is stored at high pressure and can be used in place of petrol and diesel and has many benefits:

- CNG produces lower levels of NOx and particulates than diesel
- CNG produces lower GHG on a well to motion basis compared to diesel, with a saving in the range 10 – 20 per cent from today's CNG trucks.
- CNG vehicles are up to 50 per cent quieter than diesel
- CNG is a cheaper fuel source and can save up to 40 per cent in costs⁶
- CNG is safer than other fuels when there's a spill because natural gas is lighter than air and disperses quickly when released
- CNG can be found above oil deposits; it's also collected from landfills or wastewater treatment plants, where it's known as biogas and is equally suitable for use in CNG vehicles.

How is it used?

CNG is used in internal combustion engine trucks that have been modified or in vehicles which were manufactured specifically for CNG use, either alone ('dedicated'), with a separate gasoline system to extend range (bi-fuel) or in modified diesel engines which burn a mixture of diesel and CNG (dual fuel).

National Grid – a network built to cope

National Grid's existing gas supply network – 284,000km of pipes – has sufficient capacity to support a UK-wide chain of filling stations supplying CNG to commercial vehicles, with no adaption required to meet expected demand. And as the predicted transport load in 2050 is just six per cent of today's demand, the network is built to cope, making CNG a viable long term solution.

Also, the environmental benefits of fuelling trucks with CNG from the National Grid are further improved when filling stations are connected to pipelines within the network that operate at higher pressure than those supplying domestic properties. The LTS has near-zero leakage, so the environmental footprint is reduced compared with traditional fossil fuels that emit CO₂.

Case study

In March 2016, CNG Fuels, in partnership with National Grid, unveiled a new state-of-the-art filling station in Leyland, Lancashire, enabling vehicles to fill up with CNG directly from the high-pressure LTS. The new facility is the first of its kind in the UK and is capable of refuelling more than 500 HGVs per day.

Located near to junction 28 on the M6, the CNG filling station will be accessible all day, every day throughout the year. The facility also supplies 100 per cent renewable biomethane (Bio-CNG) and is an important part of the UK's rapidly growing CNG refuelling infrastructure. The biomethane is made from waste at anaerobic digestion plants and delivered to the filling station through the National Grid pipeline system.

Waitrose has a regional distribution centre less than one mile from the new CNG filling station and will be its anchor customer. John Lewis Partnership is committed to running a sustainable logistics operation, and the use of low carbon fuels in our vehicle fleet is a key element of that. This filling station is an important step that will help us continue to improve our fleet sustainability.

Tail pipe v Well-to-Motion (WTM) emissions

DfT Emissions testing project

Gas fuelled HGVs offer potential CO₂ savings but these might be offset by engine efficiency losses and methane slip (dual fuel conversions). No methane slip from new dedicated CNG Euro 6 trucks.

WTM CO₂ emissions are reduced even further when renewable forms of gas are used as a transport fuel.

- Injected into the LTS system so no processing or shipping CO₂ implications
- Waste food or rubbish turned into gas that fuel transport

- Producers of waste trade 'green gas certificates' with those wishing to buy 'green gas', thereby authenticating its validity
- Examples: refuse trucks running on rubbish, supermarkets running delivery trucks on waste food.



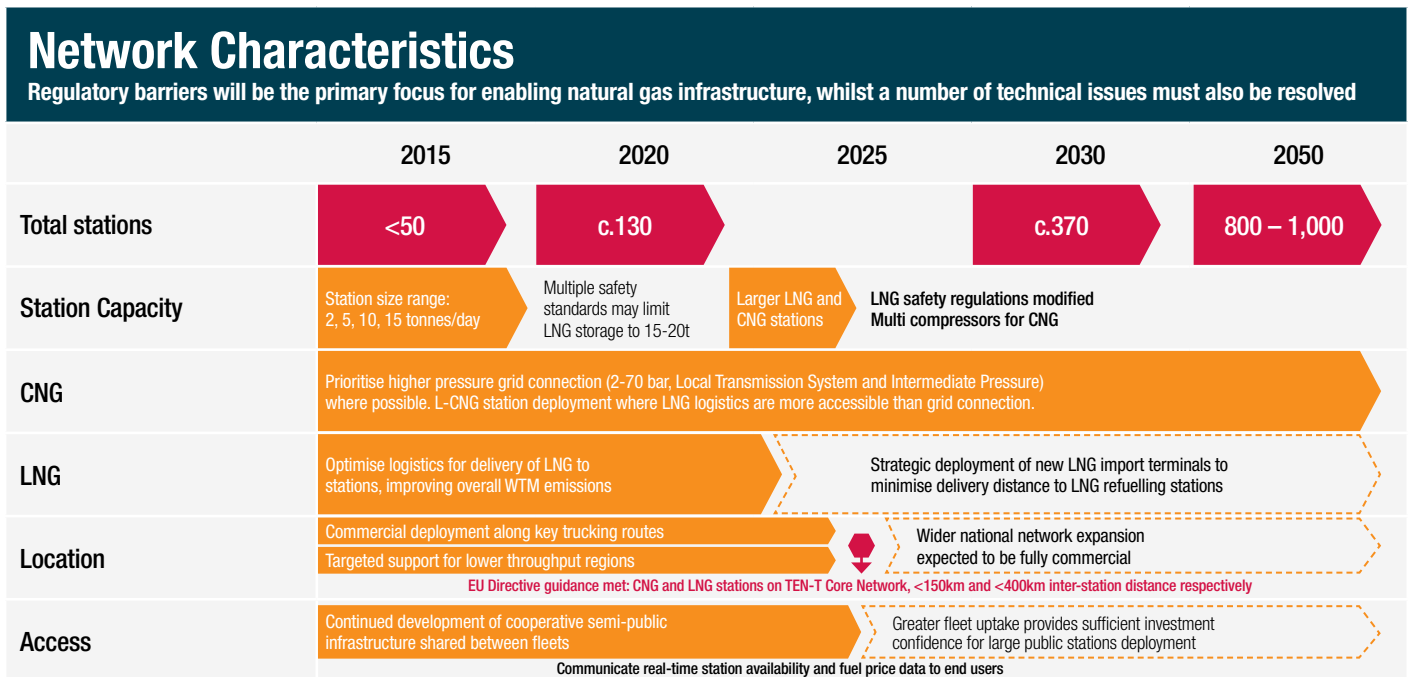
The future

Providing clean, quiet, affordable alternatives to diesel is a complex challenge that goes beyond simply replacing vehicle fleets or retro-fitting engines. However, the future is ours to influence, and the key is working in partnership with industry, technology innovators and the Government towards a shared vision of a future transport network powered by cleaner energy.

Towards a critical mass

What comes first – the vehicles, or the filling stations to supply alternative fuels? And how do we ensure we have a network of engineers trained to maintain new technologies? As is the way for emerging technologies, the tipping point for CNG will happen through a combination of investment, innovation and commercial viability. The will of policy makers is also an important factor.

We don't know the answers to all these questions but the roadmap below aims to demonstrate the key points in time for decisions to be made and actions taken to ensure that we can support an alternative fuel fleet and meet our sustainability targets.



Hydrogen powered vehicles

Throughout the Future of Gas series we have explored about the option to introduce hydrogen into the gas network. If we do choose to move to a hydrogen economy there is also a potential role for hydrogen powered vehicles:

- Hydrogen is finally coming on stream as a viable fuel to power vehicles
- Two decades after they launched petrol-electric hybrids, Toyota recently started producing fuel-cell vehicles, underlining its plan to eliminate petrol













and diesel vehicles from its fleet by 2050. Other car manufacturers are also investing in hydrogen.

- Fuel-cell technology – which is effectively hydrogen-electric hybrids – is also being developed by other car manufacturers who see it as an integral part of a fossil-free future.
- In California, the authorities are investing heavily in filling stations on the 'hydrogen highway' which will eventually stretch from Canada to Mexico.⁷

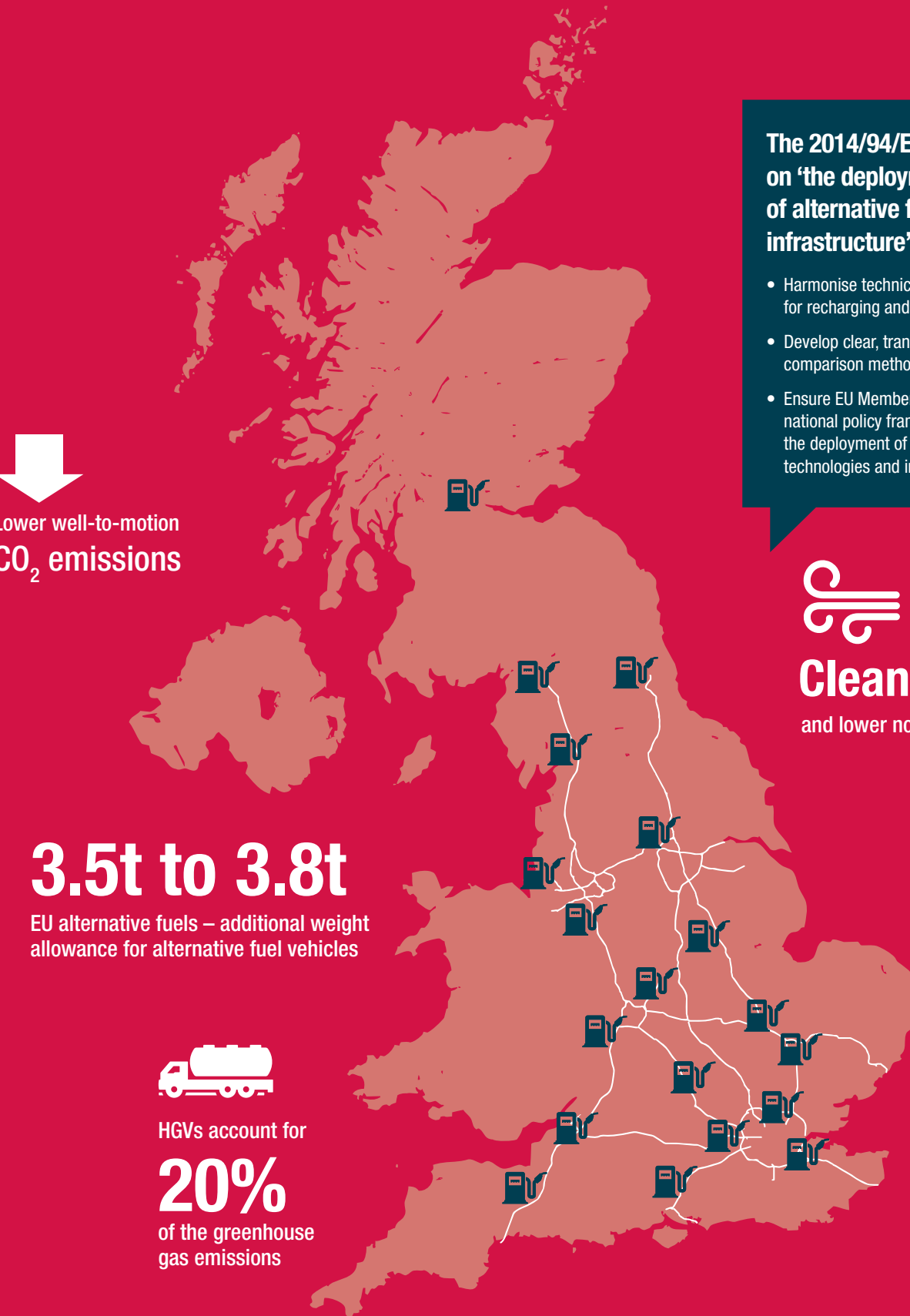


“John Lewis Partnership is committed to running a sustainable logistics operation, and the use of low carbon fuels in our vehicle fleet is a key element of that. Our strategy is to displace diesel with bio-methane where practical, and we run one of the largest alternatively fuelled heavy truck fleets in the UK to enable us to do that. This filling station is an important step that will help us continue to improve our fleet sustainability.”

Justin Laney, Central Transport General Manager for the John Lewis Partnership

	2020	▶	2030	▶	2050
Vehicle stock: (no. of buses)	c.2,000:		c.10,000:		c.17,000:
Energy demand: (tonnes/year)	c.50,000:		c.220,000:		c.340,000:
Required stations:	c.80 (2t per day, 80% utilisation)		c.130 (5t per day, 90% utilisation)		c.200 (5t/day, 90% utilisation)
Vehicle stock: (no. of HGVs)	c.8,000:		c.50,000:		c.190,000:
Energy demand: (tonnes/year)	c.200,000:		c.1,000,000:		c.4,000,000:
Required 10t per day stations:	c.45 (15t per day, 90% utilisation)		c.230 (15t per day, 90% utilisation)		c.800 (15t/day, 90% utilisation)

CNG: Benefits case



Lower well-to-motion
CO₂ emissions

The 2014/94/EU directive on 'the deployment of alternative fuels infrastructure' aims to:

- Harmonise technical specifications for recharging and refuelling stations
- Develop clear, transparent fuel price comparison methodologies
- Ensure EU Member States develop national policy frameworks to support the deployment of alternative fuel technologies and infrastructure.



Cleaner air

and lower noise levels



40%

fuel cost saving compared with diesel

3.5t to 3.8t

EU alternative fuels – additional weight allowance for alternative fuel vehicles



HGVs account for

20%

of the greenhouse gas emissions

Call to action

Here in the UK, the gas network stands ready to deliver green fuel to help decarbonise transport and ensure a secure and affordable supply. This will also help the UK government to meet its commitment to reduce total emissions by at least 80 per cent in 2050 from 1990 levels.

The next step is to deliver a national filling station infrastructure and a supply chain to support it. National Grid has started this in Leyland by connecting the first commercial CNG refuelling station to the transmission system; and on the Isle of Grain, operating an LNG depot which is of strategic national importance to UK energy infrastructure.

Life after oil

We can no longer plan around fossil fuels; it is not a long term secure source, it is not sustainable, and as it runs out will become more and more expensive. Vehicle manufacturers know this, and it is why for the last 20 years or more they have been developing petrol-electric, hydrogen-electric and other types of hybrid power units.

We are calling on the Government, technology innovators, the road transport industry and vehicle manufacturers to work together to implement the infrastructure to deliver alternative fuel solutions. There are many views about how BioSNG and other natural gas should be used, but we believe there is a major opportunity to achieve significant benefits from using CNG to power commercial vehicles.

Small investment, big return

Building the infrastructure covering all major UK trucking routes for at least 100 HGV friendly CNG refuelling stations will require an investment of around £150 million. The funding could be shared between private companies and the Government, and over time, these stations could dispense increasing amounts of renewable gas.

Urgent actions for the UK Government

- Investment support is needed, but not in the form of incentives
- Invest £150 million in LTS connected CNG stations so least 100 HGV friendly refuelling stations are built covering all major UK trucking routes
- Encourage and incentivise the use of natural gas vehicles in the transport mix
- Improve tailpipe emissions testing and imposing sanctions on failing vehicles
- Enact the EU Weights and Dimensions Directive
- Allow B licence holders to drive 3.5 tonne category delivery vehicles with additional weight of low emission technology, i.e. increase to approximately 3.8t
- Support for use of biomethane via Green Gas Certificates (so hauliers can book GHG savings in their carbon reporting)
- Preferred access for gas vehicles in low emission zones
- Allow night time deliveries for low noise NGVs
- Encourage public sector fleet procurement to consider alternatively fuelled vehicles
- Increase the differential fuel levy between diesel and gas pump prices

Investment

- Support needed from Government for R&D but not incentives
- Fuel price differential must be maintained because CNG trucks are slightly more expensive to buy than diesel equivalent
- Weight allowance for vans
- Support for QUIET trucks to be allowed to deliver into cities at night – CNG ideal for this
- Support for use of biomethane via Green Gas Certificates (so hauliers can book GHG savings in their carbon reporting).

References

1. Edmond Toy, a Ph.D. candidate at Harvard University, Cambridge, Mass.
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6. <http://www.cngfuels.com/why-cng/#cost-savings>
7. The Sunday Times, 29.11.2015

Addressing the demands of the energy trilemma will not be easy, but when it comes to the use of natural gas for transport we need to work together to achieve a critical mass and find the tipping point where investment, commercial viability and technologies converge.



Other publications in this series

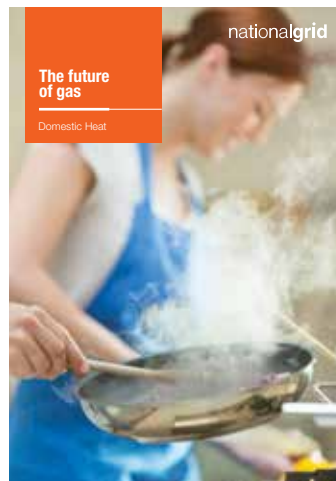
The Future of Gas series seeks to address the challenges and opportunities to help the UK move towards a low carbon economy. These include efficiency measures that customers can take to reduce their consumption, and new sources of gas that could deliver energy in a more sustainable way. Look out for the following publications:



Introduction to the Future of Gas
Overview of the challenges in meeting the UK's carbon reduction targets



Supply of renewable gas
The benefits of renewable gas in relation to the energy trilemma



Domestic heat
How gas networks can help deliver low carbon solutions to heat our homes



Network capability
How our networks and network investment will look in the future
Coming soon

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