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MORGAN STANLEY BLUE PAPER

Natural Gas as a Transportation Fuel

Energy Market Wild Card

Oil is still the dominant fuel for transportation, but natural gas is becoming competitive. Natural Gas Vehicles (NGVs) only make up ~1.5% of the global automotive fleet. However, with global natural gas resources now exceeding 240 years of consumption and gas prices at sharp discounts to oil in the US and Europe, NGV popularity could grow. The technology is well developed, environmental benefits meaningful, and the economics attractive in many cases.

If NGVs reach a 'tipping point', this could alter the outlook for oil & gas demand. So far, growth in the NGV fleet has been concentrated in emerging markets, despite many of those countries having neither the largest gas reserves nor the lowest gas prices. Those dynamics are more favourable in parts of the developed world, particularly the US. If developed markets become a second source of NGV growth, we estimate this could displace 1.5 - 4.5 mb/d of gasoline/diesel demand over the next 10 years. However, this could be as much as ~5.6 mb/d in a 'Blue Sky' scenario.

But there are obstacles. The rollout of refuelling infrastructure remains the most significant barrier, but there are a large and growing number of initiatives to address this.

Who could benefit? If this trend plays out, equipment manufacturers such as Dresser-Rand and Chart Industries look well placed. Higher gas prices would benefit holders of large natural gas resources including many US E&P companies, Royal Dutch Shell and Gazprom in Europe, and Reliance Industries and Santos in Asia-Pacific.

MORGAN STANLEY RESEARCH
Global

Martijn Rats, CFA[1]
Martijn.Rats@morganstanley.com
+44 (0)20 7425 6618

Haythem Rashed, CFA[1]
Haythem.Rashed@morganstanley.com
+44 (0)20 7425 9943

Adam Longson, CFA, CPA[2]
Adam.Longson@morganstanley.com
+1 212 761 4061

Pavel Sorokin[3]
Pavel.Sorokin@morganstanley.com
+7 495 287 2312

Ole Slorer[2]
Ole.Slorer@morganstanley.com
+1 212 761 6198

Vinay Jaising[4]
Vinay.Jaising@morganstanley.com
+91 22 6118 2252

Evan Calio[2]
Evan.Calio@morganstanley.com
+1 212 761 6472

Stuart Baker[5]
Stuart.Baker@morganstanley.com
+61 3 9256 8929

Jessica Alsford, CFA[1]
Jessica.Alsford@morganstanley.com
+44 (0)20 7425 8985

Stuart Pearson, CFA[1]
Stuart.P.Pearson@morganstanley.com
+44 (0)20 7425 6654

Robert Pulleyn[1]
Robert.Pulleyn@morganstanley.com
+44 (0)20 7425 4388

Igor Levi, CFA[2]
Igor.Levi@morganstanley.com
+1 212 761 3232

***See page 2 for all contributors to this report**

[1] Morgan Stanley & Co. International plc+
[2] Morgan Stanley & Co. LLC
[3] OOO Morgan Stanley Bank+
[4] Morgan Stanley India Company Private Limited+
[5] Morgan Stanley Australia Limited+

Morgan Stanley Blue Papers focus on critical investment themes that require coordinated perspectives across industry sectors, regions, or asset classes.

Contributors to this Report

European Integrated Oil & Refining

Martijn Rats, CFA[1]	+44 20 7425 6618	Martijn.Rats@morganstanley.com
Haythem Rashed, CFA[1]	+44 20 7425 9943	Haythem.Rashed@morganstanley.com
Jamie Maddock[1]	+44 20 7425 4405	Jamie.Maddock@morganstanley.com
Paul Loudon[1]	+44 20 7425 7049	Paul.Loudon@morganstanley.com
Aaditya Chintalapati[1]	+44 20 7425 9761	Aaditya.Chintalapati@morganstanley.com
Sasikanth Chilukuru[1]	+44 20 7425 3016	Sasikanth.Chilukuru@morganstanley.com

EEMEA Oil & Gas

Pavel Sorokin[3]	+7 495 287 2312	Pavel.Sorokin@morganstanley.com

European Oil Services

Robert Pulleyn[1]	+44 20 7425 4388	Robert.Pulleyn@morganstanley.com
Jessica Alderson[1]	+44 20 7425 9237	Jessica.Alderson@morganstanley.com
James Lamb[1]	+44 20 7425 0749	James.Lamb@morganstanley.com

North America Oil Services, Drilling & Equipment

Ole Slorer[2]	+1 212 761 6198	Ole.Slorer@morganstanley.com
Igor Levi, CFA[2]	+1 212 761 3232	Igor.Levi@morganstanley.com
Fotis Giannakoulis[2]	+1 212 761 3026	Fotis.Giannakoulis@morganstanley.com
Benjamin Swomley, CFA[2]	+1 212 761 4248	Benjamin.Swomley@morganstanley.com
Jacob Ng[2]	+1 212 761 5676	Jacob.Ng@morganstanley.com

North America Integrated Oil & Refining

Evan Calio[2]	+1 212 761 6472	Evan.Calio@morganstanley.com
Todd Firestone[2]	+1 212 761 7674	Todd.Firestone@morganstanley.com
Jacob Dweck[2]	+1 212 761 6172	Jacob.Dweck@morganstanley.com
Manav Gupta[2]	+1 212 761 8194	Manav.Gupta@morganstanley.com

Asia Pacific Oil & Gas

Vinay Jaising[4]	+91 22 6118 2252	Vinay.Jaising@morganstanley.com
Stuart Baker[5]	+61 3 9256 8929	Stuart.Baker@morganstanley.com
Wee-Kiat Tan[6]	+852 2848 7488	Weekiat.Tan@morganstanley.com
Mayank Maheshwari[7]	+65 6834 6719	Mayank.Maheshwari@morganstanley.com
Rakesh Sethia[4]	+91 22 6118 2253	Rakesh.Sethia@morganstanley.com
Vanessa d'Souza[4]	+91 22 6118 2245	Vanessa.DSouza@morganstanley.com

Global Commodities

Adam Longson, CFA[2]	+1 212 761 4061	Adam.Longson@morganstanley.com
Chris Corda[2]	+1 212 761 6005	Chris.Corda@morganstanley.com

Sustainable & Responsible

Jessica Alsford, CFA[1]	+44 20 7425 8985	Jessica.Alsford@morganstanley.com

European Autos & Auto Parts

Stuart Pearson, CFA[1]	+44 20 7425 6654	Stuart.P.Pearson@morganstanley.com
Laura Lembke[1]	+44 20 7425 7944	Laura.Lembke@morganstanley.com

Asia Utilities

Vincent Chow, CFA[6]	+852 2239 1588	Vincent.Chow@morganstanley.com

1 Morgan Stanley & Co. International plc+
2 Morgan Stanley & Co. LLC
3 OOO Morgan Stanley Bank+
4 Morgan Stanley India Company Private Limited+
5 Morgan Stanley Australia Limited+
6 Morgan Stanley Asia Limited+
7 Morgan Stanley Asia (Singapore) Pte+

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Natural Gas Vehicles: The Energy Market Wild Card

What is the opportunity?

Gasoline and diesel are still the dominant fuels for transport, but this could change as natural gas is increasingly becoming competitive. Exploration success and technological innovation have boosted global gas resources to ~240 years of current consumption, natural gas is priced at a 45-75% discount to oil in the US and Europe, and Natural Gas Vehicle (NGV) technology exists and is tried and tested.

With input from our global oils, autos and commodity teams, this Blue Paper explores the potential for natural gas to gain share from oil in the last but most entrenched 'oil bastion', the transport market.

How significant could it be?

In many cases, the economics of switching to natural gas are compelling, particularly for return-to-base fleets such as courier trucks, buses, taxis, etc. as well as heavy duty trucks that do high annual mileage. The payback period on the additional investments in a 'Class 8' Liquefied Natural Gas (LNG) truck for example can be as short as 2-3 years. In a hypothetical scenario in which all Class 8 trucks in the US were fueled with LNG, annual savings of $40-70 billion could be realised, we estimate.

NGV penetration in emerging markets (EM) is currently ~3.6%. Developed markets (DM) lag this considerably with just ~0.2% penetration. If the share in emerging markets were to improve to ~5% (i.e. in-line with Brazil currently) and the share in DM were to increase to 1-2% (in-line with Sweden, Italy), this could boost gas demand by 8-16 billion cubic feet per day (3-5% of current global gas demand) but shave off 1.5-2.7 million barrels per day of gasoline/diesel demand (3-6% of global gasoline/diesel demand). If 30% of US medium and heavy duty trucks were to switch to natural gas, this could increase to 26 bcf/d (8% of global gas demand) and 4.5 mb/d (9% of global gasoline/diesel demand), but this still requires a number of obstacles to be overcome.

Whether the number of NGVs will pass the 'tipping point' at which adoption accelerates is still uncertain. However, if it does, its impact on oil & gas demand is likely to be large.

Who could be the winners?

Selected equipment manufacturers could be well placed to benefit from broader NGV adoption, including Chart Industries and Dresser-Rand. Also, higher natural gas prices would benefit major gas resource holders, including many E&P companies in the US, but also Royal Dutch Shell and Gazprom in Europe, and Reliance Industries and Santos in Asia-Pacific.

Natural gas is now relatively cheap and abundant…

Discoveries of new conventional gas fields alone have been sufficient in recent years to replace nearly all of the world's natural gas consumption. In addition, reserve estimates for previous discoveries continue to increase and the 'shale revolution' has unleashed substantial unconventional natural gas resources. The IEA estimates that technically recoverable gas resources now stand at ~28,000 tcf globally, which is equivalent to ~240 years of current consumption, substantially ahead of oil.

In addition, natural gas is also much cheaper than oil on an energy-equivalent basis, particularly in Europe and the US. The Henry Hub natural gas price of ~$4/mmbtu is at a ~75% discount to WTI, for example. European hub prices are somewhat higher, but ~$10/mmbtu is still at a ~45% discount to Brent. Only spot LNG import prices into Asia at ~$16/mmbtu come close to oil prices.

… and 'tried-and-tested' technology is making it more viable as a transport fuel

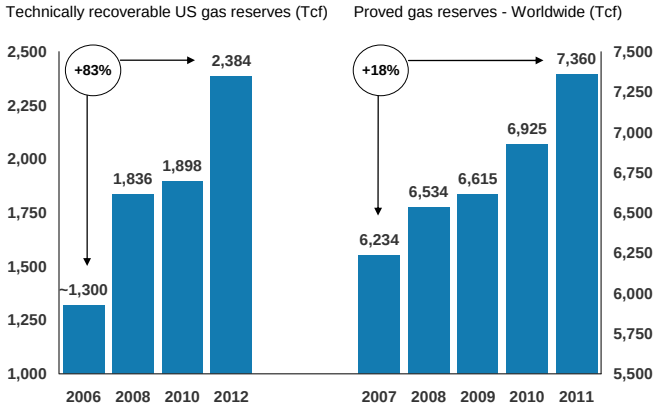
Its low price and increased availability has already made natural gas more competitive in other markets. For example, gas has already taken market share from coal in power generation in the US. Yet, these additional sources of demand have so far been insufficient to absorb all excess production.

In the transportation market, natural gas has so far not played a meaningful role, but NGV technology has been available since at least the 1930s and is already relatively mature. Increasingly, car manufacturers are offering versions of existing models that can run on compressed natural gas (CNG). In Europe, this includes Fiat, Lancia, Mercedes, VW, Seat Skoda, Audi, Volvo and Saab. In the US, the offering is more limited, but Honda, Ford, General Motors and Chrysler have various CNG cars in their fleets, and after-market conversion systems are available for a wide range of models. In China and India, there more than 50 models of CNG vehicles on offer and after-market conversions are common.

The same holds for trucks: several OEMs offer natural gas fueled models, including Volvo, Scania, Daimler and Iveco, and others can be converted using third-party engines. Similarly, converting natural gas into LNG or CNG is relatively straightforward.

Exhibit 1

Global gas reserves have risen sharply …



Source: Potential Gas Committee, BP Statistical Review of World Energy

So far, NGV adoption has been driven by emerging markets, including China and India …

The global NGV fleets currently stands at ~16 million units, including ~700,000 buses and ~360,000 medium and heavy duty trucks. The number of NGVs worldwide has been growing relatively strongly at a compound annual rate of ~15% since 2008. Still, this is off a small base: NGV share of the global car fleet still only stands at ~1.5%.

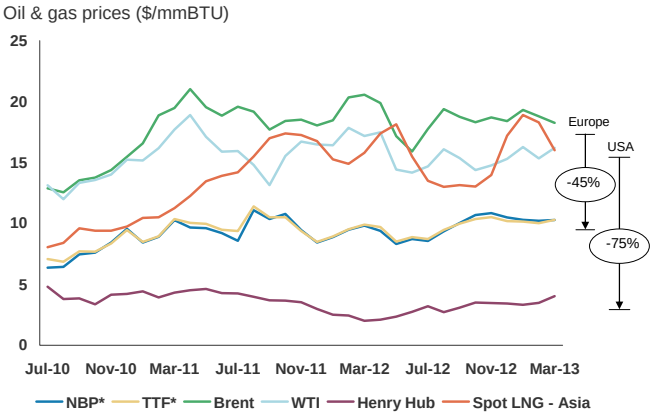
So far, the global NGV fleet has been concentrated in emerging markets. Based on data from NGVA Europe, we estimate that the penetration of NGVs in emerging countries is ~3.5%, more than double the global average. This is offset by penetration in developed markets of merely ~0.2%.

Emerging countries have also been the main drivers of growth of the global NGV fleet in absolute terms: for example, China's NGV parc has increased from ~0.4 million at end-2008 to ~1.2 million currently, a CAGR of 37%. Similarly, India's fleet has increased 24% p.a. over this period from ~0.7 million to ~1.5 million units. Other countries that have added substantially to their NGV fleet are Pakistan (+1.1 million units since late 2008), Argentina (+0.4 million) and the Ukraine (+0.3 million).

In many of these countries, there are strong government incentives in place that stimulate adoption of NGVs. These are usually introduced to reduce import dependence on oil and/or reduce pollution (e.g. Mumbai, Beijing). As a result, governments in emerging countries have so far been more supportive of NGVs than their counterparts in developed markets.

Exhibit 2

… leaving gas at a discount in Europe and the US



* Month ahead
Source: Thomson Reuters, Datastream

… but the economics appear attractive in many developed markets too

Growth trends in China, India, and Argentina for example, are well established and with current government incentives in place, we expect those to continue. It is noteworthy, however, that many of the countries with the largest and fastest growing NGV fleets have neither the largest gas reserves nor the lowest gas prices.

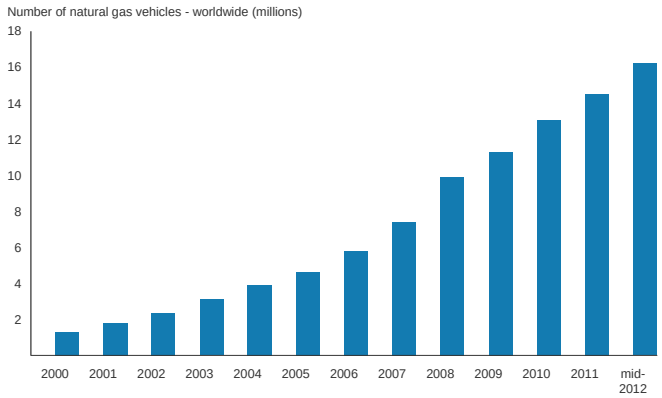
Natural gas is particularly cheap and abundant in the United States, and also Europe is, on the whole, better supplied than most countries topping the NGV fleet chart. In principle, this creates potential for those developed markets to become a second source of NGV growth.

Below we attempt to show that the economics of switching to natural gas for transportation can be very attractive in those markets. Our analysis focuses on the US market, partly because its gas resource base has grown particularly quickly and its gas prices are at the largest discount to oil. However, we have also focused on the US because it offers greater availability of data for analysis. Nevertheless, we believe that the conclusions for the US also broadly hold true for other developed countries.

In the United States, there are now ~1,074 CNG stations (of which ~500 are privately owned), up from ~816 three years ago. The average CNG price at these stations is currently ~$2.10/gge[1], which is a ~36% discount to the average gasoline price across the US of $3.29/gallon

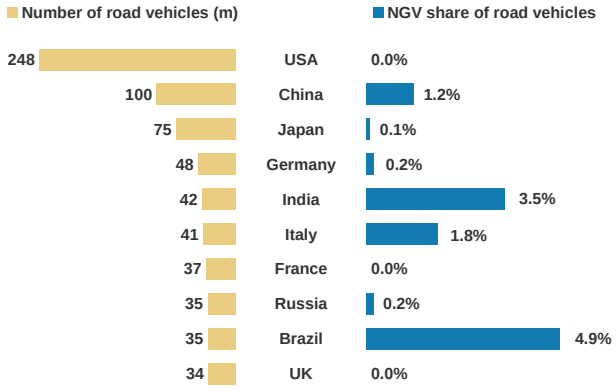
[1] Gasoline gallon equivalent (~114 mbtu)

Exhibit 3
The NGV fleet has grown 15% p.a. since 2008 …



Source: NGVA Europe

Exhibit 4
… but is still a small part of the global vehicle parc



Source: NGVA Europe

The number of LNG stations is more limited at ~28 but set to expand rapidly to ~150 by end 2013. LNG prices at those stations typically range from $2.5-3.0/dge[2] at the moment. Again, this is well below the current average diesel price of $4.13/gallon across the US (30-40% discount).

Whether current market prices are still indicative of future prices if LNG and CNG sales volumes reach much higher levels is an important question. An in-depth study by the National Petroleum Council late last year estimated the full cost of dispensing CNG at $1.60-2.20/gge, and $2.1-2.3/dge even at larger scale. This assumes a natural gas price of $4/mmbtu (or $0.5/gge), but this represents only a quarter of these fully dispensed prices. Therefore, even if Henry Hub prices move higher towards $5-6/mmbtu, CNG and LNG will likely remain at large discounts to current gasoline and diesel prices.

The 'sweet spot' for NGV adoption are fleets of return-to-base vehicles, such as buses, taxis and refuse trucks, as well as heavy duty trucks with high annual mileage. We have had a detailed look at the economics of 'Class 8' LNG trucks compared to their diesel-fueled equivalents and found that the payback period of the additional investment can be relatively short: the additional investment for a truck to run on LNG is typically around $78,000-$91,000. Assuming annual mileage of 100,000-120,000 miles and an LNG price of $2.5-3.0/dge, annual fuel savings quickly reach $19,000-$33,000 on a diesel price of $4.13/gallon. At this rate, the payback period is around 3-4 years, achieving a 5-year IRR of 40% on the incremental investment. Also buses and refuse trucks, which typically achieve high annual mileage, seem to come close to these economics.

For CNG cars, the savings are generally less attractive but are still compelling in many instances. At current retail prices, we estimate the premium for a CNG car at around $4,000. For drivers that exceed 15,000 miles (~24,000 kilometres) a year, the payback on that investment falls below five years if gasoline prices exceed $3.6/gallon – as they already do currently in 27 of the 51 US states and in 96 of its 166 largest cities.

We base our estimates on the current additional costs for a vehicle with a natural gas engine and fuel system. The scale of manufacturing of that equipment is still relatively small. If NGVs gain market share, those costs would likely fall, which, all other things equal, would reduce the payback period further.

Exhibit 5
Still, the economics can be attractive, for example for long-distance 'Class 8' trucks

Additional investments	**Low**	**High**
Engine	$26,000	$39,000
Fuel System	$52,000	$52,000
Additional investment ($k)	**$78,000**	**$91,000**
Cost saving and payback		
Miles travelled/year	100,000	120,000
Fuel Efficiency (mpg)	6.0	6.0
Fuel consumption (gal)	**16,700**	**20,000**
LNG price ($/dge)	$3.00	$2.50
Diesel price ($/gal)	$4.13	$4.13
Annual savings ($k)	**$18,800**	**$32,600**
Payback (years)	**4.5**	**2.6**

Source: National Petroleum Council, company data, Morgan Stanley Research

[2] Diesel gallon equivalent (~129 mbtu)

Current initiatives in selected countries

In many emerging countries, government efforts to stimulate NGV adoption have resulted in a large number of small-scale gas to transport projects and initiatives. Whilst not material on their own, collectively, these add up to a significant effort on the part of the emerging countries. Below we highlight some recent examples.

China

- Hainan Province plans to add 100 CNG and LNG stations by 2014.
- Dongguan in Guandong Province plans to have 60 CNG and LNG stations by 2020.
- Lianyungang and Xuzhou Provinces provide a 2,000 Yuan (US$350) subsidy to car owners for retrofitting.
- In 2010, Xingjang Guianghui targeted to produce/convert 30,000 LNG-powered vehicles and build 300 LNG filling stations within the next 3-5 years.
- 10 LNG filling stations and ~100 mobile stations are planned along the Yi Chang – Wuhan Central route.

India

- Agartala in Tripura, Northeast India, plans to make all vehicles run on CNG by the end of 2013.
- Indraprastha Gas Limited plans to come up with 32 new CNG stations every year across various cities.
- A court order in Mumbai has banned all old trucks in the city that don't run on CNG.
- Andhra Pradesh state government has set a directive to ensure at least one-third of the 6,000 buses to be purchased in the next 3 years operate on CNG.

Pakistan

- The federal government is to provide a Rs 2.5 billion (US$25 million) subsidy for 4,000 CNG buses in Karachi over 5 years.
- Around 15-20 mega CNG refuelling stations are expected to be built in Karachi to facilitate the buses.
- The public transport company of Lahore plans to incorporate 2,000 new natural gas-powered buses.

Thailand

- •The Transport Ministry of Thailand aims for 15,000 more taxis to switch to bi-fuel CNG/petrol systems.
- •Import duty exemptions and reduced excise taxes have recently been implemented for CNG conversion kits, CNG refuelling facilities and NGV engines.

Economics plus upcoming regulation could also incentivize the use of natural gas to fuel ships

LNG is also a fuel option for ships, and may become more attractive after upcoming changes in regulation. The International Maritime Organisation has declared that all vessels sailing in so-called Emission Control Areas (ECAs) must reduce the sulphur level in fuel oil to 0.1% or clean the exhaust gas to the equivalent level by 2015. A similar reduction could be enforced worldwide by 2020. In practice, shipping vessels will have three options: 1) use marine gas oil; 2) install a 'scrubber'; or 3) switch to LNG. In a recent joint study on container vessels, Germanishe Lloyd and MAN calculated that LNG is likely to be the most economically attractive option in many cases. Payback periods depend heavily on vessel size and time spent in ECAs, but were less than two years in many of their scenarios (relative to the use of marine gas oil).

The environmental case is sound – with one catch

Transport generates 13% of global greenhouse gas emissions. On an energy-equivalent basis, burning natural gas produces almost no sulphur dioxide and 30% less carbon dioxide and 80% less nitrogen oxide than burning oil. Therefore, using natural gas as a transport fuel should significantly reduce harmful pollutant emissions from the burning of oil-based fuels.

But, there is a catch. These figures assume that during the extraction and production process of natural gas little or no methane leaks into the atmosphere. Natural gas is ~90% methane, and the US EPA estimates leakage rates at around 2.4% from various stages of the production process. This matters, because one molecule of methane is able to trap over twenty times more heat than one molecule of carbon dioxide. Recent studies suggest that methane leakage rates above 2-3% would probably negate the environmental benefit of burning natural gas as a fuel. Cost-effective technologies that reduce methane leakage rates to below 1% would therefore be needed to ensure the environmental benefits of switching to natural gas.

Key obstacle is a lack of refuelling infrastructure …

Getting the gas from the well head to refuelling sites requires major infrastructure investment. We estimate that adding CNG capability to an existing petrol station costs ~$0.4 million, whilst building a CNG fueling station on a new site requires an investment of ~$1.6 million. For LNG, the cost of refuelling infrastructure is even higher, at $1.4-2.2 million per station. LNG stations also need to be located within 150-300 miles of a small to mid-sized LNG liquefaction plant.

To get NGVs to the 'tipping point' where large-scale adoption takes place, we assume that the US, for example, requires no

more than ~3,000 LNG and ~50,000 CNG refuelling stations, i.e. the equivalent of ~30% of the existing conventional refuelling stations. With unit costs as estimated above, this implies a total investment of $5-8 billion in LNG fueling stations and ~$50 billion in CNG stations. In addition, we estimate $30-60 billion would be required to build sufficient small to mid-size LNG liquefaction plants.

… but there are also obstacles to overcome at the micro-level

Building the necessary infrastructure will require both time and investment, but with sufficient visibility on demand and supportive economics, these barriers appear surmountable. However, particularly in the case of US trucking, there are other barriers to consider.

In the US, the heavy duty trucking industry is highly fragmented, with a large number of carriers owning less than 20 trucks. Although the payback period can be short, the initial investment in an LNG-fueled truck is still nearly twice that of a conventional, diesel-fueled truck. With access to credit still limited for many of those players, many may not be able to finance the initial investment.

Also, trade-in value is an important part of the purchase economics of small carriers. The average truck will have 3-4 owners before being retired. LNG as a fuel typically has less wear and tear on engines, but the resale value of LNG-fueled trucks is not yet well established, which introduces additional uncertainty.

Finally, our analysis does not yet capture the additional overheads of running a fleet of both LNG and diesel-fueled trucks. This is difficult to estimate, but could mean payback periods are longer than we have estimated. UPS, for example, is converting some of its fleet to natural gas, but has indicated that it also sees much potential in Gas-to-Liquids (GTL) in the US, precisely to avoid this problem.

Several investment projects are already under way

Corporates and governments are already engaged in projects to promote the adoption of natural gas as a transport fuel. At the forefront is the US where we see a number of projects designed to overcome the key hurdle of lack of refuelling infrastructure. Shell, for example, has announced plans to build two small-scale liquefaction units in North America, forming the basis of two new LNG transport corridors in the Great Lakes and Gulf Coast regions. Clean Energy is constructing 'natural gas highways' and aims to build LNG fuel stations along every major interstate trucking corridor with a target to reach 150 LNG fuel stations by the end of 2013. Chesapeake's 'CNG in a box' system allows easier adoption of CNG refuelling for fuel retailers and fleet operators.

In China, ENN Energy Holdings is a first mover in terms of CNG and LNG refuelling stations in the country. The company aims to add 30-40 CNG stations each year and over 100 LNG filling stations in 2013.

In Europe, Eni, the Natural Gas Vehicle Association of Europe and the European Union are collaborating on the LNG 'Blue Corridors' project to develop LNG refuelling infrastructure across four pan-European long-distance truck routes. Royal Dutch Shell and Volvo recently announced a collaboration to use LNG as a transport fuel for Volvo's heavy duty commercial trucks, with Volvo targeting a new 13-litre LNG engine for its long-haul fleet by next year.

There are also developments in the shipping segment. Royal Dutch Shell recently launched the first LNG-powered barge that will operate on the Rhine. These barges carry enough LNG to sail for up to seven days without refuelling, and also help to meet strict emissions standards in coastal and inland shipping areas.

What initiatives are already going on?

Around the world, both corporates and governments have already announced or implemented a wide range of initiatives designed to increase the adoption of natural gas as a fuel in transportation.

Below we outline some of the key projects:

- Shell is establishing two North American LNG trucking corridors.
- Volvo and Shell are collaborating to use LNG in heavy duty trucks in North America and Europe.
- Chesapeake and GE have launched a 'CNG in a box' system to allow easier adoption of CNG refuelling.
- Shell has contracted two new LNG-powered barges to operate on the Rhine from 2013.
- FedEx plans to convert the majority of its 90,000 US ground vehicles to CNG/LNG in the next few years.
- MAN Diesel & Turbo has received first orders for its dual fuel ME-GI gas powered engine.
- Volkswagen announced it is launching a new CNG-powered Golf called the "TGI BlueMotion" this summer.
- The Beijing Public Transport Group in China recently announced ~3,200 new LNG buses for its fleet in 2013.
- BNSF announced last month it plans to test a small number of locomotives in the US using LNG this year.
- Clean Energy is currently targeting to reach150 LNG fuel stations in the US in 2013.

Exhibit 6
How will NGV growth impact oil & gas demand?

	NGV penetration (%)		NGV fleet	Nat gas
	EM	DM	size (mln)	use (bcf/d)
Current situation - baseline				
Cars and LD trucks	3.7%	0.2%	15.2	3.2
MD+HD Buses	10.0%	2.9%	0.7	2.4
MD+HD Trucks	1.0%	0.2%	0.4	1.3
Total	**3.6%**	**0.2%**	**16.2**	**6.9**
Scenario 1 - DM goes to Sweden				
Cars and LD trucks	3.7%	0.9%	36.3	7.6
MD+HD Buses	10.0%	2.9%	1.4	5.0
MD+HD Trucks	1.0%	0.2%	0.8	2.7
Total	**3.6%**	**0.9%**	**38.5**	**15.3**
Incremental gas demand				8bcf/d
Incremental gasoline/diesel displaced				1.5mb/d
Scenario 2a - EM goes to Brazil; DM goes to Italy				
Cars and LD trucks	5.0%	2.0%	54.5	11.4
MD+HD Buses	15.0%	2.9%	2.1	7.4
MD+HD Trucks	1.5%	0.2%	1.1	3.9
Total	**4.9%**	**1.9%**	**57.7**	**22.7**
Incremental gas demand				16bcf/d
Incremental gasoline/diesel displaced				2.7mb/d
Scenario 2b - Scenario 2a + US gas trucking revolution				
Cars and LD trucks	5.0%	2.0%	54.5	11.4
MD+HD Buses	15.0%	2.9%	2.1	7.4
MD+HD Trucks	1.5%	13.1%	4.1	14.2
Total	**4.9%**	**2.4%**	**60.7**	**33.0**
Incremental gas demand				26bcf/d
Incremental gasoline/diesel displaced				4.5mb/d
Scenario 3 - Blue sky				
Cars and LD trucks	6.9%	2.0%	70.2	14.7
MD+HD Buses	18.7%	10.0%	2.8	9.8
MD+HD Trucks	1.9%	13.1%	4.4	15.2
Total	**6.7%**	**2.4%**	**77.4**	**39.6**
Incremental gas demand				33bcf/d
Incremental gasoline/diesel displaced				5.6mb/d

Source: NGVA Europe, IEA, BP, OPEC, Morgan Stanley Research

Natural gas could displace 1.5 – 5.6 mb/d of gasoline and diesel demand by 2021

With compelling economics for many vehicle owners and a large number of industry initiatives in place to stimulate take-up of natural gas, we foresee further growth in the global NGV fleet, despite some of the obstacles. An important question is how this will impact demand for oil & gas?

At the moment, the global NGV fleet consists of ~16.2 million units, of which ~15.2 million cars and light duty trucks, ~0.7 million medium and heavy duty buses and ~0.4 million medium and heavy duty trucks. Based on standard consumption figures (180Nm3/month of natural gas for light duty vehicles and 3,000Nm3/month for medium and heavy duty vehicles), we estimate that this fleet currently consumes ~6.9 bcf/d in natural gas, which likely displaces ~1.2 mb/d of diesel and gasoline combined already.

From this we have modeled four scenarios, which are described below. In each one, we assume the vehicle fleet in developed countries to grow at a trend rate of 1% p.a. and in emerging countries at 8% p.a. over the next 10 years.

- **Scenario 1: 'DM goes to Sweden':** Average NGV penetration in developed countries is still a very low 0.2% but several countries are well ahead of this. In scenario 1, we assume the NGV share of the vehicle fleet in DM goes to 0.9%, on a par with the current penetration of Sweden, over the next 10 years. In emerging countries, the NGV share of the market stays stable at 3.6%. This drives the number of NGVs from ~1.1 million to 6.3 million in DM, and from ~15.1 million to ~32.3 million in EM over the next 10 years. This scenario would likely drive incremental gas demand of ~8 bcf/d, displacing another ~1.5 mb/d of gasoline and diesel demand.

- **Scenario 2a: 'EM goes to Brazil; DM goes to Italy':** NGVs are currently already 2% of the car and LD truck fleet in Italy. In scenario 2a, we assume that the developed world converges to this level. This would increase the number of NGVs in DM from 1.1 million to 13.8 million over the next 10 years. Incidentally, this would be the same growth in absolute terms over the next 10 years that the emerging countries have seen during 2000-10 (i.e. from ~1.2 million in 2000 to ~13.0 million in 2010). In emerging countries, penetration converges to the current level in Brazil of 4.9%, which would yield ~44 million NGVs in EM. In this scenario, we see incremental gas demand of ~16 bcf/d and another 2.7 mb/d of gasoline/diesel displaced, compared to the baseline.

- **Scenario 2b: 'US Trucking Revolution'**: Given the favourable economics of switching to natural gas for at least part of the US trucking fleet and various projects ongoing to drive this change, there is some probability of accelerated adoption. Scenario 2b has the same underlying assumptions as scenario 2a with the exception that ~30% of US medium and heavy duty trucks adopt natural gas. The current MD/HD trucking fleet in the US consists of ~9.0 million units, which we assume will increase to ~10 million over the next 10 years. An adoption rate of 30% suggests that ~3 million MD/HD trucks are fueled by natural gas in 10 years. Compared to the , the global NGV fleet would consume an incremental 26 bcf/d of natural gas, displacing ~4.5 mb/d of gasoline and/or diesel in this scenario.

Exhibit 7
Impact from NGV growth on oil & gas demand: four possible scenarios

Scenario 1 – 'DM goes to Sweden'

- The global vehicle fleet grows 1% p.a. in developed countries but at 8% p.a. in emerging countries.
- In developed markets, NGVs reach 0.9% of the fleet, similar to the share in Sweden today.
- In Emerging countries, NGVs stay stable at 3.6% of the vehicle fleet.

Scenario 2a – 'EM goes to Brazil; DM goes to Italy'

- Market penetration in DM increases to ~2%, similar to the current situation in Italy
- In emerging markets, NGVs become ~5% of the fleet, in-line with current penetration in Brazil

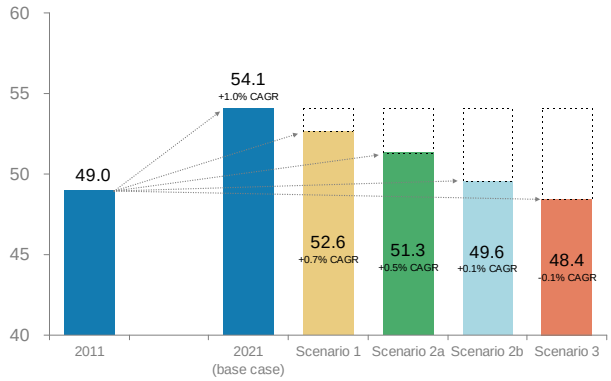
Scenario 2b – US Gas Trucking Revolution

- In addition to scenario 2a, 30% of medium- and heavy-duty trucks switch to natural gas.

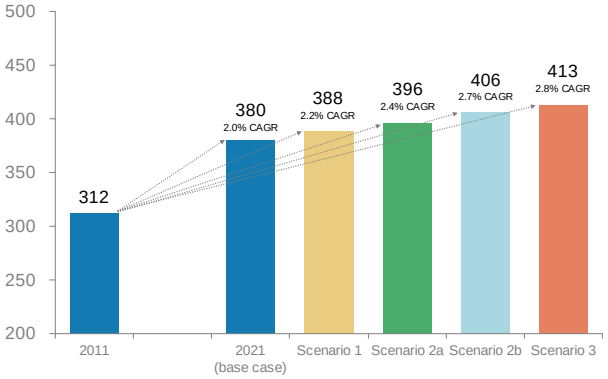
Scenario 3 – Blue Sky

- In addition to scenario 2b, market penetration amongst buses in developed markets increases from 2.9% to 10%, similar to current share in emerging markets.
- In emerging markets, the NGV fleet continues to grow at 15%, in-line with the growth rate in recent years. As a result, NGVs reach 6.7% of the fleet in EM.

Global gasoline & diesel combined demand growth under various NGV adoption scenarios
mb/d



Global natural gas demand growth under various NGV adoption scenarios
bcf/d



Source: Morgan Stanley Research

- **Scenario 3: 'Blue Sky'**: The NGV fleet has grown ~15% p.a. since 2008 in emerging countries, but in all of the three scenarios above, we assume this will slow down to ~8%, in-line with total fleet growth in EM. However, even in EM the penetration is still low and NGV growth may still be disconnected from overall fleet growth. If the NGV fleet continues to grow at its current trend rate of ~15% p.a. but total EM vehicle growth slows down to 8%, NGVs would increase their share from 3.6% to 6.7% over the next 10 years. On top, in this 'Blue Sky' scenario we assume that NGV adoption for buses will increase in developed markets. We believe the economics of natural gas are attractive in many cases for bus operators, including in developed markets. In emerging markets, ~10% of buses are already fueled by natural gas, but in developed countries, this is still only 2.9%. In this 'Blue Sky' scenario we assume that the NGV share of the bus fleet in DM converges to the current level in EM over the next 10 years. For cars and trucks in DM, this scenario uses the same assumptions as scenario 2b. In this scenario, NGVs globally consume another 33 bcf/d, displacing an incremental 5.7 mb/d of gasoline/diesel demand.

Projections for oil demand growth from the IEA, EIA, OPEC, BP and CERA all centre around 1% p.a. over the next 10 years. For natural gas, most forecasts are around 2% p.a. As far as we have been able to observe, those forecasts tend to assume little impact of greater adoption of natural gas vehicles (except BP's forecast, which incidentally assumes higher gas demand growth of ~2.5% to the end of the

decade). Assuming this is indeed the case, Exhibit 8 outlines what each of the scenarios above would do to global gasoline/diesel and gas demand growth.

Exhibit 8

How could NGVs affect gasoline/diesel and gas demand growth over the next 10 years?

Annual growth next 10 years (%)	Gasoline/diesel demand	Gas demand
	1.0%	2.0%
Scenario 1	0.7%	2.2%
Scenario 2a	0.5%	2.4%
Scenario 2b	0.1%	2.7%
Scenario 3	-0.1%	2.8%

Source: Morgan Stanley Research

Three factors can speed up NGV adoption

For the more optimistic scenarios above to materialize, NGV use needs to surpass a level that allow economies of scale and network benefits. Three factors could bring a meaningful boost to NGV adoption, in our view:

- **Reduction in the cost of equipment:** The lack of refuelling stations remains a key argument against switching to a natural gas vehicle. Yet, building out this infrastructure is capital intensive and can only be justified if there is sufficient certainty of demand. If economies of scale and/or technological progress were to allow the cost of fueling equipment to fall, this deadlock could be broken more quickly. This also holds true for CNG/LNG engines and fuel systems.

- **Better access to capital:** Many companies that own trucking fleets or plan to build refuelling stations are relatively small and often poorly capitalized. Despite low interest rates, access to credit remains challenging for many.

- **Government incentives:** The United States government currently provides some tax relief on the construction of NGV fueling property and allows a 50 cent/gallon tax credit on alternative fuels, which includes CNG and LNG. Certain other incentives are in place in other countries around the world. Whilst further government support may not be necessary, it could stimulate NGV adoption meaningfully.

Two broad sectors could benefit

The use of natural gas as a transportation fuel still has many obstacles to overcome, but there are also powerful drivers in place towards greater adoption. Whether NGVs will be able to pass the 'tipping point' remains uncertain for now. However, if it does, the impact on oil & gas demand and prices will be meaningful. In that scenario, several companies look set to benefit substantially.

1. Equipment manufacturers and service providers exposed to global natural gas markets. Higher demand for natural gas vehicles and the associated refuelling infrastructure would benefit components manufacturers. Several companies stand out: Chart Industries produces LNG fuel tanks for example, and Westport manufactures natural gas engines.

Also, Dresser Rand produces portable liquefaction plants used to convert pipeline gas into LNG at refuelling stations. Clean Energy is currently rolling out CNG and LNG fueling stations across the US. In Europe, Technip is a leader in small scale LNG, which would be critical in rolling out LNG refuelling infrastructure. In Asia, ENN operates 203 natural gas refuelling stations in 50 cities in China.

2. Large holders of natural gas resource, particularly in the US. A global increase in adoption rates of natural gas vehicles could have a meaningful impact on natural gas demand, as discussed. All else equal, this would probably narrow the wide discount between natural gas prices and oil-linked fuel prices. US gas prices could potentially re-rate more than in other regions, given the clear opportunities to expand the use of natural gas in its transport system and the fact that the US Henry Hub gas price is one of the lowest spot gas prices in the world. In that scenario, large gas resource holders, particularly in the US, could therefore see some valuation benefit.

This includes a potentially large number of companies, but amongst our coverage universe, we highlight Noble Energy and Range Resources in the US, Royal Dutch Shell in Europe and Reliance Industries in Asia. BG, ENI, Gazprom, BPCL, Santos and Karoon Gas all have exposure to tightening gas markets outside the US, or to a tightening LNG market, in the event that demand for liquefaction capacity increases significantly.

Increased use of natural gas as a transportation fuel could however increase the overcapacity that already exists in the global refining sector. Therefore, refiners might be adversely impacted by this development.

Exhibit 9

Companies exposed to the NGV growth theme

Resource Holders	US	Chesapeake Energy* NobleEnergy Range Resources
	EMEA	BG Group ENI Gazprom Royal Dutch Shell
	Asia Pacific	BPCL ENN Energy Karoon Gas Reliance Industries Santos
Equipment Suppliers	US	Chart Industries Clean Energy* Dresser Rand Westport*
	EMEA	Technip

Source: Morgan Stanley Research
*Not covered

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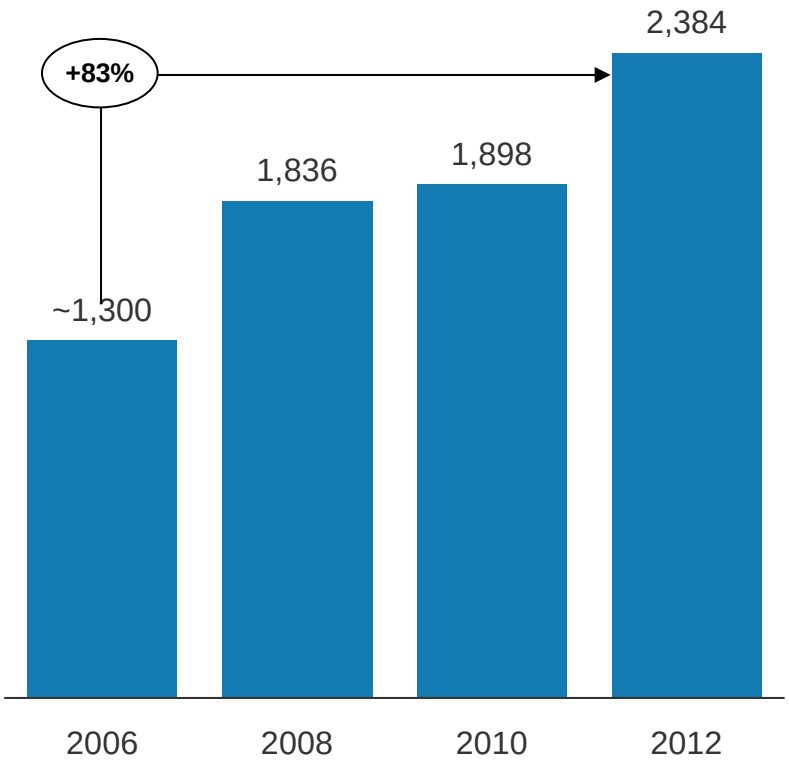
Exploration success and technological innovation have boosted natural gas reserves

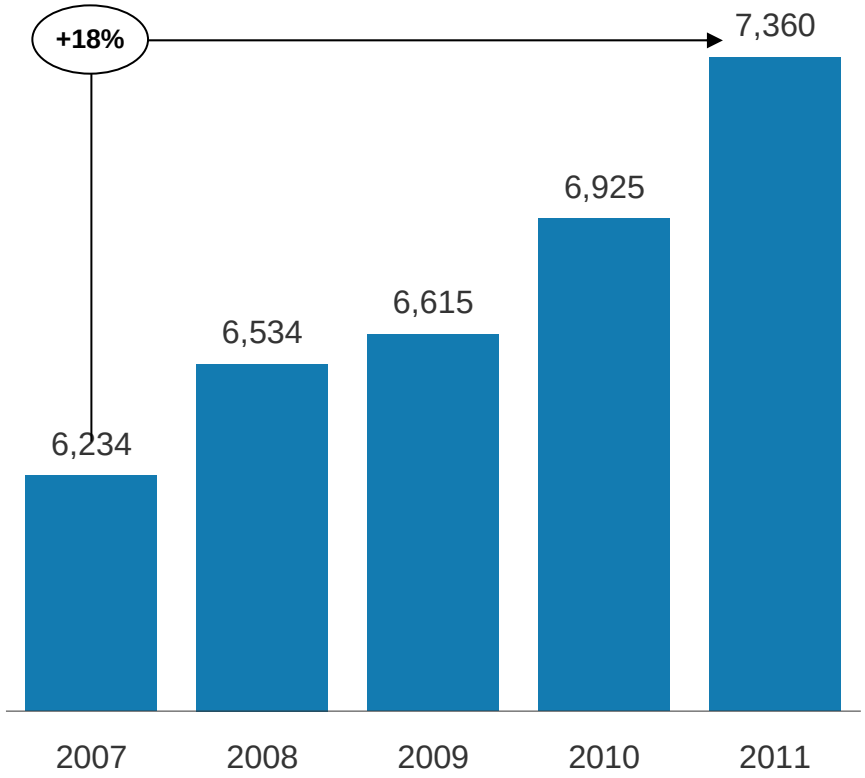
US Gas Resource – Potential Gas Committee estimates

Tcf



Proved gas reserves - worldwide

Tcf



Source: Wood Mackenzie, BP Statistical Review

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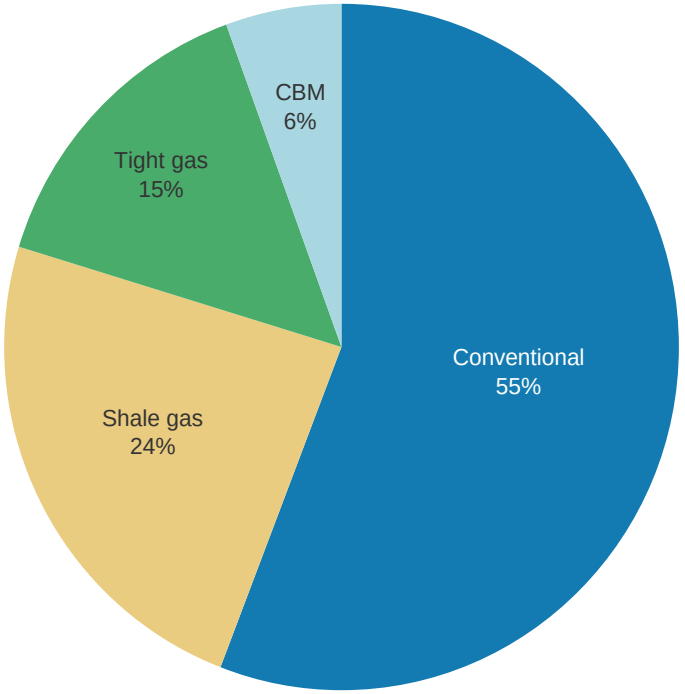
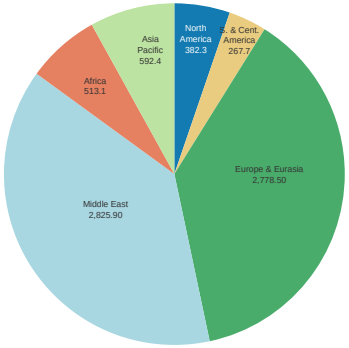
Technically recoverable reserves stand at ~240 years of consumption

Natural gas reserves and consumption - worldwide

Tcf





Technically recoverable
~28,000 tcf

Proved reserves
~7,360 tcf

Annual consumption
~114 tcf

Source: Wood Mackenzie, BP Statistical Review

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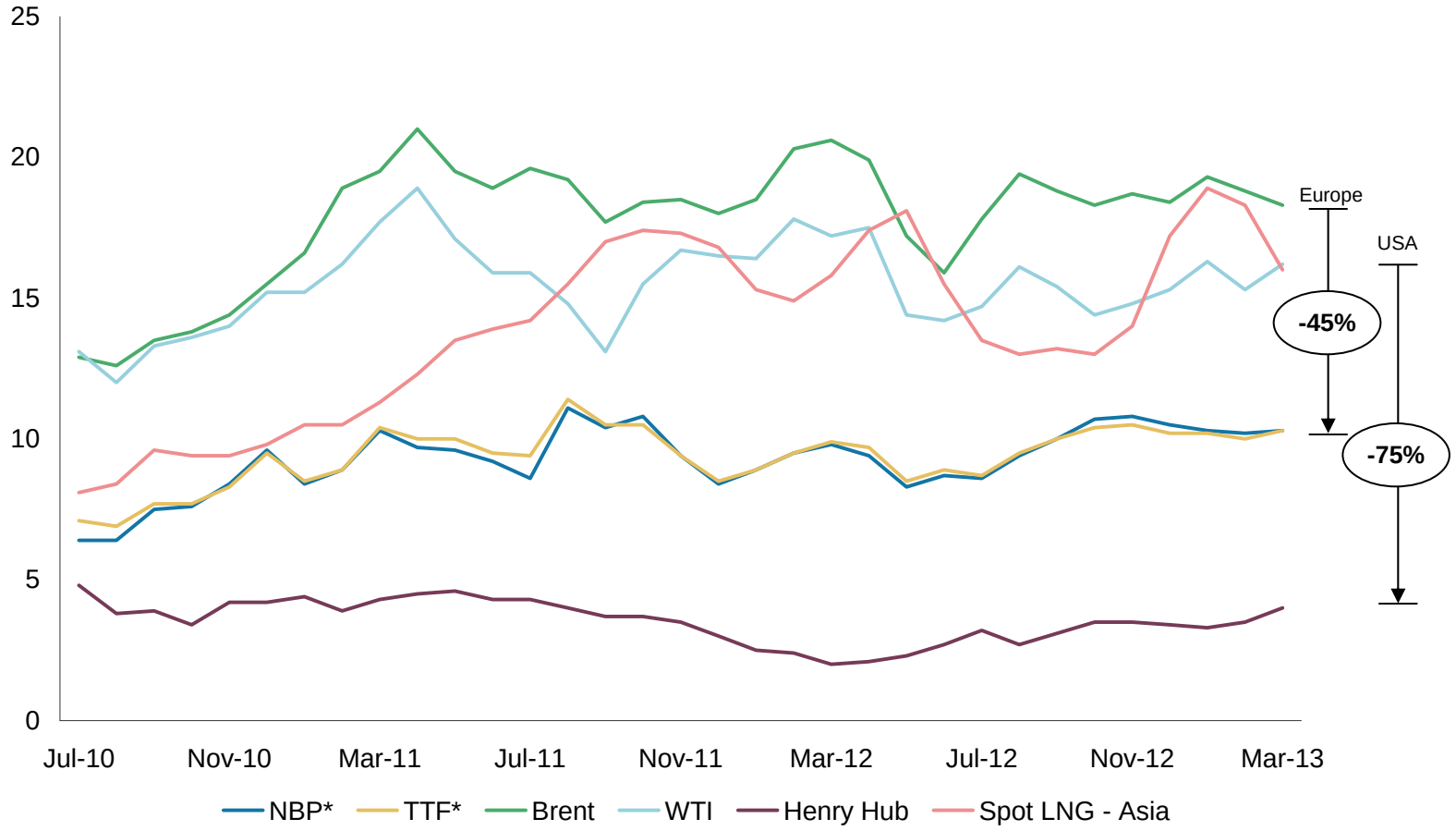
In Europe and the US, natural gas is trading at a deep discount to oil

Oil & gas prices
$/mmBTU



* Month ahead
Source: Thomson Reuters, DataStream

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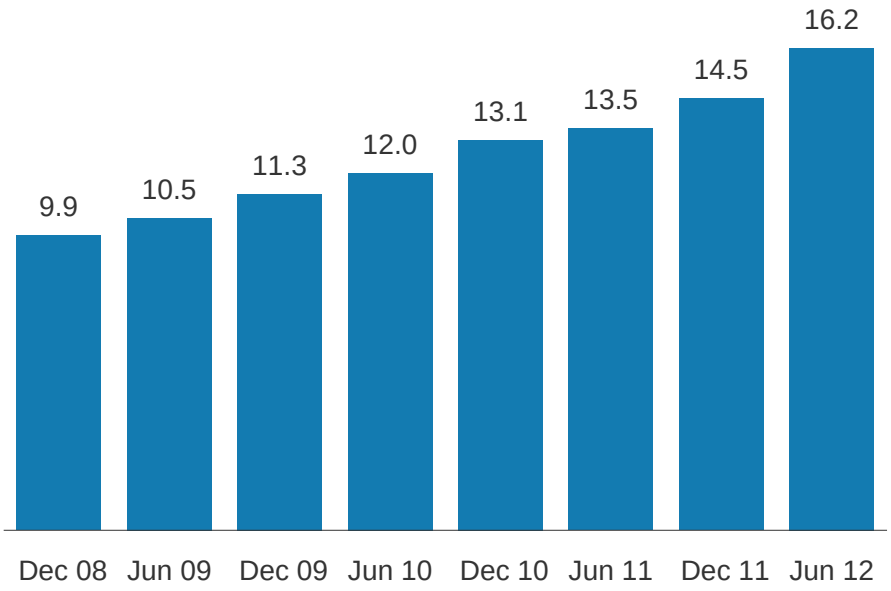
The global NGV fleet has been growing at ~15% p.a. since 2008

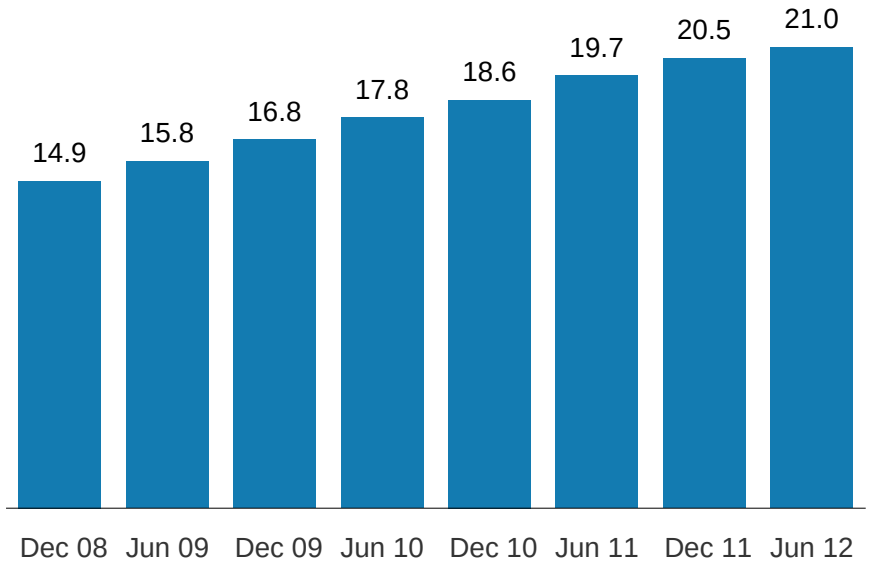
Number of NGVs - worldwide
Millions

CAGR
15%



Number of refuelling stations
Thousands

CAGR
10%



Source: NGVA Europe, GVR

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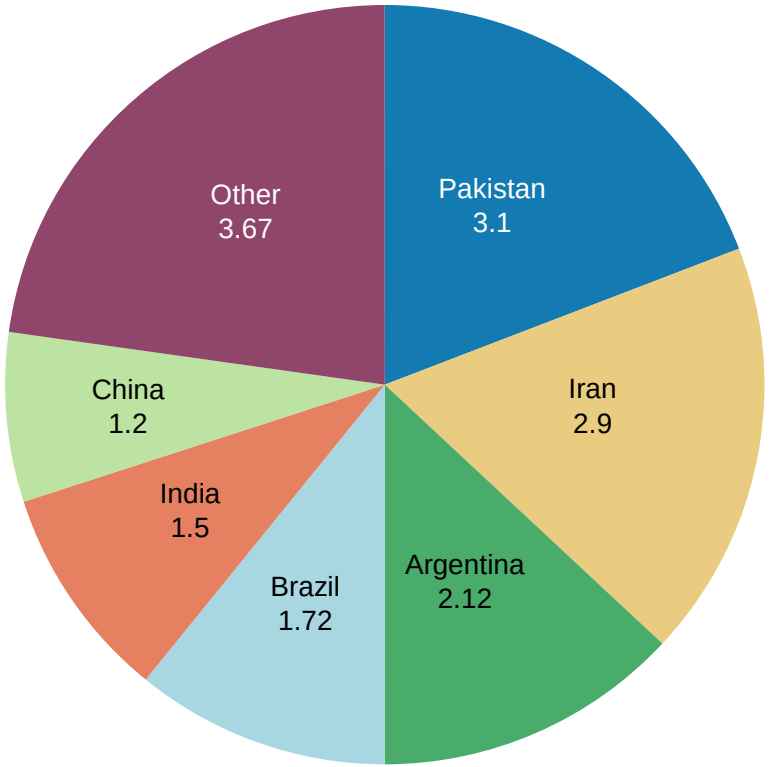
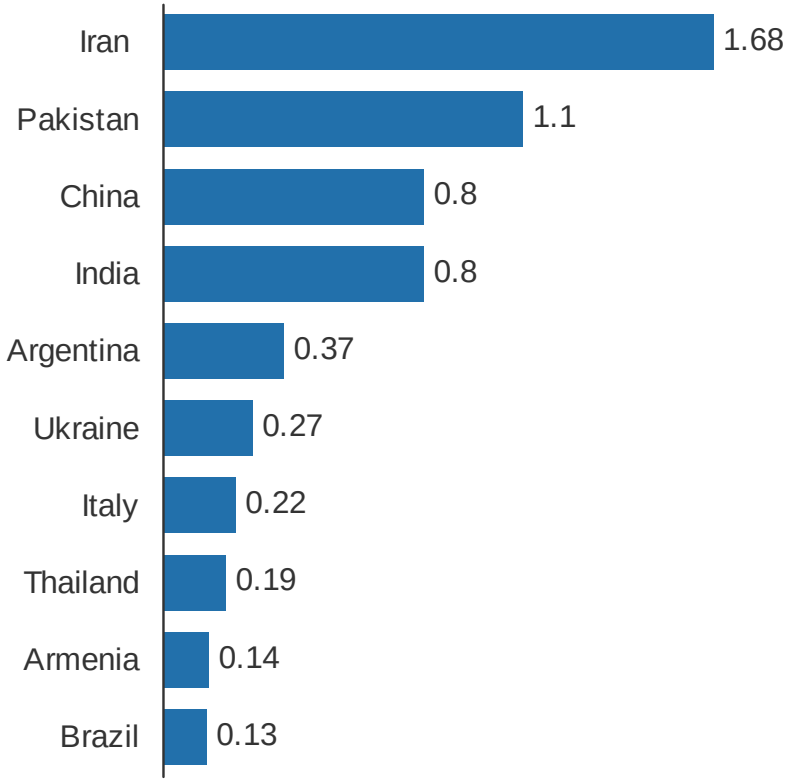
So far, growth has been concentrated in emerging economies

Number of NGVs by country
Millions



Growth in NGV fleet by country
Between Dec-08 and Jun-12, in millions



Source: NGVA Europe, GVR

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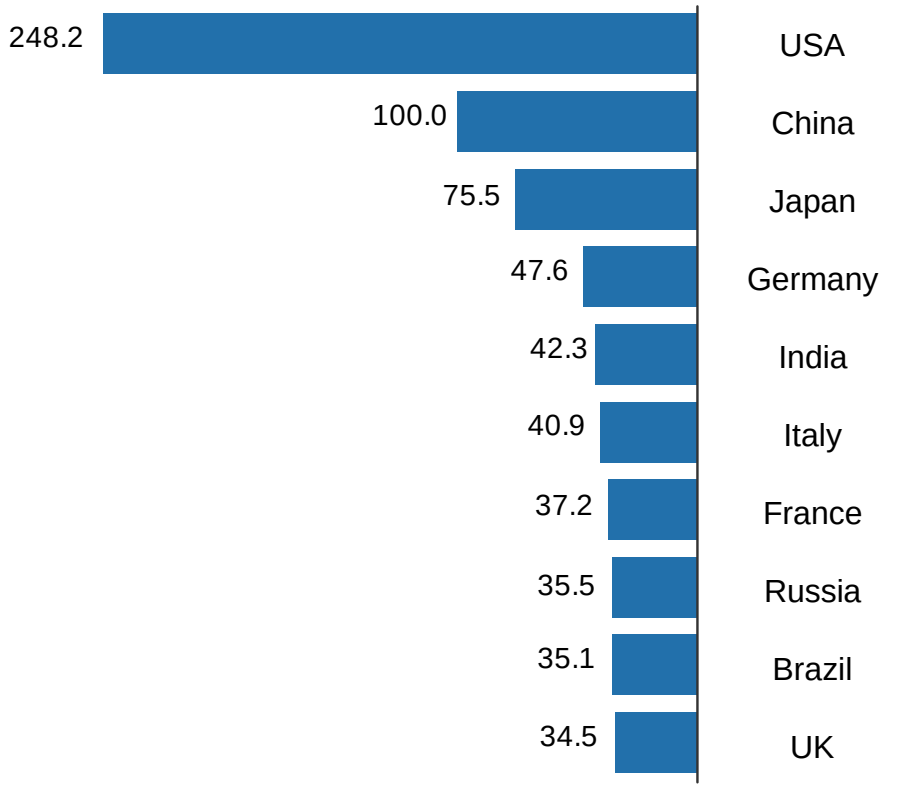
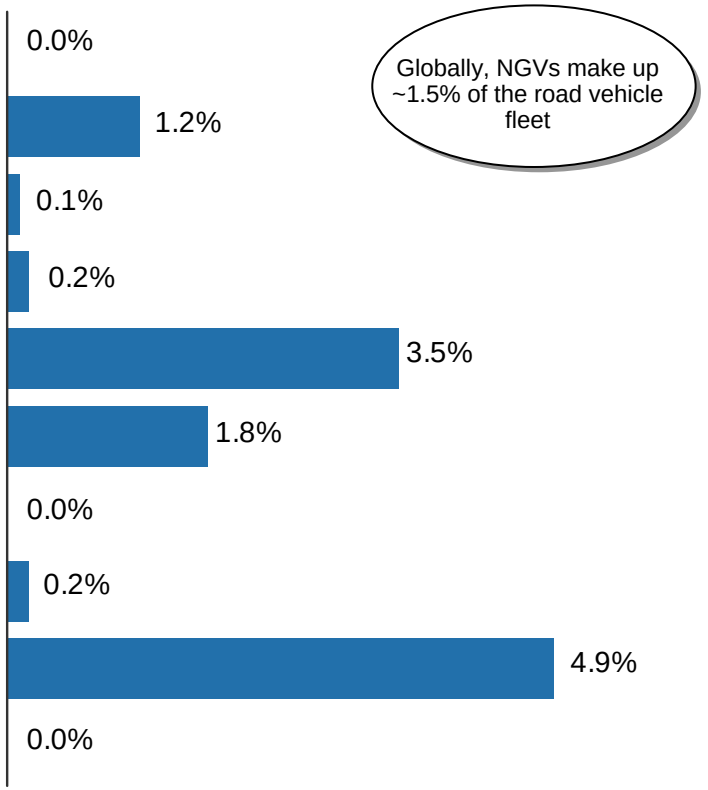
The share of NGVs in the road vehicle fleet is still very low

Number of road vehicles by country
Millions



NGV share of total number of road vehicles
%



Source: NGVA Europe, GVR

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CNG is suitable to replace gasoline or diesel in passenger cars

Natural Gas can power all the vehicles currently fuelled by gasoline and diesel with relatively simple modifications

Engine Technology

NGV engines can be dedicated to natural gas use or compatible with both gas and diesel/gasoline. Dedicated NGV engines operate similarly to gasoline-powered vehicles, with a few modifications. Gas flows into a regulator to reduce its pressure before feeding through a gaseous fuel-injection system. Computers then adjust the fuel-air mix for optimum efficiency. A dual-fuel engine burns a mixture of diesel and gas introduced by carburetion or gas injection. These are usually converted diesel engines. Bi-fuel engines that run on either natural gas or gasoline are also available through conversion.

Storage

CNG is stored on board in high-pressure tube-shaped cylinders, called Integrated Storage Systems, contained within a fiberglass shell and impact-absorbing foam to mitigate safety concerns. There is a direct trade-off between cost and weight, the lighter tubes being more expensive.

Re-fueling Infrastructure

Refuelling stations are supplied by piped natural gas and compressed on site. Refuelling essentially takes the same time as for gasoline vehicles. The special refuelling nozzle clicks onto the vehicle's receptacle, forming a leak-free seal, after which gas is simply passed into the on-board cylinders.

Source: Honda Motors, NGV Global

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LNG is an alternative to diesel for use in trucks …

Heavy-duty vehicles with high mileage demands and greater capacity to store additional weight are more suited for LNG-use

Engine Technology

Heavy-duty natural gas vehicles powered by LNG have similar engine technology requirements to CNG-powered vehicles. The main additional modification is the capacity to heat the liquid gas before it is fed through the gaseous fuel-injection system.

Storage

With superior energy density, LNG requires only 30% of the storage space of CNG. However, the higher energy density brings greater storage system complexity. To maintain its liquid form, LNG is stored in thermal storage tanks, designed with a special vacuum layer of insulation. The extra storage weight required means LNG is more suited to heavy-duty vehicle use as the incremental addition to the weight of the vehicle is less significant. Furthermore, as LNG will start to vapourise in a storage tank after 8-14 days, vehicles in constant use, such as truck fleets, are better suited to LNG use.

Re-fueling Infrastructure

LNG is typically delivered to refuelling stations via tanker truck and stored in special cryogenic storage tanks. Special cryogenic equipment is needed to pump the gas into the NGVs, but in general the process is similar to CNG in that a refuelling nozzle clicks onto the vehicle receptacle to create a leak-proof seal. Given the very cold temperatures of the LNG, gloves are required to handle the equipment for LNG refuelling.

Source: Westport, Clean Energy Fuels, www.gowithnaturalgas.ca

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… as well as in ships

The technology is available for shipping vessels to run on LNG; however, the lack of infrastructure is still problematic

Engine Technology

The engine technology for marine vessels to run on LNG is also well established. Conversion of current engines is problematic, given the lack of engine type retrofit options, so new engine installation is required. Engines compatible with LNG-use are not prohibitively expensive in relation to fuel cost gains.

Storage

The additional space requirements of on-board LNG storage means current ship designs are generally unsuitable, and hence it is more likely newly built ships will run on LNG. Technological advancements in vacuum isolated pressure storage tanks ensure large enough quantities of LNG can be stored to make long maritime journeys viable.

Bunkering Infrastructure

The technology is available for LNG bunkering. LNG can be transferred by pump to a vessel in a bunkering station, taking around two hours. For instance, Warstila has developed a self-propelled bunkering feeder vessel able to transport LNG from standard large-scale facilities directly to the mooring sites. Yet the widespread roll-out of bunkering stations is unlikely to occur until LNG-fuelled vessels become more prominent.

Source: Dutch International Shipbuilding Consultants, TGE Marine Gas Engineering

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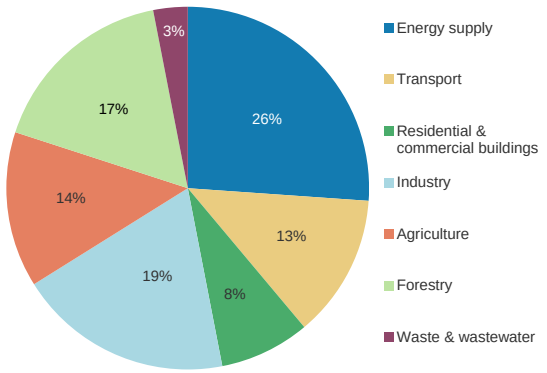
Natural gas produces less emissions during combustion compared with other fuels

Globally, transport accounts for 13% of all greenhouse gas emissions. These gasses, such as carbon dioxide, methane and nitrous oxides, trap heat in the atmosphere, acting in a similar way to the glass panels of a greenhouse.

Switching from oil-based fuel to natural gas would materially reduce emissions generated during combustion. For the same amount of energy input, natural gas emissions have half the impact on global warming compared with oil.

Global greenhouse gas emissions by source



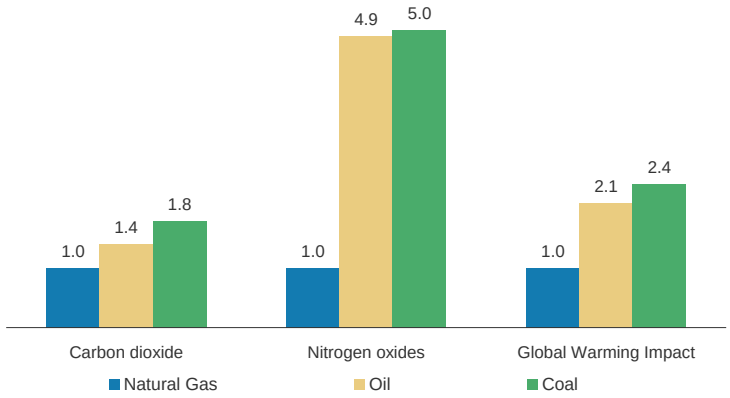
Source: IPCC (2007) based on global emissions from 2004.

Pollutant emissions: natural gas vs oil vs coal

Pollutant (Pounds per Billion Btu of Energy Input)	Natural Gas	Oil	Coal	Impact on global warming relative to carbon dioxide
Carbon dioxide	117,000	164,000	208,000	1
Carbon monoxide	40	33	208	--
Nitrogen oxides	92	448	457	310
Sulphur dioxides	1	11,222	2,591	--
Particulates	7	84	2,744	--
Total Global Warming Impact*	145,520	302,880	349,670	--

* Total Global Warming Impact accounts for the relative impact of each pollutant
Source: EIA: Natural Gas Issues and Trends 1998, US EPA: GWP Estimates

Natural gas emissions have a much smaller impact on global warming than oil emissions



Source: EIA: Natural Gas Issues and Trends 1998, US EPA: GWP Estimates

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The natural gas production process: serious concerns over methane leakage

Life-cycle GHG emissions need to be considered. Analysis of the environmental benefits of LNG also needs to factor in the extraction, production and transportation of the energy sources.

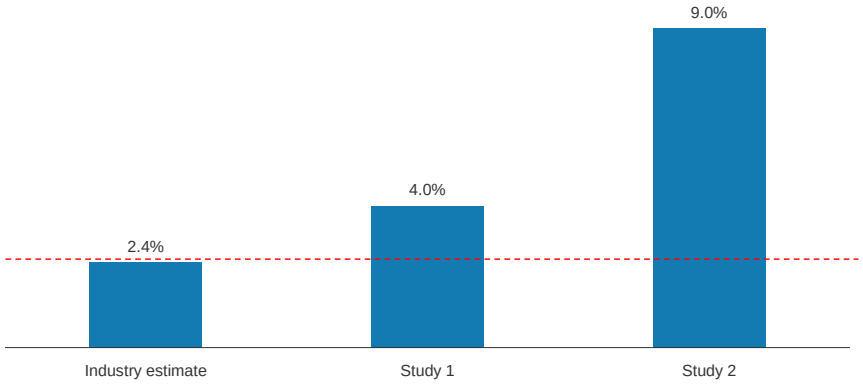
Leakage of methane is significant. Methane makes up around 90% of natural gas, and leakages have been found at various stages of the natural gas production process. The US EPA currently estimates leakage rates of 2.4%. However, recent studies suggest it could be as high as 4-9%. If methane leakage rates breach 2-3%, the environmental gains of burning natural gas could be completely negated.

One molecule of methane traps 21x more heat than one molecule of carbon dioxide

	Impact on global warming relative to carbon dioxide	Source
Carbon dioxide	1	Burning oil, coal & natural gas
Methane	21	Emitted during the extraction, production & transportation of natural gas
Nitrous oxide	310	Burning oil, coal & natural gas

Source: US EPA

Methane leakage rates above 2-3% would probably offset the environmental gains of natural gas



Source: The National Oceanic and Atmospheric Administration, The University of Colorado, US EPA The Environmental Defence Fund, Princeton University & The Centre for Atmospheric Research

Recent studies have shown methane leakage rates that are much higher than the average industry estimate

Industry estimate	The EPA estimates current methane leakage rates at 2.4%, based on assumptions rather than direct measurements
Study #1	Research conducted last year suggested a methane leakage rate of 4% in the Denver-Julesburg Basin of Colorado
Study #2	Earlier this year, a preliminary study indicated a methane leakage rate of 9% in the Uinta Basin of Utah

Source: The National Oceanic and Atmospheric Administration, The University of Colorado, US EPA

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Cost-effective technology could significantly reduce methane leakage rates

Regulations should help reduce leakage rates. Last year, the EPA finalised regulations that target volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) from the oil and natural gas industry. These new rules will have the added benefit of cutting methane emissions by reducing flow-back from fracking and leakage rates from compressors, controllers and storage tanks.

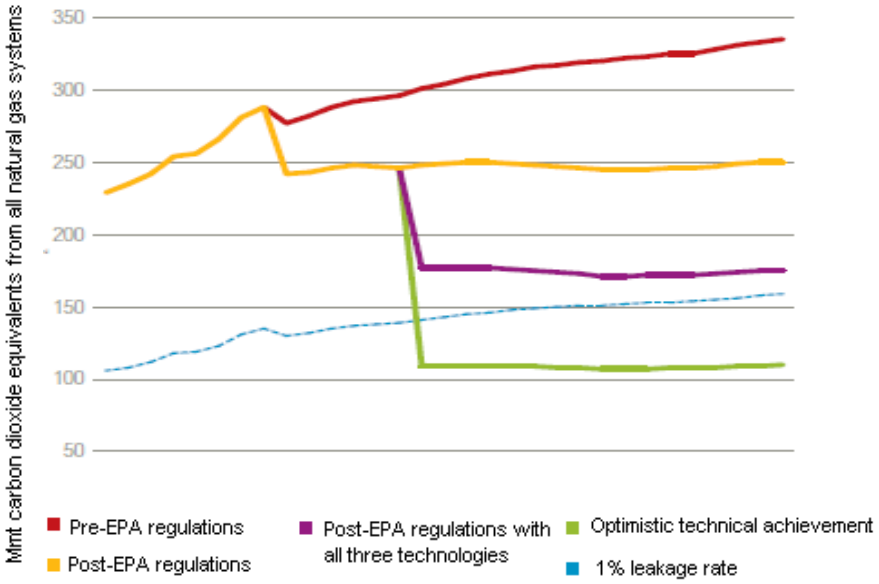
Adopting cost-effective technologies can have a significant impact. Leakage rates of <1% would ensure that the climate impacts of natural gas are lower than those of coal or oil over any time horizon. This is achievable using some of the technology outlined below.

Three technologies available for reducing methane leakage

Technology	Description	Initial cost	Annual cost	Gas captured per facility (mcf)	Payback Period (Years)
Plunger lifts	Remove contaminants (e.g. water, sand) from natural gas wells and reduce methane emissions by avoiding blow-downs, which remove liquids when wells are blocked	$11,813	$1,482	2,670	1.1
Replace high-bleed pneumatics with low-bleed equivalents	Pneumatic controllers are powered by natural gas and are used in the natural gas industry to regulate variables such as pressure, flow rate and liquid levels	$3,420	$0	255	3.1
Leak detection & repair	Carefully monitoring leak rates and repairing leak junctions/safety valves can greatly reduce methane leakage	$59,000	$59,000	28,400	0.9

Source: World Resources Institute: EPA Natural Gas STAR (2013c), Harvey et al 2012

Use of these technologies could cut methane leakage by ~30%



Source: World Resources Institute: Clearing the Air: Reducing Upstream GHG Emissions from US Natural Gas Systems

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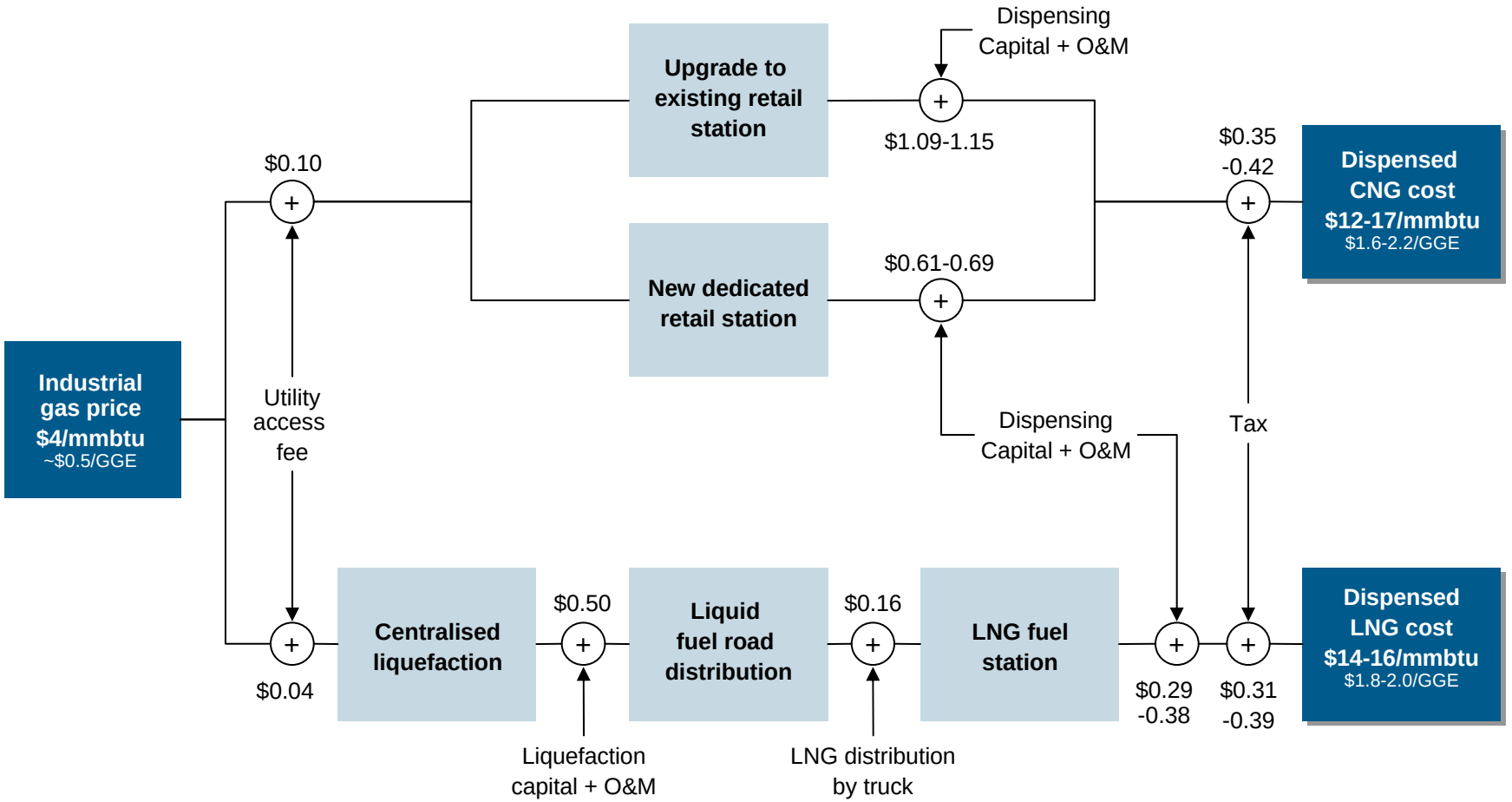
With Henry Hub at $4/mmbtu, CNG and LNG can reach customers for ~$2/GGE

CNG and LNG cost structure
$/GGE*



* GGE = Gasoline gallon equivalent
Source: National Petroleum Council

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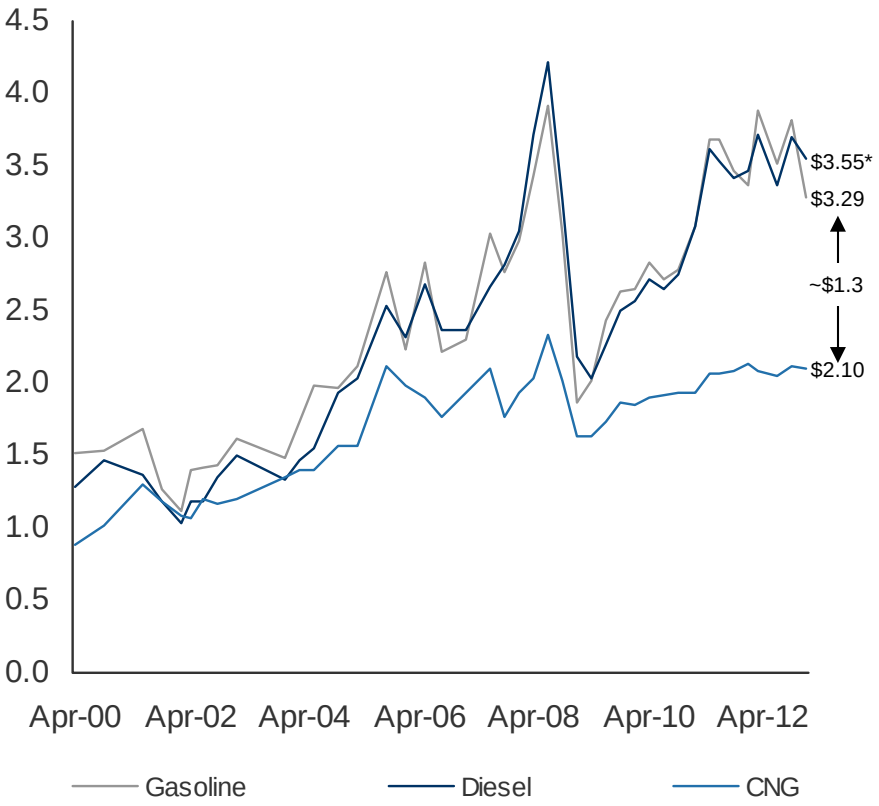
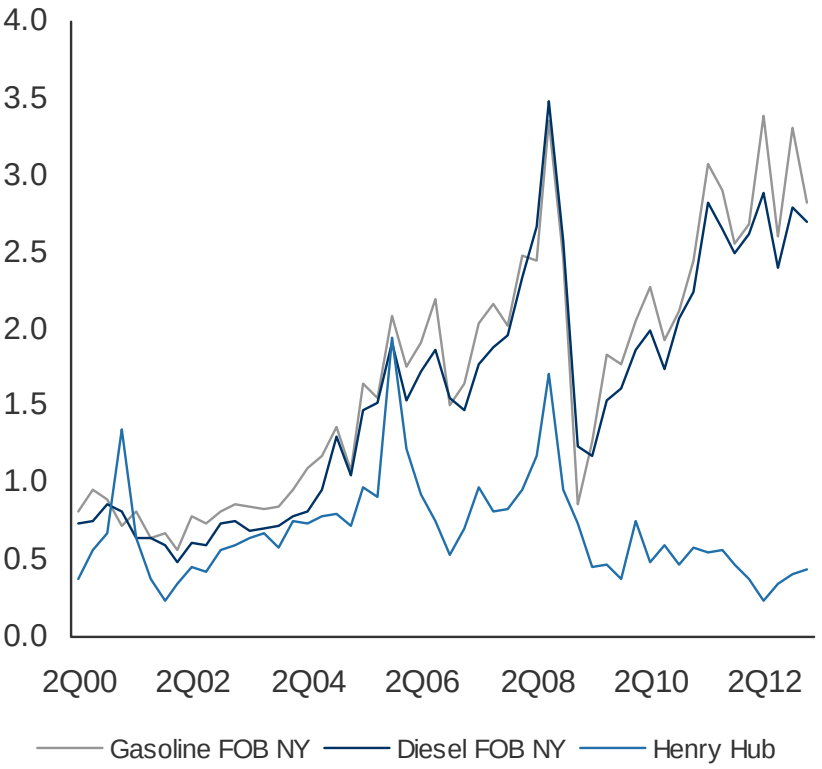
The average price of CNG in the US today is ~$2.1/GGE, a 35-40% discount to gasoline and diesel

Average US retail fuel prices
$/GGE



Average US wholesale fuel prices
$/GGE



* Equals $4.03 per diesel gallon equivalent (DGE)
Source: US Department of Energy, Alternative Fuels Data Center, EIA

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At an LNG price of $2.5-3/DGE, we estimate payback for heavy-duty trucks in ~3.5 years

Economics of LNG-fueled Class 8 Truck
Differences to diesel-fueled equivalent

Additional investments	Low	High
Engine	$26,000	$39,000
Fuel System	$52,000	$52,000
Additional investment ($k)	**~$78,000**	**~$91,000**

Cost saving and payback	Low	High
Miles travelled/year	100,000	120,00
Fuel efficiency (mpg)	6.0	6.0
Fuel consumption (gal)	**16,700**	**20,000**
LNG price ($/dge)	$3.00	$2.50
Diesel price ($/gal)	$4.13	$4.13
Annual savings ($k)	**$18,800**	**$32,600**
Payback (years)	**4.5**	**2.6**

Converting all
2.4 million Class 8 trucks in
the US to LNG represents a savings
opportunity of
$40-70bn per year

Source: National Petroleum Council, Morgan Stanley Research estimates

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For CNG-fuelled cars travelling >15k miles/year, the payback period falls below ~5 years when gasoline exceeds $3.6/gal

Economics of CNG-fueled cars

Differences to gasoline-fueled equivalent

Additional investments	Gasoline	CNG	Difference
Ford Focus 2.0	€20,000	€23,400	$4,420
Opel Zafira 1.6 ecoFlex	€19,995	€22,425	$3,160
Volkswagen Touran 1.4 TSI	€24,575	€27,900	$4,320
Fiat Punto Evo 1.4 8V	€12,800	€15,300	$3,250
Seat Mii (Ecofuel)	€9,300	€12,050	$3,580
Volvo V70 2.4	€33,949	€38,356	$5,730
Average	**-**	**-**	**$4,000**

Cost saving and payback	Low	High
Miles travelled/year	12,000	24,000
Fuel efficiency (mpg)	28.0	28.0
Fuel consumption (gal)	**430**	**860**
LNG price ($/gge)	$2.10	$2.10
Gasoline price ($/gal)	$3.29	$3.29
Annual saving ($k)	**$510**	**$1,020**
Payback (years)	**7.8**	**3.9**

Source: NGVA Europe, National Petroleum Council, Cars-of-Europe.com, Morgan Stanley Research estimates

- ~20% of US cars drive more than 15,000 miles p.a. At that annual mileage, payback on a CNG vehicle drops below 5 years if gasoline prices are above $3.60/gal. The average gasoline price is above this level in 27 out of 51 US states and in 96 of the largest 166 cities in the US
- *A caveat…*Whilst fuel consumption for CNG-fueled cars may be similar, both power and range are lower for CNG vehicles compared to the equivalent conventional models. This difference has not been incorporated within our payback economics

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Upcoming new emissions regulation requires ship-owners to reduce emissions in certain situations

Regulation

The International Maritime Organization (IMO) has declared that all vessels sailing in pre-defined Emission Control Areas (ECA's) must reduce the sulphur level in fuel oil to 0.1% or clean the exhaust gas to the equivalent level by 2015. A similar reduction is expected to be enforced for worldwide shipping by 2020.

Options

There are three widely discussed options to achieve the stated sulphur reductions:

1. Low-sulphur fuel
2. Scrubber technology
3. LNG

Comparison

The economics of these technologies will be instrumental in determining which option is implemented most widely. We start with a comparison of initial capex:

Capex for Srubber Installation (US$)

Scrubber machinery and equipment	$2,600,000
Steel (150ft) / pipe / electrical installations and modifications	$2,400,000
Design and classification costs	$500,000
Off-shire cost (20 days @ 17,000 USD/day)	$340,000
Total	**$5,840,000**

Capex for LNG Installation (US$)

LNG machinery and equipment, main engine conversion	$4,300,000
Steel (300t)	$2,000,000
Design and classification cost	$500,000
Off-shire cost (40 days @ 17,000 USD/day)	$680,000
Total	**$7,560,000**

Source: Green Ship of the Future, *Vessel Emission Study: Comparison of Various Abatement Technologies to Meet Emission Levels of ECA's*

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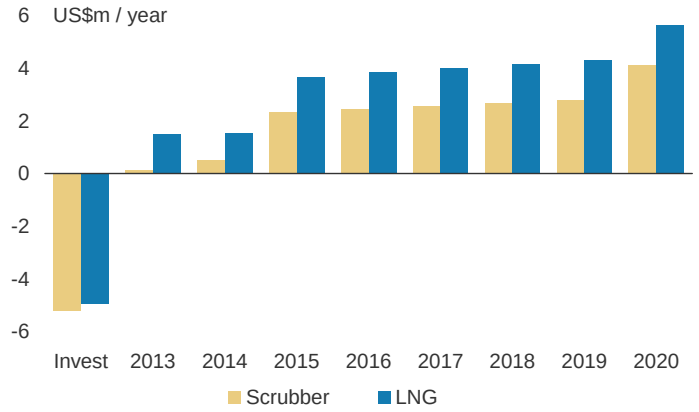
Analysis from Germanischer Lloyd suggests that switching to LNG engines is often the most cost-efficient way to achieve this

Annual cost advantage for container vessels

(compared to a standard vessel using standard fuels)



Source: Germanischer Lloyd and MAN: *Costs and benefits of LNG as ship fuel for container vessels*

Model Assumptions

- 2,500 TEU ship; 20 knots; 14,500 kW engine; 5,300nm round trip; 65% ECA share
- LNG tank volume gives vessel half-round-trip endurance
- Average cost of open/closed loop scrubber - $5/MWh
- Extra LNG operation costs 10% higher than standard
- Extra scrubber operation costs 20% higher than standard
- Continuous fuel price increase
- Starting year pricing scenario: HFO = 650 $/t (15.3 $/mmBTU); MGO = 900 $/t (21.2 $/mmBTU); LNG = 13 $/mmBTU (inc small-scale distribution 4 $/mmBTU)

Payback Period

Payback time depends heavily on ECA exposure and vessel size. With high ECA exposure, small LNG vessels can have a payback of as little as 2 years.

Conclusion

When standard assumptions are used, LNG systems offer shorter payback times than scrubber systems. Using LNG as ship fuel promises less emissions and lower fuel costs under the right circumstances, hence a wide roll-out of LNG-powered ships is a realistic possibility.

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Various barriers of different complexity exist on the path to full scale implementation

While the technology is available, the key problem for a prompt switch to gas as a replacement in motor fuels is the time and money required for a country-wide roll out of relevant infrastructure and associated risks

Group 1
Minimal/Resolved Issues

- Resource availability (gas) does not raise concerns
- Commoditized fuel; generally accepted standards for quality exist
- Abundant wholesale storage available
- Gas transport infrastructure covers key areas; over 60% of homes are connected to gas supply in US
- No inconvenience for the consumer with either vehicle performance or refuelling process
- Sustainably cheaper than gasoline and diesel in DGE and GEG terms
- Necessary technology exists and has been tested

Group 2
Time and Capex Required

- Large investment required in creating small/mid sized liquefaction capacity across the country ($30bn-$60bn)
- Heavy duty LNG station availability is limited – needs material capex ($4bn-$9bn at least) and time investments to make the fuel an attractive and convenient replacement for diesel and gasoline
- On-site storage is subject to venting; significant associated capex needed to construct LNG storage on sites.
- Limited fleet availability due to high conversion capex

Group 3
Major Risks/Barriers

- Light duty CNG station availability is very low – needs material capex ($70bn+) and time investments to make the fuel an attractive and convenient replacement for gasoline for private cars and users
- 'Chicken-Egg' dilemma: infrastructure roll out is needed to popularise conversion of traditional vehicles to NGVs, but justifying the roll-out capex for investors, requires a sufficient consumer base
- In-house refuelling for CNG raises safety and environmental concerns as well as requiring material investment in technology and equipment

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Getting the LNG/CNG to consumers implies a full supply chain roll-out from feed stock to car tank

Feedstock

1. **Small/mid sized LNG plants** (10,000 to 500,000 gallons per day) will be needed within 150-300 mile radius of key LNG refuelling station clusters to reduce LNG transportation costs. Capex to roll out the liquefaction capacity may be $30bn-$60bn for the US in total ($70mn for 180,000 gpd facility) to supply a network of 2,000-3,000 LNG stations across the country.
2. **CNG stations need to be built near feedstock**, for example trunk gas pipelines or landfill sites. Gas is delivered across intrastate pipelines to the CNG stations, which act as a buffer between the natural gas network and the vehicle. Gas is then compressed and dispensed to consumers.

Retail

Both LNG and CNG stations have to either be built from scratch or on new sites. Complementing existing sites is cheaper, but can stumble in certain areas due to size of equipment to be installed and/or safety regulation involved when adding equipment to the already densely packed and regulated traditional locations.

Key components to be constructed:
LNG – storage tanks able to withstand extremely cold temperature, usually 15,000 gallons and above, to be able to take in a whole LNG road tanker load
CNG – dryer, compressor unit with capacity of at least 1.25 mm GEG/yr, dispenser

Model capex for LNG station (US$)

1-2 storage tanks of 15,000 gallons each	$400,000 - $800,000
Modular dispensing system with capacity of 0.1 GEG/yr (*optional*)	$400,000
Other equipment including dispenser	$1,000,000
Total	**$1,400,000 - $2,200,000**

Model capex for CNG station (US$)

Existing Site	
Modular dispensing system with capacity of 0.1 GEG/yr	$400,000
Total	**$400,000**
- OR -	
New Site	
0.5 acre plot of land @ $2mn/acre	$1,000,000
Compressor with capacity of 1.25 MM GEG/yr	$600,000
Total	**$1,600,000**

Source: National Petroleum Council, IHS CERA, Morgan Stanley Research Estimates

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A partial roll-out of gas refuelling stations in the US could cost ~$5bn in the case of LNG and ~US$50bn in the case of CNG

Economics of rolling out LNG/CNG infrastructure

Cost to achieve minimal required level of penetration

Heavy Duty Trucks	
Annual consumption, mn gallons	32,000
# of truck refuelling stations in the US	10,000
Assumed number of LNG stations	~3,000
Construction cost, $mn per station	$1.4 - $2.2mn
Infrastructure roll-out cost (partial displacement), $bn	**$4bn - $7bn**

Private Light Duty Vehicles	
Annual consumption, mn gallons	134,000
# of car refuelling stations in US	150,000
Assumed number of CNG stations	~50,000
Construction cost, $mn/station (*average of brownfield & greenfield cost*)	$1mn
Infrastructure roll-out cost (partial displacement), $bn	**$50bn**

- We estimate the number of LNG/CNG fuel stations required for partial displacement of traditional fuels needs to be no more than 30% of existing fuel stations
- LNG station infrastructure needs to be backed up by small/mid size LNG plants within a 150-300 mile radius, which could add a further $30bn-60bn to LNG infrastructure roll out
- Calculations are based on costs of $1.4mn-$2.2mn per LNG station and $1mn per CNG station (a blended average of brownfield and greenfield CNG station costs)

Source: IHS CERA, National Petroleum Council, Morgan Stanley Research estimates

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A large number of LNG fuelling stations are planned in North America; China also rapidly rolling out infrastructure

Existing and planned LNG fuelling stations along key transportation arteries (see insert)
North America

Source: Westport, www.zeusintel.com

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What could be the impact in the next 10 years? We look at several scenarios

Scenario 1 – *DM goes to Sweden*

- In developed countries, the share of natural gas vehicles in the overall fleet is a very low 0.2%. We assume that this grows to 0.9% over the next 10 years, on a par with Sweden today. Along with underlying vehicle fleet trend growth of 1% p.a., this increases the DM natural gas vehicle fleet to 6.3m from 1.1m today.
- In emerging countries, we assume natural gas vehicle penetration rates remain stable at the current level of 3.6%. With underlying vehicle fleet growth of 8% p.a., this increases the EM NGV fleet to 32.3m from 15.1m today.
- Using standard consumption figures (180Nm^3/month of natural gas for light duty vehicles and 3,000Nm^3 for medium- and heavy-duty vehicles), we estimate some 1.5mb/d of gasoline/diesel demand is displaced by 2021, whilst natural gas demand is increased by 8bcf/d.

Scenario 2a – *EM goes to Brazil; DM goes to Italy*

- In this scenario, we assume NGV adoption rates accelerate further in developed countries over the next 10 years and reach levels close to Italy today, i.e. 2%.
- Natural gas vehicles are already 4.9% of the total vehicle fleet in Brazil today. In this scenario, we also assume emerging countries move to a similar penetration rate on average from 3.6% currently.
- As a result, the global NGV fleet increases to ~58m vehicles over the next 10 years.

In a 'Blue Sky' scenario, global diesel and gasoline demand could decline by -0.1% p.a. (from growth of 1% on our base-line forecast), while growth in global gas demand could rise from ~2% p.a. to 2.8% p.a. over the next 10 years

Scenario 2b – *US Trucking Revolution*

- Alongside the assumptions of scenario 2a, we assume accelerated adoption of natural gas in US trucking aided by low natural gas prices and refuelling infrastructure installed along all major US trucking routes.
- In this scenario, penetration rates for medium- and heavy-duty trucks in the US increase from 0.03% today to 30% in the next 10 years, growing the US NGV truck fleet from 2,500 today to ~3 million units by 2021.

Scenario 3 – Blue Sky

- In addition to scenario 2b, market penetration amongst buses in developed countries increases from 2.9% to 10% over the next 10 years, similar to the current share in emerging markets today.
- In emerging countries, we assume the NGV fleet continues to grow at 15% p.a. over the next 10 years, inline with the average growth rate over the last 5 years.
- As a result, NGV penetration in DM increases to 2.4% from 0.2% today whilst EM penetration increases to 6.7% from 3.6% currently. Together this raises the share of NGVs in the global vehicle fleet from ~1.5% currently to 4.8% at the end of the period.

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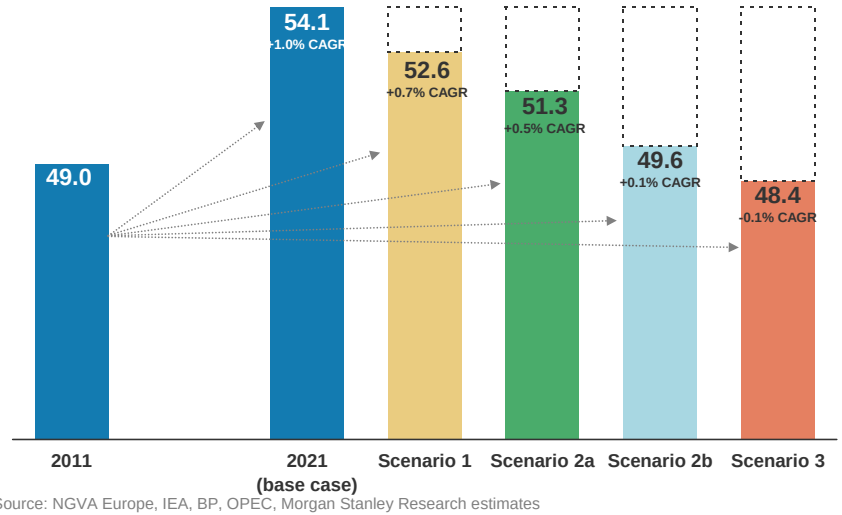
Our scenarios imply 1 - 6mb/d of global diesel and gasoline demand displaced by 2021 … but also meaningful upside for global natural gas demand growth

Global penetration of NGVs could increase by ~100-300bps from ~1.5% today, under a range of scenarios

- **Scenario 1** *(DM goes to Sweden)* – we estimate global gasoline & diesel demand growth falls from +1% p.a. in our baseline scenario to +0.7% p.a. over the next 10 years. On the other hand, we forecast global gas demand growth to increase to +2.2% p.a. from +2.0% over the same period.
- **Scenario 2a** (*EM goes to Brazil; DM goes to Italy*) – we estimate global gasoline & diesel demand growth halves to +0.5% p.a. over the next 10 years, whilst global gas demand growth increases to +2.4% p.a. compared to +2.0% p.a. in our base case as the global NGV fleet more than doubles from ~16mn vehicles today.
- **Scenario 2b** (*Scenario 2a + US gas trucking revolution*) – almost all gasoline & diesel demand growth is displaced over the next 10 years (+0.1% CAGR). Global gas demand growth picks up further with an incremental 26bcf/d of demand by 2021 implying a +2.7% CAGR over the period.
- **Scenario 3** (*Blue sky*) – Some 5.6mb/d of gasoline and diesel is displaced by an additional ~60mn NGV vehicles globally and implies demand actually falls over the next 10 years (-0.1% CAGR). Gas demand growth on the other hand accelerates towards 3% p.a. over the next 10 years with an incremental 33bcf/d of demand by 2021.

Global gasoline & diesel combined demand growth under various NGV adoption scenarios

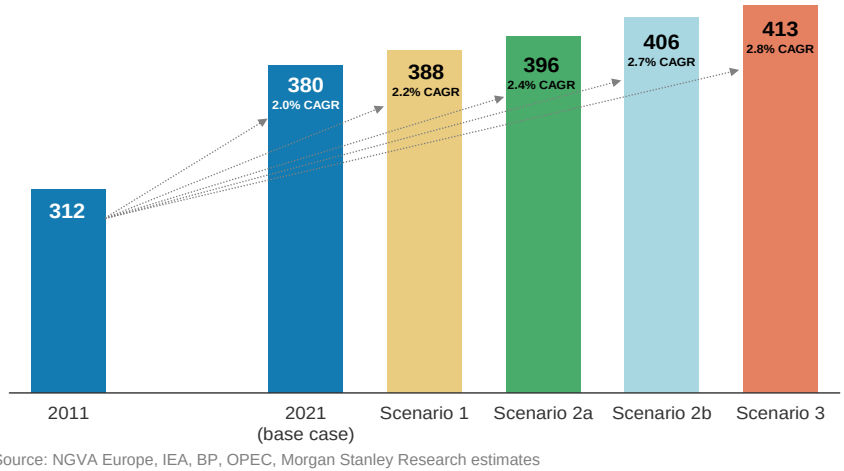
mb/d



Source: NGVA Europe, IEA, BP, OPEC, Morgan Stanley Research estimates

Global natural gas demand growth under various NGV adoption scenarios

bcf/d



Source: NGVA Europe, IEA, BP, OPEC, Morgan Stanley Research estimates

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A closer look at our scenario and baseline assumptions

How we arrive at our base case …

- The total worldwide fleet of light-, medium- and heavy-duty vehicles is just over 1bn units today. The global NGV fleet currently stands at ~16.2 million units, implying a NGV penetration rate of just 0.2%.
- Based on standard consumption figures (180Nm3/month of natural gas for light duty vehicles and 3,000Nm3/ month for medium- and heavy-duty vehicles), we estimate that this fleet currently consumes ~6.9 bcf/d in natural gas, which likely displaces ~1.2 mb/d of diesel and gasoline combined.
- From this baseline, we assume under each of our scenarios that the overall vehicle fleet in developed countries grows at a trend rate of 1% p.a. and in emerging countries at 8% p.a. over the next 10 years, broadly similar to historical growth rates.
- For our base case gasoline/diesel and natural gas demand assumptions of 1% p.a. and 2% p.a. respectively, we approximate the average of trend forecast rates from the IEA, OPEC and BP.

How will NGV growth impact oil & gas demand?

	NGV penetration (%)		NGV fleet	Nat gas
	EM	DM	size (mln)	use (bcf/d)
Current situation - baseline				
Cars and LD trucks	3.7%	0.2%	15.2	3.2
MD+HD Buses	10.0%	2.9%	0.7	2.4
MD+HD Trucks	1.0%	0.2%	0.4	1.3
Total	**3.6%**	**0.2%**	**16.2**	**6.9**
Scenario 1 - DM goes to Sweden				
Cars and LD trucks	3.7%	0.9%	36.3	7.6
MD+HD Buses	10.0%	2.9%	1.4	5.0
MD+HD Trucks	1.0%	0.2%	0.8	2.7
Total	**3.6%**	**0.9%**	**38.5**	**15.3**
Incremental gas demand				8bcf/d
Incremental gasoline/diesel displaced				1.5mb/d
Scenario 2a - EM goes to Brazil; DM goes to Italy				
Cars and LD trucks	5.0%	2.0%	54.5	11.4
MD+HD Buses	15.0%	2.9%	2.1	7.4
MD+HD Trucks	1.5%	0.2%	1.1	3.9
Total	**4.9%**	**1.9%**	**57.7**	**22.7**
Incremental gas demand				16bcf/d
Incremental gasoline/diesel displaced				2.7mb/d
Scenario 2b - Scenario 2a + US gas trucking revolution				
Cars and LD trucks	5.0%	2.0%	54.5	11.4
MD+HD Buses	15.0%	2.9%	2.1	7.4
MD+HD Trucks	1.5%	13.1%	4.1	14.2
Total	**4.9%**	**2.4%**	**60.7**	**33.0**
Incremental gas demand				26bcf/d
Incremental gasoline/diesel displaced				4.5mb/d
Scenario 3 - Blue sky				
Cars and LD trucks	6.9%	2.0%	70.2	14.7
MD+HD Buses	18.7%	10.0%	2.8	9.8
MD+HD Trucks	1.9%	13.1%	4.4	15.2
Total	**6.7%**	**2.4%**	**77.4**	**39.6**
Incremental gas demand				33bcf/d
Incremental gasoline/diesel displaced				5.6mb/d

Source: NGVA Europe, IEA, BP, OPEC, Morgan Stanley Research estimates

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Key gas-to-transport projects

Royal Dutch Shell – LNG powered barges on the Rhine

Project Description	On 5th September 2012, Shell announced it had signed a contract to charter two new build LNG-powered tank barges, which will operate on the Rhine in Europe from 2013. The barges are being built at Peters Shipyards in Kampen, the Netherlands and will be operated by Interstream Barging. When in operation, each barge will be able to carry enough LNG to sail for up to seven days without refuelling. Shell sees significant growth opportunity in LNG as a fuel for European coastal and inland shipping. LNG in inland shipping also offers the added benefit of helping to meet emissions standards on rivers such as the Rhine.
Location	Netherlands, Switzerland, Germany
Timing	First barge "Greenstream" launched in March 2013
Capital Spending	Unknown
Companies / Entities	Shell, Peters Shipyards, Interstream Barging

Source: Shell

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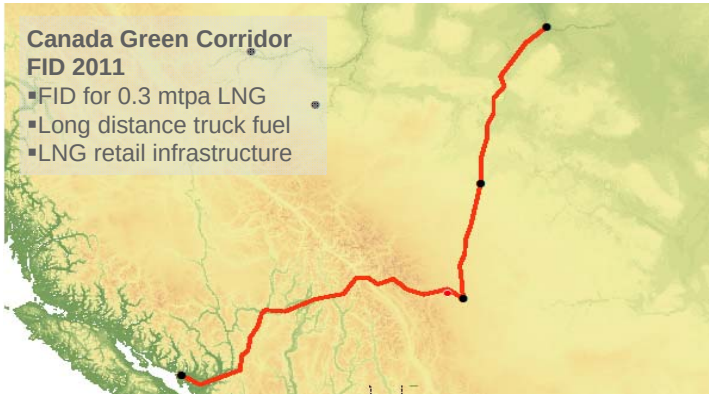
Key gas-to-transport projects

Royal Dutch Shell – natural gas for transport corridors in North America

Project Description	Shell and its affiliates plan to bring LNG fuel one step closer for its marine and heavy-duty on-road customers in North America by taking a final investment decision on two small-scale liquefaction units, forming the basis of two new LNG transport corridors in the Great Lakes and Gulf Coast regions. In the Great Lakes Corridor, Shell plans to install a small-scale liquefaction unit at its Shell Sarnia Manufacturing Centre in Sarnia, Ontario. Once operational, this project will supply LNG fuel to all five Great Lakes, and their bordering US states and Canadian provinces.
Location	North America
Timing	Project commenced in March 2013, expected to be operational within 3 years
Capital Spending	Unknown
Companies / Entities	Shell, Martin Energy Services, Interlake Steamship Company



Source: Shell

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Key gas-to-transport projects

Shell & BOC – Melbourne to Sydney LNG Hume Highway

Project Description	Shell and BOC are jointly developing an LNG supply chain for trucks on the Hume Highway. Targeting one of the busiest truck routes in Australia, Shell will construct eight LNG refuelling ports at existing truck stops in 2013 and 2014. In 2011, BOC opened its Dandenong LNG project in Victoria after a $265m expansion project. The LNG plant and refuelling stations act as the vital link to establish the new LNG highway. LNG is seen as having the potential in the next five to ten years to annually displace 750 million litres of diesel, equivalent to 6% of Australian consumption. That would put more than 5000 LNG trucks on the road.
Location	Australia – Sydney to Melbourne
Timing	2013/2014
Capital Spending	$465m
Companies / Entities	BOC, Shell

Source: Shell, BOC

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Key gas-to-transport projects

Shell & Volvo – LNG powered long-haul trucks

Project Description	On 27th March 2013, based on Volvo's FM MethaneDiesel concept, Volvo Trucks and Shell announced a collaboration to use LNG as a transport fuel for Volvo's heavy-duty commercial trucks. Volvo also aims to have a new 13-litre LNG engine for its long-haul trucking fleet by next year. The Volvo FM MethaneDiesel is equipped with the new methane-diesel technology and uses LNG as its main fuel. The truck is already available in Sweden, Norway, Belgium, Spain, the Netherlands and the UK and at the present the market roll-out is expanding into Italy and France.
Location	North America & Europe
Timing	2013
Capital Spending	Unknown
Companies / Entities	Volvo, Shell

Source: Volvo Inc.

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Key gas-to-transport projects

Clean Energy – building 'natural gas highways' in the US

Project Description	Clean Energy is a NASDAQ listed company that specialises in providing CNG and LNG fueling solutions to customers in heavy duty trucking, transit, refuse collection and airports. The company has already set up a number of LNG truck fuelling stations across 33 states in the US in 2012 to create key 'LNG corridors' or 'natural gas highways' with plans to reach 150 LNG fuel stations by the end of 2013. The company sees the heavy duty trucking market as the largest opportunity for natural gas fuelling in the US with a potential market of over 3 million class 8 trucks. The goal is to have stations along every major interstate trucking corridor in the US with stations every 250-300 miles
Location	USA
Timing	Ongoing
Capital Spending	Unknown
Companies / Entities	Clean Energy, General Electric, Pilot Flying-J (largest truck stop operator in North America)

Source: Clean Energy Inc.

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Key gas-to-transport projects

Chesapeake & GE – 'CNG In A Box' system

Project Description	GE and Peake Fuel Solutions (a division of Chesapeake Energy) launched the CNG In A Box system in October 2012, designed to allow easier adoption of CNG refuelling options for fuel retailers and fleet owners. The GE certified system provides an on-site fueling solution to fleet operators, compressing natural gas from a pipeline, and could save ~40% in ongoing fuel costs. Peake Fuels also launched the first EPA certified diesel to natural gas conversion kit for heavy duty trucks. The Diesel Natural Gas (DNG) Conversion Kit allows trucks to run on a mixture of diesel and up to 70% CNG or LNG, while retaining the ability to run on 100% diesel. The kit can be used for a variety of engines with power ratings ranging from 400 to 600 horsepower.
Location	USA
Timing	Ongoing
Capital Spending	$2,500 - $35,000 DNG conversion cost per vehicle
Companies / Entities	Peake Fuel Solutions, GE

Source: Peake Fuels, Chesapeake Energy, GE

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Key gas-to-transport projects

BNSF Railway – LNG locomotives in the US

Project Description	On 6th March 2013, US rail freight company BNSF, announced it will begin testing a small number of locomotives using LNG. The pilot project will assess the technical and economical viability of using LNG in through-freight service. Locomotive manufacturers GE and EMD (a unit of Caterpillar) will be helping to develop the natural gas engine technology to be used in the pilot. BNSF estimates it is the second largest user of diesel fuel in the USA, after the Navy and therefore the potential savings could be substantial
Location	USA
Timing	Pilot project due to commence late summer 2013 and last for approximately one year
Capital Spending	Potential investment of $5-7bn for full scale conversion of fleet
Companies / Entities	BNSF, General Electric, Caterpillar

"...it would be truly the largest change for the industry since the transition from the steam locomotive to diesel"

Matt Rose, CEO BNSF

Source: Derek Brown – Buffiebest.com

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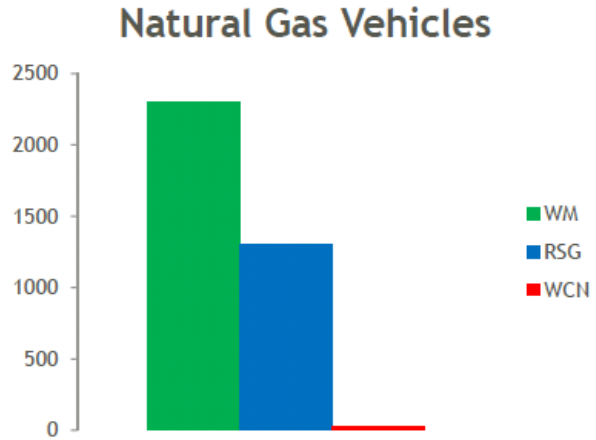
Key gas-to-transport projects

Waste Management – CNG and LNG powered truck fleet

Project Description	On 12th July 2011, Waste Management (NYSE: WM) added its 1,000th natural gas truck to its fleet, which makes it the largest owner and operator of clean-running CNG and LNG heavy duty refuse trucks in North America. Waste Management also has CNG and LNG refuelling station at 17 of its facilities throughout North America with more under development. Trucks emit nearly zero air particulates and 25% fewer greenhouse gas emissions. The engines emit less noise than traditional diesel engines during collection. The trucks use a "slow-fill" procedure to achieve greater engine efficiency, carry approximately 50 gallons of CNG. This capacity allows them to run 10 to 12 hours and complete a typical days waste or recycling.
Location	USA
Timing	Ongoing
Capital Spending	~$500m/annum
Companies / Entities	Waste Management, Linde Group



Source: Waste Management Inc.

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Key gas-to-transport projects

Eidesvik - LNG powered offshore supply boat vessels

Project Description	In 2012, Eidesvik, the offshore support services company, took receipt of a second LNG powered supply boat, the Viking Prince from Kleven Maritime constructed the world's first gas supply vessel, the Viking Energy, in 2003. The Viking Energy has a diesel-electric propulsion plant with four Wärtsilä duel-fuel engines, driving the main generating sets. The engines run on LNG to reduce emissions, but can also run on diesel oil. Should the gas supply be interrupted, they can be switched over from gas to liquid fuel automatically while continuing to deliver full power. The Viking Energy will take supply materials to Statoil's North Sea platforms for two years.
Location	Global
Timing	Ongoing
Capital Spending	2003/2012
Companies / Entities	Eidesvik, Kleven, Wärtsilä

Source: Eidesvik Offshore

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Key gas-to-transport projects

European Union LNG Blue Corridors Project

Project Description	The Blue Corridors project is a European Union & NGVA initiative to develop LNG refuelling infrastructure across four pan-European long distance truck routes. The four routes selected are - Portugal-Spain to France, Netherlands, UK and Ireland; Portugal-Spain to France, Germany, Denmark and Sweden; Mediterranean arch to Italy, with a branch to Croatia; Ireland-UK to Austria. The project aims to enable cooperation between gas suppliers, vehicle manufacturers, haulage firms and various local administrative organisations for a coordinated expansion of the LNG refuelling network. Italy has the largest fleet of natural gas vehicles in Europe, with Eni building further refuelling stations in Northern Italy as part of the corridor from Portugal to Croatia.
Location	Europe
Timing	Ongoing
Capital Spending	Unknown
Companies / Entities	European Union, NGVA Europe, Eni

Source: NGVA Europe, European Union

Morgan Stanley

Key gas-to-transport projects

China National Science and Technology Ministry

Project Description	In December, 1999, China's National Science and Technology Ministry and State Environmental Projection Administration set 10% as a target for clean vehicles as a portion of the overall vehicle population, and set a target of 40-50% for taxis and buses. Additionally, the police called for the launch of clean vehicle model zones in 19 cities, including Beijing, Shanghai, Tianjin, and Chongqing. In Chongqing, 85% of taxis and 92% of buses are using an LNG engine. In Shanghai, Chengdu, Xi'an, Xinjiang and Hebei, these percentages are above 90%. The Beijing Public Transport Group recently announced that ~3,200 new LNG city buses would be added to its fleet during 2013, taking its total fleet of Natural Gas powered buses to ~5,700. In 2012, 840 conventional buses were converted to LNG.
Location	China
Timing	Ongoing
Capital Spending	Unknown
Companies / Entities	China National Science and Technology Ministry; Beijing Public Transport Group

Source: NGV Global

Morgan Stanley

Key gas-to-transport projects

Kunlun - LNG powered inter-city bus fleet and railway corridor

Project Description	Kunlun Energy (formerly CNPC, Hong Kong) is assisting in China's rapid expansion of its LNG transportation fleet, with the construction of 227 new refilling stations throughout the country, and aims to convert 200,000 vehicles to LNG by 2015. Recently, the company commenced operations at the Daguan Road LNG refuelling station in Guangzhou, supporting 310 LNG powered buses, growing to 3,000 by year-end. With support from the government, the company is working on a railway corridor for LNG transportation between Golmud, Qinghai and Lhasa, Tibet, to further enable the expansion of retail LNG distribution.
Location	China
Timing	Ongoing
Capital Spending	Unknown
Companies / Entities	Kunlun Energy

Source: Yutong, NGV Global

Morgan Stanley

Key gas-to-transport projects

UPS – LNG powered heavy duty trucks

Project Description	On 22nd February 2012, Westport announced UPS's commitment for LNG trucks powered by Westport HD Systems. The new heavy-duty trucks will be used in interstate operations for the Ontario, California to Las Vegas, Nevada route. UPS plans to build publicly accessible LNG fuel stations in Las Vegas and will be able to access existing fuel stations in Ontario, California, and Salt Lake City, Utah, thus filling in an LG trucking corridor form California to Utah. Funding for the trucks and fuelling stations is supported by the U.S. Department of Energy's Clean Cities program and the South Coast Air Quality Management District's UPS Ontario-Las Vegas LNG Corridor Expansion project. At the end of the project UPS will have a fleet of more than 1,100 natural gas trucks including CNG delivery vehicles.
Location	North America
Timing	Ongoing
Capital Spending	Unknown
Companies / Entities	Westport, UPS

Source: UPS, Interstate Clean Transport Corridor (US)

Morgan Stanley

Key gas-to-transport projects

Volkswagen – Golf TGI BlueMotion natural gas version

Project Description	The new CNG variant of the popular VW Golf, called "TGI BlueMotion", is set to be launched in 2013, with a Hatchback edition to be released in Summer followed by an Estate Car edition in Autumn 2013. This is the first natural gas vehicle based on the new Modular Transverse Matrix (MQB) platform. The car accelerates from 0 to 100 Km/h in 10.7 seconds, with a top speed of 194 Km/h. It also has a range of 420Km in pure CNG mode (3.5Kg of Natural Gas per 100Km), and more than 1,360Km in the dual-fuel mode (5.3L of Petrol per 100Km). The car emits 92 g/Km of CO2, below fleet average EU requirements (95 g/Km of CO2 by 2020), however, electric vehicles remain a more effective way at reducing CO2 emissions.
Location	Europe
Timing	Summer 2013
Capital Spending	Unknown
Companies / Entities	Volkswagen

Source: Volkswagen

Morgan Stanley

Key gas-to-transport projects

FedEx – Converting 90,000 ground transportation units

Project Description	FedEx expects to convert a majority of its 90,000 ground transportation vehicles in the US to CNG/LNG in the next few years and is currently testing prototypes to evaluate potential cost savings. FedEx's CEO, Frederick Smith estimates, with declining upfront costs and the proliferation of fuelling stations, up to 30% of US long-distance trucking could be fueled by CNG/LNG within the next 10 years.
Location	USA
Timing	Summer 2013
Capital Spending	Ongoing; 2013-2023
Companies / Entities	FedEx

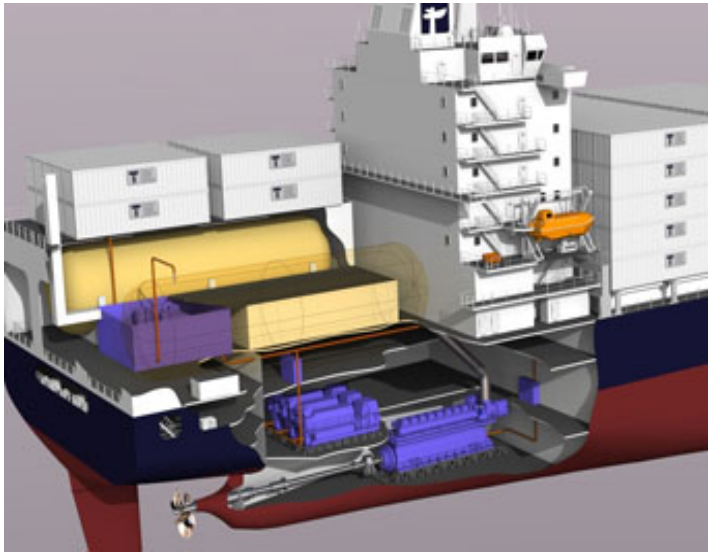
Source: Fleets & Fuels, NGV Global

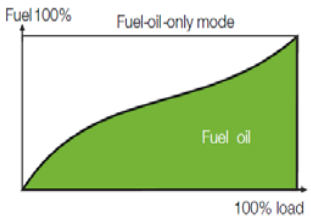
Morgan Stanley

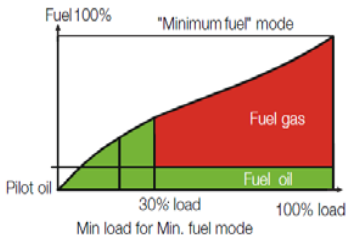
Key gas-to-transport projects

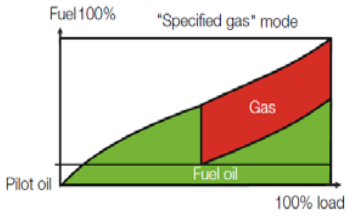
MAN – LNG powered ship engines

Project Description	MAN Diesel & Turbo has received first orders for its 2-stroke low-speed, dual-fuel ME-GI gas-powered engine, which gives ship owners the option of using either HFO or natural gas but also, eventually LPG. MAN sees significant opportunities arising for gas-fueled tonnage as fuel prices rise and exhaust-emission limits tighten, as the ME-GI engine delivers significant reductions in CO2, NOx and SOx emissions (20-30%, 10-15%, 90-100% respectively). Furthermore, the ME-GI engine has no methane slip, and is therefore the most environmental friendly technology available. MAN predicts a broad potential market for its ME-GI engine, extending from LNG and LPG carriers to other oceangoing vessel segments such as containerships as well as ships plying a fixed trade.
Location	USA
Timing	2012 Launch
Capital Spending	Unknown
Companies / Entities	MAN, Burckhardt Compression, Cryostar, Hamworthy









Source: MAN Diesel & Turbo

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Key gas-to-transport projects

Honda – The Civic Natural Gas

Project Description	Honda's Civic Natural Gas is currently the only commercially produced passenger CNG car available in the US. The car (or its predecessor) has been available to fleets since 1998 and to retail customers in certain states since 2005. The CNG Civic costs $27k, a premium of $5.6k to the gasoline version, and a $2.1k premium to the hybrid version. Fuel economy is similar to the gasoline model, giving a c.35% fuel cost saving given the lower price of gas. However with 110hp, it loses 30hp in power versus its gasoline sibling, and has a much shorter range (200 miles). Honda has started to offer a $3k fuel incentive to improve the economics of the CNG Civic to retail customers. A pre-loaded debit card can be used at ~200 Clean Energy refilling stations in the US.
Location	USA
Timing	Ongoing
Capital Spending	NA
Companies / Entities	Honda

Source: Honda Motors

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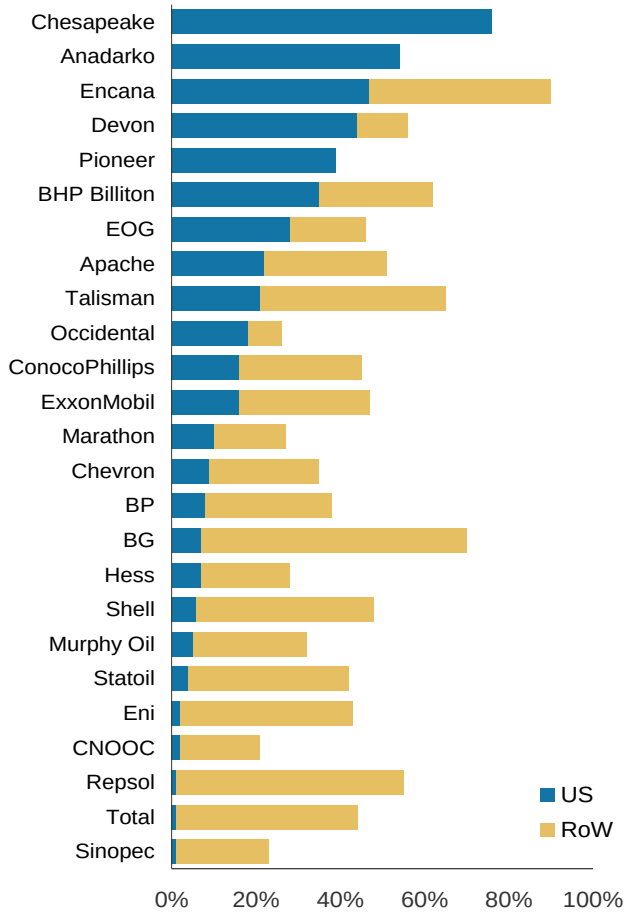
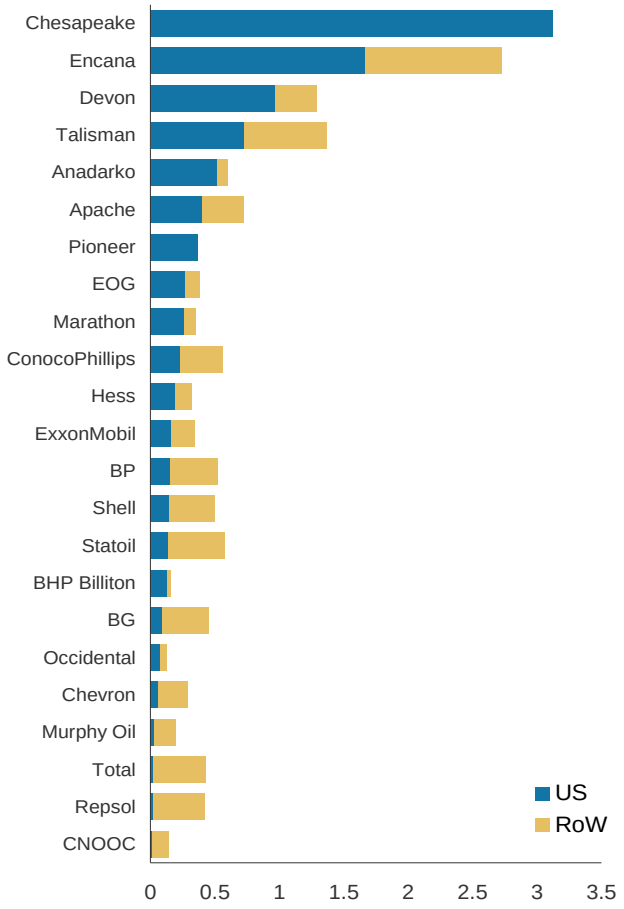
Among European Integrateds, Shell, BG and ENI likely to benefit

Natural gas as a % of total production - 2013



Source: Wood Mackenzie estimates

Gas reserves relative to market capitalisation
(mcf/$)



Source: Wood Mackenzie, DataStream. Latest commercial 2P gas reserves used and price data as of 27th March 2013

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Companies likely to benefit most from increased natural gas vehicle usage

Royal Dutch Shell

Covered by: Martijn Rats

Key Initiatives in Natural Gas for Transport

- Shell believes that natural gas could play an important role in meeting the world's rising transport needs across shipping, trucking and aviation.
- In shipping, Shell bought Norwegian LNG fuel company Gasnor in July 2012 to improve its ability to supply LNG to industrial and marine operators. Shell also plans to charter the first LNG-powered inland barges, which are expected to sale on the Rhine in 2013.
- In trucking, Shell has announced projects in Canada, Australia and the US to produce and supply LNG to heavy-duty trucks along designated LNG 'corridors' or 'natural gas highways'.

Investment Thesis: Overweight

- As key projects come on-stream, free cash flow increases structurally, creating considerable potential for Shell to grow the dividend over the medium term, which Shell management has started to express in its recent increase.
- Given the strength of Shell's balance sheet, we estimate that it could withstand an oil price of $50/bbl until end-2016 before balance sheet gearing reaches 30%, maintaining capex and dividends in the meantime.
- Shell's total resource base stands at ~58 years of production. This is significantly larger than for BP and Total and therefore underpins a higher long-term dividend growth estimate.
- We see Shell's free cash flow yield reaching 7-7.5% during 2014-2015, ahead of its peers.

BG Group

Covered by: Martijn Rats

Key Initiatives in Natural Gas for Transport

- BG is a leading natural gas company whose LNG business spans across all segments of the value chain. It managed 13mmtpa of LNG volumes in 2012 and plans to increase this to 30mmtpa by 2020.
- BG is established in the Indian CNG market through Mahanagar Gas (MGL, BG 49.8%) and Gujarat Gas (GGCL, BG 65.1%). By June 2012, MGL fuelled 250,000 vehicles with CNG from 150 CNG stations, whilst GGCL fuelled 180,000 NGVs with CNG. In October 2012, BG announced an agreement to sell its stake in GGCL to GSPC.
- In 2008, BG signed an agreement with KazTransGas (KTG) to implement a CNG pilot project, aimed at converting vehicles in Kazakhstan to CNG. The partnership also opened the first CNG station in Almaty in 2010.
- BG Group also held 60.1% interest in Comgás, which supplied ~340 NGV filling stations in 2011. The sale of its Comgás stake to Cosan was completed in November 2012.

Investment Thesis: Equal-weight

- We estimate BG increases operating cash flow from $7bn in 2011 to ~$16bn by 2018. Whether BG will indeed deliver on this forecast, and how it will subsequently redeploy this cash flow are key questions for the valuation. We see rising uncertainty over:
- #1 Long-term strategy: Transformation in size means the firm may start to make different strategic choices.
- #2: Project execution: Technical and operational challenges in Australia and Brazil remain significant.
- #3: Investment opportunities: Limited visibility on where BG will make its investments, post Brazil and Australia.
- #4: Financing: If oil prices fall, focus could return to the balance sheet.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

ENI

Covered by: Martijn Rats

Key Initiatives in Natural Gas for Transport

- Eni is leader in the natural gas vehicle market in Italy and actively plays a role in its development in Europe.
- The company is a partner in the EU "LNG Blue Corridors" Project to develop a network of LNG stations in EU for re-fueling long-haul trucks. It is planning to build its first LNG re-fueling station in Italy along the Italian portion of the corridor from Portugal to Croatia.
- Eni sells CNG for road transport through its grid of CNG-dedicated fuel service stations and other retailers, with a 60% market share out of the 900 mcm of CNG sold in Italy. Eni manages almost 60 multi-fuel re-fueling stations, which also deliver CNG.

Investment Thesis: Overweight

- Eni's conventional portfolio generates significant free cash flow, which provides significant dividend cover in the medium term and its ability to sustain the dividend is among the strongest in the sector.
- Strong balance sheet underpins dividend safety. It would take around four years of oil trading at $50/bbl for gearing to reach 30%, we estimate.
- Eni has a strong track record of value creation through exploration. Drilling programmes in Angola, Mozambique and Norway create potential for this to continue.
- Eni offers sector-leading average dividend and free cash flow yields of 6.6% and 9.7% for 2013-15, on our estimates. The 2013 dividend yield of 6.4% is at an above-average spread of ~290bp over the yield on its long-dated corporate bonds. We estimate the shares discount a decline in the dividends after 2014 at a rate of 0.1% per annum.

Technip

Covered by: Rob Pulleyn

Key Initiatives in Natural Gas for Transport

- Technip sees good scope for growth in small scale LNG, where key end-markets are transportation fuel for trucks. A benefit of small scale LNG is that gas can be distributed by truck to remote areas, which avoids the need for a pipeline network. Technip has also mentioned the growing potential for GTL technology in future.
- Technip has worked on a number of small scale projects, including Dynevor Arms (70k/tpa, UK, 1982), ALT, Topock (50k/tpa, US, 1997) and Ningxia Hanas (2x 400k/tpa, China, 2009).
- Technip also has a strong position relating to overall gas projects. The Company is the leader in FLNG, is part of 1 or 2 leading consortia for the construction of LNG plants, has the capability to install gas pipelines and has also undertaken upstream gas developments & gas processing.

Investment Thesis: Overweight

- With offshore accounting for ~70% of backlog, we expect Technip to be a key beneficiary of the increase in higher-margin offshore activity.
- We expect significant backlog growth through 2013 as Technip rolls out its new Global Industries rigid pipelayers and bids for contracts with its new vessels, the Deep Energy and Deep Orient.
- We consider Technip well placed with its large exposure to key West African hotspots, GoM, Brazil, FLNG, the emerging US downstream market and the strengthening North Sea market. We also view Technip as having a well diversified portfolio of contracts in terms of size and client exposure.
- We consider the shares attractively valued on 14 times our 2013 forecast earnings and 11 times 2014 earnings. We see a strong likelihood that future earnings growth is similar to that in the past cycle.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

Petrofac

Covered by: Rob Pulleyn

Key Beneficiary of Gas Demand Growth

- We view Petrofac as well placed to benefit from growing gas-for-fuel demand, given its exposure to upstream gas development and gas processing contracts.
- Petrofac is among the most exposed to gas projects in its E&C business, which will remain a significant proportion of earnings even with the IES growth.
- Petrofac has undertaken several significant gas contracts in recent years, most notably the $3.4bn South Yoloton, $2.2bn El Merk, $1.2bn In Salah and $900m Laggan-Tormore contracts.

Investment Thesis: Overweight

- We expect an improvement in sentiment regarding the IES strategy as 2013 sees net income from this division double to 24% of the group total.
- We see a better outlook for onshore awards and backlog growth in 2013 than last year and also expect the offshore business to expand. These contracts should act as catalysts, de-risk 2014 consensus and provide the cash generation to fund IES and Offshore investments.
- We think the shares are attractively valued at 11 times 2013 earnings and 10 times 2014 earnings, on our forecasts, given the growth we forecast out to 2015 and a return on equity of 40% over this period.

Saipem

Covered by: Rob Pulleyn

Key Beneficiary of Gas Demand Growth

- We view Saipem as well placed to benefit from increasing gas demand through multiple markets, given its current position and capabilities.
- LNG projects are a key business area for Saipem onshore, and we expect the joint venture with Chiyoda to be successful at securing contracts in this space. We also expect Saipem to secure FLNG contracts, which we see as an increasingly attractive solution given the challenges for onshore plants.
- Saipem is the leading offshore trunk/export-line installer, which for offshore stranded gas requires pipelines to onshore facilities (if not doing FLNG). Saipem is also exposed through its onshore division to upstream gas developments and gas processing.

Investment Thesis: Equal-weight

- Following the large profit warning in January, we believe it will take time for investor confidence to return and that there will be higher perceived risk in the stock in the next three to six months.
- We look forward to the Spring Strategic Review for clarity on the company strategy going forward. However, we highlight the risks to the share price in the near term regarding the required order intake to support our 2014 forecasts, the outcome of the Algerian investigation, the change in management and the future level of profitability following the profit warning on 29th January this year.
- Although we think the shares have attractive upside on a medium-term view, we believe the factors above and reduced confidence will limit upside in the coming months.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

Noble Energy

Covered by: Evan Calio

Key Beneficiary of Gas Demand Growth

- NBL's production is 53% natural gas, of which 55% is located in North America. We believe that incremental natural gas demand from an emerging Natural Gas Vehicle market will be one step in a process of rebalancing the North American gas markets.
- NBL works as a commodity-agnostic stock call (see below), yet also has US natural gas exposure in the highest return, lowest cost basin, the Marcellus (breakeven below $2/MMBtu).
- NBL has several large, gas projects in the Eastern Mediterranean Sea. NBL recently announced first production at Tamar (10 Tcf gross mean), with production of 300 MMcf/d and expectations to reach design capacity of 1 Bcf/d during peak summer demand in 3Q13. NBL will also be exposed to LNG through production from Leviathan (Israel) and prospects offshore Cyprus.

Investment Thesis: Overweight

- Outsized production growth in a lower-growth environment for Large-Cap E&P peers. We expect NBL to grow production by 16% and 22% in 2013 and 2014, respectively, compared to peers at 3% and 2%.
- NBL has a balanced portfolio in 5 core areas: Niobrara, Marcellus, Gulf of Mexico, West Africa, and Eastern Mediterranean. We believe 4 of 5 core areas will be FCF positive in 2014.
- NBL has the leading position in the oily Core Wattenberg (Niobrara) where we expect continued operational momentum through 2014 with (60-100+% IRR wells).
- Offshore exploration provides significant upside potential in 2013 ($50+/sh unrisked). NBL is an experienced explorer and discovered 2.8 BBoe net in 2007-12, which management expects to contribute to 25% of 2014 production.

Range Resources

Covered by: Todd Firestone

Key Beneficiary of Gas Demand Growth

- Natural Gas Upside: ~79% of RRC's production is natural gas; each $0.50/MMBtu of price increase equates to ~$200 MM of EBITDAX, an 18% increase.
- Leading operator in the Marcellus, the highest return and lowest cost natural gas play in North America.
- Leader in securing NGL and natural gas transportation through strong midstream relationships (i.e. Mariner East pipeline). The location of the Marcellus, in addition to the onset of planned pipeline takeaway capacity, gives unparalleled access to high-demand northeast markets.

Investment Thesis: Overweight

- RRC is a leading operator in the Marcellus, the most economic gas play in North America. It has excelled peers in securing long-term off-take agreements. Its exposure to the play makes it well positioned to benefit from sustainably higher natural gas prices.
- RRC has 100k net acres in the Permian, a top-tier emerging play in North America. RRC's results in the Cline formation (Permian) have potential to surprise to the upside, potentially beating management's type curve and adding up to $5/sh, in our opinion.
- RRC has ~160k net acres in the key Mississippian play; recent results have shown initial production rates (24-hr) of over 1,000 Boe/d with higher liquids percentages than competitors.
- RRC has 190k net acres in the Utica. While the play is still in an early stage, the Utica's close proximity to the Marcellus should allow its production to benefit from the rapid growth of local midstream infrastructure. The acreage is likely to show increasing liquids prospectivity and could provide a substantial catalyst into 2013/14, as the play is de-risked.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

Chart Industries

Covered by: Ole Slorer

Key Beneficiary of Gas Demand Growth

- Chart Industries (GTLS) manufactures heat exchangers that cool gases in the liquefaction process, as well as LNG tanks used in natural gas vehicles and fueling stations.
- Growth in liquefaction capacity would drive demand for GTLS' brazen aluminum heat exchangers and cold-boxes used in the liquefaction process.
- Growing demand for natural gas vehicles and refuelling infrastructure in the US and China drives demand for the company's cryogenic trailers, bulk storage tanks, and LNG vehicle refuelling stations for centrally fueled vehicle fleets.
- Revenue from LNG storage tanks in vehicles and fueling stations has been growing at a very fast clip, from ~$20mn in 2010 to over $100mn in 2013, largely driven by robust NGV initiatives in China.

Investment Thesis: Equal-weight

- We expect Chart Industries to benefit from the following secular natural-gas related trends: (i) growth in natural gas production in the US (especially wet gas) driving demand for natural gas processing, (ii) low natural gas feedstock prices driving demand for petrochemical infrastructure investment in the US, which requires gas cooling capability, (iii) increased demand for LNG and a high global gas price driving demand for liquefaction capacity in low natural gas price regions, such as the US and Australia, (iv) growing demand for LNG trucks and buses in China, the largest driver in demand for LNG tanks, followed by the US.

Dresser-Rand

Covered by: Ole Slorer

Key Beneficiary of Gas Demand Growth

- Dresser-Rand (DRC) sells compressors, gas turbines, and engines into natural gas driven end-markets. In our view, it will benefit from increased natural gas demand, including growing demand for natural gas vehicles.
- Increased demand for natural gas and the high price of LNG in Asia should drive demand for development of offshore gas fields, requiring FPSOs that use DRC's capital equipment.
- Growing demand for liquefaction capacity for both export and LNG fueling stations is another driver for DRC's product offering.
- Increased demand for LNG as a fuel for frac equipment and heavy duty vehicles would drive demand for DRC's portable liquefaction plants used to convert pipeline gas into LNG at the fueling stations.

Investment Thesis: Overweight

- Dresser Rand is leveraged to secular growth in: (i) global liquefaction capacity due to the depletion of existing fields and fuel substitution, and (ii) FPSO capacity as oil companies look to develop recently discovered deepwater fields.
- Unlike most companies in our coverage, DRC benefits from low natural gas prices as, (i) we see increased investment in petrochemical infrastructure driven by cheap natural gas feedstock, (ii) LNG export facilities are being constructed in the US, and (iii) use of LNG is increasing at the well site and in natural gas vehicles.
- Its competitive advantages include: (i) flexible capacity, which helps reduce fixed costs by outsourcing the manufacturing process, and (ii) applied technology initiative, which allows the company to grow market share by servicing its competitors' capacity.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

Gazprom

Covered by: Pavel Sorokin

Exposure to the Natural Gas for Transport

- Gazprom is looking to establish a presence in EU gas to transport projects across bunkering, light duty (CNG) and heavy duty vehicles (LNG).
- Gazprom's expects the infrastructure investment it is making will secure it a 10% share of the global LNG for transport market, 10% of the developing CNG market and 25% of the developed CNG market by 2030.
- Gazprom's LNG capacity is limited to the 50%+1 share stake in Sakhalin 2 projects (11mn tpa). However, the project pipeline should make Gazprom one of the larger LNG players globally, with capacity of over 50mn tpa (Shtokman 25mn tpa+, Vladivostok LNG 15mn tpa+, Sakhalin-2 expansion 5mn tpa).
- Gazprom boasts a reserve base of over 33tcm of gas reserves and existing natural gas export capacity of over 210bcm pa, with the potential to increase it to c.350bcm if all projects proceed as planned.

Investment Thesis: Equal-weight

- Gazprom's top line is under pressure across key markets. European clients are pushing for faster contract-spot price convergence. Gazprom's resistance is leading to market share loss to more flexible competitors. Domestic market share is contracting as independent gas producers ramp up their gas output amid stagnating domestic demand.
- Sizeable capex plans leave minimal free cash flow for minorities. The Eastern Gas program, Nord and South Streams, Yamal megaproject should all expand Gazprom's export capacity, but leave no FCF for the next two to three years.
- Gazprom trades on 2.8 times our 2013 forecast earnings, making it the cheapest Russian energy major. We think the shares are fairly valued, as the fixed dividend policy at 25% of RAS net income leaves little room for dividend surprise, while the transition to 25% payout of IFRS net income is only scheduled for 2015.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

Reliance Industries

Covered by: Vinay Jaising

Key Beneficiary of Gas Demand Growth

- We view RIL as likely to benefit from the global theme of growing gas for fuel demand given its exposure to Shale gas assets in the US.
- RIL has three shale gas JVs; volumes (RIL's share) from these are likely to equate to 50% of its overall volumes and 12% of its overall EBITDA by F2016.
- We have assumed long-term Henry Hub Gas prices at US$4.5/mmbtu in our base case, which could likely increase if NGVs create incremental demand.

Investment Thesis: Overweight

- Improving operating environment: RIL's operating environment is improving across its core businesses, which should spur a renewed earnings upgrade cycle. RIL's refocus on capital employed, its lagging share price, and an all-time low foreign portfolio ownership keep us Overweight.
- Spot LNG prices are at a high: The Indian government is considering linking gas prices in the country to international prices, which include LNG prices as a key component. We currently assume US$8/mmbtu in estimates.
- Focus returns to core business: RIL did not participate in 900Mhz spectrum auction in telecom. We now estimate RIL to invest US$28bn (~80% of overall capex) in its core businesses over F2013-17; this should yield 87% higher EBITDA and 75% higher net profits by F2017, implying a 15% earnings CAGR over F2013-17.
- Valuation attractive, and the stock is under-owned: On our F2014e earnings, the stock trades at an EV/EBITDA of ~7.0x, and a P/E of 10.6x, which is a ~8-15% discount to its historical average. It is trading at a P/BV of 1.3x, 30% lower than its historical average.

BPCL

Covered by: Vinay Jaising

Key Beneficiary of Gas Demand Growth

- BPCL has a 10% stake in Area-1 block in Mozambique, which is believed to have 32-65tcf of recoverably natural gas.
- BPCL and other partners on the block are looking to monetize the gas discoveries through exports on LNG from Mozambique.
- Every dollar increase in gas prices increases our estimate of BPCL's E&P value by 3% or Rs18/share.

Investment Thesis: Overweight

- Significant wealth creation at its E&P venture: BPCL's upstream footprint has proven to be a game changer in our view, especially its 10% stake in Mozambique Area-1 Block. We value BPCL's E&P business at US$2.5bn, or Rs197/share, which is ~50% of its CMP.
- Defensive pick to play diesel deregulation: The domestic fuel marketing business contributes <22% of BPCL's current value, based on our what's in the price analysis.
- Bina refinery to start contributing meaningfully to earnings: BPCL owns 50% of Bina, a high complexity refinery with Nelson Complexity of 9 and capacity of 6MTPA, which has recently been commissioned and ramped up to 100% utilization. Assuming GRMs of US$8/bbl, we expect Bina to contribute ~13-14% of BPCL's consolidated EBITDA and ~3-5% of PAT in F2013-15e.
- Valuation not expensive in the wake of positive momentum on fuel reforms; rerating to continue: The stock is currently implying 0.3x price to book for its core business. Historically, the stock has traded at an average of 1.4x during the periods when the momentum of fuel reforms was positive. We continue to see a valuation re-rating if the price reforms continue.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

ENN Energy

Covered by: Vincent Chow

Key Beneficiary of Vehicle Gas Usage

- ENN is the first mover in CNG and LNG vehicle refilling stations in China. Vehicle accounted for ~15% of gas sales volume in 2012.
- Vehicle gas not only provides volume growth potential but ENN also enjoys higher dollar margins on vehicle gas sales vs other customers.
- ENN targets to add 30-40 CNG stations per annum and >100 LNG vehicle refilling stations in 2013.

Investment Thesis: Overweight

- Beneficiary of gas volume growth: Strong natural gas demand in China with high affordability, increased domestic supply, cost competitiveness relative to alternative energies and government's strong push for rising gas utilization.
- Self funded growth model: With free cash flow, ENN does not need any equity funding to fund growth. ENN expects free cash flow to continue to increase going forward.
- Focus on return instead of capacity: With a focus on second-/third-cities and industrial zones in economically developed regions, the new projects enjoyed (i) higher margins due to lower residential gas sales and (ii) lower risk of margin squeeze.
- Excellent management track record: Management has a good long track record of beating/ meeting guidance given on operational data.
- First mover in CNG/ LNG vehicle refilling stations: Being a first mover in LNG vehicle refilling stations helps provide a margin of safety on gas sales volume growth.

Other gas distributors will benefit too

- Other gas distributors such as BJE (392 HK), Towngas China (1083 HK), HKCG (3 HK), CR Gas (1193 HK) are also beneficiaries of the growth in the natural gas vehicle market. However, they do not have explicit targets for this market.
- Kunlun Energy (135 HK, EW) is the strongest promoter of NGVs in China. However, its major focus, LNG processing plants, will face oversupply in near term.

Equipment manufacturers should benefit from the capex boom

- Gas equipment manufacturers (e.g. cylinders, tankers, compressors etc.) will also benefit from the growing investment in LNG processing plant, NGVs, and gas refilling stations.
- CIMC Enric (3899 HK, not covered) is the only offshore listed gas equipment name in China.

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Companies likely to benefit most from increased natural gas vehicle usage

Karoon Gas Australia

Covered by: Stuart Baker

Key Beneficiary of Gas Demand Growth

- Karoon is currently in a joint venture with partners Conoco Phillips and Petrochina, where they are exploring and appraising the large “Poseidon” gas field, located in the Browse Basin, Western Australia. This is in proximity to a number of world-scale LNG developments, namely the INPEX/Total "Ichthys" project and the Shell 'Prelude " FLNG development, and Woodside's' proposed Browse Basin LNG scheme.
- Transactions in 2012 for equity in Woodside's nearby 15 Tcf Browse basin total around $6bn and equate to around 90c/mcf for proven, but undeveloped, gas, evidencing continued strong interest from large companies in aggregating gas resources.
- A further four wells are planned on Poseidon this year, after which the reserves range will be tightened and booked, paving the way for (another) potential LNG development, possibly using FLNG technology, or by piping the gas to Darwin, where Conoco Phillips is the operator of a single train, 3.6 MTPA project (Darwin LNG)

Investment Thesis: Overweight

- Exploration for oil offshore Peru and Brazil are materially value-additive in the event of success.
- Exploration results from six wells to date on the “greater Poseidon” resource offshore Western Australia have identified a potentially world-scale resource.
- Transactions for undeveloped gas on nearby fields underscore value.
- Karoon, however, lacks immediate production, so value depends on drilling and appraisal success, to be followed in time by monetization via sale of resources or development.

Santos

Covered by: Stuart Baker

Key Beneficiary of Gas Demand Growth

- Santos’ growth is coming from a number of LNG projects in Papua New Guinea (PNG LNG) and in Australia (Gladstone LNG). These projects provide substantial top-line production growth for Santos from mid 2014.
- In addition, the company has 56 million acres that are prospective for shale gas and oil onshore Australia, where there has been a "land boom" over the last two years as large cap oil companies have acquired acreage. Recent entrants include Chevron, BG, Hess and Statoil.
- Santos has the largest shale oil and gas acreage position in Australia, and also has access to pipelines and owns key infrastructure.

Investment Thesis: Overweight

- Santos has a production and earnings profile that will increase significantly with successful development and contributions from new LNG projects from the middle of the decade.
- The company has significant 3P gas reserves, including CSG and shale gas in Australia. LNG projects are required to monetize this, but they are long dated and involve large capital risks.
- Santos is currently trading substantially below our discounted cash flow valuation, and we believe this discount should close over time as development milestones are met and help de-risk future cash flows.

Morgan Stanley

Companies likely to benefit most from increased natural gas vehicle usage

PetroChina

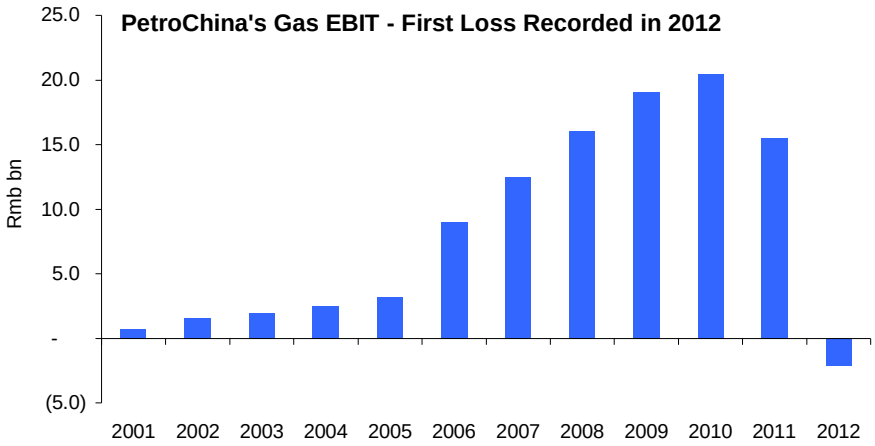
Covered by: Wee-Kiat Tan

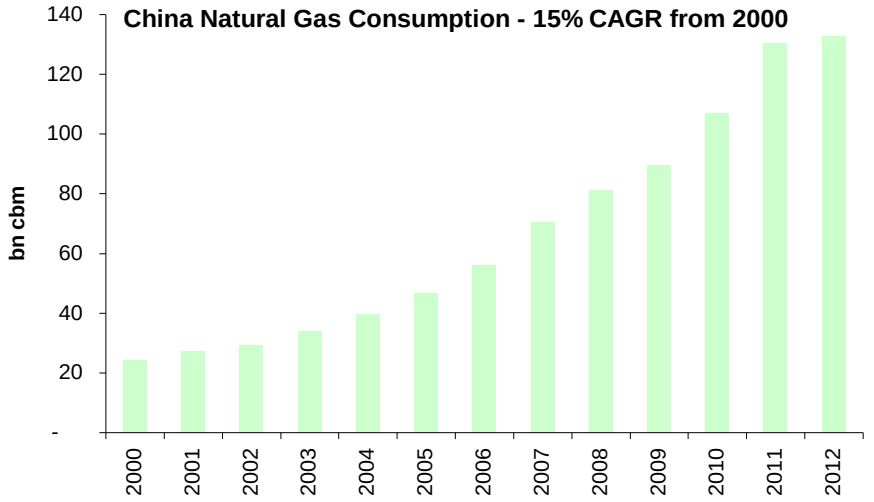
Beneficiary of Potential Gas Pricing Reform

- As the largest natural gas provider in China, PetroChina started to incur losses in 2012 mainly due to the significant loss from import gas. The company reported an aggregate loss of Rmb2.1 bn in 2012 for its natural gas business. The imported gas business recorded a total loss of Rmb41.9 bn in 2012.
- Despite the loss making nature of PetroChina's natural gas business, China's natural gas consumption maintains rapid growth momentum with 15% CAGR achieved in 2000-2012. We believe the growth will remain strong in the coming years.
- Also, with the losses incurred in 2012, there are increased expectations that China will start to increase natural gas prices in 2013. Some cities, such as Changchun, Suzhou, etc., have already announced gas price increases in the past one to two months.
- PetroChina has invested Rmb73 bn in 2012 to further enhance its gas distribution network. The capex is likely to reach Rmb65.7 bn in 2013 based on the existing project pipeline.

Investment Thesis: Underweight

- We believe the combination of rising gearing, huge capex and relatively slow earnings growth is starting to put PetroChina's balance sheet under pressure. Significant policy reforms are needed (yet out of company's control) to turn PetroChina's refining and gas pipeline operations around and reaccelerate its earnings. Otherwise, debt levels will rise and interest expense will begin to drag on its earnings and ROE.
- PetroChina is however a beneficiary of potential gas pricing reform given its high exposure to gas.





Source: Company data, Morgan Stanley Research

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India: Our Perspective on Natural Gas Vehicles

The story so far

- In India, the push on NGV development largely started with several court rulings and public campaigns related to controlling air pollution.
- Currently the key regions where NGV development has been most successful are Delhi, Mumbai and in the state of Gujarat.
- This was aided by the price differential between CNG and gasoline/diesel prices as domestic natural gas prices at US$4.2/mmbtu (~US$25/boe) were much cheaper compared to oil prices.
- Lower taxation (VAT) on CNG (average 9%) as compared to gasoline/diesel (average 22%) has also helped the price differential advantage to CNG.
- This helped the number of NGVs to increase to 1.8mn as compared to ~0.15mn in 2002, which now constitutes ~6% of overall fleet size including cars, buses and LCVs.

Future - challenges ahead

We believe this phase of growth is now likely fading with many future challenges ahead:

- Domestic gas prices in India are expected to double as they are proposed to be linked to international gas prices.
- Domestic gas supplies in the country are declining in the near-term and CNG players need to rely on imported LNG prices, which are much higher thus reducing the advantage of CNG.
- Setting up the distribution infrastructure, especially CNG pumps, is expensive and OMCs are likely to be reluctant to set-up new pumps unless adequately incentivized.
- Incrementally, we think only ‘green’ legislations likely to be a key demand driver for CNG.

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China: Our Perspective on Natural Gas Vehicles

- Industry players we talked to, including gas operators, vehicle owners, equipment manufacturers, and vehicle OEM manufacturers, all agree that NGVs will continue to grow in China.
- The government has classified vehicle as one of the priority natural gas usages.
- Compared to other potential alternative fuels including power, ethanol, methanol, biodiesel, and dimethyl ether, NG is the best candidate to replace oil in the vehicle sector because: (i) the heat value of NG is high while the pollution is low, (ii) the technology and the value chain are more mature, (iii) the retail NG price is more competitive.
- However, despite a strong YoY growth rate, NGVs will account for an immaterial amount (<5%) of the China auto market in the next few years.
- In 2012, the number of LNG vehicles and CNG vehicles in China were around 81k and 1.7mn respectively. There are various estimates on the growth rate by industry experts, with a range of 15-25% CAGR in 2013-15.

Price competitiveness is the key incentive:

- The key factor in determining the growth rate and the ultimate market size is pricing.
- The retail LNG price guideline from the government is a 25% discount to diesel/gasoline prices. Currently, gas distributors are selling at ~30-50% discount to the diesel/ gasoline price.
- At current price, the payback period for converting a gasoline taxi to CNG taxi is ~2-3 months while the payback period for LNG heavy truck is ~ 1year.
- We estimate the retail price will gradually increase to 25% discount to diesel/ gasoline price. Since it is in line with the government interest to promote NGVs, we estimate the retail price of natural gas will remain competitive versus gasoline/ diesel in the coming years.

What are the concerns and bottlenecks?

- The bottlenecks are - (i) Insufficient government planning: There is no planning and incentive policy on a national level. Only a few provinces have set up their own incentive policy. (ii) Convenience: The number of gas refilling stations is too low and far from a network in the near term. (iii) Lack of a visible natural gas pricing mechanism. (iv) Reliability and safety.

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Indonesia: Taking the Baby Steps

The story so far

- Indonesia, a country which until recently was focused on oil production and hence oil led demand, has started to look at gas as an alternative to oil.
- The country has 41 years of reserve life and is the third largest exporter of LNG globally. With the rising oil based fuel demand and an increasing fiscal deficit, the Indonesian government, through PERTAMINA started pilot studies to open CNG stations in Jakarta in 2012 and allocated a small 10-15 mmscfd of gas for the project.
- Government is also incentivizing conversion kit imports by giving import tax rebates.
- Indonesia gas is priced at US$10/mmbtu and considering retail fuel prices in Indonesia are ~ 50% below the market price, we see the shift towards gas being driven by government decontrolling the oil fuel market and improving the gas supply stations in the country.

Future – normalized growth ahead

- With a higher domestic well head gas price, we see improving gas supplies in Indonesia, which should support offtake of CNG.
- Also, with the Indonesian government looking at increasing pump prices for fuel, we see a long-term incentive for consumers to move to CNG as they see the improved CNG station network in the country.

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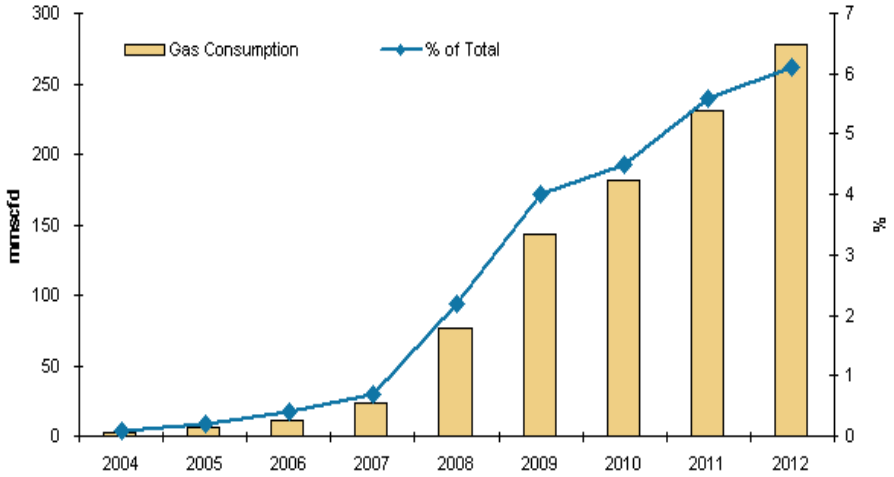
Thailand: Our Perspective on Natural Gas Vehicles

The story so far

- Natural gas taxi cabs have been in Thailand for a decade. Due to favourable supplies from domestic gas fields, the Thailand government started to promote NGV (as CNG is called locally in Thailand) and ethanol to replace gasoline around 2003. Thailand via the listed company PTT (Thailand's state-owned energy company) has 483 CNG stations with the about 6.5% of total Thailand natural gas consumption used for automobiles.
- Thailand has some 700,000 LPG fueled vehicles, and 380,000 CNG fueled, with 1,000 LPG stations. Demand increased 26% YoY in 2012 for CNG in Thailand as the price of CNG at Bt8.5-10.5/kg (US$280-350/ton) is ~ 30% lower than the market price.
- Government is looking to decontrol CNG prices to protect 1) the 12-14 years of gas reserves in Thailand, 2) prepare Thailand for AEC 2015, and 3) reduce subsidies of ~US$600mn/annum on CNG sales.
- Price of CNG is still ~ 15% cheaper than gasoline/diesel (at market price) making it a viable option.



Source: Company data, Morgan Stanley Research

Future – normalized growth ahead

- Higher CNG prices over the next few years would normalize the growth of CNG consumption in the country.
- With Thailand having 3-4% of LNG in its gas sourcing mix, we believe CNG prices in Thailand would remain high in the medium term. Also Thailand has domestic gas prices linked to oil prices, hence volatility in oil prices could hurt demand once the CNG prices move to free market.
- CNG car models have been introduced by global car majors in Thailand (which also is an automobile manufacturing hub) to take advantage of the tax benefits provided by the government on clean cars. This, along with its competitive pricing relative to other fuels, we believe should continue to support demand.

	LPG	NGV	Petrol Price
Local Price (bt/kg)	21	10.5	43.25
Calorific Value	46,827	35,947	47,000
Market Price adjusted for Calorific Value	30	20	43.25
Subsidised Price Adjusted for Calorific Value	21	14	43.25
Discount	-30%	-46%	0%
Cost of Conversion	25,000	50,000	
Milage (km/lit)	11	15	18
Cost/kms	1.91	0.70	2.40
Nos of kms Travelled/annum	20,000	20,000	20,000
Amount of fuel required per annum	1,818	1,333	1,111
Fuel Savings per annum	**40,313**	**39,362**	**-**
Savings/km	**2.02**	**1.97**	
Cost Recovery of Equipment	0.62	1.27	

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Share prices

Company Name	Close price (as 0f 15/04/2013)
Royal Dutch Shell	2,164p
BG Group	1,085p
ENI	EUR 17.64
Technip	EUR 79.45
Petrofac	1,348p
Saipem	EUR 21.60
Chart Industries	$75.49
Dresser-Rand	$54.66
Karoon Gas Australia	AUD 4.16
Santos	AUD 12.13
Gazprom	$7.72
Nobel Energy	$107.99
Range Resources	$73.99
Reliance Industries	INR 804
BPCL	INR 406
ENN Energy	HKD 43.80
Beijing Enterprises Holdings	HKD 60.05
Towngas China	HKD 7.41
Hong Kong & China Gas	HKD 22.50
China Resources Gas	HKD 21.10
Kunlun Energy	HKD 15.82
PetroChina	HKD 9.49

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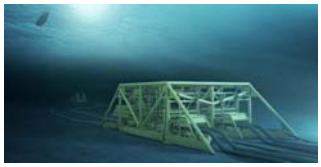

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Morgan Stanley

The Americas
1585 Broadway
New York, NY 10036-8293
United States
Tel: +1 (1)212 761 4000

Europe
20 Bank Street, Canary Wharf
London E14 4AD
United Kingdom
Tel: +44 (0)20 7425 8000

Japan
4-20-3 Ebisu, Shibuya-ku
Tokyo 150-6008
Japan
Tel: +81 (0)3 5424 5000

Asia/Pacific
1 Austin Road West
Kowloon
Hong Kong
Tel: +852 2848 5200