PÖYRY

PÖYRY POINT OF VIEW:
BEING RESOURCE SMART

How can small-scale LNG help grow the European gas market?

As use of fossil fuels declines, where will the growth in gas demand come from?

A large new market for natural gas is under rapid development whilst also reducing emissions. LNG is reaching markets previously inaccessible to pipeline gas; as a fuel for transport and for communities remote from the gas grid. A significant development is the use of LNG in marine transport, which currently uses heavy fuel oils.

LNG has significant emission related advantages in comparison to petroleum products: any traces of sulphur will have been removed in advance of liquefaction, and nitrogen levels are cut by 90%[1]. The use of LNG results in a 10-15% reduction in CO_2 emissions per unit of converted energy, and there are practically no particulate emissions.

Disadvantages of LNG, however, include the requirement for a different engine and storage technology for the user, and for fuel supply companies it is more expensive to supply both in terms of capital and operating cost. In addition, the infrastructure required to provide LNG as a wide scale alternative for maritime use has yet to be developed, so the supply network is limited. On the other hand, continued use of petroleum products will require significant new investments (e.g. in scrubbing technology which has yet to be developed) whilst rising prices and potential penalties may increase the cost.

On a global basis, the amount of maritime fuel consumed every year is equivalent to 171 million tonnes of oil[2]. This is comparable to the annual natural gas consumption of the whole of the EU-27 in all applications. Around 68% is burned on dry bulk, cargo and container routes; 29% during transport of chemicals and liquids; and 3% on passenger ferries.

Marine transport continues to play an important role in international trade, so there is further scope for growth, even beyond the replacement of existing shipping, as a consequence of rising populations and the growing importance of developing economies in Asia and Africa.

It is expected that retrofitting of ships to run on LNG rather than oil products will not be economically possible given current oil and gas prices. The market share of LNG will thus be largely restricted to new builds.

What is Liquified Natural Gas (LNG)? LNG is natural gas cooled to -161°C - the temperature at which methane, its main component, changes state into liquid. Impurities are reduced in the cooling process. It is an odourless, colourless liquid that is stored and transported at atmospheric pressure as a boiling liquid.

As a liquid, it is 1/600th the volume of natural gas, giving it a high energy density for transport and storage.

How can LNG be provided to ports and small-scale users?

1. Local liquefaction – if the location has access to pipeline gas then this is a way of ensuring continuous supply, but loses out on economies of scale. Further distribution by ship or truck can mean a reasonably large facility.
2. Truck loading at large-scale terminals – this has the benefit of being relatively easy to establish, but has a relatively limited range.
3. Ship loading at large-scale terminal – this provides a bigger range, due to larger tanks than on trucks, but would still be a regional business.

DIFFICULTIES IN PENETRATING OTHER POTENTIAL SEGMENTS

Developments in replacing oil for land transport or for remote industry or communities may prove more difficult to penetrate, as follows:

Inland transport

LNG is well suited to large vehicles and several manufacturers are actively developing and testing LNG engines for trucks. The U.S. is the front runner due to established long distance trucking routes and cheaper gas, but LNG filling station infrastructure is also being developed in Europe. The technical solutions are proven, but the market is still at an early stage.

Stationary energy

Small, but well established markets already exist in Japan, China, the U.S. and the Nordics for local LNG-based gas consumption. LNG is used where total demand is insufficient for pipeline transmission to be economical, but still offers cost and environmental benefits in comparison to oil. There are opportunities to use it as a “spear head” – to develop customers and markets that can later be supplied by pipeline as they reach critical size. This is a mature and well proven technology, but the economics may be challenging.

Why are we seeing the growth now?

EMISSION CONTROL AREAS

In 1997, the International Maritime Organisation, a UN agency tasked with maritime safety and security and preventing pollution at sea, introduced the concept of special protection-worthy Emission Control Areas (ECAs), within which special limitations apply concerning fuel use. These areas currently include the Baltic Sea, North Sea the East and West coasts of the U.S. and Canada and the US Caribbean coast, and further areas are under evaluation (see Figure 1). From 2015, within these areas the already low SOx (sulphur) emissions limits will be reduced to just 10% of current limits. It will therefore only be permitted to use fuels resulting in very low or negligible emissions of SOx, NOx (nitrogen) and particulates. By 2020 even the areas not currently within ECAs will have limits of half of those currently in operation within the ECAs.

These very strict limitations imply that ships will need to have expensive scrubbers installed to capture the SOx and NOx emissions from the funnel or convert to very highly refined grades of diesel oil and gas oil. As these will be in short supply, prices are expected to increase. LNG, which has considerably better environmental characteristics than petroleum products, has so far been uncompetitive against the high sulphur heavy fuel oils used for bunkers. However, in the future only the lighter (and cleaner) marine petroleum products such as marine diesel oil (MDO) and gas oil will be permitted. Currently, the price differentials between LNG and these are much narrower, so that a wide scale shift is both economically and technically conceivable and as well as being desirable from an environmental point of view.

WHERE IS IT HAPPENING?

Developments so far have been restricted to existing ECA areas and by availability of small-scale LNG, specifically, the Nordics, Baltics and the East Coast of the United States. However, as the ECA areas are expanded, the scope for LNG as a bunker fuel will grow significantly.

Nordics / Baltics

In Norway, a small-scale LNG industry has been thriving for about a decade: two small-scale LNG-producing facilities have been supplying LNG to the shipping sector along the Norwegian coastline and additionally to local industry. At the time of writing, there are already about 35 ships in operation and another 35 on order, including cruise ships, product tankers and barges. This has been facilitated by the Norwegian state providing subsidies and imposing emission restrictions.

In Sweden too, the use of small-scale LNG is growing. The first receiving terminal, in Nynäshamn, south of Stockholm, was recently commissioned and caters to the needs of local industry, domestic gas supply in the Stockholm area and an emerging demand from ferries crossing the Baltic Sea. More terminals are being planned on the west coast and north of Stockholm. On the other side of the Baltic Sea, a race is on for the construction of a medium scale LNG import terminal. Poland already has one under development (due to open in 2014), and Lithuania, Latvia, Estonia and Finland also have plans for their own import facilities.

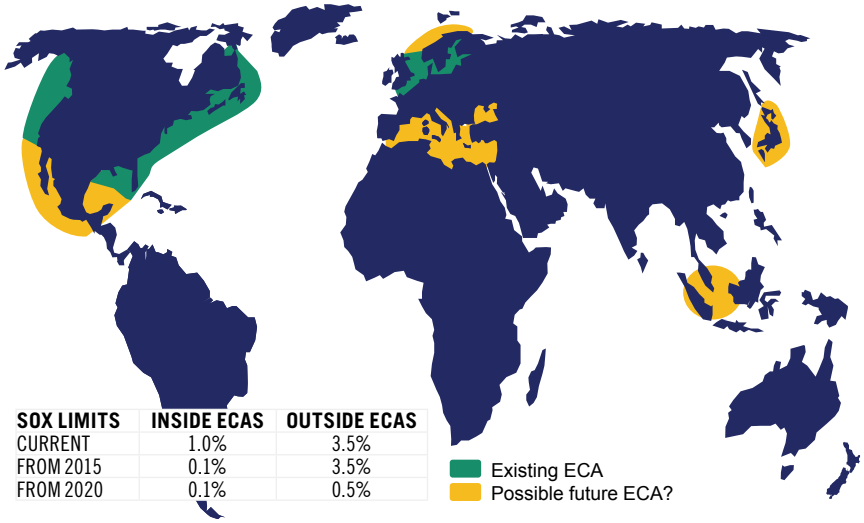
Other North West Europe

In the wider European context, LNG import terminals are an important part of the gas infrastructure. Existing facilities are already being equipped for bulk breaking (i.e. to reload LNG onto smaller vessels for subsequent distribution to other terminals, or onto road tankers to distribute to smaller ports). Investments are being made at terminals in Rotterdam and Zeebrugge within the ECA and Montoir on the west coast of France. Beyond the sea ports, plans are also being developed to convert barges on the major waterways of Europe. For example, Shell has ordered barges to operate on the Rhine and Gazprom has signed an MOU with Gasunie to promote the use of infrastructure for small-scale LNG and LNG as a bunkering fuel for marine and river transport.

The Mediterranean

Maritime traffic in the Mediterranean and adjacent waters is significant. Trading routes include internationally important waterways: the Gibraltar Straits, the Suez Canal and the Bosporus. The Suez Canal alone sees about 8% of all global ocean trade and, with the Mediterranean to be designated an ECA in future, an important new market will open up. LNG receiving terminals in Spain, Portugal, France, Italy, Greece and Turkey could act as hubs for LNG distribution. Terminals in Spain have already fuelled LNG powered

FIGURE 1: WHERE IS IT HAPPENING?



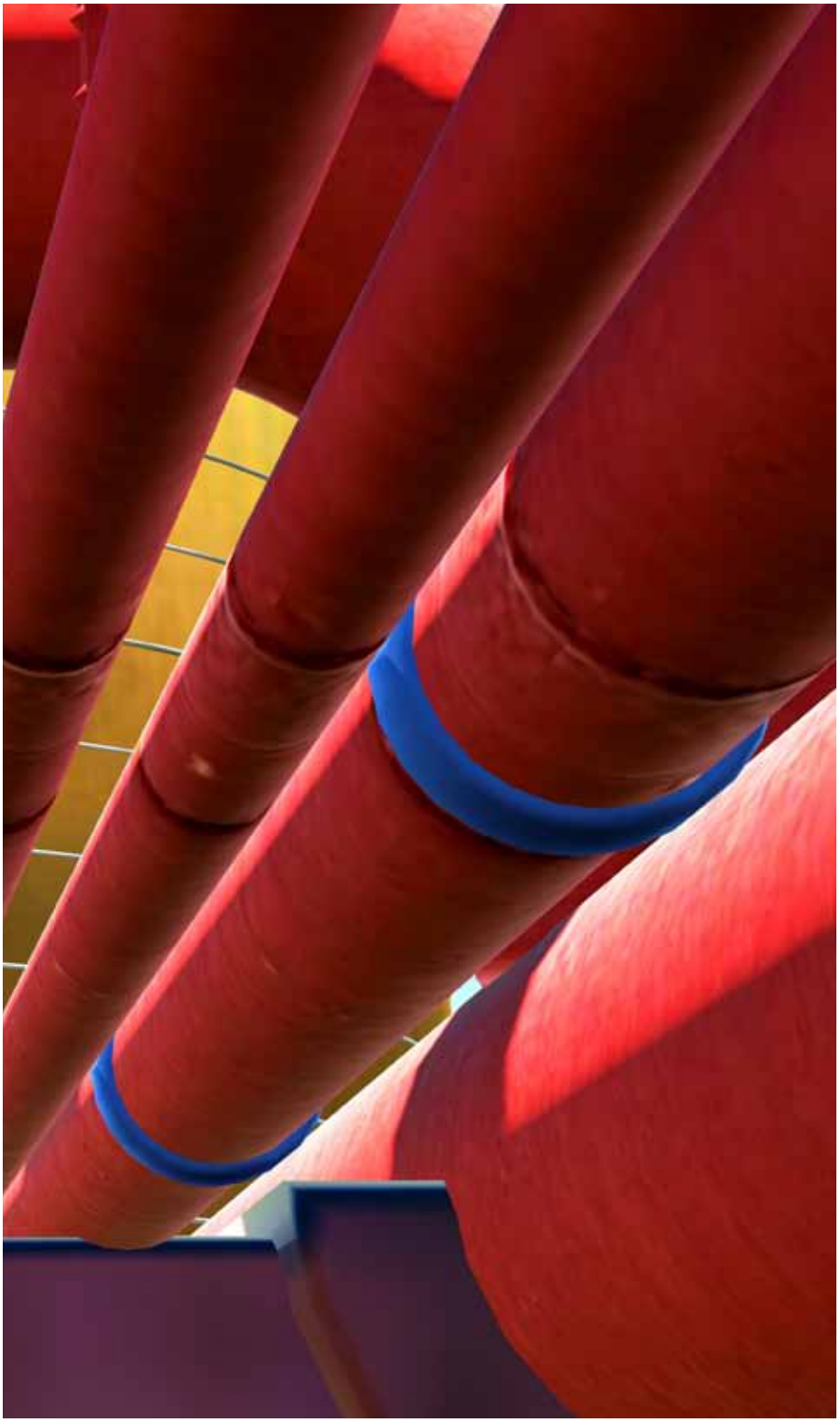
SOX LIMITS	INSIDE ECAS	OUTSIDE ECAS
CURRENT	1.0%	3.5%
FROM 2015	0.1%	3.5%
FROM 2020	0.1%	0.5%

vessels being delivered to Norway and have provided LNG to industry and generators by road tankers. The Fos Tonkin terminal in France is also being adapted to accommodate loading onto smaller vessels. There are LNG production facilities in Algeria, Libya and Egypt that can be used as hubs and, in the future, there may be further production facilities built in Israel, Lebanon and Cyprus.

So far, little has happened towards use of LNG as a bunker fuel, but at least the large-scale infrastructure is in place. This also has important implications for Northern Europe, since ships trading wider international routes will be able to access supply points in other parts of Europe.

The Americas

The U.S. remains the world's largest consumer of bunker fuels, with several major ports in LA, Houston and New York handling a significant share of worldwide cargo. But the recent adoption of the U.S. and Caribbean coasts as an ECA is bound to have an effect on consumption of bunker fuel: the reduction in ECA SOx limits will require a shift away from standard heavy fuel oil (HFO) consumption, leaning heavily on low-sulphur HFO with scrubbing equipment or high-priced distillates after 2015. Surveys conducted as late as 2012 showed moderate or no interest from key U.S. ports to develop LNG infrastructure[3], despite low gas prices locally and continued shale gas expansion. At the time of writing, however, we see developments with the port of LA, the largest container handler on the continent, actively joining leading European ports to assess expansion[4]. This could be a big move, with the U.S. fleet gaining access to LNG bunkering facilities in the next 3 to 5 years, primarily for use on pure-ECA routes. First orders for larger LNG-fuelled container ships are also on the books, scheduled to sail in ECA waters between Florida and Puerto Rico[5]. It remains to be seen if these developments can serve as a catalyst, but with lead times for ship deliveries well below pre-financial crisis figures, there is scope for demand to build up relatively quickly[6].



What are the challenges?

WHAT ARE THE CHALLENGES?

For investments to take place a win-win-win situation is required:

- For buyers (i.e. shipping and transport companies and local businesses): delivered LNG prices must be low enough compared to the relevant oil alternative, taking into account all investment costs for conversion or new equipment compared with the cost of continuing with the dirtier fuel;
- For infrastructure developers: the return on investments (e.g. LNG tankers, barges, road tankers, bunkering tanks, specialist loading and unloading facilities, etc.) must be at least as good as other available investment options, taking into account the opportunity cost of losing market share in existing operations if someone else develops it;
- For LNG producers or importers: who will want to make sure they earn a market price for their LNG.

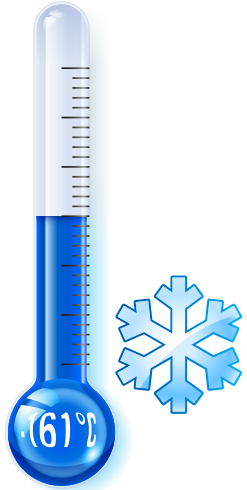
This is creating a 'chicken and egg' situation – who will make the first move? Customers hesitate to commit to using LNG unless there is a cost effective supply and suppliers hesitate to invest in costly supply infrastructure unless there is a market.

This has several implications:

- There must be a sufficient price differential between LNG and the petroleum-based alternatives to pay for the additional infrastructure required to ship the fuel from import terminals to distribution points, and subsequently to pump it from bunker barges into fuel tanks of the ships requiring supply.
- The differential must also be sufficiently large to offset the added capital and operating costs of storing and burning LNG rather than petroleum products.
- A market equilibrium price will also differ depending on local demand and supply-side structures, where the dominating party will leverage potential negotiating power.

A competitive price for LNG as a marine fuel is thus likely to be set at a level which is in line with gas oil or MDO, adjusted for added capital and operating costs of using LNG.

Note: Over time, costs related to energy efficiency and capital expenditure are expected to decrease with technological advancement, but given the life cycles and age structures of existing fleets, the growth in market share on a global basis is likely to be relatively slow in the bunker market and, unless there are other incentives to accelerate this, could take 25 years before the full potential is reached.



Production	• In the hands of traditional gas producers (economies of scale) • Complemented by close-to-source producers • Large-scale producers are not investing downstream, as it is not core business
Import terminals / hub operatiors	• In TSO ownership or by independent operators, depending on regulation • Separated from supplies in deregulated markets, provided on a booked capacity basis
Reloading / shipping	• Optimal supply routes key factors for success, and is also one key challenge to be overcome • Limited number of attractive locations for depots implies a positioning race • Late arrivers to pay for significant entry barriers and potential high risk on capital investments. Key investors expected to include traditional energy and petroleum product suppliers
Bunkering	• Remain in the hands of current players • Squeezed between large shipping and energy suppliers, this segment will remain in the hands of established professionals • Current bunker business must adapt to maintain volumes / market shares / margins

Concerns about the cost competitiveness of LNG compared with alternative fuels are unfounded, in that:

- existing fuels place an effective cap on LNG, even in the long term
- technological development will increase the cost competitiveness of LNG even further over time
- global progress will be rapid.

Interested parties should consider their business cases quickly to capture the most attractive positions.

Will LNG pricing be competitive?

LNG PRICING

As with other marine fuels, LNG is likely to be supplied on a short-term basis for maritime purposes (i.e. there will be no long-term take-or-pay contracts, as in the domestic gas markets). This means that the need to maintain fuel cost competitiveness is even more important: to safeguard market share and the ability to recover capital costs. It can therefore be safely assumed that alternative fuels such as MDO and gas oil will place an effective price cap on LNG (see figure 2).

On the other hand, demand from the marine market is likely to grow gradually from a low basis, and suppliers of LNG will always have the regular, large-scale spot markets as an alternative offtake point. Spot markets for LNG will therefore provide an effective floor for maritime LNG prices. Within this spectrum, maritime LNG prices can be expected, over time, to move in line with other marine fuels.

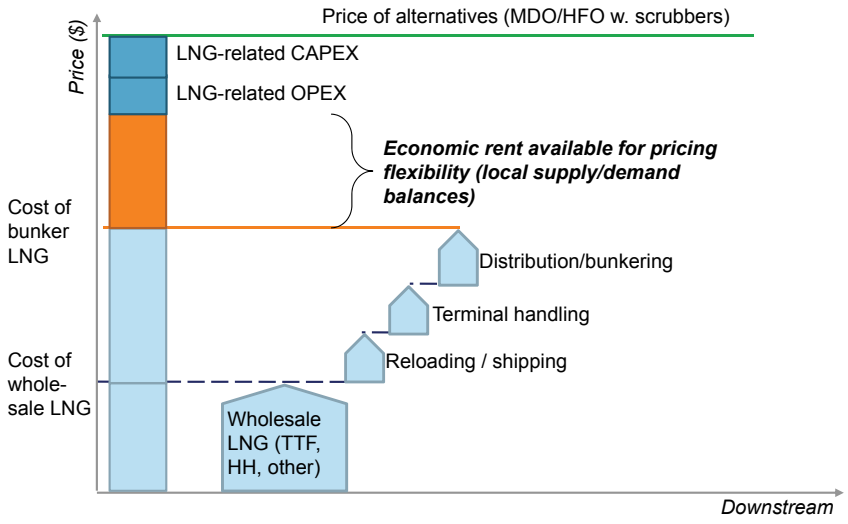
SPOT MARKETS FOR LNG

Unlike the international markets for crude oil and petroleum products, there is not yet a global natural gas market. Gas is traded in three distinct regional markets with very little interconnection:

- the North American market, which since the incredible growth in shale gas production in the last 5 years has had an oversupply and very low prices;
- the Far East, much of which is solely reliant on imported LNG and which is mostly supplied on long-term contracts linked to oil; and
- Europe, where LNG competes with pipeline gas from a mixture of sources, some of which are on long-term oil-indexed contracts and some of which are uncontracted or on contracts related to the traded gas prices in the market hubs. Market prices are therefore based on the supply/demand balance and the cost of supply subject to many contractual and physical constraints.

At the time of writing, oil has a relatively high price and demand in Asia is strong, particularly since the switch from nuclear generation to gas-fired generation following the Fukushima accident in 2011. Due to the large price differentials between the markets, LNG spot cargoes and cargoes destined for Europe and America are often redirected to Asian markets. Spot LNG therefore has a relatively high price and European prices would have to rise to match those prices to attract cargoes.

FIGURE 2

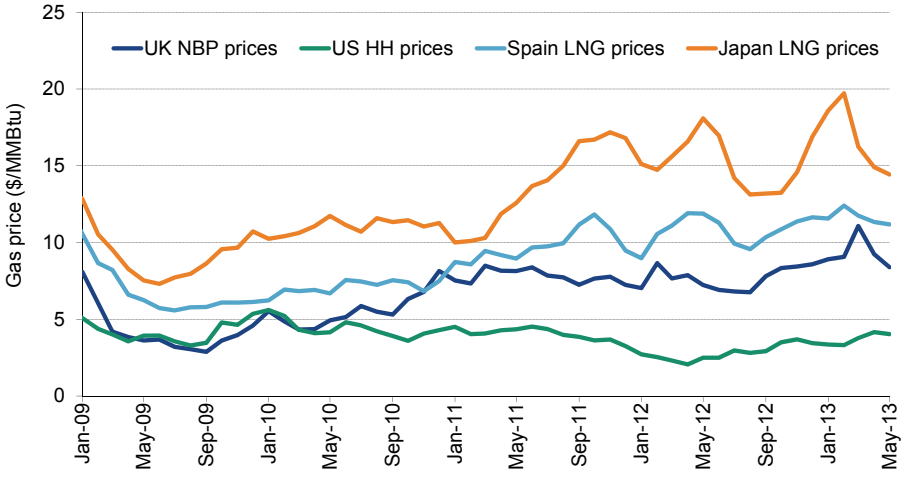


LONG TERM COST COMPETITIVENESS OF LNG

In Pöyry's view, petroleum products will continue to be an important source of energy on a global basis for decades. Even if energy demand stagnates or decreases in industrialised markets due to substitution or conservation measures, these effects are likely to be more than offset by demand growth in developing economies. At the same time, low cost sources of crude are depleting, and new wells are increasingly more expensive to develop. Additionally, more stringent emission restrictions place pressure on refineries to provide cleaner grades of fuel, increasing refining costs. In the long run, petroleum product prices, particularly ultra-low sulphur fuels, can be expected to rise further.

With increasing supply of gas from 'unconventional' sources, and the potential for large-scale liquefaction facilities in Australia, East Africa, the East Mediterranean and North America helping to rebalance the gas supply and demand globally, gas and LNG price developments can be expected to be more moderate. This rebalancing, along with the on-going move for more flexible contract terms and duration, leads to increased price correlation adjusted for costs of transportation between markets. Transparency and price correlation will then become very similar to that in the petroleum-based bunker fuel market.

FIGURE 3



Source: ICIS Heren, Reuters

Where are the opportunities?

WHERE ARE THE OPPORTUNITIES FOR INVESTORS IN SMALL-SCALE LNG?

In this relatively new market area there are significant investments to be made in the supply chain, such as reloading facilities, small-scale liquefaction facilities, local terminals and depots, trucks and vessels for distribution, bunker barges, bunkering equipment, as well as special training for operatives and safety personnel to deal with cryogenic substances.

The competitiveness of the LNG bunkering market depends on the ability of suppliers to optimize logistics and make it cost effective for customers to convert their existing fleet to LNG. The capital-intensive infrastructure is much more expensive than that of similar value chains (e.g. oil) and as a result, infrastructure costs constitute a large share of the cost of energy compared to competing energy carriers.

However, these relatively high costs also mean limited room for the installation of parallel infrastructure. This makes it possible for suppliers to secure first mover advantage in local markets and those companies with sufficient investment capital who can wait a number of years to recover their investments could therefore gain in the long run. Investors should be investigating the most attractive opportunities now to make sure they stay ahead in the race.

With the introduction of fuel and emissions restrictions at sea, shipowners will experience increasing cost incentives to find cheaper solutions such as LNG. The position of LNG in this respect is likely to improve over time. The extent to which it does will depend very much on market developments, but the underlying drivers are clear. The three fundamental cost drivers are:

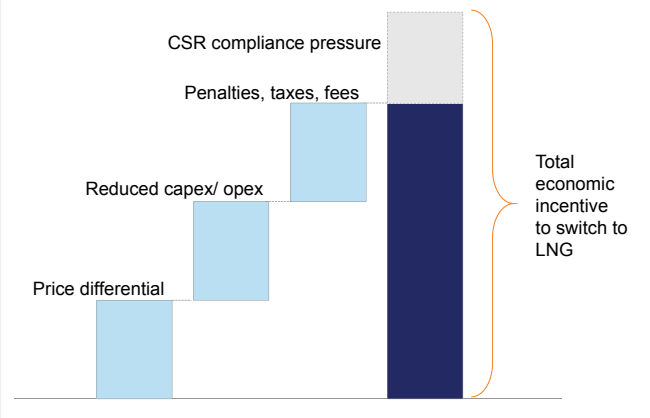
1) Increasing price differential due to oversupply of gas and a tightening market for low sulphur petroleum products, especially diesel fuels

2) Decreasing capex and opex for using LNG in single or dual fuel engines due to technological advancement, learning curve effects and large scale production

3) Introduction of penalities, taxes and other environmental surcharges and other obstacles for breach against restrictions concerning use of sulphur-rich fuels

In addition to these cost factors, ship owners over time will experience increasing pressure from other drivers of performance, such as the need to visibly display behaviour in line with Corporate Social Responsibility, for example through the adoption of best available technology within current operations. These additional drivers will, over time, also work in favour of a switch from petroleum products to LNG.

ECONOMIC INCENTIVES FOR FUEL SWITCH



In **Pöyry's view,** there are several attractive investment opportunities to be considered for new and existing players in the maritime LNG market. The market is potentially large and will grow as market share increases and consumption rises; driving forces towards gradual replacement of petroleum products are significant; ship owners will experience increasing incentives to switch away from their existing fuels.

Our unique combination of strong market expertise, shipping / LNG technology insight and experience working with clients means we're well positioned and excited to support you in taking a deeper dive into the world of small-scale LNG opportunities.

[1] Energy demand and emissions of marine engines, Hans Otto Kristensen, Technical University of Denmark, 2012.
[2] EIA Statistics for 2010.
[3] LNG-fuelled deep sea shipping, Lloyd's register, Aug 2012
[4] http://www.portoflosangeles.org/newsroom/2013_releases/news_031113_IAPH.asp
[5] Marinelog.com – TOTE orders two LNG-fuelled container ships.
[6] http://www.clarksons.net/markets/feature_display.asp?section=&news_id=32938&title=Lengthy+Lead+Times+On+a+Downwards+Slope

About the Pöyry Point of View

Staying on top of your game means keeping up with the latest thinking, trends and developments. We know that this can sometimes be tough as the pace of change continues...

At Pöyry, we encourage our global network of experts to actively contribute to the debate - generating fresh insight and challenging the status quo. The Pöyry Point of View is our practical, accessible and issues-based approach to sharing our latest thinking. We invite you to take a look – please let us know your thoughts.

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