DRIVERS AND CHALLENGES TO GROWTH OF LNG-FUELLED POWER IN EMERGING LNG MARKETS

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Many emerging markets around the world continue to struggle to provide adequate power supply to meet demand. Power shortages and oil-fired generation are common, limiting economic growth.

LNG-fuelled power is increasingly an option for developing power markets of all sizes for several reasons. These include: enhanced availability of FSRUs; government and international agency financial support to overcome barriers such as poor credit ratings; and improving LNG supply availability as several portfolio players develop new strategies to develop or target specific power projects. Furthermore, volatile and uncertain oil prices combined with low efficiency mean that oil-fired power can be a significant economic burden to many countries. Finally, for smaller-scale power projects, declining costs mean small-scale LNG could be a realistic option. Utilising LNG in new, efficient CCGT units and smaller-scale gas turbines potentially offers significant savings.

Countries like Pakistan have recently developed large-scale LNG to power projects, and numerous other smaller markets like Malta have used LNG to replace oil-fired power. Even some small markets such as Indonesian and Caribbean islands are considering LNG. However, another significant factor impacting this trend is the revolution in renewables and energy storage, which is making access to low-carbon technologies an increasingly viable option for emerging markets.

In this paper, we assess the drivers and global outlook for the growth of LNG to power as a means to improve power supply and displace oil used in power generation. We also consider to what extent renewables pose a threat to this growth market. Finally, we focus on the comparative costs of different technologies, as well as their advantages, disadvantages and constraints.
Introduction

Many emerging markets around the world struggle to provide adequate power supply to meet demand. Unmet demand, power outages and localised pollution are common. This limits economic growth and damages public health. Where power is available, many of these markets continue to rely on oil-fired generation. Indeed, globally, there are over 40 countries that rely on oil for more than 10% of their power generation, with the vast majority of them importing all of this oil. There are some advantages to this reliance on oil, particularly in terms of secure fuel supply stemming from established and straightforward supply chains. However, much of this generation is from inefficient, small generators that have been installed over the course of multiple decades. The outcome is expensive electricity and high foreign exchange costs to purchase oil.

There are numerous fuel options for emerging power markets that wish to reduce their oil use and that do not have proximate gas supplies. These include coal, LNG and renewables, and potentially combinations of these with battery technologies. A purely economic comparison of these options would appear not to favour LNG. However, in most instances, not all of these options are available in and suitable to every market. Consequently, there are numerous markets where we see LNG as a strong contender to replace oil use.

Indeed, in recent years, the case for LNG has become even more robust. Its supply availability has improved, resulting in a reduction in the oil indexation levels seen in long-term contracts. As such, the cost of LNG relative to oil has fallen, making the economics of LNG under these new pricing arrangements more attractive to those burning large volumes of oil for power generation. We expect that due to sustained competition from LNG suppliers and reduced LNG costs, this cost-competitiveness compared to oil will be maintained.

Additionally, the development of floating storage and regasification units allows new markets to be opened up more quickly, and at a lower cost, than in the past, as well as at lower risk to buyers and suppliers. A number of new technologies and project models have been proposed to allow the delivery of much smaller volumes of LNG than has traditionally been the case. Importing LNG is now an option for many more markets of all sizes.

As a consequence of these developments, numerous markets have recently started to import LNG, with several more planning to do so. In 2010, only 25 countries imported LNG; as of the end of 2018, there were 40 countries importing worldwide. By 2025, we expect this number to have grown to 48. Of these countries, at least five are expected to be driven by LNG to power projects, with several replacing oil. Beyond this number, there are many more potential importers of LNG currently using oil-fired power extensively. Realising and converting these markets to LNG will not be simple or straightforward for multiple reasons. Firstly, the prospect of rapidly reducing costs of renewables and batteries may cause markets to hold off on making decisions regarding switching from oil. Secondly, the creditworthiness of some new LNG buyers is questionable, often requiring external financing support. Thirdly, as many of the potential new markets are small in scale, a substantial and creative business development effort will be required on the part of suppliers.

Nonetheless, whilst challenging, many of these markets offer opportunities for suppliers. The recent period of anticipated oversupply prompted several suppliers to seek proactively to unlock new markets in order to diversify
and place volume. While tightening fundamentals may make this process appear less pressing, developing projects and replacing oil-fired power can take several years to realise. As such, companies that can develop this competency now while also maintaining a project pipeline will be well positioned to capitalise when the next long market materialises, potentially in the mid-2020s.

**Pure power economics of LNG to power challenged by coal now and by renewables in the future**

*Levelised cost of energy, 2019 vs. 2025*

Currently, LNG to power globally is not economic when we assess the levelised cost of electricity (LCOE). This is the breakeven cost or the minimum cost at which the electricity must be sold over the lifetime of a power plant to break even. LCOE analyses normally are used for investment decisions in regulated electricity markets. LNG-fired combined-cycle turbines are less competitive than coal and renewables. Meanwhile, by 2025, the relative economics of LNG will continue to worsen, as renewables costs are expected to decline.

However, not all power options are always available, and the case for LNG against oil still holds

Every power market is different. Large-scale, efficient, coal-fired generation doesn’t suit smaller grids. Meanwhile, financing for smaller, less-efficient coal-fired power plants is becoming more challenging as finance rules become stricter. Renewables are increasingly viable, but there may be limited options to manage intermittency. Other mechanisms to alleviate this issue, such as batteries, are still unproven at scale.

LNG’s competitive position undoubtedly remains strong against oil, both fuel oil and diesel. At the current juncture, oil still accounts for over 25% of the generation mix in over 40 countries. Where these markets have large coastal conurbations or at least reliable transmission, LNG can offer the ability to deliver electricity directly to centres of demand.

The prospect for LNG to replace oil for power at a more aggressive pace has been further improved by two key trends seen in recent years. The first trend is that as LNG supply availability has improved, oil indexation levels in
long-term contracts have dropped. As such, the cost of LNG relative to oil has fallen. In turn, this has made the economics of LNG under new pricing arrangements increasingly attractive to those burning large volumes of oil for power generation.

The second trend has been the increased availability of FSRUs in recent years. The development of floating storage and regasification units (and other concepts involving floating solutions) will allow new markets to be opened up more quickly than in the past, and at lower cost and with lower risk to suppliers. A number of new technologies and project models have been proposed to allow the delivery of much smaller volumes of LNG than has traditionally been the case. Importing LNG is now an option for many more markets of all sizes.

Both of these trends have contributed to the successful replacement of oil-fired power in several countries. Large-scale replacement is ongoing in Pakistan; smaller-scale replacement of oil-fired power has occurred in Malta, Puerto Rico, Dominican Republic, Jamaica and Panama, which collectively consumed 3.2 Mt of LNG in 2018.

Pakistan demonstrates that large-scale LNG to power works when it displaces fuel oil

Pakistan suffers from two crippling energy shortages: electricity and gas. Grid-based power shortages result in load shedding and inefficient fuel-oil-based generation. Around 7,000 MW of fuel-oil-based capacity exists, which is typically of very low efficiency (~20%). According to the most recent available statistics from the IEA, oil accounts for some 37% of generation, consuming approximately 3,500 ktoe annually. This makes it the fifth-largest oil to power consumer globally, but unlike most of the other very large consumers such as Kuwait and Saudi Arabia, it relies on imports. LNG to power has been seen as a way to overcome power shortages and also reduce this extensive use of fuel oil. Four new-build, highly efficient LNG-based power plants, each 1.2 GW, were fast-tracked. The first of these plants came online in 2018, and all 4.8 GW should be delivered by 2023. To support the new
power plants, several major LNG contracts were signed, including 15-year deals between Pakistan State Oil and Qatargas, and between Pakistan LNG Limited and ENI.

The successful delivery of these projects highlights that concerted efforts by companies, governments and international financing groups such as the International Finance Corporation and the Asian Development Bank can use LNG as an economic solution to serious power problems.

We calculate that in Pakistan, LNG can compete with fuel oil when oil is priced over US$60/bbl. For example, LNG can be imported up to a Brent slope of 14.5% or US$9.8/mmbtu DES using our 2020 oil price forecast of US$68/bbl.

Small-scale LNG can be economic against diesel, but only in specific circumstances

Pakistan is a relatively unusual example of a major oil to power consumer. However, there are multiple small-scale markets reliant on oil to power that could still switch to LNG. Unlocking this demand is not easy given the requirement to build a small-scale LNG supply chain. However, the period of high oil prices that persisted from 2011 to 2014, together with the more recent reduction in lower LNG contract prices, have led to increased interest in, and a proliferation of, small-scale solutions.

This is particularly the case for diesel-based generation, as is frequently seen in many small power markets such as islands and remote urban conurbations. With an oil price of US$70/bbl, the variable cost savings could be over US$10/mmbtu from switching to gas.
However, despite this high potential saving, the challenges of building a small-scale LNG supply chain and the fixed costs associated with this have been enough to prevent widespread uptake. Small-scale LNG to power costs are highly dependent on technology, size and throughput. Furthermore, many proposals include the requirement for transshipment if shipping over longer distances or from terminals without small-scale loading capabilities. This adds significantly to the cost compared to direct shipping from a relatively proximate liquefaction project (within approximately 1,500 kilometers). Consequently, there is a significant range of costs for small-scale LNG solutions. As such, minimising these costs as much as possible will have a major impact. Our analysis based on Indonesia as part of our South East Asian Gas and Power Service suggests the costs range from a lowest case of US$3.8/mmbtu for a 0.4 mmtpa regas facility connected to a 250 MW power plant, using existing ships of 20,000 m³ in size and no transshipment. At the other end of the scale, we have assessed a high cost range of US$11.5/mmbtu for a very small-scale regas facility of 0.04 mmtpa linked to a 30 MW plant, shipping via a 5,000 m³ ship and a US$2.2/mmbtu intermediate transshipment hub.

Assessing these costs and the potential savings from switching from diesel, we calculate that most 100 MW projects are commercially viable when oil prices are above US$60/bbl. However, sustained oil prices above US$70/bbl would present a more comfortable and attractive margin to suppliers. The economics are more certain when the requirement for a transshipment hub can be avoided. However, this reduces the number of markets suitable for small-scale LNG to locations close to liquefaction projects. In turn, these projects would require the installation of small-scale loading facilities, such as the situation that transpired in Bontang, Indonesia. However, given the complexity of shipping logistics, liquefaction projects may not seek to install small-scale facilities unless there is a compelling netback.

**Comparative small-scale price economics across different oil prices**

**Small-scale LNG fixed cost range**

[Graph showing comparative small-scale price economics across different oil prices]

[Graph showing small-scale LNG fixed cost range]

*Source: Wood Mackenzie South East Asia Gas & Power Service*
Scale of opportunity

Wood Mackenzie forecasts that the global LNG market will reach nearly 450 Mt by 2025. The vast majority of this growth will come from established markets like China, India and South East Asia. Meanwhile, our base case is for 12 new markets to start importing LNG by 2025, contributing some 20 Mt of demand growth, with at least two markets driven by oil replacement in the power sector. Beyond this, there may be a maximum potential for an additional 20 markets with a combined demand of approximately 21 Mt to potentially import LNG as a result of oil to gas switching in the power sector. However, these markets differ in scale, location and attractiveness. Given this, realising even some of this upside will require a concerted effort by LNG suppliers.

Sources of demand growth to 2025 with potential oil to LNG switching upside

| Source: Wood Mackenzie, * above WM Hz 2018 base case |

Summary and conclusion

This paper assesses the recent trends in the cost-competitiveness of LNG to power in emerging markets. In particular, it focused on the relative economics and benefits of utilising LNG to replace oil-fired generation, both large and small scale. The cost-competitiveness of LNG has improved in recent years given reduced contract indexation levels and improved availability of FSRUs. The benefits of replacing large-scale usage of fuel oil are clear in Pakistan, with LNG competitive up to a slope of 14.5% of oil at US$65/bbl. While there aren’t many oil importing markets that use oil to the same extent in the power sector, smaller-scale replacement of oil-fired power has successfully occurred in Malta, Puerto Rico, Dominican Republic, Jamaica and Panama.

Looking ahead, there remain numerous potential opportunities to replace oil-fired power with LNG in developing power markets. Globally, there are significant amounts of oil-fired generation, often small-scale and inefficient. Given the high fixed costs of building out an LNG supply chain, the economics of switching these facilities are less
clear. However, replacing 100 MW diesel-fired power plants should be achievable when oil prices are above at least US$60/bbl. We estimate there is the potential for at least 20 markets with an additional demand of 21 Mt import LNG, driven by oil to gas switching in the power sector. The development of these potential LNG markets will likely be challenging, given that they are overwhelmingly developing power markets. As such, converting oil-fired power to LNG-based power will require a concerted business development effort by LNG marketers, combined with government support. Despite these headwinds, the time is right to initiate this course of action. Delaying too long may see the cost of renewable power fall to the extent that the opportunity disappears for LNG. Additionally, while expected tightening fundamentals in the early 2020s may make this appear less pressing, developing projects and replacing oil-fired power can take several years. As such, companies that can develop this competency now will be well positioned to capitalise when the next global LNG long-market materialises, potentially in the mid-2020s.