

LNG *North America*

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Analysis: US wildcatters impair OPEC's production cuts

Swing supply sets the price of oil and significantly influences that of natural gas. Though OPEC members seem to have finally overcome internal rifts and are starting to implement production cuts – the cartel has lost much of its clout to US wildcats drillers who have effectively emerged as the new price-setters. A marginal recovery in oil prices can prompt American shale drillers to produce more liquids as well as shale gas that helps underpin an expansion of US LNG exports.

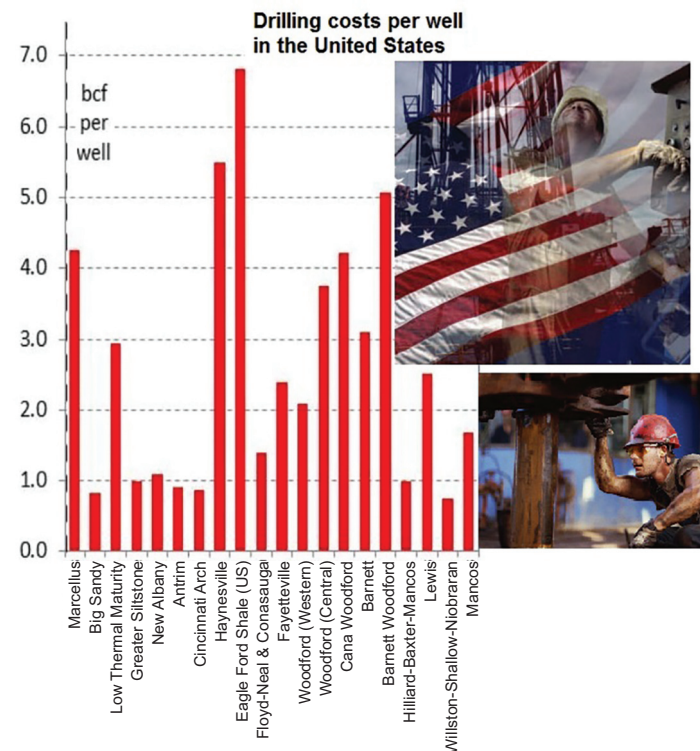
OPEC's strategy to swamp the market with cheap oil has failed to drive a substantial number of small-scale shale wildcatters into bankruptcy – the oversupply rather hurt the cartel's cash-constrained members. Economies of most of them are hugely dependent on oil revenues, so it was a question of time until the cash-rich Saudis became willing to soften their stance on production quotas.

Now the two foes within OPEC – Saudi Arabia and Iran – have put aside months of disputes in the interest of realising a common goal: a rise in hydrocarbon prices from rock-bottom levels. The cartel agreed to cut production by 1.2 million barrel per day but analysts doubt that this will have a huge

impact on oil prices given the overhang in storage, the reluctance of non-OPEC producers and the anticipated swift action of US shale oil and gas drillers, who will react to marginal price increases by turning on the taps.

Flexibility comes at a cost

A rush to tap shale resources has prompted some overly keen US developers to go heavily into debt. Data collected by S&P Capital IQ shows that borrowing by American oil and gas companies increased by 55% since 2010, to almost \$200 million. Their need to service and repay that debt helps to explain why some U.S. producers keep pumping oil and gas regardless



of rock-bottom prices.

For some, the squeeze is too much: One of the first casualties of oil low prices has been WBH Energy, a private company that drills for shale gas and liquids

in Texas. Analysts anticipate further company breakdowns, suggesting “there are too many ugly balance sheets” and smaller drillers are “not positioned for this downturn.”

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“If you can't be good, be lucky”

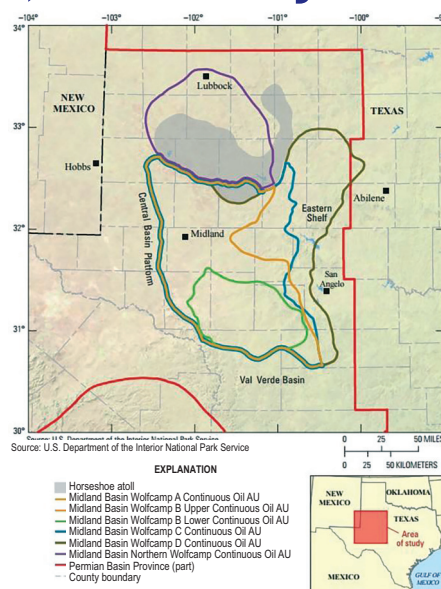
To quote an American saying – and President-elect Donald Trump just got lucky with the discovery of the vast Wolfcamp Shale in Texas that holds oil and gas reserves worth up to \$900 billion.

With the post of the US energy secretary handed to Texas governor Rick Perry and Exxon chief Rex Tillerson nominated for secretary of state, it becomes apparent that the green energy stance of the Obama administration will be ‘trumped’. Domestic energy resources may well become the basis for Mr Trump's infrastructure programme.

Tax proceeds from hydrocarbon extraction, albeit moderate, will help bankroll the incoming Presidents promised expansive fiscal policy to create and secure jobs, as promised during his election rally.

Turning tables

Texas, the heartland of the US energy industry, saw its



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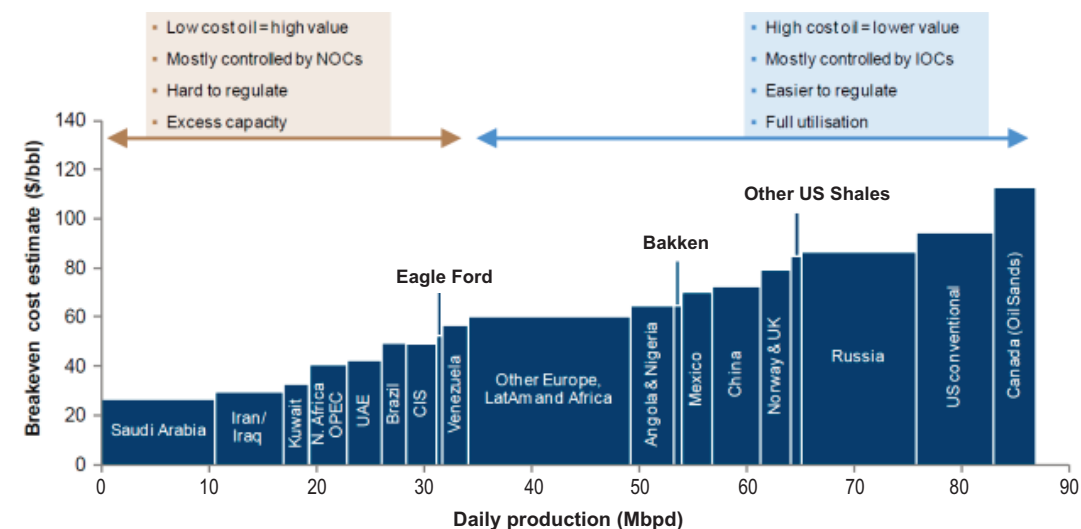
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Wildly fluctuating oil prices destabilize, if not derail, prospects for U.S. LNG exports - they also undermine the economics of producing shale gas particularly of so-called 'wet gas plays'. Profits of shale gas drilling used to be highest in Marcellus Shale in south-western Pennsylvania, which is a wet gas play where natural gas is produced in connection with gas liquids such as ethane and butane. Prices of natural gas liquids are, however, sensitive to oil prices and a drop in developers' profit margins will also undermine the economics of associated gas, produced in from oil wells, which have reached a 2-year high.

Analysts at Rice University's Baker Institute Center for Energy Studies extensively researched U.S. shale gas play breakeven prices. "Some wells are profitable at \$2.65 per thousand cubic feet, others need \$8.10 ... the median is \$4.85," said Ken Medlock, senior director at the institute. Determining cost factors are whether there are any liquids, but also infrastructure access, lease costs and local fiscal conditions.

Break-even estimate vary greatly: Spectra Energy put the breakeven price for Pennsylvania's central Marcellus region at \$4.26 and that for the north-eastern part of the state at \$3.44. In contrast, energy consultant Enercom put the Marcellus breakeven price at \$2.88, lower than that for the Haynesville, Woodford and Fayetteville Shale.

A positive exception is Cabot's Marcellus drilling program, limited



to Susquehanna County, PA. Cabot so far is the only driller to achieve 1 Bcf/day gas production in Marcellus. Shale break-even price point is understood to be as low as \$1.67/MMBtu, so they make money if they sell gas above that price.

Struggling to break even

Breakeven for U.S. shale gas drilling can be achieved if oil prices average \$73/bbl, according to Robert W. Baird Equity Research. Analysts suggest drilling at liquid-rich shale formations like Eagle Ford can break even at an oil price of \$53/bbl, while Wolfcamp North Midland would need \$57, Bakken Core \$61, Niobrara Extension \$64 and Niobrara Core \$68.

More capital intensive shale plays such as Wolfcamp South Midland and Bakken Non-Core are estimated to require oil price at \$75/bbl to turn profitable, while Texas Panhandle would need \$81, Mississippi Lime \$84 and Barnett

Combo \$93.

Booming output from the Marcellus and Utica shale-gas plays in the north-eastern U.S., meanwhile, is not going to stop anytime soon because companies can maintain profitability even if prices move toward \$2, said James Sullivan, a New York-based analyst for Alembic Global Advisors.

Most drillers would however turn their back at less lucrative rigs and dry gas plays in the event of even weaker oil prices. Yet falling rig counts are not an indicator of slowing production as nearly 2,000 wells in the Northeast are still not connected to gas gathering infrastructure.

"We have a huge backlog of wells that are currently in inventory" in Ohio, Pennsylvania, and West Virginia. "That represents around 5 Bcf/d to 10 Bcf/d of trapped production," according to Chuck Stanley, CEO of QEP Resources and chairman of America's

Natural Gas Alliance (ANGA).

Responding to sustained low oil prices

Should OPEC's cut in oil production fail to take effect and prices stay near \$50/bbl, US wildcatters will have two possible ways to respond: one is a reduction in absolute levels of drilling activity which will reduce the level of associated gas production and two is a shift from drilling for liquids back to drilling for gas.

Scepticism is widespread among traders over the cartel's commitment to follow through on its promise as many member states are exempt from any commitment to lower oil production. "The only tool they have is to constrain production," former Saudi oil minister and legendary OPEC icon Ali al-Naimi said at an event in Washington, D.C. in December "The unfortunate part is we tend to cheat."

continued from page 1

crude oil and natural gas reserves fall during the most of 2016 - until the discovery of the vast Wolfcamp reserves turned the tables and sparked a new drilling rush as E&P companies eye ample returns. Employment in the Texas' upstream sector is already on the up while tax take will benefit the incoming Trump administration.

Wolfcamp Shale, located in the Midland Basin portion of Texas' Permian Basin province, contains an estimated mean of 20 billion barrels (bbl) of oil, 16 Tcf of associated

natural gas, and 1.6 bbl of gas liquids, according to the U.S. Geological Survey (USGS). Estimates of the resource base are enormous: they trump the 2013 USGS Bakken-Three Forks resource assessment by nearly three times, making Wolfcamp is the largest continuous oil accumulation in the United States.

"Even in areas that have produced billions of barrels of oil, there is still the potential to find billions more," commented Walter Guidroz, program coordinator for the USGS Energy Resources Pro-

gram. "Changes in technology and industry practices can have significant effects on what resources are technically recoverable."

Since the 1980s, the Wolfcamp shale has been part of the "Wolfberry" play that encompasses Mississippian, Pennsylvanian, and Lower Permian reservoirs. Oil has been produced there, using traditional vertical well technology - but in the past few years, over 3,000 horizontal wells that have been drilled and completed in that section.

LNG North America

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New pipelines price out LNG shipments to Mexico

Manzanillo, a regasification plant at the Mexican Pacific Coast, has recently received a few cargoes from Sabine Pass. Cheniere, having exported its first cargo to Manzanillo in August for \$4.23/mmBtu, has sent out another cargo in October and one more in November. Yet, such shipments will abate – they will be priced out by pipeline gas deliveries once the 12 new interconnectors are up and running.

US pipeline exports of natural gas have doubled since 2009 and currently account for around 4.2 billion cubic feet per day (Bcf/d). According to EIA figures, US daily pipeline exports to Mexico through August 2016 are at a yearly average of 3.6 Bcf/d, 25% above the year-ago level and 85% above the five-year (2011-15) average level.

Costs for US LNG fluctuates with Henry Hub prices, but added to this are shipping expenses, including the transit of the Panama Canal to access Mexico's Pacific Coast, and regasification costs.

Twelve interconnectors in the making

Pipeline natural gas is more economically attractive to the Mexicans; hence the government embarked on a five-year plan to add 12 gas pipelines that will expand the network by over 3,200 miles. The Mexican Energy Ministry has already awarded contracts for seven of the 12

proposed pipeline ventures.

"These imports would help meet increasing power demand, offset declining domestic natural gas production, reduce reliance on LNG imports and create new markets for natural gas in currently supply-constrained regions," EIA analysts commented.

The largest and most expensive of the awarded projects is the Sur de Texas-Tuxpan pipeline, which aims to supply the Mexican states of Tamaulipas and Veracruz with natural gas from southern Texas via an underwater route through the Gulf of Mexico. The pipeline will extend nearly 500 miles and provide a total transport capacity of 2.6 Bcf/d.

"Growth in Mexico's domestic electricity market has largely driven the country's increasing natural gas usage. Because of the availability and affordability of US pipeline natural gas, Mexico is meeting its growing electricity demand with generation from new natural gas-

fired plants," analysts at the US Energy Information Administration (EIA) said, anticipating that "Mexican imports of natural gas continue to outpace most projections.

"The 4.1 Bcf/d exported in August 2016 matched the level originally forecasted in 2013 to be reached in 2018."

Bullish signals for Henry Hub prices

Forecasters at the EIA say growing domestic gas consumption, along with higher pipeline exports to Mexico and LNG exports will contribute to the benchmark Henry Hub spot price rising from an average of \$2.49 per million British thermal units in 2016 to \$3.27 per MMBtu in 2017.

Yet, higher US prices still make it economic to ship LNG to Europe and Asia, with the UK seen as a particularly attractive destination with regards to pricing as the NBP hub is hovering around \$5.45/mmBtu or 43.00 pence per therm. ■

Choppy waters ahead

Jeremy Weir, CEO of Trafigura said 2017 is likely to bring uncertainty and change. "Growth in liquidity observed in the past two years accelerated at a pace faster than many had expected. More and more market participants now realise that market liquidity is a solid basis for security of supply, creating a virtuous circle of increasing confidence and increasing participation in the spot market," he said.

As for the past year, new buyers helped Trafigura to boost its trades LNG volume by 53% to just over 6.4 million tons; hence more traders were hired as sales volumes in Asia grew 80% year-on-year.

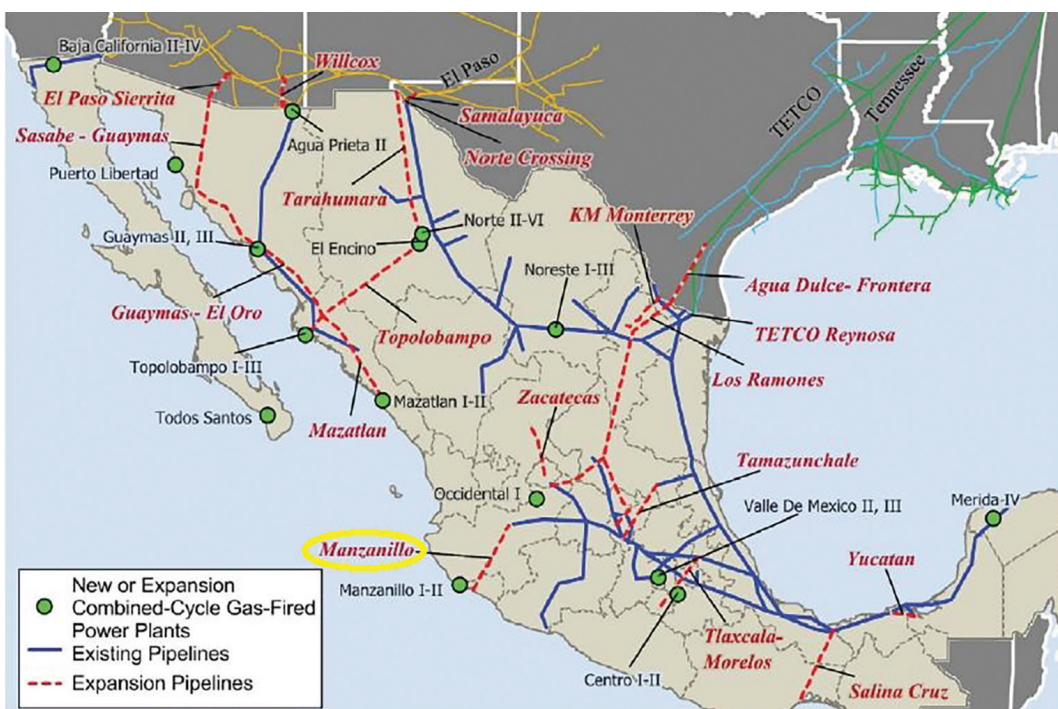
US shale sale for \$450m

Chesapeake has divested some acreage in Haynesville shale for \$450 million to an unnamed private buyer. The assets comprise around 72,800 net acres and about 250 producing wells with current output of 30 mm cf/d. The transaction is meant to close in Q1-2017.

Prices firm amid drop in output

US natural gas marketed production is forecast to decline for the first time since 2005, so growing domestic gas consumption, along with higher LNG exports and pipeline deliveries to Mexico, will push up the Henry Hub benchmark price.

EIA analysts anticipate natural gas production to rise by an average of 2.9 Bcf/d from the 2016 level. "Natural gas marketed production is forecast to average 77.3 Bcf/d in 2016 and 80.3 Bcf/d in 2017, which are 0.2 Bcf/d and 0.9 Bcf/d lower than the previous forecast, respectively.





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Global LNG boom unfolds in 2017

The incoming year will see a boost in global LNG supply. Australia is expected to add 15 mtpa to reach 66 mtpa, catching up the top LNG exporter, Qatar, with 78 mtpa. In the US, start-up of Cove Point will gradually add 13.5 mtpa, while a further two trains at Sabine Pass will add another 9 mtpa.

"All this new capacity will mean, according to analysis from the Economist Intelligence Unit, that LNG prices in 2017 will rise just slightly on 2016 (on the back of higher oil prices), to \$7.31/mmBtu from \$6.82/mmBtu, languishing at less than half of the 2014 level of \$16.04/mmBtu.

"Stronger consumption growth of 2% in 2017, accelerating from 1.5% in 2016, means LNG prices will nonetheless climb [despite the supply glut]", EIU analysts say, suggesting that "this will be especially pronounced in the US, where prices will average US\$3/mmBtu in 2017, up from US\$2.5/mmBtu in 2016, while in Europe LNG will creep up to \$4.7/mmBtu from US\$4.5 mmBtu.

"Owing partly to those slightly higher gas prices, switching from coal to gas in the power sector will slow in the US," they conclude.

Questions over supply sustainability

Though the ramp-up and flexibility of US shale gas production has been impressive, the International Energy Agency questioned whether shale-gas well productivity gains in the US that will underpin growing

LNG production could be maintained at current levels in areas such as the Marcellus Shale in the northeast US.

IEA analysts noted that while the reservoir quality is the dominant factor in determining well productivity, the design of the US shale-gas wells play an important role too. "The lateral length and the number of fracturing stages are the main determinants of cost and there is a trade-off between the additional cost of longer and more extensively fractured wells and the associated productivity gain," they said in the latest World Energy Outlook.

Operators in the largest shale gas play, the Marcellus, have increased lateral lengths and wells per pad for several years, but more recently the increases are levelling off, suggesting that an economic optimum has been reached at current gas prices and well costs.

"The number of wells on a pad, a proxy for how tightly wells can be spaced in the reservoir, illustrates a trade-off that operators need to make. More wells on a pad increase the total recovery of the volume of gas in place and provide

“

Stronger consumption growth of 2% in 2017, accelerating from 1.5% in 2016, means LNG prices will nonetheless climb

”

- Energy Intelligence Unit analysts

for economies of scale, but if the well spacing becomes too tight, the wells often interfere with and cannibalise each other, resulting in a drop in the flow rate," the IEA explained.

Several shale gas plays other than the Marcellus show a similar evolution of key parameters, such as lateral lengths and wells per pad, but the effect on productivity is not uniform. "This is probably the result of the overriding impact of the quality of the reservoir and the ability to consistently optimise the productivity trade-off," analysts said, suggesting "Operators and service companies continue to push the limits of what is technically possible to boost productivity, until the gains and associated costs result in diminishing returns."

Glut seen absorbed by 2030

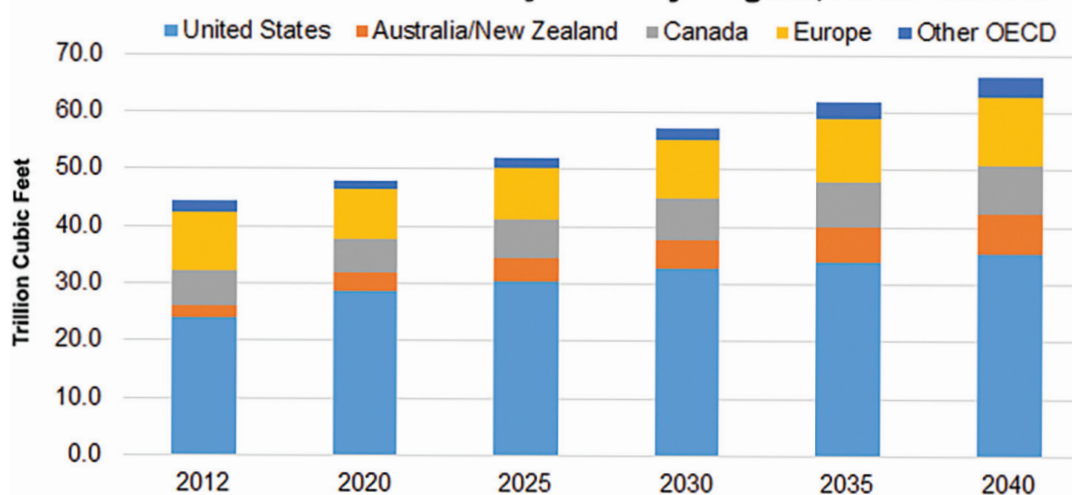
With the LNG overcapacity forecast to wane in the mid-2020s, IEA analysts say that timely investment in new gas supply projects is needed to pre-empt price volatility. Inter-regional natural gas and LNG trade is set to grow by 45% over the next 10 years and by 70% through 2040 as overcapacity is gradually absorbed and the market rebalances.

"Floating storage and regasification units help to unlock new and smaller markets for LNG and LNG captures around 70% of the additional gas trade and thus manages to increase its share in inter-regional gas trade from 42% in 2014 to 53 percent in 2040," it said.

The United States and Australia contribute two-thirds to gas production growth until 2020, but from the early 2020s onwards the global gas balance increasingly relies on output growth from a much broader range of producers.

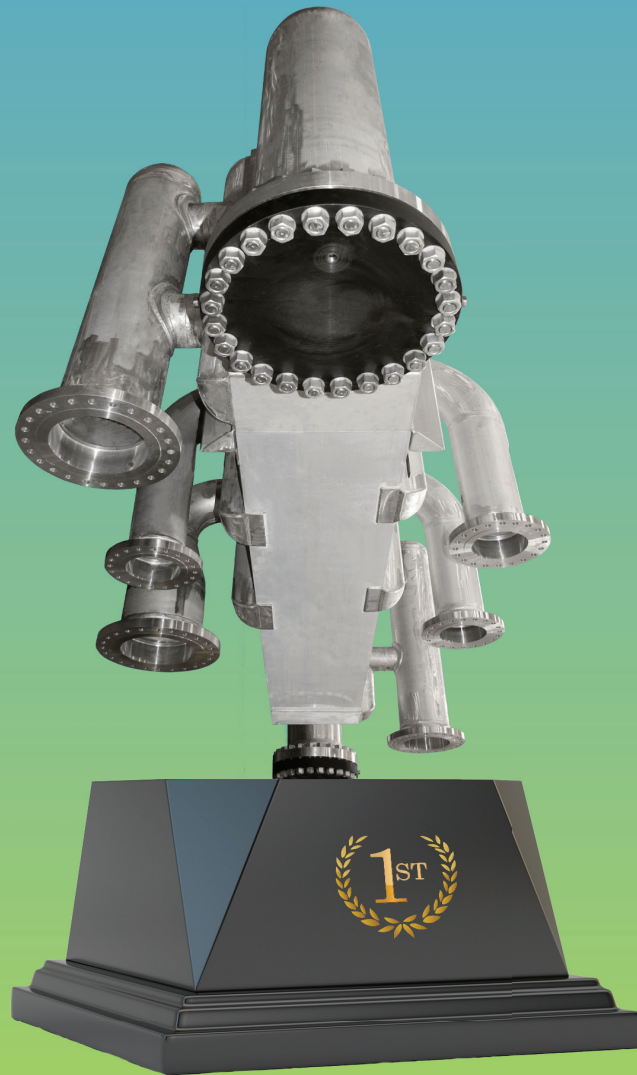
Global gas demand, meanwhile, is forecast to grow by nearly half over the period amid what the IEA calls its "New Policies Scenario" whereby renewable energy source replace some fossil fuel over time.

OECD NatGas Production By Country/Region, 2012 - 2040E



Note: Data for 2020 - 2040 are EIA forecasts. Source: EIA International Energy Outlook 2016

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China: Rudong regas expansion still awaits BC cargo shipments

PetroChina recently commissioned new storage and regasification facilities at its Rudong terminal in Jiangsu province. Rudong could be the only Chinese import terminal to handle regasified Canadian LNG in 2020 – as 35% in the terminal is held by Woodfibre, the developer of an export plant at Squamish, north of Vancouver.

Woodfibre is now the only liquefaction plant moving forward in British Columbia: It received all necessary permits with 25 conditions attached, won support from the Squamish First Nation and is taking FID to proceed. Most others among 20 originally planned for BC have been shelved for economic reasons or have been ground to a

halt by ever stricter Canadian environmental policies.

The minority Rudong stake is held by Pacific Oil & Gas Co. of the Indonesian billionaire Sukanto Tanoto, owner of Woodfibre LNG. The regasification terminal is now one of the largest in China after being upgraded by China Huanqiu Contracting & Engineering, a unit of PetroChina's parent company, China National Petroleum Corp. Huanqiu Contracting said it had commissioned the new storage tank with just over 200,000 cubic metres of additional capacity, as well as more regasification equipment and adjoining pipelines.

Rudong LNG has been in operation since 2011 and the new storage adds to the existing two tanks, each with 160,000 cubic metres of capacity. The Chinese facility can now handle 6.5 mtpa of LNG shipments.

However, the Woodfibre project is also the smallest venture put forward in BC and will only produce 2.1 mtpa of LNG, about one third of the annual handling capacity of the Rudong terminal, one of 14 operating on the Chinese coast. In contrast, the postponed Shell-led LNG Canada project and the Petronas' Pacific NorthWest LNG project would each ship roughly 10 times that amount and bring 30 times more investment. ■



Phase-2 of Rudong terminal is ready

Elba Island LNG gets non-FTA permit

Green light to ship US LNG to all destinations has been granted to the Elba Island LNG export project, where Shell is waiting in the wings as the main offtaker.

Project owner Kinder Morgan and its subsidiaries, Southern LNG Co. (SLNG) and Elba Liquefaction Co. have received a non-FTA permit from the US Department of Energy (DoE) which allows SLNG to export up to 130 Bcf/a of domestic natural gas to nations with without a Free Trade Agreement with the US. The same volume has earlier been permitted for export to FTA countries.

The Elba Island LNG export project near the city of Savannah, Georgia, is an existing regas terminal turned into a liquefaction facility. The US Federal Energy Regulatory Commission (FERC) has already issued a notice to proceed with construction to project owner Kinder Morgan,

"As authorized by FERC, the aggregate maximum liquefaction capacity of the Elba Island Export

Project equates to approximately 2.5 million tonnes per annum of LNG," the DoE said when issuing the permit, adding that "The 20-year authorization period will commence when SLNG starts

commercial export of domestically sourced LNG from Elba Island, but not before. SLNG may export commissioning volumes prior to the commencement of the terms of this order."

The Elba Island project involves the installation of 10 small-scale liquefaction units and modifications to the terminal infrastructure. If construction proceeds as planned, the Georgia liquefaction plant could be producing LNG by



the end of 2018 or early 2019.

Kinder awarded the engineering, procurement, construction, commissioning and start-up contract in April 2016 to the US subsidiary of Japan's IHI Engineering & Construction, based in Houston, Texas. The existing terminal on Elba Island is about eight miles upstream from the mouth of the Savannah River. It was first authorized by the FERC in 1972 as an import facility. ■

LNG containers headed for Caribbean



Carib Energy, a subsidiary of US shipping line Crowley Maritime Corp., is gearing up to export LNG in containers to Latin America after it was given a 20-year permit by the US Department of Energy (DoE) to export around 1.3 Bcf of natural gas.

The venture will increase LNG deliveries into the Caribbean and Latin American region where the ISO containers of LNG can be used for small-scale power plants or for fuel projects. ISO containers of LNG leaving the US have recently commanded the highest prices of around \$10/mmBtu.

Carib said it would purchase the LNG for export from any of five existing small-volume natural gas liquefaction facilities, owned and operated by Pivotal LNG in the US states of Alabama, Georgia and Tennessee. The LNG will be sourced from affiliates of Pivotal LNG and exported on ships from the ports of Jacksonville and Port Everglades in Florida and Gulfport in Mississippi.

Carib signed a sale and purchase agreement with Pivotal back in March 2014 and since then five small-scale liquefaction plants have been lined up to supply the containers.

The five liquefaction facilities owned and operated by Pivotal include the 1.82 Bcf/a Trussville LNG plant in Alabama, the 3.65 Bcf/a peak-shaving Chattanooga liquefaction plant, the 2.5 Bcf/a Riverdale plant and the LNG plant located in Ball Ground - the latter two are both located in Georgia, owned and operated by Atlanta Gas Light. ■

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Drillers start getting 'back in the black'

Exploration is gradually returning to profitability after five years of only single-digit returns. Dr Andrew Latham, VP of exploration at Wood Mackenzie commented: "The industry has a good chance of achieving double digit returns in 2017."

"Smarter portfolio choices and lower costs are already paying off."

As the E&P industry continues to transform itself into a smaller, more efficient segment, analysts caution that "overall investment will at best match 2016 year's spend of around US\$40 billion, and may yet fall further."

To that end, over-supplied LNG plays will be de-emphasised as the industry is looking for pipe gas opportunities near under-supplied markets such as parts of North Africa, Eastern Europe and Latin America. Moreover, WoodMac analysts predict that high-cost frontiers, such as the ice-impacted offshore Arctic and extreme high pressure/high temperature plays, will be shunned.

Budgets remain tight

"On the bright side, lower costs mean well counts may hold up

close to 2016 numbers. Flat budgets should mean exploration's headcount cuts are now mainly in the past," Latham suggested.

As for new discoveries, Wood Mackenzie expects that the best discoveries to come from new plays and frontiers, despite greater emphasis on infrastructure-led drilling from many explorers. "More than half of the volumes are expected to be found in deep water. Here some well costs will fall to US\$30 million or less, with full-cycle economics that are positive at less than US\$50 per barrel," he said.

"The majors and a handful of bolder Independents will drill most of the wells to watch, as in both 2015 and 2016."

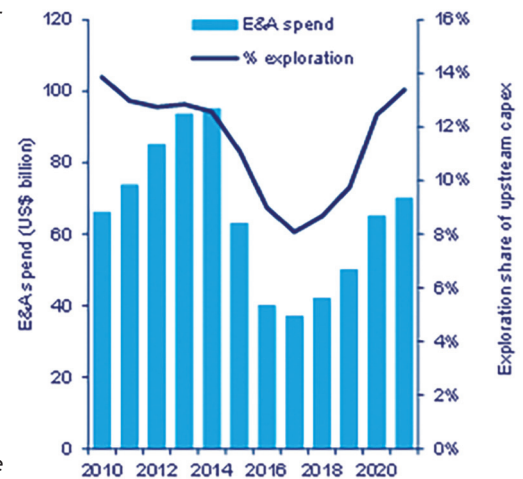
Deep cuts on exploration costs

According to Wood Mackenzie's latest report, the industry has cut

exploration deeper than other upstream spending. Its share of upstream investment will dip to a new low of just 8% in 2017. An eventual return to historic norms - around one dollar in seven - depends on oil price recovery.

Brent prices are anticipated to rise sharply from 2019, averaging US\$77 per barrel in real terms for the year. If this happens, then recovery in exploration spend will follow a year or two later.

"The industry is focusing on acreage capture and re-loading for the longer term. Companies will be signing acreage with firm 2017



Source: Wood Mackenzie

wells may be spoilt for choice," Dr Latham said, anticipating that "A spate of new licensing in outer slope plays will continue as explorers digest news of better-than-expected reservoir quality and source rock potential in these ultra-deepwater setting."

Corpus Christi LNG nearly half built

Cheniere Energy second liquefaction and export plant at Corpus Christi that will add to volumes from the Sabine Pass terminal is 47.1% complete, the Houston-based company told FERC in a project update report just prior to the festive season.

"Engineering has progressed to 99.7%, procurement to 64.1% and Bechtel's direct hire construction was 18.5%," Cheniere stated in the filing to the regulator.

Bechtel is undertaking EPC for the liquefaction plant, being built on the shore of Corpus Christi Bay, at the north end of the La Quinta Channel. The US engineering firm has been building Sabine Pass and will construct all three Trains planned at Corpus Christi.

Phase 1 of the Corpus Christi EPC includes building two liquefaction Trains, each with 4.5 mtpa of capacity, two storage tanks, one complete berth and a second partial berth. Phase 2 foresees construction of another LNG Train, one additional tank, and completion of the second berth. Once all completed, the plant's total ca-



Project site of Corpus Christi LNG

capacity will be 13.5 mtpa.

Cargo sales agreements for Corpus Christi LNG already amount to more than 9 mtpa - which equals two whole Trains of production.

Foundation customers include the Indonesian energy company Pertamina, Australian LNG producer Woodside and the European-based utilities Endesa, Iberdrola, Gas Natural Fenosa and EDF.

JERA adds coal to LNG trade

The Singapore arm of JERA Trading, jointly owned by Tepco and Chubu Electric, will become one of the world's largest coal traders through the acquisition of EDF Trading's coal and freight business.

This strategic move gives JERA Trading a major presence in both the Atlantic and Pacific basins and total physical coal sales of around 60 mtpa.

The Japanese major said it would keep on key staff from the EDF Trading subsidiary. It underlined that "coal is an important part of the fuel mix in the global energy markets," suggesting the transaction will "considerably strengthen" its procurement and sales. JERA Trading will be managed from Singapore but the Atlantic basin activities will be run out of London.

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