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Unconventional gas, a global phenomenon

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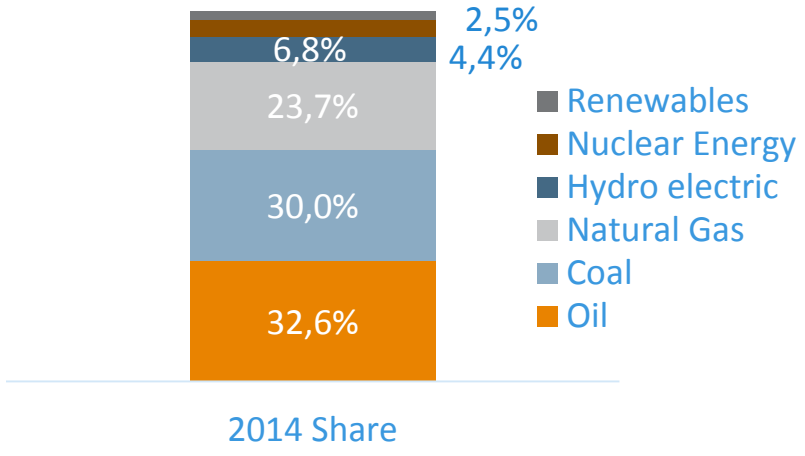
WEC Austria

Unconventional gas, a global phenomenon

- Natural gas is the number three fuel in the global energy mix
- Unconventional gas has the potential to take a substantial share of future natural gas supplies
- New supplier landscape emerging as unconventional gas, led by the United States (US) shale gas story, enters regional natural gas markets as LNG

Global Energy Mix 2014



Source: BP Statistical Review 2015

Facts and figures: US progress in shale gas development

<$30/bbl
Breakeven costs for liquids rich wells in Marcellus, Utica

10%
Share of global natural gas production from top 7 unconventional basins in the US in 2014

49%
Share of US natural gas production from top 7 unconventional basins in the US in 2014

~63 MTPA
US LNG export capacity under construction (~26% 2014 market)

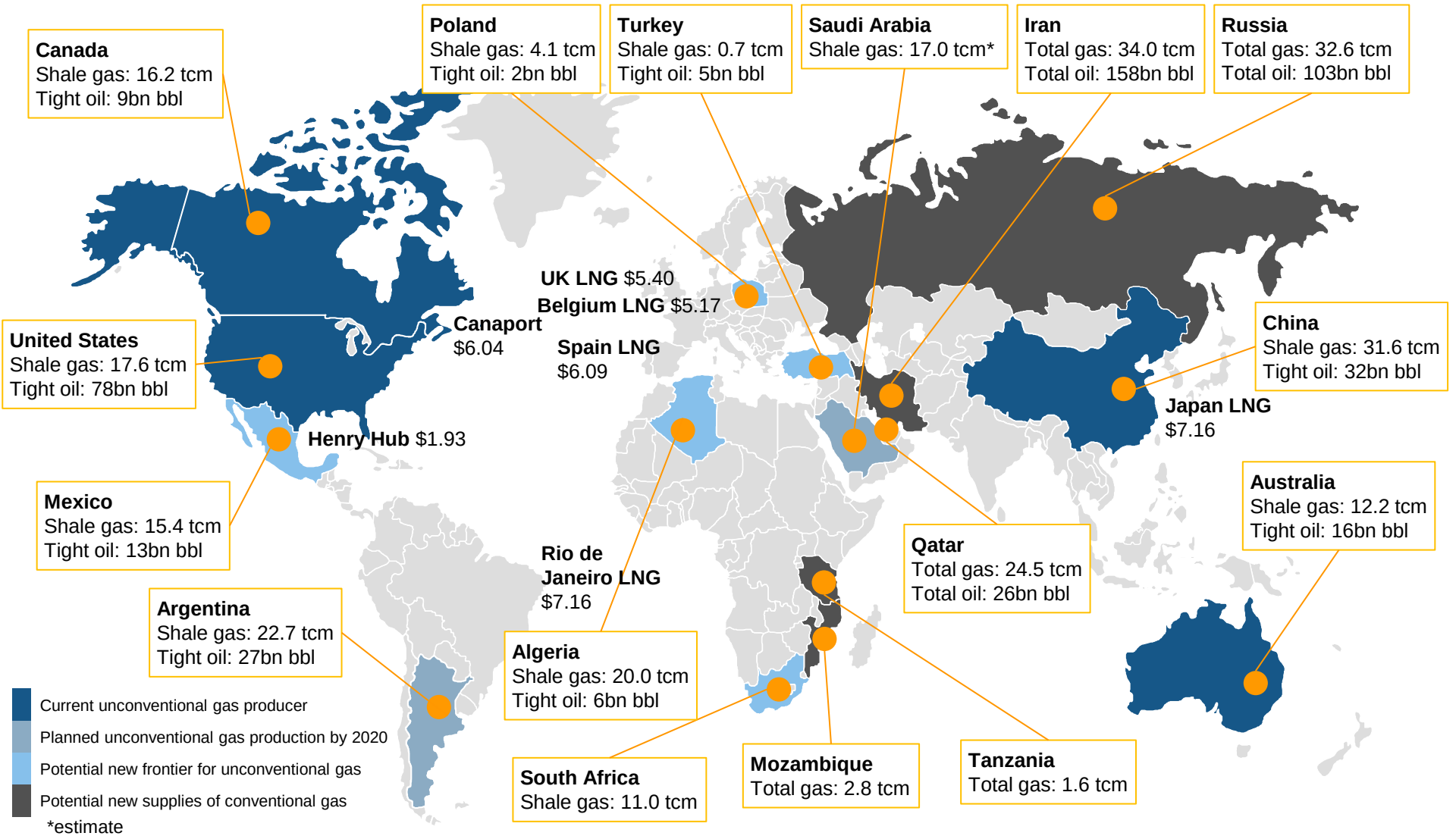
Source: BP Statistical Review 2015, EIA, FERC, Reuters

Unconventional gas, a global phenomenon

- The '2012 World Energy Council Survey of Energy Resources: Shale Gas – What's New' predicted that shale gas development would have a "significant impact on the dynamics and prices" of future natural gas markets
- This latest study finds unconventional gas is changing market dynamics now
- Australian coal bed methane (CBM) and US shale gas are emerging on the global market as liquefied natural gas (LNG)
- In particular, three trends emerge as the most meaningful in the global context:
  - **Interconnected markets**: With excess supplies in the market, there has been price normalisation and other structural shifts towards a more global and transparent market across the three main regional hubs: Asia, Europe, and North America.
  - **International growth of unconventional gas**: Exploration and production (E&P) operators in Australia, China, and Argentina have made progress in growing unconventional gas supplies outside of North America.
  - **Shifting portfolio allocations**: In this time of uncertainty, US unconventional gas emerged as a cost competitive asset type that continues to shift industry capital towards flexible, shorter-cycle investments in North America shale assets.

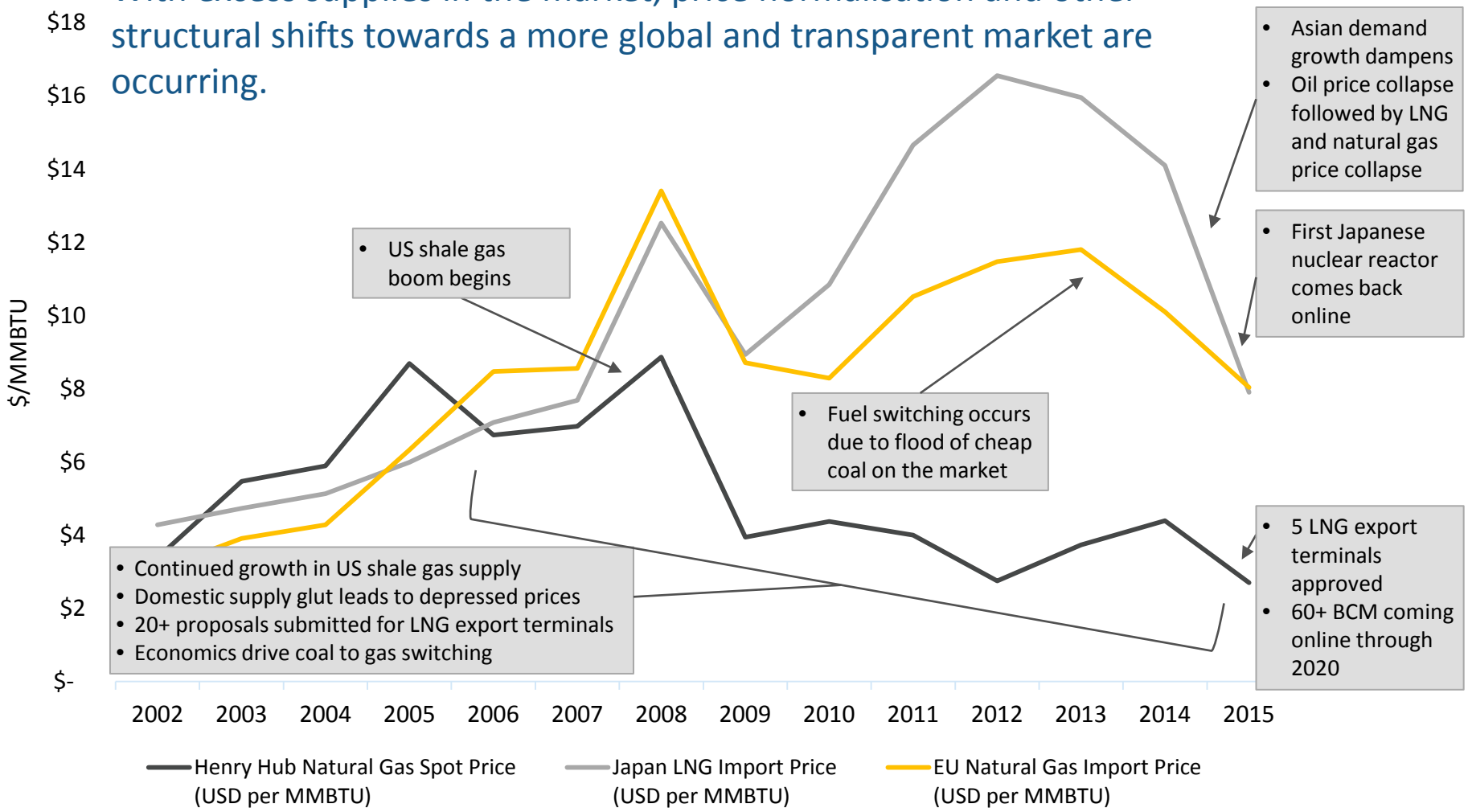
New supply landscape

Technically Recoverable Reserves (trr)



Interconnected markets

With excess supplies in the market, price normalisation and other structural shifts towards a more global and transparent market are occurring.

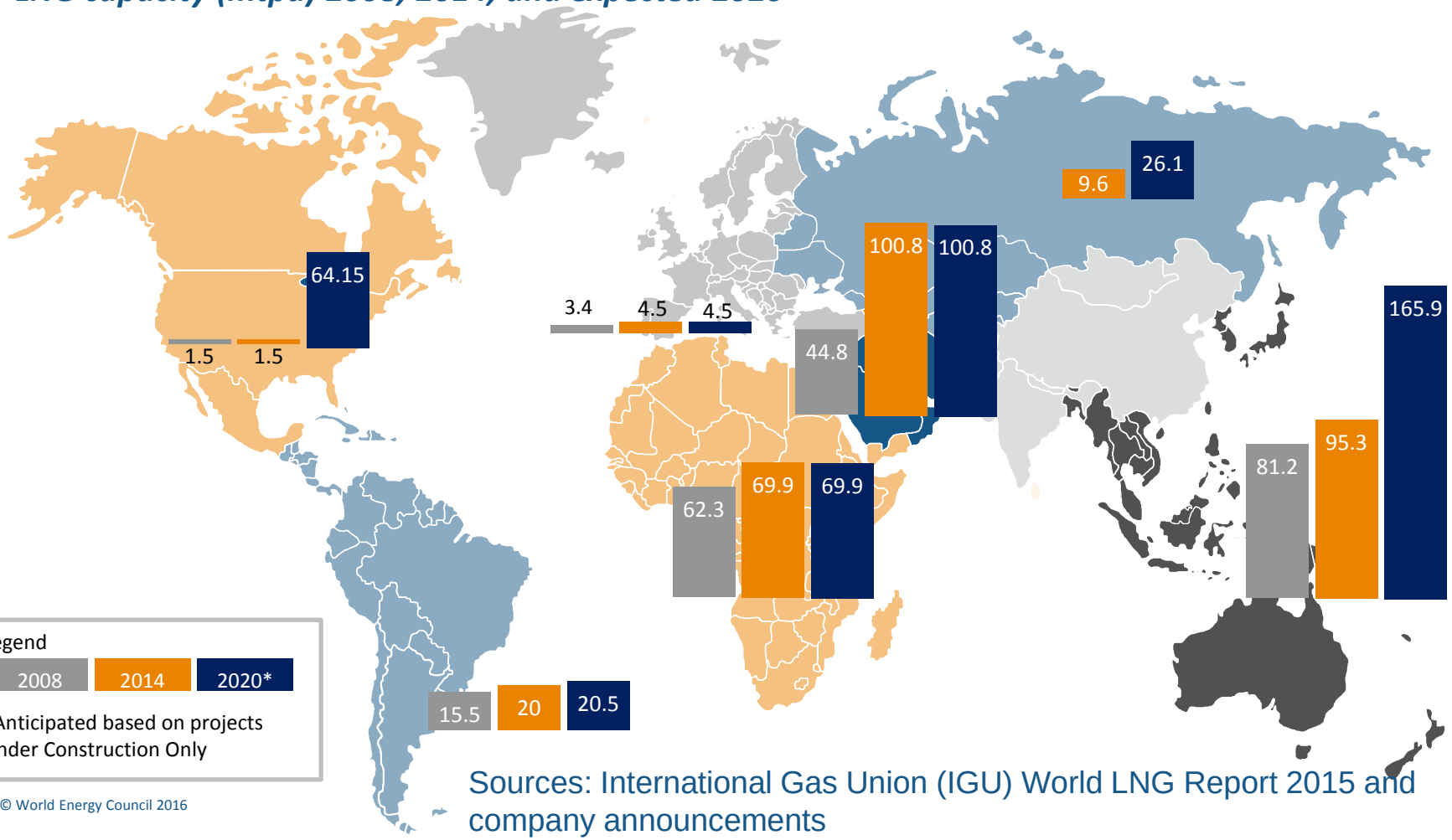


Sources: EIA, the World Bank, and Japan Ministry of Economy, Trade and Industry (METI)

Interconnected markets

From regional to global implications: The US and Australia will add almost all new LNG export capacity through 2020.

LNG capacity (mtpa) 2008, 2014, and expected 2020



Sources: International Gas Union (IGU) World LNG Report 2015 and company announcements

Interconnected markets

Driven by:

- **Gas-on-gas competition**
- **Liquidity**
- **Growing bargaining power of consumers**
- **Clear price signal**

International growth of unconventional natural gas

- Outside of North America, China and Australia are making strides as commercial producers of unconventional gas.
- National Oil Companies (NOCs), driven by the desire to bring affordable natural gas supplies online, are cg New Frontiers for unconventional resources:
  - Argentina and Saudi Arabia are set to become commercial producers by 2020
  - Mexico, Poland, Algeria, South Africa and Turkey need at least five to 10 years

Technically Recoverable Reserves (TRR)

No.	Country	Trillion Cubic Feet (tcf)	Trillion Cubic Metre (tcm)
1	China	1115	31.6
2	Argentina	802	22.7
3	Algeria	707	20.0
4	US	623	17.6
5	Canada	573	16.2
6	Mexico	545	15.4
7	Australia	429	12.2
8	South Africa	390	11.0
9	Russia	285	8.1
10	Brazil	245	6.9
11	United Arab Emirates	205	5.8
12	Venezuela	167	4.7
	World	7577	214.5

Source: EIA World Shale Resource Assessments

Australia

CBM to LNG Potential

- Australia accomplished a world first in 2014 using CBM as feedstock to produce LNG
- In 2014 and 2015, three CBM to LNG projects came online or were in the final stages of construction
- LNG export capacity will grow from 36.6 to 86.5 mtpa by 2020 and CBM LNG will account for nearly 40% of LNG export capacity
- Australia will become the number one export capacity holder of LNG in 2017

Challenges

- Projects have faced delays and cost overruns
- Supplies will enter the market in a down period
- There are risks regarding project valuations and the long-run commercial viability of Australian CBM

Australian CBM to LNG Projects

Project	Owner	Capacity (mtpa)	CAPEX ($bn)	Commercial Operating Date
QCLNG (CBM to LNG)	Train 1: BG Group 50%, CNOOC 50% Train 2: BG Group 97.5%, Tokyo Gas 2.5%	Trains 1&2: 8.5 Train 3: 4.25	$20.4	8.5 mtpa online in 2014-15
APLNG (CBM to LNG)	Origin Energy 37.5% ConocoPhillips 37.5% Sinopec 25%	9-18	$35	2015
Gladstone LNG (CBM to LNG)	Santos 30% Petronas 27.5% Total 27.5% KOGAS 15%	3.9-7.8	$18.5	First cargoes in Oct 2015

Source: IGU World LNG Report 2015, company announcements, and press releases

China

Shale Gas Potential

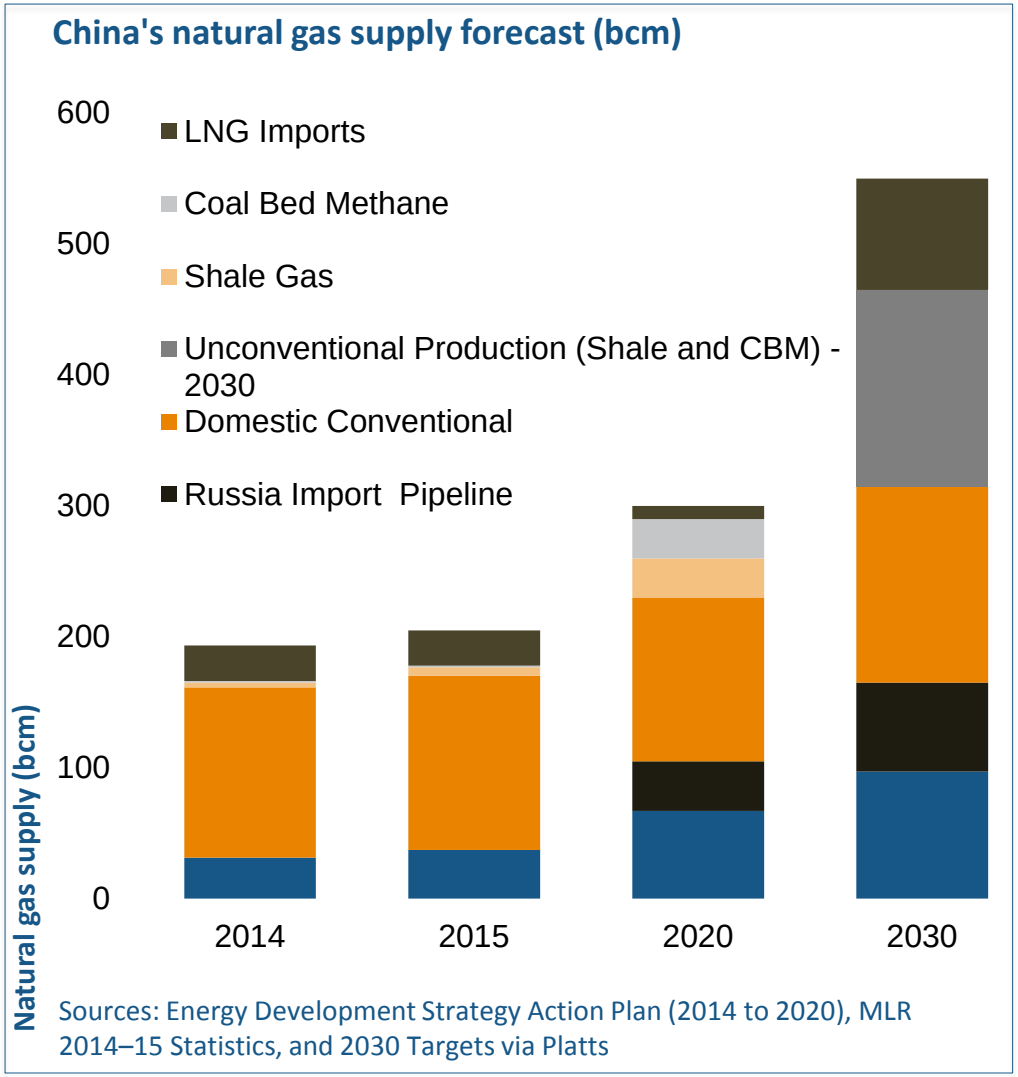
- Fuling field in Sichuan basin has a potential estimated at 380.6 bcm
- Production rates of 60,000- 200,000 cubic metres per day per well, comparable to Marcellus wells
- Sinopec's production in Fuling could be 10 bcm by end of 2017 and 15 bcm by 2020
- Revised target in 13th 5 year plan expected to be 30 bcm per year by 2020

CBM Gas Potential

- 3.6 bcm from coal seam operations in 2014
- CBM is expected to reflect 30 bcm of production by 2020

Challenges

- Land access and operability
- Infrastructure development
- Technical capability



International growth of unconventional natural gas

Eight critical factors for unconventional gas development:

1. Size of potential resources
2. Enabling fiscal regime
3. Geology
4. Land access and operability
5. Unconventional services sector
6. Oil and gas distribution network
7. Conventional and other competition
8. Skilled workforce

New frontiers

Argentina and Saudi Arabia have the potential to become commercial producers of unconventional resources by 2020.

	Neuquén basin Potential	Challenges
Argentina 	• Vaca Muerta formation bears a resemblance to the early-stage Eagle Ford basin in the US • Well-established oil and gas production basin in Argentina • Good road infrastructure, a developed services sector, and a substantial pipeline network • Drilling and completion of a "super well" with an IP of 1,600 barrels per day (Bpd)	• Immature unconventional supply chain (e.g. logistical challenges for sand and water) • Insufficient skilled labour for the oil and gas sector to address the upcoming boom
	Shale gas potential	Challenges
Saudi Arabia 	• Saudi Aramco announced plans to become a commercial shale gas producer by 2020 • Investing another $7bn to develop shale gas resources • Saudi Arabia burns liquids fuels and crude oil for the electric power sector, which, without an intervention, could exceed four million Bpd by 2020	• Depth of reservoirs and permeability of rocks make fracturing difficult • Water scarcity issues • Technical expertise

New frontiers

	Burgos Basin Potential	Challenges
Mexico 	• Burgos basin represents 20% of Mexico's hydrocarbon outputs and therefore has existing roads • Geology extends from the Texas Eagle Ford basin • Energy reform in December 2013 improved the fiscal attractiveness of the market	• Well data is limited • Security issue around the border • The availability of abundant, cheap US shale gas in the region may serve to derail investments in Mexican assets

	Baltic Basin Potential	Challenges
Poland 	• Estimated 4.1 tcm trr of shale gas and 2 bn bbl of shale oil. • Recent policy changes attempt to eliminate chokepoints e.g. state-controlled production, improving licensing • ~60 wells have been drilled and there is good data availability • Low population density for Europe • Good surface conditions, and favourable infrastructure • Connected by existing natural gas transmission pipeline • Access to the European services sector and labour force	• Further infrastructure development is required e.g. infrastructure for water treatment and disposal • Cheap LNG imports will create competition for shale gas investments

New frontiers

	Potential	Challenges
South Africa 	• Karoo basin is a good prospect due to the presence of mature black shales • Electricity system near Karoo could absorb up to 1-2 GW with no need for pipelines • Infrastructure Development Bill covers expropriation risk • Some presence of maintenance and oil field services skills	• Water scarcity • Fiscal attractiveness • Mineral rights • Limited existing service sector • No infrastructure coverage in the Karoo Basin • Limited access to oil and gas technical skills • No exposure to unconventional gas

	Potential	Challenges
Algeria 	• Significant resource base • Well placed geographically • Growing domestic demand for natural gas and declining conventional production • Leading source of natural gas in Europe (26.9 mtpa of LNG export capacity) • Well-established natural gas industry • Strong conventional gas skills • Substantial network of pipelines • Well-developed local service industry	• Water scarcity • Security concerns • Aging infrastructure • Community protests

New frontiers

	Potential	Challenges
Turkey 	• Actively pursuing an energy security strategy with a diversified supplier base • Geographically positioned along trade routes to the EU and the Middle East and Mediterranean gas fields in Cyprus, Greece, and Israel • Early stage exploration activities targeting a liquids-rich shale resource in the Dadas Shale.	• Not enough known about the resource potential • Policy and industry frameworks for resource development must be established

Competing conventional projects

Sub-Saharan Africa natural gas potential

- Finds offshore Mozambique could reflect ~7.1 tcm of recoverable natural gas.
- Tanzania's Energy and Minerals Ministry estimates ~1.6 tcm of natural gas reserves
- Current supply glut means projects may not begin construction before 2020

Potential future for African Natural Gas

Benefits

- Funding source for the development of strategic infrastructure
- Limits the need for fossil fuel imports
- Provides protection against commodity price volatility

Economic Growth

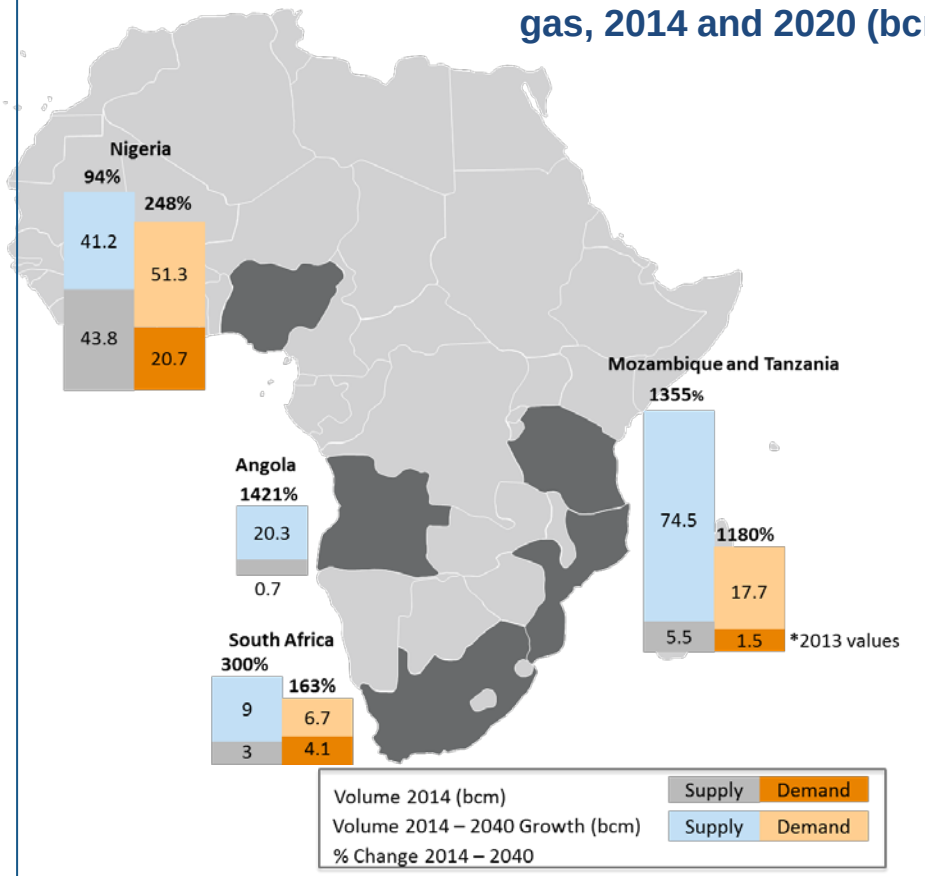
Exports to boost national coffers

Domestic gas to support local and regional development

Foundation

- Regional cooperation and energy system integration

Sub-Saharan Africa supply and demand for natural gas, 2014 and 2020 (bcm)



Sources: BP Statistical Review of World Energy 2015, EIA International Energy Statistics, IEA World Energy Outlook 2014, National Petroleum Institute of Mozambique, Nigerian National Petroleum Corporation, OPEC Statistical Bulletin 2015, and Accenture Analysis

Competing conventional supplies

Russia

Pipeline gas from Russia continues to be one of the most economic natural gas options for Europe.

- Long standing supplier in the natural gas industry
- Cost of getting Russian supplies to Europe borders is significantly lower than US or Australian LNG
- Current pricing of Russia's oil indexed exports make the resource more competitive than LNG imports

Iran

The Iran Nuclear Deal lifted international oil and gas sanctions and the nation is moving quickly to bring natural gas export projects online.

- Substantial base of proved natural gas reserves, estimated at 34.0 tcm as of 2014.
- Iran's NOC is said to be in talks to develop several projects, one of which could have Iranian LNG landing in Europe within two years
- The European Commission estimates that Iranian LNG exports to Europe could grow to supply 25-35 bcm by 2030

Qatar

Qatar is already well positioned to supply both Europe and Asia. In 2014, Qatar supplied 45% of all LNG imported to the Eurasia region and 31% of LNG imports to Asia.

- Long standing supplier in the natural gas industry
- Ability to produce and process large quantities of gas at lower costs than US and Australia (estimates are $2/MMBTU for production and liquefaction)
- Even in the down market, QatarGas, has substantial margin to continue investing in export capacity

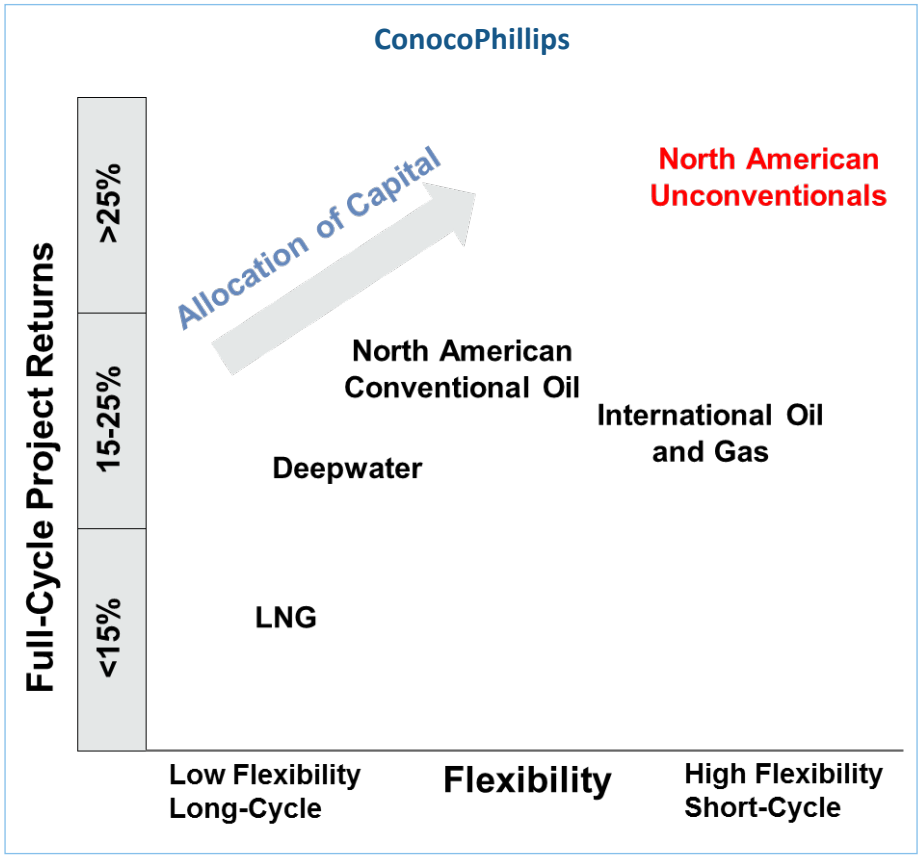
Looking Forward

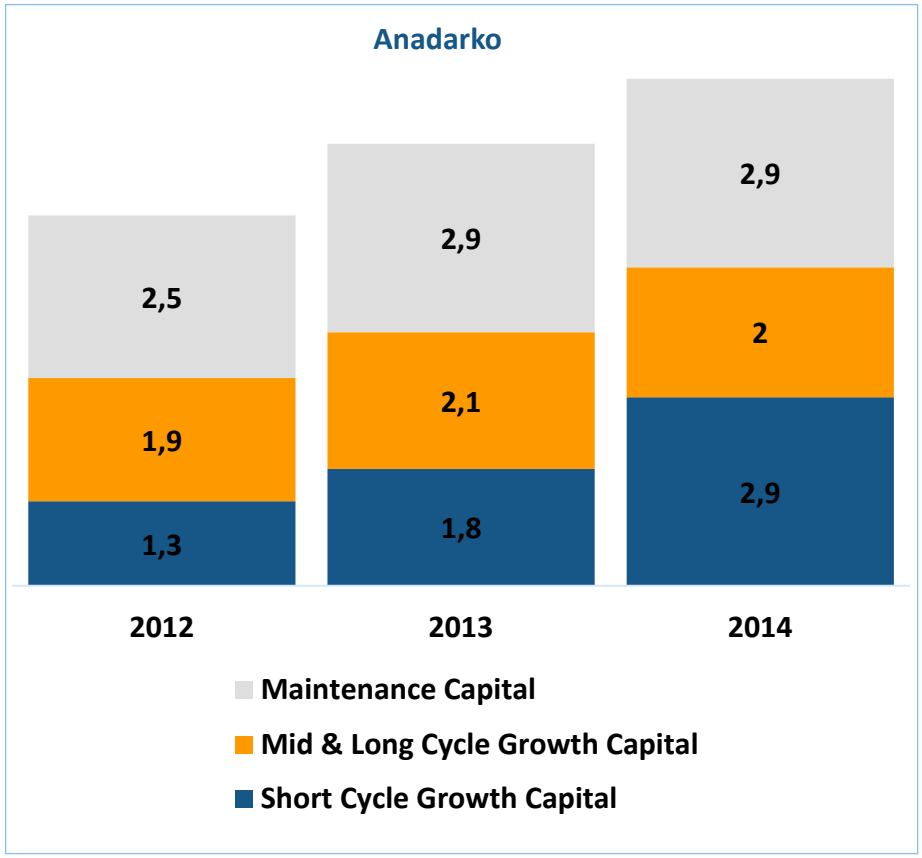
- Affordability and security will drive exploration into unconventional resources outside of North America
- Continued growth in unconventional gas in the US, Australia, and China will significantly influence the balance of supply and demand out to 2020
- Argentina and Saudi Arabia may emerge as commercial unconventional resource suppliers before 2020
- Most other frontier markets are at least five to ten years away and will face competition from large conventional projects in sub-Saharan Africa and the Middle East
- NOCs will have many advantages in addressing societal and environmental concerns associated with unconventional gas operations
- Many nations with shale gas resources also face water stress and their NOCs have many incentives to deploy new technologies that overcome water related operational risks and constraints

Shifting portfolio allocations

In 2015, many E&P operators with US land assets reshuffled their portfolios towards North America land shale gas at a time when overall capital expenditure was declining.

Examples of industry preference for short-cycle, flexible returns





Source: Anadarko and ConocoPhillips Investor Presentations

Shifting portfolio allocations

Three main drivers led to the rapid economic improvements seen in the shale gas development process and enabled the fast-tracking of US LNG projects in the last five years:

- Operational flexibility
- Continued operational and technical innovation
- Favourable regulatory climate

Operational Flexibility

US shale gas LNG can respond quickly to a price rebound across regional gas markets.

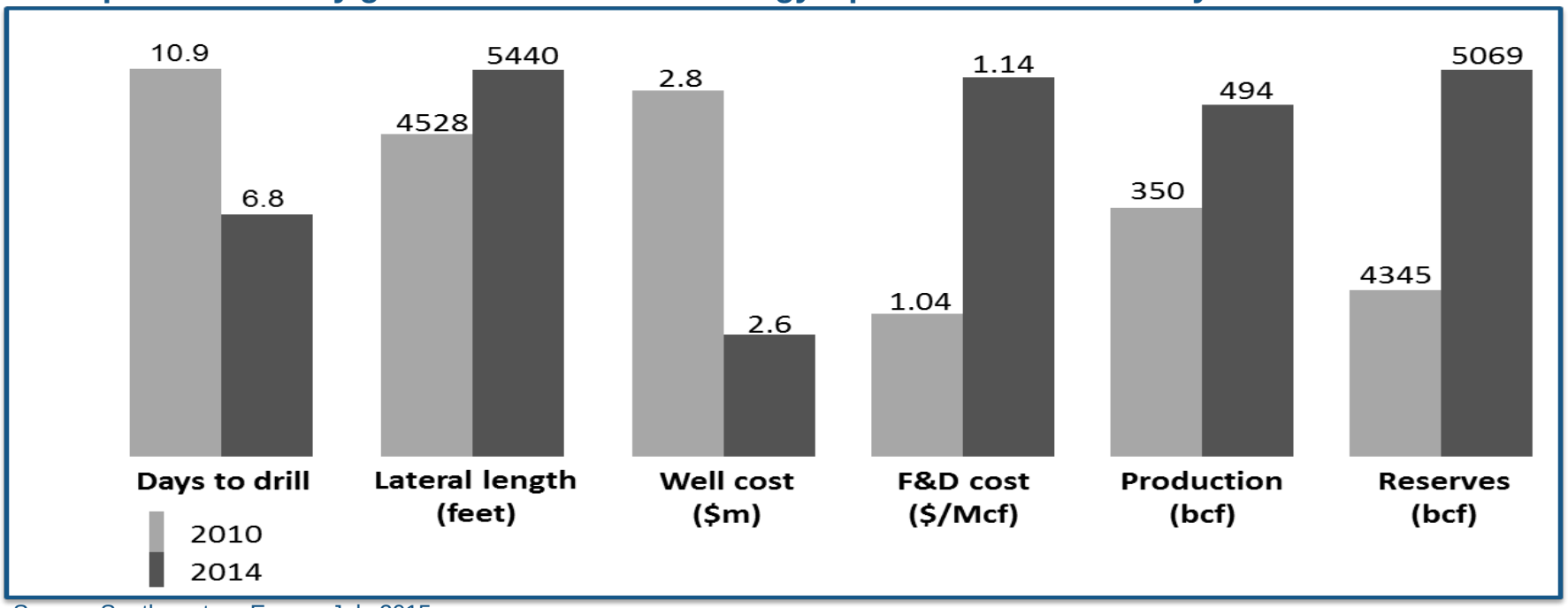
- Unconventional E&P operators can drill wells and not complete them
- The EIA estimates there are between 2,000 and 4,000 uncompleted wells representing the potential to add 350,000 Bpd of production
- Cost and cycle time improvements in drilling and completions mean production can be ramped up or down quickly
- Flexibility makes shale gas assets more favourable and responsive in a volatile market

Continued operational and technical innovation

Production optimisation and efficiency gains have improved the economics of US shale gas

- EOG, Anadarko, and ConocoPhillips now have significant share of production that is able to break even in the $40-$50/Bbl range. In wet gas basins, operations are estimated to break even in the $25-$30/Bbl range.

Example of efficiency gains - Southwestern Energy's performance in the Fayetteville Shale



Source: Southwestern Energy July 2015

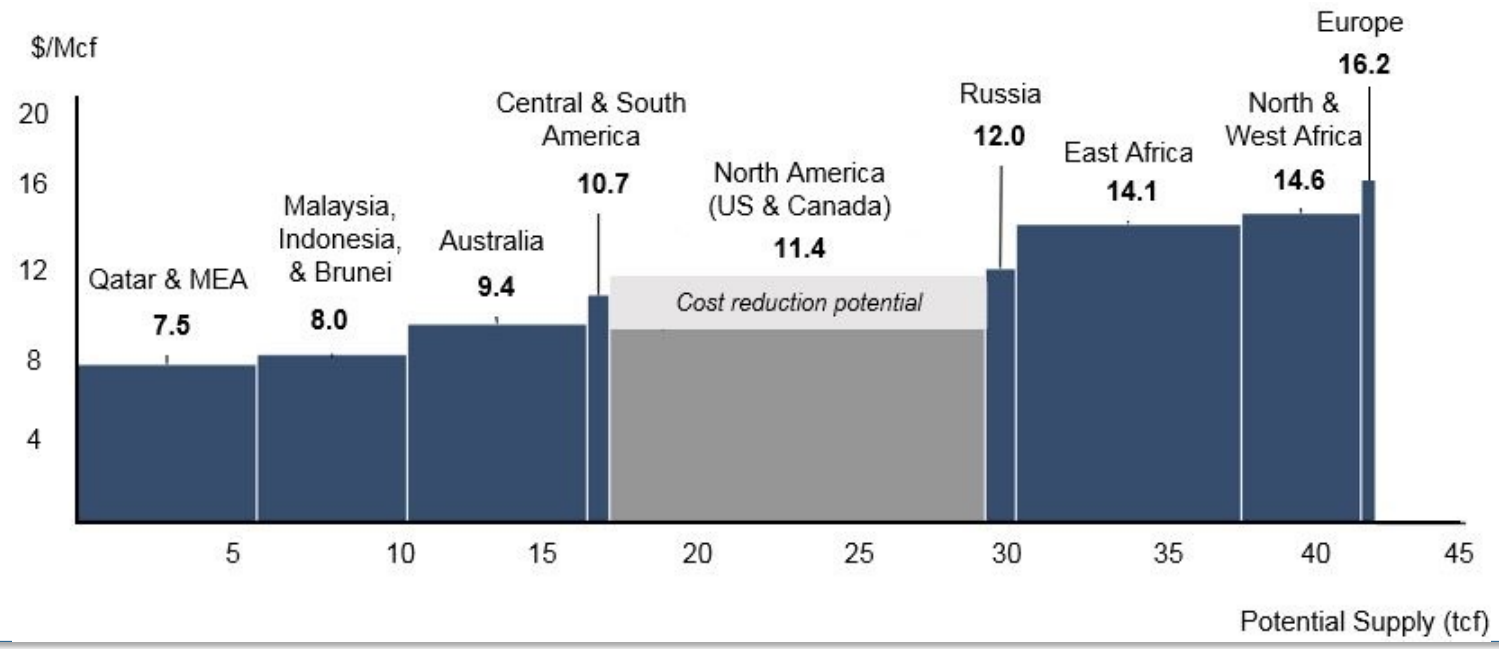
Favourable Regulatory Climate

- Mineral rights allow landowners to reap the benefits of production
- A relatively fast permitting process for LNG export facilities enabled the US to enter the global LNG market as an exporter
- The learnings from US shale operations are also enabling a new set of policies to reduce safety and environmental risks
  - New set of standards set to cut methane emissions by 25%
  - Best practices for water management make water treatment and reuse more economic and operationally feasible

Looking forward

- US LNG exports are economically competitive in the market
- The US economic model positions the US well to respond quickly to the “right price” and emerge as a marginal LNG supplier

LNG cost in Japan vs. expected global capacity by country



Source: Accenture Strategy Upstream

Conclusions

- New supply landscape emerging as unconventional gas, led by the United States (US) shale gas story, enters regional natural gas markets as LNG
- Key uncertainties in the market create concerns about the future of demand and about the ability for suppliers to deliver affordable and secure supplies for the long-term
- Certain decisive interventions by market actors were called out by industry leaders as having the potential to tackle the significant challenges around affordability and security that could prevent natural gas from fulfilling its role as a transition fuel in the journey to a cleaner energy future.
  - **Industry:** Bring a higher degree of focus to portfolio allocation, risk management, and efficiency and continue to seek new and innovative investment partnerships to deliver projects.
  - **Policymakers:** Establish policies that promote a liquid market and competition needed for security of supply and the formation of clear price signals.
  - **Consumers:** Evaluate the economic and environmental benefits of diversifying energy assets with natural gas in power, industry, transportation, and chemicals and consider innovative investment partnerships to secure supplies.

WEC Austria

office@wec-austria.at

www.wec-austria.at
www.worldenergy.org