How unconventional are changing global oil and gas markets

Presentation to the Scottish Oil Club
Edinburgh, 7th November 2013

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Contents

- Overview of McKinsey in Oil and Gas
  - Overview of the global context
  - Overview of Light Tight Oil (LTO)
  - Overview of shale gas
Who is McKinsey & Company?

- Global firm with >8,500 management consultants
- More than 100 offices in 60 countries
- Serving the world’s leading institutions for over 85 years
- Expertise in all industries, e.g., energy, pharmaceuticals, telecommunications, healthcare, insurance, banking

SOURCE: McKinsey & Company
McKinsey serves many of the world’s oil & gas industry shapers

Companies served in the last five years

Since 2008 McKinsey has served 75% of the top 50 oil & gas companies worldwide

1 Companies in PIW Top 50 by country of origin; at least one engagement since 2006
Today’s presenters

Mark Davis
Junior Partner
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Peter Lambert
Senior Expert
Peter_Lambert@mckinsey.com
Contents

- Overview of McKinsey in Oil and Gas
  - Overview of the global context
  - Overview of Light Tight Oil (LTO)
  - Overview of shale gas
Demand for oil is expected to grow around 1% per year.

Projected global petroleum products demand

- Million barrels of oil equivalent per day
- Non-OECD
- Global Lost Decade
- OECD
- Global Growth Renewed
- Reference case

**Global growth renewed**
- Continued growth in emerging markets fueled by China
- Avg. GDP growth rate: 4.0%

**Reference case**
- Continuation of current trends (econ. growth, technological progress, GHG regulation)
- Avg. GDP growth rate: 3.2%

**Global lost decade**
- Major emerging markets are unable to insulate themselves against the slowdown in global growth
- Avg. GDP growth rate: 2.3%

Gas demand will grow by 2% per year, driven by Asia

Global natural gas consumption
Trillion ma

<table>
<thead>
<tr>
<th>Region</th>
<th>2010-2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row</td>
<td>2.1</td>
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<tr>
<td>Middle East</td>
<td>2.3</td>
</tr>
<tr>
<td>Non-OECD Asia</td>
<td>4.5</td>
</tr>
<tr>
<td>E Europe/Eurasia</td>
<td>1.1</td>
</tr>
<tr>
<td>OECD</td>
<td>0.9</td>
</tr>
</tbody>
</table>

SOURCE: Energy Insights
Unconventionals are a small but fast-growing part of overall supply

### Sources of global gas production

**Trillion Cubic Meters**

<table>
<thead>
<tr>
<th>Year</th>
<th>US shale gas</th>
<th>Other gas¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.0</td>
<td>0.0</td>
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<td>2001</td>
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<tr>
<td>2012</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

1 Includes Coal Bed Methane and Tight gas

### Sources of global oil production

**Billion Barrels**

<table>
<thead>
<tr>
<th>Year</th>
<th>US Light Tight Oil</th>
<th>Conventional oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.0</td>
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<tr>
<td>2012</td>
<td>0.0</td>
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</tbody>
</table>

1 Includes Coal Bed Methane and Tight gas

**2012 share**

- US shale gas: 7%
- Other gas¹: 93%
- Conventional oil: 98%

**2007-12 Growth rate**

- US shale gas: 40%
- Other gas¹: 1.6%
- Conventional oil: 0.9%

**Sources**

- BP Statistical Review; Energy Information Administration; Drilling Info
Unconventionals has made “fracking” more “popular” than “peak oil”
Contents

- Overview of McKinsey in Oil and Gas
- Overview of the global context
- **Overview of Light Tight Oil (LTO)**
- Overview of shale gas
US Light Tight Oil (LTO) reached 2 million barrels per day in March 2013

### U.S. LTO production

<table>
<thead>
<tr>
<th>Kb/d</th>
<th>Eagleford</th>
<th>Bakken</th>
<th>Granite Wash</th>
<th>Sprayberry</th>
<th>Austin Chalk</th>
<th>Mississippi Lime</th>
<th>Other US LTO Plays</th>
</tr>
</thead>
</table>

- 2,000 kbod March 2013
- 100 kbod Dec 2005

### Proportion of US crude oil production

#### Percent of Mar. 2013 prod

- **L48¹**
  - 100% = 5.4 MMb/d
  - LTO: 37%
  - Austin Chalk: 63%

- **US**
  - 100% = 7.2 MMb/d
  - LTO: 47%
  - Other: 28%
  - GoM & Alaska: 25%

### Comments

- Rapid growth in US LTO
- LTO development in the US is happening at a faster pace than shale gas

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1 L48 = Lower 48 states (excludes Alaska & GoM)
Flared gas from unconventional gas is visible from space.

SOURCE: NASA
North Dakota is peppered with well pads: LTO required very high drilling activity and well densities

Image 2.9 km x 1.6 km, taken from 2500 m eye elevation

SOURCE: Google Earth
McKinsey’s bottom up models expect significant growth from LTO by 2020

**US oil production**

MMb/d

- **LTO**
- **Lower 48 onshore conventional**
- **GoM**
- **Alaska**


**2020 LTO production**

MMb/d

- High LTO resource: 7.8
- Constant activity: 6.8
- Constrained resource: 5.3
- Constrained resource & activity: 3.9

**Boom is likely to lead to:**

- Energy independence
- Changing crude flows
- Changing geopolitics
- Shifting supply balance

*SOURCE: Energy Insights, EIA AEO 2013; Rystad; Belfer Center; Bentek; Bernstein Research; McKinsey; EIA AEO2013; multiple others*
LTO will impact crude flows and shipping markets

SOURCE: Energy Insights
US LTO will materially change global the supply cost curve, potentially stalling the development of deepwater

Global liquids cost curve of assets producing in 2025

Production cost, $/barrel, 2012 real

OPEC\textsuperscript{1,3}     Non-OPEC\textsuperscript{2}

SOURCE: Energy Insights
**But a continued LTO boom is not without risk on many fronts**

<table>
<thead>
<tr>
<th>Technology &amp; skills</th>
<th>Need to understand the rocks</th>
<th>Insufficient export infrastructure adds cost and lowers price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>Rigs constraints</td>
<td>High CO2 content and (potential) methane leakage</td>
</tr>
<tr>
<td>Water</td>
<td>High water usage – 2-3 barrels injected per barrel + disposal too</td>
<td>Land use &amp; pollution</td>
</tr>
<tr>
<td>Noise</td>
<td>700-1300 trucks per well (equipment, fluids, waste)</td>
<td>Government support</td>
</tr>
</tbody>
</table>

**SOURCE:** McKinsey analysis; multiple
Large LTO resources in the ROW might also add to the supply mix

Shale oil technically recoverable

<table>
<thead>
<tr>
<th>Country</th>
<th>BBBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>75</td>
</tr>
<tr>
<td>United States</td>
<td>58</td>
</tr>
<tr>
<td>China</td>
<td>32</td>
</tr>
<tr>
<td>Argentina</td>
<td>27</td>
</tr>
<tr>
<td>Libya</td>
<td>26</td>
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<tr>
<td>Australia</td>
<td>18</td>
</tr>
<tr>
<td>Venezuela</td>
<td>13</td>
</tr>
<tr>
<td>Mexico</td>
<td>13</td>
</tr>
<tr>
<td>Pakistan</td>
<td>9</td>
</tr>
<tr>
<td>Canada</td>
<td>9</td>
</tr>
</tbody>
</table>

SOURCE: EIA (June 2013)
**Summary**

- Light Tight Oil is booming and is making a material impact on US oil supply
- Already LTO is changing international crude flows, trade and geopolitics
- We expect LTO in the US to continue rapid growth trajectory
- But there are many subsurface challenges and risks

**Signposts to watch**

- **Operating behaviour**: how will producers behave and by how much will *well efficiency* improve?
- **Geoscience**: how quickly can the industry increase its fundamental understanding of the *reservoir effectiveness*?
- **Technology**: Will shale technology plateau or see substantial advances in the coming few years?
- **Environment**: how will the story on gas, emissions, water, noise, and pollution play out?
- **Regulation**: How much will evolving regulation and litigation affect the industry
- **Infrastructure**: how and when will bottlenecks change the game?
Contents

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- Overview of Light Tight Oil (LTO)
- Overview of shale gas
US gas resources have nearly doubled in 10 years

Major US shale gas and liquids resources

L48 gas resources

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale Gas</td>
<td>1,211</td>
<td>1,309</td>
<td>2,074</td>
<td>2,310</td>
</tr>
<tr>
<td>Tight Gas</td>
<td>928</td>
<td>963</td>
<td>1,093</td>
<td>1,122</td>
</tr>
<tr>
<td>CBM</td>
<td>58</td>
<td>109</td>
<td>163</td>
<td>159</td>
</tr>
</tbody>
</table>

**Exploration**

- Barnett (118)
- Haynesville/Bossier (251)
- Eagle Ford / Pearsall (>100)
- Shale Gas.com

**Developing**

- Woodford Caney
- Haynesville/Bossier
- Fayetteville (20)
- New Albany
- Antrim
- Marcellus (256)
- Utica
- Niobrara
- Cody
- Mowry
- Davey
- Mancos
- Mancos
- Lewis
- Mancos

**Producing (Tcf resources)**

- Bakken
- Niobrara
- Montney (152)
- Horn River Shale (40)
- Woodford (42)
- Marcellus (256)
- Utica
- Niobrara
- Cody
- Mowry
- Davey
- Mancos
- Lewis
- Mancos

**Conventional**

- Flood-Neal
- Conven-
- Conventional

**Resource to production ratio (years)**

- Barnett (118): xx
- Haynesville/Bossier (251): xx
- Eagle Ford / Pearsall (>100): xx
- Shale Gas.com

**SOURCE:** EIA; Deutsche Bank; Shale Gas.com; USGS; NPC; company announcements; Team analysis

**Map**

- Continental US
- Shale gas and liquids resources
- Major plays
- Resource to production ratio (years)

**Notes**

- Orange: considered to have large amounts of liquids
Development of Barnett shale wells during 1997-2010

SOURCE: EIA
Drilling between the runways at Dallas-Fort Worth airport!

SOURCE: Google Earth
As shale gas production has grown, US gas prices have collapsed. The graph shows the Henry Hub Gas price (LHS) and US shale gas production (RHS) over the years.

SOURCE: EIA
Low US gas prices provide > $500 million daily benefit to the US economy

**Henry Hub Gas Price**

<table>
<thead>
<tr>
<th>Year</th>
<th>Price ($/MMBtu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008 Henry Hub</td>
<td>8.86</td>
</tr>
<tr>
<td>2012 German Border</td>
<td>11.13</td>
</tr>
<tr>
<td>2012 Henry Hub</td>
<td>2.76</td>
</tr>
</tbody>
</table>

**SOURCE:** EIA, CME
The biggest benefits from shale have gone to midstreamers and energy users while the Majors and power utilities have suffered

Total Return to Shareholders across the NA gas value chain

<table>
<thead>
<tr>
<th>Industry segment¹</th>
<th>2009-2012²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Companies</td>
<td>15</td>
</tr>
<tr>
<td>Majors</td>
<td>8</td>
</tr>
<tr>
<td>US Onshore Independents</td>
<td>19</td>
</tr>
<tr>
<td>G&amp;P MLP’s</td>
<td>59</td>
</tr>
<tr>
<td>Gas Pipelines</td>
<td>25</td>
</tr>
<tr>
<td>Power Merchants</td>
<td>-9</td>
</tr>
<tr>
<td>LDC’s</td>
<td>27</td>
</tr>
<tr>
<td>Chemicals</td>
<td>39</td>
</tr>
</tbody>
</table>

Shale writedowns 2012-3

<table>
<thead>
<tr>
<th>Company</th>
<th>Writedowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENCANA</td>
<td>$1.7bn</td>
</tr>
<tr>
<td>bhpbilliton</td>
<td>$2.8bn</td>
</tr>
<tr>
<td>BG GROUP</td>
<td>$1.3bn</td>
</tr>
<tr>
<td>Shell</td>
<td>$2.1bn</td>
</tr>
</tbody>
</table>

“Peter Voser said the failure of Royal Dutch Shell's huge bet on US shale was the biggest regret of his time as chief executive of the company.”
– FT, 6 October 2013

¹ Service companies (SLB, HAL, WFT, BHI); majors (BP, RDS, XOM, CVX); US onshore independents (XTO, UPL, SWN, RRC, QEP, PXD, NBL, NFX, MRO, XCO, APC, APA, EHT, EOG, DVN, CLR, XEC, CHK, CRZO, COG); G&P MLP (CPNO, CMLP, DPM, EROC, MWE, NGLS, RGNC, WES); gas pipelines (BWP, EPB, SEP); power merchants (CPN, GEN, DYN); LDCs (CNP, OGE, SCG, NFG, OKE, STR); chemicals (WLK, DOW, PPG)

2 Till Nov 2012

SOURCE: Press searches, McKinsey analysis
Will shale gas also shake up markets outside the North America?

<table>
<thead>
<tr>
<th>Shale gas technically recoverable resources</th>
<th>Top 10 countries, Tcf</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1,115</td>
</tr>
<tr>
<td>Argentina</td>
<td>802</td>
</tr>
<tr>
<td>Algeria</td>
<td>707</td>
</tr>
<tr>
<td>United States</td>
<td>665</td>
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<tr>
<td>Canada</td>
<td>573</td>
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<tr>
<td>Mexico</td>
<td>545</td>
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<tr>
<td>Australia</td>
<td>437</td>
</tr>
<tr>
<td>South Africa</td>
<td>390</td>
</tr>
<tr>
<td>Russia</td>
<td>285</td>
</tr>
<tr>
<td>Brazil</td>
<td>245</td>
</tr>
</tbody>
</table>

SOURCE: Financial Times; EIA (June 2013)
Exploration for unconventional gas outside North America is at an early stage of development

Position based on most advanced basins

SOURCE: Expert interviews; McKinsey Analysis
Most countries have access to only a tiny fraction of the well data available in the US.

Estimated well density
Wells per 1000 Square KM

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<tbody>
<tr>
<td>US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China¹</td>
<td></td>
<td></td>
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<tr>
<td>Argentina</td>
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</tr>
<tr>
<td>Algeria</td>
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<tr>
<td>Europe</td>
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</table>

¹ Estimate assumes 1500 active Chinese rigs in 2012 and rig count growth equal to oil and gas production growth.

SOURCE: Baker Hughes; McKinsey analysis
Learning effects mean that a large capital commitment is required to take a basin from shale discovery to commercial production.

**Production costs**
USD per MMBtu

**Number of wells**

SOURCE: HPDI; Team Analysis
Shale development requires a lot of infrastructure

SOURCE: Google Earth, all taken at 2500 km eye height (approx 2 x 1.8 km)
Is there another way for shale to transform international gas markets?

SOURCE: FERC Office of Energy Projects; As of September 12 2013; LNG World
North American LNG exports can reduce the need for high cost Australian and Russian supplies, pushing down break even LNG prices

Global LNG cost curve excluding North America and existing/under development projects
US$/mmbtu, post tax

SOURCE: Energy Insights
Summary

- Shale gas has transformed the North American market
- There is a large potential for shale development outside North America but we expect it to progress slowly
- North American exports of (shale) gas could have a much bigger impact on global gas markets over the next decade

Signposts to watch

- Geoscience: How quickly can the industry build its understanding of shale resources outside North America?
- Technology: Will technology allow shale development on a significantly smaller footprint at acceptable costs?
- Public opinion: Can the public be convinced that the benefits from shale gas production outweigh the risks (real or perceived)?
- Regulation: Will government and industry find a reasonable balance between the need for public reassurance and commercial realities?
- Markets: How great an incentive will the market provide to invest in developing shale gas

SOURCE: McKinsey
How unconventionals are changing global oil and gas markets

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