Offshore Arctic Oil & Gas: Stop or Go?

3rd December 2012
James Hall
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Introduction to Infield Systems

SECTION I
Geographic Locations

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<table>
<thead>
<tr>
<th>Data, Reports &amp; GIS Mapping</th>
<th>Business Strategy and Analysis</th>
<th>Transaction Services</th>
</tr>
</thead>
</table>
| • Offshore specific data covering production infrastructure, rigs, specialist vessels, construction yards, contracts and OFS providers  
  • Sector specific reports  
  • GIS mapping services covering operational and forecasted production infrastructure | • Market matching and market tracking – “Match & Track”  
  • Complete market intelligence outsourcing  
  • Bespoke sector services  
  • Market entry strategy  
  • Procurement strategy advisory – “Project Flow”  
  • Ad-hoc sector analysis | • Pre IPO due diligence  
  • Market overview IPO  
  • Debt financing analysis  
  • Distressed asset purchases  
  • Buy/sell side market due diligence  
  • Opportunity identification |

Source: Infield Systems
The Offshore Arctic Region

SECTION II
The Arctic Region

The Arctic Circle is a vast area covering approximately 21 million square kilometres (sqkm), or 6% of the earth’s surface

- Arctic Ocean continental shelves:
  - USA (Alaska)
  - Canada (Arctic Ocean)
  - Russia
  - Norway
  - Greenland

- Additional offshore ‘sub-Arctic’ areas:
  - Russia (Sakhalin Island)
  - Canada (Newfoundland and Labrador)

- Offshore sub-Arctic areas not covered by this presentation:
  - Iceland (Jan Mayen Ridge)
  - Caspian Sea

Source: Infield Systems
Offshore Arctic Resources

SECTION III
Offshore Arctic Resources

There are 174 discovered fields in the offshore Arctic containing approximately 137 billion barrels of oil equivalent (Bboe)

- The offshore Arctic is primarily a natural gas play:
  - 116.6Bboe (85% of discovered resources) are natural gas
  - 17.2Bbbl (13%) are oil
  - 2.8Bbbl (2%) are condensates

- Discovered resources are overwhelmingly Russian (high Arctic and Sakhalin Island):
  - 83% of total resources
  - 89% of natural gas reserves
  - Large number of super-giant fields

**Discovered Offshore Arctic Fields by Country**

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (Arctic Ocean)</td>
<td>33</td>
</tr>
<tr>
<td>Russia</td>
<td>23</td>
</tr>
<tr>
<td>Russia (Sakhalin)</td>
<td>19</td>
</tr>
<tr>
<td>USA (Alaska)</td>
<td>27</td>
</tr>
<tr>
<td>Norway</td>
<td>41</td>
</tr>
<tr>
<td>Canada (Arctic Ocean)</td>
<td>31</td>
</tr>
<tr>
<td>Russia</td>
<td>23</td>
</tr>
<tr>
<td>Russia (Sakhalin)</td>
<td>19</td>
</tr>
<tr>
<td>USA (Alaska)</td>
<td>27</td>
</tr>
</tbody>
</table>

**Discover Natural Gas Reserves (Bcf) by Country**

<table>
<thead>
<tr>
<th>Country</th>
<th>Reserves (Bcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (Arctic Ocean)</td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td></td>
</tr>
<tr>
<td>Russia (Sakhalin)</td>
<td>505,000</td>
</tr>
<tr>
<td>Russia</td>
<td>490,000</td>
</tr>
<tr>
<td>USA (Alaska)</td>
<td></td>
</tr>
</tbody>
</table>

**Discover Oil Reserves (Mbbl) by Country**

<table>
<thead>
<tr>
<th>Country</th>
<th>Reserves (Mbbl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (Arctic Ocean)</td>
<td>1,950</td>
</tr>
<tr>
<td>Norway</td>
<td>75</td>
</tr>
<tr>
<td>Russia (Sakhalin)</td>
<td>4,000</td>
</tr>
<tr>
<td>Russia</td>
<td>3,750</td>
</tr>
<tr>
<td>USA (Alaska)</td>
<td>2,250</td>
</tr>
</tbody>
</table>

Source: Infield Systems
Undiscovered Resources

The USGS estimates that the onshore and offshore Arctic contains a further 412Bboe of undiscovered, technically recoverable reserves

- Approximately 84%, or 346Bboe, is thought to be offshore.
- As with discovered resources, there is a big skew towards natural gas:
  - Around 67% of undiscovered Arctic resources are thought to be natural gas, with just 22% oil and 11% NGLs.
- Russia again leads the way in undiscovered reserves:
  - West Siberian and East Barents basins contain 194Bboe, or approximately 47% of all undiscovered natural gas resources within the Arctic Circle.

Technically Recoverable Reserves (Mboe) by Type

- Natural Gas 67%
- Crude Oil 22%
- Condensate 11%

Technically Recoverable Gas Reserves (Tcf) by Region

- West Siberian Basin, 651.5
- Arctic Alaska, 221.4
- East Greenland Rift Basins, 86.18
- West Greenland-East Canada, 51.82
- Amerasia Basin, 56.89
- Yenisey-Khatanga Basin, 99.96
- Other, 183.35

Technically Recoverable Oil Reserves (Bbbl) by Region

- West Siberian Basin, 3.66
- Arctic Alaska, 29.96
- East Greenland Rift Basins, 8.9
- East Barents Basin, 7.41
- Laptev Sea Shelf, 3.12
- West Greenland-East Canada, 7.27
- Amerasia Basin, 9.72
- Yenisey-Khatanga Basin, 5.58
- Other, 14.36

Key Drivers

SECTION IV
Offshore Arctic – Key Drivers

There has been renewed interest in the offshore Arctic in recent years. This section analyses the key driving forces behind this trend, beginning with high oil prices.

- Strong oil demand growth from Asia Pacific:
  - The IEA estimates that global primary oil demand will rise by 14.6% to 99.4mnb/d 2035 (CAGR: 0.5%)
  - Asia will see most growth with demand hitting 29.9mnb/d by 2035 (CAGR: 2.1%)
- High long-term oil prices: US$100+/bbl
- Dwindling ‘easy oil’ reserves
  - IEA estimates that, by 2035, gross capacity additions of 47mn b/d will be required to maintain current production levels.

Long-Term Brent Price Scenarios

Source: Infield Systems
Offshore Arctic – Key Drivers

Natural gas price divergence between key markets will narrow but a fully traded global market remains unlikely

• Since 2000 gas demand has switched onto a steeper rising trajectory:
  - Surging demand from rapidly industrialising Asia-Pacific. Chinese consumption levels have more than tripled over the past 10 years. IEA expect Beijing’s new 12 year plan to push up gas demand by 6.7% a year to 2035 when the country’s total gas consumption could hit 500Bcm.
  - The Middle East region has seen gas consumption almost double over the past 10 years, from 20Bcf per day (Bcf/d) in 2001 to 39Bcf/d in 2011.
  - Fukushima nuclear disaster: LNG now accounts for 48% of Japan’s energy requirements, up 16% from 2010.
  - Low nuclear scenario

• Natural Gas: Asia-Pacific liquid natural gas (LNG) spot prices US$12+ per thousand cubic feet (mcf)

• Price divergence to narrow slowly from 2013:
  - Local demand dynamics
  - Global supply increases from shale gas
  - Differentials in local gas market pricing contracts

• Fully traded global gas market remains unlikely

Source: Infield Systems; BP, IEA
Offshore Arctic – Key Drivers

Factors such as rapid environmental change and improved technology are also helping to unlock new frontiers

- **Rapid environmental change:**
  - September 2012, another record: 3.6mn sqkm (NSIDC)
  - North Sea Route, North West Passage
  - No permanent ice by mid-century?
    (Maslowski & Wadhams, 2012)
    (Wang & Overland, 2009), (Stroeve & Holland, 2007)
    IPCC (AR4)

- **Technological improvements:**
  - Fully winterised, ‘ICE Class’ drilling equipment
  - 3D seismic surveying through ice, aerial surveying (openwater)
  - Improved ice monitoring technology
  - New floating production and pipeline systems

**Retreating Sea Ice Extent (September Coverage)**

![Graph of sea ice extent from 1979 to 2012](image)

Offshore Arctic – Status Update

SECTION V
**Offshore Activity Status Update - Canada**

New developments restricted to sub-Arctic or ice-free areas where operational challenges are less acute and physical isolation less severe

- High-Arctic: 41 discoveries, 0 developments
- Activity restricted to sub-Arctic Newfoundland and Labrador:
  - New licences:
    - Flemish Pass: Statoil, ConocoPhillips & Repsol (NL 11-02), Husky, Suncor & Repsol (NL 12-02)
    - Laurentian sub-basin: Royal Dutch Shell (NL 12-01)
  - Planned exploration drilling: Flemish Pass (Cupids, Harpoon) and Jeanne d'Arc basin (Searcher, Federation)
- 2013-2018: Development Capex of US$5.8bn: platform (33%) and pipeline (55%) due to isolation and iceberg prevalence

### Canadian Capex (US$m) by Market Type

<table>
<thead>
<tr>
<th>Year</th>
<th>ControlLine</th>
<th>Pipeline</th>
<th>Platform</th>
<th>SubseaCompletion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td>200</td>
<td></td>
</tr>
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<td>2011</td>
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</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>3000</td>
<td>2500</td>
<td>2000</td>
<td>1500</td>
</tr>
</tbody>
</table>

### Exploration

<table>
<thead>
<tr>
<th>Region</th>
<th>Operator</th>
<th>Number of Wells</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flemish Pass</td>
<td>Statoil</td>
<td>2</td>
<td>2008-2011</td>
<td>Completed</td>
</tr>
<tr>
<td>Flemish Pass/ Jeanne d'Arc Basin</td>
<td>Statoil</td>
<td>2</td>
<td>2013</td>
<td>Proposed</td>
</tr>
<tr>
<td>Jeanne d'Arc Basin</td>
<td>Statoil, Husky Energy</td>
<td>2</td>
<td>2012-2013</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

### Development

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Operator</th>
<th>Reserves (Mboe)</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hibernia South</td>
<td>ExxonMobil</td>
<td>267</td>
<td>2012</td>
<td>Completed</td>
</tr>
<tr>
<td>West White Rose</td>
<td>Husky Energy</td>
<td>120</td>
<td>2014</td>
<td>Proposed</td>
</tr>
<tr>
<td>Hebron</td>
<td>ExxonMobil</td>
<td>672</td>
<td>2017</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

Source: Infield Systems
Offshore Activity Status Update - Greenland

Cairn Energy has led renewed interest in Greenland but none of the UK independent’s eight exploration wells have proved commercial

- **Cairn Energy’s Greenland campaign:**
  - Statoil takes 30.625% interest in Pitu block
  - Currently processing and interpreting 3D seismic data. First exploration well scheduled for 2014, subject to Government of Greenland approval.
  - Statoil to operate any future development
  - Tullow Oil farm-in to Tooq licence (evaluating seismic data)
- **Shell, Conoco and Maersk Oil** currently acquiring a combination of seismic and stratigraphic data across Melville Basin blocks.
- Two new licensing rounds covering 19 blocks in the Greenland Sea during 2012-2013.
  - 11 open only to KANUMAS* group
  - 8 blocks subject to open round

<table>
<thead>
<tr>
<th>Exploration</th>
<th>Region</th>
<th>Operators</th>
<th>Number of Wells</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baffin Bay</td>
<td>Cairn Energy</td>
<td>8</td>
<td>2010-2011</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td>Baffin Bay</td>
<td>Cairn Energy, Statoil</td>
<td>1</td>
<td>2014</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

*Notes: KANUMAS Group includes ExxonMobil, Statoil, BP, Japan National Oil Corporation (JNOC), Chevron, Royal Dutch Shell, and NUNAOIL

Source: Infield Systems
Offshore Activity Status Update - Norway

The ice-free Norwegian Barents Sea is home to the largest share of offshore Arctic exploration and development

- Two Arctic fields developed to date - Snohvit and Albatross
- Increasing exploration activity:
  - Statoil’s ‘high-impact’ Skrugard & Havis discoveries
  - Settlement of long-term maritime border dispute
  - 20th & 21st licensing rounds: 21 blocks awarded
  - Tax incentives
- 11 wildcat wells completed 2011-2012, further 9 from Statoil alone in 2012-2013
- 2013-2018: Development Capex of US$8.3bn: Large pipeline (61%), control line (11%) and subsea completion (17%) shares due to deepwaters (>300m)

Norwegian Capex (US$m) by Market

<table>
<thead>
<tr>
<th>Region</th>
<th>Operators</th>
<th>Number of Wells</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barents Sea</td>
<td>Statoil, Eni, Lundin, GDF Suez, Total, Dong</td>
<td>11</td>
<td>2011-2012</td>
<td>Completed</td>
</tr>
<tr>
<td>Barents Sea</td>
<td>Statoil</td>
<td>9</td>
<td>2012-2013</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Operator</th>
<th>Reserves (Mboe)</th>
<th>On-stream Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goliat</td>
<td>Eni</td>
<td>243</td>
<td>2014</td>
<td>Under development</td>
</tr>
<tr>
<td>Skrugard</td>
<td>Statoil</td>
<td>252</td>
<td>2018</td>
<td>Proposed</td>
</tr>
<tr>
<td>Havis</td>
<td>Statoil</td>
<td>252</td>
<td>2018</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

Source: Infield Systems, NPD
Offshore Activity Status Update – Russia (high-Arctic)

Russia’s high-Arctic is immensely rich in resources but relatively few offshore developments have been brought to production

- High-Arctic developments:
  - Obskoye (launched 2012), Prirazlomnoye (first oil now expected H2 2013)
- The demise of Shtokman: High costs, no tax incentives, lack of markets
- Landmark ‘strategic partnership’ agreements with Rosneft:
  - ExxonMobil (Kara Sea, Black Sea)
  - Eni (Barents Sea)
  - Statoil (Barents Sea, Sea of Okhotsk)
  - Gazprom, Novatek leading exploration offshore Yamal Peninsular
- 2013-2018: Development Capex of US$3.2bn. High platform (69%) share due to very heavy ice coverage

![Russia (high-Arctic) Capex (US$m) by Market](chart.png)

### Exploration

<table>
<thead>
<tr>
<th>Region</th>
<th>Operators</th>
<th>Number of Wells</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barents Sea, Pechora Sea, Black Sea, Kara Sea, Sea of Okhotsk</td>
<td>Gazprom, Rosneft (alongside ExxonMobil, Eni, Statoil)</td>
<td>N/A</td>
<td>from 2014</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

### Development

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Operator</th>
<th>Reserves (Mboe)</th>
<th>On-stream Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prirazlomnoye</td>
<td>Gazprom</td>
<td>848</td>
<td>2013</td>
<td>Under development</td>
</tr>
<tr>
<td>Obskoye</td>
<td>Gazprom</td>
<td>310</td>
<td>2012-2013</td>
<td>Under development</td>
</tr>
<tr>
<td>Shtokmanovskoye Phase One</td>
<td>Gazprom</td>
<td>24,060</td>
<td>N/A</td>
<td>Suspended</td>
</tr>
</tbody>
</table>

*Source: Infield Systems*
Offshore Activity Status Update – Russia (Sakhalin Island)

Russia’s Sakhalin Island is both rich in resources and well positioned to meet rising demand for oil and gas from Asia’s industrialising economies

- Large reserves base:
  - 8.2Bboe of discovered resources
  - Approximately 2.6Bboe to be developed by 2018: Kiriniskoye & Kiriniskoye South (Sakhalin Three) Arkutun Dagi (Sakhalin Three)
  - Sakhalin One satellites: Lebedinskoye and North Chayvo could also be brought to production by 2018

- Major source of offshore Arctic Capex:
  - 2013-2018: US$4.2bn in development spending
  - Majority platform (51%) and pipeline (43%): Isolated, ice-prone, seismically active region

<table>
<thead>
<tr>
<th>Exploration</th>
<th>Region</th>
<th>Operators</th>
<th>Number of Wells</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sakhalin Three</td>
<td>Gazprom</td>
<td>2</td>
<td>2010-2011</td>
<td>Completed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development</th>
<th>Field Name</th>
<th>Operator</th>
<th>Reserves (Mboe)</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odoptu More (Sakhalin One)</td>
<td>ExxonMobil</td>
<td>1,156</td>
<td>2010</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td>Kiriniskoye (Sakhalin Three)</td>
<td>Gazprom</td>
<td>708</td>
<td>2012-2013</td>
<td>Under development</td>
</tr>
<tr>
<td></td>
<td>Arkutun Dagi (Sakhalin Three)</td>
<td>Gazprom</td>
<td>1,482</td>
<td>2014</td>
<td>Under development</td>
</tr>
<tr>
<td></td>
<td>Kirinskoye South (Sakhalin Three)</td>
<td>Gazprom</td>
<td>375</td>
<td>2018</td>
<td>Proposed</td>
</tr>
</tbody>
</table>

Source: Infield Systems
Offshore Activity Status Update – USA (Alaska)

Exploration is gathering pace in Alaska’s deeper waters but developments will still be restricted to the shallow waters of the Beaufort Sea and Cook Inlet

- Exploration:
  - Royal Dutch Shell: 4 well Chukchi/Beaufort Sea campaign.
  - ConocoPhillips, Statoil to follow from 2014/2015
  - Furie Alaska: First jack-up to be deployed in >10 years
  - Apache Energy: 3D seismic survey offshore Kenai Peninsula

- New developments:

- 2013-2018: Development Capex of US$707mn: All pipeline and production platform (artificial island) investment

*Notes: Top hole drilling completed on two wells to date
Source: Infield Systems
Offshore Arctic Challenges

SECTION VI
While some developments are taking shape, the offshore Arctic remains a region of largely unrealised potential.

- Of the 174 offshore Arctic discoveries, just 69 have been brought to production to date, representing just 11% of total discovered resources
- Field development lag:
  - 13 years, third longest in the world
  - Short lag for small satellite developments
  - Particularly big lag (26 years) for fields over 1Bboe:
    - Technology catch-up
    - Capital intensity
    - Regulatory hurdles

### Number of Offshore Arctic Discoveries

- **Russia (Sakhalin)**: 19
- **Norway**: 31
- **Canada**: 33
- **USA (Alaska)**: 27
- **Russia**: 23
- **Canada (Arctic Ocean)**: 41

### Average Offshore Field Development Lag (Years)

- **Russia (Sakhalin)**: 25
- **Norway**: 24
- **Canada**: 12
- **USA (Alaska)**: 8
- **Russia**: 23
- **Canada (Arctic Ocean)**: 41

Source: Infield Systems
Offshore Arctic - Challenges (Engineering)

Offshore Arctic developments pose unique engineering challenges due to intense cold, ice, remoteness and even seismic activity

- Exploration
  - Arctic conditions are highly varied so exploration apparatus must be tailored accordingly
  - Ultra-harsh environments in the high-Arctic are prompting the development of bespoke drilling units.
    - New drillship/jack-up concepts
    - Specialist conversion and winterisation of existing rigs

- Post-Deepwater Horizon regulatory ‘gold standard’ in Canada, US, Greenland:
  - Double shear rams
  - Capping stack in place
  - Same season relief well capability
  - Oil spill: Early detection and rapid response capability

- Development
  - Each has unique set of engineering challenges and environmental considerations
  - Often complicated by rapidly changing environmental conditions

**Sakhalin Two Development**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large winter ice-sheets</td>
<td>Four 56 X 20m concrete piles designed to withstand 30,000 tonne ice-load</td>
</tr>
<tr>
<td>Ice scour</td>
<td>Deep offshore pipeline burrial</td>
</tr>
<tr>
<td>Open water waves</td>
<td>Large platform air gap</td>
</tr>
<tr>
<td>Earthquake prone area</td>
<td>Sliding platform joints designed to withstand 8.0M tremor*</td>
</tr>
<tr>
<td>Isolation</td>
<td>Twin 800km pipeline corridor</td>
</tr>
<tr>
<td>Vulnerable Species</td>
<td>Pipeline re-routing, under-stream tunnelling, minimum platform emission</td>
</tr>
</tbody>
</table>

*Notes: Richter Scale
Source: Infield Systems; Gazprom
Offshore Arctic - Challenges (Logistics)

Offshore Arctic developments also pose unique logistical challenges due to the need for specialist drilling rigs and ICE-Class offshore support/construction vessels.

- **Exploration:**
  - Global supply of ‘harsh-environment’* drilling rigs running above demand for open water development wells.
  - Significant spare capacity for open-water exploration.

- **Development:**
  - Offshore operations require ice management from ICE Class OSVs.
  - Market well supplied with lower ICE classes, tightens from 2016 on the back of new developments.
  - Similar story with specialist pipelay vessels. Non ICE classes may be required in open waters from 2017/2018.

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Supply and Demand of Available Open Water Drilling Rigs

*Notes: ‘Harsh environment’ rigs refer to winterised systems capable of operating in open water Arctic or sub-Arctic conditions. Ice conditions in some areas require bespoke rig systems that are in much shorter supply. Source: Infield Systems*
Offshore Arctic – Challenges (High Costs)

The technical and logistical challenges of the offshore Arctic mean that exploration and production is relatively expensive.

- **Very high costs:**
  - Cairn Energy Greenland exploration: US$1.5bn, 8 wells
  - Yamal LNG: US$18-20bn (excluding Sabetta Port & ICE-Class LNG tanker fleet)

- **Oil:**
  - Large cost range due to varied Arctic conditions
  - Some offshore Arctic oil developments viable at ‘medium oil price scenario’ **BUT**...
  - Often higher margins with most EOR, deepwater, heavy oil projects & increasing competition from tight oil
  - Bakken, Eagle Ford... Bazhenov formation

- **Natural Gas:**
  - Offshore Arctic natural gas projects increasingly vulnerable
  - New conventional resources:
    - East Africa
    - Western Australia
    - FLNG
  - Onshore Arctic more competitive?
    - Bovanenkovo, Yamal LNG
    - Chayanda & Eastern Gas Programme

**Production Cost Curve**

*Source: Infield Systems; EIA; IEA World Energy Outlook (2008), Rosnedra*
Offshore Arctic – Challenges (Unconventional Resources)

Competition from shale gas is set to have a potentially detrimental effect on the offshore Arctic

US Natural Gas Production (tcf) 1990-2035

- 97Tcf of proved shale gas reserves in US lower 48 states
- Projections indicate US shale gas output could hit 13.6Tcf, or 49% of total production by 2035 (EIA ‘Reference Case,’ 2012)
- Already hitting shallow-water Gulf of Mexico so expensive offshore Arctic developments are very unlikely to go ahead
- EIA suggests that only in their ‘Low EUR*’ scenario is an Alaskan natural gas pipeline viable
- Even in the ‘Lower EUR’ case the pipeline would not be operational before 2031

Gulf of Mexico Shallow Water Platform Installations vs. E&A Wells

- The tight oil boom has not had quite the same effect
- Just 5% of total US oil production in 2010.
- Projected to hit 1.2mn b/d, or 12% of US oil production by 2020 – just 1.3% world oil production (under IEA ‘New Policies Case,’ 2011)
- Much smaller price impact, so offshore Arctic oil projects less vulnerable
- Shutdown in North Slope production before 2035 only in EIA’s ‘Low Oil Price’ scenario

*Notes: Estimated Ultimate Recovery (EUR)
Sources: Infield Systems, EIA, IEA, Reuters, BOEMRE
Offshore Arctic – Challenges (Finding Markets)

The suspension of Shtokman has highlighted a new challenge for offshore Arctic developments - finding markets. This is a particular challenge for natural gas projects targeting the Atlantic basin.

Atlantic Basin

- Post-industrial economies: The IEA estimates that European Union gas demand will rise by just 0.8% (CAGR) to 2035
  - Eurozone debt crisis
  - European shale gas, new regasification capacity
- Shale Gas Boom:
  - US net-exporter of LNG by 2016-2017
  - Low Henry Hub prices
- Projects under particular threat:
  - Shtokman
  - Hammerfest LNG expansion
  - Mackenzie Delta Pipeline and Canadian high-Arctic fields
  - Stranded North Slope natural gas fields

Pacific Basin

- Rapidly industrialising Asian economies: The IEA estimates that non-OECD Asia gas demand will rise by 4.3% (CAGR) to 2035
- Reorientation of offshore Arctic projects:
  - Russia’s ‘Eastern Gas Programme’ Sakhalin Three and the Sakhalin-Khabarovsk-Vladivostok pipeline system
  - Yamal LNG (North Sea Route)
- USA (Alaska):
  - ExxonMobil, ConocoPhillips, BP, TransCanada: North Slope-Valdez gas pipeline and liquefaction facility

Natural Gas Price Differential

![Henry Hub - Japanese LNG Spread](image)

Source: Infield Systems
Offshore Arctic – Challenges (Arctic Shipping)

Key to that reorientation will be opening of the Northern Sea route, an important gateway to Asia for projects such as Yamal LNG and Shtokman

- The Northern Sea Route (NSR) could provide an important gateway to Asia for offshore Arctic projects.
- Year-round navigation from Dudinka to Murmansk since 1970s but only recently tanker traffic successfully traversed route.
  - Vladimir Tikhonov (Suezmax) shipped the first NSR gas condensate cargo in 2011
  - During summer 2012, the Ribera del Duero Knutsen made the NSR’s first LNG tanker transit (unloaded)
  - Finally, in November 2012, Gazprom’s ‘Ob River’ began the first NSR shipment of LNG to Japan
- NSR vital for: Yamal LNG & other future gas developments in Russia’s high-Arctic
- Northwest Passage (NWP) much more difficult route:
  - Highly seasonal with hazardous multi-year ice (3-6m)
  - Contested Sovereignty
  - Lack of escort/transhipment support

### Northern Sea Route vs. Northwest Passage

<table>
<thead>
<tr>
<th>Destination</th>
<th>Distance (Nm)*</th>
<th>Speed (Kts)</th>
<th>Days*</th>
<th>Days Saved (vs. Suez Canal)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shanghai</td>
<td>6,500</td>
<td>12.9</td>
<td>21</td>
<td>-16</td>
</tr>
<tr>
<td>Bursan</td>
<td>6,050</td>
<td>12.9</td>
<td>19.5</td>
<td>-18.5</td>
</tr>
<tr>
<td>Yokohama</td>
<td>5,750</td>
<td>12.9</td>
<td>18.5</td>
<td>-20.5</td>
</tr>
</tbody>
</table>

*From Murmansk, Russia or Kirkenes, Norway

### Northern Sea Route Conditions

<table>
<thead>
<tr>
<th>Season</th>
<th>Kara Sea</th>
<th>Laptev Sea</th>
<th>East Siberian Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>October-May</td>
<td>October-June</td>
<td>October-May/June</td>
</tr>
<tr>
<td>Average Temperature (°C)</td>
<td>-26</td>
<td>-30</td>
<td>-21</td>
</tr>
<tr>
<td>Extreme Temperature (°C)</td>
<td>-48</td>
<td>-50</td>
<td>-48</td>
</tr>
<tr>
<td>Ice thickness (m)</td>
<td>1.8-2.5</td>
<td>1.6-2.5</td>
<td>1.2-2</td>
</tr>
<tr>
<td>Summer</td>
<td>June-September</td>
<td>July-September</td>
<td>June-September</td>
</tr>
<tr>
<td>Average Temperature (°C)</td>
<td>7</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Extreme Temperature (°C)</td>
<td>20</td>
<td>26</td>
<td>30</td>
</tr>
</tbody>
</table>

Conclusions

SECTION VII
Offshore Arctic – Stop or Go?

The offshore Arctic faces an extremely uncertain future given competition from new lower-cost resources.

- Two speed Arctic
  - Oil better than gas
  - Pacific better than Atlantic
  - Sub-Arctic/ice-free areas better than high-Arctic
  - Onshore better than offshore

- High costs and struggle for markets the main challenges
  - Increasing competition from new sources

- Infield Systems have identified 38 fields that could be on-stream by 2018 but only 7 are under development or have firm plan in place. A further 7 fields are likely to be sanctioned and are therefore classified as ‘probable.’
  - The 14 fields under development, firm plan or ‘probable’ hold only 7.6Bboe, 5.5% of offshore Arctic reserves
  - Around 3% of global resources to be on-stream pre-2018

- Primarily an exploration play
- Unconventional and deepwater resources will continue to hold back developments in offshore Arctic
- Piecemeal production growth unlikely to destabilise global oil and gas markets
- Long lead times: a decade until new production

Source: Infield Systems
Appendices

SECTION VIII
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