# Arctic Resource Potential and Development Challenges

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## **The Arctic**



### **Historical Perspective**

Industry has 90 years experience operating in Arctic conditions
Arctic offshore development platforms have all been in shallow water



Alaska Cook Inlet Steel Piled Jacket -- 1964



Sakhalin 1 Orlan GBS -- 2005



Photo source: Wikimedia Commons, Author: Edibobb

#### **Endicott Gravel Production Platform -- 1987**



Hibernia iceberg resistant GBS in the Grand Banks -- 1997

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#### **100m Contour Defines Beginning of Arctic "Deep Water"**



There are practical water depth limits for bottomfounded structures in Arctic conditions

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Beyond ~100m, floating or all-subsea systems are required

Technology extensions are needed for >100m

### **2008 USGS Circum-Arctic Resource Appraisal**

#### **Appraised Hydrocarbon Potential in 33 Geologic Provinces**



**USGS CARA Oil Assessment Map** 

240 BBOE already discovered in >400 fields north of the Arctic Circle

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25 provinces judged to have >10% probability of at least one significant undiscovered accumulation

**Assessed Undiscovered Potential:** 

- > 82 Billion barrels oil\* (12% of estimated world total)
- > 1663 TCF gas\* (30% of estimated world total)
- > 44 Billion barrels NGL (20% of estimated world total)

403 BBOE total\* (22% of estimated world total)

\* revised based on 2010 USGS re-assessment of Alaska NPR

## **How Much Oil in Arctic Deep Water?**



#### **Simple Projection**

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- Assumed uniform distribution • of oil within provinces
- **Computed fraction of area of** each province in >100m water
- Estimated undiscovered oil in >100m water depth
  - ~40 Billion Barrels
  - ~75% in 4 provinces:
- **Beaufort Sea-Canada Basin** 1.
- West Greenland-East Canada 2.
- 3. East Greenland
- **East Barents Basin** 4.

**Recent Deep Water Arctic Lease Areas** 

## **Potential for Economic Oil Accumulations**

#### 500 million to 1+ billion bbl minimum recoverable oil accumulation likely required for initial fields



- >400 discovered fields
- ~60 >500 MOEB
  - 12 of the 60 are Oil

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- 9 Supergiants (>5 GOEB)
  - 1 Oil (Prudhoe Bay)

### **Economic oil accumulations are possible!**

# High Cost-of-Supply for Arctic Hydrocarbons

- Lack of infrastructure
- Long distance from fabrication yards
- Supply chain complexity
- Short summer installation windows
- Inhospitable to labor force
- Need for icebreaking vessels
- Deep burial for subsea pipelines due to ice gouging



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# Ice Conditions in the Most Prospective Provinces



Province*	Key Challenges
East Greenland (3)	<ul> <li>near year-round pack ice</li> <li>high percentage multi-year ice</li> <li>icebergs embedded in pack ice</li> </ul>
Beaufort Sea-Canada Basin (1)	<ul> <li>limited open water season</li> <li>frequent ice intrusions</li> <li>exposure to multi-year ice</li> </ul>
W. Greenland – E. Canada (2)	<ul> <li>very large icebergs</li> <li>some multi-year ice</li> <li>icebergs embedded in pack ice</li> </ul>
East Barents Basin (4)	<ul> <li>pack ice in many years</li> <li>v. large icebergs in some years</li> </ul>

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\* Ordered by most challenging ice conditions

The highest oil prospectivity coincides with some of the most challenging ice conditions

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### **Complex Drift and Composition of Sea Ice**

#### **Requires high-confidence ice surveillance and drift forecasting capabilities**



30-day track of sea ice over a fixed position in the Beaufort Sea

![](_page_9_Picture_5.jpeg)

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Beaufort Sea Multi-Year Ice inclusion

# Oil Production and Export Technology Development

- Extended season drilling capability
- Specialized well control and oil spill response capabilities
- Subsea facilities to minimize surfacepiercing structures
- Deep trenching capability to protect export pipelines from ice
- Large icebreaking tankers and loading terminals in ice

![](_page_10_Picture_6.jpeg)

**E**x on Mobil

![](_page_11_Picture_0.jpeg)

# Summary

- Industry has long experience with onshore and shallow water development in Arctic conditions
- Potential exists for large oil accumulations in >100m water depth in the Arctic
- The highest oil prospectivity areas have very challenging ice conditions
- Multi-year ice is the most challenging physical feature
- The foremost technology hurdle is economic drilling of development wells
- Intensive technology development efforts are underway to extend safe, environmentally sound operations to more challenging Arctic areas

# Thank you!

![](_page_12_Picture_1.jpeg)

![](_page_12_Picture_2.jpeg)