Resources for the Future

National Petroleum Council Study

Arctic Potential

Realizing the Promise of U.S. Arctic Oil and Gas Resources

April 1, 2015

Study Teams

Study Committee, with members from 30 organizations

- 30 team members: 18 industry, 9 non-industry, 3 government

Coordinating Subcommittee, with participants from 20 organizations

- 23 team members: 7 industry, 9 non-industry, 4 government

Prudent Development led by Chevron

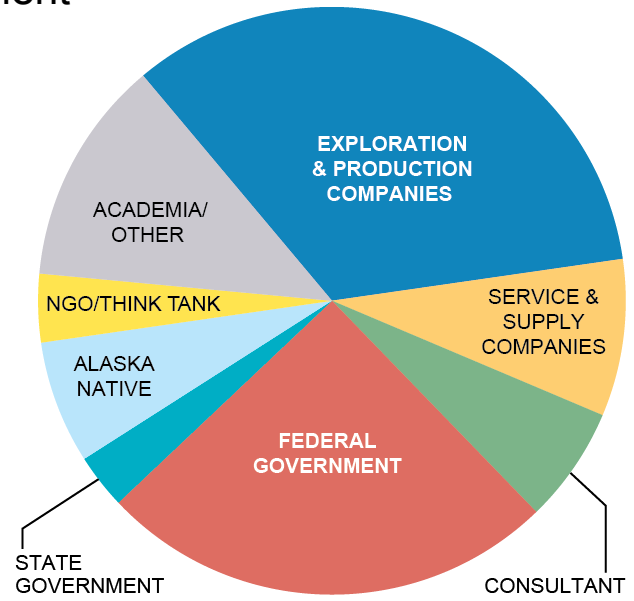
- 47 team members from 20 organizations

Technology and Operations led by ExxonMobil

- 110 team members from 53 organizations

Ecology & Human Environment led by Shell

- 21 team members from 13 organizations



Federal & Alaska Technology Workshops

- 111 participants from industry, government, native, academic, and NGO organizations

Key Findings

1. Arctic Oil and Gas Resources are Large and Can Contribute Significantly to Meeting Future U.S. and Global Energy Needs
2. The Arctic Environment Poses Some Different Challenges Relative to Other Oil and Gas Production Areas, But is Generally Well Understood
3. The Oil and Gas Industry Has a Long History of Successful Operations in Arctic Conditions Enabled by Continuing Technology and Operational Advances
4. Most of the U.S. Arctic Offshore Conventional Oil and Gas Potential Can Be Developed Using Existing Field-Proven Technology
5. The Economic Viability of U.S. Arctic Development is Challenged by Operating Conditions and the Need for Updated Regulations that Reflect Arctic Conditions
6. Realizing the Promise of Arctic Oil and Gas Requires Securing Public Confidence
7. There Have Been Substantial Recent Technology and Regulatory Advancements to Reduce the Potential for and Consequences of a Spill

The Arctic Environment

The Arctic Environment Poses Some Different Challenges Relative to Other Oil and Gas Production Areas, but is Generally Well Understood

- The Arctic has been studied for many years by industry, government, and academia, and much is known about the physical, biological, and human environment
- Key characteristic distinguishing the Arctic is ice: ice type, water depth, open water season
- Experiences from other remote and challenging oil and gas areas applicable
- The climate is changing and there are additional information / monitoring opportunities, such as interaction of key species with oil and gas activities

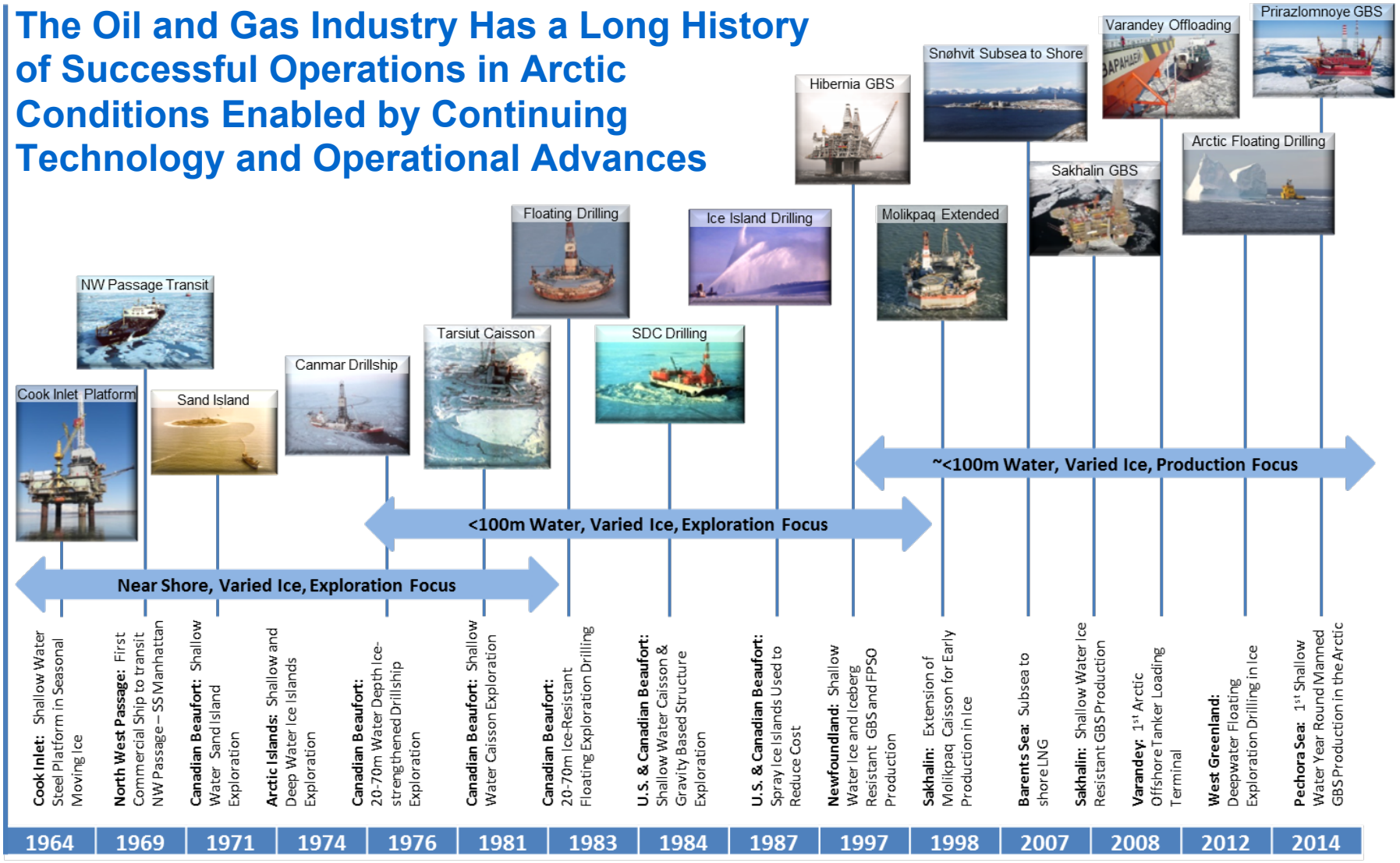
First-year ice with numerous pressure ridges

Multi-year ice ridge in the Canadian Beaufort Sea

Iceberg, ~ 200 meters across, in open water

Long History, Enabled by Technology Advances

The Oil and Gas Industry Has a Long History of Successful Operations in Arctic Conditions Enabled by Continuing Technology and Operational Advances



Most U.S. Arctic Offshore is Developable Today

Most of U.S. Arctic Offshore Conventional Oil and Gas Resources Can Be Developed Using Existing Field-Proven Technology

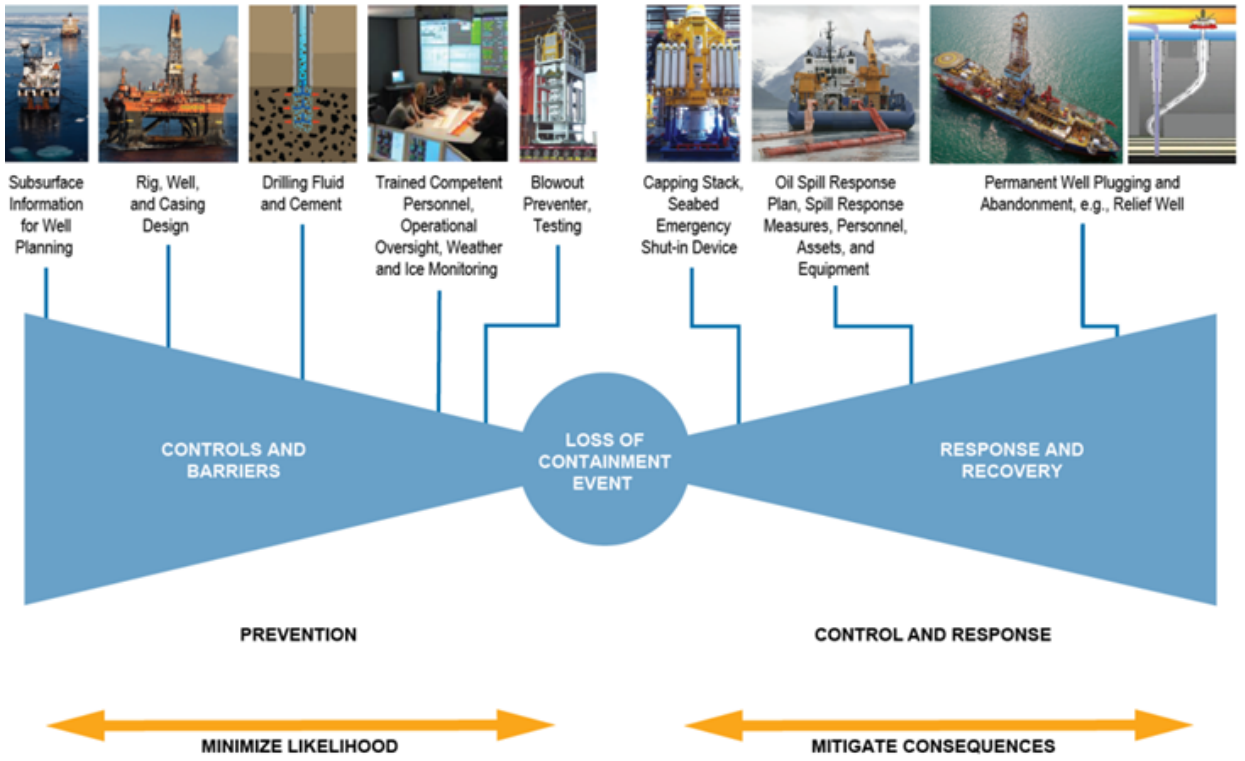
Increasing Complexity to Explore & Develop

Physical Ice Environment and Water Depth		Technology to Explore & Develop
Description	**Examples**	
Typically ice free, any water depth - *Minor first year ice intrusions, icebergs possible*	- South Barents Sea - Newfoundland	**Exploration & development proven** (Various drilling rigs, floating solutions, GBS, subsea tieback)  Snøhvit Subsea  Hibernia GBS
Any ice conditions, near shore & shallow water - *~<15m water*	- Globally, near shore (including US Beaufort and Chukchi Seas)	**Exploration & development proven** (Ice & gravel islands, concrete & steel structures, extended reach drilling from onshore)  Spray Ice Island  Northstar
Open water > ~2 months, any water depth - *Mainly first year ice, potential for combination of multi-year ice, icebergs and ice islands* - *Water depth determines development concept (greater or less than ~100m is key)*	- Sea of Okhotsk - Pechora Sea - Labrador Sea - US Chukchi & Beaufort Seas - South Kara Sea	**Exploration proven; development proven mainly in ~<100m water** Ice management required ~<100m development by GBS ~>100m development by floating drilling & subsea tieback  Canmar Drillship  Sakhalin-2 GBS
Open water <~2 months, any water depth - *Likely to encounter multi-year ice and/or icebergs, and in some locations ice islands* - *Water depth determines development concept, (greater or less than ~100m is key)*	- Deepwater Beaufort Sea - Deepwater Northern Russian Arctic Seas	**Exploration & development possible with technology improvements** Increased ice management capability and possible new technology
Limited to no open water - *Frequent multi-year ice with embedded icebergs, and ice islands*	- North East Greenland - Deepwater Northern Russian Arctic Seas	**Technology extensions or new technology required** Floating, robust ice managed solutions GBS / Subsea technology extensions or new technologies Difficult to mobilize equipment without open water season

Well Control Technology Improvements

There Have Been Substantial Recent Technology and Regulatory Advancements to Reduce the Risk and Consequences of a Spill

- The greatest reduction of environmental risk comes from preventing a spill
- Recently developed control and mitigation technologies should be assessed



Environmental Stewardship

The NPC recommends:

- Industry and regulators should work together to perform the analysis, investigations and any necessary demonstrations to validate technologies for improved well control
- Government agencies should participate in ongoing and future industry collaborative research programs for oil spill response in ice, such as the Arctic Response Technology Joint Industry Programme that has been underway since 2012
- Regulators should continue to evaluate oil spill response technologies in Arctic conditions, and all spill response technologies should be pre-approved to enable selection of the appropriate response technology to achieve the greatest reduction in environmental impacts

Subsea Isolation Device

Capping Stack

Environmental Stewardship, continued

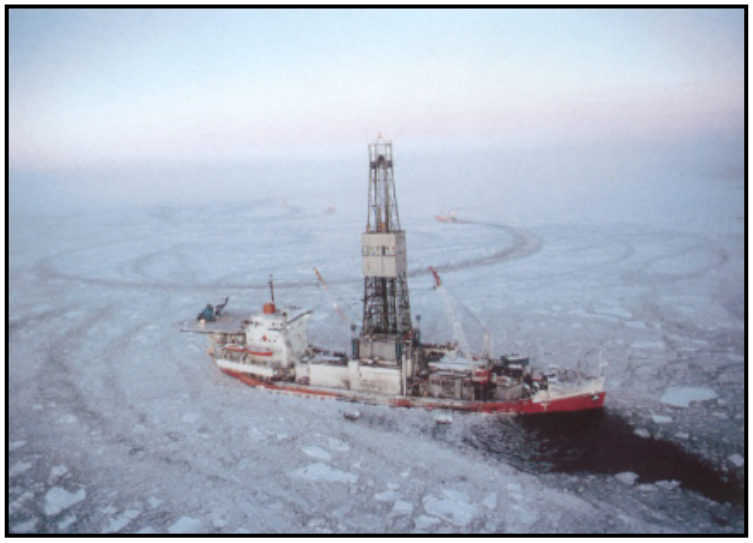
The NPC recommends:

- Long term population estimates and understanding of the interactions of key species with oil and gas activities should be enhanced, to improve efficiency of exploration and environmental stewardship
- Collaboration and coordination of ecological and human environment research should be improved
- An updated Socioeconomic Impact Assessment protocol is needed

Economic Viability

Considering economic viability, the NPC recommends:

- Industry, government, and regulators should perform the analysis, investigations and necessary demonstrations to validate technologies / capabilities to safely extend the drilling season
- The Department of Energy and the Department of the Interior should assess the timelines to progress an offshore exploration and development program, compared with current U.S. lease durations and practices in other jurisdictions
- Policies, regulations, and implementation practice should encourage innovation and enable use of technology advances



Government Leadership and Policy Coordination

Considering domestic leadership and policy coordination, the NPC recommends:

- The Arctic Executive Steering Committee should reaffirm U.S. commitment to prudent Arctic oil and gas development, assess alignment across federal agencies, and clarify the process by which it will collaborate with Alaskans
- The Arctic Executive Steering Committee as part of its mandated gap analysis should request regulators to compile a comprehensive and integrated inventory of regulatory requirements, and assess the interagency working group for lessons learned and improvement opportunities
- The Department of Energy should designate a senior advisor to support DOE's representative on the Arctic Executive Steering Committee and be a focal point for Arctic policy

Considering the Arctic Council, the NPC recommends:

- As Arctic Council members implement the two international agreements on search and rescue (2011) and on oil pollution preparedness and response (2013), the U.S. government should engage with the energy industry on response exercises
- The U.S. government should strengthen the Arctic Economic Council's interaction and engagement with the Arctic Council

Part 1 – Prudent Development

- Arctic Resource Potential/History of Operations
- Development Potential and Challenges
- Implementation of U.S. Strategy for the Arctic Region
- Policy and Regulatory Opportunities to Promote Prudent Development

Part 2 – Technology and Operations

- Characterization/Measurement of Ice Environment
- Offshore Exploration and Development Technology
- Logistics and Infrastructure
- Offshore Oil Spill Prevention, Control, and Response

Part 3 – The Environment

- The Ecological Environment
- The Human Environment

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