

TOPIC PAPER #7

GLOBAL ACCESS TO OIL AND GAS

On July 18, 2007, The National Petroleum Council (NPC) in approving its report, *Facing the Hard Truths about Energy*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the Task Groups and their Subgroups. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached Topic Paper is one of 38 such working document used in the study analyses. Also included is a roster of the Subgroup that developed or submitted this paper. Appendix E of the final NPC report provides a complete list of the 38 Topic Papers and an abstract for each. The printed final report volume contains a CD that includes pdf files of all papers. These papers also can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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Global Access to Oil and Gas Resources

For many reasons including the preservation of wildlife habitat or fragile ecosystems and public policies to further domestic economic and energy security goals, governments around the globe, including the United States, have reduced access to oil and natural gas resources.

Potentially adverse implications of reduced access to global oil and gas resources include foregone energy resources, foregone revenues to government, reduced oil and natural gas recovery efficiency due to actions that may constrain the rapid transfer and deployment of more advanced technologies, and uncertainty for investors. Counterpoints raised by some analysts suggest that reduced access accurately reflects competing public priorities.¹

Experience around the globe has shown that providing access to energy resources, particularly in remote and geologically or environmentally challenging settings, can sometimes be a compelling driver for the development of more efficient, more environmentally-benign oil and gas recovery and delivery technologies.² Yet, nations with the largest share of the world's remaining oil and gas resources may have the greatest challenges or opportunities in achieving energy for sustainable development.

Volume of Oil and Gas Resources with Access Restrictions

Estimates of the volume of oil and natural gas resources to which access for exploration and development is limited are fragmented. Often studies provide estimates that focus on specific geographic regions or topics. Nonetheless, in aggregate, such estimates provide useful information for understanding how nations manage their oil and gas resource endowments. The United States is illustrative of a nation with a maturing resource base and a complex legal and regulatory framework governing energy development within its borders.

United States Onshore

A comprehensive review³ of oil and natural gas resources managed by the federal government ("federal lands") within 11 geologic provinces across the United States conducted by the U.S. Departments of the Interior, Agriculture and Energy as mandated by the Energy Policy and

World Oil and Gas Resources: Access in Perspective

- Today over 60% of proven conventional world oil reserves (~ 600 BBbls) are held by national oil companies.
- Over half of the top 20 oil and gas producers worldwide are national oil companies or newly privatized national oil companies.
- Up to 97% of oil (20 BBbls) and 87% of natural gas (162 Tcf) resources beneath federal lands onshore in the United States have significant access restrictions.
- Marginal wells produce over 17% of oil (31million barrels per day) and 9% (1.7 Tcf per day) of natural gas onshore in the United States.
- Over 30 BBbls of oil and 134 Tcf of natural gas resources in offshore waters of North America (U.S. and Canada) are in moratoria areas inaccessible for leasing and development.
- Of these offshore resources, about 18 BBbls of oil and 76 Tcf of natural gas in the U.S. Outer Continental Shelf (OCS) areas are currently off limits to leasing and development.

Conservation Act of 2000 and the Energy Policy Act of 2005 showed that up to 97 percent of oil resources (20.5 billion barrels) and 87 percent of natural gas resources (161.6 trillion cubic feet)⁴ that lie beneath onshore federal lands have restrictions beyond standard lease terms or are entirely off-limits to development. These 11 areas encompass 99 million acres of federal lands and contain an estimated 21 billion barrels of oil and 187 trillion cubic feet of natural gas, or an estimated 76 percent of total onshore oil and gas resources under federal lands in the United States.

A Phase I inventory included the Uinta-Piceance, Paradox/San Juan, Powder River, and Greater Green River Basins and the Montana Thrust Belt. A Phase II inventory included Northern Alaska (the National Petroleum Reserve in Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR) Section 1002 only); Wyoming Thrust Belt, Denver Basin, Florida Peninsula, Black Warrior Basin, and Appalachian Basin. The ANWR coastal plain is estimated to contain 45 percent (7.7 billion barrels of oil) of the total estimated 17 billion barrels of oil in northern Alaska and is inaccessible. The other 55 percent is located in the NPR-A which has limited access. These efforts to more fully understand the impacts of federal land management decisions on access to oil and natural gas resources in the United States began with a 1999 National Petroleum Council study.⁵

All oil and gas leases on federal land, including those issued with only the standard lease terms, are subject to full compliance with all environmental laws and regulations. These laws include, but are not limited to, the National Environmental Policy Act, Clean Water Act, Clean Air Act, Endangered Species Act, and National Historic Preservation Act. While compliance with these laws may delay, modify, or prohibit oil and gas activities, federal land managers perceive these laws represent the values and bounds Congress believes appropriate to their stewardship of these lands.⁶

Federal stewardship of mineral leases provides revenue from bonuses, rents and royalties. In 2006, the Department of the Interior collected \$9.8 billion in oil and gas revenues onshore and offshore with these monies disbursed to American Indian Tribes and Allottees (4%), Bureau of Reclamation water projects in 17 western states (11%), states (15%) and the U.S. Treasury's general fund (70%).⁷

Figure 1. U.S. Onshore Oil and Gas Resources with Access Restrictions – Federal Lands

Study Area	Area		Undiscovered Technically Recoverable Resources			
	Acres (x1000)		Oil (Million Barrels)		Gas Bcf	
Inaccessible or With Restrictions	75,452	76%	20,473	97%	161,647	87%
Standard Lease Terms	23,751	24%	743	3%	25,210	13%
Total	99,203	100%	21,216	100%	186,857	100%

Source: DOI, DOA and DOE, 2006.

ANWR

The Alaska National Interest Lands Conservation Act of 1980 established the Arctic National Wildlife Refuge (ANWR). In Section 1002 of the Act, Congress deferred a decision regarding the future management of the 1.5 million acre coastal plain (“1002 Area”), in recognition of this area’s significant potential for oil and natural gas resources, along with its significance as wildlife habitat. The U.S. Congress continues to debate the issue of whether to open this portion of ANWR to oil and gas leasing and exploration and eventually possible development if economic oil and gas resources are discovered. Using the USGS estimates for mean and high undiscovered crude oil resources in the 1002 Area, the potential energy and economic impacts are shown below.⁸

Figure 2. Estimated Production, Federal Royalties, and Federal Tax Revenues Associated with the Leasing and Development of the ANWR 1002 Area

	<u>2020</u>	<u>2025</u>	<u>2030</u>	<u>Cumulative by 2030</u> <u>(Million Barrels)</u>
Production Rate (1000 Bbl/Day)⁹				
ANWR 1002 Mean	539	723	576	3,034
ANWR 1002 High	741	1,175	1,092	4,812
				<u>Cumulative by 2030</u> <u>(Million 2006 \$)</u>
Federal Royalties (Million 2006 \$)				
ANWR 1002 Mean	\$1,487	\$1,993	\$1,587	\$22,922
ANWR 1002 High	\$2,044	\$3,240	\$3,012	\$36,353
Federal Income Taxes (Million 2006 \$)				
ANWR 1002 Mean	\$1,372	\$1,583	\$1,346 ¹⁰	\$19,014
ANWR 1002 High	\$1,987	\$2,886	\$2,840	\$33,801

Source: ARI, 2006.

United States Marginal Wells/Existing Fields

In 2005, over 17 percent of oil and 9 percent of natural gas produced onshore in the United States (over 321 million barrels of oil per day and 1.7 Tcf of natural gas per day) came from marginal oil and gas wells. The nation has over 400,000 marginal oil wells (each producing 10 barrels or less of oil per day, or on average 2.2 barrels per day) and almost 290,000 natural gas wells (each producing 60 thousand cubic feet (Mcf) or less of natural gas per day as defined by the Interstate Oil and Gas Compact Commission, or 75 Mcf or less of natural gas per day as defined by the Internal Revenue Service for tax purposes). Without these wells, it has been estimated that U.S. imports would increase by nearly 7 percent to make up for the shortage.¹¹ Increasing operational and regulatory costs and diminishing access to markets via pipelines are key factors that can contribute to the premature abandonment of marginal wells. When wells and fields are prematurely abandoned, the associated oil and gas resources may never be recovered due to economics, lease

termination and related issues. Access to existing fields provides the opportunity to deploy new technologies to enhance the ultimate recovery of oil and gas from these fields.

Over 60% of U.S. technically recoverable oil resources and 66% of U.S. technically recoverable natural gas resources lie beneath state, Tribal and private lands.¹² Over the past several decades, urban growth, competing land uses, and changing public values have placed ever increasing constraints on existing and new oil and gas development. Industry has been continually challenged to develop and deploy new technologies that are compatible with widely varying geologic, geographic, environmental and cultural settings. At the same time, oil and gas production from these lands has generated considerable earnings for private royalty owners and tax authorities.

North America Offshore

Over 30 billion barrels of undiscovered technically recoverable oil resources and 134 Tcf of undiscovered technically recoverable natural gas resources in offshore waters of North America (specifically the U.S. and Canada) are in moratoria areas precluded by law or public policy from leasing and development. Of these resources, about 18 billion barrels of oil and 76 Tcf of natural gas in the U.S. Outer Continental Shelf (OCS) areas are currently off limits to leasing and development. There is significant uncertainty in resource estimates for those areas of the OCS subject to long-standing moratoria or presidential withdrawal. In areas like the north, mid-, and south Atlantic, most of the west coast, and portions of the eastern Gulf of Mexico, the last acquisition of geophysical data and drilling of exploration wells occurred more than 25 years ago and in some cases nearly 40 years ago. At that time, there were a few prospective discoveries and numerous indications of potential for the occurrence of oil and gas. However, in areas that have undergone leasing and development, estimates of hydrocarbon resources have tended to grow over time.

Figure 3. U.S. and Canada Offshore Oil and Natural Gas Resources in Moratoria Areas

	Undiscovered Technically Recoverable Resources	
	Oil (Billion Barrels)	Gas (Tcf)
United States – Federal OCS	17.84	76.47
Gulf of Mexico	3.65	22.46
Atlantic	3.82	36.99
Pacific	10.37	18.02
United States – Other	1.38	6.78
Great Lakes	.43	5.23
State Waters	.95	1.55
Canada	10.86	51.10
Northern Canada	.10	4.00
Nova Scotia	1.06	5.30
British Columbia	9.80	41.80
Total in Moratoria Areas	30.08	134.25

Source: DOI (MMS and USGS) and IOGCC.¹³¹⁴ Oil includes natural gas liquids. Does not include resources in areas already under lease.

Discussion among policy makers continues regarding the merit of opening OCS moratoria areas, including concepts for sharing federal royalty revenues with coastal states. Estimates developed in 2006 showed that the potential energy and economic benefits of increasing access to oil and gas resources in OCS moratoria areas could be substantial¹⁵:

- By 2025, U.S. crude oil production could increase by over 1.0 million barrels per day, and U.S. natural gas production could increase by nearly 1.4 trillion cubic feet (Tcf) per year.
- Cumulatively, nearly 2.8 billion barrels of crude oil and 12 Tcf of natural gas would be produced between now and 2025 – production that would not be realized if the existing moratoria were continued.
- The oil and gas industry would spend \$98 billion dollars in the U.S. by 2025 to develop these resources.
- Between now and 2025, the U.S. trade imbalance would be reduced by \$145 billion if this domestically produced crude oil serves to offset imports on a one-to-one basis.
- The U.S. would collect an additional \$41 billion in royalties by 2025 from OCS production.¹⁶
- An additional \$28 billion in federal income taxes would be collected from OCS production between now and 2025.
- The economic activity generated by this development would result in the addition of as many as 130,000 direct domestic, high-paying jobs.

Figure 4.

Estimated Energy Supply and Economic Benefits from OCS Moratoria Areas
Assuming MMS Mean Resource Estimates and the January 2006 CBO Price Forecast
(All Estimates in 2006 Dollars)

Moratoria Area	Incremental Production by 2025		Cumulative Production through 2025		Cumulative Investment to 2025	Value of Avoided Oil Imports to 2025	Cum. Federal Royalties to 2025	Cum. Federal Inc. Taxes to 2025	Maximum Direct Jobs	Maximum Total Jobs
	Crude Oil	Natural Gas	Crude Oil	Natural Gas						
	(MMB/day)	(Bcf/year)	Million Bbl	(Bcf)	(Million \$)	(Million \$)	(Million \$)	(Million \$)		
Alaska - N. Aleutian Basin	0.02	45	89	601	\$2,681	\$4,671	\$1,642	\$1,132	2,221	8,576
Atlantic Offshore	0.17	392	400	2,717	\$19,238	\$21,095	\$7,423	\$5,115	25,447	57,860
Eastern Gulf of Mexico	0.20	370	488	2,564	\$21,099	\$25,736	\$7,977	\$5,490	40,820	76,039
Central Gulf of Mexico	0.15	286	650	3,785	\$18,432	\$34,273	\$11,149	\$7,684	19,020	79,440
<u>Pacific Offshore</u>	<u>0.47</u>	<u>300</u>	<u>1,132</u>	<u>2,078</u>	<u>\$36,714</u>	<u>\$59,697</u>	<u>\$12,937</u>	<u>\$8,865</u>	<u>54,561</u>	<u>212,306</u>
All Moratoria Areas	1.01	1,394	2,758	11,746	\$98,163	\$145,472	\$41,128	\$28,285	130,634	328,984

Pace of Leasing and Development in Moratoria Areas

Perspectives vary on whether moratoria areas represent a strategic energy asset. Nonetheless, the lead time for the leasing and development of oil and gas resources in moratoria areas if access were eventually provided may be lengthy. For example, assumptions in the above analysis were that: 1) it would take three years between the year of first leasing and the year of first production, 2)

a reasonably functioning offshore leasing program would be established in a region by the time leasing begins (similar to that currently in place in the Gulf of Mexico), and 3) that all litigation regarding leasing has been resolved. When leasing would begin in each region was varied, either 2007 or 2012.

The assumed pace of development, e.g., the pace at which the economic resource in the region would be converted into proved reserves, also varied by region, based on the size of the resource in the region and the leasing history in the region. These assumptions are summarized below:

	Number of Years to Fully Develop Economic Resources
Aleutian Basin	15 years
Atlantic OCS	25 years
New Central GOM	15 years
Eastern GOM	20 years
Pacific OCS	30 years

For all regions, the timing of production was estimated assuming a reserves-to-production ratio of 8-to-1 for crude oil and 6-to-1 for natural gas. This was based on the average ratios for the Federal offshore Gulf of Mexico for the last ten years.

Arctic Oil and Gas Resources

The Arctic has a large oil and gas resource potential. Various countries, companies and consultancies have begun to assess the Arctic resource and production potential, with one firm projecting production from five Arctic nations (Russia, Norway, Greenland, Canada and the United States-Alaska) will contribute some 3 million barrels of oil equivalent (BOE) per day liquids and 5 million BOE of gas at peak.¹⁷ USGS assessments have addressed only a few Arctic basins, specifically basins in Russia, Greenland, Canada and the United States-Alaska) identifying undiscovered technically recoverable resources of about 176 billion barrels of oil and 1,179 Tcf of natural gas. More assessments are underway¹⁸

Challenges for exploration, production and delivery of these remote resources, onshore and offshore, have been and will in the future be substantial, requiring advanced technology, new infrastructure, and corporate responsible development that respects this unique environment and the more than 50 diverse groups of indigenous peoples that consider this rugged terrain their homeland.¹⁹ Under a treaty known as the United Nations Convention on the Law of the Sea, not yet ratified by the United States, territory is determined by how far a nation's continental shelf extends into the sea. Russia was the first in 2001 to stake claim to large portions of the Arctic Ocean. Several countries have initiated mapping expeditions to support expanding their territories. And, bilateral disputes regarding Arctic territory continue to emerge.

The Arctic Council is a high level forum for cooperation, coordination and interaction between Arctic governments (Canada, Denmark - including Greenland and the Faroe Islands, Finland, Iceland, Norway, Russia, Sweden and the United States), indigenous communities and other Arctic residents.²⁰ Council activities of note to oil and gas include the Arctic Marine Protection Working Group and the Arctic Monitoring and Assessment Program which plans in 2007 to release an *Assessment of Oil and Gas Activities in the Arctic*.²¹

Regulatory and Policy Frameworks

Forecasts can overestimate production potential by not accounting for permitting delays, lease restrictions or other government policies that constrain the pace or extent of development. Conversely, forecasts can underestimate production potential by not accounting for resources in moratoria areas.

Delays associated with obtaining permits and other government approvals for the siting and operation of energy projects can be substantial²² sometimes due to government inefficiency, overly complex or burdensome regulation, or public opposition. Such delays pose risks and uncertainties for project developers that may discourage investments in relatively high-risk ventures.

In the United States, progress in regulatory streamlining has oft times been countervailed by increasingly complex regulatory requirements. As such, many states have begun to recognize the value of supportive public policies that enable both resource development and environmental stewardship.²³

Internationally, greater emphasis is being placed on environmentally responsible development and sustainable development as these concepts relate to supply. Over the past decade, corporate policies and increasing public, shareholder and government expectations have made it necessary and sometimes advantageous for companies to address societal and environmental issues as part of a comprehensive business strategy.

Quantitative performance measurement has proven enormously valuable in fields such as economics, health care management, and education, where policies are driven by indicators such as the unemployment rate, infant mortality, and standardized test scores. While lagging behind these other domains, policymakers in the environmental field have also begun to recognize the importance of data and analysis for decision making. In 2006, the Center for Environmental Law & Policy at Yale University and the Center for International Earth Science Information Network (CIESIN) at Columbia University in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission, introduced the *Pilot 2006 Environmental Performance Index (EPI)* as a means to benchmark the environmental and natural resource management performance of individual nations.²⁴ The EPI centers on two broad environmental protection objectives: 1) reducing environmental stresses on human health and 2) protecting ecosystem vitality. These goals mirror the priorities expressed by some policymakers, most notably the environmental dimension of the United Nations' Millennium Development Goals. Aspects of the EPI scoring relative to energy sector environmental performance are limited.²⁵ However, the tool provides insights on the current range of performance among countries. See Figure 5. Similar indices for monitoring the progress of energy for sustainable development have been developed by the IEA.²⁶

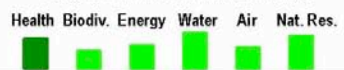
By EPI rank, the top world oil or gas reserves holders²⁷ on the chart are: Canada (8), United States (28), Russia (32), Brazil (34), Venezuela (44), United Arab Emirates (47), Iran (53), Saudi Arabia (59), and Kazakhstan (70). If expanded to top 20, would for natural gas also include Turkmenistan (104), Indonesia (79), Norway (18), China (94), Malaysia (9), Uzbekistan (105), Egypt (85), Canada (8) and Libya (not rated). Additions for oil would include Nigeria (123), Qatar (not rated), Mexico (66), Algeria (63), Angola (128), and Azerbaijan (95).

Pilot 2006 Environmental Performance Index

Overall EPI Scores (0–100)

Rank	Country	EPI Score	Policy Categories*	Rank	Country	EPI Score	Policy Categories*	Rank	Country	EPI Score	Policy Categories*
1	New Zealand	88.0		47	Unit. Arab Em.	73.2		93	Kenya	56.4	
2	Sweden	87.8		48	Suriname	72.9		94	China	56.2	
3	Finland	87.0		49	Turkey	72.8		95	Azerbaijan	55.7	
4	Czech Rep.	86.0		50	Bulgaria	72.0		96	Papua N. G.	55.5	
5	Unit. Kingdom	85.6		51	Ukraine	71.2		97	Syria	55.3	
6	Austria	85.2		52	Honduras	70.8		98	Zambia	54.4	
7	Denmark	84.2		53	Iran	70.0		99	Viet Nam	54.3	
8	Canada	84.0		54	Dom. Rep.	69.5		100	Cameroon	54.1	
9	Malaysia	83.3		55	Philippines	69.4		101	Swaziland	53.9	
10	Ireland	83.3		56	Nicaragua	69.2		102	Laos	52.9	
11	Portugal	82.9		57	Albania	68.9		103	Togo	52.8	
12	France	82.5		58	Guatemala	68.9		104	Turkmenistan	52.3	
13	Iceland	82.1		59	Saudi Arabia	68.3		105	Uzbekistan	52.3	
14	Japan	81.9		60	Oman	67.9		106	Gambia	52.3	
15	Costa Rica	81.6		61	Thailand	66.8		107	Senegal	52.1	
16	Switzerland	81.4		62	Paraguay	66.4		108	Burundi	51.6	
17	Colombia	80.4		63	Algeria	66.2		109	Liberia	51.0	
18	Norway	80.2		64	Jordan	66.0		110	Cambodia	49.7	
19	Greece	80.2		65	Peru	65.4		111	Sierra Leone	49.5	
20	Australia	80.1		66	Mexico	64.8		112	Congo	49.4	
21	Italy	79.8		67	Sri Lanka	64.6		113	Guinea	49.2	
22	Germany	79.4		68	Morocco	64.1		114	Haiti	48.9	
23	Spain	79.2		69	Armenia	63.8		115	Mongolia	48.8	
24	Taiwan	79.1		70	Kazakhstan	63.5		116	Madagascar	48.5	
25	Slovakia	79.1		71	Bolivia	63.4		117	Tajikistan	48.2	
26	Chile	78.9		72	Ghana	63.1		118	India	47.7	
27	Netherlands	78.7		73	El Salvador	63.0		119	D. R. Congo	46.3	
28	United States	78.5		74	Zimbabwe	63.0		120	Guin.-Bissau	46.1	
29	Cyprus	78.4		75	Moldova	62.9		121	Mozambique	45.7	
30	Argentina	77.7		76	South Africa	62.0		122	Yemen	45.2	
31	Slovenia	77.5		77	Georgia	61.4		123	Nigeria	44.5	
32	Russia	77.5		78	Uganda	60.8		124	Sudan	44.0	
33	Hungary	77.0		79	Indonesia	60.7		125	Bangladesh	43.5	
34	Brazil	77.0		80	Kyrgyzstan	60.5		126	Burkina Faso	43.2	
35	Trin. & Tob.	76.9		81	Nepal	60.2		127	Pakistan	41.1	
36	Lebanon	76.7		82	Tunisia	60.0		128	Angola	39.3	
37	Panama	76.5		83	Tanzania	59.0		129	Ethiopia	36.7	
38	Poland	76.2		84	Benin	58.4		130	Mali	33.9	
39	Belgium	75.9		85	Egypt	57.9		131	Mauritania	32.0	
40	Ecuador	75.5		86	Côte d'Ivoire	57.5		132	Chad	30.5	
41	Cuba	75.3		87	Cen. Afr. Rep.	57.3		133	Niger	25.7	
42	South Korea	75.2		88	Myanmar	57.0					
43	Jamaica	74.7		89	Rwanda	57.0					
44	Venezuela	74.1		90	Romania	56.9					
45	Israel	73.7		91	Malawi	56.5					
46	Gabon	73.2		92	Namibia	56.5					

* This column contains sparklines for each of the 6 EPI policy categories showing the relative strengths & weaknesses for each country.



Global Access and National Oil Companies

New players continue to emerge in international energy markets. Significant discussion surrounds the evolving role of government-controlled oil or gas companies, commonly known as national oil companies (NOCs). Such discussion includes NOCs with diminishing or expanding production, those more or less adept in utilizing technology to increase the efficient or ultimate recovery of a given country's oil and gas assets, those positioning as competitors to IOCs, and NOCs or countries that represent current and potential upstream and midstream investment opportunities for IOCs and service companies. The role of NOCs can vary from being a commercial firm to being an instrument of government social, economic or foreign policy.

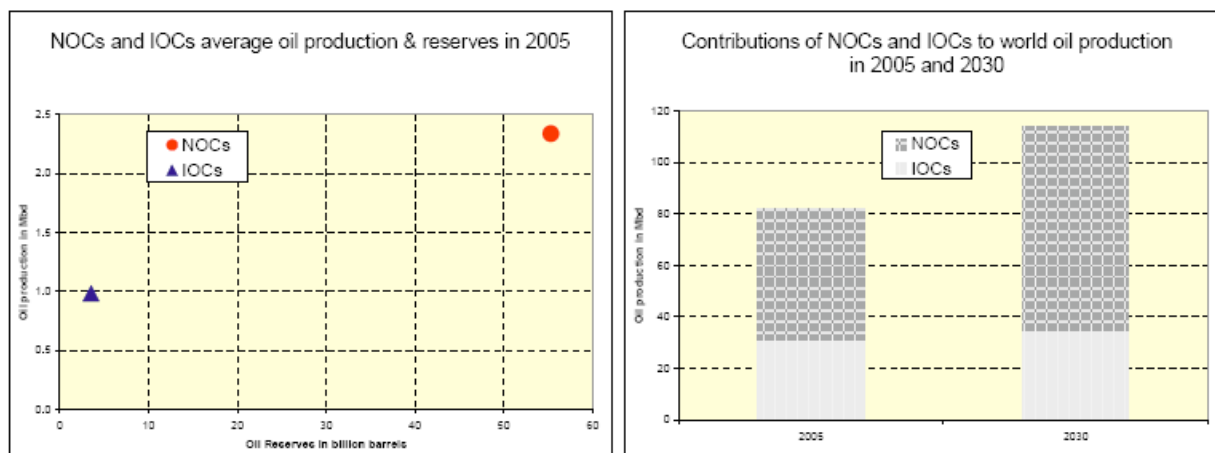
NOCs have national goals that go beyond maximizing the return on capital to shareholders. These may include: wealth creation for the nation; industrialization and economic development; security of energy supply, and foreign and strategic policy and alliance building. National priorities NOC can interfere with the ability of NOCs to: maximize the value of oil and gas resources; replace reserves; expand production; and perform in a technically efficient manner. The challenge of meet rising energy demand in the face of other pressing national priorities is prompting many NOCs to reevaluate and adjust their business strategies. Their choices will have significant consequences for the international oil and gas market.²⁸

IOCs are also refining their business strategies and moving away from their traditional roles of full equity developers of oil and gas fields, to pursuing a variety of commercial arrangements with host countries and governments that range from full equity interest to partial equity sharing and fee-for-services. Shrinkage of equity oil and gas owned by IOC's has been substantial. In the 1960s, 85% of global oil and gas reserves was reportedly fully open to IOCs equity participation, 14% was held by Soviet Russia, and NOCs controlled less than 1%. This situation has now reversed.²⁹ As illustrated below, over 60 to nearly 80 percent of world proved oil reserves are now in countries that have NOCs or have established substantial restrictions on foreign investment and activity in the oil and gas energy sector.³⁰

Decreasing access to world oil and gas reserves has impaired the ability of IOCs to replace reserves. Ranked on the basis of oil and gas reserve holdings, 14 of the top 20 upstream oil and gas companies in the world are national oil companies or newly privatized national oil companies, according to an annual survey of Petroleum Intelligence Weekly (PIW). State monopolies represent the top 10 reserve holders internationally, not reflecting the significant oil sands resources in Canada. In terms of world oil production, however, only six of the top firms are national oil companies.³¹ Today, NOCs hold reserves equal to more than 10 times those of IOCs, whereas production from NOCs represent only 2.3 times the output from IOCs. The International Energy Agency's WEO 2006 forecast shows the contribution of NOCs to increase substantially by 2030.³²

From the perspective of some analysts, the development of unconventional oil and gas resources (e.g., oil sands, coalbed methane and shales) presents unique opportunities for IOC's with technology, capital and expertise that cannot be deployed in nations whose oil and gas development are strictly controlled by NOCs. In IEA and EIA forecasts, non-conventional oil plays a larger role in future oil supply, growing from 2% today to as much as 12% in 2030 under the reference cases.³³

Figure 6. Estimated NOC and IOC Oil Production and Reserves



Source: IEA 2007.

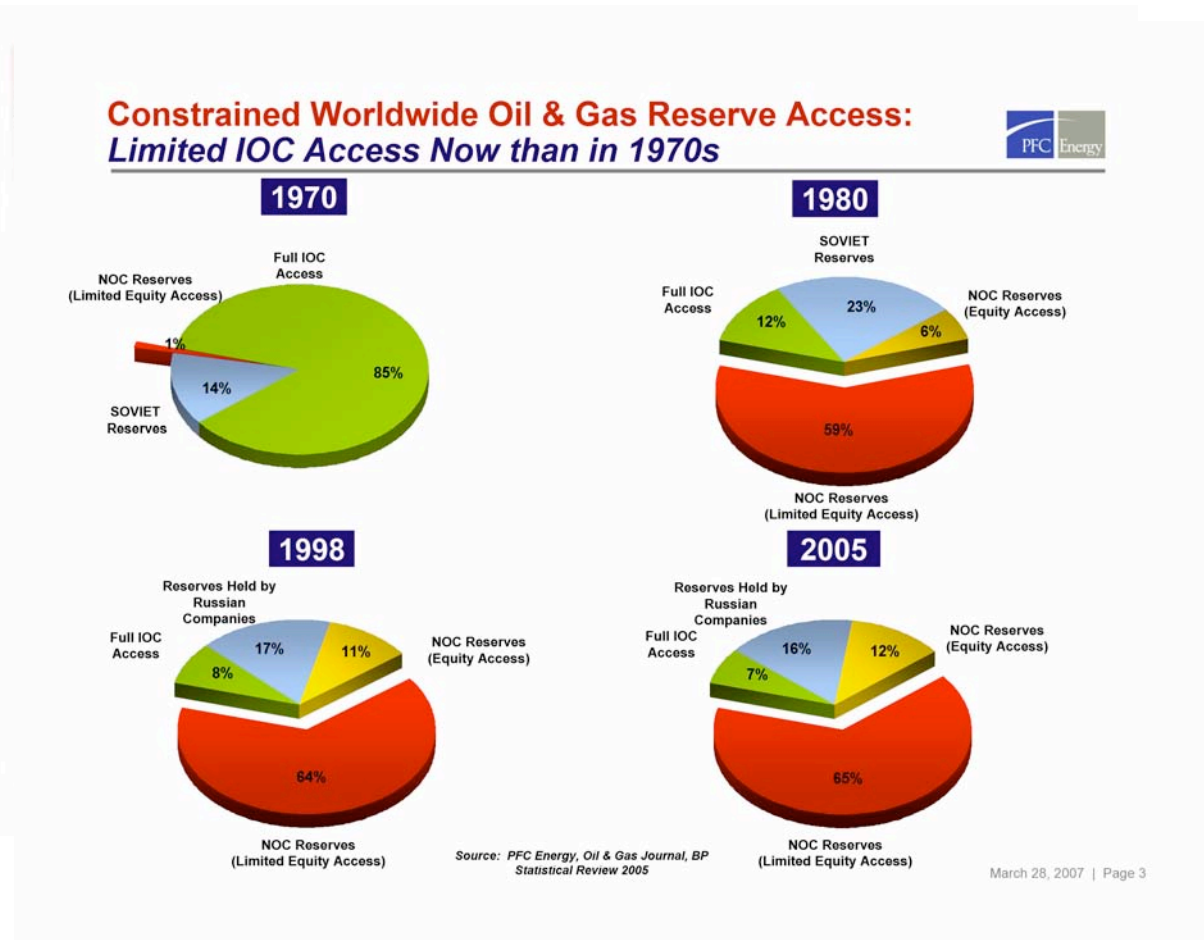
Figure 7. Global Access to Proved Conventional Oil Reserves

Today						1960s
IEA 2006	Proved Oil Reserves B bbl	%	PFC Energy	%	Proved Oil Reserves B bbl	Proved Oil and Gas Reserves %
NOC only	478.41	37%	NOC (No Equity Access)	77%	883.96	1%
Limited Access (NOC dominant)	168.09	13%				
Iraq	116.37	9%				
Concession	387.90	30%	NOC (Equity Access)	11%	126.28	85%
Production Sharing	142.23	11%	Full IOC Access	6%	68.88	
			Reserves Held by Russian Companies	6%	68.88	14%
Totals	1,293.00	100%	Totals	100%	1,148.00	100%

Source: IEA and PFC Energy, 2006, and Ellsworth and Vikas, 2007.

Also see Britt Dearman (Apache), *Topic Report: Access to Global Oil and Gas Reserves*, January 23, 2006 (NOC Controlled: 66%, Full IOC Access: 10%, Other: 24%).

Figure 8: Access to World Oil and Gas Reserves has Decreased Over Time



Source: PCF Energy, 2007.³⁴

Figure 9. Access World Proved Oil Reserves

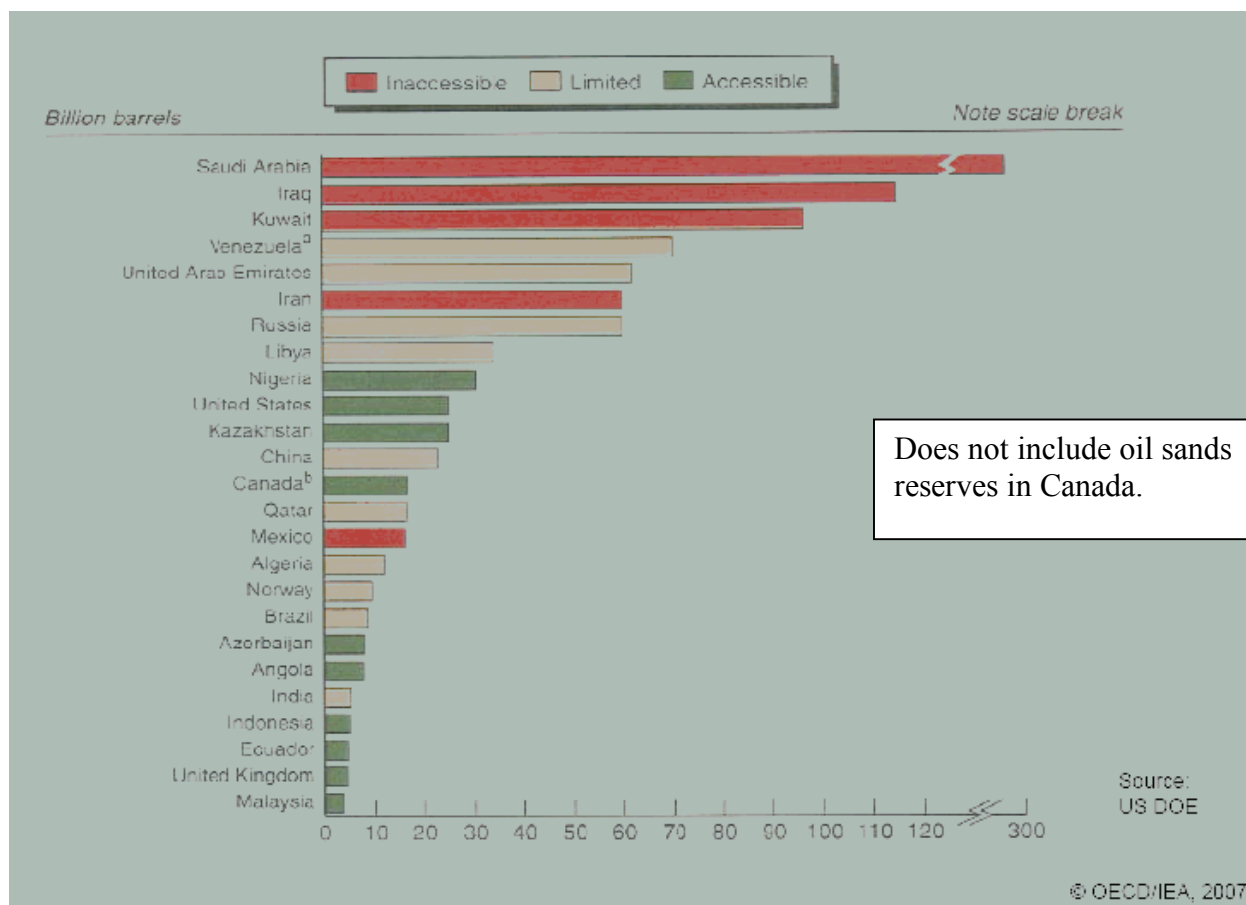


Figure 10. World Proved Reserves of Oil and Natural Gas: Top Ten Nations

84% of the world's proved oil reserves; 78% of world's proved gas reserves

Country/Region	Oil (Billion Barrels)	Country/Region	Natural Gas (Trillion Cubic Feet)
Saudi Arabia	262.7	Russia	1,680.0
Canada	179.2	Iran	974.0
Iran	136.3	Qatar	910.5
Iraq	115.0	Saudi Arabia	240.0
Kuwait	101.5	UAE	214.4
UAE	97.8	United States	204.4
Venezuela	80.2	Nigeria	181.9
Russia	60.0	Algeria	161.7
Kazakhstan	41.5	Venezuela	152.4
Libya	30.0	Iraq	112.0
Others	213.2	Others	1,351.39
Total	1,317.4	Total	6,182.7

Source: Oil and Gas Journal, 2007, as reported by EIA.³⁵ Oil reserve estimate for Canada includes 5.2 billion barrels of conventional crude oil and condensates reserves and 174.0 billion barrels of oil sands reserves.

Endnotes

¹ See Geopolitics Task Group report for additional information.

² See Technology Task Group reports and U.S. DOE, *Environmental Benefits of Advanced Oil and Gas Technology*, 1999.

³ *Scientific Inventory of Onshore Federal Land's Oil and Gas Resources and the Extent and Nature of Restrictions or Impediments to Their Development (EPCA Inventory)*, 2006.

⁴ **Undiscovered technically recoverable resources and reserves growth.**

⁵ NPC, *Meeting the Challenges of the Nation's Growing Natural Gas Demand*, December 1999, available at www.npc.org.

⁶ *EPCA Inventory*, 2006.

⁷ See www.mrm.mms.gov.

⁸ Advanced Resources International, *Potential Federal Royalty and Income Tax Revenues Resulting from the Leasing and Development of the Coastal Plain of the Arctic National Wildlife Refuge*, prepared for U.S. DOE, 2006. Also see EIA, *Analysis of Oil and Gas Production in the Arctic National Refuge*, March 2004, SR/OIAF/2004-04. USGS surveys suggest between 5.7 and 16.0 billion barrels of technically recoverable crude oil are in the coastal plain of ANWR, with a mean estimate of 10.4 billion barrels that includes oil resources in Native lands and state waters out to a 3-mile boundary within the coastal plain. The mean estimate for the Federal portion of the ANWR coastal plain is 7.7 billion barrels of crude oil. In comparison, the estimated volume of technically recoverable unproven oil in the rest of the United States was 136 billion barrels as of January 1, 2006.

⁹ These production estimates are lower than some previous estimates, such as those reported by EIA, because they only include development of resources on federal lands in the coastal plain, and not also potential resources on native lands or state offshore coastal waters.

¹⁰ Tax revenues in 2030 are lower than those in 2020, despite higher levels of production, because larger (and more profitable) fields were assumed to be developed first, with smaller (and less profitable) fields developed later.

¹¹ IOGCC, *Marginal Wells: Fuel for Economic Growth*, 2006.

¹² About 83% and 80% of US onshore technically recoverable oil and gas resources, respectively.

¹³ U.S.: DOI, Minerals Management Service, *Continental Margin and Gulf of Mexico Data*, MMS Fact sheet RED-2006-01b, February 2006. USGS, *Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf*, 2006. Great Lakes: USGS, *Great Lakes*, USGS Fact Sheet 2006-3049, April 2006. USGS, *Undiscovered Oil and Gas Resources Underlying the U.S. Portion of the Great Lakes*, 2005. Canada and U.S. states: IOGCC, *Untapped Potential: Offshore Oil and Gas Resources Inaccessible to Leasing*, January 2006.

¹⁴ **In January 2007, the presidential moratoria was lifted for the entire North Aleutian Basin and a small portion of the Eastern Gulf (in aggregate representing 1.08 Bbbls and 9.32 Tcf of undiscovered technically recoverable resources, mean estimate). Revised resource estimates were released by the Department of the Interior in May 2007.**

¹⁵ Advanced Resources International, *Estimate of the Potential Economic Benefits From the Leasing and Development of Oil and Gas Resources in OCS Moratoria Areas*, prepared for U.S. Department of Energy, June 6, 2006. Based on mean MMS estimates of undiscovered oil and gas resources in the areas in question. **Analysis does not reflect moratoria areas lifted in January 2007.**

¹⁶ No assumption was made about how federal royalty revenues may be shared or allocated with coastal states.

¹⁷ Wood Mackenzie, *Future of the Arctic*, Private Report, November 2006. See www.woodmacresearch.com.

¹⁸ See http://certmapper.cr.usgs.gov/rooms/we/index.jsp?thePage=include_arctic.jsp.

¹⁹ Rune S. Fjelheim John B. Henriksen, *Oil and Gas Exploitation on Arctic Indigenous Peoples' Territories: Human Rights, International Law and Corporate Social Responsibility*, Gáldu Čála – Journal of Indigenous Peoples Rights No. 4/2006. See www.galdu.org.

²⁰ Six international organizations representing many Arctic indigenous communities have the status of Permanent Participants of the Arctic Council: Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Conference, Russian Association of Indigenous Peoples of the North Saami Council. Observers to the Arctic Council include European non-arctic countries, international organizations and NGOs.

²¹ See www.arctic-council.org and www.amap.no.

²² See the Infrastructure and Refining Team reports.

²³ IOGCC, *Mature Region, Youthful Potential: Oil and Natural Gas Resources in the Appalachian and Illinois Basins*, 2005.

²⁴ Esty, Daniel C., Marc A. Levy, Tanja Srebotnjak, Alexander de Sherbinin, Christine H. Kim, and Bridget Anderson Christine H. Kim, and Bridget Anderson, *Pilot 2006 Environmental Performance Index*. New Haven: Yale Center for Environmental Law & Policy, 2006. The EPI is available online at www.yale.edu/epi.

²⁵ Environmental health and ecosystem vitality are gauged using sixteen indicators tracked in six established policy categories: Environmental Health, Air Quality, Water Resources, Biodiversity and Habitat, Productive Natural Resources, and Sustainable Energy.

²⁶ *Energy Indicators For Sustainable Development: Guidelines and Methodologies*, International Energy Agency (in collaboration with the International Atomic Energy Agency, United Nations Department of Economic and Social Affairs, International Energy Agency, Eurostat and European Environment Agency), 2005. See <http://www.iea.org>.

²⁷ Based on Oil and Gas Journal, 2007.

²⁸ A.M. Jaffee, et al., *The Changing Role of National Oil Companies in International Energy Markets*, Baker Institute Policy Report, Rice University, March 2007. See <http://www.rice.edu/energy/publications/nocs.html>.

²⁹ Chris Ellsworth and Shree Vikas (SAIC), *Oil Companies Adjust as Government Roles Expand*, Oil and Gas Journal, Volume 105, Issue 12, March 26, 2007. Also see: Dr. Robert Skinner, Oxford Institute for Energy Studies, *Power and Order: the Energy Dimension, background speaking notes for presentation to the Global Policy Council, "Global Power and International Order in the 21st Century"*, June 2006.

³⁰ Estimates among analysts vary based on definitions of access and world oil resources.

³¹ As reported by Baker Institute on <http://www.rice.edu/energy/research/nationaloil/index.html>.

³² William C. Ramsay, International Energy Agency, *Energy Developments and Prospects*, Presentation to Committee on Economics and Security, NATO Parliamentary Assembly, February 2007.

³³ IEA World Energy Outlook 2006 and EIA International Energy Outlook 2006.

³⁴ Jason Nunn, PFC Energy, Presentation at World Oil HPHT Conference, April 12-13, 2007.

³⁵ See <http://www.eia.doe.gov/emeu/international/reserves.html>.