

Technological Innovation and the Future of the Oil and Gas Industry

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Extended Abstract

The oil and gas industry are undergoing profound changes on many fronts. Demand is shifting away from the advanced industrialized countries of the OECD toward Asia and there are growing fears about difficulty in mobilizing adequate supplies. Looking to the future, the most important determinants of the structure of the industry will be twofold: the application of technology, and the control over access to oil and gas resources. Firms that are able to combine skills in these two areas are likely to be the winners in the 21st century oil and gas industry.

One of the great puzzles in the oil market is why prices, notwithstanding the battering of recent months, are so high. This Talk will look at a range of explanations for high prices and will focus on the special role of national oil companies (NOCs). While the role of the state has declined in nearly every sector of world economic activity, the pattern in the oil and natural and gas industries has been quite different. State-controlled oil companies—so-called National Oil Companies (NOCs)—remain firmly in control over the vast majority of the world's hydrocarbon resources. NOCs control up to 89% of the world's oil reserves, 82% of gas reserves, 64% of oil production, 48% of gas production, and 43% of refining capacity. But the NOCs vary widely in their performance. Some help define world class benchmarks through their own operations and in alliance with outside partners—such as Brazil's Petrobras, Norway's Statoil, Saudi Arabia's Aramco and Abu Dhabi's ADNOC. Others lag far behind—among them Venezuela's PdVSA and Mexico's Pemex. Firms in the Persian Gulf vary widely over a short geographical space because their political and management contexts vary so markedly—a reminder that the situation “above ground” probably matters a lot more than the size and quality of geological resources “below ground.”

The Talk will explore the many causes for this huge variation in performance. Chief among them are two. One is the relationship that is crafted between a NOC and its host government. The NOCs that have the most difficult struggles with performance are those whose host governments are so intrusive in governance that the firm is unable to make the strategic choices needed for success in exploration and production. Second is the management of risk in the deployment of capital. Technology is crucial to risk management, and with the world oil market being in the middle of a rapid shift away from the “easy oil” of the last century, to more complex new fields as well as mature fields, the role of technology and risk management will grow.

In addition to these profound changes in the oil market, there are similar changes under way in the markets for all other major sources of primary energy.

In natural gas, liquefied natural gas (LNG) has already coupled remote supplies and regions of demand to the point where elements of global gas pricing are now evident. The Talk will discuss these profound changes and explore their implications for the kinds of firms that are poised to succeed in the global gas market. Among the pivotal countries, Russia deserves special attention. Traditionally, analysts have looked at the areas of the world with the richest gas resources, and assumed that those nations will dominate the industry. More likely is that the most successful firms will be those that can combine upstream access to hydrocarbon resources with the ability to master costly and complex gas delivery technologies and final marketing. The Talk will also include a review of major gas sources and pricing arrangements in the U.S. market, which has become an anchor for some elements of world gas pricing.

Similar changes are under way in the pricing and trade in coal, and the full globalization of the coal market could be the most important trend of the last two decades. In many countries, notably the emerging Asian giants, coal is the key source of primary energy, and coal pricing is moving offshore to global markets. There are wildcards in the world coal supply that are as puzzling as the wildcards in oil and gas supply. Among them is the question of whether Indonesia will be able to sustain its position as a leader in coal exports. The globalization of coal is the result of a cluster of innovations—some technological and other organizational—that are similar to those that have globalized the gas industry.

Suppliers of primary fuels need to focus not only on technology and organization in their fuels markets, but also in the ways that primary fuel is turned into useful products. The most important of these is electrification. Nearly every country has electrified massively as part of industrialization, and there is no indication that the electrification process is abating. Even the one area that electricity was thought to leave untouched—transportation—now shows sign of electricity. The fate of electric vehicles is still too early to assess, but even a modest penetration of this equipment could couple the fuels that dominate electric power (mainly coal and gas) to those that reign in transportation (oil). That coupling will produce a discipline in the oil market that will be unlike anything seen since the early 1970s when a large fraction of oil went to power generation and was fairly easily replaced with rivals. This discipline could even spell the end of OPEC as a central force in oil pricing.

A fresh challenge for the world's energy system—electricity in particular—is the rising concern about global climate change. Fixing the climate problem will require new technology. Failure to develop the technology will mean that climate controls will impose politically untenable costs on society and probably will lead to unchecked and dangerous levels of climate change. Effective remedies to the climate problem require many elements. One is a price on CO₂, the leading human cause of climate change. But prices are not enough, and evidence from the E.U.'s emission trading system shows that even in the market that has the world's highest CO₂ prices, there has not been a fundamental change in the decisions around deployment of power generation technologies. Additional policies that focus on technology are also needed, and the Talk will focus on which are likely to be most important and their implications for the hydrocarbon industry. Among them will be nuclear power, renewable energy and especially carbon capture and storage. Despite huge interest in carbon capture and storage, actual investment in the technology is perhaps only 1% the level needed to make a substantial difference in CO₂ emissions. The central obstacle is lack of a viable business model for commercializing carbon capture and storage. Enhanced oil recovery is probably crucial to that business model, and there are promising signs in Abu Dhabi and a few other locations worldwide.

Bibliography

1. The Program on Energy & Sustainable Development, <http://pesd.stanford.edu>
2. D.G. Victor, 2007, "Fragmented Carbon Markets and Reluctant Nations: Implications for the Design of Effective Architectures," in Joe Aldy and Rob Stavins, eds., *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World*, chapter 4 (Cambridge: Cambridge University Press).
3. D.G. Victor, Amy M. Jaffe, and M.H. Hayes, Eds., 2006, *Natural Gas and Geopolitics* (Cambridge: Cambridge University Press).
4. B. Steil, D.G. Victor, and R. Nelson, Eds., 2002, *Technological Innovation and Economic Performance* Princeton, Princeton University Press.
5. A. Grübler, N. Nakićenović, and D.G. Victor, 1999, "Dynamics of Energy Technologies and Global Change," *Energy Policy*, vol. 27, pp. 247-280.

Speaker's Biography

Professor David Victor is Professor of Law at Stanford Law School and Director of the Program on Energy and Sustainable Development at Stanford University's Freeman Spogli Institute for International Studies. The Program, launched in September 2001, examines the political and regulatory forces that affect world energy markets. Current research concentrates on the role of state-controlled oil and gas companies in the world's hydrocarbon markets; viable strategies for protecting the global climate; and the emerging global market for coal. Much of the Program's research concerns the rapidly emerging markets of Brazil, China, India, Mexico and South Africa. He teaches energy law, regulation and political economy at Stanford Law School.

Previously, Dr. Victor directed the Science and Technology program at the Council on Foreign Relations in New York, where he remains Adjunct Senior Fellow. He directed the Council's task force on energy co-chaired by Jim Schlesinger and John Deutch and was senior adviser to the task force on climate change chaired by George Pataki and Tom Vilsack. He also leads study groups on energy security and on the design of strategies to regulate climate geoengineering. In the past, his research at the Council his research focused on the sources of technological innovation and the impact of innovation on economic growth. His research also examined global forest policy, global warming, and genetic engineering of food crops.

His publications include: *Natural Gas and Geopolitics* (Cambridge University Press, July 2006), *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming* (Princeton University Press, April 2001; second edition July 2004); *Climate Change: Debating America's Policy Options* (New York:



Council on Foreign Relations); *Technological Innovation and Economic Performance* (Princeton University Press, January 2002, co-edited with Benn Steil and Richard Nelson); and an edited book of case studies on the implementation of international environmental agreements (MIT Press, 1998). He is author of more than 120 essays and articles in scholarly journals, magazines and newspapers, such as *Climatic Change*, *The Financial Times*, *Foreign Affairs*, *International Journal of Hydrogen Energy*, *Nature*, *Newsweek (International Edition)*, *The New York Times*, *Science*, *Scientific American*, and *The Washington Post*.