Massachusetts Institute of Technology

MIT News Office
77 Massachusetts Avenue
Cambridge, MA 02139-4307
Phone: 617-253-2700
http://web.mit.edu/press

For Immediate Release
FRIDAY, JUN. 25, 2010

Contact: Jen Hirsch, MIT News Office
E: jfhirsch@mit.edu, T: 617-253-1682

==========
MIT releases major report: The Future of Natural Gas
-- Study finds significant potential to displace coal, reducing greenhouse gas emissions
==========

CAMBRIDGE, Mass., June 25, 2010 -- Natural gas will play a leading role in reducing greenhouse-gas emissions over the next several decades, largely by replacing older, inefficient coal plants with highly efficient combined-cycle gas generation. That's the conclusion reached by a comprehensive study of the future of natural gas conducted by an MIT study group comprised of 30 MIT faculty members, researchers, and graduate students. The findings, summarized in an 83-page report, were presented to lawmakers and senior administration officials this week in Washington.

The two-year study, managed by the MIT Energy Initiative (MITEI), examined the scale of U.S. natural gas reserves and the potential of this fuel to reduce greenhouse-gas emissions. Based on the work of the multidisciplinary team, with advice from a board of 16 leaders from industry, government and environmental groups, the report examines the future of natural gas through 2050 from the perspectives of technology, economics, politics, national security and the environment.

The report includes a set of specific proposals for legislative and regulatory policies, as well as recommendations for actions that the energy industry can pursue on its own, to maximize the fuel's impact on mitigating greenhouse gas. The study also examined ways to control the environmental impacts that could result from a significant expansion in the production and use of natural gas — especially in electric power production.

"Much has been said about natural gas as a bridge to a low-carbon future, with little underlying analysis to back up this contention. The analysis in this study provides the confirmation — natural gas truly is a bridge to a low-carbon future," said MITEI Director Ernest J. Moniz in introducing the report.

Massachusetts Institute of Technology

MIT News Office
77 Massachusetts Avenue
Cambridge, MA 02139-4307
Phone: 617-253-2700
http://web.mit.edu/press

Moniz further noted, “In the very long run, very tight carbon constraints will likely phase out natural gas power generation in favor of zero-carbon or extremely low-carbon energy sources such as renewables, nuclear power or natural gas and coal with carbon capture and storage. For the next several decades, however, natural gas will play a crucial role in enabling very substantial reductions in carbon emissions.”

Two major factors that can make a significant difference in the near term in reducing carbon emissions are using less energy and using gas instead of coal — especially by replacing the oldest, least-efficient coal plants with the most-efficient modern combined-cycle gas plants, said Moniz, who chaired the study, along with co-chairs Henry Jacoby, Professor of Management, and Tony Meggs, MITEI Visiting Engineer. Professor Jacoby is co-director of the MIT Joint Program on the Science and Policy of Global Change.

The study found that there are significant global supplies of conventional gas. How much of this gas gets produced and used, and the extent of its impact on greenhouse gas reductions, depends critically on some key political and regulatory decisions.

In the United States, for example, there is a substantial amount of low-hanging fruit available by displacing inefficient power generation with more efficient, lower CO_2 emitting gas plants. “That kind of substitution alone,” Moniz said, “reduces those carbon emissions by a factor of three. It does however raise complicated regulatory and political issues that will have to be resolved to take advantage of this potential.”

Some of the study’s key findings:

1. The United States has a significant natural gas resource base, enough to equal about 92 years’ worth at present domestic consumption rates. Much of this is from unconventional sources, including gas shales. While there is substantial uncertainty surrounding the producibility of this gas, there is a significant amount of shale gas that can be affordably produced.

   Globally, baseline estimates show that recoverable gas resources probably amount to 16,200 trillion cubic feet (Tcf) — enough to last over 160 years at current global consumption rates. Further, this global resource figure, excluding the U.S. and Canada, does not include any unconventional gas resources, which are largely uncharacterized in the rest of the world. Russia, the Middle East, and the U.S. have the highest concentration of global gas reserves.

Massachusetts Institute of Technology

MIT News Office
77 Massachusetts Avenue
Cambridge, MA 02139-4307
Phone: 617-253-2700
http://web.mit.edu/press

In the U.S., unconventional gas resources are rapidly overtaking conventional resources as the primary source of gas production. The U.S. currently consumes around 22 Tcf per year and has a gas resource base now thought to exceed 2,000 Tcf.

In order to bring about the kind of significant expansion in the use of natural gas identified in this study, substantial additions to the existing processing, delivery and storage facilities will be required in order to handle greater amounts and the changing patterns of distribution (such as the delivery of gas from newly developed sources in the Midwest and Northeast).

2. Environmental issues associated with producing unconventional gas resources are manageable but challenging. Risks include**:** Shallow freshwater aquifer contamination with fracture fluids; surface water contamination by returned fracture fluids; excessive demand on local water supply from fracturing operations; and surface and local community disturbance, due to drilling and fracturing activities.

3. Natural-gas consumption will increase dramatically and will largely displace coal in the power generation sector by 2050 (the time horizon of the study) under a modeling scenario where, through carbon emissions pricing, industrialized nations reduce CO_2 emissions by 50 percent by 2050, and large emerging economies, e.g. China, India and Brazil reduce CO_2 emissions by 50 percent by 2070. This assumes incremental reductions in the current price structures of the alternatives, including renewables, nuclear and carbon capture and sequestration.

4. The introduction of large intermittent power generation from, for example, wind and solar, will have specific short and long term effects on the mix of generation technologies. The short term effects (meaning daily dispatch patterns of various fuels) of large amounts of wind generation for example will reduce gas generation significantly and could force baseload coal plants to cycle, an outcome which is highly undesirable from an operational perspective.

   In the longer term, the reliability of a system in which renewables assume a baseload role in power generation will require additional flexible natural gas peaking capacity, although this capacity may be utilized for only short periods of the time. Renewables as baseload power, firmed by natural

gas generation, will require new regulatory structures to ensure reliability of the system and incentivize the building of flexible gas capacity.

5. The overbuilding of natural gas combined cycle plants starting in the mid-1990s presents a significant opportunity for near term reductions in CO_2 emissions from the power sector. The current fleet of natural gas combined cycle (NGCC) units has an average capacity factor of 41 percent, relative to a design capacity factor of up to 85 percent. However, with no carbon constraints, coal generation is generally dispatched to meet demand before NGCC generation because of its lower fuel price.

   Modeling of the ERCOT region (largely Texas) suggests that CO_2 emissions could be reduced by as much as 22 percent with no additional capital investment and without impacting system reliability by requiring a dispatch order that favors NGCC generation over inefficient coal generation; preliminary modeling suggests that nationwide CO_2 emissions would be reduced by over 10 percent. At the same time, this would also reduce air pollutants such as oxides of sulfur and nitrogen

6. In the transportation sector, the study found a somewhat smaller role for natural gas. The use of compressed or liquefied natural gas as a fuel for vehicles could help to displace oil and reduce greenhouse gas emissions, but to a limited extent because of the high cost of converting vehicles to use these fuels. By contrast, making methanol, a liquid fuel, out of natural gas requires much less up-front conversion cost and could have an impact on oil usage and thus improve energy security, but would not reduce greenhouse gases.

7. A global “liquid” market in natural gas in which supply sources are diverse and gas prices are transparent, set by supply and demand with price differences based on transportation costs, is desirable for U.S. consumers.

   There are currently three regional gas markets – North America, Europe and Asia – which have very little integration and which rely on completely different pricing structures. Modeling suggests that the integration of these markets would result in substantially lower consumer prices for US consumers.

The study makes many recommendations regarding the role of natural gas in a carbon-constrained world, suggesting that policy makers should consider supportive policies in the following areas:

Massachusetts Institute of Technology

MIT News Office
77 Massachusetts Avenue
Cambridge, MA 02139-4307
Phone: 617-253-2700
http://web.mit.edu/press

Supply

- Require disclosure of all components of hydraulic fracture fluids.
- Require integrated regional water usage /disposal plans for unconventional gas production.
- Support renewed DOE R&D program weighted towards basic research and "off-budget" industry-led program weighted to technology development, demonstration, and transfer. Programs should be designed to optimize gas resources and ensure that they are produced in environmentally sound ways.

Power Generation

- Pursue displacement of inefficient coal generation with natural gas combined cycle generation.
- Develop policy and regulatory measures to facilitate natural gas generation capacity investments concurrent with the introduction of large intermittent renewable generation.

Transportation

- Remove policy and regulatory barriers to natural gas as a transportation fuel.

Global Markets

- Support polices to foster an integrated global gas market, including the integration of natural gas issues into the foreign policy apparatus, with strong involvement of the Executive Office of the President, supported by a strengthened natural gas policy apparatus at the Department of Energy.
- Export U.S. knowledge in unconventional gas characterization and production to nations that can advance U.S. strategic interests.

While the new report emphasized the great potential for natural gas as a transitional fuel to help curb greenhouse gases and dependence on oil, it also stresses that it is important as a matter of national policy not to favor any one fuel or energy source in a way that puts others at a disadvantage. The most useful policies, the authors suggested, are ones that produce a truly "level playing field" for all forms of energy supply and for demand reduction, and thus let the marketplace, and the ingenuity of the nation's researchers, determine the best options.

Illustrating the role of natural gas as a bridge to a low carbon future, the study's authors stressed that it would be a mistake to let natural gas crowd out research

Massachusetts Institute of Technology

MIT News Office
77 Massachusetts Avenue
Cambridge, MA 02139-4307
Phone: 617-253-2700
http://web.mit.edu/press

on other low- or no-carbon energy sources, but it would also be a mistake to let investments in such alternatives crowd out the expansion of natural gas resources in the near term, particularly for the purposes of CO_2 emissions mitigation.

The study received support from the American Clean Skies Foundation, Hess Corporation, Agencia Nacional de Hidrocarburos of Colombia, and the Energy Futures Coalition and the MIT Energy Initiative. The report issued this week is a preliminary overview of a more detailed report that will be released later this year.

“In a carbon-constrained world, natural gas will become a larger part of the energy mix,” Moniz said. But in the longer term, it will be necessary to shift to “essentially zero-carbon” sources so “we better not get mesmerized by gas either. We need to do the hard work of getting those alternative technologies ready to take over.”

# # #