Webinar Format:

- At the start of today's session presentation, all attendees may be muted by the Moderator/Host in order to maintain sound quality during the presentation (first 45 minutes of the webinar).
- > During the presentation, the Moderator/Host and Presenter will be taking questions for clarity only.
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- All other questions will be addressed during the Q&A period (second 45 minutes of the webinar). We encourage your participation.
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- At the conclusion of the Webinar, online attendees will be presented with a brief survey. We hope that you will take a few minutes to provide feedback on today's session and make suggestions for future webinar topics. Also, we welcome your comments at any time by email to Frances Goldstein (<u>fkg@mit.edu</u>).

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The webinar will begin shortly.

http://globalchange.mit.edu/

Long-Term Trends in Global Trade of Natural Gas

Sergey Paltsev

Principal Research Scientist, Assistant Director for Economic Research, MIT Joint Program on the Science and Policy of Global Change



MIT Joint Program Webinar

June 20, 2012

http://globalchange.mit.edu/

Questions or comments? Contact: Sergey Paltsev paltsev@mit.edu

Motivation

- 1. Shale gas and LNG
- 2. Move from coal to gas
- 3. Move to renewables
- 4. Economics vs geopolitics









IEA 2011

On one hand...

Los Angeles Tîmes

Obama talks up natural gas development in State of the Union speech

January 24, 2012 | By Neela Banerjee

In his State of the Union speech, President Obama made no mention of his controversial decision to reject the Keystone XL oil pipeline, but shifted his focus to shale gas development, another contentious topic where the promise of badly needed near-term jobs clashes with widespread fears of environmental damage.

"We have a supply of natural gas that can last America nearly 100 years, and my administration will take every possible action to safely develop this energy," he said. "Experts believe this will support more than 600,000 jobs by the end of the decade. America will develop this resource without putting the health and safety of our citizens at risk."







On the other hand...





March 2012

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Natural Gas a Weak Weapon Against Climate Change, New Study Asserts



Nathan Myhrvold found "some really counterintuitive results" when he and study coautho out to see what the climate effect would be if the world switched from coal power plants.

The new kid on the energy block, shale gas, may be worse in climate change terms than coal, a study concludes.

Drawn from rock through a controversial "fracking" process, some hail the gas as a "stepping stone" to a low-carbon future and a route to energy security.

But US researchers found that shale gas wells leak substantial amounts of methane, a notent



Gas is a natural by-product of shale rock



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Another Dent In The Shale Gas Revolution?



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About IF

Posted by Andrew Gordon on March 22, 2012



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Major shale gas producer US is looking for a partner. So far it's the only nation that is engage in widespread exploitation of shale gas (much to the dismay of local environmentalists).

Poland looked like it would be the first country to join the US in the shale gas revolution.

But now Poland many have to postpone the revolution.

The high estimates of shale gas in Poland are plunging. Thought to be as high as 5.3 trillion cubic meters, a recent report put shale gas reserves at between 346 billion and 768 billion cubic meters.

It's quite a comedown for a country eager to wean itself off of Russian gas supplies.

From Canada's Globe and Mail

Poland's shale gas reserves are far lower than originally forecast, the government said Wednesday, a disappointment for a country that had been hoping to break its dependence on Russian energy imports.

March 2012



Natural Gas Prices, BP (2012)



Winter 2011-2012 Prices: US – (Sept - \$4; March - \$2), UK - \$10 (NBP on Oct 3 – \$6.50; Feb 7 - \$15.50, end of March - \$9.40), Germany - \$11, Japan - \$15-16.



Global Natural Gas Use





IEA 2010: 2030-140 Tcf, 2035 - 150 Tcf

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Natural Gas Resources, Tcf



Source: MIT (2011)

Global Consumption: 2000 - 100 Tcf 2050 - 160-190 Tcf

Global Reserves: 6,600 Tcf (BP, 2010)

Global Resources: World – 16,000 Tcf

(plus shale gas in non-North America)



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Shale Gas Resources, Tcf



IEA (2012): Similar numbers for shale gas; lower for Europe than EIA (560 vs 640 Tcf); Russia and the Middle East together as Europe (560 Tcf)

Global Conv. Reserves: 7,000 Tcf

Global Conv. Resources: 15,000 Tcf

Additional Shale : 7,000 Tcf

CBM&Tight: 3,000-4,000 Tcf

Global Resources: 25,000 Tcf

Top 10 in 2011

Global Consumption: 114 Tcf

Consumers	Tcf
1. USA	24.4
2. Russia	15.0
3. Iran	5.4
4. China	4.7
5. Japan	3.7
6. Canada	3.7
7. Saudi Arabia	3.5
8. UK	2.8
9. Germany	2.6
10. Italy	2.5
	68.3
share of world	60%

Middle East growth (region getting close to EU consumption), China growth (2010 - 3.9 Tcf)Asia 2011 – India 2.2; S. Korea - 1.6, Thailand - 1.6, Pakistan -



1.3 Tcf

Coloring scheme represents the world regions

No Latin America, Australia (1.6), Turkmenistan (2.1), Azerbaijan (0.5)

Producers	Tcf
1. USA	23.0
2. Russia	21.4
3. Canada	5.7
4. Iran	5.4
5. Qatar	5.2
6. China	3.6
7. Norway	3.6
8. Saudi Arabia	3.5
9. Algeria	2.8
10. Indonesia	2.7
	76.8
share of world	66%

Top 10 Exporters in 2011

Global Consumption: 114 Tcf

Global Trade: 36 Tcf (25 Tcf – pipeline; 11 Tcf – LNG)

LNG Exporters	Tcf
1. Qatar	3.6
2. Malaysia	1.2
3. Indonesia	1.0
4. Australia	0.9
5. Nigeria	0.9
6. Trinidad	0.7
7. Algeria	0.6
8. Russia	0.5
9. Oman	0.4
10. Brunei	0.3
	10.2
share of world	87%

Pipeline Exporters Tcf 1. Russia 7.3 3.3 2. Norway 3. Canada 3.1 4. Netherlands 1.8 5. USA 1.4 6. Turkmenistan 1.2 7. Algeria 1.2 8. Qatar 0.7 9. UK 0.6 10. Bolivia 0.5 21.1 share of world 86%

Source: BP (2012)

Qatar waits, Australia plans to reach 2.5 Tcf by 2015-16, USA capacity by 2015-16 -0.7-0.9 Tcf



Coloring scheme represents the world regions to supply

Pipelines to Europe New projects: Russia -EU/China; Caspian – EU/China

Top 10 Importers in 2011

Global Consumption: 114 Tcf

Global Trade: 36 Tcf (25 Tcf – pipeline; 11 Tcf – LNG)

LNG Importers	Tcf
<mark>1. Japan</mark>	3.8
2. S. Korea	1.7
3. UK	0.9
4. Spain	0.9
<mark>5. India</mark>	0.6
<mark>6. China</mark>	0.6
7. Taiwan	0.6
8. France	0.5
9. USA	0.4
10. Italy	0.3
	10.2
share of world	87%

Pipeline Importers	Tcf
1. USA	3.1
2. Germany	3.0
3. Italy	2.1
4. Ukraine	1.4
5. Turkey	1.3
6. France	1.1
7. Russia	1.1
8. UK	1.0
9. Canada	0.9
10. Belgium	0.8
	15.8
share of world	65%

Source: BP (2012)

2010-2011 increase of LNG to Asia: Japan, Korea, India, China. Decrease of LNG to EU (except UK)



Coloring scheme represents the world regions to supply Pipelines to Europe New projects: Russia – EU/China; Caspian – EU/China 2011 pipeline gas to China – 0.5 Tcf

Proposed U.S. LNG

Source: FERC (2012)

Plus:

Bcfd

Approved LNG

(Cheniere): 2.6

Sabine Pass



As of May 24, 2012

North American LNG Import/Export Terminals

Import Terminal

PROPOSED TO FERC

1. Robbinston, ME: 0.5 Bcfd (Kestrel Energy - Downeast LNG) 2. Astoria, OR: 1.5 Bcfd (Oregon LNG)

Corpus Christi, TX: 0.4 Bcfd (Cheniere – Corpus Christi LNG)

Export Terminal

PROPOSED TO FERC

- Freeport, TX: 1.8 Bcfd (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction)
- 5. Corpus Christi, TX: 1.8 Bcfd (Cheniere Corpus Christi LNG)
- 6. Coos Bay, OR: 0.9 Bcfd (Jordan Cove Energy Project)
- 7. Lake Charles, LA: 2.4 Bcfd (Southern Union Trunkline LNG)
- Hackberry, LA: 1.7 Bcfd (Sempra Cameron LNG)

PROPOSED CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS

- 9. Kitimat, BC: 0.7 Bcfd (Apache Canada Ltd.)
- 10. Douglas Island, BC: 0.25 Bcfd (BC LNG Export Cooperative)

POTENTIAL U.S. SITES IDENTIFIED BY PROJECT SPONSORS

- 11. Cove Point, MD: 1.0 Bcfd (Dominion Cove Point LNG)
- 12. Brownsville, TX: 2.8 Bcfd (Gulf Coast LNG Export)
- Astoria, OR: 1.25 Bcfd (Oregon LNG)
- 14. Pascagoula, MS: 1.5 Bcfd (Gulf LNG Liquefaction)
- 15. Lavaca Bay, TX: 0.4 Bcfd (Excelerate Energy)
- 16. Elba Island, GA: 0.5 Bcfd (Southern LNG Company)

POTENTIAL CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS

Office of Energy Projects

17. Prince Rupert Island, BC: 1.0 Bcfd (Shell Canada)

GLOBAL CHANGE

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MARAD/USCG

Proposed LNG

Global Consumption: 114 Tcf

Global Trade: 36 Tcf (25 Tcf – pipeline; 11 Tcf – LNG)

Existing LNG capacity – 12 Tcf Qatar – 3.7 Tcf

Proposed Additions USA: Sabine Pass – 0.8 Tcf Proposed – 3 Tcf Potential – 2.7 Tcf Alaska – 1 Tcf (Jensen: US – 5.3 Tcf; Alaska 1.1 Tcf)

Australia – 1.6 Tcf Canada – 0.7 Tcf Nigeria– 1 Tcf Indonesia – 0.5 Tcf Papua New Guinea Russia



GLOBAL CHANGE

Figure 1 CAPACITY OF PROPOSED PROBABLE, POSSIBLE (SCHEDULED) AND POSSIBLE (UNSCHEDULED) LIQUEFACTION PLANTS BY COUNTRY (ESTIMATES FROM A JENSEN DATABASE CLASSIFICATION SYSTEM)



Source: James Jensen, Jensen Associates (2012)

Gas Trade, Tcf, 2011



Trade flows larger than 1 Tcf; Coloring scheme – EPPA regions

Source: BP (2012)

Other Large Flows: RUS – ROE 2.1 Tcf ASI – JPN (Asia) 1.2 Tcf ANZ – JPN (Asia) 0.7 Tcf

Inside regions: EUR 6.5 Tcf MES 0.8 Tcf REA 0.8 Tcf



International Gas Market Development, 2030



Regional Markets

Source: MIT (2011)

Global Market



Russian Natural Gas Exports



Russia's Exports -Reference

	2010	2020	2030	2040	2050
Europe	6.6	8.2	8.7	9.6	11.5
Asia	0.5	0.8	1.3	2.1	3.4
N.America		0.3	0.3	0.3	0.4
Total	7.1	9.3	10.4	12.0	15.3

Russia's Exports – Asia Demand

	2010	2020	2030	2040	2050
Europe	6.6	7.8	8.1	9.0	10.1
Asia	0.5	1.9	3.3	5.0	6.9
N.America		0.3	0.3	0.4	0.4
Total	7.1	10.0	11.7	14.4	17.4

Source: MIT Joint Program Report 201 (2011)



How much natural gas does Europe need?

- Proved Reserves (BP):
- EU 100 Tcf (Netherlands 50 Tcf), Norway 100 Tcf







Source: MIT Joint Program Report 201 (2011)

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Natural gas in Europe





Source: MIT Joint Program Report 201 (2011)

Major Russian Gas Infrastructure





Source: MIT Joint Program Report 201 (2011)

Shale Gas in China



Source: EIA (2011)



(No) Shale Gas in China and Global supply



Source: Paltsev, Ejaz, O'Sullivan (2012)



Shale Gas in China and Global supply



Source: Paltsev, Ejaz, O'Sullivan (2012)



China Gas – Potential Futures





China Gas – Potential Futures



By 2050 China might become natural gas exporter



Gas Trade – No Shale in China, Tcf, 2040



Trade flows larger than 1 Tcf; Coloring scheme – EPPA regions

2040 Gas Flows to Asia about 20 Tcf

Current International Gas Trade in Asia (including supplies from a region) – 8 Tcf

Current Non-Asia originated LNG to Asia – 4.7 Tcf



Gas Trade – Shale in China, Tcf, 2040



Trade flows larger than 1 Tcf; Coloring scheme – EPPA regions

Gas Flows to Asia are lower by 6 Tcf



Global natural gas use will grow from the current 110 Tcf to 130 Tcf in 2020, 160 Tcf in 2030, and 180-200 Tcf in 2050.

Gas markets are still regional (U.S., Europe, Asia)

Integrated gas markets lead to an even greater use and relatively lower prices.

Realization of shale gas in China leads to a smaller gas trade.

U.S. - \$2-4, Europe - \$8-10, Japan - \$15: A case for substantial U.S gas exports? -Maybe not.

Shale gas in China *might* be a game changer -But perhaps not in the next decade

Demand uncertainty in China (and India) also plays a big role.



Thanks are due:

Qudsia Ejaz Francis O'Sullivan

John Reilly

Henry Jacoby

James Jensen





MIT Joint Program Sponsors Webinar Series June . 20 . 2012 10:30 am - 12:00 pm EDT

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- Today's webinar has been recorded, and will be available in our webinar archive in the 'Sponsors Only' section of the Joint Program website, at: <u>http://globalchange.mit.edu/sponsors-only/webinar</u> (Click on the "Archived webinars" tab)
- The next webinar in the series will be:

Date: **TBD** Time: **10:30 a.m. - 12:00 p.m. EST** Title: **TBD** Presenter: **TBD**

We do hope you hold this event on your calendar and plan to attend. Details will be sent as we move closer to the event.

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