Global, Long-Term Implications of Abundant Natural Gas

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Launch of the JGCRI/GTSP Workshop Series

Objective: develop a forum for interactive dialogue regarding the findings and implications of GTSP-related research to strengthen understanding of research implications and to better inform future work

Initial Topic: **Global Implications of Abundant Gas**
Preliminaries
Background & Scene Set
Gas and the Global Energy System

Gas has been a growing component of the global energy system for some time.
The Shale Gas Revolution

An ongoing technology transformation has dramatically increased gas production and commercial reserves… and reduced natural gas prices in the United States

Figure 107. Natural gas production by source, 1990-2035 (trillion cubic feet)

Figure 105. Annual average Henry Hub spot natural gas prices in five cases, 1990-2035 (2010 dollars per million Btu)

Source: EIA, Annual Energy Outlook 2012
The Shale Gas Revolution …

In the USA more abundant, less expensive natural gas:

- Lowers cost of primary energy not only in electric power but also in energy intensive industry, commercial and residential buildings, …
- Alters competition among primary energy sources (e.g. coal, nuclear, wind, solar and biomass) in several sectors
- Benefits local, state and national economy through more and lower cost gas, jobs, supply chain interactions and added revenues
- Leads to new investment in energy intense industry
- Improves energy security
- Presents environmental and social opportunities and challenges (air pollution, water use, traffic, …)
- Affects greenhouse gas emissions and mitigation opportunities

Issues for the workshop: will, how will the technology spread globally and with what long term implications?
Common Energy and Climate Change Relations

<table>
<thead>
<tr>
<th></th>
<th>Energy Content</th>
<th>Standard Unit</th>
<th>Practical Unit</th>
<th>Emission Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1 EJ</td>
<td>0.034 Gtce</td>
<td>0.038 bil. short tons</td>
<td>27 PgC/EJ</td>
</tr>
<tr>
<td>Oil</td>
<td>1 EJ</td>
<td>0.024 Gtoe</td>
<td>0.175 bil. Barrel</td>
<td>20 PgC/EJ</td>
</tr>
<tr>
<td>Gas</td>
<td>1 EJ</td>
<td>27 bcm</td>
<td>948 bil. cubic ft</td>
<td>14 PgC/EJ</td>
</tr>
</tbody>
</table>

* Average numbers for energy content and emissions coefficients

Energy and Carbon
1 Quad BTU = 1.055 EJ
1 PgC = 1 GtC
3.67 PgCO₂ contain 1 Pg C

Equilibrium Climate Change

<table>
<thead>
<tr>
<th>Radiative forcing</th>
<th>CO₂ concentration</th>
<th>Global Temperature Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6 Wm⁻²</td>
<td>~ 450 ppm CO₂e</td>
<td>~ 2 °C</td>
</tr>
<tr>
<td>4.5 Wm⁻²</td>
<td>~ 650 ppm CO₂e</td>
<td>~ 3.5 °C</td>
</tr>
</tbody>
</table>

~ shorthand: model results span a large range and many caveats apply
CO₂e converts net effect from all changes to “equivalent” CO₂ concentration

See Handout
JGCRI Abundant Gas Scenarios

- Use GCAM model with conventional assumptions for future population, economic growth, technologies and land use change

- Evaluate reference and mitigation scenarios through 2050
  (Scenarios incorporate understanding circa 2000 and 2010)
  - GT2000 without technologies to utilize shale gas resources
  - GT2010 widespread ability to utilize shale gas results in abundant, less expensive supply of natural gas early in the century

- Through 2050, relative to GT2000, gas use expands considerably in GT2010, but offsetting factors result in virtually identical global energy demand and net GHG forcing

- Offsetting factors include lower CO$_2$ and sulphur emissions from reduced coal use and increased demand for power from lower cost gas

- Gas use alters the balance of energy sources in many sectors, with the largest change in power, the smallest in transport

Opportunity at the workshop to consider the basis for scenarios and adequacy of essential information and understanding
Energy use in 2050 approximately doubles in both scenarios, with significantly more gas consumed under GT2010.
More abundant, less expensive gas displaces other sources in all sectors with the largest impact in power, and very little penetration in transport.
CO$_2$e increases from ~380 ppm in 2005 to ~640 ppm in 2050 in both scenarios.
JGCRI Abundant Gas Scenarios

- See the abundant gas 2-pager
- Full details this afternoon
Program and Process for the Dialogue Workshop

• Sessions on six topical themes
  – Resources, technology, business drivers and enablers
  – Implications for energy, economy and environment
  – Global opportunities and barriers
  – JGCRI/GCAM Climate and Energy Scenarios with Abundant Gas
  – Global Outlooks and Scenarios with Abundant Gas
  – Research Opportunities and Directions

• Process
  – Opening remarks (~15 minutes each)
  – Facilitated discussion … not limited to
    + Q&A
    + Engaging the panel
  – Chatham House Rule

• Encourage interaction and networking
Thank You