The 4th Japan-U.S. Joint Public Policy Forum
The Future of Energy: Choices for Japan and the United States
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Senior Fellow and Co-Director

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U.S. Energy Policy has Emphasized Transformation to Clean Energy

- Economic stimulus package 2009 included $80 Billion to clean energy investments. Tax incentives maintained.
- Vehicle Fuel Efficiency standards increased. Faster implementation of other efficiency standards.
- EPA began process to regulate greenhouse gases and moved on additional regulations affecting coal.
- Climate legislation failed.
- Copenhagen commitment to 17% reduction in 2020 from 2005 baseline.
- Unexpected increases in natural gas and oil production now driving U.S. energy sector.

“The nation that leads the world in creating a new clean energy economy will be the nation that leads the 21st century global economy” – President Obama
New Technologies and Practices Drive Production from Shale and other Unconventionals Deposits
Unconventional Resources are Extensive

North American shale plays (as of May 2011)

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI. Updated: May 9, 2011
Increased Contribution of Shale Gas to Total US Supply

U.S. dry gas production
trillion cubic feet per year

<table>
<thead>
<tr>
<th>Year</th>
<th>History</th>
<th>2010</th>
<th>Projections</th>
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<tbody>
<tr>
<td>1990</td>
<td>9%</td>
<td>23%</td>
<td>49%</td>
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<td>1995</td>
<td>9%</td>
<td>21%</td>
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<td>2000</td>
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</tr>
<tr>
<td>2005</td>
<td>9%</td>
<td>26%</td>
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<tr>
<td>2010</td>
<td>9%</td>
<td>23%</td>
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<td>2015</td>
<td>2%</td>
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<tr>
<td>2020</td>
<td>7%</td>
<td>7%</td>
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<tr>
<td>2025</td>
<td>7%</td>
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<td>2030</td>
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<tr>
<td>2035</td>
<td>7%</td>
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</table>

Source: EIA, Annual Energy Outlook 2012 Early Release
U.S. Oil Outlook also being Reshaped by Unconventionals as well as Efficiency means lower imports

Expectations of Natural Gas Production Have Increased Significantly

EIA US natural gas production projections, tcf/year

Source: EIA AEO Forecasts from Trevor Houser, Peterson Institute for International Economics, Unpublished Manuscript
And Natural Gas Price Expectations are Significantly Lower

Sources: EIA, Annual Energy Outlook 2011; EIA, Annual Energy Outlook 2010; and EIA, An Updated Annual Energy Outlook 2009 Reference Case
Oil and Gas Prices have Disconnected

Crude and Natural Gas Prices, 2011 USD per MMBTU

Source: EIA from Trevor Houser, Peterson Institute for International Economics, Unpublished Manuscript
An Overview of Natural Gas Pathways

Source: Royal Dutch Shell
Increasing Natural Gas Production Allows U.S. to Transition from Net Importer to Net Exporter of Natural Gas

Shale Gas has Major Implications for Electric Power Sector

• Utilities switching to gas fired capacity rather than coal. Coal share of power generation reduced.

• Cheaper gas combined with new environmental rules will accelerate closer of older coal power plants.

• Investment in new nuclear power plants will likely not happen except for protected markets or with substantial government support.

• Existing nuclear power plants under competitive pressure.

• Investment in renewable energy will also be challenged though state renewable standards and tax credits will provide support.
**FIGURE 28: LEVELISED COST OF ELECTRICITY FOR DIFFERENT GENERATION TECHNOLOGIES, Q1 2012 V Q1 2011 $ PER MWH**

- Marine - Wave: +8% (+23%)
- Marine - Tidal: +9%
- STEG - Parabolic Trough: +14%
- STEG - LFR: -14%
- STEG - Parabolic Trough + Storage: -33%
- STEG - Tower & Heliostat: -31%
- STEG - Tower & Heliostat w/Storage: -13%
- Wind - Offshore: +20%
- PV - c-Si: -35%
- PV - Thin Film: -4%
- Biomass - Gasification: -3%
- PV - c-Si Tracking: -2%
- Biomass - Anaerobic Digestion: -6%
- Biomass - Incineration: -4%
- Municipal Solid Waste: -2%
- Geothermal - Binary Plant: +5%
- Wind - Onshore: +13%
- Small Hydro: -3%
- Large Hydro: +5%
- Geothermal - Flash Plant: -1%
- Landfill Gas: +5%
- Natural Gas CCGT: -2%
- Nuclear: -1%
- Coal Fired: -2%

Source: Bloomberg New Energy Finance estimates
Federal and State Actions Supporting Renewable Energy

- Federal production tax credits supporting solar and wind energy.
- No progress on national clean energy standard.
- 36 states have some sort of renewable or alternative electricity standard (27 States have mandatory renewable RPS, 5 states have RE goals, 4 states have alternative portfolio standards that include CCS)
- 42 states offer green pricing - 11 have made it a mandatory utility offering
- One fully operational cap and trade market and one to begin soon

Source: Pew Center on Global Climate Change
Energy use grows slowly. Efficiency improves and mix shifts toward renewables and natural gas.

U.S. primary energy consumption quadrillion Btu per year

History

Projections

2010

Renewables (excluding liquid biofuels)

Nuclear

Natural gas

Liquid biofuels

Coal

Oil and other liquids

Source: EIA, Annual Energy Outlook 2012
Electricity Generation Shifts to Natural Gas and Renewables in Reference Case

Electricity net generation
trillion kilowatthours per year

<table>
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<tr>
<th></th>
<th>History</th>
<th>2010</th>
<th>Projections</th>
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<tbody>
<tr>
<td>Natural gas</td>
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<td>24%</td>
<td>28%</td>
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<tr>
<td>Renewables</td>
<td>10%</td>
<td>15%</td>
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<tr>
<td>Nuclear</td>
<td>20%</td>
<td>18%</td>
<td>18%</td>
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<tr>
<td>Coal</td>
<td>45%</td>
<td>38%</td>
<td>38%</td>
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<tr>
<td>Oil and other liquids</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
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</table>

Source: EIA, Annual Energy Outlook 2012
Natural gas and Renewables May Account for More than 90% of New Capacity to 2035

2010 capacity

- Coal: 313 giga-watts (30%)
- Nuclear: 101 giga-watts (10%)
- Hydropower*: 101 giga-watts (10%)
- Other renewables: 16 giga-watts (2%)
- Wind: 39 giga-watts (4%)
- Natural gas: 350 giga-watts (34%)
- Other fossil: 111 giga-watts (11%)

Total capacity: 1,036 giga-watts

Capacity additions 2010 to 2035

- Natural gas: 142 giga-watts (60%)
- Other renewables: 34 giga-watts (14%)
- Wind: 30 giga-watts (13%)
- End-use coal: 11 giga-watts (5%)
- Coal: 6 giga-watts (2%)
- Other fossil: 1 giga-watts (0.4%)

Total capacity additions: 235 giga-watts

* Includes pumped storage

Source: EIA, Annual Energy Outlook 2012
<table>
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<tr>
<th>Issue</th>
<th>Obama</th>
<th>Romney</th>
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<tbody>
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<td>LNG Exports</td>
<td>Under study; likely approval with volumetric/economic considerations</td>
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<tr>
<td>CAFE Standards</td>
<td>Increase mileage requirements (54.5 mpg by 2025)</td>
<td>Oppose mandates, could roll back</td>
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<tr>
<td>Nuclear</td>
<td>Supportive, economic/safety challenges</td>
<td>Improve NRC process, Yucca?*</td>
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<tr>
<td>Renewables</td>
<td>Supports tax credit extension*</td>
<td>Opposes tax credits</td>
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<tr>
<td>Climate</td>
<td>Continue GHG regulation by sector</td>
<td>Stop EPA regulations; repeal CAA requirements*</td>
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<tr>
<td>Alternative Fuel Vehicles</td>
<td>Continue to support credits*</td>
<td>“Not picking winners”</td>
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<tr>
<td>Energy Taxes</td>
<td>Favors reallocation of $/credits*</td>
<td>Thought to retain preferences though debate notion of all on the table?*</td>
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<tr>
<td>Oil Exports</td>
<td>Products permitted; no decision on crude</td>
<td>Opposes crude exports</td>
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<tr>
<td>Oil and Gas Access and Transport</td>
<td>GOM and Alaska, no ANWR. Stringent OCS permit rules. Likely approval of Keystone XL with conditions.</td>
<td>Streamline permits, relax rules, open more (federal) areas, increase states’ role. Approval of Keystone XL.</td>
</tr>
</tbody>
</table>

*requires Congressional action
Extra Slides
Unconventional Resources are Distributed Globally

IEA Estimate of Global Natural Gas Resources
Prospects for Shale Gas Development in China

• Shale gas development among government priorities.
• Shale resource estimates vary. Knowledge of the geology is limited.
• Desire to develop as indigenously as possible. The role of foreign companies uncertain.
• Access to technologies a key driver behind Chinese investments in N. America.
• Bottlenecks to the Development include:
  Lack of geological data; Technologies and Expertise; Fiscal regimes; Pricing regimes; Infrastructure; and Water.
• Chinese shale gas production may not eliminate import needs, but may serve as a bargaining leverage with gas exporters on price.
• Successful shale gas development in Asia may eventually affect global gas trade, primarily as LNG, but its scale may largely depend on the future trajectory of overall energy demand in China and India.