Implications of the U.S. Shale Revolution

For
US-Canada Energy Summit
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By
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U.S. Energy Information Administration
U.S. is the largest producer of petroleum and natural gas in the world

estimated U.S., Russia, and Saudi Arabia petroleum and natural gas production

<table>
<thead>
<tr>
<th></th>
<th>quadrillion Btu</th>
<th>million barrels per day of oil equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>Russia</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: U.S. Energy Information Administration
Note: Petroleum production includes crude oil, natural gas liquids, condensates, refinery processing gain, and other liquids, including biofuels; barrels per day oil equivalent were calculated using a conversion factor of 1 barrel oil equivalent=5.55 million British thermal units (Btu)
These seven regions accounted for 95% of U.S. oil production growth and all U.S. natural gas production growth from 2011-2013.

Source: EIA, Drilling Productivity Report
The U.S. has experienced a rapid increase in natural gas and oil production from shale and other tight resources.

Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through August 2014 and represent EIA’s official tight oil & shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).
U.S. shale gas leads growth in total gas production through 2040, when production exceeds 100 billion cubic feet per day

U.S. dry natural gas production
trillion cubic feet

billion cubic feet per day

history

2012

projections


- 100
- 90
- 80
- 70
- 60
- 50
- 40
- 30
- 20
- 10
0

Shale gas

Tight gas

Non-associated onshore

Tight gas

Associated with oil

Coalbed methane

Non-associated offshore

Alaska

Source: EIA, Annual Energy Outlook 2014, Reference case
Natural gas consumption growth is driven by electric power, industrial, and transportation use

U.S. dry gas consumption
trillion cubic feet

Source: EIA, Annual Energy Outlook 2014, Reference case

*Includes combined heat-and-power and lease and plant fuel
**Includes pipeline fuel
U.S. becomes a net exporter of natural gas in the near future

Source: EIA, Annual Energy Outlook 2014 Reference case
Projected U.S. natural gas trade depends on assumptions regarding resources and future technology advances.

- Reference case (trillion cubic feet per year):
  - 2010: 0
  - 2015: 0
  - 2020: 2
  - 2025: 4

- High Oil and Gas Resource case (trillion cubic feet per year):
  - 2010: 0
  - 2015: 0
  - 2020: 2
  - 2025: 4

- Exports to Mexico:
  - Reference case: 0
  - High Oil and Gas Resource case: 0

- Exports to Canada:
  - Reference case: 0
  - High Oil and Gas Resource case: 0

- Lower 48 LNG exports:
  - Reference case: 0
  - High Oil and Gas Resource case: 0

- Imports from Canada:
  - Reference case: 0
  - High Oil and Gas Resource case: 0

- LNG imports:
  - Reference case: 0
  - High Oil and Gas Resource case: 0

Source: EIA, Annual Energy Outlook 2014, Reference case and High Oil and Gas Resource case
Shale gas in eastern Canada

- Of the four shale plays in Eastern Canada, two have been assessed by ARI
  - **Utica** in Quebec has 31.1 Tcf of technically recoverable resources
  - **Horton Bluff** in Nova Scotia has 3.4 Tcf of technically recoverable resources

- These shale resource volumes are not included in NEB’s 2013 estimates

- Quebec enacted a hydraulic fracturing moratorium in 2012 pending further research

- New Brunswick permits hydraulic fracturing, but has imposed strict rules surrounding it

- Nova Scotia, similar to Quebec, will not permit hydraulic fracturing until the completion of a review, due mid-2014

*Source: Advanced Resources International, “Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States”*
### LNG export projects in eastern Canada

<table>
<thead>
<tr>
<th></th>
<th>Goldboro LNG Terminal</th>
<th>H-Energy LNG Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned year in service</td>
<td>2019</td>
<td>2020</td>
</tr>
<tr>
<td>Liquefaction capacity</td>
<td>1.3 Bcf/d</td>
<td>0.6 Bcf/d</td>
</tr>
<tr>
<td>Storage capacity</td>
<td>14.6 Bcf</td>
<td>N/A</td>
</tr>
<tr>
<td>Contract</td>
<td>20 year supply deal with E. On AG</td>
<td>N/A</td>
</tr>
<tr>
<td>Supply sources</td>
<td>Marcellus, eastern Canada</td>
<td>N/A</td>
</tr>
<tr>
<td>NEB approval</td>
<td>Under review</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Source:** Company websites
Resources in eastern Canada are modest compared with the Canada national total

Canada marketable resources in trillion cubic feet as of 12/31/12

<table>
<thead>
<tr>
<th>Region</th>
<th>Resources (Tcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario and Quebec</td>
<td>8</td>
</tr>
<tr>
<td>West coast</td>
<td>17</td>
</tr>
<tr>
<td>East coast</td>
<td>91</td>
</tr>
<tr>
<td>Northern Canada</td>
<td>116</td>
</tr>
<tr>
<td>WCSB*</td>
<td>861</td>
</tr>
</tbody>
</table>

Note: WCSB stands for Western Canada Sedimentary Basin. All Territories are included under Northern Canada.
Resource and technology assumptions have major implications for projected U.S. crude oil production beyond the next few years.

Reference case
million barrels per day

<table>
<thead>
<tr>
<th>1990</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>history</td>
<td>2012</td>
<td>projections</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
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High Oil and Gas Resource case
million barrels per day

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<td>14</td>
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Source: EIA, Annual Energy Outlook 2014; Short Term Energy Outlook, October 2014
Most of the growth in production between 2011 and 2015 consists of sweet grades with API gravity of 40 or above.

U.S. crude oil production by type

Source: EIA, DrillingInfo, Colorado DNR, Texas RRC. [http://www.eia.gov/analysis/petroleum/crudetypes/]
U.S. rail carloads of crude oil and petroleum products exceed 1.5 million b/d in 2014

Source: U.S. Energy Information Administration, based on Association of American Railroads
U.S. is already a major net exporter of petroleum products

U.S. petroleum product net exports
million barrels per day

Source: EIA, Annual Energy Outlook 2014 Reference case and Short Term Energy Outlook
Over 60% of U.S. petroleum product exports go to the Americas, with Mexico and Canada as its largest global trading partners.

U.S. petroleum product gross exports
million barrels per day

Source: EIA Americas Report
Most significant contributors to non-OPEC crude and lease condensate production: Canada, Brazil, U.S., Kazakhstan, Russia

non-OPEC crude and lease condensate production, Reference case
million barrels per day

Tight oil production will spread to nations outside of the United States and Canada over the projection

Tight oil production, Reference case
million barrels per day

Growing U.S. oil production and rising demand in China have together made China the world’s largest net oil importer.

Note: Net oil imports are defined as total liquid fuels consumption less domestic production.

Source: EIA, Short-Term Energy Outlook, October 2014
Over the IEO projection, OPEC crude and lease condensate suppliers produce an additional 14 MMbbl/d

petroleum and other liquid fuels production, Reference case

million barrels per day

Areas of uncertainty in the outlook

• China’s energy demand growth; particularly in transportation
  – EIA is working with MIT and others to upgrade the structural and macroeconomic determinates of transportation demand in all regions for IEO2015

• Increasing global trade of natural gas and HGL in addition to oil
  – EIA is integrating the representation of oil and natural gas supply and other hydrocarbons

• Global development of tight oil and shale gas resources
  – EIA is gathering geology and production information, and conducting outreach

• Impact of geopolitical tensions on energy supply
  – EIA exploring options for representing these uncertainties in the outlook
For more information

U.S. Energy Information Administration home page | [www.eia.gov](http://www.eia.gov)

Annual Energy Outlook | [www.eia.gov/aEO](http://www.eia.gov/aEO)

Short-Term Energy Outlook | [www.eia.gov/steo](http://www.eia.gov/steo)

International Energy Outlook | [www.eia.gov/ieo](http://www.eia.gov/ieo)

Monthly Energy Review | [www.eia.gov/mer](http://www.eia.gov/mer)

Today in Energy | [www.eia.gov/todayinenergy](http://www.eia.gov/todayinenergy)

State Energy Portal | [www.eia.gov/state](http://www.eia.gov/state)

Drilling Productivity Report | [www.eia.gov/petroleum/drilling/](http://www.eia.gov/petroleum/drilling/)