The U.S. Energy Situation

EXPLORING CONSUMPTION & SUPPLY ISSUES

BY J. RICHARD MOORE
# US/Canada Energy Relationship

### Canada
- Major energy exporter
- Largest oil & gas supplier to US

**2008 Canada statistics**
- Oil production: 3.35 mm bopd
- Oil exports: 1.90 mm bopd
- Oil export % to US = 99+
- Gas production: 6.0 TCF
- Gas exports: 3.6 TCF
- Gas export % to US = 100

### United States
- Major energy importer
- Largest buyer of Can. oil and gas

**2008 US statistics**
- Oil consumption: 15.00 mm bopd
- Oil imports: 9.80 mm bopd
- Oil import % from Canada = 19
- Gas consumption: 23.3 TCF
- Gas imports: 4.0 TCF
- Gas import % from Canada = 90

**Source:** US EIA, Canada ERB
U.S. energy consumption
Measuring energy consumption

"BTU"
British Thermal Unit (ability to do work)

"QUAD"
Quadrillion BTU ($10^{15}$)

1 BTU × 1 million = 1 million BTU = 1 MM BTU
1 QUAD = 1 billion × 1 million BTU

1 QUAD is equivalent to the annual energy consumption of 5.5 million U.S. households in 2009.

1 gigajoule ("GJ"): approximately 1 million BTU
1000 petajoules ("PJ"): approximately 1 "quad"
# Energy consumption in the U.S.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Total (QUADS)</td>
<td>34.62</td>
<td>78.00</td>
<td>94.77</td>
<td>101.60</td>
<td>94.58</td>
</tr>
<tr>
<td>Per capita (MMBTU)</td>
<td>227</td>
<td>354</td>
<td>348</td>
<td>337</td>
<td>308</td>
</tr>
<tr>
<td>Per $ real GDP (MBTU)</td>
<td>19.48</td>
<td>14.5</td>
<td>9.62</td>
<td>7.66</td>
<td>7.28</td>
</tr>
</tbody>
</table>
### Primary U.S. energy consumption by sector (QUADS)

<table>
<thead>
<tr>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>4.85</td>
<td>8.21</td>
<td>7.04</td>
<td>6.69</td>
<td>6.61</td>
</tr>
<tr>
<td>Commercial</td>
<td>2.82</td>
<td>4.22</td>
<td>4.26</td>
<td>3.90</td>
<td>3.97</td>
</tr>
<tr>
<td>Industrial</td>
<td>13.88</td>
<td>23.19</td>
<td>23.72</td>
<td>21.44</td>
<td>18.75</td>
</tr>
<tr>
<td>Transportation</td>
<td>8.39</td>
<td>19.79</td>
<td>24.70</td>
<td>29.00</td>
<td>26.95</td>
</tr>
<tr>
<td>Electric Generation*</td>
<td>4.68</td>
<td>22.59</td>
<td>35.05</td>
<td>40.57</td>
<td>38.30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>34.62</td>
<td>78.00</td>
<td>94.77</td>
<td>101.60</td>
<td>94.58</td>
</tr>
</tbody>
</table>

*Electricity is generated from other energy sources and used in all 4 sectors

**Source:** EIA AER 2009, Table 21.a,
Our lives & standard of living are dependent on consumption of energy.

U.S. energy consumption is growing, driven by population increase & rising standard of living.

Largest & fastest growing consumption sector is electric generation.

Payment for delivered energy consumed in residential sector not made (or cost known) when consumption occurs. More (maybe substantially more) than 50% of total energy costs paid in prices of goods & services purchased; not apparent as energy costs to us.
Sources of primary energy consumed in the U.S.
2009
U.S. primary energy consumption
BY SOURCE & SECTOR (QUADS)

Total = 94.6

SOURCE: EIA AER 2009
## Source of Primary energy consumed (Quads)

### 2009

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Domestic Production</th>
<th>Net* Imports</th>
<th>Total Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum &amp; NGL</td>
<td>13.78</td>
<td>21.47</td>
<td>36.72</td>
</tr>
<tr>
<td>Natural gas</td>
<td>21.50</td>
<td>1.86</td>
<td>24.20</td>
</tr>
<tr>
<td>Coal</td>
<td>21.58</td>
<td>&lt;1.82&gt;</td>
<td>22.68</td>
</tr>
<tr>
<td>Nuclear** (loaded into reactors)</td>
<td>.92</td>
<td>7.43</td>
<td>8.46</td>
</tr>
<tr>
<td>Renewables</td>
<td>7.76</td>
<td>&lt;.02&gt;</td>
<td>7.32</td>
</tr>
<tr>
<td>Inventory / Bal.***</td>
<td>.07</td>
<td>.05</td>
<td>.12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>65.61</strong></td>
<td><strong>28.97</strong></td>
<td><strong>94.58</strong></td>
</tr>
</tbody>
</table>

*Net imports=consumption minus production (includes inventory change & balancing)

**Nuclear based on ratio of quantities of domestic production/imported uranium oxide(9.3)

***Ratio of domestic/import to total

Source: EIA AIR 2009, TABLES 1.1 through 1.4, 9.3; Uranium Marketing Annual 2009
Energy consumption is a vital part of our standard of living.

We now import nearly 1/3 of the energy we consume (37% in 2007).

Imports provide 2/3 of our petroleum.

Energy prices have been rising and volatility has increased.

Supply security is uncertain.

World demand is increasing.
U.S. energy situation

CONCERNS & PROBLEMS
The cost of energy we rely on for our way of life is increasing because “cheap” energy supplies have been consumed.

Rising energy costs can reduce our economic competitiveness & our standard of living.

Growth in energy imports increases our exposure to economic & political threats related to supply interruptions.

Current methods of using traditional energy resources produce undesirable environmental side effects that are expensive to mitigate.
What do we need?

1) More efficient use of energy AND expanded supplies of energy

OR,

2) Fewer people AND reduced standard of living
U.S. energy situation

POSSIBLE SOLUTIONS
Efficiency & conservation
2009 U.S. non-transportation energy consumption (67.6 QUADS)

- **Primary energy***
  - Electrical generation

- **Residential (21.3)**
  - Lights
  - HVAC
  - Appliances

- **Commercial (18.2)**
  - Lights
  - HVAC
  - Appliances
  - Machines

- **Industrial (28.1)**
  - Lights
  - HVAC
  - Appliances
  - Machines
  - Feedstock/process fuel

*Includes renewables (hydro, biomass, etc.)*

**SOURCE:** 2009 AER Table 2.1a-d
Electric generation conversion efficiency

End-use electrical consumption by sector-2009 (QUADS)

- Retail sales of electricity
- Electric system loss allocation
- Total electrical consumption (Sum of retail sales + losses)

Source: EIA Apr. 2010 MER
Thermal efficiency of electric generation

<table>
<thead>
<tr>
<th>Primary Fuel</th>
<th>Conversion Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td></td>
</tr>
<tr>
<td>• Typical steam/electric</td>
<td>30-35</td>
</tr>
<tr>
<td>• Integrated gasification</td>
<td>39</td>
</tr>
<tr>
<td>Natural gas</td>
<td></td>
</tr>
<tr>
<td>• Simple cycle gas turbine</td>
<td>35-40</td>
</tr>
<tr>
<td>• Combined cycle gas turbine (CCGT)</td>
<td>60</td>
</tr>
<tr>
<td>• Cogeneration/CCGT</td>
<td>90</td>
</tr>
</tbody>
</table>

ROOM FOR IMPROVEMENT

Improved efficiency will lower fuel consumption and emissions.
Expanded energy supplies
U.S. energy problems
Big picture

EXPANDED ENERGY SUPPLIES:
WHAT FUELS FOR WHAT PURPOSES?

Source: AER 2009

SECTOR

Transportation fuel
Electric generation

PROBLEMS

Imports (petroleum) cost & security
Emissions (fossil fuels) cost & efficiency
**Expanded U.S. Energy Supplies Summary**

<table>
<thead>
<tr>
<th>Source</th>
<th>U.S.</th>
<th></th>
<th>World</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proved</td>
<td>Potential</td>
<td>Proved</td>
<td>Potential</td>
</tr>
<tr>
<td>Oil</td>
<td>10</td>
<td>94 (1150)*</td>
<td>52</td>
<td>97 (244)*</td>
</tr>
<tr>
<td>Gas</td>
<td>11</td>
<td>91 (13,922)**</td>
<td>61</td>
<td>125 (7,000)**</td>
</tr>
<tr>
<td>Coal</td>
<td>237</td>
<td>446</td>
<td>149</td>
<td>56</td>
</tr>
<tr>
<td>Nuclear</td>
<td>19</td>
<td>70-117</td>
<td>39</td>
<td>N/A</td>
</tr>
<tr>
<td>Renewables</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Shale & tar sands

**Hydrates

**We are not running out of energy; We are running out of cheap energy.**
**Solution 1**

Significant room for energy consumption reductions through conservations & efficiency

**Requires**
- Incentives
- Education

**Solution 2**

Additional energy resources available domestically & worldwide

**Requires**
- Economic energy prices
- Access to land
- Government policies supporting expansion of economic domestic energy supplies
Practical constraints & appropriate policies
## Lead times & required investment of representative projects

<table>
<thead>
<tr>
<th>Source</th>
<th>Lead time (years)</th>
<th>Size of typical project</th>
<th>$ Cost/unit</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oil/gas field</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Onshore</td>
<td>1-5</td>
<td>n/a</td>
<td>$2-10 MM/well</td>
<td>$100 MM</td>
</tr>
<tr>
<td>Offshore</td>
<td>8-12</td>
<td>n/a</td>
<td>$55-100 MM</td>
<td>$200 MM-3 billion</td>
</tr>
<tr>
<td>Alaska (PT Thompson)</td>
<td>8-12</td>
<td>5-well pkg (delineation)</td>
<td></td>
<td>$1.3 billion</td>
</tr>
<tr>
<td><strong>Oil refinery</strong></td>
<td>3-8</td>
<td>300k BBL/D</td>
<td>$15-20k/BBL</td>
<td>$4.5-6 billion</td>
</tr>
<tr>
<td><strong>Electric generation Plant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas</td>
<td>5-6</td>
<td>400 mw</td>
<td>$.5-2.5 k/kw</td>
<td>$2-6 billion</td>
</tr>
<tr>
<td>Coal</td>
<td>6-8</td>
<td>600 mw</td>
<td>$1.5-2.5 k/kw</td>
<td>$9-1.5 billion</td>
</tr>
<tr>
<td>Nuclear</td>
<td>10-12</td>
<td>1,350 mw</td>
<td>$2.5 k/kw</td>
<td>$3.5 billion</td>
</tr>
<tr>
<td>Wind</td>
<td>4-6</td>
<td>50 mw</td>
<td>$1.5-2.8k/kw</td>
<td>$.08-.14 billion</td>
</tr>
<tr>
<td><strong>Transmission Lines</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Electric</td>
<td>1-3</td>
<td>n/a</td>
<td>$.5-3.5 MM/mi (above ground)</td>
<td></td>
</tr>
<tr>
<td>Natural gas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onshore</td>
<td>1-3</td>
<td>n/a</td>
<td>$.7-6.0 MM/mi. (avg. $2.1 MM/mi.)</td>
<td></td>
</tr>
<tr>
<td>Offshore</td>
<td>2-5</td>
<td>n/a</td>
<td>$8-12 MM/mi.</td>
<td></td>
</tr>
<tr>
<td><strong>Oil shale production</strong></td>
<td>5-10</td>
<td>100k BBL/D</td>
<td>$4-6 billion</td>
<td>$4-6 billion</td>
</tr>
</tbody>
</table>

*Source: EIA AEO 2008, O&G J. 9/1/08, 2/2/09 & Exxon 8/28/08*
Policy Implications

Oil exploration & production
- Frac water re-use
- Road traffic/noise limitations

Electric generation
- Fossil fuel plant emissions
- Nuclear facility design & fuel storage/disposal

Auto emissions (miles per gallon)

Building & appliance efficiency
To **accept** inevitable cost increases & **modify** behavior, the public must **understand** energy issues.

- Cheap energy is gone.
- Cleaning up environment will add costs.
- Doing nothing is not really an option; doing the **wrong** thing will be expensive.
- Analysis & debate should be encouraged.
- Differing opinions should be addressed, not ridiculed.
- Media should provide complete picture to the public.
- Role for government & schools is to inform public.
Thank you.

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