Efficiency and Intensity in the AEO 2010

Session 9
Energy Efficiency: Measuring Gains and Quantifying Opportunities

April 7, 2010
2010 Energy Conference
Washington, DC

Steve Wade, Economist
Overview

• What are the sources of efficiency in the AEO 2010?

• What is the contribution of energy efficiency to projected U.S. energy intensity?

• How do AEO scenarios relate to technical potential?
Sources of efficiency

• Technology
  – Stock turnover
  – Progress and learning

• Mandates
  – CAFÉ, efficiency standards (NAECA, EPACT), building codes…
  – Renewable fuel standards

• Incentives
  – Tax credits, loan guarantees, grants, …
    ◆ Energy efficiency and renewables - ACESA, ARRA (stimulus bill) …
    ◆ Investment tax credits
    ◆ Production tax credits for renewable generation
  – Voluntary programs like Energy Star, Rebuild America
Key Concepts

• Energy Efficiency
  – Primary energy consumption per energy services provided
  – Driven by technology improvements

• Energy Intensity
  – Primary energy consumption per real GDP
  – Efficiency + structural changes

• Carbon Intensity
  – Carbon emissions per real GDP
  – Efficiency + structural changes + decarbonization
Decomposition of carbon intensity

De-carbonization: 2035 Carbon/Energy ratio is 95% of its 2008 value in Reference case

Average annual rate of decrease

Efficiency
-0.5%
Structure
-1.9%
Decarbonization
-2.1%

Index, 2008=1

Examples of structural changes

• Conservation
  – Changes in energy use that reduce consumption by reducing services provided

• Buildings
  – Migration to moderate climates
  – Housing type shifts / commercial building mix

• Industry
  – Shifts to less energy-intensive industries
  – Growth of service sector relative to industry

• Transportation
  – Vehicle type shifts (cars, mini-vans, SUVs, and light trucks)
  – Urbanization, shifts to mass transit, biking / walking…
# Structural drivers grow slower than GDP

<table>
<thead>
<tr>
<th>CAGR: 2008 - 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macroeconomic</strong></td>
</tr>
<tr>
<td>Real Gross Domestic Product</td>
</tr>
<tr>
<td>Population</td>
</tr>
<tr>
<td><strong>NEMS Sectoral Drivers</strong></td>
</tr>
<tr>
<td><strong>Buildings</strong></td>
</tr>
<tr>
<td>Households</td>
</tr>
<tr>
<td>Commercial Floorspace</td>
</tr>
<tr>
<td><strong>Industrial (Real Value Shipments)</strong></td>
</tr>
<tr>
<td>Non-Manufacturing</td>
</tr>
<tr>
<td>Energy Intensive Manufacturing</td>
</tr>
<tr>
<td>Non-Energy Intensive Manufacturing</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
</tr>
<tr>
<td>Light Duty Vehicle-Miles Traveled</td>
</tr>
<tr>
<td>Freight Truck Vehicle-Miles Traveled</td>
</tr>
<tr>
<td>Air Seat Miles</td>
</tr>
<tr>
<td>Rail Ton-Miles</td>
</tr>
</tbody>
</table>

Contribution of technology improvements

• Low technology integrated case
  – No future technology advances
    ♦ Equipment and shells limited to what was available in 2009
    ♦ Equipment stocks improve through turnover

• Reference case
  – Future technology improvements
  – Equipment purchases calibrated to observed behavior

• High technology integrated case
  – Advanced equipment available earlier at lower cost
  – Purchases based on reduced discount rates
  – Building shells get more efficient than Reference

Note: All cases have same stock turnover rate
  – No aggressive retrofitting
Energy efficiency and intensity across technology cases

Primary Energy Consumption difference from Reference Case, 2035

2009 Technology = 2.4 quad Btu increase

High Technology = 5.7 quad Btu decrease

Approaching technology potential: buildings best case

• Buildings case only
  – Residential and commercial sectors
  – Not integrated with other modules

• Best technology case
  – Equipment costs ignored
  – Only the most efficient technologies are allowed
  – Shells even better than High technology case

• Reference assumptions on stock turnover
  – *No aggressive retrofitting*
Buildings delivered energy use per square foot

Approaching technical potential: buildings best case

• Best case still not maximum technical potential
• Long-lived, rapidly advancing technologies do not fully penetrate by 2035
  – LED lighting
  – Geothermal heat pumps
  – Miscellaneous buildings equipment
  – Building shells

• Technical Potential
  – Post-2035 intensity could ultimately fall to 43 percent lower than 2009 (from 38 percent in 2035)
For more information


Thank you

Steve Wade
Steven.Wade@eia.gov
202-586-1678

U.S. Energy Information Administration
www.eia.gov