Energy Demand, Supply and Prices: A Look Ahead

presented to the
National Conference of State Legislators
by
Robert T Eynon
Energy Information Administration
U.S. Department of Energy
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Louisville, Kentucky
Energy Information Administration

- Independent statistical agency within the Department of Energy
  - www.eia.doe.gov
- Produce monthly short-term and annual long-term forecasts of U.S. and world energy markets
- Short Term Energy Outlook
- Annual Energy Outlook, 2010
- International Energy Outlook, 2010
- Produce special analyses of emerging issues and the impacts of regulatory/legislative changes
  - http://www.eia.doe.gov/oiaf/service_rpts.htm
  - http://www.eia.doe.gov/oiaf/analysis.htm
- EIA’s analyses and projections should not be seen as advocating or reflecting any position of the Department of Energy, the Administration, or any other organization.
Assumptions in the Annual Energy Outlook 2010

• Long-term economic growth averages about 2.4 percent per year between 2008 and 2035
• World oil prices are projected to decline from current levels and then increase at the end of the projection period
• Federal, State, and local laws and regulations in effect on December 31, 2009 are assumed to remain in effect.
The economy, oil prices, resources, policies, and behavior drive the AEO2010 reference case

• World crude oil prices reach $133 per barrel (in 2008 dollars) by 2035

• A robust domestic natural gas resource base allows for a steady expansion of production given projected growth in demand and prices

• Recently-enacted policies and concerns over greenhouse gas (GHG) emissions, combined with high energy prices, moderate projected growth in energy consumption and emissions
About the Annual Energy Outlook 2010

• Energy markets are uncertain!

• AEO2010 includes 39 cases, including:
  – Three alternative economic growth cases
  – Three alternative oil/gas price cases
  – Three coal price cases
  – Dozens of alternative technology cases
    • Lower and higher renewable technology cost and performance cases
    • Lower and higher nuclear technology cost and performance cases
    • Lower and higher fossil technology cost and performance cases
    • Lower and higher end use technology cost and performance cases
  – Several regulatory sensitivity cases
  – Across cases:
    • 2035 world oil price ranges from $51 to $210 per barrel
    • 2035 wellhead natural gas price ranges $7.39 to $ 8.85 per thousand cubic feet
• All cases should be considered
Primary energy use by end-use sector, 2008-2035

Source: Annual Energy Outlook 2010
Energy use per capita and per dollar of gross domestic product, 1980-2035

Source: Annual Energy Outlook 2010
Energy Production by Fuel, 1980-2035
(quadrillion Btu)

- **Coal**: 0.2%
- **Natural gas**: 0.5%
- **Petroleum**: 0.9%
- **Non-hydro renewables**: 5.9%
- **Nuclear**: 0.4%
- **Hydropower**: 0.7%
Energy Prices, 1980-2035
(2008 dollars per million Btu)

History

Projections

- Electricity: 0.1%
- Crude Oil: 1.0%
- Natural gas: 0.0%
- Coal: 0.1%

U.S. electricity demand growth, 1950-2035

percent, 3-year moving average

Source: Annual Energy Outlook 2010
Factors in technology selection

- Demand growth and load characteristics
- Existing generating technology mix
- New generating technology cost and performance characteristics
- Fuel prices
- Interest rates / cost of capital
- Tax and other policy incentives
- Environmental regulations
- Regulatory structure
- Uncertainty about all of the above
Levelized electricity costs for new power plants, 2020 and 2035

- **Natural gas**: 2020
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Wind**: 2020
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Coal**: 2020
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Nuclear**: 2020
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Natural gas**: 2035
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Wind**: 2035
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Coal**: 2035
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

- **Nuclear**: 2035
  - Capital costs
  - Incremental transmission costs
  - Variable costs, including fuel
  - Fixed costs

*Source: Annual Energy Outlook 2010*
Electricity generation capacity additions by fuel type, 2009-2035

Source: Annual Energy Outlook 2010
Electricity Generation by Fuel, 1980-2035
(billion kilowatthours)

Electricity Demand

Coal

Natural gas

Nuclear

Renewables

Liquids

History

Projections

Capacity additions as a percent of 2008 capacity by North American Electric Reliability Council region, 2009-2035

National Total = 20.4%

- 175 to 225
- 125 to 175
- 75 to 125
- 50 to 75
- 25 to 50

EIA

18.9%
37.2%
11.7%
16.6%
10.8%
14.0%
20.3%
39.9%
45.3%
17.7%
10.2%
Electricity generation capacity additions, including combined heat and power, by region and fuel, 2009-2035

- **ECAR**
- **ERCOT**
- **MAAC**
- **MAIN**
- **MAPP**
- **NY**
- **NE**
- **FL**
- **SERC**
- **SPP**
- **NWP**
- **RA**
- **CA**

Gigawatts

- Coal
- Nuclear
- Renewable/Other
- Natural Gas
Nonhydroelectric renewable electricity generation by energy source, 2008-2035

Source: Annual Energy Outlook 2011
Regional growth in nonhydroelectric renewable electricity generation capacity, including end-use capacity, 2008-2035

Source: Annual Energy Outlook 2010
Electricity prices rise with higher capital and fuel costs and growing demand

cents per kilowatthour

History

Projections

Nominal

Real 2008

17.1

10.2

0 2 4 6 8 10 12 14 16 18

1990 2000 2010 2020 2030

10.2

17.1
Average Electricity Prices, 2009-2035

2008 cents/kWh

- National
- Ecar
- Ercot
- Maac
- Main
- Mapp
- NY
- NE
- FI
- STV
- SPP
- NWP
- RA
- CNV
Natural gas price drivers

- Resource depletion
- Demand growth
- Increased production from non-conventional sources
- Production from Alaska
- LNG imports
Natural Gas Consumption by Sector, 1990-2035 (trillion cubic feet)

- **Industrial**: Includes lease and plant fuel
- **Electric Power**: Includes pipeline fuel

*Source: Annual Energy Outlook 2010*
U.S. natural gas supply, 1990-2035

trillion cubic feet

History

Projections

Shale gas

Coalbed methane

Non-associated onshore

Non-associated offshore

Associated (with oil)

Net imports

Source: Annual Energy Outlook 2010
Incremental natural gas production by region, 2008-2035 (trillion cubic feet)

* Includes Offshore

Source: Annual Energy Outlook 2010
Lower 48 Wellhead and Henry Hub Spot Natural Gas Prices, 1990-2035 (2008 dollars per thousand cubic feet)

Source: Annual Energy Outlook 2010
Coal price drivers

- Production in Powder River basin
- Miner productivity
- Natural gas prices
Distribution of coal to domestic markets by supply and demand regions, including imports, 2008 and 2035 (quadrillion Btu)

**Supply Region**
- Appalachia
- Interior
- West
- Imports
- Total

**Demand East of the Mississippi River**

**Demand West of the Mississippi River**

- 2008
- 2035
Coal production, 2035 (and 2008) (million short tons)

U.S. Total: 1,285 (1,172) million short tons

*Includes production from all mines in Wyoming’s Powder River Basin.
** Includes production from mines in both Alaska and Washington.

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting
Average minemouth price of coal by region, 1990-2035
(2008 dollars per million Btu)

U.S. Average, Nominal Dollars

- **Appalachia**
  - History: $2.43
  - Projections: $2.43

- **Interior**
  - History: $2.00
  - Projections: $2.00

- **West**
  - History: $1.50
  - Projections: $1.50

- **U.S. Average**
  - History: $1.00
  - Projections: $1.00

The chart provides a historical perspective and projections for the average minemouth price of coal in the United States for the specified regions from 1990 to 2035.
Liquid fuels consumption by sector, 1990-2035

- **Transportation**
- **Industrial**
- **Electric power**
- **Buildings**

Source: Annual Energy Outlook 2010
Domestic crude oil production by source, 1990-2035

million barrels per day

History

Projections

Source: Annual Energy Outlook 2010
Liquids production from biomass, coal, and oil shale, 2008-2035

thousand barrels per day

Source: Annual Energy Outlook 2010
U.S. Imports of Liquid Fuels

- 2025 projecting an increase to 57%.
- Historical data shows a steady rise from 1970 to 2005.
- Projected future shows a steady rise beyond 2005.

- Historical consumption data shows a peak around 1985.
- Projected future consumption is expected to increase steadily.

- Production data shows a general increase from 1970 to 2005, with a slight decrease in the late 1990s.
- Projected future production is expected to continue this trend.

Net imports in 2025 are projected to be 45% of consumption.
Carbon dioxide emissions by sector and fuel, 2008 and 2035

Source: Annual Energy Outlook 2010
Annual Energy Outlook 2010 indicates that over the next two decades there will be ....

- Moderate growth in energy consumption
- Increased use of renewables
- Declining reliance on imported liquid fuels
- Strong growth in shale gas production
- Slow growth in carbon dioxide emissions in the absence of new policies designed to mitigate greenhouse gas emissions
If you have questions, please contact me at:

robert.eynon@eia.gov
### Cost and Performance Characteristics of New Central Station Electricity Generating Technologies

<table>
<thead>
<tr>
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<td>1.07</td>
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<td>Integrated Coal-Gasification Combined Cycle (IGCC)</td>
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<td>1.07</td>
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<td>2,559</td>
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<td>2016</td>
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<td>1.07</td>
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<td>937</td>
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<td>1.05</td>
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<td>984</td>
<td>2.11</td>
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<td>Adv Gas/Oil Comb Cycle (CC)</td>
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<td>897</td>
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<td>1.08</td>
<td>1.00</td>
<td>968</td>
<td>2.04</td>
<td>11.98</td>
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<td>ADVCC with Carbon Sequestration</td>
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<td>400</td>
<td>3</td>
<td>1,720</td>
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<td>1.08</td>
<td>1.04</td>
<td>1,932</td>
<td>3.01</td>
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<td>160</td>
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<td>1.05</td>
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<td>Adv Combustion Turbine</td>
<td>2011</td>
<td>230</td>
<td>2</td>
<td>617</td>
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<td>1.05</td>
<td>1.00</td>
<td>648</td>
<td>3.24</td>
<td>10.77</td>
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<td>Fuel Cells</td>
<td>2012</td>
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<td>3</td>
<td>4,744</td>
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<td>1.05</td>
<td>1.10</td>
<td>5,478</td>
<td>49.00</td>
<td>5.78</td>
<td>7,930</td>
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<td>Advanced Nuclear</td>
<td>2015</td>
<td>1,350</td>
<td>6</td>
<td>3,436</td>
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<td>1.10</td>
<td>1.05</td>
<td>3,620</td>
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<td>Distributed Generation-Base</td>
<td>2012</td>
<td>2</td>
<td>3</td>
<td>1,334</td>
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<td>1.05</td>
<td>1.00</td>
<td>1,400</td>
<td>7.28</td>
<td>16.39</td>
<td>9,050</td>
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<td>Distributed Generation-Peak</td>
<td>2011</td>
<td>1</td>
<td>2</td>
<td>1,601</td>
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<td>1.05</td>
<td>1.00</td>
<td>1,661</td>
<td>7.28</td>
<td>16.39</td>
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<td>Biomass</td>
<td>2013</td>
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<td>4</td>
<td>3,414</td>
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<td>1.07</td>
<td>1.05</td>
<td>3,849</td>
<td>5.86</td>
<td>65.89</td>
<td>9,461</td>
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<td>Geothermal*</td>
<td>2010</td>
<td>50</td>
<td>4</td>
<td>1,666</td>
<td></td>
<td>1.05</td>
<td>1.00</td>
<td>1,749</td>
<td>0.00</td>
<td>168.33</td>
<td>32,969</td>
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<td>MSW - Landfill Gas</td>
<td>2010</td>
<td>30</td>
<td>3</td>
<td>2,490</td>
<td></td>
<td>1.07</td>
<td>1.00</td>
<td>2,569</td>
<td>0.01</td>
<td>116.80</td>
<td>13,648</td>
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<td>Conventional Hydropower*</td>
<td>2013</td>
<td>500</td>
<td>4</td>
<td>2,084</td>
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<td>1.10</td>
<td>1.00</td>
<td>2,281</td>
<td>2.40</td>
<td>13.93</td>
<td>9,884</td>
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<td>Wind</td>
<td>2009</td>
<td>50</td>
<td>3</td>
<td>1,837</td>
<td></td>
<td>1.07</td>
<td>1.00</td>
<td>1,966</td>
<td>0.00</td>
<td>30.98</td>
<td>9,884</td>
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<td>Wind Offshore</td>
<td>2013</td>
<td>100</td>
<td>4</td>
<td>3,402</td>
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<td>1.10</td>
<td>1.02</td>
<td>3,937</td>
<td>0.00</td>
<td>86.92</td>
<td>9,884</td>
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<td>Solar Thermal*</td>
<td>2012</td>
<td>100</td>
<td>3</td>
<td>4,798</td>
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<td>1.07</td>
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<td>0.00</td>
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<td>Photovoltaic*</td>
<td>2011</td>
<td>5</td>
<td>2</td>
<td>5,879</td>
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<td>1.05</td>
<td>1.00</td>
<td>6,171</td>
<td>0.00</td>
<td>11.94</td>
<td>9,884</td>
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</table>
Overnight construction costs
(2008 dollars per kilowatt)
2025 levelized costs
(2008 dollars per megawatt-hour)
Fuel Prices to Electricity Generators

(2008 dollars per million Btu)

- Distillate (0.9%)
- Natural Gas (-0.3%)
- Coal (0.1%)
- Uranium (0.7%)
Electricity generation by fuel in three cases, 2008 and 2035

<table>
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<tr>
<th>Fuel</th>
<th>2008</th>
<th>Low Economic Growth</th>
<th>Reference</th>
<th>High Economic Growth</th>
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<tr>
<td>Nuclear</td>
<td>373</td>
<td>806</td>
<td>883</td>
<td>951</td>
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<tr>
<td>Renewables</td>
<td>1995</td>
<td>2130</td>
<td>2305</td>
<td>2505</td>
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<tr>
<td>Natural gas</td>
<td>879</td>
<td>953</td>
<td>1093</td>
<td>1181</td>
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<tr>
<td>Petroleum</td>
<td>1039</td>
<td>1181</td>
<td>1206</td>
<td>1226</td>
</tr>
<tr>
<td>Coal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Annual Energy Outlook 2010
Electricity Sales by Sector, 2007-2035 (billion kilowatthours)

Average annual sales growth is 0.8%
Biomass Resources Available in the United States

This study estimates the technical biomass resources currently available in the United States by county. It includes the following feedstock categories:
- Agricultural residues (crops and animal manure)
- Wood residues (forest, primary mill, secondary mill, and urban wood)
- Municipal discards (methane emissions from landfills and domestic wastewater treatment)
- Dedicated energy crops (on Conservation Reserve Program and Abandoned Mine Lands)
Oil prices in the reference case rise steadily; the full AEO includes a wide range of price cases.
Technically Recoverable U.S. Natural Gas Resources, as of January 1, 2008 (trillion cubic feet)

Proved reserves: 238 trillion cubic feet

Inferred nonassociated reserves:
- Offshore: 647 trillion cubic feet
- Onshore: 51 trillion cubic feet

Undiscovered nonassociated:
- Offshore: 144 trillion cubic feet
- Onshore: 233 trillion cubic feet
- Total: 377 trillion cubic feet

Unconventional:
- Offshore: 103 trillion cubic feet
- Onshore: 347 trillion cubic feet
- Total: 449 trillion cubic feet

Other unproved:
- Offshore: 117 trillion cubic feet
- Onshore: 291 trillion cubic feet
- Total: 408 trillion cubic feet

Total: 2,119 trillion cubic feet

Source: Annual Energy Outlook 2010
Natural Gas Production, Consumption, and Imports, 1960-2035 (trillion cubic feet)

- **Consumption**: 24.9 Tcf (6% increase)
- **Production**: 23.3 Tcf
- **Net imports**: 13%

Source: Annual Energy Outlook 2010
U.S. Dry Natural Gas Production, 1990 - 2035 (trillion cubic feet)

![Graph showing U.S. dry natural gas production from 1990 to 2035. The graph includes projections for Nonassociated Onshore Conventional, Onshore Unconventional, Non-associated Offshore, Associated/Dissolved, and Alaska. The source is the Annual Energy Outlook 2010.]

* Includes tight gas

Source: Annual Energy Outlook 2010
U.S. LNG Imports, 1990-2035
(trillion cubic feet)

* Includes Gulf Gateway Energy Bridge and Northeast Gateway- Excelerate Energy

Source: Annual Energy Outlook 2010
Natural gas production by source, 1990-2035 (trillion cubic feet)

Source: Annual Energy Outlook 2010
Natural Gas Prices by End-use Sector, 1990-2035 (2008 dollars per thousand cubic feet)

Source: Annual Energy Outlook 2010
Shale Gas Plays, Lower 48 States

Source: Energy Information Administration based on data from various published studies
Updated: May 28, 2009
U.S. Unconventional Natural Gas Production, 1990-2035 (trillion cubic feet)

Source: Annual Energy Outlook 2010
Coal market assumptions

- **Coal mining productivity:** 0.3 percent average annual increase from 2008
- **East transportation rates:** 0.3 percent lower in 2035 compared to 2008 (constant dollars)
- **West transportation rates:** 5 percent higher in 2035 compared with 2008 (constant dollars)
Coal consumption by sector, 1970-2035
(million short tons)

Source: Annual Energy Outlook 2010
Coal consumption in the industrial and buildings sectors and at coal-to-liquids plants, 2008, 2020, and 2035 (quadrillion Btu)

- Other Industrial
- Coke Plants
- Coal to Liquids
- Residential and Commercial

2008: Other Industrial (0.2), Coke Plants (1.5), Residential and Commercial (0.5)
2020: Other Industrial (0.2), Coke Plants (1.4), Residential and Commercial (0.5)
2035: Other Industrial (0.2), Coke Plants (1.0), Residential and Commercial (1.0)
Coal exports and imports, 1970-2035
(million short tons)

Coal import data and projections exclude imports to Puerto Rico and the U.S. Virgin Islands.
Average Price of Coal to U.S. Electric Power Sector,
January 2002 – January 2010
(dollars per million Btu)

Note: Data for 2009 and 2010 are preliminary. Source: 2002-2007: Federal Energy Regulatory Commission (FERC) and Energy Information Administration (EIA); 2008-present: EIA.
Delivered energy consumption for transportation by mode, 2008 and 2035

- Light-duty vehicles
- Heavy-duty vehicles
- Air
- Marine
- Rail
- Pipeline

Source: Annual Energy Outlook 2010
Sales of unconventional light-duty vehicles by fuel type, 2008, 2020, and 2035

Source: Annual Energy Outlook 2010
Net import share of U.S. liquid fuels consumption in three cases, 1990-2035

Source: Annual Energy Outlook 2010