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# Assumptions to the Annual Energy Outlook 2007

**Table 38. Generating Capacity Types Represented in the Electricity Market Module**

| Capacity Type |
|---|
| Existing coal steam plants[1] |
| High Sulfur Pulverized Coal with Wet Flue Gas Desulfurization |
| Advanced Coal - Integrated Coal Gasification Combined Cycle |
| Advanced Coal with carbon sequestration |
| Oil/Gas Steam - Oil/Gas Steam Turbine |
| Combined Cycle - Conventional Gas/Oil Combined Cycle Combustion Turbine |
| Advanced Combined Cycle - Advanced Gas/Oil Combined Cycle Combustion Turbine |
| Advanced Combined Cycle with carbon sequestration |
| Combustion Turbine - Conventional Combustion Turbine |
| Advanced Combustion Turbine - Steam Injected Gas Turbine |
| Molten Carbonate Fuel Cell |
| Conventional Nuclear |
| Advanced Nuclear - Advanced Light Water Reactor |
| Generic Distributed Generation - Baseload |
| Generic Distributed Generation - Peak |
| Conventional Hydropower - Hydraulic Turbine |
| Pumped Storage - Hydraulic Turbine Reversible |
| Geothermal |
| Municipal Solid Waste |
| Biomass - Integrated Gasification Combined-Cycle |
| Solar Thermal - Central Receiver |
| Solar Photovoltaic - Single Axis Flat Plate |
| Wind |

[1]The EMM represents 32 different types of existing coal steam plants, based on the different possible configuration of $No_x$, particulate and $SO_2$ emission control devices, as well as future options for controlling mercury.

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

## Table 39. Cost and Performance Characteristics of New Central Station Electricity Generating Technologies

| Technology | Online Year[1] | Size (mW) | Leadtimes (Years) | Base Overnight Costs in 2006 ($2005/kW) | Contingency Factors: Project Contingency Factor | Contingency Factors: Technological Optimism Factor[2] | Total Overnight Cost in 2006[3] (2005 $/kW) | Variable O&M[4] ($2005 mills/kWh) | Fixed O&M[4] ($2005/kW) | Heatrate in 2006 (Btu/kWhr) | Heatrate nth-of-a-kind (Btu/kWr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scrubbed Coal New[7] | 2010 | 600 | 4 | 1,206 | 1.07 | 1.00 | 1,290 | 4.32 | 25.91 | 8,844 | 8,600 |
| Integrated Coal-Gasification Combined Cycle (IGCC)[7] | 2010 | 550 | 4 | 1,394 | 1.07 | 1.00 | 1,491 | 2.75 | 36.38 | 8,309 | 7,200 |
| IGCC with Carbon Sequestration | 2010 | 380 | 4 | 1,936 | 1.07 | 1.03 | 2,134 | 4.18 | 42.82 | 9,713 | 7,920 |
| Conv Gas/Oil Comb Cycle | 2009 | 250 | 3 | 574 | 1.05 | 1.00 | 603 | 1.94 | 11.75 | 7,163 | 6,800 |
| Adv Gas/Oil Comb Cycle (CC) | 2009 | 400 | 3 | 550 | 1.08 | 1.00 | 594 | 1.88 | 11.01 | 6,717 | 6,333 |
| ADV CC with Carbon Sequestration | 2010 | 400 | 3 | 1,055 | 1.08 | 1.04 | 1,185 | 2.77 | 18.72 | 8,547 | 7,493 |
| Conv Combustion Turbine[5] | 2008 | 160 | 2 | 400 | 1.05 | 1.00 | 420 | 3.36 | 11.40 | 10,807 | 10,450 |
| Adv Combustion Turbine | 2008 | 230 | 2 | 379 | 1.05 | 1.00 | 398 | 2.98 | 9.91 | 9,166 | 8,550 |
| Fuel Cells | 2009 | 10 | 3 | 3,913 | 1.05 | 1.10 | 4,520 | 45.09 | 5.32 | 7,873 | 6,960 |
| Advanced Nuclear | 2014 | 1350 | 6 | 1,802 | 1.10 | 1.05 | 2,081 | 0.47 | 63.88 | 10,400 | 10,400 |
| Distributed Generation -Base | 2009 | 2 | 3 | 818 | 1.05 | 1.00 | 859 | 6.70 | 15.08 | 9,500 | 8,900 |
| Distributed Generation -Peak | 2008 | 1 | 2 | 983 | 1.05 | 1.00 | 1,032 | 6.70 | 15.08 | 10,634 | 9,880 |
| Biomass | 2010 | 80 | 4 | 1,714 | 1.07 | 1.02 | 1,869 | 2.96 | 50.18 | 8,911 | 8,911 |
| MSW - Landfill Gas | 2009 | 30 | 3 | 1,491 | 1.07 | 1.00 | 1,595 | 0.01 | 107.50 | 13,648 | 13,648 |
| Geothermal [6,7] | 2010 | 50 | 4 | 1,790 | 1.05 | 1.00 | 1,880 | 0.00 | 154.92 | 36,025 | 30,641 |
| Conventional Hydropower[6] | 2010 | 500 | 4 | 1,364 | 1.10 | 1.00 | 1,500 | 3.30 | 13.14 | 10,107 | 10,107 |
| Wind | 2009 | 50 | 3 | 1,127 | 1.07 | 1.00 | 1,206 | 0.00 | 28.51 | 10,280 | 10,280 |
| Solar Thermal[7] | 2009 | 100 | 3 | 2,675 | 1.07 | 1.10 | 3,149 | 0.00 | 53.43 | 10,280 | 10,280 |
| Photovoltaic[7] | 2008 | 5 | 2 | 4,114 | 1.05 | 1.10 | 4,751 | 0.00 | 10.99 | 10,280 | 10,280 |

[1]Online year represents the first year that a new unit could be completed, given an order date of 2006.

[2]The technological optimism factor is applied to the first four units of a new, unproven design, or regulatory structure. It reflects the demonstrated tendency to underestimate actual costs for a first-of-a-kind unit.

[3]Overnight capital cost including contingency factors, excluding regional multipliers and learning effects. Interest charges are also excluded. These represent costs of new projects initiated in 2006.

[4]O&M = Operations and maintenance.

[5]Combustion turbine units can be built by the model prior to 2008 if necessary to meet a given region's reserve margin.

[6]Because geothermal and hydro cost and performance characteristics are specific for each site, the table entries represent the cost of the least expensive plant that could be built in the Northwest Power Pool region, where most of the proposed sites are located.

[7]Capital costs are shown before investment tax credits are applied.

Sources: The values shown in this table are developed by the Energy Information Administration, Office of Integrated Analysis and Forecasting, from analysis of reports and discussions with various sources from industry, government, and the Department of Energy Fuel Offices and National Laboratories. They are not based on any specific technology model, but rather, are meant to represent the cost and performance of typical plants under normal operating conditions for each plant type. Key sources reviewed are listed in the 'Notes and Sources' section at the end of the chapter.

## Table 40. Learning Parameters for New Generating Technology Components

| Technology Component | Period 1 Learning Rate | Period 2 Learning Rate | Period 3 Learning Rate | Period 1 Doublings | Period 2 Doublings | Minimum Total Learning by 2025 |
|---|---|---|---|---|---|---|
| Pulverized Coal | - | - | 1% | - | - | 5% |
| Combustion Turbine - conventional | - | - | 1% | - | - | 5% |
| Combustion Turbine - advanced | - | 10% | 1% | - | 5 | 10% |
| HRSG[1] | - | - | 1% | - | - | 5% |
| Gasifier | - | 10% | 1% | - | 5 | 10% |
| Carbon Capture/Sequestration | 20% | 10% | 1% | 3 | 5 | 20% |
| Balance of Plant - IGCC | - | - | 1% | - | - | 5% |
| Balance of Plant - Turbine | - | - | 1% | - | - | 5% |
| Balance of Plant - Combined Cycle | - | - | 1% | - | - | 5% |
| Fuel Cell | 10% | 5% | 1% | 3 | 5 | 10% |
| Advanced Nuclear | 5% | 3% | 1% | 3 | 5 | 10% |
| Fuel prep - Biomass IGCC | 20% | 10% | 1% | 3 | 5 | 20% |
| Distributed Generation - Base | - | 5% | 1% | - | 5 | 10% |
| Distributed Generation - Peak | - | 5% | 1% | - | 5 | 10% |
| Geothermal | - | 8% | 1% | - | 5 | 10% |
| Municipal Solid Waste | - | - | 1% | - | - | 5% |
| Hydropower | - | - | 1% | - | - | 5% |
| Wind | - | - | 1% | - | - | 1% |
| Solar Thermal | 20% | 10% | 1% | 3 | 5 | 20% |
| Solar PV | 15% | 8% | 1% | 3 | 5 | 20% |

[1]HRSG = Heat Recovery Steam Generator

Note: Please see the text for a description of the methodology for learning in the Electricity Market Module.

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

## Table 41. Component Cost Weights for New Technologies

| Technology | Combustion Turbine-conventional | Combustion Turbine-advanced | HRSG | Gasifier | Carbon Capture/ Sequestration | Balance of Plant-IGCC | Balance of Plant-Turbine | Balance of Plant-Combined Cycle | Fuelprep Biomass IGCC |
|---|---|---|---|---|---|---|---|---|---|
| Integrated Coal_Gasification Comb Cycle (IGCC) | 0% | 15% | 20% | 41% | 0% | 24% | 0% | 0% | 0% |
| IGCC with carbon sequestration | 0% | 10% | 15% | 30% | 30% | 15% | 0% | 0% | 0% |
| Conv Gas/Oil Comb Cycle | 30% | 0% | 40% | 0% | 0% | 0% | 0% | 30% | 0% |
| Adv Gas/Oil Comb Cycle (CC) | 0% | 30% | 40% | 0% | 0% | 0% | 0% | 30% | 0% |
| Adv CC with carbon sequestration | 0% | 20% | 25% | 0% | 40% | 0% | 0% | 15% | 0% |
| Conv Comb Turbine | 50% | 0% | 0% | 0% | 0% | 0% | 50% | 0% | 0% |
| Adv Comb Turbine | 0% | 50% | 0% | 0% | 0% | 0% | 50% | 0% | 0% |
| Biomass | 0% | 12% | 16% | 33% | 0% | 20% | 0% | 0% | 19% |

Note: All unlisted technologies have a 100% weight with the corresponding component. Components are not broken out for all technologies unless there is overlap with other technologies.

HRSG = Heat Recovery Steam Generator.

Source: Market Based Advanced Coal Power Systems, May 1999, DOE/FE-0400

**Table 42. Component Capacity Weights for New Technologies**

| Technology | Combustion Turbine-conventional | Combustion Turbine-advanced | HRSG | Gasifier | Carbon Capture/ Sequestration | Balance of Plant-IGCC | Balance of Plant-Turbine | Balance of Plant-Combined Cycle | Fuelprep Biomass IGCC |
|---|---|---|---|---|---|---|---|---|---|
| Integrated Coal_Gasification Comb Cycle (IGCC) | 0% | 67% | 33% | 100% | 0% | 100% | 0% | 0% | 0% |
| IGCC with carbon sequestration | 0% | 67% | 33% | 100% | 100% | 100% | 0% | 0% | 0% |
| Conv Gas/Oil Comb Cycle | 67% | 0% | 33% | 0% | 0% | 0% | 0% | 100% | 0% |
| Adv Gas/Oil Comb Cycle (CC) | 0% | 67% | 33% | 0% | 0% | 0% | 0% | 100% | 0% |
| Adv CC with carbon sequestration | 0% | 67% | 33% | 0% | 100% | 0% | 0% | 100% | 0% |
| Conv Comb Turbine | 100% | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| Adv Comb Turbine | 0% | 100% | 0% | 0% | 0% | 0% | 100% | 0% | 0% |
| Biomass | 0% | 67% | 33% | 100% | 0% | 100% | 0% | 0% | 100% |

HRSG = Heat Recovery Steam Generator.

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

**Table 43. Nuclear Upratres by EMM Region**
(gigawatts)

| Region | |
|---|---|
| East Central Area Reliability Coordination Agreement | 0.1 |
| Electric Reliability Council of Texas | 0.4 |
| Mid-Atlantic Area Council | 0.1 |
| Mid-America Interconnected Network | 0.1 |
| Mid-Continent Area Power Pool | 0.0 |
| New York | 0.1 |
| New England | 0.1 |
| Florida Reliability Coordinating Council | 0.1 |
| Southeastern Electric Reliability Council | 1.8 |
| Southwest Power Pool | 0.0 |
| Northwest Power Pool | 0.0 |
| Rocky Mountain Power Area, Arizona, New Mexico, and Southern Nevada | 0.2 |
| California | 0.0 |
| Total | 2.7 |

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting, based on Nuclear Regulatory Commission survey, http://www.nrc.gov/reactors/operating/licensing/power-uprates.html

**Table 44. Summer Season $NO_x$ Emissions Budgets for 2004 and Beyond**
(Thousand tons per season)

| State | Emissions Cap |
|---|---|
| Alabama | 29.02 |
| Connecticut | 2.65 |
| Delaware | 5.25 |
| District of Columbia | 0.21 |
| Illinois | 32.37 |
| Indiana | 47.73 |
| Kentucky | 36.50 |
| Maryland | 14.66 |
| Massachusetts | 15.15 |
| Michigan | 32.23 |
| New Jersey | 10.25 |
| New York | 31.04 |
| North Carolina | 31.82 |
| Ohio | 48.99 |
| Pennsylvania | 47.47 |
| Rhode Island | 1.00 |
| South Carolina | 16.77 |
| Tennessee | 25.81 |
| Virginia | 17.19 |
| West Virginia | 26.86 |

Source: U.S. Environmental Protection Agency, Federal Register, Vol. 65, number 42 (March 2, 2002) pages 11222-11231.

**Table 45. Coal Plant Retrofit Costs**
(2005 Dollars)

| Coal Plant Size (MW) | FGD Capital Costs ($/KW) | SCR Capital Costs ($/KW) |
|---|---|---|
| 300 | 291 | 120 |
| 500 | 223 | 105 |
| 700 | 184 | 95 |

Note: The model was run for each individual plant assuming a 1.3 retrofit factor for FGDs and 1.6 factor for SCRs.

Source: CUECOST3.xls model (as updated 2/9/2000) developed for the Environmental Protection Agency by Raytheon Engineers and Constructors, Inc. EPA Contract number 68-D7-0001.

**Table 46. Mercury Emission Modification Factors**

| Configuration | | | EIA EMFs | | | EPA EMFs | | |
|---|---|---|---|---|---|---|---|---|
| $SO_2$ Control | Particulate Control | $NO_x$ Control | Bit Coal | Sub Coal | Lignite Coal | Bit Coal | Sub Coal | Lignite Coal |
| None | BH | — | 0.11 | 0.27 | 0.27 | 0.11 | 0.26 | 1.00 |
| Wet | BH | None | 0.05 | 0.27 | 0.27 | 0.03 | 0.27 | 1.00 |
| Wet | BH | SCR | 0.10 | 0.27 | 0.27 | 0.10 | 0.15 | 0.56 |
| Dry | BH | — | 0.05 | 0.75 | 0.75 | 0.05 | 0.75 | 1.00 |
| None | CSE | — | 0.64 | 0.97 | 0.97 | 0.64 | 0.97 | 1.00 |
| Wet | CSE | None | 0.34 | 0.73 | 0.73 | 0.34 | 0.84 | 0.56 |
| Wet | CSE | SCR | 0.10 | 0.73 | 0.73 | 0.10 | 0.34 | 0.56 |
| Dry | CSE | — | 0.64 | 0.65 | 0.65 | 0.64 | 0.65 | 1.00 |
| None | HSE/Oth | — | 0.90 | 0.94 | 0.94 | 0.90 | 0.94 | 1.00 |
| Wet | HSE/Oth | None | 0.58 | 0.80 | 0.80 | 0.58 | 0.80 | 1.00 |
| Wet | HSE/Oth | SCR | 0.42 | 0.76 | 0.76 | 0.10 | 0.75 | 1.00 |
| Dry | HSE/Oth | — | 0.60 | 0.85 | 0.85 | 0.60 | 0.85 | 1.00 |

Notes: $SO_2$ Controls - Wet = Wet Scrubber and Dry = Dry Scrubber, Particulate Controls, BH - fabric filter/baghouse. CSE = cold side electrostatic precipitator, HSE = hot side electrostatic precipitator, $NO_x$ Controls, SCR = selective catalytic reduction, — = not applicable, Bit = bituminous coal, Sub = subbituminous coal. The $NO_x$ control system is not assumed to enhance mercury removal unless a wet scrubber is present, so it is left blank in such configurations.

Sources: EPA, EMFs. http://www.epa.gov/clearskies/technical.html EIA EMFs not from EPA: Lignite EMFs, Mercury Control Technologies for Coal-Fired Power Plants, presented by the Office of Fossil Energy on July 8, 2003. Bituminous coal mercury removal for a Wet/HSE/Oth/SCR configured plant, Table EMF1, Analysis of Mercury Control Cost and Performance, Office of Fossil Energy & National Energy Technology Laboratory, U.S. Department of Energy, January 2003, Washington, DC.

**Table 47. Planned $SO_2$ Scrubber Additions Represented by Region**

| Region | Capacity (Gigawatts) |
|---|---|
| East Central Area Reliability Coordination Agreement | 4.2 |
| Electric Reliability Council of Texas | 0.0 |
| Mid-Atlantic Area Council | 1.2 |
| Mid-America Interconnected Network | 0.0 |
| Mid-Continent Area Power Pool | 0.5 |
| New York | 0.0 |
| New England | 0.6 |
| Florida Reliability Coordinating Council | 0.0 |
| Southeastern Electric Reliability Council | 13.5 |
| Southwest Power Pool | 0.0 |
| Northwest Power Pool | 0.0 |
| Rocky Mountain Power Area, Arizona, New Mexico, and Southern Nevada | 0.0 |
| California | 0.0 |
| Total | 20.1 |

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting, based on public announcements and reports to Form EIA-767, "Annual Steam-Electric Plant Operation and Design Data".

## Table 48. Cost and Performance Characteristics for Fossil-Fueled Generating Technologies: Three Cases

| | Total Overnight Cost in 2006 Reference (2005 $/kW) | Total Overnight Cost[1] | | | Heatrate in 2006 (Reference) Btu/kWhr | Heat Rate | | |
|---|---|---|---|---|---|---|---|---|
| | | Reference (2005 $/kW) | High Fossil (2005 $/kW) | Low Fossil (2005 $/kW) | | Reference BTU/kWhr | High Fossil Btu/kWhr | Low Fossil Btu/kWhr |
| Pulverized Coal | 1290 | | | | 8844 | | | |
| 2015 | | 1260 | 1260 | 1260 | | 8661 | 8661 | 8661 |
| 2020 | | 1235 | 1243 | 1232 | | 8600 | 8600 | 8600 |
| 2025 | | 1219 | 1226 | 1213 | | 8600 | 8600 | 8600 |
| 2030 | | 1209 | 1209 | 1205 | | 8600 | 8600 | 8600 |
| Advanced Coal | 1491 | | | | 8309 | | | |
| 2015 | | 1436 | 1355 | 1491 | | 7477 | 6937 | 8309 |
| 2020 | | 1400 | 1280 | 1491 | | 7200 | 6480 | 8309 |
| 2025 | | 1335 | 1205 | 1491 | | 7200 | 6480 | 8309 |
| 2030 | | 1254 | 1129 | 1491 | | 7200 | 6480 | 8309 |
| Conventional Combined Cycle | 603 | | | | 7163 | | | |
| 2015 | | 569 | 589 | 589 | | 6866 | 6866 | 6866 |
| 2020 | | 581 | 581 | 581 | | 6800 | 6800 | 6800 |
| 2025 | | 573 | 573 | 573 | | 6800 | 6800 | 6800 |
| 2030 | | 565 | 565 | 565 | | 6800 | 6800 | 6800 |
| Advanced Gas Technology | 594 | | | | 6717 | | | |
| 2015 | | 576 | 564 | 594 | | 6403 | 5875 | 6717 |
| 2020 | | 561 | 522 | 594 | | 6333 | 5700 | 6717 |
| 2025 | | 542 | 497 | 594 | | 6333 | 5700 | 6717 |
| 2030 | | 525 | 472 | 594 | | 6333 | 5700 | 6717 |
| Conventional CombustionTurbine | 420 | | | | 10807 | | | |
| 2015 | | 410 | 410 | 410 | | 10486 | 10486 | 10486 |
| 2020 | | 405 | 405 | 405 | | 10450 | 10450 | 10450 |
| 2025 | | 399 | 399 | 399 | | 10450 | 10450 | 10450 |
| 2030 | | 394 | 394 | 394 | | 10450 | 10450 | 10450 |
| Advanced CombustionTurbine | 398 | | | | 9166 | | | |
| 2015 | | 384 | 362 | 398 | | 8612 | 7828 | 9166 |
| 2020 | | 371 | 343 | 398 | | 8550 | 7695 | 9166 |
| 2025 | | 353 | 323 | 398 | | 8550 | 7695 | 9166 |
| 2030 | | 337 | 304 | 398 | | 8550 | 7695 | 9166 |

[1]Total overnight cost (including project contingency, technological optimism and learning factors, but excluding regional multipliers), for projects initiated in the given year.

Source: AEO2007 National Energy Modeling System runs: AEO2007.D112106A, HFOSS07.D112706A, LFOSS07.D112706A.

## Table 49. Cost Characteristics for Advanced Nuclear Technology: Two Cases

| Advanced Nuclear Technology | Overnight Cost in 2006 (Reference) (2005$/kW) | Total Overnight Cost[1] | | |
|---|---|---|---|---|
| | | Reference Case (2005$/kW) | Low Nuclear Cost (2005$/KW) | High Nuclear Cost (2005$/kW) |
| | 2081 | | | |
| 2015 | | 1983 | 1886 | 2080 |
| 2020 | | 1797 | 1777 | 2080 |
| 2025 | | 1795 | 1667 | 2080 |
| 2030 | | 1732 | 1559 | 2080 |

[1]Total overnight cost (including project contingency, technological optimism and learning factors, but excluding regional multipliers), for projects initiated in the given year.

Source: AEO2007 National Energy Modeling System runs: AEO2007.D112106A, ADVNUC07.D112906A, LONUC07.D112706A.