

## Assumptions to the Annual Energy Outlook 2006

**Table 37. Generating Capacity Types Represented in the Electricity Market Module**

Capacity Type
Existing coal steam plants <sup>1</sup>
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

<sup>1</sup>The EMM represents 32 different types of existing coal steam plants, based on the different possible configuration of No<sub>x</sub>, particulate and SO<sub>2</sub> emission control devices, as well as future options for controlling mercury.

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

**Table 38. Cost and Performance Characteristics of New Central Station Electricity Generating Technologies**

Technology	Online Year <sup>1</sup>	Size (mW)	Leadtimes (Years)	Base Overnight Costs in 2005 (\$2004/kW)	Contingency Factors		Total Overnight Cost in 2005 <sup>3</sup> (2004 \$/kW)	Variable O&M <sup>4</sup> (\$2004 mills/kWh)	Fixed O&M <sup>5</sup> (\$2004/kW)	Heatrate in 2005 (Btu/kWhr)	Heatrate nth-of-a-kind (Btu/kWhr)
					Project Contingency Factor	Technological Optimism Factor <sup>6</sup>					
Scrubbed Coal New <sup>7</sup>	2009	600	4	1,167	1.07	1.00	1,249	4.18	25.07	8,844	8,600
Integrated Coal-Gasification Combined Cycle (IGCC) <sup>7</sup>	2009	550	4	1,349	1.07	1.00	1,443	2.65	35.21	8,309	7,200
IGCC with Carbon Sequestration	2010	380	4	1,873	1.07	1.03	2,065	4.04	41.44	9,713	7,920
Conv Gas/Oil Comb Cycle	2008	250	3	556	1.05	1.00	584	1.88	11.37	7,196	6,800
Adv Gas/Oil Comb Cycle (CC)	2008	400	3	532	1.08	1.00	575	1.82	10.65	6,752	6,333
ADV CC with Carbon Sequestration	2010	400	3	1,021	1.08	1.04	1,147	2.68	18.12	8,613	7,493
Conv Combustion Turbine <sup>5</sup>	2007	160	2	388	1.05	1.00	407	3.25	11.03	10,842	10,450
Adv Combustion Turbine	2007	230	2	367	1.05	1.00	385	2.89	9.59	9,227	8,550
Fuel Cells	2008	10	3	3,787	1.05	1.10	4,374	43.64	5.15	7,930	6,960
Advanced Nuclear	2013	1000	6	1,744	1.10	1.05	2,014	0.45	61.82	10,400	10,400
Distributed Generation -Base	2008	2	3	791	1.05	1.00	831	6.49	14.60	9,650	8,900
Distributed Generation -Peak	2007	1	2	951	1.05	1.00	998	6.49	14.60	10,823	9,880
Biomass	2009	80	4	1,659	1.07	1.02	1,809	3.13	48.56	8,911	8,911
MSW - Landfill Gas	2008	30	3	1,443	1.07	1.00	1,544	0.01	104.03	13,648	13,648
Geothermal <sup>6,7</sup>	2009	50	4	2,100	1.05	1.00	2,205	0.00	75.00	32,173	35,460
Conventional Hydropower <sup>8</sup>	2009	500	4	1,320	1.10	1.00	1,452	3.20	12.72	10,338	10,338
Wind	2008	50	3	1,091	1.07	1.00	1,167	0.00	27.59	10,280	10,280
Solar Thermal <sup>7</sup>	2008	100	3	2,589	1.07	1.10	3,047	0.00	51.70	10,280	10,280
Photovoltaic <sup>7</sup>	2007	5	2	3,981	1.05	1.10	4,598	0.00	10.64	10,280	10,280

<sup>1</sup>Online year represents the first year that a new unit could be completed, given an order date of 2005.

<sup>2</sup>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.

<sup>3</sup>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 2005.

<sup>4</sup>O&M = Operations and maintenance.

<sup>5</sup>Combustion turbine units can be built by the model prior to 2007 if necessary to meet a given region's reserve margin.

<sup>6</sup>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.

<sup>7</sup>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 39. 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 <sup>1</sup>	-	-	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%

<sup>1</sup>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 40. 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 41. 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 42. Load Segments in the Electricity Market Module**

Season	Months	Period	Hours
Summer	June-September	Daytime	0700-1800
		Morning/Evening	0500-0700 and 1800-2400
		Night	0000-0500
Winter	December-March	Daytime	0800-1600
		Morning/Evening	0500-0800 and 1600-2400
		Night	0000-0500
Off-peak	April-May	Daytime	0700-1700
	October-November	Morning/Evening	0500-0700 and 1700-2400
		Night	0000-0500

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

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

Region	
East Central Area Reliability Coordination Agreement	0.2
Electric Reliability Council of Texas	0.4
Mid-Atlantic Area Council	0.3
Mid-America Interconnected Network	0.2
Mid-Continent Area Power Pool	0.0
New York	0.1
New England	0.2
Florida Reliability Coordinating Council	0.1
Southeastern Electric Reliability Council	1.6
Southwest Power Pool	0.0
Northwest Power Pool	0.0
Rocky Mountain Power Area, Arizona, New Mexico, and Southern Nevada	0.1
California	0.0
Total	3.2

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<sub>x</sub> 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**  
(2004 Dollars)

Coal Plant Size (MW)	FGD Capital Costs (\$/KW)	SCR Capital Costs (\$/KW)
300	282	116
500	215	101
700	179	92

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

Source: CUJECOST3.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**

SO <sub>2</sub> Control	Configuration		EIA EMFs			EPA EMFs		
	Particulate Control	NO <sub>x</sub> 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<sub>2</sub> 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<sub>x</sub> Controls, SCR = selective catalytic reduction, — = not applicable, Bit = bituminous coal, Sub = subbituminous coal. The NO<sub>x</sub> 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<sub>2</sub> 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	1.3
Mid-America Interconnected Network	0.0
Mid-Continent Area Power Pool	0.6
New York	0.0
New England	0.8
Florida Reliability Coordinating Council	0.0
Southeastern Electric Reliability Council	15.3
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	22.1

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 2004 Reference (2004 \$/kW)	Total Overnight Cost <sup>1</sup>			Heatrate in 2005 (Reference) Btu/kWhr	Heat Rate		
		Reference (2004 \$/kW)	High Fossil (2004 \$/kW)	Low Fossil (2004 \$/kW)		Reference BTU/kWhr	High Fossil Btu/kWhr	Low Fossil Btu/kWhr
Pulverized Coal	1249				8844			
2010		1233	1233	1233		8763	8763	8763
2015		1217	1217	1217		8661	8661	8661
2020		1199	1202	1191		8600	8600	8600
2025		1184	1186	1176		8600	8600	8600
2030		1171	1171	1163		8600	8600	8600
Advanced Coal	1444				8309			
2010		1415	1376	1437		7939	7699	8309
2015		1386	1300	1437		7477	6937	8309
2020		1340	1223	1437		7200	6480	8309
2025		1265	1147	1437		7200	6480	8309
2030		1190	1070	1437		7200	6480	8309
Conventional Combined Cycle	584				7196			
2010		576	576	576		7031	7031	7031
2015		569	569	569		6866	6866	6866
2020		562	562	562		6800	6800	6800
2025		555	555	556		6800	6800	6800
2030		547	547	547		6800	6800	6800
Advanced Gas Technology	575				6752			
2010		565	552	573		6577	6314	6717
2015		555	528	573		6403	5875	6717
2020		532	502	573		6333	5700	6717
2025		517	476	573		6333	5700	6717
2030		502	452	573		6333	5700	6717
Conventional Combustion Turbine	407				10842			
2010		402	402	402		10664	10664	10664
2015		397	397	397		10486	10486	10486
2020		392	392	392		10450	10450	10450
2025		387	387	388		10450	10450	10450
2030		381	381	381		10450	10450	10450
Advanced Combustion Turbine	385				9227			
2010		378	368	383		8920	8492	9166
2015		369	347	383		8612	7828	9166
2020		347	329	383		8550	7695	9166
2025		333	308	383		8550	7695	9166
2030		320	288	383		8550	7695	9166

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

Source: AEO2006 National Energy Modeling System runs: AEO2006.D111905A, HFOSS06.D120105B, LFOSS06.D120105A.

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

Advanced Nuclear	Overnight Cost in 2005 (Reference) (2004\$/kW)	Reference Case (2004\$/kW)	Total Overnight Cost <sup>1</sup>	
			Advanced Nuclear (2004\$/KW)	Nuclear Vendor Estimate (2004\$/kW)
	2014			
	2010	1964	1902	1659
	2015	1913	1772	1528
	2020	1832	1644	1310
	2025	1782	1515	1136
	2030	1733	1387	1136

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

Source: AEO2006 National Energy Modeling System runs: AEO2005.D111905A, ADVNUC20.D120105A, ADVNUC5A.D120105A.