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Assumptions to the Annual Energy Outlook 2010

Table 8.1. 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
Wind Offshore

[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 8.2. Cost and Performance Characteristics of New Central Station Electricity Generating Technologies

Technology	Online Year[1]	Size (mW)	Leadtime (Years)	Base Overnight Cost in 2009 ($2008/kW)	Contingency Factors: Project Contingency Factor[2]	Contingency Factors: Technological Optimism Factor[3]	Total Overnight Cost in 2009[4] (2008 $/kW)	Variable O&M[5] ($2008 mills/kWh)	Fixed O&M[5] ($2008/kW)	Heatrate[6] in 2009 (Btu/kWhr)	Heatrate nth-of-a-kind (Btu/kWr)
Scrubbed Coal New[7]	2013	600	4	2,078	1.07	1.00	2,223	4.69	28.15	9,200	8,740
Integrated Coal-Gasification Combined Cycle (IGCC)[7]	2013	550	4	2,401	1.07	1.00	2,569	2.99	39.53	8,765	7,450
IGCC withCarbon Sequestration	2016	380	4	3,427	1.07	1.03	3,776	4.54	47.15	10,781	8,307
Conv Gas/Oil Comb Cycle	2012	250	3	937	1.05	1.00	984	2.11	12.76	7,196	6,800
Adv Gas/Oil Comb Cycle (CC)	2012	400	3	897	1.08	1.00	968	2.04	11.96	6,752	6,333
ADVCC with Carbon Sequestion	2016	400	3	1,720	1.08	1.04	1,932	3.01	20.35	8,613	7,493
Conv Combustion Turbine[8]	2011	160	2	653	1.05	1.00	685	3.65	12.38	10,788	10,450
Adv Combustion Turbine	2011	230	2	617	1.05	1.00	648	3.24	10.77	9,289	8,550
Fuel Cells	2012	10	3	4,744	1.05	1.10	5,478	49.00	5.78	7,930	6,960
Advanced Nuclear	2016	1350	6	3,308	1.10	1.05	3,820	0.51	92.04	10,488	10,488
Distributed Generation -Base	2012	2	3	1,334	1.05	1.00	1,400	7.28	16.39	9,050	8,900
Distributed Generation -Peak	2011	1	2	1,601	1.05	1.00	1,681	7.28	16.39	10,069	9,880
Biomass	2013	80	4	3,414	1.07	1.05	3,849	6.86	65.89	9,451	7,765
Geothermal [7,9]	2010	50	4	1,666	1.05	1.00	1,749	0.00	168.33	32,969	30,326
MSW - Landfill Gas	2010	30	3	2,430	1.07	1.00	2,599	0.01	116.80	13,648	13,648
Conventional Hydropower[9]	2013	500	4	2,084	1.10	1.00	2,291	2.49	13.93	9,884	9,884
Wind	2009	50	3	1,837	1.07	1.00	1,966	0.00	30.98	9,884	9,884
Wind Offshore	2013	100	4	3,492	1.10	1.02	3,937	0.00	86.92	9,884	9,884
Solar Thermal[7]	2012	100	3	4,798	1.07	1.00	5,132	0.00	58.05	9,884	9,884
Photovoltaic[7]	2011	5	2	5,879	1.05	1.00	6,171	0.00	11.94	9,884	9,884

[1]Online year represents the first year that a new unit could be completed, given an order date of 2009. For wind, geothermal and landfill gas, the online year was moved earlier to acknowledge the significant market activity already occuring in anticipation of the expiration of the Production Tax Credit.

[2]A contingency allowance is defined by the American Association of Cost Engineers as the "specific provision for unforeseeable elements if costs within a defined project scope; particularly important where previous experience has shown that unforeseeable events which will increase costs are likely to occur."

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

[4]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 2009.

[5]O&M = Operations and maintenance.

[6]For hydro, wind, and solar technologies, the heatrate shown represents the average heatrate for conventional thermal generation as of 2008. This is used for purposes of calculating primary energy consumption displaced for these resources, and does not imply an estimate of their actual energy conversion efficiency.

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

[8]Combustion turbine units can be built by the model prior to 2011 if necessary to meet a given region's reserve margin.

[9]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.

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 8.3. 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	20%	10%	1%	3	5	20%
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%
Wind Offshore	20%	10%	1%	3	5	20%
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 8.4. 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%	25%	0%	20%	0%	0%	27%

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 8.5. 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 8.6. Nuclear Uprates by EMM Region

(gigawatts)

Region	
East Central Area Reliability Coordination Agreement	0.3
Electric Reliability Council of Texas	0.3
Mid-Atlantic Area Council	1.0
Mid-America Interconnected Network	0.4
Mid-Continent Area Power Pool	0.1
New York	0.2
New England	0.1
Florida Reliability Coordinating Council	0.0
Southeastern Electric Reliability Council	1.6
Southwest Power Pool	0.1
Northwest Power Pool	0.0
Rocky Mountain Power Area, Arizona, New Mexico, and Southern Nevada	0.0
California	0.0
Total	4.0

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 8.7. 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 8.8. Coal Plant Retrofit Costs
(2008 Dollars)

Coal Plant Size (MW)	FGD Capital Costs ($/KW)	SCR Capital Costs ($/KW)
300	364	150
500	278	131
700	229	118

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 8.9. 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 8.10. Planned SO_2 Scrubber Additions Represented by Region

Region	Capacity (Gigawatts)
East Central Area Reliability Coordination Agreement	13.6
Electric Reliability Council of Texas	0.0
Mid-Atlantic Area Council	7.6
Mid-America Interconnected Network	3.7
Mid-Continent Area Power Pool	0.7
New York	0.0
New England	0.0
Florida Reliability Coordinating Council	1.8
Southeastern Electric Reliability Council	12.6
Southwest Power Pool	0.0
Northwest Power Pool	0.0
Rocky Mountain Power Area, Arizona, New Mexico, and Southern Nevada	0.6
California	0.0
Total	40.5

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 8.11. Cost and Performance Characteristics for Fossil-Fueled Generating Technologies: Three Cases

	Total Overnight Cost in 2009 (Reference) (2008 $/kW)	Total Overnight Cost[1]		
		Reference (2008 $/kW)	High Fossil Cost (2008 $/kW)	Low FossilCost (2008 $/kW)
Pulverized Coal	2223			
2015		2418	2457	2104
2020		2283	2356	1918
2025		2076	2177	1981
2030		1872	1996	1459
2035		1681	1823	1261
Advanced Coal	2569			
2015		2769	2338	2408
2020		2590	2722	2176
2025		2329	2516	1887
2030		2065	2306	1610
2035		1829	2107	1372
Advanced Coal withSequestration	3776			
2015		4022	4172	3499
2020		3568	4002	2997
2025		3163	3697	2562
2030		2765	3391	2156
2035		2410	3098	1807
Conventional Combined Cycle	984			
2015		1070	1086	931
2020		1010	1042	849
2025		918	963	743
2030		823	884	647
2035		744	806	559
Advanced Gas	968			
2015		1048	1070	913
2020		985	1070	828
2025		889	949	719
2030		786	869	613
2035		698	795	524
Advanced Gas with Sequestration	1932			
2015		2054	2134	1787
2020		1795	2048	1507
2025		1585	1892	1285
2030		1375	1735	1072
2035		1191	1585	893
Conventional CombustionTurbine	685			
2015		745	757	648
2020		703	726	590
2025		640	671	518
2030		577	615	450
2035		518	562	388
Advanced CombustionTurbine	648			
2015		699	717	608
2020		655	687	550
2025		588	634	476
2030		513	582	401
2035		552	532	339

[1]Total overnight cost (including project contingency, technological optimism and learning factors, but excluding regional multipliers), for projects online in the given year.
Source: AEO2010 National Energy Modeling System runs: AEO2010R.D111809A, HCFOSS10.D020510A, LCFOSS19.D020510A.

Table 8.12. Cost Characteristics for Advanced Nuclear Technology: Three Cases

Advanced Nuclear Technology	Overnight Cost in 2009 (Reference) (2008$/kW)	Total Overnight Cost[1]		
		Reference Case (2008$/kW)	High Nuclear Cost (2008$/KW)	Low Nuclear Cost (2008$/kW)
	3820			
2015		4089	4180	3470
2020		3670	3994	2943
2025		3203	3678	2514
2030		2835	3370	2141
2035		2496	3133	1872

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

Source: AEO2010 National Energy Modeling System runs: AEO2010R.D111809A, HCNUC09.D121109A, LCNUC09.D121109A.