

APPENDIX A

Key Assumptions for Levelized Cost of Electricity Ranges

This appendix describes the key assumptions and sources used in calculating a range of levelized costs for generating electricity from different fossil, nuclear, and renewable energy technologies brought online in 2015 (as shown in Figures ES.5 and 13 in the report). Levelized cost of electricity is a measure often used by analysts to compare and evaluate the relative costs and competitiveness of different generation technologies. As defined by the Energy Information Administration (EIA), “levelized cost represents the present value of the total cost of building and operating a generating plant over an assumed financial life and duty cycle, converted to equal annual payments and expressed in terms of real dollars to remove the impact of inflation” (EIA 2011b).

Below, we present a range of costs to account for the uncertainty around capital, fuel, and other costs, as well as regional variations in the costs of building and operating these technologies. Such variations include resource quality and cost for wind, solar, geothermal, biomass, coal, and natural gas. The levelized cost ranges illustrate the impact of federal tax credits on a wide range of technologies and loan guarantees for nuclear power that we assume will be available in 2015. They also show the impact of a range of future carbon prices we assume will be in place during the operating life of these technologies (see Part 4 for more detail).

KEY SOURCES

The range of cost and performance assumptions presented below are based primarily on data from recently built or proposed projects for several technologies (pulverized coal, natural gas combined-cycle, nuclear, wind, and solar PV); the data were collected by UCS, power plant construction and engineering firms, and several other sources (Barbose 2010; Black & Veatch 2010; Pietruszkiewicz 2010; Wiser 2010; Cleetus 2009). We also use recent estimates from state and federal agencies (EIA 2011a; Klein 2009), utilities (Exelon 2010), and financial institutions (Lazard 2010).

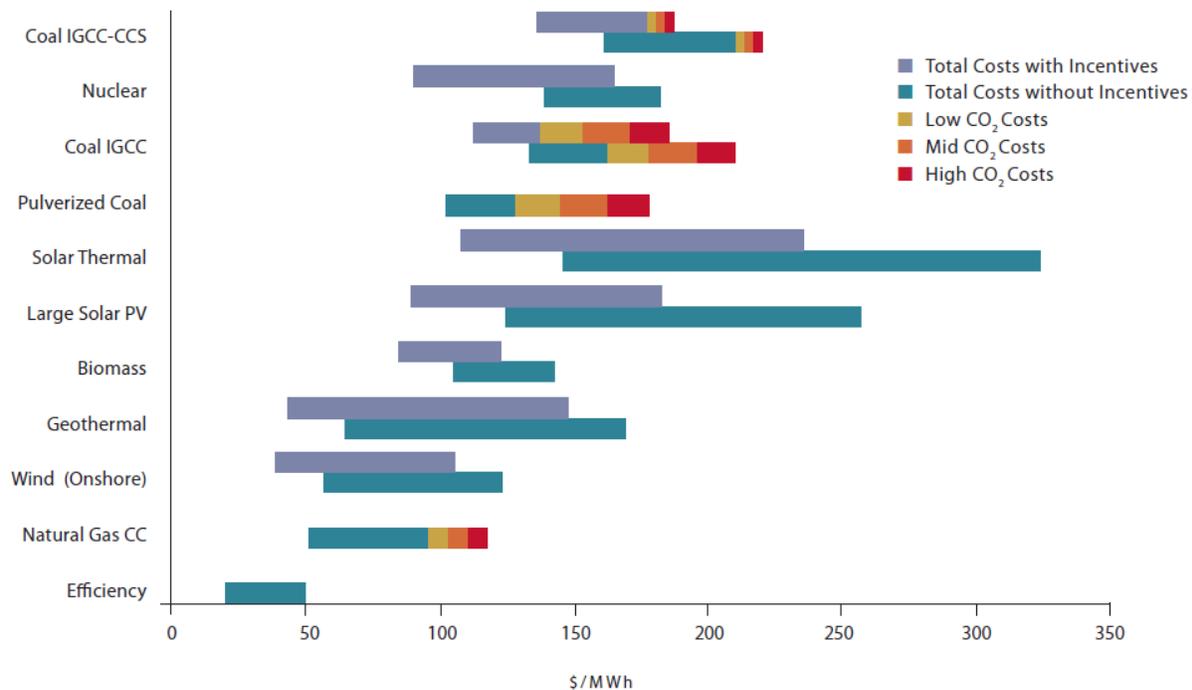
The range of costs for energy efficiency is based on an assessment of state and utility energy efficiency programs (Hurley 2008). The range of future carbon prices is based on a 2011 study reviewing more than 75 different scenarios examined in the recent modeling of various federal climate bills (Johnston 2011), as described in more detail in Part 4 of the report. A full list of references can be found at the end of this appendix.

KEY ASSUMPTIONS

- All technologies are assumed to be brought online in the year 2015.
- All costs are shown in real 2010 dollars (not including inflation) and are assumed to be levelized over a 20-year cost recovery period, as assumed in the EIA’s Annual Energy Outlook (AEO) 2010 (EIA 2010b) and previous reports.
- Capital costs are represented as overnight costs, not including interest during construction or other financing costs.

- Financing costs are included by multiplying overnight capital costs by the EIA’s technology-specific fixed charge rates from AEO 2010, resulting in a levelized capital cost. Fixed charge rates from AEO 2011 were not available when this analysis was completed. The EIA includes a 3 percent higher cost of capital for greenhouse-gas-intensive projects such as coal-fired power plants without carbon capture and storage to reflect the implicit hurdle faced by carbon-intensive investments.
- O&M costs and heat rates are based on assumptions from AEO 2011 developed by R.W. Beck (EIA 2010).
- Capacity factors are based on a range of operating conditions and regional variations in resource quality, from various sources listed at the end of this appendix.
- Incentives include tax credits for a wide range of technologies and both tax credits and loan guarantees for new nuclear plants. Tax credits currently available for wind and biomass are assumed to be extended to 2015 for illustrative purposes.

Figure A.1. Levelized Cost of Electricity for Various Technologies in 2015 (2010\$)

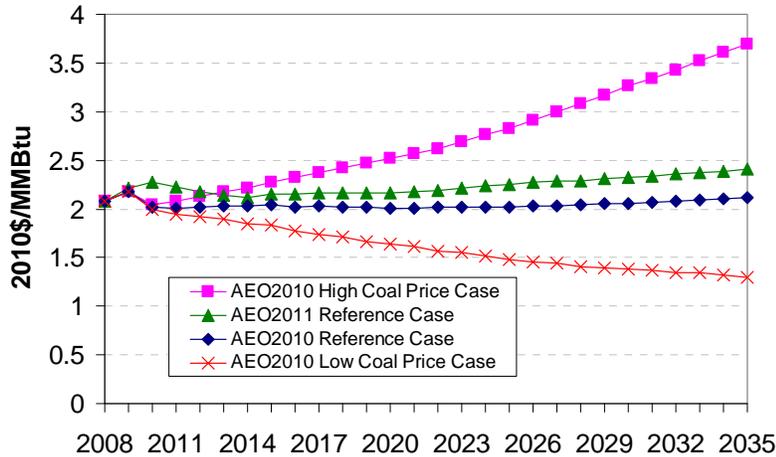


Fuel Cost Assumptions

- *Biomass*: We assume a range of \$30 to \$65 per dry ton of biomass based on the biomass supply curves developed for the UCS Climate 2030 Blueprint by Marie Walsh, agricultural economist at the University of Tennessee. Lower- and higher-cost biomass sources are available that were not considered in this range.
- *Coal*: The range of delivered coal prices is based on the EIA’s AEO 2010 high and low coal cost side cases (Figure A.2). The AEO 2011 reference case is in the middle of the range and slightly higher than AEO 2010. The AEO 2011 high and low coal cost cases were not available when this analysis was completed. The possibility that coal prices

could rise dramatically in response to global demand, depleting reserves, or both (as discussed in Part 3) is not fully reflected.

Figure A.2. Delivered Coal Prices to the Electricity Sector under Various EIA Scenarios



- Natural gas*: The range is based on NYMEX futures prices from December 2, 2010, transitioning to the EIA’s AEO 2011 forecast and using a long-term, 20 percent confidence interval for upper and lower cost projections (Figure A.3). Calculations were made using a modified version of a spreadsheet developed by the EIA for its December 2010 Short-Term Energy Outlook, and were extended out to 2035. Using a 20 percent confidence interval results in a range similar to the EIA’s AEO 2010 high and low natural gas price cases, except the entire range is shifted downward to reflect the lower reference case prices in AEO 2011 compared with AEO 2010. The AEO 2011 high and low natural gas cost cases were not available when this analysis was completed.

Figure A.3. Henry Hub Wholesale Natural Gas Prices

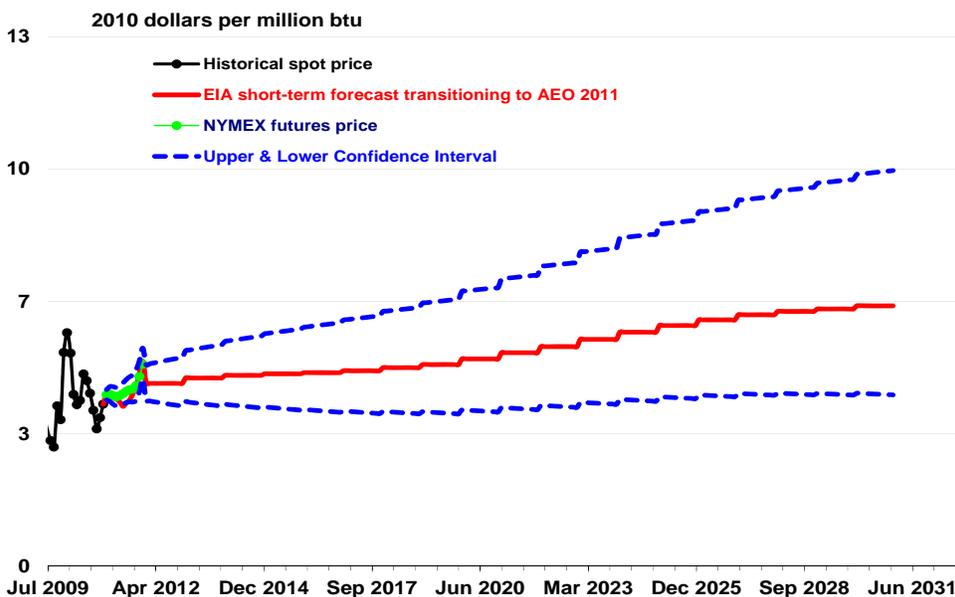


Table A.1. Levelized Cost of Electricity from Fossil and Nuclear Technologies (2010\$)

	Units	Supercritical Pulverized Coal	Coal IGCC	Coal IGCC- CCS	Natural Gas CC	Nuclear
Plant Nameplate Capacity	MW	600	600	380 - 520	400	1100 - 1350
Overnight Capital Cost	\$/kW	2800-3400	3200 - 3800	5000 - 6500	1000 - 1300	5000 - 6000
Fixed Charge Rate (a)	%	21.3%	23.1%	18.0%	15.9%	18.9%
Fixed O&M Cost	\$/kW-yr	35.97	59.23	69.3	14.62	88.75
Variable O&M Cost	\$/MWh	4.25	6.87	8.04	3.11	2.04
Heat Rate	Btu/kWh	8800	8700	10700	6430	10500
Capacity Factor	%	85%	80%	80%	50% - 87%	80% - 90%
Fuel Price (levelized)	\$/MMBtu	1.60 - 2.70	1.60 - 2.70	1.60 - 2.70	4.00 - 6.75	0.8
Fuel Price (levelized)	\$/MWh	14.1 - 23.9	13.9 - 23.6	17.1 - 29.1	26 - 43.5	8.2
Construction Period	years	4 - 5	4 - 5	4 - 6	3	6 - 7
Levelized Cost of Electricity	\$/MWh	103-130	135-164.5	163.4 - 214	52 - 97.5	141 - 184
Incentives (levelized) (b)	\$/MWh	n/a	21.1 - 25.1	25.7 - 33.4	n/a	49.9 - 17.5
CO2 Cost (levelized)	\$/MWh	16.6 - 49.8	16.2 - 48.5	3 - 9	6.8 - 20.5	n/a
Levelized Cost of Electricity with Incentives & CO2	\$/MWh	120 - 180	130 - 188	141 - 190	59 - 118	91 - 167

Table A.2. Levelized Cost of Electricity from Renewable Energy Technologies (2010\$)

	Units	Wind (Onshore)	Geothermal	Biomass CFB	Large Solar PV	Solar Thermal (b)
Plant Nameplate Capacity	MW	50 - 100	50	50	1-100	50 - 100
Overnight Capital Cost	\$/kW	2000-2500	3000 - 10000	3800 - 4300	3000 - 4500	4700 - 6800
Fixed Charge Rate (a)	%	9.8%	11.0%	11.4%	9.8%	10.5%
Fixed O&M Cost	\$/kW-yr	28.07	84.27	100.5	16.7	64
Variable O&M Cost	\$/MWh	n/a	9.64	5	n/a	n/a
Heat Rate	Btu/kWh	n/a	n/a	13500	n/a	n/a
Capacity Factor	%	25% - 45%	85%	80%	20% - 28%	27% - 43%
Fuel Price (levelized)	\$/MMBtu	n/a	n/a	1.88 - 4.06	n/a	n/a
Fuel Price (levelized)	\$/MWh	n/a	n/a	25.3 - 54.8	n/a	n/a
Construction Period	years	1	3 - 4	3 - 4	1	2 - 3
Levelized Cost of Electricity	\$/MWh	57 - 125	65 - 169	107 - 144	126 - 260	147 - 328
Incentives (levelized)(c)	\$/MWh	21	21	21	35.8 - 75.3	39 - 90
CO2 Cost (levelized)	\$/MWh	n/a	n/a	n/a	n/a	n/a
Levelized Cost of Electricity with Incentives & CO2	\$/MWh	36 - 104	44 - 148	86 - 123	90 - 185	108 - 238

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