Economics

Nuclear Energy Is Competitive in Independent Cost Analyses of New Generating Capacity

September 2011

Key Facts

- Like with all new electric generating capacity, there is some volatility in the capital cost of new nuclear energy facilities. Estimates are in the $4 billion range in today's dollars for the engineering, procurement and construction cost of a single reactor. Variation in costs can be attributed to uncertainty about commodity prices and wages and differences in the financial assumptions and scope used in each analysis.

- Although nuclear energy project costs are large, total project cost does not measure a project's economic viability. The most relevant metric is the cost of the electricity produced by the nuclear energy facility relative to alternative sources of electricity and relative to the market prices of electricity at the time the reactor comes into service.

- Analyses by industry, academia and government show that even at capital costs in the $4,000 to $6,000 per kilowatt electric range, the electricity generated from nuclear energy can be competitive with other large power plants. If regional or national programs put a significant price on carbon emissions, nuclear energy has a greater cost advantage.

Energy Information Administration Analysis

The Energy Information Administration (EIA) publishes an annual forecast called the Annual Energy Outlook, which includes estimates of the capital cost of all electric generating technologies and their likely market penetration out to 2035. The 2011 edition provides the expected average national levelized cost of electricity from various technologies in 2016 (see table below). As defined by the 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."

The EIA results indicate that nuclear energy is one of the least-cost technologies that do not emit greenhouse gases. EIA's analysis does not reflect financial incentives, such as state or federal tax credits. An adjustment similar to a $15 per ton carbon tax is applied to the cost of capital for greenhouse-gas-intensive technologies that are (coal-fired and coal-to-liquids plants without carbon capture and sequestration). Additional system investments such as transmission are included, but the cost of backup power for intermittent sources such as wind and solar is not included in the analysis.

U.S. Average Levelized Costs for Facilities Entering Service in 2016				
Plant Type	**Capacity Factor**	**Cost Range in 2009 Dollars per Megawatt Hour**		
		Minimum	Average	Maximum
Natural gas—conventional combined cycle (CC)	87%	60.0	66.1	74.1
Hydro	52%	58.5	86.4	121.4
Natural gas—advanced CC with carbon capture & sequestration (CCS)	87%	80.8	89.3	104.0
Wind—onshore	34%	81.9	97.0	115.0
Geothermal	92%	91.8	101.7	115.9
Advanced coal	85%	100.7	109.4	122.1
Biomass	83%	99.5	112.5	133.4
Advanced nuclear	90%	109.7	113.9	121.4
Advanced coal with CCS	85%	126.3	136.2	154.5
Solar PV	25%	158.7	210.7	323.9
Wind—offshore	34%	186.7	243.2	349.4
Solar thermal	18%	191.7	311.8	641.6

Source: Energy Information Administration, Annual Energy Outlook, April 2011, DOE/EIA-0383 (2011).

National Research Council—America's Future Energy Project
The National Research Council, an arm of the National Academy of Sciences and the National Academy of Engineering, published a report in 2009 titled, "America's Energy Future: Technology and Transformation." The study evaluates contributions and estimated costs of existing and new energy technologies. The report modeled levelized costs of electricity for several different technologies. For nuclear energy, the range is from 6 cents to 13 cents per kilowatt-hour. The low end of the range corresponds to plants that secure low-cost financing through the DOE's loan guarantee program. As indicated in the report, natural gas could be the lowest- or highest-cost option, depending on the price of the fuel, with a cost range from 4 cents to 16 cents per kilowatt-hour (and up to 21 cents per kilowatt-hour if gas prices are high and carbon capture and sequestration technology is added). The estimated levelized costs for electricity from offshore wind facilities range from 5 cents to 18 cents per kilowatt-hour and 4 cents to 10 cents per kilowatt-hour for onshore wind facilities. The cost of electricity from solar power ranges from 14 cents to 30 cents per kilowatt-hour, according to the report.

The National Research Council's analysis shows that nuclear energy facilities can be competitive when compared with other low-carbon technologies. The levelized costs for nuclear facilities "are likely to be comparable to future costs of electricity from other sources, particularly if fossil plants are required to store CO2 or pay a carbon fee," the report said.

Electric Power Research Institute
The Electric Power Research Institute is a nonprofit research organization funded by companies that produce and deliver more than 90 percent of U.S. electricity and members from 40 countries. EPRI's Program on Technology Innovation conducts research to estimate the costs of electricity generating technologies.

EPRI's 2011 update included estimated costs for electric generating technologies in 2015 and 2025. For each technology, the analysis provides the levelized cost of electricity. The report assumes significant improvements in renewable technology cost and output. The report also provides costs for carbon capture and storage for coal and natural gas technologies in 2025.

Since nuclear energy technology for large reactors is based on existing technology, the cost range does not change in the 2015 to 2025 time frame. However, the analysis shows that nuclear energy is among the most competitive sources of non-carbon electricity even after other technology advances are taken into consideration.

Representative Cost for Power Generation Technologies in 2025					
All Costs in Constant December 2010	**Nominal Plant Capacity, MW**	**Capaci-ty Factor**	**Total Plant Cost $/kW**	**Total Capital Required $/kW**	**Levelized Electricity Cost $/MWh**
Coal: pulverized coal with carbon capture	600	80%	3,200 - 4,100	3,850 - 4,920	87 - 105
Coal: integrated gasification combined cycle (CC) with carbon capture	500	80%	3,100 - 3,800	3,750 - 4,600	85 - 101
Natural gas CC	550	80%	1,060 - 1,150	1,275 - 1,375	47 - 74
Natural gas CC with carbon capture	450	80%	1,600 - 1,900	1,900 - 2,250	68 - 109
Nuclear	1,400	90%	3,800 - 4,250	5,100 - 5,700	76 - 87
Biomass—bubbling fluidized bed	100	85%	3,400 - 4,250	3,900 - 4,850	80 - 136
Wind—onshore	100	28 - 40%	1,960 - 2,600	2,050 - 2,720	73 - 134
Wind—offshore	200	40%	2,850 - 3,650	3,000 - 3,825	122 - 147
Concentrating solar thermal	100 - 250	26 - 58%	3,000 - 4,800	3,700 - 5,900	116 - 173
Solar (photovoltaic)	10	15 - 28%	2,900 - 3,950	3,175 - 4,325	210 - 396

Source: Electric Power Research Institute Program on Technology Innovation: Integrated Generation Technology Options, June 2011.

For more information, see NEI's status report, "The Cost of New Generating Capacity in Perspective," September 2011.