Generic Capital Costs of Supply-Side Resources

Planning Advisory Committee

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RESOURCE ADEQUACY

Revised

Background

Objective: Provide an update on generic capital costs for new supply-side resources to support Regional System Plan studies

- Following stakeholder requests, ISO-NE has provided generic capital costs of generation technologies since 2009
- An annual update of these costs is useful to reflect any changes in conditions affecting capital costs
- This information could be used for some regional planning studies

Different Ways Capital Costs are Presented

- Total plant costs (TPC)
  - Also referred to as “Overnight Construction Costs” or “Overnight Capital Costs”
  - Developed on the theoretical basis of construction occurring at a single point of time
  - Includes materials, equipment and labor for all process facilities, fuel handling and storage, water intake structure and wastewater treatment, offices, maintenance shops, warehouses, step-up transformer and transmission interconnection, etc.
- Total capital requirement (TCR)
  - Also referred to as “All-In Costs”
  - Includes TPC plus owner’s cost and interest expenses during construction (often referred to as Allowance for Funds Used During Construction, or AFUDC)
  - Larger disparity between TPC and TCR when comparing technologies with prolonged construction periods
- <u>All costs presented in this presentation reflect TPC or overnight costs</u>

Source 4

Factors Affecting Total Plant Cost

Specific project costs may differ from generic costs for the following reasons:

- Technology development
- Unit size
- Costs of materials, labor and overhead
- Inflation and interest during construction
- Regulation and other policy interventions
- Specific site requirements
- Regional costs differences

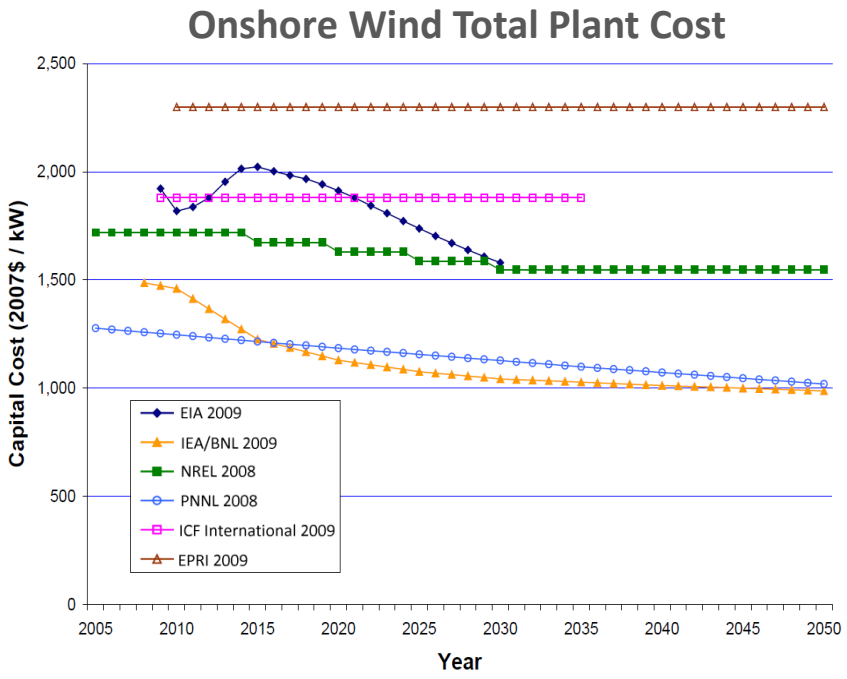
Data Sources

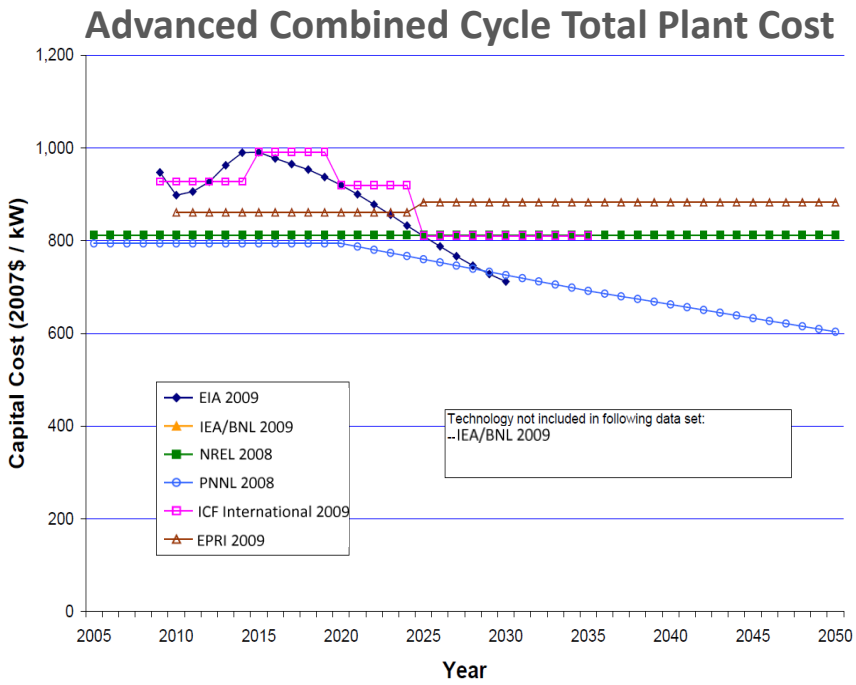
1. ICF International, "Cost and Performance Assumptions for Modeling Electricity Generation Technologies," NREL, Golden, 2010.
2. Black & Veatch, "Cost and Performance Data for Power Generation Technologies," NREL, 2012.
3. US EIA, "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants," US DOE, Washington, 2013.
4. EPRI, "Program on Technology Innovation: Integrated Generation Technology Options 2012," EPRI, Palo Alto, 2013.
5. Energy and Environmental Economics, "Cost and Performance Review of Generation Technologies: Recommendation of WECC 10- and 20- Year Studies," WECC, Salt Lake City, 2012.
6. The Brattle Group, Capital Cost Assumptions Developed for ISO-NE Forward Capacity Market, 2014.

Variety of Assumptions Observed

NREL compared 6 data sets of assumptions

- EIA, IEA, NREL, PNNL, ICF International and EPRI
- Many different assumptions





Source 1

Investigation of a Conventional NGCC Unit

Source	Plant Size (MW)	Heat Rate (Btu/kWh)	Total Plant Cost ($/kW)
Black and Veatch/ NREL	615	6,705	1230 (2009$)
EIA	620	7,050	917 (2012$)
EPRI	550	7,000	900-1,150 (2011$)

Source 2, 3, 4

WECC Research Summary and Recommendation (2012$)

Source	Installation Vintage	Capital Cost [$/kW]	Fixed O&M [$/kW-yr]	Heat Rate [Btu/kWh]
APS IRP		$827	$4.7	6,473
B&V/NREL	2010	$1,336	$6.4	6,705
Brattle/CH2M Hill	2015	$856	$14.1	7,096
EIA/RW Beck		$1,045	$14.4	7,050
IPC IRP[a]		$1,241	$11.6	6,800
		$1,338	$6.8	6,800
NETL		$807	$10.9	6,798
NVE IRP[b]		$1,086	$13.3	6,975
		$1,713	$26.6	6,989
PacifiCorp IRP[c]	2014	$928	$7.1	6,885
		$1,181	$13.5	7,302
Xcel IRP[d]	2011 – 2018	$719	$6.9	6,947
		$1,145	$10.8	6,733
Recommendation		**$1,100**	**$10.0**	**7,000**

Source 5

[a] Low cost estimate is a 540 MW CCGT; high cost estimate is a 270 MW CCGT.
[b] Low cost estimate is 612 MW; high cost is 261 MW.
[c] The range presented includes variation in plant size and location. Low cost estimate is a 620 MW plant in the Northwest; high cost estimate is a 270 MW plant in Utah.
[d] Low cost estimate is 808 MW; high cost is 346 MW.

Generic Overnight Capital Costs

Technology Types in the Interconnection Queue as of 4/1/14

Technology Type	Plant Size (MW)	Heat Rate (Btu/kWh)	Total Plant Cost ($/kW)
Advanced CC	340 – 400	6,430 – 7,525	1,025 – 2,095
Advanced GT	190 – 210	9,130 – 9,750	675 – 1,260
Biomass	20 – 100	12,350 – 13,500	3,600 – 8,180
Conventional CC	550 – 730	7,000 – 7,525	820 – 1,150
Conventional GT	85 – 420	10,580 – 10,850	640 – 975
NG Fuel Cells	10	9,500	7,110
Offshore Wind	200 – 400	N/A	3,100 – 6,230
Onshore Wind	50 – 200	N/A	1,750 – 2,400
Solar Photovoltaic	5 – 150	N/A	2,000 – 4,185

2011/12/13$

Note 1: EIA (Source 3), EPRI (Source 4) and the Brattle Group (Source 6) are used as assumptions. These are the most recent reports available.
Note 2: When ranges of values are absent, only single value assumptions are provided.
Note 3: Values may be rounded to the nearest increment of 5.

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Generic Overnight Capital Costs (Cont.)

Other Technology Types Not in Interconnection Queue as of 4/1/14

Technology Type	Plant Size (MW)	Heat Rate (Btu/kWh)	Total Plant Cost ($/kW)
Conventional Hydro	500	N/A	2,935
Geothermal	50	N/A	4,360 – 8,400
IGCC (Single Unit)	600	8,700 – 8,900	2,800 – 4,400
Municipal Solid Waste	50	18,000	8,310
Nuclear	1,400 – 2,235	10,000	4,000 – 5,530
Pulverized Coal	650 – 750	8,750 – 8,800	2,000 – 3,245
Pumped Storage	250 – 1,000	N/A	1,500 – 5,290

2011/12/13$

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Questions

Abbreviations

APS IRP – Arizona Public Service Company

B&V/NREL – Black & Veatch

Brattle/CH2M Hill – The Brattle Group with CH2M HILL

EIA – US Energy Information Administration

EPRI – Electric Power Research Institute

IEA – International Energy Agency

IPC IRP – Idaho Power Company

NETL – National Energy Technology Laboratory

NREL – National Renewable Energy Laboratory

NVE IRP – Nevada Energy

PacifiCorp IRO – Pacifi Corp

PNNL – Pacific Northwest National Laboratory

Xcel IRP – Xcel Energy