Default MOPR Floor Offer Prices for New Generation Capacity Resources

Market Implementation Committee

March 11, 2020

Default MOPR Floor Price for New Resources

- Based on Net Cost of New Entry ("CONE") for relevant technology type
- Net CONE = Gross CONE – Net E&AS revenue
  - Gross CONE: levelized annual cost to construct a new resource plus annual fixed operation and maintenance costs
  - Net E&AS: expected energy and ancillary service market revenues
- PJM has developed preliminary Gross CONE values for the following generation technology types:
  - CT, CC, Coal, Nuclear, Solar Tracking, Solar Fixed, Onshore Wind, Offshore Wind, Battery Storage, Demand Response (generation backed)

Updates

- Investigated alternative sources for renewables
  - NREL solar data is in $/kW$_{DC}$, multiply by 1.3 ILR to convert to $/kW$_{AC}$
- Split solar resource category into “tracking” and “fixed”
  - Fixed costs (94% of tracking, based on LBNL and IHS cost ratios)
  - Applied 60% capacity value for tracking, 42% for fixed
- Increased Onshore Wind capacity value from 14.7% to 17.6%
- Added resource category Demand Response (generation backed)
- Completed E&AS methodologies and Net CONE values

Appendix provides E&AS methods, resource links and a comparison of capital costs from the various data sources

Table 1 – Total Capital Cost and Fixed O&M Cost

Resource Type	Technology Description	Source of Information	Fixed O&M ($/kW-year)	Installed Capital Cost ($/kW)
Nuclear	2 x Westinghouse AP1000 Pressurized Water Reactor (2,156 MW)	EIA (Case 11)	122	6,041
Coal	Ultra-Super Critical Coal (650 MW)	EIA (Case 1)	41	3,676
Combined Cycle	2x1 GE Frame 7HA with evaporative cooling and SCR (1,152 MW)	Quadrennial Review	24	874
Combustion Turbine	GE Frame 7HA CT with evaporative cooling, SCR, dual fuel (352 MW)	Quadrennial Review	17	875
Solar PV - Tracking	Single-axis tracking (150 MW AC)	EIA (Case 24)	15	1,313
Solar PV - Fixed	Fixed-tilt (100 MW AC)	EIA, LBNL, IHS	14	1,234
Onshore Wind	17 x 2.8 MW WTGs (50 MW)	EIA (Case 21)	35	1,677
Offshore Wind	40 x 10 WTGs, 100’ depth (400 MW)	EIA (Case 22)	110	4,375
Battery Storage	50 MW utility scale, Li, 200 MWh rating	EIA (Case 18)	25	1,389
Demand Response	2 MW RICE, ultra-low sulfur diesel	*TBA*	*TBA*	*TBA*

Financial Assumptions

Financial assumptions developed during 2018 Quadrennial Review used to determine Gross CONE from the installed capacity costs and fixed costs

Financial Assumptions	
Expected Life	20 Years
Debt Ratio	55.0%
Debt Rate	6.0%
Equity Rate	13.0%
Total Tax Rate	27.7%
ATWACC	8.2%
Inflation Rate	2.2%

Table 2 – Gross CONE Values

Resource Type	Fixed O&M ($/kW-year)	Installed Capital Cost ($/kW)	Gross CONE ($/MW-Day) (*Nameplate*)
Nuclear	122	6,041	2,000
Coal	41	3,676	1,068
Combined Cycle	24	874	320
Combustion Turbine	17	875	294
Solar PV (Tracking)	15	1,313	290
Solar PV (Fixed)	14	1,234	271
Onshore Wind	35	1,677	420
Offshore Wind	110	4,375	1,155
Battery Storage (4h.)	25	1,389	532

Gross CONE reflects 100% bonus depreciation and 30% Investment Tax Credit for solar and wind

Table 3 – Gross CONE Value Comparison

Resource Type	NREL - Gross CONE ($/ICAP MW-Day) (*Nameplate*)	EIA - Gross CONE ($/ICAP MW-Day) (*Nameplate*)	Difference ($/ICAP MW-Day) (*Nameplate*)
Nuclear	2,062	2,000	62
Coal	1,118	1,068	50
Combined Cycle	320	320	N/A
Combustion Turbine	294	294	N/A
Solar PV (Tracking)	297	290	7
Solar PV (Fixed)	279	271	8
Onshore Wind	405	420	-15
Offshore Wind	999	1,155	-156
Battery Storage (4h.)	473	532	-59

PJM intends to use the EIA-based values

Net E&AS Offset Revenues

- FERC order requires that net E&AS offset revenues be determined for each transmission zone
- A proposed method for estimating the net energy market revenues for each technology type is described in the Appendix
- Proposed method would use historical zonal LMPs from three most recent calendar years to develop zonal Net E&AS values
- Table 4 provides Net CONE values determined using the Gross CONE and Net E&AS Revenue Offset

Table 4 – Average Zonal Net CONE – Capacity Value Basis

Resource Type	Gross CONE ($/MW-Day) (*Nameplate*)	Average Zonal E&AS Revenue Offset ($/MW-Day) (*Nameplate*)	Net CONE ($/MW-Day) (*Nameplate*)	Capacity Value (Percent of *Nameplate*)	Net CONE ($/ICAP MW-Day)
Nuclear	2,000	517	1,483		**1,483**
Coal	1,068	43	1,025		**1,025**
Combined Cycle	320	168	152		**152**
Combustion Turbine	294	48	246		**246**
Solar PV (Tracking)	290	185	105	60%	**175**
Solar PV (Fixed)	271	117	154	42%	**367**
Onshore Wind	420	240	180	17.6%	**1,023**
Offshore Wind	1,155	337	818	26%	**3,146**
Battery Storage	532	116	416	40%	**1,040**

Table 5 – Net CONE Values – ICAP Basis

Resource Type	Gross CONE ($/MW-Day) (*Nameplate*)	Avg. Zonal E&AS Revenue Offset ($/MW-Day) (*Nameplate*)	Net CONE ($/ICAP MW-Day)
Demand Response (Gen)	*TBA*	*TBA*	*TBA*
Energy Efficiency	N/A	N/A	46

Next Steps

- Continue coordinated refinement with IMM of estimates of costs and revenues
- Prepare and submit FERC filing by March 18

Appendix

Energy & Ancillary Services Offset Revenue

Resource Type	E&AS Methodology
Nuclear	Gross revenue determined by average annual LMP multiplied by annual energy output times class average equivalent availability factor. Net revenue determined by gross revenue minus cost to generate annual energy output (i.e. fuel cost, Variable O&M)
Coal	Simulated dispatch of a 650 MW coal unit (with heat rate of 9,250 BTU/kWh and variable operations and maintenance costs of $9.50/MWh) with the unit committed in profitable blocks of at least eight hours
Combined Cycle	Simulated dispatch with commitment for entire 16-hour period between HE 8 and HE 23 of each day if average LMP exceeds cost to generate (+10%) over this period. HR = 6,533 Btu/kWh, Variable O&M = $2.11/MWh
Combustion Turbine	Simulated dispatch with commitment for each 4-hour blocks between HE 8 and HE 23 of each day if average LMPs exceed cost to generate (+10%) in 2 of the 4 hours of each block. HR = 9,134 Btu/kWh, Variable O&M = $6.93/MWh
Solar PV (fixed & tracking)	Net energy market revenue estimate shall be determined using a solar resource model that provides the average output level, expressed as a percentage of nameplate rating, by hour of day (for each of the 24-hours of a day) and by calendar month (for each of the twelve months of a year). The annual energy market revenues are determined by multiplying the solar output level of each hour by the hourly LMP applicable for that hour with this product summed across all of the hours of an annual period. Two separate solar resource models are used, one model for a fixed panel resource and a second model for a tracking panel resource

Energy & Ancillary Services Offset Revenue

Resource Type	E&AS Methodology
Onshore Wind	Net energy market revenue estimate shall be determined using a wind resource model that provides the average output level, expressed as a percentage of nameplate rating, by hour of day (for each of the 24-hours of a day) and by calendar month (for each of the twelve months of a year). The annual energy market revenues are determined by multiplying the solar output level of each hour by the hourly LMP applicable for that hour with this product summed across all of the hours of an annual period
Offshore Wind	Average annual zonal LMP multiplied by annual wind energy output at 45% capacity factor
Battery Storage	Simulated dispatch with commitment for 4 highest LMP hours of a daily 24 hour period if average LMP of 4 lowest LMP hours exceeds (+120%) of average LMP of 4 highest LMP hours of the 24 hour period. Net revenues equal hourly MW output times hourly LMP for each discharging minus hourly MW consumed times hourly LMP when charging.
Demand Response (Gen)	Simulated dispatch of a 2 MW RICE unit (with heat rate of 9,660 BTU/kWh and variable operations and maintenance costs of $7.50/MWh) with the unit committed in any profitable hour

Capital Cost Sources

Source	Link
NREL: 2019 Annual Technology Baseline	atb.nrel.gov
Lazard: 2019 Levelized Cost of Energy & Storage	https://www.lazard.com/perspective/lcoe2019
	https://www.lazard.com/media/451087/lazards-levelized-cost-of-storage-version-50-vf.pdf
	https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf
EPA: IPM Platform 2018 Reference Case	https://www.epa.gov/airmarkets/documentation-ipm-platform-v6-november-2018-reference-case-all-chapters
EIA: 2020 Capital Cost Report	https://www.eia.gov/analysis/studies/powerplants/capitalcost/
PJM: Quadrennial Review	https://pjm.com/-/media/library/reports-notices/special-reports/2018/20180420-pjm-2018-cost-of-new-entry-study.ashx?la=en
LBNL: Utility Scale Solar – 2019 Edition	https://emp.lbl.gov/utility-scale-solar/
IHS: US Solar PV Capital Cost and LCOE Outlook	https://ihsmarkit.com/research-analysis/index.html

Installed Capital Costs from Different Sources ($/kW)

Technology	NREL 2022	Lazard 2019	EPA 2021	EIA 2019	PJM
Nuclear	6,506	6,900 – 12,200	5,644	6,041	6,041
Coal	3,944	3,000 – 6,250	3,580	3,676	3,676
Combined Cycle	894	700 – 1,300	1,081	1,084 (H)	874
Combustion Turbine	905	700 – 950	662	713 (7FA)	875
Solar PV (tracking)	1,343	1,100	1,034	1,313	1,313
Solar PV (fixed)	*1,262	900		1,234*	1,234
Onshore Wind	1,472	1,100 – 1,500	1,404	1,677	1,677
Offshore Wind	3,682	2,350 – 3,550	4,529	4,375	4,375
Battery Storage	1,157	898 – 1,874	N/A	1,389	1,389

** Fixed cost obtained from multiplying Tracking cost by 0.94*