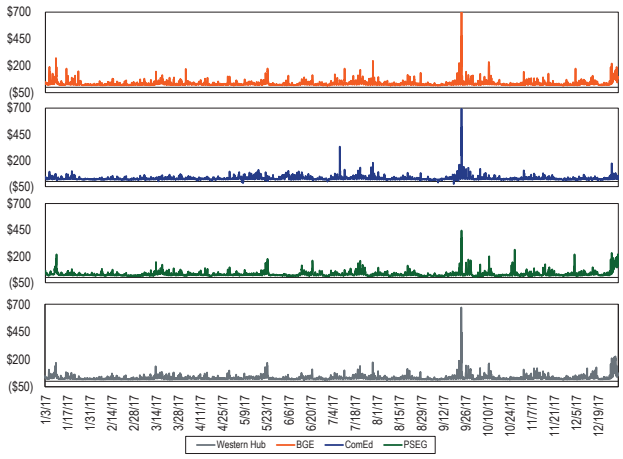
Figure 7-4 Hourly quark spread (uranium) for selected zones ($/MWh): 2017[3]



Theoretical Energy Market Net Revenue

The net revenues presented in this section are theoretical as they are based on explicitly stated assumptions about how a new unit with specific characteristics would operate under economic dispatch. The economic dispatch uses technology specific operating constraints in the calculation of a new entrant's operations and potential net revenue in PJM markets.

Analysis of energy market net revenues for a new entrant includes seven power plant configurations:

- The CT plant has an installed capacity of 747.9 MW and consists of two GE Frame 7HA.02 CTs, equipped with full inlet air mechanical refrigeration and selective catalytic reduction (SCR) for NO_x reduction.[4]
- The CC plant has an installed capacity of 1,137.2 MW and consists of two GE Frame 7HA.02 CTs equipped with evaporative cooling, duct burners, a heat recovery steam generator (HRSG) for each CT with steam reheat and SCR for NO_x reduction with a single steam turbine generator.[5] [6]
- The CP has an installed capacity of 600.0 MW and is a sub-critical steam unit, equipped with selective catalytic reduction system (SCR) for NO_x control, a flue gas desulphurization (FGD) system with chemical injection for SO_x and mercury control, and a bag-house for particulate control.
- The DS plant has an installed capacity of 2.0 MW and consists of one oil fired CAT 2 MW unit using New York Harbor ultra low sulfur diesel.
- The nuclear plant has an installed capacity of 2,200 MW and consists of two units and related facilities using the Westinghouse AP1000 technology.
- The wind installation consists of 21 Siemens 2.625 MW wind turbines totaling 55.1 MW installed capacity.
- The solar installation consists of a 60 acre ground mounted solar farm totaling 10 MW of AC installed capacity.

Net revenue calculations for the CT, CC and CP include the hourly effect of actual local ambient air temperature on plant heat rates and generator output for each of the three plant configurations.[7] [8] Plant heat rates account for the efficiency changes and corresponding cost changes resulting from ambient air temperatures.

CO_2, NO_x and SO_2 emission allowance costs are included in the hourly plant dispatch cost, the short run marginal cost. CO_2, NO_x and SO_2 emission allowance costs were obtained from daily spot cash prices.[9]

A forced outage rate for each class of plant was calculated from PJM data and incorporated into all revenue calculations.[10] In addition, each CT, CC, CP, and DS plant was assumed to take a continuous 14 day planned annual outage in the fall season.

Ancillary service revenues for the provision of regulation service were calculated for the CP. The regulation clearing price was compared to the day-ahead LMP. If the reference CP could provide regulation more profitably than energy, the unit was assumed to provide regulation during that hour. No black start service capability is assumed for any of the unit types.

3 Quark spreads use a heat rate of 10,000 Btu/kWh, zonal hourly LMPs, and daily uranium prices.

4 GE Power, "7HA Power Plants," 7HA.02 unit capacity was updated based on GE unit specifications. (November 2017) <https://www.gepower.com/content/dam/gepower-pgdp/global/en_US/documents/product/gas%20turbines/Fact%20Sheet/2017-prod-specs/7ha-power-plants.pdf>.

5 The duct burner firing dispatch rate is developed using the same method as for the unfired dispatch rate, with adjustments to the duct burner fired heat rate and output.

6 GE Power, "7HA Power Plants," 7HA.02 unit capacity was updated based on GE unit specifications. (November 2017) <https://www.gepower.com/content/dam/gepower-pgdp/global/en_US/documents/product/gas%20turbines/Fact%20Sheet/2017-prod-specs/7ha-power-plants.pdf>.

7 Hourly ambient conditions supplied by DTN.

8 Heat rates provided by Pasteris Energy, Inc. No-load costs are included in the dispatch price since each unit type is dispatched at full load for every economic hour resulting in a single offer point.

9 CO_2, NO_x and SO_2 emission daily prompt prices obtained from Evolution Markets, Inc.

10 Outage figures obtained from the PJM eGADS database.

Levelized Total Costs

Table 7-7 New entrant 20-year levelized total costs (By plant type (Dollars per installed MW-year))[19] [20]

	20-Year Levelized Total Cost								
	2009	2010	2011	2012	2013	2014	2015	2016	2017
Combustion Turbine	$128,705	$131,044	$110,589	$113,027	$109,731	$108,613	$111,639	$113,821	$95,264
Combined Cycle	$173,174	$175,250	$153,682	$155,294	$150,654	$146,443	$146,300	$148,327	$129,731
Coal Plant	$446,550	$465,455	$473,835	$480,662	$491,240	$504,050	$517,017	$523,540	$528,701
Diesel Plant	$153,143	$153,143	$153,143	$153,143	$153,143	$161,746	$170,500	$173,182	$158,817
Nuclear Plant	$801,100	$801,100	$801,100	$801,100	$801,100	$880,770	$935,659	$963,107	$1,349,850
Wind Installation (with 1603 grant)				$196,186	$196,148	$198,033	$202,874	$231,310	$188,747
Solar Installation (with 1603 grant)				$394,855	$263,824	$236,289	$234,151	$218,937	$200,931

Levelized Cost of Energy

The levelized cost of energy is a measure of the total cost per MWh of energy from a technology, including all fixed and variable costs. If a unit's revenues cover its levelized cost of energy, it is covering all its costs and earning the target rate of return. Table 7-8 shows the levelized cost of energy for a new entrant unit by technology type operating at a defined capacity factor for the new entrant unit type. CCs had a low levelized cost of energy in 2017 because low gas prices resulted in low short run marginal costs which increased dispatch and the capacity factor, which increased the MWh over which costs are spread. DS units had a high levelized cost of energy in 2017 because DS units ran for extremely few hours in 2017, which decreased the capacity factor, which decreased the MWh over which costs are spread. The levelized cost of wind is comparable to or less than that of all other resources except CCs. The levelized cost of solar is high as a result of a low capacity factor.

New Entrant Combustion Turbine

Energy market net revenue was calculated for a new CT plant economically dispatched by PJM. It was assumed that the CT plant had a minimum run time of two hours. The unit was first committed day ahead in profitable blocks of at least two hours, including start costs. If the unit was not already committed day ahead, it was run in real time in standalone profitable blocks of at least two hours, or any profitable hours bordering the profitable day-ahead or real-time block.

The new entrant CT is larger and more efficient than most CTs currently operating in PJM. The economically dispatched new entrant CT ran for more than twice as many hours as large CTs currently operating in PJM. The new entrant CT energy market net revenue results must therefore be interpreted carefully when comparing to existing CTs which are generally smaller and less efficient than the newest CT technology used by the new entrant CT.

Table 7-8 Levelized cost of energy: 2017

	CT	CC	CP	DS	Nuclear	Wind (ComEd)	Wind (PENELEC)	Solar (PSEG)
Levelized cost ($/MW-Yr)	$95,264	$129,731	$528,701	$158,817	$1,349,850	$188,747	$188,747	$200,931
Short run marginal costs ($/MWh)	$28.95	$20.07	$30.52	$142.62	$8.50	$0.00	$0.00	$0.00
Capacity factor (%)	34%	87%	37%	0%	99%	35%	30%	14%
Levelized cost of energy ($/MWh)	$61	$37	$194	$5,007	$163	$62	$73	$166

19 Levelized total costs provided by Pasteris Energy, Inc.

20 Under Section 1603 of the American Recovery and Reinvestment Tax Act of 2009 the United States Department of the Treasury makes payments to owners who place in service specified energy property and apply for such payments. The purpose of the payment is to reimburse eligible applicants for a portion of the capital cost of such property. Solar and wind energy properties are eligible for a 30 percent payment of the total eligible capital cost of the project. This 30 percent payment reduced the calculated fixed nominal levelized revenue requirements of the solar and wind technologies.