# Renewable Technology Costs

**Prepared for**

New York ISO
Independent System Operator

**New York ISO**

**Final**

**June 25, 2020**

**Project A14045.002**

55 East Monroe Street
Chicago, IL 60603-5780 USA
312-269-2000
www.sargentlundy.com

Sargent & Lundy

# LEGAL NOTICE

This deliverable was prepared by Sargent & Lundy, L.L.C. (S&L) expressly for the sole use of New York ISO (Client) in accordance with the contract agreement between S&L and Client. This deliverable was prepared using the degree of skill and care ordinarily exercised by engineers practicing under similar circumstances. Client acknowledges: (1) S&L prepared this deliverable subject to the particular scope limitations, budgetary and time constraints, and business objectives of Client; (2) information and data provided by others, including Client, may not have been independently verified by S&L; and (3) the information and data contained in this deliverable are time-sensitive and changes in the data, applicable codes, standards, and acceptable engineering practices may invalidate the findings of this deliverable. Any use or reliance upon this deliverable by third parties shall be at their sole risk.

Sargent & Lundy is one of the oldest and most experienced full-service architect engineering firms in the world. Founded in 1891, the firm is a global leader in power and energy with expertise in grid modernization, renewable energy, energy storage, nuclear power, and fossil fuels. Sargent & Lundy delivers comprehensive project services—from consulting, design, and implementation to construction management, commissioning, and operations/maintenance—with an emphasis on quality and safety. The firm serves public and private sector clients in the power and energy, gas distribution, industrial, and government sectors.

**55 East Monroe Street • Chicago, IL 60603-5780 USA • 312-269-2000**

# TABLE OF CONTENTS

# FIGURES AND TABLES



# APPENDIXES

# 1. TECHNOLOGY DESCRIPTIONS

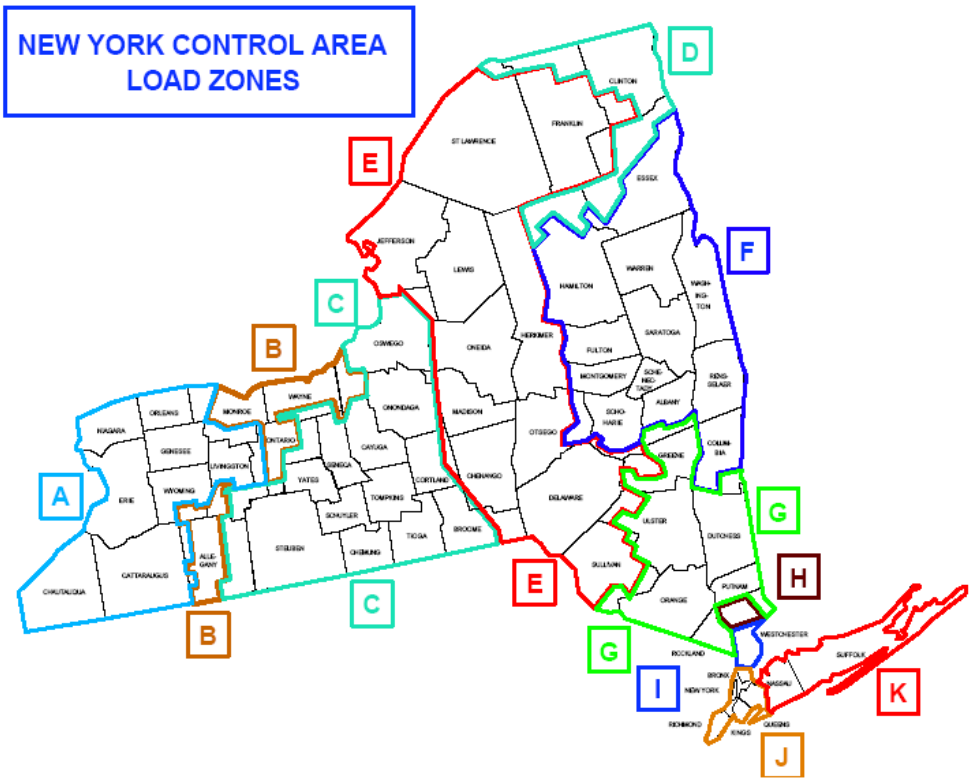
Sargent & Lundy estimated capital and O&M costs for representative renewable technologies located in NYISO Zones G, H, I, and J and entering commercial operation in 2020. The technologies and corresponding NYISO Zones are summarized in Table 1-1. A map of the control area load zones is shown in Figure 1. The following subsections describe the key characteristics of each technology and the assumptions used to estimate the capital and O&M costs.

**Table 1-1 — Technology Summary for NYISO Zones**

| | NYISO Zones | | | |
|---|---|---|---|---|
| | G | H | I | J |
| **Ground Mounted Solar PV**<br>*Project Size:* 1–10 MW | ✓ | ✓ | ✓ | ✓ |
| **Ground Mounted Solar PV**<br>*Project Size:* 10–50 MW | ✓ | ✓ | ✓ | ✓ |
| **Ground Mounted Solar PV**<br>*Project Size:* Greater 50 MW | ✓ | — | — | — |
| **Wind Onshore 2–4-MW WTG Size**<br>*Project Size:* 2–50 MW | ✓ | — | — | — |
| **Wind Onshore 2–4-MW WTG Size**<br>*Project Size:* 50–200 MW | ✓ | — | — | — |
| **Wind Offshore 6–12.5-MW WTG Size**<br>*Project Size:* up to 400 MW | — | — | — | ✓ |
| **Wind Offshore 6–12.5-MW WTG Size**<br>*Project Size:* 400–800 MW | — | — | — | ✓ |
| **Run of River Hydro**<br>*Project Size:* 1–10 MW | ✓ | — | — | — |
| **Landfill Gas**<br>*Project Size:* 2–10 MW | ✓ | ✓ | ✓ | ✓ |

PV = photovoltaic | WTG = wind turbine generator

**Figure 1-1 — Map of New York Control Area Load Zones**




## 1.1. GROUND MOUNTED SOLAR PV

Solar PV technologies convert sunlight directly into electricity through solar panels that can be arranged in arrays to increase electricity output. The PV solar resource is approximately 4 kWh/m$^2$/day in Zones G, H, I, and J. Since solar PV is scalable, the technology is not as dependent on economies of scale with respect to the solar resource to be technically viable, compared with other technologies such a concentrating solar. The technical assumptions for the representative solar PV technologies are summarized in Table 1-2.

**Table 1-2 — Technical Assumptions – Solar PV**

| Project Size | 1–10 $MW_{AC}$ | 10–50 $MW_{AC}$ | > 50 $MW_{AC}$ |
|---|---|---|---|
| DC/AC Ratio | 1.3 | 1.3 | 1.3 |
| Locations | Zones G, H, I, J | Zones G, H, I, J | Zone G |
| Racking and Solar Tracking | Ground Mounted, Single Axis Tracking | Ground Mounted, Single Axis Tracking | Ground Mounted, Single Axis Tracking |
| Panels | Crystal Si | Crystal Si | Crystal Si |
| Solar Resource (kWh/m2/day) | 4 | 4 | 4 |
| Capacity Factor | 16.8% | 16.8% | 16.8% |

The single-axis tracking system is commonly placed in a north-south orientation and tracks the sun across the sky from east to west. Each block within a PV is made up of identical components and functionality. Electrical components include:

- DC and AC wiring
- Combiner boxes
- Inverters
- Step-up transformers
- Control system
- Switchyard with electrical interconnection to the grid

Solar PV costs have decreased significantly in the past decade because of lower module prices and continued advances in technical efficiency.

## 1.2. WIND – ONSHORE

The use of wind power for electrical generation is based on proven and commercially available technology that is currently used in the state of New York. Wind turbine technology typically uses a horizontal axis with three blades. Lift is generated when wind flows around the turbine blades, resulting in rotation. The blades are connected to a central hub and drivetrain that turns a generator located inside of the nacelle, which is the housing positioned atop the wind turbine tower. Wind turbines are scalable and, when multiple turbines are installed that share a common electrical collection system and substation, they are referred to as a wind farm. The technical assumptions for the representative onshore wind technologies are summarized in Table 1-3.

**Table 1-3 — Technical Assumptions – Onshore Wind**

| Project Size | 2 MW–50 MW | 50 MW–200 MW |
|---|---|---|
| Location | Zone G | Zone G |
| Wind Turbine Generator Size | 2 MW to 4 MW | 2 MW to 4 MW |
| Hub Height (m) | 80 | 80 |
| Rotor Diameter (m) | 100 | 100 |
| Wind Speed (m/s) | 5–6 | 5–6 |
| Capacity Factor | 35% | 35% |

The performance of wind farms is primarily based on the wind potential in the area and the wind turbine generator properties. Parameters that affect project cost and performance include turbine nameplate capacity, rotor diameter, and hub height. The primary advantage of taller hub heights and larger rotor

diameters include access to better wind profiles at higher altitudes and increased turbine swept area, enabling the unit to capture more energy.

## 1.3. WIND – OFFSHORE

Wind speeds offshore are typically higher and steadier than wind speeds onshore, resulting in higher potential electricity generation. The average annual wind speed in the concession areas approximately 30 miles offshore from Zone J is approximately 9 m/s. Parameters that affect project cost and performance include project size, turbine nameplate capacity, water depth, and distance to shore. The project scope includes construction of offshore-to-shore submarine cables, port infrastructures, installation vessels (construction and cable laying) and electrical interconnection to the transmission system. The technical assumptions for the representative offshore wind technologies are summarized in Table 1-4.

**Table 1-4 — Technical Assumptions – Offshore Wind**

| Project Size | < 400 MW | 400 MW–800 MW |
|---|---|---|
| Location | Zone J | Zone J |
| Wind Turbine Generator Size | 6 MW to 12.5 MW | 6 MW to 12.5 MW |
| Hub Height (m) | 80 | 80 |
| Rotor Diameter (m) | 100 | 100 |
| Distance Offshore (miles) | 30 | 30 |
| Onshore Cable Run (miles) | 1 | 1 |
| Water Depth (feet) | 100 | 100 |
| Wind Speed (m/s) | 9 | 9 |
| Capacity Factor | 45% | 45% |

## 1.4. RUN-OF-RIVER HYDRO, 1–10 MW, ZONE G

The representative hydroelectric plant is a run-of-river facility with turbine nameplate ratings of 1 MW to 10 MW. Run of river systems divert water from a flowing river to a channel, or penstock, which carries water downstream to a powerhouse. The force of the moving water spins a turbine and drives a generator. Run-of-river plants do not store water behind dams, and thus have limited control over the timing of electricity production.

The representative plant has a Kaplan turbine, which is a propeller-type water turbine with adjustable blades. The Kaplan turbine is an inward-flow reaction turbine, with the working fluid changing pressure as it moves through the turbine. The inlet is a scroll-shaped tube that wraps around the turbine's wicket gate. Water is directed tangentially through the wicket gate and spirals on to a propeller shaped runner, causing

it to spin. The outlet is a specially shaped draft tube that helps decelerate the water and recover kinetic energy. Variable geometry of the turbine's wicket gate and turbine blades allows efficient operation for a range of flow conditions. Kaplan turbine efficiencies typically are over 90%.

## 1.5. LANDFILL GAS; 2–10 MW; ZONES G, H, I, & J

The representative landfill gas-fired power plant is powered by reciprocating internal combustion engines having a capacity of 2 MW to 10 MW. Reciprocating engines have a higher efficiency than a typical frame or aeroderivative gas turbine. The project scope includes the power block and the fuel for combustion, which is delivered through the landfill gas gathering system. The gas-fired engines are coupled to a generator and include the necessary engine auxiliary systems, which are fuel gas, lubricated oil, compressed air, cooling water, air intake, and exhaust gas. The plant also includes water and wastewater treatment systems. An onsite switchyard is connected to the transmission system through a nearby substation.

# 2. CAPITAL COSTS

## 2.1. METHODOLOGY

Sargent & Lundy estimated fixed and variable O&M costs for each representative renewable technology, expressed in 2020 dollars. The estimates were derived from a variety of sources including actual projects, vendor publications, and internal resources. Fixed O&M costs, which are costs that do not vary with generation, consist of labor, materials and supplies, and administrative and general costs. Variable O&M costs, which are proportional to the amount of generating output, include major maintenance expenses (for reciprocating engines) and chemicals and consumables. Other operating costs are relatively independent of the plant configuration and output, consisting of property taxes, insurance, and lease payments.

We estimated O&M costs for the representative solar PV plants using recent public sources and Sargent & Lundy's project database.[1, 2] We adjusted the cost data in the public sources to account for differences in the solar panel type, tracking type, plant size, and ages relative to the representative plants and validated the results against proprietary data for similar plants in operation. Likewise, we estimated O&M costs for the representative wind plants using recent public sources and Sargent & Lundy's project database.[1, 3] We adjusted the cost data in the public sources to account for differences in turbine sizes, number of turbines at the site, and ages relative to the representative plants and validated the results against proprietary data for similar plants in operation. We assumed that all the costs necessary to operate a solar PV plant or wind farm are fixed costs that are not directly attributable to the production of electricity, and thus did not include any variable costs for those technologies.

Property taxes are equal to the unadjusted property tax rate for the given jurisdiction, multiplied by an assessment ratio, and multiplied by the market value of the plant. The assessment ratio is the percentage of market value applied in the tax calculation. The representative solar and wind plants are sometimes exempt from property taxes or have a negotiated payment in lieu of taxes (or "PILOT") agreement with the local jurisdiction for a significantly reduced rate. Otherwise, property taxes were estimated as 2.00% of the overnight capital cost, per year. Insurance costs were estimated as 0.30% of the overnight capital cost, per year, based on a sample of renewable power projects recently under development. Site leasing costs are equal to the annual lease rate ($/acre-year) multiplied by the land requirement in acres.

[1] National Renewable Energy Laboratory, 2019 Annual Technology Baseline, 2019.
[2] Lawrence Berkeley National Laboratory, Utility-Scale Solar: Empirical Trends in Project Technology, Cost, Performance, and PPA Pricing in the United States – 2019 Edition, December 2019. Available at: https://emp.lbl.gov/sites/default/files/lbnl_utility_scale_solar_2019_edition_final.pdf
[3] U.S. Energy Information Administration, Cost and Performance Estimates for New Utility-Scale Electric Power Generating Technologies, prepared by Sargent & Lundy, December 2019.

# APPENDIX A. CONSTRUCTION COST AND UNIT OPERATING COST DETAILS

This appendix provides more detailed information about the capital and O&M costs of the representative renewable technologies evaluated in this study.

# Renewable Technology Cost Table for NYISO Zones G, H, I, J

| Revision: | 0 |
|---|---|
| Date: | 4/24/2020 |
| Preparers: | John Wroble, Han Li, Gregor Gnaedig |

| Unit Technology | Ground Mounted Solar PV 2–10 MW | | | | Ground Mounted Solar PV 10–50 MW | | | | Ground Mounted Solar PV 50 MW and up | Wind – Onshore 2–4-MW WTGs up to 2–50 MW | Wind – Onshore 2–4-MW WTGs up to 50–200 MW | Wind – Offshore 6–12.5-MW WTGs up to 400 MW | Wind – Offshore 6–12.5-MW WTGs up to 400–800 MW | Run of River Hydro 1–10 MW | Landfill Gas (LFG) 2–10 MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Zones*** | G | H | I | J | G | H | I | J | G | G | G | J | J | G | G | H | I | J |
| ***Base Case Size (MW)*** | 10 | 10 | 10 | 10 | 20 | 20 | 20 | 20 | 100 | 50 | 100 | 400 | 800 | 5 | 10 | 10 | 10 | 10 |
| ***Capacity Factor*** | 16.80% | 16.80% | 16.80% | 16.80% | 16.80% | 16.80% | 16.80% | 16.80% | 16.80% | 35% | 35% | 45% | 45% | 60% | 70% | 70% | 70% | 70% |
| **Capital Costs Inputs ($)** | | | | | | | | | | | | | | | | | | |
| **EPC Cost Components** | | | | | | | | | | | | | | | | | | |
| **Equipment** | | | | | | | | | | | | | | | | | | |
| Owner Furnished Equipment | $ 3,616,000 | $ 3,616,000 | $ 3,616,000 | $ 3,616,000 | $ 7,233,000 | $ 7,233,000 | $ 7,233,000 | $ 7,233,000 | $ 27,665,000 | $ 30,533,000 | $ 54,959,000 | $ 636,644,000 | $ 1,145,960,000 | $ 8,148,000 | $ 6,048,000 | $ 6,048,000 | $ 6,048,000 | $ 6,048,000 |
| Owner Furnished Equipment - Labor | $ 3,847,000 | $ 3,847,000 | $ 3,847,000 | $ 3,847,000 | $ 7,695,000 | $ 7,695,000 | $ 7,695,000 | $ 7,695,000 | $ 29,431,000 | $ 32,482,000 | $ 58,467,000 | $ 677,281,000 | $ 1,219,106,000 | $ 8,668,000 | $ 6,434,000 | $ 6,434,000 | $ 6,434,000 | $ 6,434,000 |
| Spare Parts | $ 108,000 | $ 108,000 | $ 108,000 | $ 108,000 | $ 217,000 | $ 217,000 | $ 217,000 | $ 217,000 | $ 830,000 | $ 916,000 | $ 1,649,000 | $ 19,099,000 | $ 34,379,000 | $ 244,000 | $ 181,000 | $ 181,000 | $ 181,000 | $ 181,000 |
| Subtotal | $ 7,694,000 | $ 7,694,000 | $ 7,694,000 | $ 7,694,000 | $ 15,389,000 | $ 15,389,000 | $ 15,389,000 | $ 15,389,000 | $ 58,862,000 | $ 64,963,000 | $ 116,933,000 | $ 1,354,562,000 | $ 2,438,212,000 | $ 17,336,000 | $ 12,868,000 | $ 12,868,000 | $ 12,868,000 | $ 12,868,000 |
| **Construction** | | | | | | | | | | | | | | | | | | |
| Construction Labor & Materials | $ 5,768,000 | $ 6,409,000 | $ 6,409,000 | $ 8,331,000 | $ 11,535,000 | $ 12,817,000 | $ 12,817,000 | $ 16,662,000 | $ 44,122,000 | $ 10,912,000 | $ 19,642,000 | $ 235,845,000 | $ 490,611,000 | $ 13,179,000 | $ 5,602,000 | $ 6,224,000 | $ 6,224,000 | $ 8,092,000 |
| Plant Switchyard | $ 437,000 | $ 486,000 | $ 486,000 | $ 631,000 | $ 874,000 | $ 971,000 | $ 971,000 | $ 1,262,000 | $ 3,343,000 | $ 827,000 | $ 1,488,000 | $ 17,867,000 | $ 37,168,000 | $ 998,000 | $ 424,000 | $ 472,000 | $ 472,000 | $ 613,000 |
| Electrical Interconnection & Deliverability (SUDs) | $ 1,049,000 | $ 1,165,000 | $ 1,165,000 | $ 1,515,000 | $ 2,097,000 | $ 2,330,000 | $ 2,330,000 | $ 3,029,000 | $ 8,022,000 | $ 1,984,000 | $ 3,571,000 | $ 42,881,000 | $ 89,202,000 | $ 2,396,000 | $ 1,019,000 | $ 1,132,000 | $ 1,132,000 | $ 1,471,000 |
| Site Prep | $ 350,000 | $ 388,000 | $ 388,000 | $ 505,000 | $ 699,000 | $ 777,000 | $ 777,000 | $ 1,010,000 | $ 2,674,000 | $ 661,000 | $ 1,190,000 | $ 14,294,000 | $ 29,734,000 | $ 799,000 | $ 340,000 | $ 377,000 | $ 377,000 | $ 490,000 |
| Engineering & Design | $ 874,000 | $ 971,000 | $ 971,000 | $ 1,262,000 | $ 1,748,000 | $ 1,942,000 | $ 1,942,000 | $ 2,525,000 | $ 6,685,000 | $ 1,653,000 | $ 2,976,000 | $ 35,734,000 | $ 74,335,000 | $ 1,997,000 | $ 849,000 | $ 943,000 | $ 943,000 | $ 1,226,000 |
| Construction Mgmt. / Field Engr. | $ 262,000 | $ 291,000 | $ 291,000 | $ 379,000 | $ 524,000 | $ 583,000 | $ 583,000 | $ 757,000 | $ 2,006,000 | $ 496,000 | $ 893,000 | $ 10,720,000 | $ 22,301,000 | $ 599,000 | $ 255,000 | $ 283,000 | $ 283,000 | $ 368,000 |
| Subtotal | $ 8,739,000 | $ 9,710,000 | $ 9,710,000 | $ 12,622,000 | $ 17,477,000 | $ 19,419,000 | $ 19,419,000 | $ 25,245,000 | $ 66,851,000 | $ 16,534,000 | $ 29,761,000 | $ 357,341,000 | $ 743,350,000 | $ 19,968,000 | $ 8,488,000 | $ 9,431,000 | $ 9,431,000 | $ 12,260,000 |
| **Startup & Testing** | | | | | | | | | | | | | | | | | | |
| Startup & Training | $ 175,000 | $ 194,000 | $ 194,000 | $ 252,000 | $ 350,000 | $ 388,000 | $ 388,000 | $ 505,000 | $ 1,337,000 | $ 331,000 | $ 595,000 | $ 7,147,000 | $ 14,867,000 | $ 399,000 | $ 170,000 | $ 189,000 | $ 189,000 | $ 245,000 |
| Testing | $ 18,000 | $ 19,000 | $ 19,000 | $ 25,000 | $ 35,000 | $ 39,000 | $ 39,000 | $ 51,000 | $ 134,000 | $ 33,000 | $ 60,000 | $ 715,000 | $ 1,487,000 | $ 40,000 | $ 17,000 | $ 19,000 | $ 19,000 | $ 25,000 |
| Subtotal | $ 193,000 | $ 213,000 | $ 213,000 | $ 277,000 | $ 385,000 | $ 427,000 | $ 427,000 | $ 556,000 | $ 1,471,000 | $ 364,000 | $ 655,000 | $ 7,862,000 | $ 16,354,000 | $ 439,000 | $ 187,000 | $ 208,000 | $ 208,000 | $ 270,000 |
| **Contingency** | $ 1,995,000 | $ 2,114,000 | $ 2,114,000 | $ 2,471,000 | $ 3,990,000 | $ 4,228,000 | $ 4,228,000 | $ 4,943,000 | $ 15,262,000 | $ 9,823,000 | $ 17,682,000 | $ 206,372,000 | $ 383,750,000 | $ 4,529,000 | $ 2,585,000 | $ 2,701,000 | $ 2,701,000 | $ 3,048,000 |
| **Subtotal EPC Cost** | $ 16,625,000 | $ 17,617,000 | $ 17,617,000 | $ 20,592,000 | $ 33,250,000 | $ 35,233,000 | $ 35,233,000 | $ 41,192,000 | $ 127,183,000 | $ 81,858,000 | $ 147,350,000 | $ 1,719,767,000 | $ 3,197,917,000 | $ 37,742,000 | $ 21,542,000 | $ 22,508,000 | $ 22,508,000 | $ 25,400,000 |
| **Subtotal EPC Cost ($/kW)** | $ 1,663 | $ 1,762 | $ 1,762 | $ 2,059 | $ 1,663 | $ 1,762 | $ 1,762 | $ 2,060 | $ 1,272 | $ 1,637 | $ 1,474 | $ 4,299 | $ 3,997 | $ 7,548 | $ 2,154 | $ 2,251 | $ 2,251 | $ 2,540 |
| **Non-EPC Cost Components** | | | | | | | | | | | | | | | | | | |
| **Owner's Costs** | | | | | | | | | | | | | | | | | | |
| Permitting | $ 166,000 | $ 176,000 | $ 176,000 | $ 206,000 | $ 333,000 | $ 352,000 | $ 352,000 | $ 412,000 | $ 1,272,000 | $ 819,000 | $ 1,474,000 | $ 17,198,000 | $ 31,979,000 | $ 377,000 | $ 215,000 | $ 225,000 | $ 225,000 | $ 254,000 |
| Legal | $ 166,000 | $ 176,000 | $ 176,000 | $ 206,000 | $ 333,000 | $ 352,000 | $ 352,000 | $ 412,000 | $ 1,272,000 | $ 819,000 | $ 1,474,000 | $ 17,198,000 | $ 31,979,000 | $ 377,000 | $ 215,000 | $ 225,000 | $ 225,000 | $ 254,000 |
| Owner's Project Mgmt. & Misc. Engr. | $ 249,000 | $ 264,000 | $ 264,000 | $ 309,000 | $ 499,000 | $ 528,000 | $ 528,000 | $ 618,000 | $ 1,908,000 | $ 1,228,000 | $ 2,210,000 | $ 25,797,000 | $ 47,969,000 | $ 566,000 | $ 323,000 | $ 338,000 | $ 338,000 | $ 381,000 |
| Owner's Development Costs | $ 499,000 | $ 529,000 | $ 529,000 | $ 618,000 | $ 998,000 | $ 1,057,000 | $ 1,057,000 | $ 1,236,000 | $ 3,815,000 | $ 2,456,000 | $ 4,421,000 | $ 51,593,000 | $ 95,938,000 | $ 1,132,000 | $ 646,000 | $ 675,000 | $ 675,000 | $ 762,000 |
| Studies (Fin, Env, Market, Interconnect) | $ 83,000 | $ 88,000 | $ 88,000 | $ 103,000 | $ 166,000 | $ 176,000 | $ 176,000 | $ 206,000 | $ 636,000 | $ 409,000 | $ 737,000 | $ 8,599,000 | $ 15,990,000 | $ 189,000 | $ 108,000 | $ 113,000 | $ 113,000 | $ 127,000 |
| **Subtotal Non-EPC Cost** | $ 1,163,000 | $ 1,233,000 | $ 1,233,000 | $ 1,442,000 | $ 2,329,000 | $ 2,465,000 | $ 2,465,000 | $ 2,884,000 | $ 8,903,000 | $ 5,731,000 | $ 10,316,000 | $ 120,385,000 | $ 223,855,000 | $ 2,641,000 | $ 1,507,000 | $ 1,576,000 | $ 1,576,000 | $ 1,778,000 |
| **Subtotal Non-EPC Cost ($/kW)** | $ 116 | $ 123 | $ 123 | $ 144 | $ 116 | $ 123 | $ 123 | $ 144 | $ 89 | $ 115 | $ 103 | $ 301 | $ 280 | $ 528 | $ 151 | $ 158 | $ 158 | $ 178 |
| ***Total CAPEX*** | $ 17,788,000 | $ 18,850,000 | $ 18,850,000 | $ 22,034,000 | $ 35,579,000 | $ 37,698,000 | $ 37,698,000 | $ 44,076,000 | $ 136,086,000 | $ 87,589,000 | $ 157,666,000 | $ 1,840,152,000 | $ 3,421,772,000 | $ 40,383,000 | $ 23,049,000 | $ 24,084,000 | $ 24,084,000 | $ 27,178,000 |
| ***Total CAPEX ($/kW)*** | $ 1,779 | $ 1,885 | $ 1,885 | $ 2,203 | $ 1,779 | $ 1,885 | $ 1,885 | $ 2,204 | $ 1,361 | $ 1,752 | $ 1,577 | $ 4,600 | $ 4,277 | $ 8,077 | $ 2,305 | $ 2,408 | $ 2,408 | $ 2,718 |
| **O&M Cost** | | | | | | | | | | | | | | | | | | |
| **Fxied O&M Cost ($/yr)** | | | | | | | | | | | | | | | | | | |
| Plant Labor | $ 49,000 | $ 54,000 | $ 54,000 | $ 70,000 | $ 97,000 | $ 108,000 | $ 108,000 | $ 140,000 | $ 460,000 | $ - | $ - | $ 13,200,000 | $ 26,400,000 | $ 240,000 | $ 81,000 | $ 81,000 | $ 81,000 | $ 81,000 |
| Maintenance and Supplies | $ 126,000 | $ 126,000 | $ 126,000 | $ 126,000 | $ 252,000 | $ 252,000 | $ 252,000 | $ 252,000 | $ 1,156,500 | $ 1,757,000 | $ 3,514,000 | $ 30,800,000 | $ 61,600,000 | $ 560,000 | $ 190,000 | $ 190,000 | $ 190,000 | $ 190,000 |
| **Subtotal ($/yr)** | $ 175,000 | $ 180,000 | $ 180,000 | $ 196,000 | $ 349,000 | $ 360,000 | $ 360,000 | $ 392,000 | $ 1,616,500 | $ 1,757,000 | $ 3,514,000 | $ 44,000,000 | $ 88,000,000 | $ 800,000 | $ 271,000 | $ 271,000 | $ 271,000 | $ 271,000 |
| **Subtotal ($/kW-yr)** | $ 17.50 | $ 18.00 | $ 18.00 | $ 19.60 | $ 17.45 | $ 18.00 | $ 18.00 | $ 19.60 | $ 16.17 | $ 35.14 | $ 35.14 | $ 110.00 | $ 110.00 | $ 160.00 | $ 27.10 | $ 27.10 | $ 27.10 | $ 27.10 |
| **Variable O&M Cost ($/MWh)** | | | | | | | | | | | | | | | | | | |
| Major Maintenance | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 4.06 | $ 4.06 | $ 4.06 | $ 4.06 |
| Chemicals and Consumables | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 1.74 | $ 1.74 | $ 1.74 | $ 1.74 |
| **Subtotal ($/MWh)** | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 5.80 | $ 5.80 | $ 5.80 | $ 5.80 |
| **Subtotal ($/yr)** | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 356,000 | $ 356,000 | $ 356,000 | $ 356,000 |
| **Other O&M Cost ($/yr)** | | | | | | | | | | | | | | | | | | |
| Property Tax Expense | $ 356,000 | $ 377,000 | $ 377,000 | $ 441,000 | $ 712,000 | $ 754,000 | $ 754,000 | $ 882,000 | $ 2,722,000 | $ 1,752,000 | $ 3,153,000 | $ 36,803,000 | $ 68,435,000 | $ 808,000 | $ 461,000 | $ 482,000 | $ 482,000 | $ 544,000 |
| Insurance Expense | $ 53,000 | $ 57,000 | $ 57,000 | $ 66,000 | $ 107,000 | $ 113,000 | $ 113,000 | $ 132,000 | $ 408,000 | $ 263,000 | $ 473,000 | $ 5,520,000 | $ 10,265,000 | $ 121,000 | $ 69,000 | $ 72,000 | $ 72,000 | $ 82,000 |
| Lease Expense | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Subtotal** | $ 409,000 | $ 434,000 | $ 434,000 | $ 507,000 | $ 819,000 | $ 867,000 | $ 867,000 | $ 1,014,000 | $ 3,130,000 | $ 2,015,000 | $ 3,626,000 | $ 42,323,000 | $ 78,700,000 | $ 929,000 | $ 530,000 | $ 554,000 | $ 554,000 | $ 626,000 |
| ***Total O&M Cost ($/yr)*** | $ 584,000 | $ 614,000 | $ 614,000 | $ 703,000 | $ 1,168,000 | $ 1,227,000 | $ 1,227,000 | $ 1,406,000 | $ 4,746,500 | $ 3,772,000 | $ 7,140,000 | $ 86,323,000 | $ 166,700,000 | $ 1,729,000 | $ 1,157,000 | $ 1,181,000 | $ 1,181,000 | $ 1,253,000 |