Agenda

• Energy Markets
  • Retail Energy Cost Components
• UMass System Metrics
• Behind the Meter DG
• Offsite Renewable Energy Strategies
Independent Energy Services Firm
- Based in Portland, ME and Topsfield, MA
- Over 800 clients
- $2 billion in energy spend
- Clients across the US and Canada

100% supplier neutral/ product neutral
- Over 50 suppliers throughout North America

Transparent fees

Customized energy solutions
- Procurement, Full Services, and Consulting
CES SUITE OF SERVICES

FULL SERVICE
- Energy Budget Management
- Alternative Fuel Analysis
- Tariff Evaluation
- Tariff Negotiation
- Utility Bill Analysis & Audit
- Utility Data Management
- Demand Response Analysis
- Grant Assistance

CONSULTING
- Greenhouse Gas Services
- Energy Master Planning
- Renewable Energy
  - Wind
  - Solar thermal & PV
  - Hydro & Biomass
- Cogeneration
- Fuel Conversion
- LNG/CNG systems

PROCUREMENT
- Market Monitoring
- RFP Management
- Bid & Financial Analysis
- Product Choice Analysis
- Contract Negotiation
### Higher Education
- Amherst College
- Bates College
- Bowdoin College
- Brandeis University
- Colby College
- Colgate University
- Dartmouth College
- Dean College
- Hampshire College
- Maine Community College System
- Maine Maritime Academy
- Northern Essex Community College
- Ohio University
- Springfield Technical Community College
- University of Connecticut
- University of Maine System (all campuses)
- University of Massachusetts System (all campuses)
- University of Rhode Island
- University of Vermont
- Wellesley College
- Wheaton College
- Williams College

### Healthcare
- Covenant Health Systems
- Eastern Maine Healthcare System
- Harrington Memorial Hospital
- Heywood Hospital
- MaineHealth (all facilities)
- Overlook Health Center

### Commercial
- Big Y Foods
- Boston North Technology Park
- Coca-Cola Bottling Company of Northern NE
- Dole & Bailey
- Ethan Allen
- Hannaford Bros/ Delhaize (all locations)
- L.L. Bean (all locations)
- New Balance Athletic Shoe
- Olympia Sports
- Southbridge Savings Bank
- Sullivan Tire Company
- Sure Winner Foods
- Unum
- Woodard & Curran
- YMCA's of Maine

### Technology & Research
- Adobe Systems
- Axcelis Technologies
- DeLorme/ Garmin
- Incom
- The Jackson Laboratory
- Netscout Systems
- Photonic
- Woods Hole Oceanographic Institution

### State & Municipal
- City of Boston
- City of Lebanon, NH
- City of Manchester, NH
- City of Montpelier, VT
- City of Portland, ME
- City of Providence, RI
- City of Somerville, MA
- City of South Portland, ME
- Province of New Brunswick
- Town of Dracut, MA
- Town of Glastonbury, CT
- Town of Millbury, MA
- Certified vendor with the MA DOER
ISO-NE IS CHANGING
SUPPLY

The SUPPLY is the source of the energy. SUPPLY is the commodity, what is bought, sold and traded. The supplier generates the power and transmits it to the power grid. This also includes ISO-NE costs for the forward capacity market along with the ancillary services.

TRANSMISSION & DELIVERY

The Utility, or Local Distribution Company (LDC), takes the power off the grid and transports it to the consumer. These TRANSMISSION & DELIVERY (T&D) charges make up the other half of your bill.
With energy, the future is always uncertain...
To know what to do, we first need to understand the 4 key factors impacting costs.
Key Energy Cost Components in ISO-NE

- Capacity Crunch
- Pipeline Pressure
- Transmission Trouble
- RPS & Renewables
FACTOR #1

POWER PLANT RETIREMENT AND CAPACITY COSTS
You pay capacity charges on your electric bill to fund power plant upgrades and new plant construction, so that there is always enough energy to meet local demand.

THE PROBLEM IS...
New England power plants are OLD

4,200 MWs of generating power have retired or plan to retire in the next few years. Another 4,100 MW are at risk for retirement.

1,600 MW of new generation has come online in the last few years, and 6,700 MW of new resources have qualified for the next auction.
- Capacity charges make up 30-70% of your energy bill
- ISO-New England holds FCM auctions to set payment rates
- End-users are charged the following on a monthly basis:

  **CAPACITY CHARGE =**
  \[
  \text{PAYMENT SETTLEMENT RATE} \times \text{RESERVE MARGIN} \times \text{CAPACITY TAG}
  \]

- FCM costs doubled in the 2017 – 18 power year
- End users can reduce the impact of the rising payment rate through demand management during the annual peak hour event
FACTOR #2

PIPES & THE IMPACT OF WINTER WEATHER
New England isn’t just running short on generation facilities, it’s also in need of greater pipeline capacity for natural gas.
Where does NE electricity come from?

**Annual Net Energy for Load**

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural Gas</th>
<th>Nuclear</th>
<th>Net Imports</th>
<th>Renewables</th>
<th>Hydro</th>
<th>Coal</th>
<th>Oil</th>
<th>Other**</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>13%</td>
<td>27%</td>
<td>14%</td>
<td>6%</td>
<td>7%</td>
<td>16%</td>
<td>19%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>2017*</td>
<td>41%</td>
<td>26%</td>
<td>17%</td>
<td>9%</td>
<td>7%</td>
<td>1%</td>
<td>1%</td>
<td>&lt;1%</td>
<td></td>
</tr>
</tbody>
</table>
CURRENT PIPELINE CAPACITY IS **2 TO 3 BCF**

ON A COLD WINTER DAY...

HEATING AND INDUSTRIAL PROCESS DEMANDS. ...............4.5 Bcf

ELECTRIC GENERATION DEMAND. ......................... +0.5 to 1.5 Bcf

TOTAL DEMAND FOR NATURAL GAS ................... 5.0 to 6.0 Bcf

SHORTFALL IS **2 TO 3 BCF**
The Impact of Winter Weather

- **Midcontinent ISO**
  - $28.78/MWh
  - $2.80/MMBtu (at Chicago City Gate)

- **ISO New England**
  - $26.86/MWh
  - $2/MMBtu (at Algonquin City Gate)

- **Midcontinent ISO**
  - $29.31/MWh
  - $3.74/MMBtu (at Chicago City Gate)

- **ISO New England**
  - $76.64/MWh
  - $10.70/MMBtu (at Algonquin City Gate)
FACTOR #3

TRANSMISSION TROUBLES
In the past, transmission charges have always been relatively low, but extensive system upgrades are on the horizon.
New generation is only worthwhile if you can deliver it to the places that need it the most.
Representative Projects and Concept Proposals

a. Northern Pass
   Hydro Quebec/Northeast Utilities
b. Northeast Energy Link
   Bangor Hydro/National Grid
c. Green Line
   New England ITC
d. Bay State Offshore Wind Transmission System
   Anbaric Transmission
e. Northeast Energy Corridor
   Maine/New Brunswick
f. Muskrat Falls/Lower Churchill
   Newfoundland and Labrador
   (Nalcor) and Nova Scotia (Emera)
g. Maine Yankee—Greater Boston
h. Maine—Greater Boston
i. Northern Maine—New England
j. Plattsburgh, NY—New Haven, VT
FACTOR #4
A NEW FOCUS ON RENEWABLES
You pay a renewable energy charge to support sustainable generation in your state. As goals to reduce fossil fuel reliance increase, so does this charge.
What is RPS?

State Renewable Portfolio Standard (RPS)*
for Class I or New Renewable Energy by 2020

<table>
<thead>
<tr>
<th>State</th>
<th>% Renewable</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME</td>
<td>10%</td>
</tr>
<tr>
<td>NH</td>
<td>11%</td>
</tr>
<tr>
<td>RI</td>
<td>12.5%</td>
</tr>
<tr>
<td>MA</td>
<td>15%</td>
</tr>
<tr>
<td>CT</td>
<td>20%</td>
</tr>
<tr>
<td>VT</td>
<td>59%</td>
</tr>
</tbody>
</table>

* Vermont’s Renewable Energy Standard has a total renewable energy requirement (reflected above), which recognizes large-scale hydro and all other classes of renewable energy.

http://www.iso-ne.com/about/key-stats/resource-mix
20% of Massachusetts’ annual greenhouse gas emissions are tied to electricity generation.

Massachusetts has mandated electricity sales from clean energy sources increase to **80% by 2050** from 16% today.

To date, costs to support clean energy expansion have been borne through electric **supply** charges.

MA RPS & CES Targets: Next 30 Years

- **Clean Energy Standard**
- **Renewable Portfolio Standard (Class I)**
Since the 2008 Global Warming Solutions Act, Massachusetts ratepayers have seen increasing RPS costs in supply charges.

Over the next three years, CES projects roughly 25% of electric supply costs for Massachusetts C&I electric customers, ~2.5 cents per kWh, will be associated with RPS obligations.
If New England state environmental targets are to be reached, there needs to be a major expansion of renewable generation in region. This can only happen if the development of renewable generation is financially viable.

This table shows the estimated price per REC necessary to support expansion of each renewable generation option.

<table>
<thead>
<tr>
<th>Break-Even REC Price</th>
<th>$/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>$36.00</td>
</tr>
<tr>
<td>Solar PV (New)</td>
<td>$64.00</td>
</tr>
<tr>
<td>Solar PV (Existing)</td>
<td>$73.00</td>
</tr>
<tr>
<td>Wind On-Shore (New)</td>
<td>$34.00</td>
</tr>
<tr>
<td>Wind On-Shore (Existing)</td>
<td>$8.00</td>
</tr>
<tr>
<td>Wind Off-Shore (Fixed Base)</td>
<td>$104.00</td>
</tr>
</tbody>
</table>

(Assumes no federal/state tax subsidies)

London Economics International, LLC, NESCOE Study, Phase 1, Winter 2017
Many of the generators operating in the New England energy market run only a few hours each year – less than 1% of the 8760 hours.

At these low capacity factors, they are not able to earn enough money in the energy market to remain in business. They must get revenues from the capacity market.
IMPACT OF RENEWABLE ENERGY POLICIES

ADD RENEWABLE GENERATION:
- NECEC - HQ PURCHASE
- OFFSHORE WIND
- SOLAR PV - SREC + SMART

SHIFTS MARKET SUPPLY CURVE TO THE RIGHT

HIGH COST GENERATING UNITS EXIT THE MARKET

- Closed or retiring 5,000 MW
- Generation at risk 4,600 MW

Source: ISO New England
IMPACT OF RENEWABLE ENERGY POLICIES

- Reduces Operating Hours of High Cost Plants – Increases financial pressure on these plants leading to retirements.
- Reduces Clearing Prices in the Market – Increases financial pressure on plants that run many hours.
- Forces Non-Renewable Generating Plants to identify/create new sources of revenues to remain financially viable.
- Forces Renewable Generating Plants to rely on sources of revenues outside of energy markets – e.g., tax credits, RECs, State/Utility above market Power Purchase Agreements (PPAs)
CES incorporates these considerations into our procurement strategies, consulting services, and long-term electricity price forecasts for New England.
UMA ENERGY COST ANATOMY
Supply & Utility Breakdown
## OVERVIEW

### Steam Generation System

#### BOILER CAPACITY

<table>
<thead>
<tr>
<th>HRSG/Boiler No.</th>
<th>Boiler Capacity (pph)</th>
<th>Firm Capacity (pph)</th>
<th>Second Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100,000</td>
<td>100,000</td>
<td>---</td>
</tr>
<tr>
<td>200</td>
<td>125,000</td>
<td>---</td>
<td>Diesel</td>
</tr>
<tr>
<td>300</td>
<td>125,000</td>
<td>125,000</td>
<td>Diesel</td>
</tr>
<tr>
<td>400</td>
<td>125,000</td>
<td>125,000</td>
<td>Diesel</td>
</tr>
<tr>
<td>Total</td>
<td>475,000</td>
<td>350,000</td>
<td>---</td>
</tr>
</tbody>
</table>

#### TURBINE SUMMARY

<table>
<thead>
<tr>
<th>Turbine No.</th>
<th>Turbine Type</th>
<th>Capacity (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-1</td>
<td>Comb. Turb.</td>
<td>10,000</td>
</tr>
<tr>
<td>STG-1</td>
<td>Steam Gen.</td>
<td>2,000</td>
</tr>
<tr>
<td>STG-2</td>
<td>Steam Gen.</td>
<td>4,000</td>
</tr>
<tr>
<td>Total</td>
<td>---</td>
<td>16,000</td>
</tr>
</tbody>
</table>
**SUPPLY**

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**TRANSMISSION & DELIVERY**

The Utility, or Local Distribution Company (LDC), takes the power off the grid and transports it to the consumer. These TRANSMISSION & DELIVERY (T&D) charges make up the other half of your bill.
COST ANATOMY | What Makes Up Your Supply Price?

ANCILLARIES: Administrative charges billed to load-serving entities by the NEISO to operate grid safely and reliably.

RENEWABLE PORTFOLIO STANDARDS (RPS): Mandates set by individual states for load-serving entities to purchase a certain amount of renewable energy; determined by state regulated compliance percentages and the financial market for renewable energy certificates (RECs).

CAPACITY: Determined by NEISO scaling factors, price auctions and customer's capacity tag. Designed to ensure grid reliability and ensure enough generation available to the region.

ENERGY: The cost of procuring the actual electrons transmitted through the T&D lines.
## Cost Anatomy

### What Makes Up Your LDC Price?

<table>
<thead>
<tr>
<th>Cost</th>
<th>$/kwh</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDC Transmission Coincident Peak</td>
<td>0.018</td>
</tr>
<tr>
<td>LDC Energy Efficiency</td>
<td>0.010</td>
</tr>
<tr>
<td>LDC Net Metering REC</td>
<td>$0.002</td>
</tr>
<tr>
<td>LDC LT Renew</td>
<td>$0.003</td>
</tr>
<tr>
<td>LDC Account Charge</td>
<td>$0.003</td>
</tr>
<tr>
<td>LDC Distribution Off Peak Energy Charge</td>
<td>$0.003</td>
</tr>
<tr>
<td>LDC Revenue Decoupling</td>
<td>$0.003</td>
</tr>
<tr>
<td>LDC Attorney General</td>
<td>$0.003</td>
</tr>
</tbody>
</table>

### Chart:

- **Cost**: $818,374
- **Energy Efficiency**: $439,168
- **Transmission Coincident Peak ($11.87/kw)**: $77,023
- **LDC Energy Efficiency**: $113,958
- **LDC LT Renew**: $149,092
- **LDC Account Charge**: $113,958
- **LDC Distribution Off Peak Energy Charge**: $77,023
- **LDC Attorney General**: $77,023
- **LDC Revenue Decoupling**: $77,023
- **LDC Attorney General**: $77,023

### Key Categories:

- LDC Transmission Coincident Peak
- LDC Net Metering REC
- LDC Account Charge
- LDC Distribution Off Peak Energy Charge
- LDC Revenue Decoupling
- LDC Attorney General
- LDC Energy Efficiency
- LDC Transition
- LDC Distribution Peak Energy Charge
- LDC Renewable Charge
- LDC Basic Service True Up
- LDC LT Renew
- LDC Res Assistance
- LDC Storm Costs
- LDC Pension
- LDC Solar Program
## LDC Coincident Peak- Cost Mitigation

<table>
<thead>
<tr>
<th>DATE</th>
<th>DAY OF WEEK</th>
<th>HE</th>
<th>UMA TOTAL LOAD (KW)</th>
<th>UMA WMECO IMPORT (KW)</th>
<th>UMA SOLAR GENERATION (KW)</th>
<th>UMA CHP GENERATION (KW)</th>
<th>UMA BATTERY DISPATCH (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/29/2016</td>
<td>Wednesday</td>
<td>17</td>
<td>18,542</td>
<td>5,055</td>
<td>370</td>
<td>13,487</td>
<td>1,000</td>
</tr>
<tr>
<td>7/22/2016</td>
<td>Friday</td>
<td>17</td>
<td>21,749</td>
<td>7,045</td>
<td>1,144</td>
<td>14,704</td>
<td>1,000</td>
</tr>
<tr>
<td>8/12/2016</td>
<td>Friday</td>
<td>15</td>
<td>23,587</td>
<td>8,710</td>
<td>2,759</td>
<td>14,877</td>
<td>1,000</td>
</tr>
<tr>
<td>9/9/2016</td>
<td>Friday</td>
<td>16</td>
<td>24,847</td>
<td>11,308</td>
<td>368</td>
<td>13,539</td>
<td>1,000</td>
</tr>
<tr>
<td>10/27/2016</td>
<td>Thursday</td>
<td>18</td>
<td>18,627</td>
<td>4,692</td>
<td>-</td>
<td>13,936</td>
<td>1,000</td>
</tr>
<tr>
<td>11/21/2016</td>
<td>Monday</td>
<td>19</td>
<td>14,850</td>
<td>3,583</td>
<td>-</td>
<td>11,267</td>
<td>1,000</td>
</tr>
<tr>
<td>12/15/2016</td>
<td>Thursday</td>
<td>18</td>
<td>18,490</td>
<td>4,525</td>
<td>-</td>
<td>13,965</td>
<td>1,000</td>
</tr>
<tr>
<td>1/9/2017</td>
<td>Monday</td>
<td>18</td>
<td>15,326</td>
<td>3,650</td>
<td>-</td>
<td>11,676</td>
<td>1,000</td>
</tr>
<tr>
<td>2/9/2017</td>
<td>Thursday</td>
<td>19</td>
<td>15,101</td>
<td>4,439</td>
<td>-</td>
<td>10,662</td>
<td>1,000</td>
</tr>
<tr>
<td>3/15/2017</td>
<td>Wednesday</td>
<td>19</td>
<td>14,902</td>
<td>3,606</td>
<td>-</td>
<td>11,295</td>
<td>1,000</td>
</tr>
<tr>
<td>4/6/2017</td>
<td>Thursday</td>
<td>17</td>
<td>16,939</td>
<td>4,839</td>
<td>1,273</td>
<td>12,099</td>
<td>1,000</td>
</tr>
<tr>
<td>5/18/2017</td>
<td>Thursday</td>
<td>18</td>
<td>17,787</td>
<td>7,493</td>
<td>127</td>
<td>10,294</td>
<td>1,000</td>
</tr>
</tbody>
</table>

### Scenario Comparison

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>NO COGEN</th>
<th>STATUS QUO</th>
<th>SOLAR REDUCTION</th>
<th>CHP REDUCTION</th>
<th>BATTERY REDUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL (KW)</td>
<td>220,746</td>
<td>68,945</td>
<td>6,041</td>
<td>151,802</td>
<td>12,000</td>
</tr>
<tr>
<td>$/KW</td>
<td>$11.87</td>
<td>$11.87</td>
<td>$11.87</td>
<td>$11.87</td>
<td>$11.87</td>
</tr>
<tr>
<td>TOTAL COST ($)</td>
<td>$2,620,260</td>
<td>$818,374</td>
<td>$71,701</td>
<td>$1,801,886</td>
<td>$142,440</td>
</tr>
<tr>
<td>$/kWh</td>
<td>$0.0582</td>
<td>$0.0182</td>
<td>$0.0016</td>
<td>$0.0400</td>
<td>$0.0032</td>
</tr>
</tbody>
</table>
# Cost Anatomy

**Supply FCM Cost Mitigation**

<table>
<thead>
<tr>
<th>Applicable Time Range</th>
<th>Settlement Rate ($/kW/month)</th>
<th>Reserve Margin</th>
<th>Effective Rate ($/kW/month)</th>
<th>UMASS AMHERST Peak (kW)</th>
<th>Estimated Annual Capacity Cost</th>
<th>Monthly Capacity Costs</th>
<th>Potential Savings per 1 MW Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/1/2016 - 5/31/2017</td>
<td>$2.74</td>
<td>47%</td>
<td>$4.03</td>
<td>9,232</td>
<td>$446,540</td>
<td>$37,212</td>
<td>$48,369</td>
</tr>
<tr>
<td>6/1/2017 - 5/31/2018</td>
<td>$7.44</td>
<td>53%</td>
<td>$11.38</td>
<td>4,621</td>
<td>$631,221</td>
<td>$52,602</td>
<td>$136,598</td>
</tr>
<tr>
<td>6/1/2020 - 5/31/2021</td>
<td>$5.29</td>
<td>48%</td>
<td>$7.83</td>
<td>5,732</td>
<td>$538,524</td>
<td>$44,877</td>
<td>$93,950</td>
</tr>
<tr>
<td>6/1/2021- 5/31/2022</td>
<td>$4.63</td>
<td>49%</td>
<td>$6.90</td>
<td>5,732</td>
<td>$474,520</td>
<td>$39,543</td>
<td>$82,784</td>
</tr>
</tbody>
</table>

## Daily Load During the Week of Peak Hour (kW)

![Daily Load Diagram](image-url)
• 1.33MW/4MWh lithium ion battery system to be owned and operated by UMass Amherst

• Battery will be operated to reduce peak electricity delivery and supply charges, help optimize operation of onsite solar PV and cogen, and bolster campus resiliency

• Comprehensive research initiative will be conducted by the UMass Clean Energy Extension to maximize lessons learned for the Commonwealth

• Project includes educational contribution by Borrego and educational collaboration with UMass Amherst students

PROJECT TEAM
University of Massachusetts Amherst, UMass Clean Energy Extension, Borrego Solar Systems, Competitive Energy Services

GRANT FUNDING AMOUNT
$1.14 million, approximately 50% of project cost
MAIN CAMPUS
ENERGY FLOWS
Key Metrics
Despite Growth, Costs not Increasing at Same Rate

*KPI’s indicate expected year end totals, based on CES collected data through April. Unavailable data points hold 2017 LBE reported values constant.
Despite Growth, Carbon & EUI are decreasing
Those with the ability to control peak consumption will be best suited to control costs.
**SOLAR PV KWH VALUE**

- **OFFSET SUPPLY PURCHASE**
  - Hourly profile – on peak vs. off-peak
  - Seasonality

- **OFFSET UTILITY DELIVERY CHARGES**
  - Tariff Structure - $/kWh, $/kW

- **REDUCE CAPACITY CHARGES**
  - Demand reduction during the annual hour of the New England system peak

- **RENEWABLE BENEFITS**
  - Offset carbon associated with grid purchase
  - Claims depend on REC ownership

- **EXCESS GENERATION**
  - Compensation depends on net metering availability
RE TECHNOLOGY TRENDS
Cost, Efficiency & Capacity Factors
Figure 1. The price of the Ford Model T from 1909-1923[2].
Learning Rate for Crystalline Silicon PV

Per-W price in 2017 dollars vs Cumulative capacity (MW)

- Historic prices (Maycock)
- Chinese c-Si module prices (BNEF)
- Experience curve at 28%
- Experience curve at 24%
Lithium-ion battery price forecast

- BNEF observed values: annual lithium-ion battery price index 2010-16.
- Implied 2025 lithium-ion battery price: $109/kWh
- Implied 2030 lithium-ion battery price: $73/kWh

Global lithium-ion battery demand (GWh)

ESS lithium-ion demand

EV lithium-ion demand

19% learning rate
RE TRENDS | Wind Installed Costs

- Interior (49.7 GW)
- West (12.4 GW)
- Great Lakes (8.3 GW)
- Northeast (4.5 GW)
- Southeast (1.1 GW)
- Capacity-Weighted Average

Installed Project Cost (2017 $/kW)

Commercial Operation Date:
- 1982
- 1983
- 1984
- 1985
- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
Average Levelized Wind PPA Price with 10th/90th Percentiles (by year of PPA execution)
FINANCIAL CFD
Leveraging Offsite Opportunities
Unsubsidized Levelized Cost of Energy—Wind & Solar PV (Historical)

Over the last eight years, wind and solar PV have become increasingly cost-competitive with conventional generation technologies, on an unsubsidized basis, in light of material declines in the pricing of system components (e.g., panels, inverters, racking, turbines, etc.), and dramatic improvements in efficiency, among other factors.
Phase Out Of Federal Renewable Incentives

- **Solar Tax Credit (% of Installed Cost)**
- **Wind Tax Credit (per megawatt-hour)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Solar Tax Credit</th>
<th>Wind Tax Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>$23.00 30%</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>$18.00 30%</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>$14.00 30%</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>$9.00 30%</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td>26%</td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td>22%</td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td>10%</td>
</tr>
</tbody>
</table>
EVALUATION CRITERIA

- **Economics**
  - Price & Net Cost

- **Message**
  - Addtionality
  - Carbon impact

- **Proximity**
  - Visibility
  - Market access

**NEW ENGLAND WIND & SOLAR**
- Pro: Nearby
- Pro: ISO-NE market access
- Con: Price premium

**MIDWEST WIND**
- Pro: Lower project prices
- Pro: Higher carbon impact
- Con: Far away
- Scale of competing off-takers
Example Market Hourly Pricing vs. Fixed Price

<table>
<thead>
<tr>
<th>HOUR</th>
<th>NET BENEFIT (PAYMENT)</th>
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<tr>
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<tr>
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<td>$0</td>
</tr>
<tr>
<td>3:00</td>
<td>($5)</td>
</tr>
<tr>
<td>4:00</td>
<td>($20)</td>
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<tr>
<td>5:00</td>
<td>($15)</td>
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<td>6:00</td>
<td>$5</td>
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<tr>
<td>22:00</td>
<td>$15</td>
</tr>
<tr>
<td>23:00</td>
<td>$15</td>
</tr>
</tbody>
</table>
1. **WHOLESALE ENERGY SALE**: Offtaker signs a long-term contract with the project owner at a specified price. Once operational, the facility delivers energy to the grid and the owner receives the locational marginal price ("LMP") at the project's interconnection point.

2. **HOURLY SETTLEMENT**: Each hour, the difference between the fixed contract price and the LMP price is multiplied by the generation delivered to the grid. At the end of each month, Offtaker either pays the project owner or receives a payment from the project owner.

3. **REC OWNERSHIP**: The project owner deposits the RECs generated by the facility to a GIS account Offtaker owns. Offtaker either retires or sells the RECs.