Wholesale Cost Savings of Distributed Solar in New England

Prepared for SunCommon

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Pat Knight and Jamie Hall

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Executive Summary

Results for New England

- Distributed solar reduced New England wholesale costs by nearly **$20 million dollars** from July 1 to July 7, 2018
- This represents over **14%** of what wholesale costs would have paid if there had been no distributed solar
- The estimated amount of distributed solar generation during this week was approximately **96 GWh**
- The maximum amount of estimated generation from distributed solar during this week was **1.6 GW**, representing **7%** of the peak demand during the week
- This is equivalent to reducing the demand from 850,000 homes

Daily Wholesale Cost Savings (Million $)

Date	Wholesale Cost Savings
July 1, 2018	$2.3
July 2, 2018	$4.0
July 3, 2018	$4.8
July 4, 2018	$2.0
July 5, 2018	$3.8
July 6, 2018	$2.2
July 7, 2018	$0.6

Results by State

- The New England-wide wholesale cost savings are allocated among the states based on the weekly load and distributed solar generation in each state
- States with higher load experienced more wholesale cost savings from the **price** impact than states with lower load
- States with more distributed solar experienced more wholesale cost savings from the **load** impact than states with less distributed solar

Wholesale Cost Savings by State (Million $)

State	Price Impact	Load Impact	Total Wholesale Cost Savings
CT	$4.0	$1.0	$5.0
ME	$1.1	$0.1	$1.2
NH	$1.4	$0.2	$1.6
VT	$0.6	$0.7	$1.3
RI	$1.1	$0.1	$1.2
MA	$7.2	$2.1	$9.3
Total	**$15.4**	**$4.3**	**$19.7**

Note: Totals may not sum due to rounding.

Background

Cost Reduction from Distributed Solar

Distributed solar reduces costs to consumers in two ways:

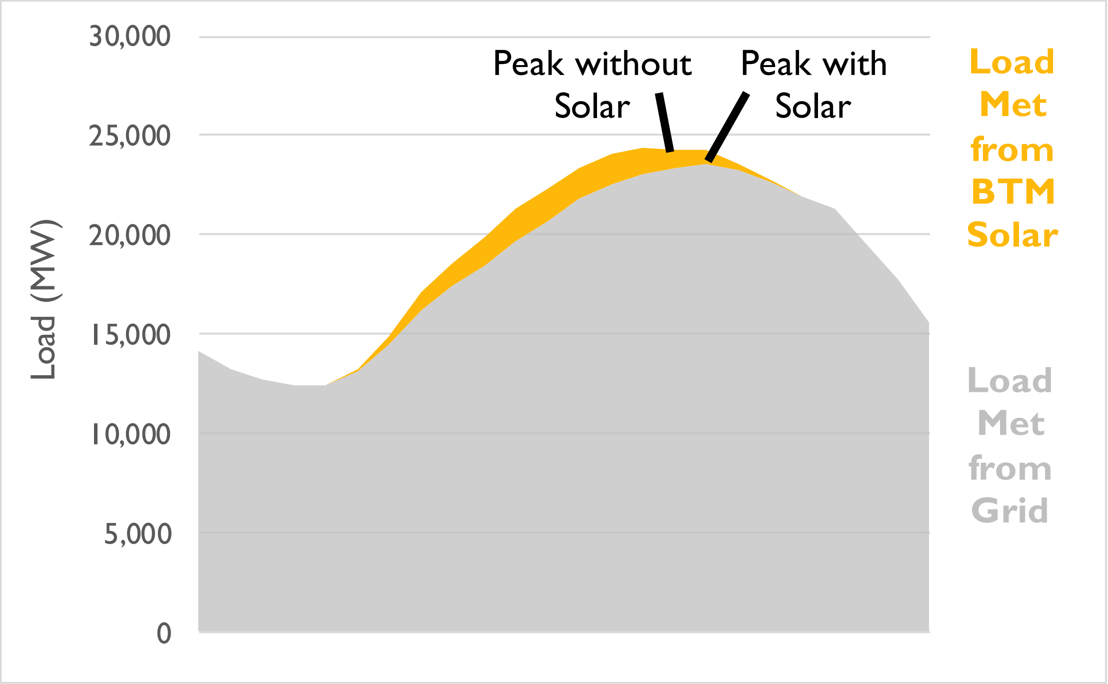
1. **Load Impact.** When consumers generate electricity using distributed solar, they reduce the amount of electricity that consumers must purchase from the electric grid. In peak hours, distributed solar can reduce demand on the New England electric system by over 1 GW. This reduces the amount of purchased electricity required to meet the demand.

2. **Price Impact.** When demand is reduced, the wholesale price per unit of generation is reduced. Therefore, distributed solar reduces the wholesale price to buy a unit of electricity from the grid. The price impact applies to very unit purchased.

Load Impact of Distributed Solar

- Distributed solar reduces load during the sunny hours of the day
- It pushes the peak demand towards a later hour in the day

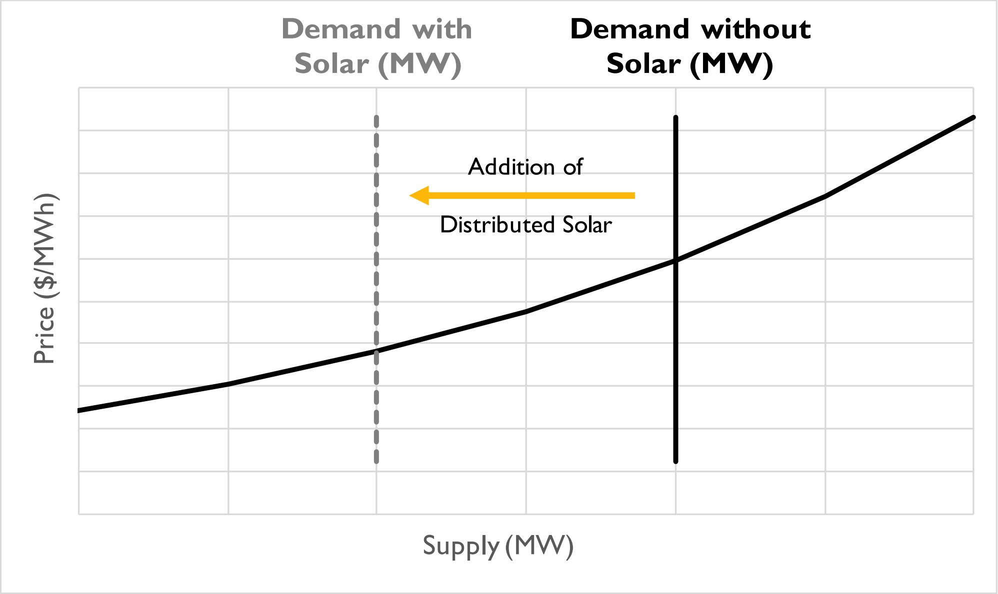
Load and Distributed Solar on July 3, 2018



Price Impact of Distributed Solar

- An increase in demand leads to an increase in price
- Conversely, a reduction in demand leads to a reduction in price for every unit purchased
- Behind-the-meter solar resources reduce demand during the sunny hours of the day, and therefore decrease the wholesale price for those hours

Price Impact from Distributed Solar



Source: Synapse Energy Economics (2018).

New England Solar over Time

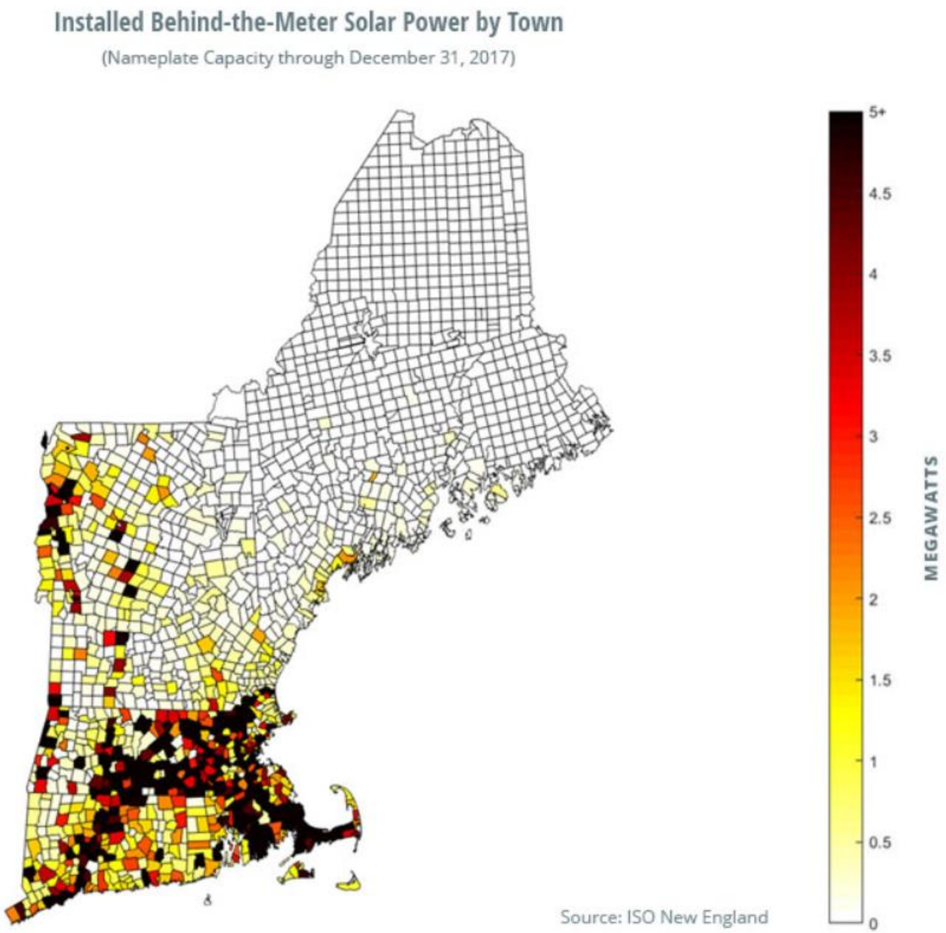
- New England solar power has increased 60x between 2010 and 2017
- Solar PV – both behind-the-meter and PV participating in the wholesale electricity market – is projected to continue growing
- Incremental distributed solar generation should further reduce wholesale market prices

Notes: Amounts include PV connected “behind the meter,” as well as PV participating in the wholesale electricity marketplace. Megawatt values are AC nameplate.

Source: ISO New England, *2018 PV Forecast* (May 2018).
Link: https://www.iso-ne.com/about/what-we-do/in-depth/solar-power-in-new-england-locations-and-impact.

Distributed Solar Map

- Behind-the-meter solar is concentrated in Southern New England and Vermont
- Of the behind-the-meter solar capacity:
  - Vermont has one-sixth of the capacity
  - Massachusetts has half of the capacity
  - Connecticut has one-quarter of the capacity



Source: ISO New England, *2018 PV Forecast* (May 2018).
Link: https://www.iso-ne.com/about/what-we-do/in-depth/solar-power-in-new-england-locations-and-impact.

Recent News on the July 2018 Heat Wave

- Green Mountain Power found that its solar-storage facilities in Rutland and Panton and ~500 Tesla Powerwalls created savings reaching $500,000
- It notes that this is the equivalent of taking 5,000 homes off the grid
- Source: https://greenmountainpower.com/2018/07/24/whoa-heatwave-savings-for-all-gmp-customers-could-reach-500000-thanks-to-innovation-and-storage/

- ISO New England found that despite the hot and humid conditions, "the timing of the holiday, coastal breezes, and abundant solar power kept electricity demand in check"
- ISO New England estimates that the electricity demand met by behind-the-meter PV systems lowered demand by ~2,000 MW at the solar peak
- Source: http://isonewswire.com/updates/2018/7/17/heat-wave-recap-reliable-operations-through-holiday-heat-hum.html

Methodology

Methodology for Estimating Savings

Compile data

1) Actual load and actual LMP data* for the week of July 1 – July 7, 2018

2) Estimated distributed solar profile for the same week

Develop but-for load profile

Add the distributed solar profile to the actual load profile to estimate a load curve in the absence of distributed solar

Create a predictor equation

Develop a best-fit line that explains the relationship between load and price

Calculate actual and but-for LMPs

Use the predictor equation to calculate actual and but-for LMPs using the actual and but-for load profiles

Estimate total savings

Estimate wholesale cost savings as the difference between 1) actual load x actual predicted LMPs** and 2) but-for load x but-for predicted LMPs

Estimate savings from load impact

Allocate state-specific savings from the load impact using states' distributed solar generation as a percent of total New England's distributed solar generation

Estimate savings from price impact

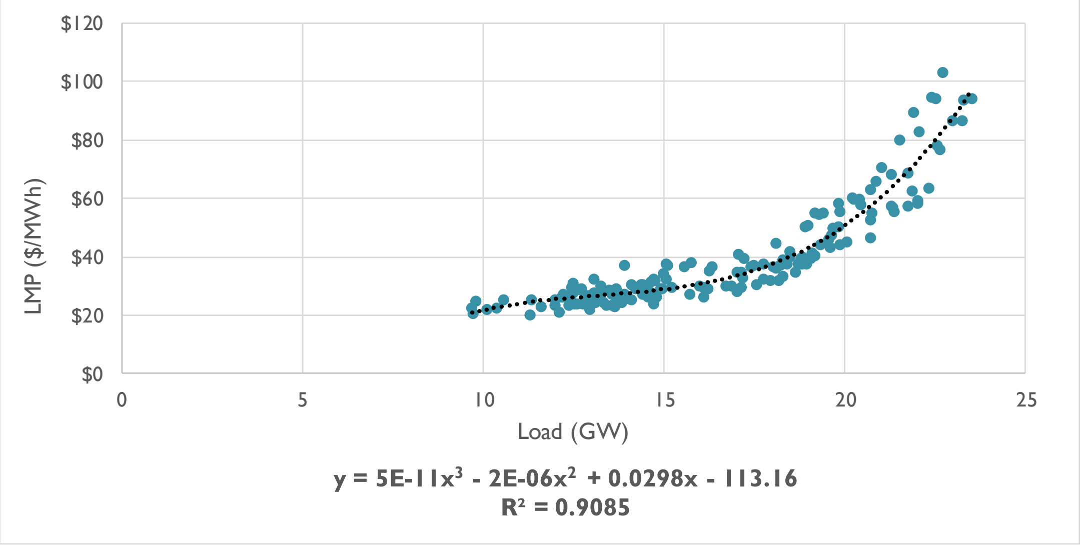
Allocate state-specific savings from the price impact using states' weekly load as a percent of New England's weekly load

Notes:
**In this analysis, day-ahead data are used to represent actual load and actual LMPs.*
***Actual predicted LMPs are those calculated using the predictor equation and the actual hourly load profile.*

Development of Predictor Equation

- We use a third degree polynomial to capture the relationship between load and LMPs
- R^2 is a measure of how closely the trendline fits the actual data points; our R^2 is 0.91, which means the polynomial predicts 91% of the variance in the LMP data
- When we apply the trendline to the actual data and predict LMPs, the average percent error is -1% (therefore, predicted LMPs are lower than actual LMPs by 1% on average)

New England Load and LMP Data with Trendline



Sources

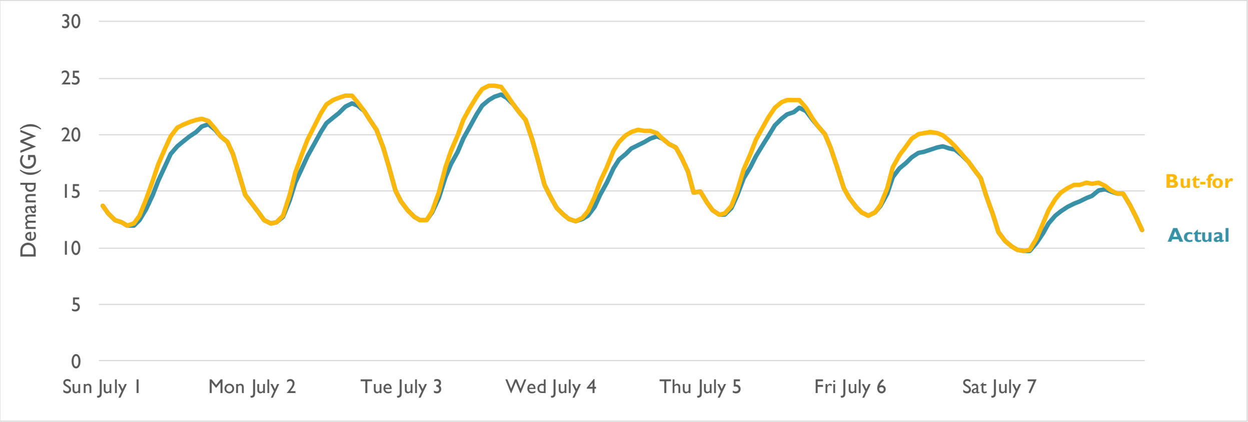
Data	Source	Notes	Link
Day-Ahead Load	ISO New England Energy, Load, and Demand Reports	July 1, 2018 – July 8, 2018	https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/zone-info
Day-Ahead LMPs	ISO New England Energy, Load, and Demand Reports	July 1, 2018 – July 8, 2018	https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/zone-info
2018 Solar Capacity	ISO New England 2018 PV Forecast		https://www.iso-ne.com/static-assets/documents/2018/03/a03-2018-pv-forecast.pdf
Hourly Solar Generation Profiles	PV Watts	Profiles were generated separately for each state	https://pvwatts.nrel.gov/pvwatts.php

Detailed Results

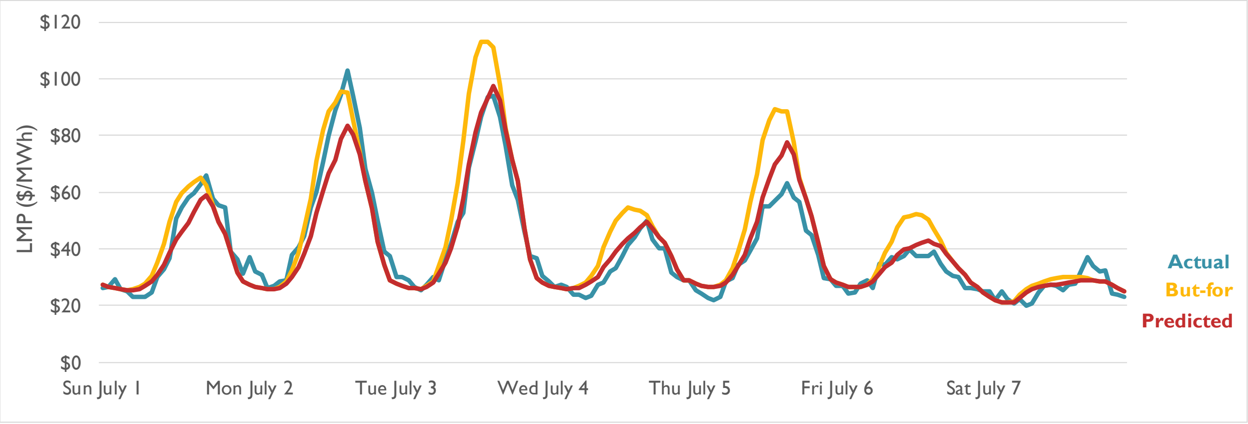
Load Profiles and LMPs

- For a given hour, but-for load is always equal to or greater than actual load
- For a given hour, but-for LMPs are always equal to or greater than predicted LMPs
- Over the entire week, predicted LMPs are on average within 1% of actual LMPs

Actual and But-for Load (MW)

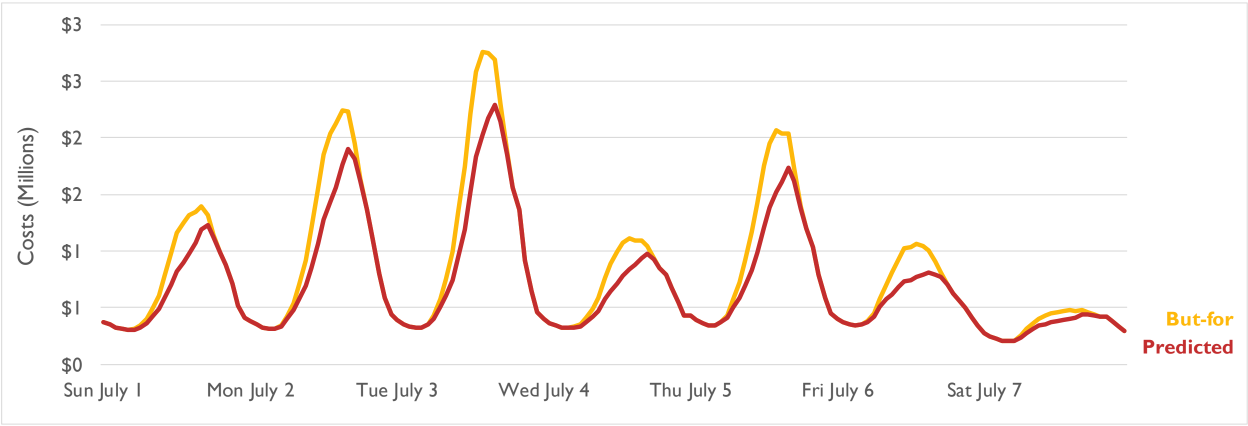


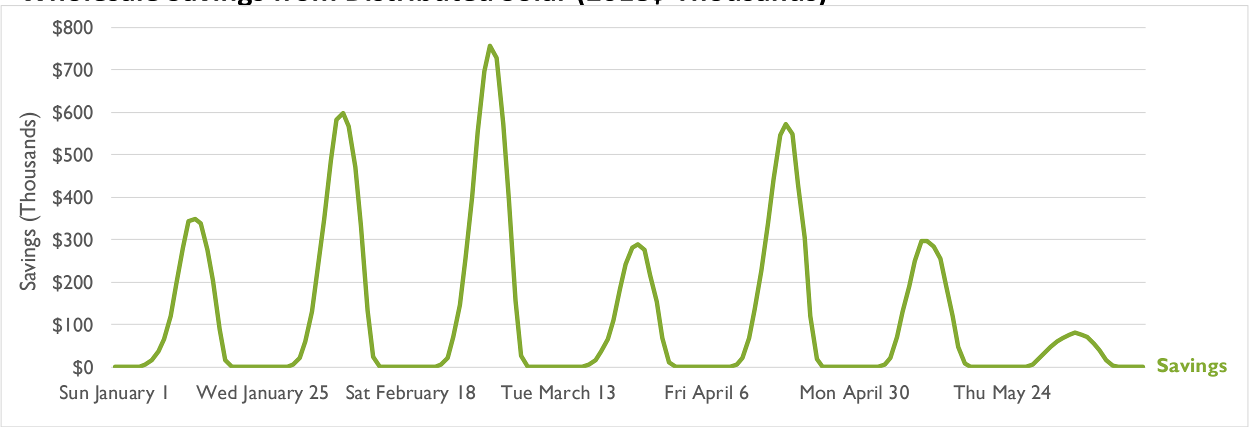
Actual, Predicted, and But-for LMPs ($/MWh)



Wholesale Costs and Wholesale Savings

- But-for wholesale costs are always equal to or greater than predicted wholesale costs in a given hour
- The wholesale savings are greatest during the periods with the most distributed solar





Caveats

Day-Ahead and Real-Time Prices

- LMPs are settled in both Day-Ahead and Real-Time markets
- **Day-Ahead Prices:**
  - Settled the day before the operating day, for each hour
  - The ISO will commit to the lowest bids for the amount of generation required to meet the expected demand throughout the operating day
  - The majority of system load is bought and sold in the Day-Ahead market at Day-Ahead prices
- **Real-Time Prices:**
  - Developed in real-time
  - Prices are trued-up (or down) in response to actual, real-time system load
  - Generally more volatile than day-ahead prices, as real-time LMPs are able to adjust to unpredicted changes in load and supply from, e.g., a power plant outage
  - Only the small differences between Day-Ahead and Real-Time load are settled at Real-Time prices; this is typically less than 10% of total wholesale costs
- Ratepayers pay for electricity that is settled in multi-month contracts which are influenced by but not directly connected to the activities of Day-Ahead and Real-Time markets
- Our analysis uses Day-Ahead LMPs, and therefore reflect wholesale cost savings rather than savings that can be directly applied to ratepayers

Energy Prices

- Our analysis focuses exclusively on energy prices
- Customers are charged for additional components of energy procurement and delivery, including:
  - Capacity prices
  - Transmission and distribution costs
  - Etc.
- The presence of distributed solar has likely reduced the costs for some if not at all of the additional components of energy procurement and delivery
- Therefore, our analysis presents only one portion – the energy component – of the total estimated savings provided by distributed solar generation

Contact

Pat Knight | pknight@synapse-energy.com | 617.453.7051

Jamie Hall | jhall@synapse-energy.com |617.453.7069