Value of Energy Efficiency in New York

Assessment of the Range of Benefits of Energy Efficiency Programs

Prepared for Natural Resources Defense Council

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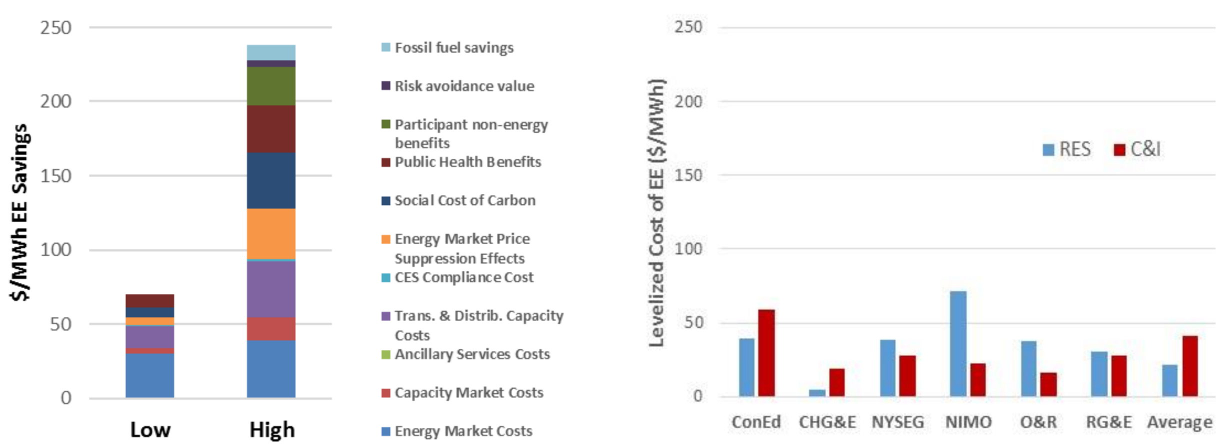
1. INTRODUCTION AND SUMMARY OF FINDINGS

National Resources Defense Council (NRDC) has engaged Synapse Energy Economics (Synapse) to identify and estimate the value of energy efficiency. NRDC seeks to estimate the value of energy efficiency for its potential to inform: (1) a rule to determine when utilities must carry out energy efficiency investments and (2) a shared savings mechanism rewarding utilities for achieving system and societal benefits through energy efficiency.

Synapse conducted a high-level assessment of the value of energy efficiency. The starting point for our analysis was a 2015 study by E3 that estimated the value of components associated with distributed solar photovoltaic (PV) resources.[1] We modified the values where appropriate to accurately represent energy efficiency. In addition, we updated several of E3's values (e.g., energy and capacity) and reviewed primary market data to develop our own value estimates.

We present our findings and analysis results below. Figure 1(a) presents a range of energy efficiency benefits. The Low Case represents a scenario in which one of the low-cost New York utilities implements an efficiency program where the societal benefits such as fossil fuel savings, participant non-energy benefits (NEB), public health benefits, and social cost of carbon are low. The High Case represents a scenario where one of the high-cost New York utilities implements an efficiency program where the societal benefits are high. In practice, the actual values of energy efficiency benefits will likely fall within this range.

Figure 1. (a) Energy efficiency benefits of Low/High cases; (b) New York energy efficiency programs 2016 costs



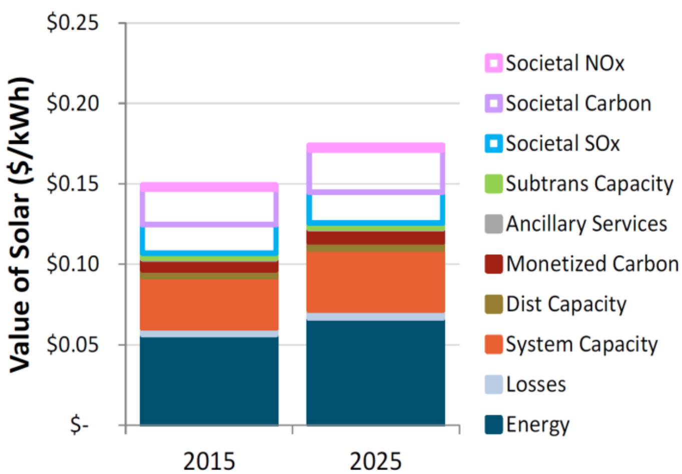
[1] Energy + Environmental Economics (E3). 2015. *The Benefits and Costs of Net Energy Metering in New York.* Prepared for New York State Energy Research and Development Authority and New York State Department of Public Service. Available at https://www.ethree.com/wp-content/uploads/2017/01/E3-NY-Legislative-NEM-Study-Report-121115-FINAL-SENT.pdf.

Figure 1(b) presents the range of costs for energy efficiency programs in New York in 2016.[2] These costs are levelized, so they are directly comparable to energy efficiency benefits in terms of lifetime dollars per megawatt-hour ($ per MWh). While there are considerable differences across the utilities and the programs, the weighted average costs are roughly $20–$40 per MWh.

2. Benefit Categories

Synapse developed estimates of the values of energy efficiency based on the benefit categories defined in the E3 net energy metering study (E3 NEM) prepared for New York State Energy Research and Development Authority and New York State Department of Public Service, cited above.

Figure 2. E3 value of solar components



Source: E3 NEM, Figure 24. Untargeted NEM Scenario, Statewide, All Classes, Solar PV.

We chose this study as the main source for finding key information on avoided cost estimates because it offers the most recent, comprehensive avoided costs estimates for New York. Many of these estimates are applicable for energy efficiency. This study identified and monetized the benefits of solar net metering in New York State. Figure 2, reproduced from that report, summarizes the overall findings. The study included the following 10 benefits: Energy, System Capacity, Societal Carbon, Societal Sulfur Oxides (SO_X), Monetized Carbon, Losses, Distribution Capacity, Subtrans Capacity, Ancillary Services, and Societal Nitrogen Oxides (NO_X). Other benefits investigated were not significant enough to include in the final results.

2 We do not include data for NYSERDA because their programs include fossil fuel measures and thus are not directly comparable to the electric IOU programs.

Unfortunately, the E3 NEM study only presents these results graphically and does not provide any numerical values. E3 based its 2015 values on historical data, while it used various projections for 2025 values, making them more uncertain. Synapse conducted a rough analysis of the E3 results to approximate the numerical values shown in Table 1.[3]

Table 1. E3 value of solar components

Value of Solar Benefits		
Category	**Approximate Benefit ($/MWh)[4]**	
	2015	**2025**
1. Energy & Losses	50	70
2. System Capacity	35	40
3. Distribution Capacity	5	10
4. Ancillary Services	2	2
5. Sub-transmission Capacity	2	2
6. Monetized Carbon	10	10
7. Societal SO_X	20	20
8. Societal Carbon	20	30
9. Societal NO_X	2	2
Total	**146**	**186**

The first six benefits in Table 1, which account for various market and customer costs, represent around $134/MWh, or 70 percent of the total benefits in 2025. The last three represent indirect societal benefits.

For comparison, the benefit categories identified by the New York Public Service Commission (PSC) staff in 2015 were:[5]

1. Avoided Energy (LBMP)
2. Avoided Generation Capacity Costs, including Reserve Margin
3. Avoided Distribution Capacity Infrastructure
4. Avoided Distribution O&M Costs
5. Avoided Distribution Losses
6. Avoided Ancillary Services

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[3] The E3 NEM report does not provide the numerical values used in this figure, so we had to approximate visually. Later in this report we develop values for specific categories based on more detailed information.

[4] To be consistent with most electric system data sources, we use cost units of (nominal) $/MWh in our analysis.

[5] New York State Department of Public Service Case 14-M-0101: "Staff White Paper on Benefit-Cost Analysis in Reforming Energy Vision Proceeding," prepared by NYDPS Staff, July 2015. Available at https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/c12c0a18f55877e785257e6f005d533e/$FILE/Staff_BCA_Whitepaper_Final.pdf.

7. Avoided Transmission Capacity Infrastructure and O&M
8. Avoided Transmission Losses
9. Wholesale Market Price Impacts
10. Net Avoided Restoration Costs
11. Net Avoided Outage Costs
12. Externalities
13. Net Non-Energy Benefits

PSC Staff identified the following costs and benefits that were not included in the E3 value of solar study:

- Net avoided restoration costs;
- Net avoided outage costs; and
- Net non-energy benefits.

We identified values for these additional benefits based on the utility benefit-cost analysis (BCA) studies.[6] We limited our analysis of externalities to the societal cost categories (7–9 in Table 1) identified in the E3 study. We have not investigated possible benefits beyond these, such as those identified in other studies, as they are beyond the current scope of our analysis.[7]

3. ISSUES AFFECTING MULTIPLE BENEFITS

Before investigating various values for energy efficiency, it is important to address a few key issues that influence multiple benefit types. Such issues are: the applicability of the E3 values to energy efficiency; load shape of energy efficiency; and New York-specific loads, energy price, and emissions.

3.1. Applicability of the E3 Benefit Values

The E3 study focused specifically on the benefits of net energy metering in the context of customer solar PV installations. A number of factors should be considered when applying those results to energy efficiency.

1. Solar energy generation and energy efficiency savings generally have very different profiles.

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[6] ConEdison. 2016. "Benefit Cost Analysis Handbook"; Central Hudson Gas & Electric. 2016. "Benefit-Cost Analysis (BCA) Handbook, www.CentralHudson.com, Version 1.1, Revised August 30, 2016; National Grid (Niagara Mohawk Power Corporation). 2016. "Benefit-Cost Analysis Handbook, Version 1.1"; Orange & Rockland. 2016. "Benefit-Cost Analysis Handbook, Version 1.1"; NYSEG and RG&E. 2016. "Benefit-Cost Analysis Handbook, Version 1.1." All filed with the NY PSC in regards to Case 16-M-0412 – In the Matter of the Benefit-Cost Analysis Handbooks.

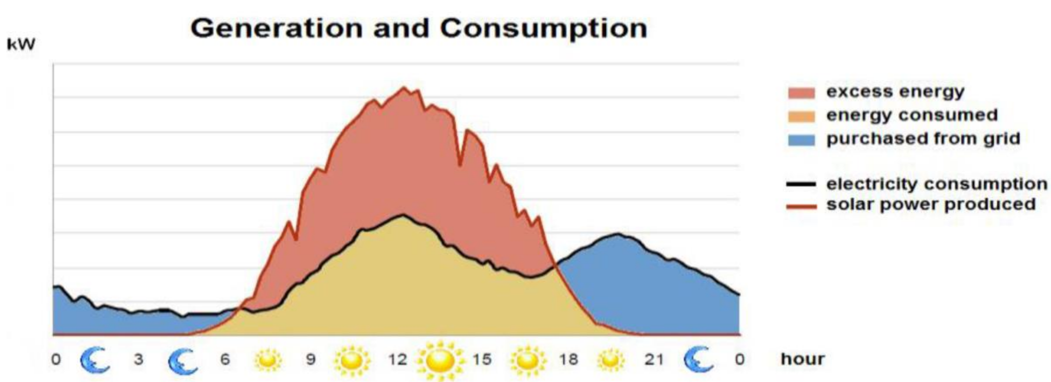
[7] International Energy Agency. 2014. "Capturing the Multiple Benefits of Energy Efficiency." Available at https://www.iea.org/topics/energyefficiency/benefits/.

2. Both solar PV and energy efficiency focus on the customer level.
3. E3 conducted its study in 2015 and looked at the historical year of 2015 and a future year of 2025. Expectations for 2025 are different now than they were then.
4. Some solar benefits, such as avoided restoration and outage costs, are not relevant to energy efficiency.

3.2. **Load Shape Issues**

Solar generation has a very specific production profile. It rises with the sun in the morning, peaks around noon, and declines with the sun in the evening. This is illustrated (roughly) in Figure 3 below, taken directly from the E3 study. Thus, there is some correspondence with mid-day peak loads in the summer. This means that (1) solar may have significant peak reduction and capacity value and (2) generation generally occurs when loads, energy prices, and emissions are high.

Figure 3. E3 system and solar load shapes



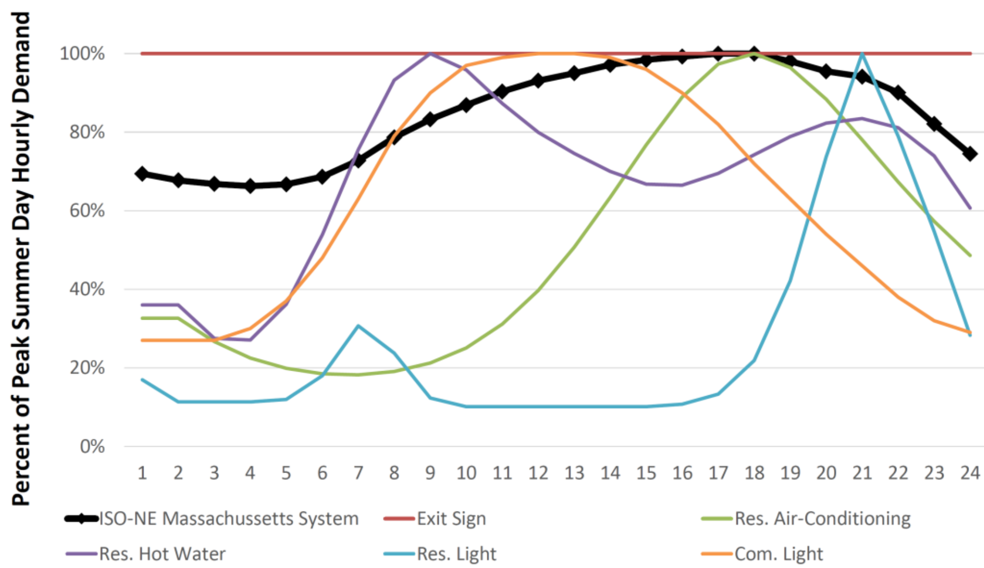
Source: E3 NEM, Figure 3, page 15.

Unlike solar PV, energy efficiency consists of a wide range of technologies and impacts. The following graphic from a Lawrence Berkeley National Laboratory (LBNL) study shows how different end-uses, and thus the efficiency measures applied to them, have very different load shapes.[8] Energy efficiency programs that focus on end-uses that contribute to the system peak load will produce greater peak savings than if they focus on end-uses that do not coincide with the system peak. For example, if savings from air-conditioning accounts for a large portion of program energy savings, then the peak coincident factor for such programs should be very high. Coincidence of end-use load shapes with system peak in Massachusetts is shown graphically in Figure 4, below. The average load shape for energy efficiency

[8] N. Mims et al. "Time-Varying Value of Energy Efficiency." Presentation by Lawrence Berkeley National Laboratory, July 10, 2017.

programs in New York needs to be investigated so that the capacity and energy benefits can be properly determined.

Figure 4. Massachusetts system and end-use load shapes



Source: N. Mims et al. "Time-Varying Value of Energy Efficiency." Presentation by Lawrence Berkeley National Laboratory, July 10, 2017.

3.3. New York Loads, Prices, and Emissions

To provide context for the economic and environmental analysis, Synapse examined the New York energy supply system in terms of loads, market costs, and emissions.

First, we looked at the typical hourly load shapes and how they differ by month, which varies throughout New York State. To illustrate, we look at the Hudson Valley zone, which has a load size that is roughly midway between the urban New York City area and the suburban and rural upstate and western areas.[9] The three months with the largest load in the Hudson Valley zone are June, July, and August, with peak occurring around 6:00 PM (see Figure 5). These peaks are largely driven by cooling plus household appliances and lighting. In the cooler months, load remains fairly flat during the day and then rises steeply into the early evening as household electricity use increases. In terms of capacity benefits, energy efficiency measures that reduce early evening loads in the summer would be most beneficial.

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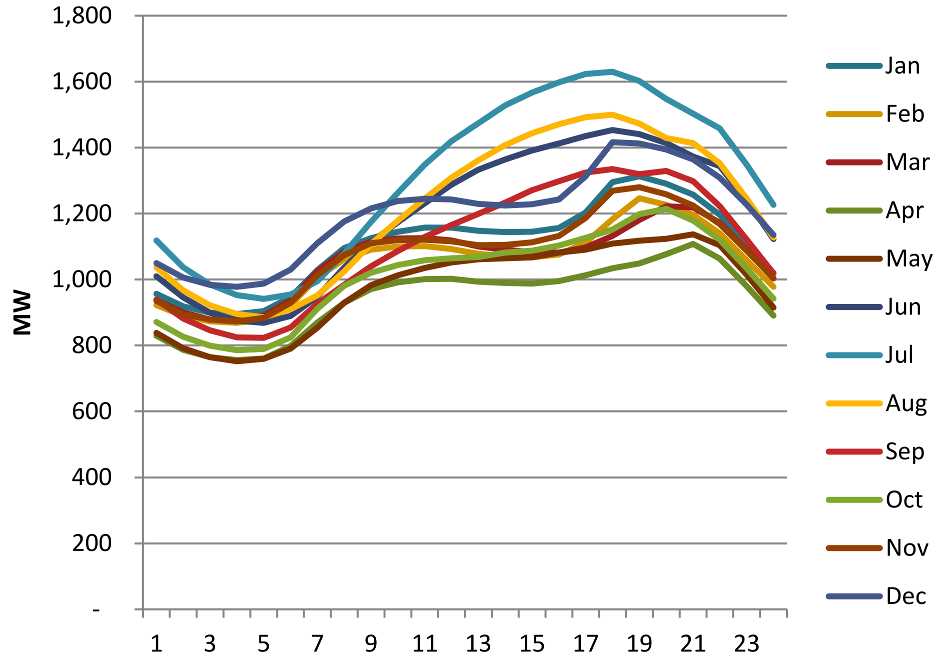
[9] Data obtained from the NY-ISO website. Available at http://www.nyiso.com/public/markets_operations/market_data/custom_report/index.jsp?report=dam_lbmp_zonal

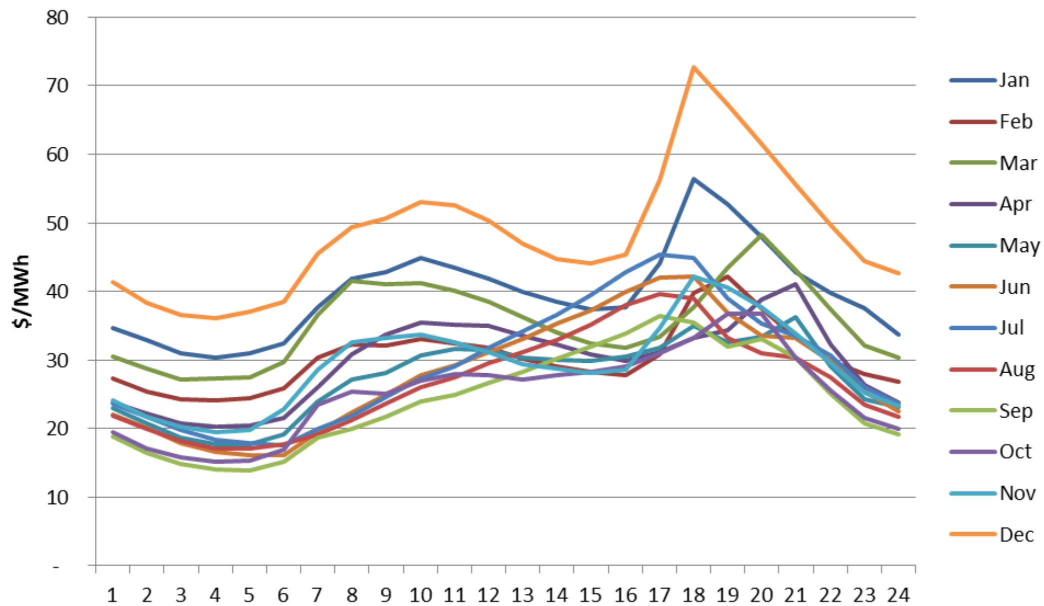
Figure 5. Hudson Valley hourly load shapes by month in 2017



Source: Synapse's analysis based on NY ISO market data.

Figure 6 (below) shows average hourly prices by month in 2017 for the Hudson Valley zone. The months with the highest electricity prices are December and January, when the demand for natural gas to meet heating needs is high and puts upward pressure on the price of gas for electric generation. Again, the peak prices are generally in the early evening. Thus, energy efficiency savings that affect those hours will be of higher value, especially in winter.

Figure 6. Hudson Valley hourly prices by month in 2017



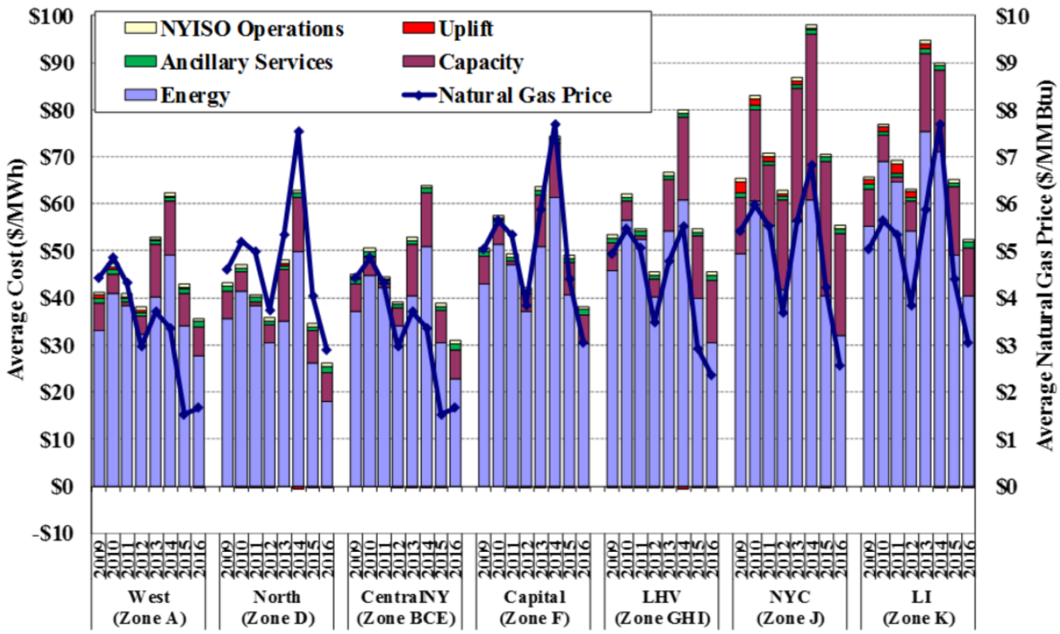
Source: Synapse's analysis based on NY ISO's market data.

We look next at the electricity markets to get a better sense of where benefits can be found. The following graph from Potomac Economics' 2016 State of the Market (SOM) Report[10] shows the relative magnitude of the various components of the New York electricity markets. This varies by zone, but in general energy represents about 80 percent of the total cost, capacity around 15 percent, and ancillary services most of the remainder. We should note however that regulated emission costs, including those for carbon, are contained in the energy market prices.

Another point of note in regard to the E3 benefit estimates is that the overall average price in 2016 was down by about 20 percent relative to 2015, the year used in the E3 NEM report. As shown by the superimposed line over the bars in the graph below, the electric energy price is strongly related to the natural gas price, which is generally the marginal generation fuel. Thus, future electricity prices depend on natural gas prices.

[10] Potomac Economics. 2017. "2016 State of the Market Report for the New York ISO Markets." Available at http://www.nyiso.com/public/webdocs/markets_operations/documents/Studies_and_Reports/Reports/Market_Monitoring_Unit_Reports/2016/NYISO_2016_SOM_Report_5-10-2017.pdf

Figure 7. New York all-in prices by region (2009–2016)



Source: Potomac Economics. 2017. Figure 1.

Table 2, excerpted from the SOM report, shows the internal generation mix and marginal generation by fuel type in New York. The largest generation sources in 2016 by fuel type were natural gas (44 percent), nuclear (31 percent), and hydro (19 percent). In terms of marginal generation, natural gas was dominant. Thus, when considering societal emission impacts, we must examine natural gas generation most closely. While natural gas combustion emits carbon dioxide (CO_2) and NO_X, it generates negligible SO_X emissions.

Table 2. New York average and marginal generation (2014–2016)

Fuel Type	Average Internal Generation						% of Intervals being Marginal		
	GW			% of Total					
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Nuclear	4.9	5.1	4.7	31%	32%	31%	0%	0%	0%
Hydro	2.8	2.8	2.9	18%	18%	19%	45%	49%	47%
Coal	0.5	0.3	0.2	3%	2%	1%	7%	2%	1%
Natural Gas CC	5.0	5.2	5.1	31%	33%	33%	60%	67%	68%
Natural Gas Other	1.6	1.7	1.7	10%	10%	11%	29%	28%	30%
Fuel Oil	0.2	0.2	0.1	2%	1%	0%	6%	5%	3%
Wind	0.5	0.5	0.5	3%	3%	3%	4%	5%	3%
Other	0.3	0.3	0.3	2%	2%	2%	0%	0%	0%

Source: Potomac Economics. 2017. Table 2.

4. VALUES OF ENERGY EFFICIENCY

We considered the benefits of energy efficiency in terms of avoided energy and losses; system (generation) capacity; ancillary services; transmission, sub-transmission, and distribution capacity; renewable energy credits; criteria pollutants; monetized and non-monetized carbon emissions; market price impacts; health impacts; non-energy benefits; and other benefits.

Throughout this section, we reference values from one of the scenarios in the E3 NEM report. The E3 NEM report considered four scenarios: Untargeted, Targeted, Lower NEM Value, and Higher NEM Value. The "Untargeted" case represents a business-as-usual scenario. The "Targeted" case represents the siting of NEM sources at higher value locations on the distribution grid. The "Lower NEM Value" and "Higher NEM Value" scenarios illustrate the uncertainty of the specific benefit values. Lower NEM Value yields values moderately lower than the Untargeted scenario, and Higher NEM Value produces values above those of the Targeted scenario. For the purpose of evaluating energy efficiency benefits, we used the Untargeted—business-as-usual—results.

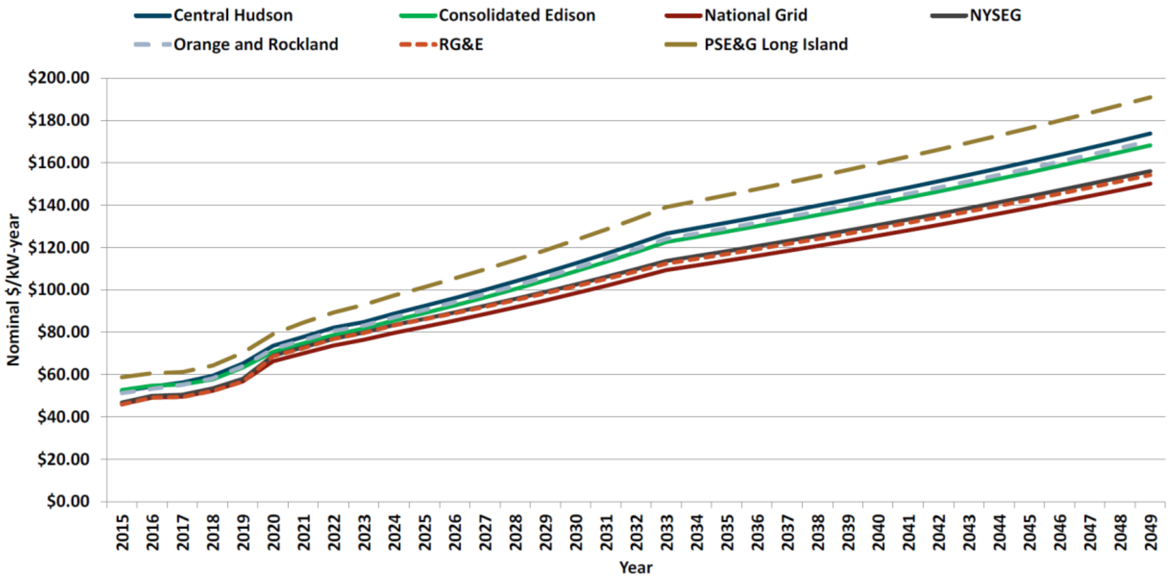
4.1. Energy and Losses

As previously established, energy prices in New York vary by location, time of day, and season. Average energy prices in 2015 ranged from about $33 per MWh in the West to about $49 per MWh on Long Island. This contrasts to a value of approximately $55 per MWh in 2015 for solar for energy and losses found in the E3 study. The E3 value represents a substantial premium over the average price, reflecting the shape of solar generation. Energy efficiency has a much broader load shape than solar, so a value consistent with the load weighted average energy price would be more appropriate. Based on the information provided in the SOM report, we recommend using a range of $35 to $50 per MWh for energy efficiency in 2015. We next consider 2025.

The E3 study used the NYISO's 2015 final Congestion Assessment and Resource Integration Study (CARIS) study with annual energy (Locational Based Marginal Pricing or LBMP), SO_X, NO_X, and CO_2 price projections from 2015-2024 by NYISO transmission zone.[11] The results of that are summarized in Figure 8 from the appendix of the E3 report. This shows a continual increase from 2015 prices. However actual prices have declined since 2015, and current expectations are for prices to stay close to current levels and only increase at moderate rates in the future.

[11] E3 2015, page 31 of Appendix.

Figure 8. E3 energy price projection



Source: E3 NEM, Appendix, Figure 10, page 34. "2015-2049 Energy Price Projections (No Carbon) by Utility for each kW of Solar PV Installed."

In 2015, prices in the Hudson Valley (based on the SOM report) were about $40 per MWh and decreased to about $30 per MWh in 2016. The price in 2017 based in the ISO hourly price data was $31.20 per MWh. For future prices, we looked at the NYMEX electricity futures. For the Hudson Valley, the all-hour futures for 2019 are $32.50 per MWh, a little above the 2017 prices. For 2020, those futures are $33.93 per MWh. By 2022, the futures are at $36.15 per MWh. Projecting that rate of increase to 2025 gives $39.15 per MWh, which is just a little under the 2015 price. Electricity prices were high in 2015 because of high natural gas prices and they have since declined considerably. Current expectations are that electricity prices in 2025, while higher than current prices, are likely to be close to those of 2015, in the range of $35 to $50 per MWh, and to increase thereafter at a nominal rate of 2 to 4 percent per year.[12]

It is important to note that load-weighted energy prices are greater than the simple hourly average. This is because prices generally are high when loads are high. The relationship between load and price varies by season and location. We analyzed the Hudson Valley load and price data for 2017 and calculated the simple average price of $31.20 per MWh and the load-weighted price of $33.01 per MWh. The load weighted energy price averaged 5.8 percent above the simple average. The premium was higher in the summer months, averaging about 8.5 percent. But the actual load shape premium depends on the

[12] For comparison, the recent 2018 Annual Energy Outlook has electricity generation costs increasing at 2 percent, but markets are driven by marginal costs. See https://www.eia.gov/outlooks/aeo/data/browser/#/?id=8-AEO2018&region=0-0&cases=ref2018&start=2016&end=2050&f=A&linechart=~ref2018-d121317a.74-8-AEO2018&ctype=linechart&sourcekey=0

nature of the specific energy efficiency measures being considered. We consider the load-weighted price a good starting point for valuing energy efficiency measures.

Lastly, we conducted an independent near-term value range analysis for energy prices to develop Synapse's own avoided energy cost estimates. More specifically, we examined the energy prices and system losses for the major New York load serving entities (LSE): National Grid/Niagara Mohawk, New York State Electricity and Gas, Orange & Rockland, Central Hudson, Con Ed, and PSEG Long Island. As discussed above, we used the NYMEX electricity futures for 2019. We then adjusted these energy prices for New York utilities' specific line losses based on their BCA Handbooks. We also added a small premium of 5 percent to represent load-weighted rather than simple all-hours prices. This assessment results in wholesale energy values with line loss factors ranging from $30 to $39 per MWh depending on location. For the low set of values, we used a weighted average from central and western New York. For the high set, we used the weighted average from the lower Hudson Valley and New York City. We also employed this methodology for other utility-related costs, e.g. system and transmission and distribution (T&D) capacity (to be discussed below).

4.2. System Capacity

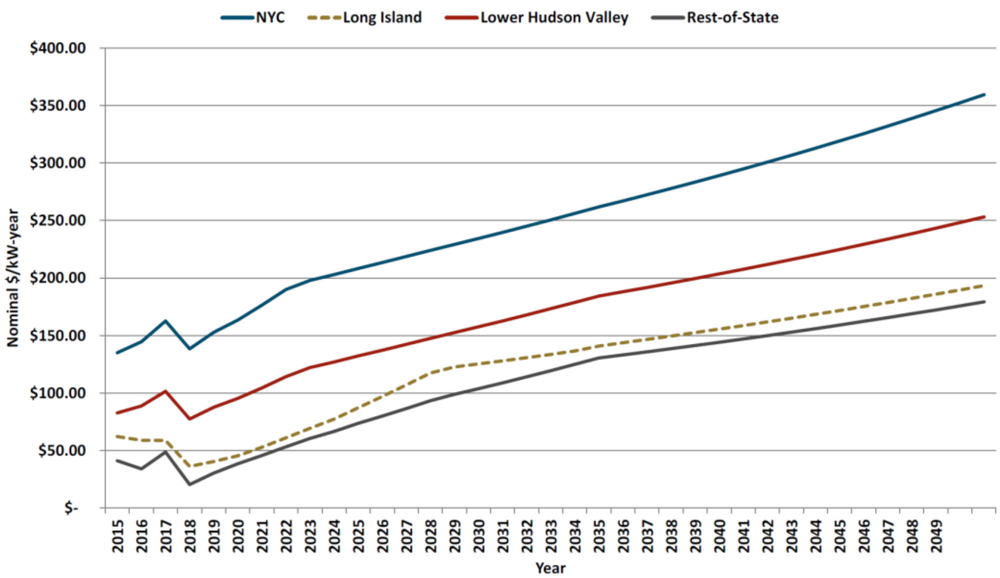
As noted previously, capacity costs are second only to energy costs in the New York electricity markets. In energy terms, they are equivalent to about $3 to $15 per MWh, depending on location. The New York Installed Capacity (ICAP) market is based on the obligation placed on LSEs to procure ICAP to meet minimum requirements. The requirements are determined by forecasting each LSE's contribution to its transmission district peak load and adding an additional amount to cover the Installed Reserve Margin.[13] Obligations are met by a variety of means including owned capacity, bilateral transactions, and Unforced Capacity (UCAP) auctions. The requirements and auctions go out a year and a half, in contrast to New England, for example, where the auctions are for three years in advance.

Figure 9, excerpted from the E3 NEM report, shows the locational differences in E3's capacity price forecast, which grows at an annual rate of about 3.5 percent.[14] This forecast now appears to be too high.

[13] NY-ISO ICAP market: http://www.nyiso.com/public/markets_operations/market_data/icap/index.jsp.

[14] E3 NEM, Appendix, p38.

Figure 9. E3 capacity price forecast



Source: E3 NEM, Appendix, Figure 13, page 38. NYISO Zonal ICAP Capacity Forecast ($/kW-year).

We backed out the E3 NEM value of solar capacity benefits looking at their values for 2020. The zonal ICAP values range from $50 per kilowatt (kW)-year for Long Island to $160 per kW-year for New York City according to the E3 NEM study. Based on the utility mapping in the E3 NEM study, that corresponds roughly to $50 per kW-year for PSEG Long Island to $130 per kW-year for Con Edison. The coincidence of the solar PV profile ranges from about 31 percent to 47 percent, based on E3's analysis of solar PV outputs during the top 100 system peak hours. Taking into account these peak coincidence factors, we estimated adjusted capacity values ranging from $22 to $61 per kW-year for solar. We further converted these values to dollars per MWh using a solar load factor of about 15 percent (from NREL[15] for New York City). Resulting solar capacity values range from $17 to $47 per MWh of solar generation.

Applying a similar set of calculations for energy efficiency—assuming a 50 percent coincidence factor[16] and a 60 percent load factor—gives values in the range of $5 to $12 per MWh of energy efficiency savings.[17] This is of course very rough and only serves as a general guide.

The following graph from the 2016 SOM report[18] shows the recent historical capacity (UCAP) prices for the New York Control area (NYCA), roughly equivalent to the prices for the Rest-of-State excluding zones

[15] See http://pvwatts.nrel.gov/

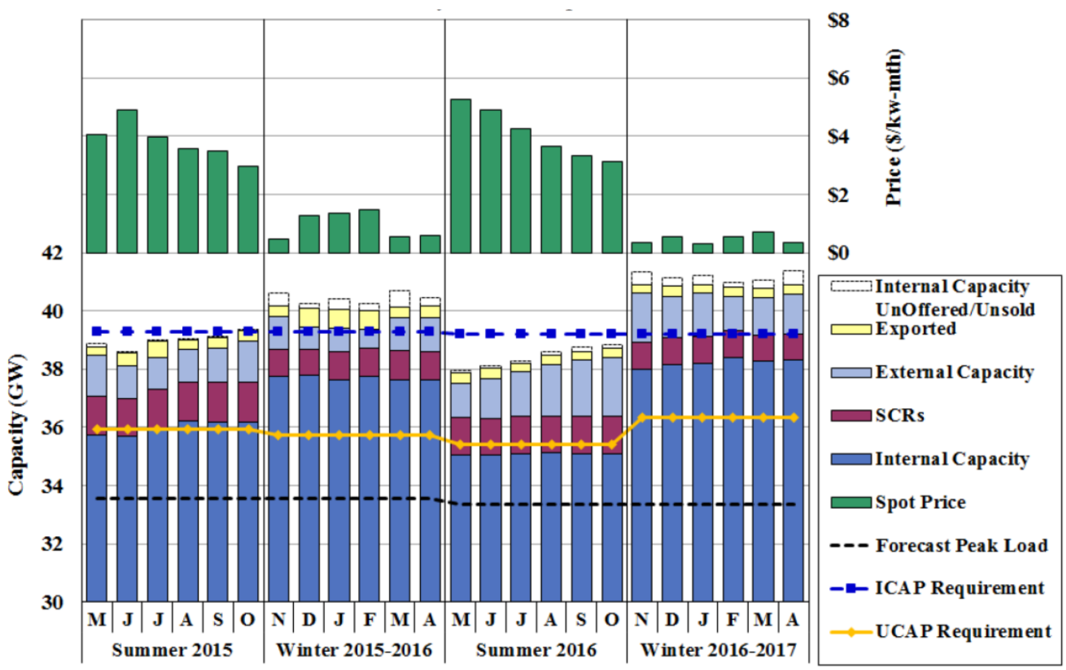
[16] This may be a conservative estimate given the New York utility Benefit Cost Analysis Handbook has high coincidence factors for energy efficiency (0.7 to 1.0). This value needs to be investigated further.

[17] A 60 percent energy efficiency load factor is close to the average performance of the current NY energy efficiency programs across the investor owned utilities provided in EIA's 861 database.

[18] 2016 SOM report, page A-165.

G-J, New York City, and Long Island. Note that prices are considerably higher for the summer (May-October) than for the winter (November-April) period. The average price for the most recent 12 months shown here is about $3 per kW-mo, equivalent to $36 per kW-year. That is a bit below the forecasted value for Rest-of-State used in the E3 report.

Figure 10. New York capacity sales and prices



Source: 2016 SOM report. Figure A-87: UCAP Sales and Prices in NYCA, May 2015 to April 2017.

We then used the current auction prices from the ISO website (Table 3). Location G-J is equivalent to the lower Hudson valley. ROS represents rest-of-state. These values roughly correspond to the dip of those of the E3 study for 2018. However, the E3 study forecasted about $140 per kW-year for New York City, which is almost twice that of the auction.

Table 3. New York strip auction capacity sales and prices ($/kW-mo)

Location	Summer 2017	Winter 2017-2018	Year	$/kW-yr
G-J	$10.50	$2.70	$6.60	$79.20
LI	$5.79	$0.75	$3.27	$39.24
NYC	$11.71	$3.10	$7.41	$88.86
NYCA	$3.00	$0.37	$1.69	$20.22
ROS	$3.00	$0.36	$1.68	$20.17

Source: NYISO's Installed Capacity View Strip Auction Summary, http://icap.nyiso.com/ucap/public/auc_view_strip_detail.do

We developed our own avoided capacity costs using the capacity prices shown in Table 3 along with a 17.5 percent reserve margin factor,[19] utility-specific marginal line loss factors, as well as utility-specific energy efficiency peak coincident factors. We used marginal loss factors to adjust capacity prices instead of average line loss factors, as marginal loss is a more appropriate loss factor during peak hours. We derived marginal loss factors based on utility-specific line loss factors provided in their BCA handbooks and the relationships between marginal loss factors and average loss factors that we derived from a 2011 report by the Regulatory Assistance Project (RAP).[20] Finally, we used energy efficiency peak coincident factors ranging from 70 percent to 100 percent based on the utilities' BCA Handbooks.[21,22] This produced avoided capacity costs ranging from approximately $19 per kW-year (or $3.7 per MWh) in the west to approximately $80 per kW-year (or $15.4/MWh) in the east, assuming the same 60 percent load factor.[23]

The capacity market does not currently offer potential revenue for energy efficiency resources. In New England, energy efficiency and demand response resources can bid into the forward capacity market and receive payments. New York markets could potentially do the same. LSEs could also compensate energy efficiency resources directly since they have the capacity obligation.

4.3. **Ancillary Services**

Regarding the ancillary services value for solar resources, the E3 NEM report recommends a proxy value of 1 percent of the energy costs.[24] We adopted this assumption for energy efficiency. While there likely are some savings from energy efficiency measures, they would be both hard to identify and difficult to convert into a revenue mechanism. LSEs, which might see a reduction in their ancillary costs, could potentially compensate the energy efficiency resources.

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[19] NY-ISO ICAP market: http://www.nyiso.com/public/markets_operations/market_data/icap/index.jsp

[20] Regulatory Assistance Project. 2011. *Valuing the Contribution of Energy Efficiency to Avoided Marginal Line Losses and Reserve Requirements*.

[21] This is a conservative approach because system peak coincident factors are typically already taken into account at an energy efficiency measure level as stipulated in New York's Technical Reference Manual.

[22] In contrast, the E3 NEM study used peak coincidence factors for solar in the order of 30 percent (or 0.3) by examining the operation of PV during the top 100 system hours.

[23] Dollars per kW-year was converted to dollars per MWh based on a 60 percent load factor for energy efficiency based on New York utilities' energy efficiency program performance for 2016 obtained from EIA 861 database.

[24] E3 NEM, Appendix, 1.4.1.4, page 41.

E3 avoided ancillary services costs

General Description	Study Calculation Methodology/Value
Reduction of the costs of services like operating reserves, voltage control, reactive power, and frequency regulation needed for grid stability associated with the adoption of distributed NEM.	A proxy value of 1 percent of energy costs is assigned. The NYISO procures ancillary services on a fixed rather than load-following basis based on a largest single contingency measure, which means the amount of ancillary services procured would not likely decrease in any appreciable way due to the adoption of distributed NEM. There could be some benefit from voltage/reactive power control or power factor correction with newly enabled smart inverter technology.

Source: E3 NEM, Appendix, 1,4,1,4, page 41.

4.4. Transmission Capacity

The E3 NEM report uses a proxy value of zero for avoided transmission capacity costs for solar resources, consistent with the New York DPS BCA whitepaper.[25] E3 determined that the value of transmission capacity is most likely captured in the avoided energy and capacity costs.

While there is likely some value that is not captured in energy and capacity costs, it would be small unless a major transmission investment could be deferred or avoided. Given this, we believe that any residual value is small, although there could be locational situations in the future when they would have some import. We did not assign any value for the avoided transmission cost for our analysis.

E3 avoided transmission capacity costs

General Description	Study Calculation Methodology/Value
Reduction or deferral of costs associated with expanding/replacing/upgrading transmission capacity associated with the adoption of distributed NEM.	The value of transmission capacity is in part captured in the NYISO CARIS zonal production simulation modeling results and is represented as congestion, i.e. energy price differentials, between the NYISO modeled zones. It is also likely captured to some extent in the various zonal NYISO capacity prices, i.e. more transmission and generation constrained capacity zones would likely have a higher zonal capacity price all else being equal.

Source: E3 NEM, Appendix, 1.4.1.5, page 43.

4.5. Sub-transmission Capacity

Sub-transmission capacity represents the intermediate level of the T&D system generally operating at voltages between 34.5 kilovolts (kV) and 138 kV. E3 used the utility marginal cost of service (MCOS) studies to estimate its value. The utility avoided cost of sub-transmission capacity estimates ranged from $2 to $8 per kW-year in 2020.[26] They analyzed the coincidence factor for solar in the top 100 zonal

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[25] E3 NEM, Appendix, 1.4.1.5, page 43; New York State DPS Case 14-M-0101: "Staff White Paper on Benefit-Cost Analysis in Reforming Energy Vision Proceeding," prepared by NYDPS Staff, July 2015. Available at https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/c12c0a18f55877e785257e6f005d533e/$FILE/Staff_BCA_Whitepaper_Final.pdf

[26] E3 NEM, Appendix, Figure 20, page 47.

hours and found that sub-transmission capacity values range from 8 to 11 percent of the original capacity values.[27]

The adjusted values for installed solar ranged from about $2 per kW-year for Niagara Mohawk to $8 per kW-year for Con Edison.[28] Most of the utilities fell in the $4–$6 per kW-year range. Some locations could qualify for much greater benefits. Energy efficiency measures that reduce the peak load on these circuits in the top 100 of the zonal load hours should also produce benefits, although the key factor is the coincidence of those reductions with the top zonal load hours. Since energy efficiency is an all-hours effect, the peak benefits likely could be greater than for solar. Our estimate of avoided sub-transmission capacity will be discussed in the following sub-section along with avoided distribution costs.

E3 avoided sub-transmission costs

General Description	Study Calculation Methodology/Value
Reduction or deferral of costs associated with expanding/replacing/upgrading sub-transmission capacity such as area substations, lines, transformers, etc. with the adoption of distributed NEM generation.	Costs based on existing estimates for marginal sub-transmission capacity costs as provided by each utility in their Marginal Cost of Service Studies. These costs are adjusted by the expected sub-transmission system peak load reduction value realized by each type of NEM technology based on NYISO zonal load data.

Source: E3 NEM, Appendix, 1.4.1.6, page 44.

4.6. Distribution Capacity

Distribution capacity represents the distribution system operating at below 34.5 kV. Distribution costs vary greatly between utilities and locations. E3 used the utility MCOS studies as the starting point.[29] The utility avoided cost estimates ranged from $20 to $90 per kW-year. E3 analyzed the coincidence factor for solar in the top 100 zonal hours and found that it ranged from 5 to 11 percent.[30]

Values for solar in 2020 ranged from about $1 per kW-year for Niagara Mohawk to $11 per kW-year for Con Edison.[31] Most of the utilities fell in the $3–$8 per kW-year range. Some locations could qualify for much greater benefits. Energy efficiency measures that reduce the peak load on these circuits in the top 100 of the zonal load hours should also produce benefits, although the key factor is the coincidence of those reductions with the top zonal load hours. Since energy efficiency generally has an all-hours effect, the peak benefits likely could be greater than for solar.

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[27] E3 NEM, Appendix, Figure 19, page 46.

[28] E3 NEM, Appendix, Figure 20, page 47. Adjusted for installed solar capacity.

[29] E3 NEM, Appendix, 1.4.1.6, page 44.

[30] E3 NEM, Appendix, Figure 25, page 52.

[31] E3 NEM, Appendix, Figure 26, page 53.

E3 avoided distribution costs

General Description	Study Calculation Methodology/Value
Reduction or deferral of costs associated with expanding/replacing/upgrading distribution capacity such as lines, transformers, etc. with the adoption of distributed NEM generation.	Costs based on existing estimates for marginal distribution capacity costs as provided by each utility in their Marginal Cost of Service Studies. These costs are adjusted by the expected distribution system peak load reduction value realized by each type of NEM technology based on utility sample substation load data.

Source: E3 NEM Appendix, 1.4.1.7, page 48.

To develop our avoided sub-transmission and distribution costs, we relied on more recent utility data. The New York utilities are currently involved in evaluating distributional marginal cost values. The utilities' recent findings were summarized in a June 2017 report (also by E3).[32] These distributional cost values appear to include both sub-transmission and distribution system costs. We summarize those bottom-line values below. These are generally consistent with the values used in the E3 NEM study. The wide range of values shows the importance of the resource location when evaluating benefits (Table 4).[33]

Table 4. Summary of distribution marginal cost values

Utility	NYSEG	RGE	Nimo LgGS	Nimo Res	ConEd	ORU	CHG&E	Weighted Average
Marginal Cost $/kW-year	$30.66	$31.38	$63.15	$159.63	$204.72	$61.83	$14.05	**$61.83**

Source: E3 Value of DER Technical Conference, June 2017.

We then adjusted these costs for marginal loss factors and T&D coincident factors. The marginal loss factors are the same factors as we used for our avoided generation capacity costs. The T&D coincident factors are based on the utilities' BCA Handbooks, which range from 64 percent to 100 percent.[34] The resulting avoided distribution costs (including sub-transmission costs) range from $75 per kW-year (or $14.3 per MWh) in the west to $195 per kW-year (or $37.2 per MWh) in the east.

4.7. Renewable Portfolio Standards

E3 NEM chose the value of zero for distributed solar because distributed solar is not part of the state renewable portfolio standard (RPS). Since the E3 study was published, New York established a Clean Energy Standard (CES) in late 2016. The CES promotes various clean energy resources including distributed solar projects and places compliance obligations on the LSEs as a growing percentage of

32 Snuller Price. 2017. "Value of DER Technical Conference." Prepared by E3.

33 E3 Value of DER Technical Conference, June 2017. Table from Synapse workbook "Value of NEM & EE.xlsx."

34 We also note the standard caveat in the BCA handbooks: "This illustration would change as specific projects and locations are considered."

LSEs' load (i.e., 0.6 percent in 2017 to 24.8 percent in 2021). Thus, energy efficiency savings could reduce the renewable requirements under the CES and provide a benefit.

This is the case in New England where such benefits are calculated as part of the AESC process for evaluating energy efficiency programs. The AESC 2015 study estimated those levelized values in New England to range from $0.00 to $8.81 per MWh depending on the state.[35] Values from the 2018 AESC study will be available later this spring.

E3 renewable portfolio standards value

General Description	Study Calculation Methodology/Value
Reduction of the compliance costs associated with utilities obligated to procure certain renewables to meet RPS related to the adoption of distributed solar.	No value assigned because there is currently no RPS compliance requirement or market in New York, such as a requirement for each utility to procure a certain number Renewable Energy Certificates (RECs) or procure certain amounts of renewables to serve its load. Therefore the adoption of distributed solar does not avoid this future cost. E3 identifies this component explicitly as one requiring further study, especially if a renewable compliance market is developed in New York.

Source: E3 NEM, Appendix, 1.4.1.8, page 53. Criteria Pollutants.

For estimating impacts on the CES obligations from energy efficiency, we used the Tier 1 target for 2020 (3.4 percent of load) as discussed in the DPS Staff White Paper on the CES,[36] the current renewable energy price under the New York RPS,[37] and the New England REC prices ($30–$60 per MWh). This assessment results in small energy efficiency effects ranging from $1 to $2 per MWh because of the low CES requirement in the early years. This will certainly increase in the future as the RPS requirements are increased.[38]

4.8. Criteria Pollutants

E3 NEM chose the value of zero for the criteria pollutants for solar as those costs are included in the zonal energy costs.[39,40] The same principle applies for energy efficiency savings.

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[35] AESC 2015, Exhibit 5-38.

[36] NY DPS. 2016. "Staff White Paper on Clean Energy Standard," Case 15-E-0302.

[37] https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard/REC-and-ZEC-Purchasers/2018-Compliance-Year

[38] For potential implications of an increased value of reducing RPS and CES compliance costs, see: Woolf, T., A. Napoleon, P. Luckow, W. Ong, and K. Takahashi. 2016. *Aiming Higher: Realizing the Full Potential of Cost-Effective Energy Efficiency in New York*. Available at http://www.synapse-energy.com/sites/default/files/Aiming-Higher-NY-CES-White-paper-15-056.pdf.

[39] E3 NEM, Appendix, 1.4.1.9, page 55.

[40] E3 NEM, Appendix, 1.4.1.9, page 55.

E3 avoided criteria pollutants

General Description	Study Calculation Methodology/Value
Reduction of SO_x, NO_x, and PM_{10} emissions due to reduction/increase in production from the marginal wholesale generating resources associated with the adoption of distributed solar generation.	The compliance costs associated with these criteria pollutants is included in the zonal energy cost NYISO CARIS forecasts.

Source: E3 NEM, Appendix, 1.4.1.9, page 55.

4.9. RGGI CO_2 Emission Costs

The E3 NEM report uses the CARIS[41] estimates of the RGGI compliance costs, which range from $8.02 per ton in 2016 to $14.67 per ton in 2020.[42] This CO_2 price is about twice the current estimate of the RGGI price.[43] E3 also uses the marginal CO_2 emission rates based on the 2014 NYISO State of the Market Report.[44] We replicated those calculations and found a marginal value of $7.90 per MWh in 2020. However, the 2017 CARIS[45] projection of the 2020 CO_2 price is only $5 per ton. Using this allowance price and making adjustments for the declining carbon intensity of the marginal generation produces a 2020 value of $2.30 per MWh for energy efficiency. This is considered to be included in the energy market price and not reported separately. However, the difference between this and the social cost of carbon is used for the social benefit calculations.

E3 Monetized CO_2 emission costs

General Description	Study Calculation Methodology/Value
Reduction of CO_2 emissions due to reduction in production from the marginal wholesale generating resources associated with the adoption of distributed NEM generation.	The monetized value of carbon as determined by the NYISO in its CARIS forecast.

Source: E3 NEM, Appendix, 1.4.1.10, page 55.

4.10. Market Price Effect

The Market Price Effect principle states that reduced demand reduces energy market prices. Some of the market price effect is passed on to the customers, but there are also market adjustments which

41 CARIS 2017 Report: http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_espwg/meeting_materials/2017-06-22/EmissionPriceForecast%20for%20CARIS%20internal%20June%2016_Updated.pdf

42 E3 NEM, Appendix, Figure 27, page 56.

43 See https://www.rggi.org/program-overview-and-design/program-review

44 Ibid, Figure 28.

45 Cohen, B. "2017 CARIS Emissions Price Forecast Development Updated," June 22, 2017, NYISO.

dampen the effect over time. E3 NEM calculated the LBMP market price effect to be $15 per MWh for each incremental MWh of solar generation in the first year. This price effect then decreases to half that in the second year and disappears in the third. Averaged over a 20-year life, this is equivalent to $1.13 per MWh. The 2018 New England AESC study calculates both a greater and longer lasting effect for energy efficiency savings. A similar analysis for New York would likely show higher values. In our current analysis, we use the values from the E3 NEM study as placeholders rather than speculating.[46]

Again, while this is an overall benefit, there is no market approach for crediting this to energy efficiency programs.

E3 market price effect

General Description	Study Calculation Methodology/Value
Potential reduction of system-wide wholesale energy costs due to reduced system load attributable to distributed NEM generation.	There are many factors that affect this component including how much the current and forecast New York wholesale energy market is at spot vs. hedged or under long-term contracts. Additionally, information on the underlying market and operational characteristics are needed to see how much if any supply can be affected and for how long due to distributed NEM PV generation now and in the future.

Source: E3 NEM, Appendix, 1.5, page 58.

We independently calculated a value range for the market price effect using New York's wholesale energy prices and other key assumptions for market effects based on the AESC 2018 report. We used both magnitude and duration values from section 9.3 of that report to come up with a range of values for New York from $5 to $34 per MWh of energy efficiency.

4.11. Social Carbon

This is an area that needs further study and quantification. The E3 NEM report uses the United States Environmental Protection Agency's (EPA) social cost of carbon forecast.[47] That forecast provides a number of cost options with different discount rates. The constant dollar price in 2030 ranges from $17 to $170 per ton. In contrast, the CARIS 2017 emissions price forecast has a range of $55 to $95 for 2026.[48] For 2020, the 3 percent value from the DPS staff white paper (based on EPA's social cost of carbon forecast) is $55 per ton (2020 $). This is about $50 per ton more than the monetized value of $5 per ton (see monetized CO_2 emission cost above). Thus, the midpoint of the residual social carbon value in 2020 would be about $23 per MWh, but with a wide range of possible values.[49]

[46] E3 NEM, Appendix, 1.5, page 58.

[47] http://www.epa.gov/climatechange/EPAactivities/economics/scc.html

[48] NYISO. 2017. "2017 CARIS Emissions Price Forecast Development Updated."

[49] E3 NEM, Appendix, 1.6.1, page 61.

Social carbon

General Description	Study Calculation Methodology/Value
Changes in agricultural productivity, human health impacts, property and infrastructure damages from increased flood risk, and the value of ecosystem service losses due to climate change.	E3 identifies this component explicitly as one requiring further study in order to establish the appropriate New York specific social carbon or societal benefit applicable in this analysis. For the purpose of this study the EPA social cost of carbon was relied upon minus the monetized CO_2 emission cost forecast from the NYISO CARIS. This EPA forecast assumes different levels of discount rates to determine the cost of carbon. The emission rate was determined by using EPA eGrid data for New York specific generators to determine average annual marginal emission rates for natural gas, oil, and coal plants along with information on which of these fuels were on the margin based on the NYISO State of the Market report.

Source: E3 NEM, Appendix, 1.6.1, page 61.

We independently calculated a value range for social carbon. We used the 2020 EPA social cost of carbon numbers from Table C-1 from the staff white paper on the benefit-cost analysis of REV, the E3 NEM CO_2 emission factors, and New York generation mix from the 2016 State of Market report, excluding the RGGI costs. This resulted in social carbon values range from $7 to $38 per MWh of energy efficiency.

4.12. Health Benefits

The E3 NEM study focused on the societal benefits of sulfur dioxide (SO_2) and NO_X reductions from New York electric generating facilities. The largest impact is from SO_2 emissions, primarily from coal plants. Using the 2014 generation mix and the costs described in the report, we calculate the cost to be about $23 per MWh in 2020. However, marginal coal generation in New York is declining rapidly. Using adjusted calculations that take into account the decline of marginal coal generation, we estimated the costs of SO_2 and NO_X emissions to be roughly $8.4 per MWh in 2020.

E3 NEM used costs of $70,000 per ton for SO_2 and $10,000 per ton for NO_X. In our adjusted 2020 calculations, SO_2 represented about three-quarters of the total cost, although the absolute emissions were less. Some studies have estimated higher NO_X emission costs in the order of $45,000–$51,000 per ton.[50] That would substantially increase the health benefit value. A value of $31,000 per ton of NO_X is proposed in the 2018 AESC report.[51] That is equivalent to about $66,000 per ton of NO_X. This value would essentially double the health benefits.[52] Health benefits provide a large potential value worthy of further investigation.

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[50] Sobota, D. J., J. E. Compton, M. L. McCrackin, S. Singh. 2015. "Cost of reactive nitrogen release from human activities to the environment in the United States," *Environmental Research Letters* 10, 025006.

[51] AESC 2018, Section 4.2.

[52] E3 NEM, Appendix, 1.6.2, page 64.

Health benefits

General Description	Study Calculation Methodology/Value
Reduction of non-emission related health benefits, such as decreased mortality rates and reduced asthma attacks, associated the adoption of distributed solar.	These externalities are often difficult to estimate. E3 identifies this component explicitly as one requiring further study in order to establish the appropriate New York specific externalities that should be examined. For the purpose of this study, high level estimates from the EPA for the costs of SO_2 and NO_X related health impacts are used. These estimates assume different levels of discount rates to determine the damage values, which are used in conjunction with the marginal emission rates of SO_2 and NO_X derived from the EPA's eGrid data similar to the methodology described above for CO_2 emissions.

Source: E3 NEM, Appendix, 1.6.2, page 64.

For our estimates of health benefits, we used the emission rates for SO_2 and NO_X from E3 NEM, adjusted for the current generation mix. We then used damage costs from E3 NEM and significantly higher ones from AESC 2018 to develop low and high values of health benefits of energy efficiency. This gave a range from $8 to $32 per MWh mainly depending on the damage value used. We also note that there may be additional health impacts from particulates that were not calculated.

4.13. Additional Non-Energy Benefits and Resource Benefits

There could be substantial additional non-energy benefits from energy efficiency programs for both customers and utilities.

In the past, NYSERDA conducted research on NEBs and reported such values in its annual program report. NYSERDA primarily reviewed benefits experienced by building occupants, such as improved comfort, safety, lighting quality and productivity, resource savings such as water, and operation and maintenance cost savings. The level of such benefits ranges from 10 to 60 percent of energy savings by program.[53]

[53] NYSERDA. 2009. New York Energy $martSM Program Evaluation and Status Report, Year Ending December 31, 2008.

Table 5. Summary of NEB estimates by NYSERDA

	Percentage of Energy Savings
Small Commercial Lighting Program (2007)	11%
Commercial HVAC Program (2004)	25-55%
New Construction Program (2005)	40%
Technical Assistance Program (2004)	37-55%
ENERGY STAR Homes (2005)	51%
Home Performance with ENERGY STAR (2003)	50%
Assisted Multifamily Program (2003)	54%
Comprehensive Energy Management Program (2004)	22-55%
Clothes Washers (2004)	27%
CFLs (2005)	60%

Source: NYSERDA. New York Energy $martSM Program Evaluation and Status Report Year Ending December 31, 2008, March 2009

Typical utility NEBs are mainly associated with low-income programs. Such benefits include reduced arrearages, reduced carrying costs on arrearages (interest), reduced bad debt written off, reduced costs on rate discounts, and reduced customer service costs.

There are a number of states that adopted NEB adders to take into account NEBs in their energy efficiency program cost-effectiveness analysis.[54] The NEB adders range from 10 to 30 percent by state. A few states have low-income-specific adders. Vermont and Washington use a 10 percent adder for risk reduction for utilities.

[54] Northeast Energy Efficiency Partnerships. 2017. *Non-Energy Impacts Approaches and Values: An Examination of the Northeast, Mid-Atlantic, and Beyond*. Table 10. For further consideration of this impact, see also the Synapse report "Benefit-Cost Analysis for Distributed Energy Resources," available at http://www.synapse-energy.com/project/benefit-cost-analysis-distributed-energy-resources.

Table 6. State examples of NEB adders

State	Adder test/program screen
Colorado	10% adder, 25% adder for low-income programs
Illinois	Ameren 10% electric, 7.5% gas; DCEO 10% adder; ComEd NA; Emissions adder
Iowa	10% adder for electric; 7.5% adder for gas
Maryland	A 1.115 cent per kWh adder has been applied to the ex-ante societal cost test in developing EmPOWER plans
New Mexico	15% adder; low income weatherization includes a multiplier of 1.25 for benefits.
Vermont	15% non-energy adder, 10% cost reduction for risk and flexibility advantages + 15% low income
Washington	10% adder
Washington D.C.	10% adder, 10% risk, 10% environ + NEIs in goals and measured benchmarking

Source: NEEP. 2017. Non-Energy Impacts Approaches and Values: An Examination of the Northeast, Mid-Atlantic, and Beyond, Table 10.[55]

For our high case scenario, we assume a 20 percent participants NEB, a 10 percent cost reduction factor, and a 5 percent resource and O&M savings factor. These factors are applied to the total utility system benefits from energy efficiency except the risk avoidance factor which is applied to energy efficiency program costs. For our low case scenario, we assume zero values for these benefit adjustment factors. Table 7 presents a summary of our assumptions. These values represent program-specific NEB values which could range widely depending on programs. The high end of the participants' NEB is based on NEB factors used for low-income programs in some states. The high end of the risk avoidance value is based on the value used in Vermont and Washington, D.C. The high case value for the resource and O&M savings estimates is our suggested proxy value based on our review of various sources.[56]

Table 7. Low case and high case NEB values at program level

	Low Case	High Case
Participants' NEB	0%	25%
Risk avoidance value	0%	10%
Fossil fuel and O&M savings	0%	10%

Note: The risk avoidance value is applied to energy efficiency program costs.

4.14. **Other Benefits**

The New York DPS staff white paper on Reforming the Energy Vision (REV) included two additional categories not included in the E3 NEM study: (1) Net Avoided Restoration Costs and (2) Net Avoided Outage Costs. It is difficult to see how energy efficiency programs would have any effect on the first

[55] For further consideration of this impact, see also the Synapse report "Benefit-Cost Analysis for Distributed Energy Resources" available at http://www.synapse-energy.com/project/benefit-cost-analysis-distributed-energy-resources.

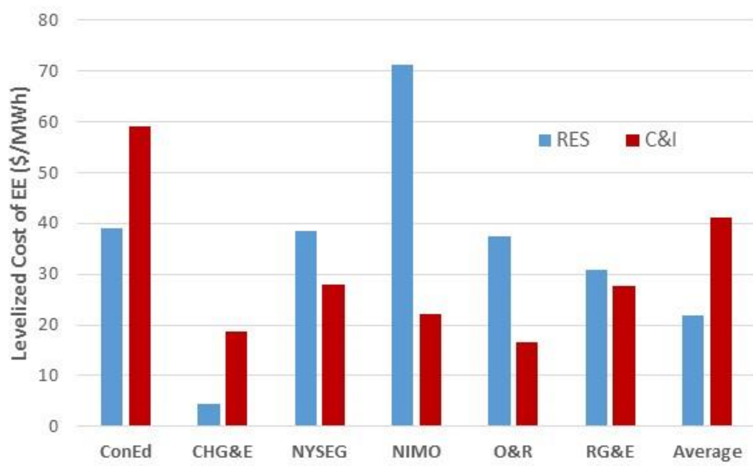
[56] See NYSERDA (2009) New York Energy $mart Program Evaluation and Status Report Year Ending December 31, 2008, March 2009 and Regulatory Assistance Project (2013) Recognizing the Full Value of Energy Efficiency, September 2013.

category. However, to the extent that energy efficiency programs reduce loads and thus outages there could be some benefit. But most outages are event-related, not load-related. Any benefits are likely to be small and difficult to determine.

5. Cost of Energy Efficiency

We obtained New York investor-owned utilities' energy efficiency program data from the EIA 861 database and estimated levelized costs of saved energy.[57] The program data are annual incremental savings, projected lifetime savings, and program costs by sector for 2016. We then estimated levelized program costs of saved energy using a 3 percent discount rate. While there are considerable differences across the utilities and the programs, the weighted average costs are roughly $20–$40 per MWh.

Figure 11. Cost of energy efficiency programs by sector and energy efficiency administrator for 2016



Source: EIA 861

6. Summary and Conclusions

The figures below provide our findings of utility system and societal benefits as a simplified value stack of energy efficiency representing near-term conditions (2018-2020). Many of these values are likely to increase in the future.

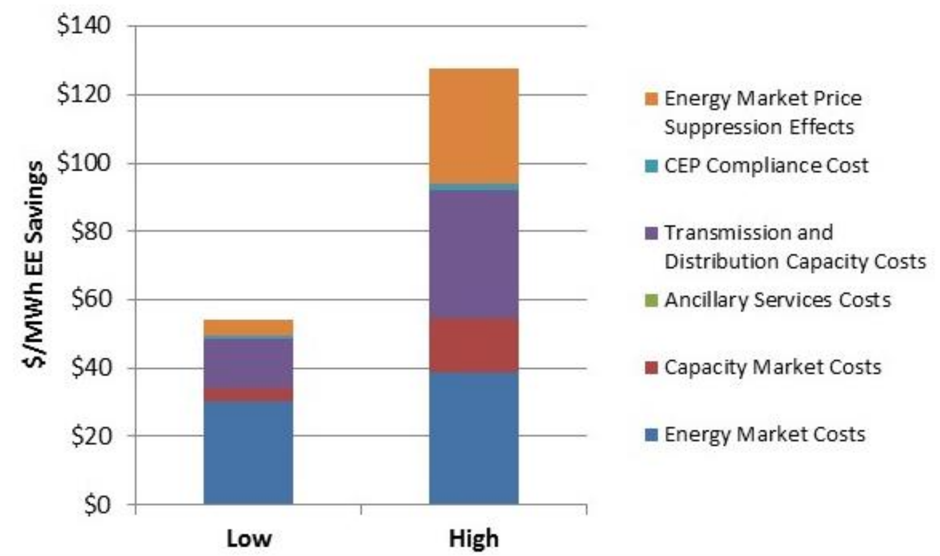
The utility system benefits are presented in Figure 12. These are, with one exception, calculated based on current market prices and utility information. The utility-based costs are energy, capacity, ancillary,

[57] We do not include data for NYSERDA because their programs include fossil fuel measures and thus are not directly comparable to the electric IOU programs.

and transmission and distribution. The range between those Low and High case costs represents the differences between utilities in New York, with those in the west and central portions of the state having low prices and those in the east around New York City having much higher prices. The three big categories are (1) energy market costs, (2) capacity market costs, and (3) T&D capacity costs. The only exception to the locational rule is for the Energy Market Price Suppression Effects, which reflect a range in the possible magnitude of such effects based on findings of the New England 2018 AESC study. Note that the value of losses, carbon allowances, and criteria pollutants are included in the energy costs in this graph.

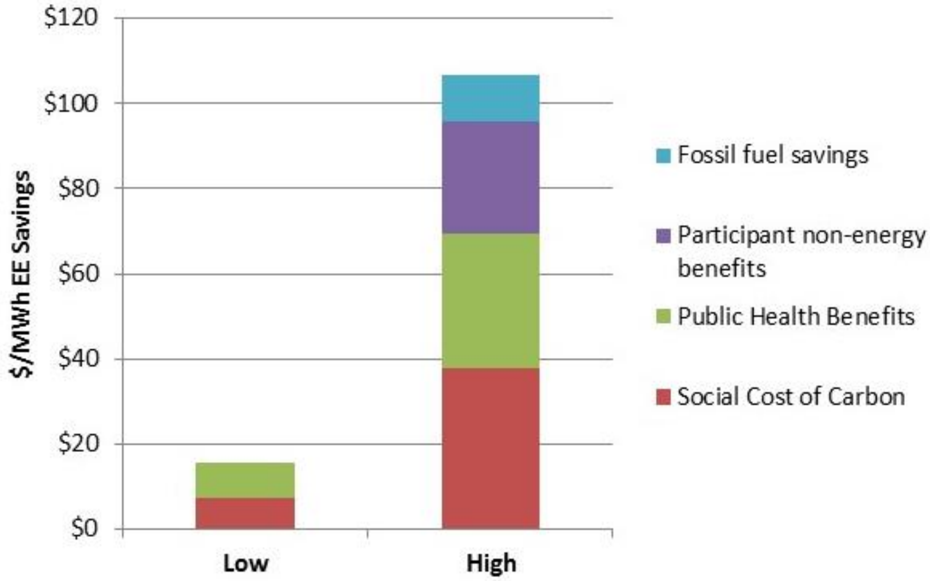
Our findings and analysis results are presented below. Aside from avoided energy costs, the largest values for energy efficiency are found in system capacity, T&D, social costs of carbon, and additional NEBs. Among these, avoided T&D and system capacity costs also provide additional potential revenue streams, which amount to $18 to $53 per MWh when combined, comparable to the delivery cost of energy efficiency.

Figure 12. Utility system benefits



The next graph presents the societal benefits which reflect parameter uncertainty rather than locational differences. Here the four benefits are of similar magnitude but the difference between the Low and High cases much greater representing greater inherent uncertainty.

Figure 13. Societal benefits



Finally we present the total value of energy efficiency for our low case and high case estimates below in Figure 14 and

Table 8. The Low Case represents a scenario where one of the low-cost New York utilities implements an efficiency program where the societal benefits (fossil fuel savings, participant NEBs, public health benefits, social cost of carbon) are low. The High Case represents a scenario where one of the high-cost New York utilities implements an efficiency program where the societal benefits are high. In practice, the actual values of energy efficiency benefits will likely fall within this range.

Figure 14. Value of energy efficiency: Low Case and High Case

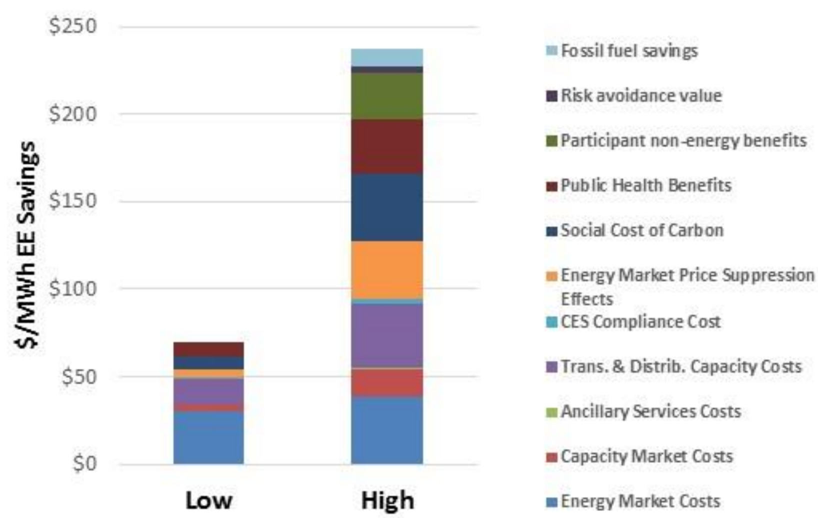


Table 8. Energy efficiency value benefit categories and ranges

Utility System Benefits

Category	Sub- Category	$/MWh Low	$/MWh High
Direct	Energy Market Costs	30.2	38.9
	Capacity Market Costs	3.7	15.5
	Ancillary Services Costs	0.3	0.4
	Transmission and Distribution Capacity Costs	14.3	37.2
	CES Compliance Cost	1.0	2.0
Indirect	Energy Market Price Suppression Effects	4.9	33.7
	Utility System Total	**$54**	**$128**

Societal Benefits

Category	Sub- Category	Low	High
Indirect	Social Cost of Carbon	7	38
	Public Health Benefits	8	32
Other NEB	Participant non-energy benefits	0	26
	Risk avoidance value	0	4
	Fossil fuel savings	0	10
	Societal Total	**$16**	**$110**
	Utility and Societal Benefits	**$70**	**$238**