MEMORANDUM

TO: Michigan Public Service Commission
Patricia Poli, Manager, Energy Waste Reduction Section {polip@michigan.gov}

FROM: Dick Spellman

CC: Joe Danes, Jeffrey Huber, Jeff Davis, Warren Hirons, Melissa Young

DATE: August 9, 2017

RE: Upper Peninsula Energy Efficiency Potential Study Final Report

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1 Executive Summary

1.1 BACKGROUND

The Michigan Public Service Commission (MPSC) staff and GDS Associates, Inc. ("GDS") coordinated to complete this assessment of electric energy efficiency potential for Michigan's Upper Peninsula (UP) region. This analysis provides a roadmap for policy makers and identifies the energy efficiency measures having the greatest potential savings and the measures that are the most cost effective. GDS combined the latest Energy Efficiency Potential Study results from Consumers Energy with UP specific data to represent the potential for energy efficiency savings in the Upper Peninsula region of Michigan.

In addition to technical and economic potential estimates, the development of achievable potential estimates for a range of feasible energy efficiency measures is useful for program planning and modification purposes. Unlike achievable potential estimates, technical and economic potential estimates do not include customer acceptance considerations for energy efficiency measures, which are often among the most important factors when estimating the likely customer response to new programs. For this study, GDS Associates, Inc. (GDS), the consulting firm retained to conduct this study, produced the following estimates of energy efficiency potential:

- Technical Potential
- Economic Potential
- Achievable Potential *(One Scenario)*
  - **SCENARIO #1** • Based on Utility Cost Test (UCT) cost-effectiveness screening, incentives for program participants set at 50% of incremental measure costs and no budget constraints.

Definitions of the types of energy efficiency potential are provided below.

Technical Potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures.

Economic Potential refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.

Achievable Potential is the amount of energy use that efficiency can realistically be expected to displace assuming different market penetration scenarios for cost effective energy efficiency measures. An aggressive scenario, for example, could provide program participants with payments for the entire incremental cost of more energy efficient equipment. This is often referred to as “maximum achievable potential”. Achievable potential considers real-world barriers to convincing end-users to adopt cost effective energy efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[1] Achievable savings potential savings is a subset of economic potential.

This potential study evaluates the following achievable potential scenario:

[1] **SCENARIO #1** ● For the first scenario, achievable potential represents the amount of energy use that energy efficiency can realistically be expected to displace assuming incentives equal to 50% of the incremental measure cost and no spending cap. Cost effectiveness of measures was determined with the Utility Cost Test (UCT).

The current achievable scenario includes an incentive level of 50% of incentive cost. This selection of the incentive level is consistent with the 2013 Michigan Statewide Study. The 2013 Study states “an incentive level of 50% of measure costs assumed in this study for the three achievable potential scenarios is a reasonable target based on the current financial incentive levels for program participants used by DTE Energy and Consumers Energy for their existing energy efficiency programs.” Additionally, the incentive levels used in several studies reviewed by GDS as well as actual experience with incentive levels in other states confirm that an incentive level assumption of 50% or below is commonly used.[2]

The purpose of this energy efficiency potential study is to provide a foundation for the continuation of utility-administered electric energy efficiency programs in the UP service area and to determine the remaining opportunities for cost effective electric energy efficiency savings. This detailed report presents results of the technical, economic, and achievable potential for electric energy efficiency measures in the UP service area for two time periods:

- The ten-year period from January 1, 2017 through December 31, 2026
- The twenty-year period from January 1, 2017 through December 31, 2036

All results were developed using customized residential, commercial and industrial sector-level potential assessment analytic models and Upper Peninsula Energy-specific cost effectiveness criteria including avoided cost projections developed by the MPSC for electricity. To help inform these energy efficiency potential models, up-to-date energy efficiency measure data were primarily obtained from the following recent studies and reports:

[1] 2016 Michigan Energy Measures Database (MEMD)

[2] Energy efficiency baseline studies conducted by Consumers Energy

[3] 2009 EIA Residential Energy Consumption Survey (RECS)

[4] 2012 EIA Commercial Building Energy Consumption Survey (CBECS)[3]

[5] 2010 EIA Manufacturing Energy Consumption Survey (MECS)

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[1] These definitions are from the November 2007 National Action Plan for Energy Efficiency “Guide for Conducting Energy Efficiency Potential Studies”

[2] GDS Associates October 25, 2013 survey of financial incentives used in energy efficiency programs implemented by Consumers Energy, DTE Energy, Ameren-Illinois, Efficiency Maine, Wisconsin Focus on Energy, and Xcel Energy (Minnesota).

[3] This is the latest publicly available CBECS data released by the Energy Information Administration (EIA).

The above data sources provided valuable information regarding the current saturation, costs, savings and useful lives of electric energy efficiency measures considered in this study.

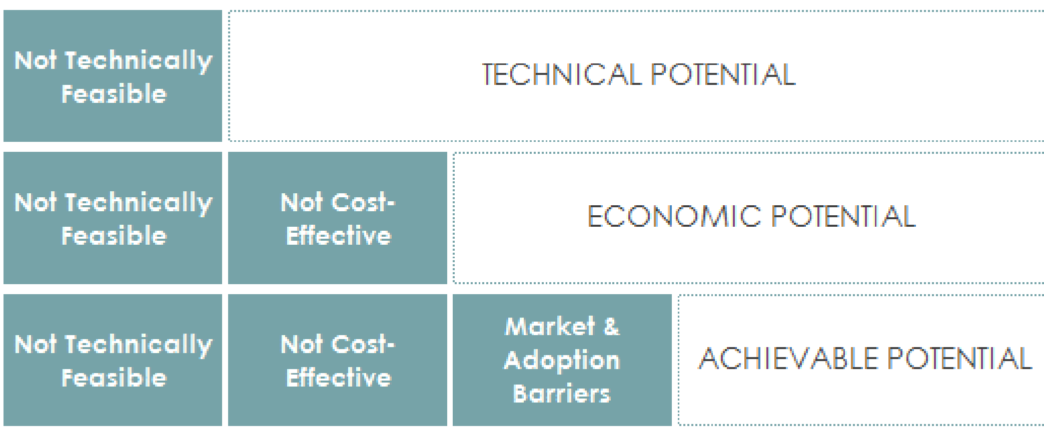
The results of this study provide detailed information on energy efficiency measures that are the most cost effective and have the greatest potential electric savings for the UP service area. The data used for this report were the best available at the time this analysis was developed. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become outdated.

1.2 STUDY SCOPE

The study examines the potential to reduce electric consumption and peak demand through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in the UP service area. This study assesses electric energy efficiency potential in the UP service area over twenty years, from 2017 through 2036.

The main objective of this study was to evaluate the electric energy efficiency technical, economic and achievable potential savings for the UP service area, based upon cost effectiveness screening with the UCT benefit/cost test. As noted above, the scope of this study distinguishes among three types of energy efficiency potential; (1) technical, (2) economic, and (3) achievable potential. FIGURE 1-1 below provides a graphical representation of the relationship of the various definitions of energy efficiency potential.

FIGURE 1-1. TYPES OF ENERGY EFFICIENCY POTENTIAL[4]



Limitations to the scope of study: As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions and data sources, including the following:

- Energy efficiency measure lives, measure savings and measure costs
- The discount rate for determining the net present value of future savings
- Projected penetration rates for energy efficiency measures
- Projections of UP specific electric avoided costs
- Future changes to current energy efficiency codes and standards for buildings and equipment

GDS utilized the recently completed Consumers Energy Potential Study models to develop a UP base case and to determine measures to be considered in the region. The MPSC forecasts for future sales, peak demand and customers for all sectors. Additionally, GDS was provided with UP specific home information for the residential sector and per feedback from the MPSC staff, GDS removed central air conditioning measures from

[4] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

consideration in the residential sector of the study. For the industrial sector, GDS developed industrial specific use ratios by industry type based upon feedback from Art Thayer at MECA. Mr. Thayer provided a list of top industries by name in the UP and GDS utilized this list, along with a count-by-county UP economic profile report from the Northern Michigan University Center for Rural Community and Economic Development, to determine the segmentation of industrial used by industry types.[5]

While the GDS Team has sought to use the best and most current available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. Furthermore, while the lists of energy efficiency measures examined in this study represent most commercially available measures, these measure lists are not exhaustive.

With respect to non-energy benefits of energy efficiency programs, GDS did not place a value on reductions in power plant emissions of CO2 or other emissions.

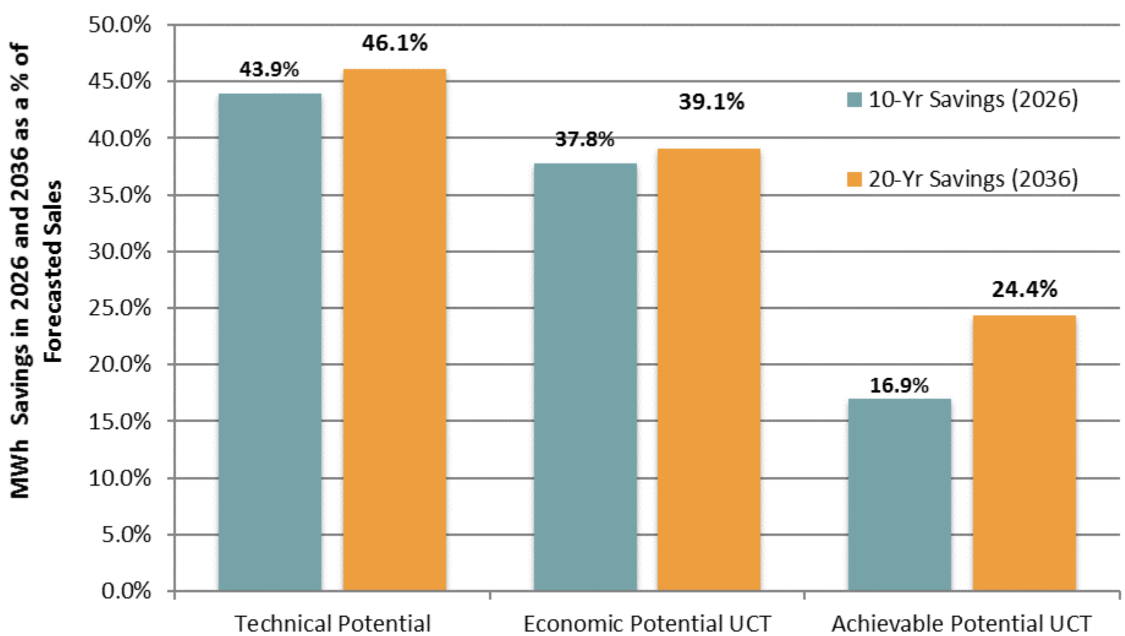
Finally, there was no attempt to place a dollar value on some difficult to quantify benefits arising from installation of some measures, such as increased comfort or increased safety, which may in turn support some personal choices to implement measures that may otherwise not be cost-effective or only marginally so.

1.3 SUMMARY OF RESULTS

This study examined several hundred electric energy efficiency measures in the residential, commercial and industrial sectors combined.

The data in FIGURE 1-2 below shows that cost effective electric energy efficiency resources can play a significantly expanded role in the Upper Peninsula' utilities energy resource mix over the next twenty years. For the UP's service area overall, the achievable potential for electricity savings based on the UCT cost effectiveness test screening is 16.9% of forecast kWh sales for 2026, and 24.4% of forecast kWh sales in 2036.

FIGURE 1-2. ELECTRIC ENERGY EFFICIENCY POTENTIAL SAVINGS SUMMARY



[5] http://upeda.com/wp-content/uploads/2015/11/county_profile_2015.pdf

TABLE 1-1 and TABLE 1-2 present additional detail, providing the energy efficiency savings potential for all scenarios over a period of and 10 and 20 years, respectively.

TABLE 1-1. SUMMARY OF TECHNICAL, ECONOMIC AND ACHIEVABLE ELECTRIC ENERGY AND DEMAND SAVINGS FOR 2026

End Use	Technical Potential	Economic Potential (UCT)	Achievable Potential (UCT)
Electric Savings as % of Sales Forecast			
Savings % - Residential	43.7%	35.0%	16.9%
Savings % - Commercial	44.9%	39.9%	18.7%
Savings % - Industrial	42.9%	39.8%	14.2%
Savings % - Total	**43.9%**	**37.8%**	**16.9%**
Electric MWh Savings			
Savings MWh - Residential	452,715	362,415	175,444
Savings MWh - Commercial	370,828	329,412	154,283
Savings MWh - Industrial	229,689	212,916	76,224
Savings MWh - Total	**1,053,232**	**904,744**	**405,951**
Electric Summer Peak Savings as % of Summer Peak Demand Forecast			
Savings % - Residential	26.4%	22.6%	10.7%
Savings % - Commercial	37.9%	32.2%	14.1%
Savings % - Industrial	36.3%	31.2%	12.3%
Savings % - Total	**33.3%**	**28.5%**	**12.4%**
Electric Summer Peak Savings			
Savings MW - Residential	47	41	19
Savings MW - Commercial	72	61	27
Savings MW - Industrial	45	38	15
Savings MW - Total	**164**	**140**	**61**

TABLE 1-2. SUMMARY OF TECHNICAL, ECONOMIC AND ACHIEVABLE ELECTRIC ENERGY AND DEMAND SAVINGS FOR 2036

End Use	Technical Potential	Economic Potential (UCT)	Achievable Potential (UCT)
Electric Savings as % of Sales Forecast			
Savings % - Residential	46.8%	36.3%	21.9%
Savings % - Commercial	46.4%	41.2%	26.6%
Savings % - Industrial	44.4%	41.1%	25.8%
Savings % - Total	**46.1%**	**39.1%**	**24.4%**
Electric MWh Savings			
Savings MWh - Residential	470,307	364,578	220,017
Savings MWh - Commercial	370,828	329,412	212,365
Savings MWh - Industrial	229,689	212,916	133,535
Savings MWh - Total	**1,070,824**	**906,906**	**565,917**
Electric Summer Peak Savings as % of Summer Peak Demand Forecast			
Savings % - Residential	28.4%	24.1%	14.3%
Savings % - Commercial	39.2%	33.3%	21.3%
Savings % - Industrial	37.6%	32.3%	22.3%

End Use	Technical Potential	Economic Potential (UCT)	Achievable Potential (UCT)
Savings % - Total	**34.8%**	**29.7%**	**19.0%**
Electric Summer Peak Savings			
Savings MW - Residential	50	42	25
Savings MW - Commercial	72	61	39
Savings MW - Industrial	45	38	27
Savings MW - Total	**166**	**142**	**91**

TABLE 1-3 provides the projected levelized cost of conserved energy for the two periods of 2017-2026 and 2017-2036. Additionally, this chart contains the first-year and lifetime MWh saved for the two periods. This levelized cost per first-year kWh saved can be used to provide program planners and decision-makers with the expected cost to utilities to acquire the electric savings for the achievable potential scenario examined in this report. It is important for program planners and other decision-makers to have a good understanding of the cost to utilities to acquire these levels of energy efficiency savings.

Cumulative Annual Savings describes the amount of savings that are active across a portfolio which have been installed up to that point in time and which have not yet burned out or expired. This is a snapshot perspective that is commonly associated with long-term resource planning and load forecasting, as it focuses on resource and system needs at specific times over long periods. This is also the perspective that we focus on primarily for Achievable Potential.

TABLE 1-3. LEVELIZED COST OF ENERGY ($/KWH)

	Achievable UCT	
Item	First 10-Years 2017-2026	Full 20-Year 2017-2036
First-Year MWh Saved	550,263	1,190,776
Lifetime MWh Saved	5,517,671	11,184,416
Levelized Cost of Energy ($/kWh)	$0.0196	$0.0205
Achievable Potential (Cumulative Annual EE Savings) MWh	405,951	565,917
Average Achievable Potential as a % of Sales	16.9%	24.4%

The current achievable scenario includes an incentive level of 50% of incentive cost. This selection of the incentive level is consistent with the 2013 Michigan Statewide Study. The 2013 Study states “an incentive level of 50% of measure costs assumed in this study for the three achievable potential scenarios is a reasonable target based on the current financial incentive levels for program participants used by DTE Energy and Consumers Energy for their existing energy efficiency programs.” Additionally, the incentive levels used in several studies reviewed by GDS as well as actual experience with incentive levels in other states confirm that an incentive level assumption of 50% or below is commonly used.

TABLE 1-4 presents the annual utility budget in total and by sector required to achieve the electric energy savings levels in each of the two achievable potential scenarios. These tables also present the percent of annual utility revenues needed each year to fund programs to obtain energy savings levels for the achievable potential scenario.

A 2015 report by the American Council for an Energy Efficient Economy (ACEEE) offers information regarding the current savings and spending related to energy efficiency by state.[6] Based on self-reported data, twelve states annually ***spent more than 2%*** of electric sales revenue on electric energy efficiency programs in 2014. GDS also examined actual energy efficiency savings data for 2010 and 2011 from the US Energy Information Administration (EIA) on the top twenty energy efficiency electric utilities. These top twenty utilities saved over 2% of annual kWh sales in 2010 with their energy efficiency programs, and 3.8% of annual kWh sales in 2011.[7] These percentage savings are attributable to energy efficiency measures installed in a one-year time frame and demonstrate what can be accomplished with full-scale and aggressive implementation of programs.

TABLE 1-4. ANNUAL ELECTRIC ENERGY EFFICIENCY PROGRAM BUDGETS ASSOCIATED WITH THE ACHIEVABLE UCT SCENARIO (IN MILLIONS)

	Residential	Commercial	Industrial	Total Budgets
2017	$4.51	$4.14	$1.46	$10.11
2018	$4.64	$4.16	$1.48	$10.27
2019	$4.58	$4.19	$1.50	$10.27
2020	$4.45	$4.22	$1.53	$10.20
2021	$4.36	$4.49	$1.55	$10.39
2022	$4.60	$4.58	$1.58	$10.76
2023	$4.84	$4.62	$1.61	$11.07
2024	$5.08	$4.75	$1.63	$11.47
2025	$5.52	$5.13	$1.66	$12.31
2026	$5.51	$5.20	$1.69	$12.41
2027	$5.68	$2.87	$1.56	$10.11
2028	$4.77	$2.91	$1.60	$9.29
2029	$4.89	$4.30	$1.82	$11.01
2030	$4.52	$4.46	$2.01	$10.99
2031	$4.46	$4.35	$2.04	$10.86
2032	$4.96	$5.97	$2.77	$13.70
2033	$5.30	$6.44	$2.87	$14.61
2034	$5.39	$6.38	$2.91	$14.68
2035	$6.21	$6.40	$3.08	$15.68
2036	$5.34	$6.43	$3.11	$14.88

1.4 COST-EFFECTIVENESS FINDINGS

This potential study concludes that significant cost effective electric energy efficiency potential remains in the Lower Peninsula service areas. TABLE 1-5 and TABLE 1-6 show the preliminary present value benefits, costs and benefit-cost ratios for the Achievable scenario.

[6] American Council for an Energy Efficient Economy, "The 2015 State Energy Efficiency Scorecard", Report #U1509, October 2015.
[7] GDS will add data for 2012 to 2014 for the final version of this report.

TABLE 1-5. BENEFIT-COST RATIOS FOR ACHIEVABLE POTENTIAL SCENARIOS FOR 2017 TO 2026 TIME PERIOD

Benefit Cost Ratios for 2017 to 2026 Time Period				
Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	Benefit/Cost Ratio	Net Benefits
Achievable UCT	$215,806,040	$78,429,216	2.75	$137,376,824

TABLE 1-6. BENEFIT-COST RATIOS FOR ACHIEVABLE POTENTIAL SCENARIOS FOR 2017 TO 2036 TIME PERIOD

Benefit Cost Ratios for 2017 to 2036 Time Period				
Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	Benefit/Cost Ratio	Net Benefits
Achievable UCT	$375,112,851	$121,687,197	3.08	$253,425,653

In addition, GDS calculated UCT benefit/cost ratios for each individual energy efficiency measure considered in this study. Only measures that had a UCT benefit/cost ratio greater than or equal to 1.0 were retained in the economic and achievable potential savings estimates. Low income-specific measures with a UCT ratio of 0.50 or greater were retained in the residential analysis of economic and achievable potential.

UPPER PENINSULA ● BEHIND THE METER ENERGY STORAGE OPPORTUNITIES

GDS performed a research review of possible behind the meter energy storage options to facilitate energy efficiency savings for the Upper Peninsula. The research shows that behind the meter energy storage solutions can offer benefits to end-use customers if utility rate structures provide time-based price signals. Additionally, since behind the meter energy storage equipment development is in its infancy, it is not currently cost-effective for most utilities and customers to install these storage solutions. However, the installed cost per kWh of behind the meter energy storage equipment is expected to fall between now and 2020 to make this technology a viable option to be considered in future energy efficiency potential studies.

Behind the meter energy storage options can provide direct benefits to end-users. According to a Rocky Mountain Institute Study, "The Economics of Battery Energy Storage"[8], behind the meter storage can provide the following customer service benefits, as seen in FIGURE 1-3 below.

FIGURE 1-3. CUSTOMER SERVICE BENEFIT OF BEHIND THE METER ENERGY STORAGE [8]

	SERVICE NAME	DEFINITION
CUSTOMER SERVICES	Time-of-Use Bill Management	By minimizing electricity purchases during peak electricity-consumption hours when time-of-use (TOU) rates are highest and shifting these purchase to periods of lower rates, behind-the-meter customers can use energy storage systems to reduce their bill.
	Increased PV Self-Consumption	Minimizing export of electricity generated by behind-the-meter photovoltaic (PV) systems to maximize the financial benefit of solar PV in areas with utility rate structures that are unfavorable to distributed PV (e.g., non-export tariffs).
	Demand Charge Reduction	In the event of grid failure, energy storage paired with a local generator can provide backup power at multiple scales, ranging from second-to-second power quality maintenance for industrial operations to daily backup for residential customers.
	Backup Power	In the event of grid failure, energy storage paired with a local generator can provide backup power at multiple scales, ranging from second-to-second power quality maintenance for industrial operations to daily backup for residential customers.

[8] https://www.rmi.org/wp-content/uploads/2017/03/RMI-TheEconomicsOfBatteryEnergyStorage-FullReport-FINAL.pdf

Behind the meter energy storage options are more likely to be adopted by customers when the underlying utility rate structure provides time-based price signals. Three different time-based rate options provide the most benefits for customers[9]:

[1] Time-of-Use rates that offer discounts to reduce energy usage during peak consumption periods

[2] Demand charges based upon usage during high peak load periods

[3] Net-Metering policies and plans that determine how much customers can sell back stored energy to their local utility.

Several UP utilities have residential, commercial and large power time of use/service rates already in place. Indiana Michigan Power Company has a Residential Off-Peak Energy Storage/Plug-In Electric Vehicle rate that encourages use energy storage devices with time-differentiated load characteristics. However, most utilities in the UP do not currently have either time-of-use or time-of-service rates on file with the Michigan Public Service Commission. The UP utilities will need to develop time-of-use and/or demand base rates to make it economically feasible and more appealing for residential and commercial customers to adopt energy storage technologies.

At current prices, it is difficult for most utilities and customers to justify purchase of behind the meter energy storage equipment. The current cost of installing energy storage batteries ranges from $400 per kilowatt hour (kWh) to $750/kWh.[10] At these prices, the installation of energy storage equipment has been found not to be cost effective in most instances. NREL estimates "small battery systems capable of fully discharging in 30 to 40 minutes offer optimal payback periods of less than 3 years when installed costs reach $300/kW"[11]. It is expected that the cost will decrease by half to $200 dollars per kWh by 2020 and to $160 per kWh by 2025.[12] Once the price for energy storage equipment decreases, it is recommended that the Upper Peninsula utilities once again consider the economics of the technology and whether or not to incent these purchases to encourage more purchases.

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9 https://www.energysage.com/solar/solar-energy-storage/benefits-of-solar-batteries/

10 https://www.energysage.com/solar/solar-energy-storage/what-do-solar-batteries-cost/

11 http://www.seia.org/sites/default/files/resources/NREL-%20Behind-the-Meter-Storage-Jan-2015.pdf

12 http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-new-economics-of-energy-storage