Northeast and Mid-Atlantic Industrial Sector Report: Market Assessment and Recommended Strategies to Accelerate Energy Efficiency

May, 2016

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Acknowledgements

The Northeast and Mid-Atlantic Industrial Sector Report was published to assess the role of the industrial base in capturing energy efficiency in the region while also providing broader economic and environmental benefits. This document provides regional and national perspectives to understand current practices related to energy efficiency in this sector. This report reflects the invaluable contributions of multiple individuals. The following individuals served as the report's authors and researchers: Dave Lis, Market Strategies Director; Samantha Bresler, Market Strategies Associate; Jon Linn; Senior C&I Advisor; and Tyler Mortis, Industrial Intern. This report reflects the opinion and judgments of the NEEP Staff developed in consultation with regional stakeholder and does not necessary reflect those of NEEP Board members, NEEP Sponsors, or projects participants and funders. NEEP would like to recognize and thank the numerous regional stakeholders for their participation in the development of the Northeast and Mid-Atlantic Industrial Sector Report.

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About NEEP

NEEP was founded in 1996 as a non-profit whose mission is to serve the Northeast and Mid-Atlantic to accelerate energy efficiency as an essential part of demand-side solutions that enable a sustainable regional energy system. Our vision is that the region will fully embrace next generation energy efficiency as a core strategy to meet energy needs in a carbon-constrained world.

Disclaimer: NEEP verified the data used for this white paper to the best of our ability. This paper reflects the opinion and judgments of the NEEP staff and does not necessarily reflect those of NEEP Board members, NEEP Sponsors, or project participants and funders.

Executive Summary

Of the four major energy-consuming sectors of the United States economy—residential buildings, commercial buildings, industrial, and transportation, the industrial sector consumes the largest amount of energy. The Industrial sector is responsible for approximately 31 percent of total energy use, or 30.5 Quads. This report seeks to characterize the current industrial market for the Northeast/Mid-Atlantic region, identify barriers keeping manufacturing facilities from participating in energy management efforts, and recommendations for furthering strategies that accelerate adoption of energy efficiency in the Industrial sector throughout the region.

The Industrial sector is comprised of several different sub-industries (i.e. Manufacturing, Agriculture, Mining, etc.). For the purposes of this report, we focus on the status and opportunities related to manufacturing facilities only. This subsector better aligns with the existing energy efficiency infrastructure that the region has developed for electricity and natural gas.

The total number of manufacturing plants in the region reaches over 69,000. This represents 19.9 percent of the number of facilities in the entire United States which stands at 346,915. Out of the Industrial sector's 30.5 Quad Btu, manufacturing facilities total 18.8 Quad Btu, or 61% of the entire sector. Included in that energy portfolio, the Northeast and Mid-Atlantic manufacturing sector consumed over 74.3 billion kilowatt hours of electricity and over 425 billion cubic feet of natural gas in 2010. This energy comes at a cost to manufacturing businesses of nearly $16.9 Billion.

The sub-sectors with the highest total energy consumption in the region include Petroleum and Coal Products, Paper, and Primary Metals. The sub-sectors with the highest electricity uses, are Primary Metals, Chemicals, and Food.

When we look at the end uses that drive electricity use in manufacturing facilities, we find Machine Drive (which encompasses any process that utilizes an electric motor), followed by Process Heating, Facility HVAC, and Lighting, representing the highest users.

Fortunately, there are existing resources in the region available to promote increased energy efficiency, including a robust infrastructure of rate-payer funder energy efficiency programs. Total Commercial and Industrial spending is over $1.5 Billion. Although efficiency programs across the Northeast and Mid-Atlantic region vary in their approach to industrial efficiency offerings, a pattern of two trends emerged in the course of this compilation. The two most common offerings were: financial incentives for energy efficient equipment (or "capital improvements") and technical assistance (including training/education). In recent years, some large commercial and industrial customers, citing insufficient value from ratepayer-funded efficiency programs, have lobbied for the means to "opt out" of those programs, or self-direct their own energy efficiency efforts.

While many of the manufacturing facilities in the United States have already implemented some form of energy management/efficiency, up to 53%, have not. We estimate that though a 20% improvement in energy efficiency across the manufacturing sector, the region would achieve 18 TWh of electricity savings.

Beyond characterizing the Industrial sector and estimating potential energy savings, we looked at key barriers to adoption of energy efficiency and recommendations for overcoming these existing barriers.

Strategic Energy Management (SEM) represents a very exciting emerging practice that has the potential to significantly accelerate the near-term and long-term adoption of energy efficient technologies and practices to

greatly reduce energy use in the Industrial sector. Between the existing SEM resources, and the increasing work of federal agencies such as U.S. DOE and U.S. EPA, and energy efficiency programs, an evolving support structure is developing. Rate-payer energy efficiency programs represent a significant enabler of energy efficiency in the region and should move to leverage the opportunities associated with SEM, not only achieve increased energy savings but to provide value-add services to Industrial customers.

Program administrators in the Northeast and Mid-Atlantic should expect to serve all sizes and types of commercial and industrial customers, even the small and medium industrial customers that are hard-to-reach and have even less in-house energy expertise than larger customers. NEEP highlights a number of near-term tactics that will be necessary to facilitate the growth of programmatic use of SEM.

- **Deliver broad Stakeholder Education**: It has been clear in the course of assessing the region's market that the lack of common definitions for program-run SEM and uniform approaches can make coordinated efforts difficult.
- **"Make the Case" for Program Incorporation of SEM**: There is a need to develop a consistent case for SEM and to clearly document and communicate its related costs and benefits for program planners.
- **Deploy Energy Management Information Systems (EMIS)**: Central to potential success of SEM is monitoring and reporting of results which relies on valid analysis of all relevant variables including productivity, occupancy, business cycles, weather, etc..
- **Develop Workforce**: Developing a SEM team and program at an enterprise customer is an involved process and there is a need for implementers and facilitators.
- **Promote Peer Exchange:** Program Administrators should continue to build upon the current regional industrial peer exchange network as issues and share experiences in industrial energy efficiency are discussed.

In order to bolster the incorporation of SEM, policies must enable efficiency programs to adopt new practices and offerings for their customers. Policy-makers should set forth strategies that facilitate next-generation efficiency: the integration of "traditional" energy efficiency measures with data-enhanced customer communication/control, real-time EM&V, demand management, distributed renewable generation, energy storage and combined heat and power. State energy offices and regulators can support program in several ways, including:

- **Encourage energy efficiency program administrators to set aggressive savings targets**
- **Encourage the programs to quantify and claim the numerous non-energy benefits when it comes to Industrial energy efficiency programs**
- **Afford flexibility with rolling program budgets**
- **Encourage PAs to explore and pilot new program approaches**
- **Understand that non-measure programs and services, including technical expertise and information systems, deliver valued benefits to customers and help ensure continuous engagement and operational efficiency gains. They also serve as a gateway to participation in shared investment opportunities, including traditional rebate programs.**

The strategies presented, while likely to be impactful for individual states and programs, will be more successful and in a shorter timeframe if coordinated regionally. In addition, a regional approach can leverage the collective experiences of a regional working group to facilitate knowledge transfers, identify best practices, share the cost and risk of new approaches, and scale-up through combined efforts to achieve long term market transformation

of the Industrial sector. Ultimately, the incorporation of SEM, and its associated benefits, into programs would complement the successes seen in other Industrial programs. NEEP invites regional efficiency programs, the industrial sector and other market interests to work together with NEEP and fellow regional market actors to transform the industrial sector in the Northeast/Mid-Atlantic region.

Introduction

Of the four major energy-consuming sectors of the United States economy—residential buildings, commercial buildings, industrial, and transportation, the industrial sector consumes the highest amount of energy, accounting for roughly 31 percent[1] of the total. The Industrial sector, according to the U.S. Energy Information Agency, encompasses not only the facilities associated with manufacturing, but sub-sectors such as agriculture, mining and construction. For the purposes of this report, we will focus on the status and opportunities related to manufacturing facilities only. This subsector better aligns with the existing energy efficiency infrastructure that the region has developed for electricity and natural gas. The world of manufacturing plants is known for its energy intensive industrial processes that produce a variety of goods and products. Although manufacturing plants can vary widely in the items they produce, ranging from textiles to plastics, they typically require large amounts of energy. This energy comes at a significant cost to our regions industrial companies and represents a major source of carbon emissions. While earnest efforts have been made to reduce energy use associated with this sector, many of the manufacturing facilities in the region have not actively implemented energy efficiency measures or practices. Energy efficiency installations have been largely driven by state goals around energy efficiency and Combined Heat and Power as well as supporting state and federal policies.

This report seeks to assess the characteristics of the regions manufacturing base, understand current practices related to energy efficiency in this sector, quantify energy and peak savings opportunities, and then provide recommended actions to realize the region's energy efficiency opportunities.

The development of the market assessment was largely conducted by NEEP staff, however the development of the recommended strategies section involved a collaborative process that included input from a range of regional Industrial energy efficiency stakeholders. NEEP engaged members of the Northeast Regional Continuous Energy Improvement (CEI) Discussion Group as a sounding board for strategy development. That stakeholder engagement culminated at NEEP's Industrial Energy Efficiency Summit in November, 2015, with significant consideration and deliberation of regional strategies moving forward. NEEP also leveraged the valuable reports recently developed by the State and Local Energy Efficiency Action (SEE Action) Network.

[1] U.S. Energy Information Administration. *Annual Energy Review September 2011*. September 2012. http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf

Market Assessment of Northeast and Mid-Atlantic Manufacturing Base

The following section will characterize the Region's Manufacturing base and its energy footprint by assessing the following:

- Region's Manufacturing Sub-sectors
- Number of Manufacturing Facilities in the Region by Sub-sector
- Energy Use of the Region's Manufacturing Base, by Sub-sectors
    - Electricity use of Region's Manufacturing Base by Sub-Sector
- Financial Cost of Electricity used by the Region's Manufacturing Base
- Energy-consuming End-uses in the Region's Manufacturing facilities
- Energy "Intensity" of sub-sectors within the Region
- Prevalence of Energy Efficiency Activities/Behaviors in the Manufacturing Sector
- Potential Electricity Reductions Associated with Increased Energy Efficiency

The U.S. Energy Information Administration (EIA) compiles industrial sector energy consumption through their Manufacturing Energy Consumption Survey (MECS). Due to the national and regional information provided, the data from the most recent MECS survey (2010) is used to compile this report, unless otherwise noted. Additionally, by leveraging U.S. Census data[2], projections for characterizing individual states in our region were made. For the purposes of this report, the regional data encompasses Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Delaware, Maryland, and the District of Columbia[3].

Types of Manufacturing Sub- Sectors

The U.S. EIA has aggregated industrial sector energy data in the latest MECS dataset. According to the EIA, "The industrial sector is an energy consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods."[4] This sector is broken down by the North American Industry Classification System (NAICS) with the following industries making up the industrial sector: Manufacturing (NAICS 311-339), Agriculture, Forestry, Fishing, and Hunting (NAICS 11), Mining - including oil and gas extraction (NAICS 21), and Construction (NAICS 23). It is important to note that for the purposes of this report, we will focus on the Industrial facilities captured by the "Manufacturing (NAICS 311-339)" categories. While many energy efficiency programs are marketed as "Industrial", they are overwhelmingly directed at those customers within the built environment (i.e. manufacturing facilities).

Number of Manufacturing Facilities in the Region

Figure 1 reflects data collected through MECS and U.S. Census, as it aims to characterize the region's manufacturing base. U.S. Census data provides a comparison of the regional aggregate to the national total for industrial facilities. The U.S. Census data provides insight to all industrial buildings, but is not limited to the sub-

[2] United States Census Bureau. American Fact Finder website. http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

[3] MECS Northeast Census Region encompasses New England (Connecticut, Maine, Massachusetts, New Hampshire, Vermont, and Rhode Island) and the Middle Atlantic (New Jersey, New York, and Pennsylvania).

[4] U.S. Energy Information Administration. Glossary website. http://www.eia.gov/tools/glossary/index.cfm?id=I

set of manufacturing facilities. The Census data is then applied to the MECS dataset, which provides the national total of manufacturing facilities in the Northeast and Mid-Atlantic. When broken out, it is clear that there is greater representation in the textile, leather, apparel, and computer sub-sectors. This report also includes a complete Northeast and Mid-Atlantic state-by-state breakout of U.S. Census data by NAICS Code sub-sector in **Appendix 2**.

Figure 1. Number of Manufacturing facilitates by Sub-sector[5]

NAICS CODE	Industrial Sub-sector	Number of National Facilities	Number of Regional Facilities
311	**Food**	**32,953**	**6,591**
312	**Beverages and Tobacco Products**	**6,130**	**1,226**
313	**Textile Mills**	**2,546**	**509**
314	**Textile Product Mills**	**4,165**	**833**
315	**Apparel**	**2,487**	**497**
316	**Leather and Allied Products**	**486**	**97**
321	**Wood Products**	**27,066**	**5,413**
322	**Paper**	**11,040**	**2,208**
323	**Printing and Related Support**	**12,679**	**2,536**
324	**Petroleum and Coal Products**	**12,337**	**2,467**
325	**Chemicals**	**45,664**	**9,133**
326	**Plastics and Rubber Products**	**14,389**	**2,878**
327	**Nonmetallic Mineral Products**	**32,023**	**6,405**
331	**Primary Metals**	**15,767**	**3,153**
332	**Fabricated Metal Products**	**42,966**	**8,593**
333	**Machinery**	**22,697**	**4,539**
334	**Computer and Electronic Products**	**8,881**	**1,776**
335	**Electronic Equipment/Appliances/Components**	**6,096**	**1,219**
336	**Transportation Equipment**	**20,612**	**4,122**
337	**Furniture and Related Products**	**10,640**	**2,128**
339	**Miscellaneous**	**15,291**	**3,058**
NAICS 311-339	**Manufacturing Total**	**346,915**	**69,383**

Figure 2 reflects how the data collected through MECS and U.S. Census aims to quantify the region's manufacturing base by state. As in Figure 1, U.S. Census data provides a pathway to develop state level estimates. The MECS data provides the national total of manufacturing facilities in the Northeast and Mid-Atlantic. As shown in Figure 1, New York and Pennsylvania have close to twice the number of facilities than New Jersey, the state with the third highest. The total number of manufacturing plants in the region reaches over 69,000. This represents 19.9 percent of the number of facilities in the entire United States which stands at

[5] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 9.1. 2010. https://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table9_1.pdf

346,915. MECS' Northeast regional data is projected with U.S. Census figures to include Maryland, Delaware, and the District of Columbia into the analysis.

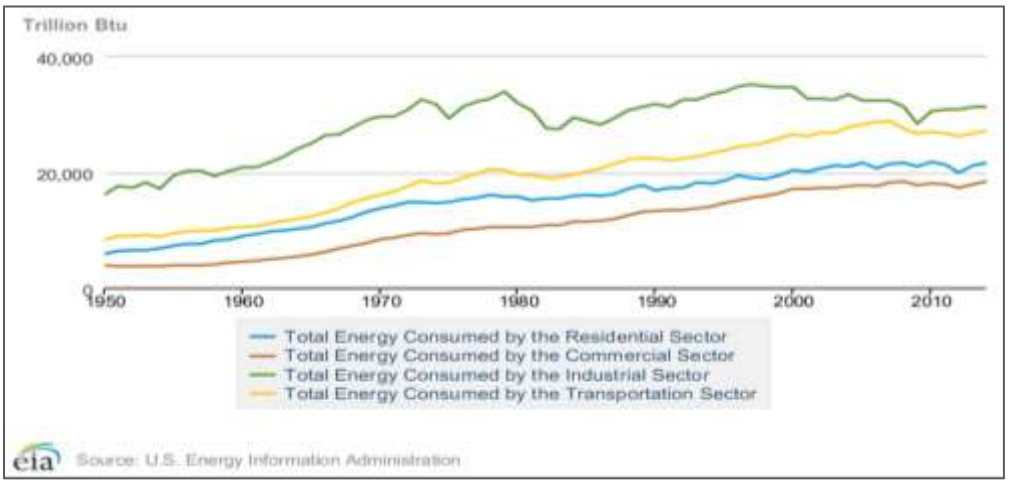
Figure 2. State Breakdown of Manufacturing Plants

State	Number of Manufacturing Plants
New York	**19,306**
Pennsylvania	**16,393**
New Jersey	**9,095**
Massachusetts	**7,983**
Connecticut	**5,093**
Maryland	**3,635**
New Hampshire	**2,173**
Maine	**1,934**
Rhode Island	**1,776**
Vermont	**1,187**
Delaware	**676**
District of Columbia	**131**
Total	**69,383**

Industrial Sector Energy Consumption

The industrial sector as a whole has historically been the largest consumer of energy in the United States. According to the U.S. EIA[6], in 2010 the U.S. consumed 97.3 Quad Btu of energy. As displayed in Figure 3. the industrial sector was responsible for approximately 31 percent, or 30.5 Quad Btu; the transportation sector consumed approximately 28 percent, or 27.1 Quad Btu; the residential sector consumed approximately 22 percent, or 21.6 Quad Btu; and the commercial sector consumed approximately 19 percent or 18 Quad Btu.

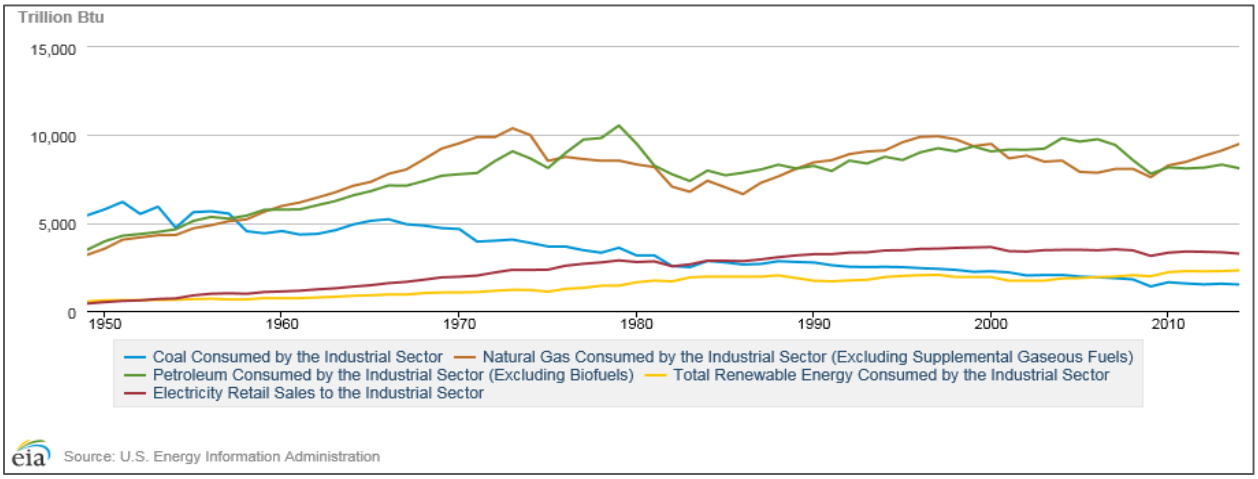
Figure 3. Total Energy Consumption Across all U.S. Sectors



[6] U.S. Energy Information Administration. *Annual Energy Review September 2011*. September 2012. http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf

It is also important to understand the breakdown of energy consumption by fuel type for the Industrial sector. As demonstrated in Figure 4 below, which details the fuel-type breakout of energy consumption, the industrial sector has a balanced diversity of fuel types. In 2010, the Industrial sector in the United States relied on 27.2 percent natural gas, 26.4 percent petroleum, 5.3 percent coal, 7.5 percent renewable sources – of which the majority was biomass, and 10.9 percent electricity sales[7].

Figure 4. Industrial Sector Energy Consumption by Fuel Type



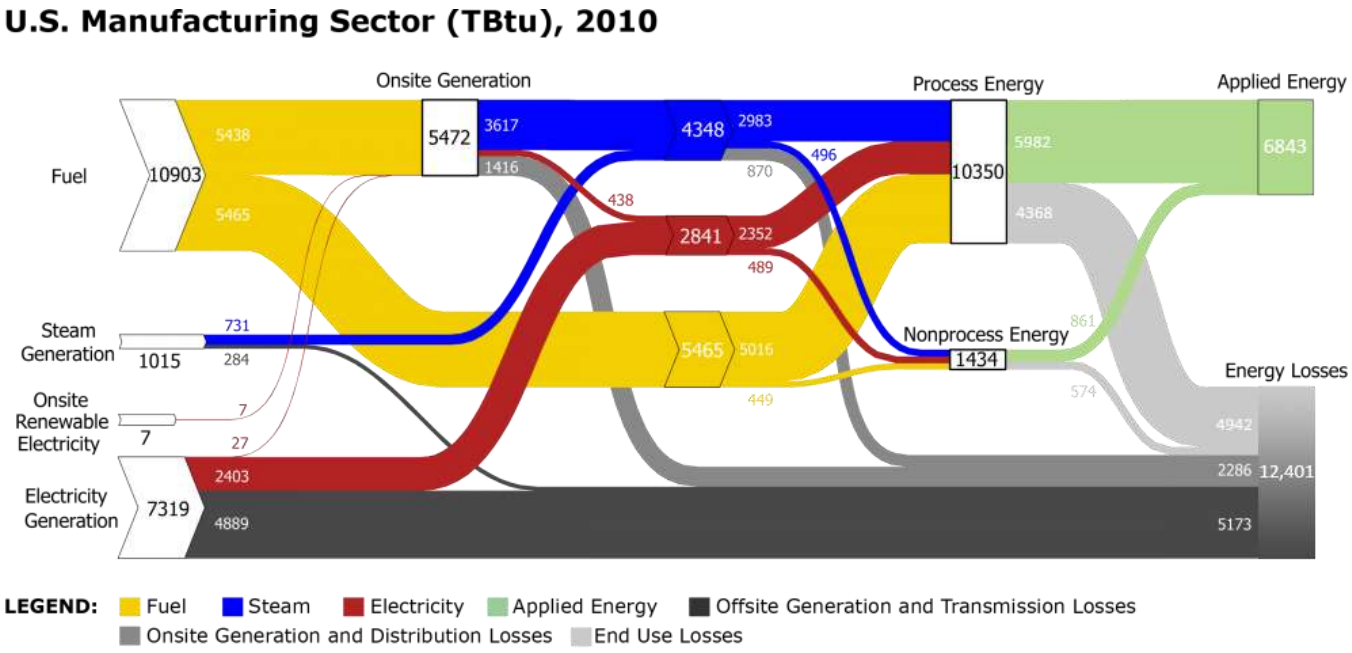
As discussed before, the industrial sector is comprised of several different sub-industries (i.e. Manufacturing, Agriculture, Mining, etc.). Of particular importance to efficiency programs is the energy consumption of Industrial sector's built environment of manufacturing facilities. Out of the Industrial sector's 30.5 Quad Btu, manufacturing facilities total 18.8 Quad Btu, or 61% of the entire "Industrial" sector.

Manufacturing Sector Energy Consumption

While it is helpful to understand the profile of the total Industrial sector, for reasons described earlier, we are interested in understanding the specific landscape and opportunity associated with the manufacturing facilities. Given that manufacturing facilities comprises 61% energy consumption of the industrial sector, we delve deeper into the details of the manufacturing sector's energy use.

[7] Not included in Figure 4 is the additional 6.9 TBtu that is sourced from Electrical System Energy Losses. These energy loses account for an additional 22.8 percent of the total 30.5 Quads in the Industrial sector.
U.S. Energy Information Administration. *Annual Energy Review September 2011*. September 2012.
http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf

Figure 5. U.S. Manufacturing Sector[8]



As can be seen in Figure 5, a major component in the breakdown of manufacturing facilities' energy use is fossil fuel inputs (i.e. natural gas, fuel oil, etc.) and electricity generation. There are significant quantities of energy that are lost and never applied to the manufacturing process. For Fuel, roughly 46% of 10,903 TBtu is lost. And for Electricity Generation from the grid, roughly 67% of 7,319 TBtu is lost. These are significant energy and cost savings that efficiency efforts can help to recover.

To further investigate those manufacturing facilities that have the most energy savings potential, an analysis was done to address the energy and electricity consumption of their sub-sectors. In Figures 6a and 6b, this analysis of both energy and electricity was undertaken.

[8]U.S. Department of Energy. Static Sankey Diagram Full Sector Manufacturing. 2010 Manufacturing Sector Analysis. 2010. http://www.energy.gov/eere/amo/static-sankey-diagram-full-sector-manufacturing

Figure 6a. Comparison of Regional and National Manufacturing Sub-sector Total[9] Energy (Trillion Btu)[10]

Industry	National Total Energy	Percent of National Total	Northeast Total Energy	Percent of Northeast Total
Food	**1,162**	**6.2%**	**89**	**5.9%**
Beverages and Tobacco Products	**85**	**0.5%**	**11**	**0.7%**
Textile Mills	**95**	**0.5%**	**8**	**0.5%**
Textile Product Mills	**20**	**0.1%**	**0**	**0.0%**
Apparel	**6**	**0.0%**	**0**	**0.0%**
Leather and Allied Products	**2**	**0.0%**	**0**	**0.0%**
Wood Products	**473**	**2.5%**	**87**	**5.8%**
Paper	**2,109**	**11.2%**	**247**	**16.5%**
Printing and Related Support	**84**	**0.4%**	**16**	**1.1%**
Petroleum and Coal Products	**6,137**	**32.6%**	**445**	**29.7%**
Chemicals	**4,995**	**26.5%**	**154**	**10.3%**
Plastics and Rubber Products	**275**	**1.5%**	**21**	**1.4%**
Nonmetallic Mineral Products	**716**	**3.8%**	**92**	**6.1%**
Primary Metals	**1,608**	**8.5%**	**179**	**12.0%**
Fabricated Metal Products	**302**	**1.6%**	**43**	**2.9%**
Machinery	**149**	**0.8%**	**21**	**1.4%**
Computer and Electronic Products	**145**	**0.8%**	**25**	**1.7%**
Electronic Equipment/ Appliances/Components	**94**	**0.5%**	**15**	**1.0%**
Transportation Equipment	**279**	**1.5%**	**26**	**1.7%**
Furniture and Related Products	**37**	**0.2%**	**5**	**0.3%**
Miscellaneous	**43**	**0.2%**	**13**	**0.9%**
Total	**18,817**	**100%**	**1,502**	**100%**

This chart indicates that many of the trends seen on a national level are echoed throughout the Northeast and Mid-Atlantic region. The most electricity consuming sub-sectors amongst manufacturing facilities in the region

[9] 'Total' is the sum of all the listed energy sources (Electricity, Oill, Natural Gas, LGP/NGL, Coal, Coke & Breeze, and Other) minus the shipments of energy sources produced onsite. It is the total amount of first use of energy for all fuel and nonfuel purposes.
[10] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 1.1. 2010. http://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table1_1.pdf

are similar to those on the national scale. The sub-sectors with the highest energy ratios, and therefore of interest to program administrators, are Petroleum and Coal Products, Paper, and Primary Metals. Those sub-sectors that differ significantly in the relative energy use they represent in the our region versus national averages include; Wood products, Paper, and Primary metals having higher percentages in the region while Chemicals has a much smaller relative footprint compared to the rest of the country.

Figure 6b. Comparison Manufacturing Sub-sector Net Electricity[11] Consumption (million kwh)[12]

Industry	National Net Electricity	Percent of National Total	Northeast Net Electricity	Percent of Northeast Total
Food	**75,407**	**11%**	**7,147**	**10%**
Beverages and Tobacco Products	**8,449**	**1%**	**1,247**	**2%**
Textile Mills	**13,240**	**2%**	**550**	**1%**
Textile Product Mills	**2,458**	**0%**	**1**	**0%**
Apparel	**1,069**	**0%**	**1**	**0%**
Leather and Allied Products	**243**	**0%**	**50**	**0%**
Wood Products	**15,323**	**2%**	**1,010**	**1%**
Paper	**60,497**	**8%**	**4,907**	**7%**
Printing and Related Support	**13,704**	**2%**	**2,447**	**3%**
Petroleum and Coal Products	**47,014**	**7%**	**4,413**	**6%**
Chemicals	**131,932**	**18%**	**12,122**	**16%**
Plastics and Rubber Products	**45,797**	**6%**	**2,679**	**4%**
Nonmetallic Mineral Products	**32,576**	**5%**	**4,133**	**6%**
Primary Metals	**117,284**	**16%**	**12,979**	**18%**
Fabricated Metal Products	**37,206**	**5%**	**4,526**	**6%**
Machinery	**20,386**	**3%**	**3,323**	**4%**
Computer and Electronic Products	**29,503**	**4%**	**5,236**	**7%**
Electronic Equipment/ Appliances/Components	**10,689**	**1%**	**1,804**	**2%**
Transportation Equipment	**38,832**	**5%**	**2,861**	**4%**
Furniture and Related Products	**4,960**	**1%**	**707**	**1%**
Miscellaneous	**7,598**	**1%**	**1,847**	**2%**
Total	**714,166**	**100%**	**74,309**	**100%**

Similarly to the energy analysis, this chart indicates that many of the trends seen on a national level are echoed throughout the Northeast and Mid-Atlantic region. The sub-sectors with the highest electricity ratios, are Primary Metals, Chemicals, and Food.

[11] Net Electricity is obtained by summing purchases, transfers in, and generation from noncombustible renewable resources, minus quantities sold and transferred out. It does not included inputs from onsite cogeneration.
[12] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 1.1. 2010. http://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table1_1.pdf

Energy Consuming End-uses in the Region's manufacturing facilities

U.S. Census data provides a state-by-state comparison to the national total for industrial facilities. The U.S. Census data provides insight to all industrial buildings, but is not limited to the sub-set of manufacturing facilities. The U.S. Census information is then applied to the MECS dataset, which provides manufacturing electricity consumption in the Northeast and Mid-Atlantic. MECS' Northeast regional data is projected with U.S. Census figures to include Maryland, Delaware, and the District of Columbia into the analysis.

Figure 7. State Breakdown of Manufacturing Electricity Consumption[13]

State	PA	NY	NJ	MA	ME	MD	DE	CT	NH	VT	RI	DC	Total
Manufacturing Electricity Consumption (Million kwh)	**29,946**	**18,613**	**7,488**	**8,219**	**2,901**	**3,559**	**1,600**	**3,412**	**1,706**	**1,224**	**799**	**28**	**79,496**

Separately, identifying those pieces of equipment that consume the most amount of electricity and natural gas, the most prevalent energy sources, also provides insight into those areas of largest energy savings opportunity.

Figure 8. Manufacturing End Use Electricity Consumption[14]

End Use	National Net Electricity (million kwh)	National Percentage	Regional Net Electricity (million kwh)	Northeast Percentage
Conventional Boiler Use	**7,788**	**1%**	**838**	**1%**
CHP and/or Cogeneration Process	**-**	**0%**	**-**	**0%**
Process Heating	**87,131**	**12%**	**10,425**	**14%**
Process Cooling and Refrigeration	**53,400**	**7%**	**5,259**	**7%**
Machine Drive	**347,224**	**49%**	**33,354**	**45%**
Electro-Chemical Processes	**55,414**	**8%**	**5,538**	**7%**
Other Process Use	**17,179**	**2%**	**1,042**	**1%**
Facility HVAC	**64,945**	**9%**	**7,649**	**10%**
Facility Lighting	**48,453**	**7%**	**5,925**	**8%**
Other facility Support	**13,896**	**2%**	**1,748**	**2%**
Onsite Transportation	**1,389**	**0%**	**170**	**0%**
Conventional Electricity Generation	**-**	**0%**	**-**	**0%**
Other Non-process Use	**2,754**	**0%**	**443**	**1%**
End Use Not Reported	**14,594**	**2%**	**1,919**	**3%**
Total Electricity Consumption	**714,166**		**74,309**	

The Northeast and Mid-Atlantic manufacturing sector consumed over 74.3 billion kilowatt hours of electricity in 2010. The process that required the most electricity was Machine Drive (which encompasses any process that

[13] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 1.1. 2010. http://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table1_1.pdf

[14] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 5.5. 2010. https://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table5_5.pdf

utilizes an electric motor) accounting for 33,354 million kWh (45 percent), followed by Process Heating, 10,425 million kWh (14 percent), Facility HVAC, 7,649 million kWh (10 percent), and Lighting 5,925million kWh (8 percent). This trend was echoed in the national scale as well. Separately, the total quantity of electricity reported in Figure 7 is greater than Figure 8 due to the inclusion of Maryland, Delaware, and the District of Columbia. Were these additional states not included, the total quantity of electricity that is consumed for various manufacturing end use would be equivalent to the total energy consumed by the reported states.

Figure 9. Manufacturing Processes Natural Gas Consumption[15]

Process	National Gas Consumption (billion cu ft)	% of National Total	Northeast Gas Consumption (billion cu ft)	% of Northeast Total
Conventional Boiler Use	**712**	**14%**	**65**	**15%**
CHP and/or Congeneration Process	**1362**	**27%**	**119**	**28%**
Process Heating	**2295**	**45%**	**178**	**42%**
Process Cooling and Refrigeration	**24**	**0%**	**7**	**2%**
Machine Drive	**116**	**2%**	**5**	**1%**
Electro-Chemical Processes		**0%**		**0%**
Other Process Use	**113**	**2%**	**2**	**0%**
Facility HVAC	**297**	**6%**	**43**	**10%**
Facility Lighting		**0%**		**0%**
Other facility Support	**35**	**1%**	**3**	**1%**
Onsite Transportation	**1**	**0%**		**0%**
Conventional Electricity Generation	**18**	**0%**		**0%**
Other Non-process Use	**7**	**0%**		**0%**
End Use Not Reported	**83**	**2%**	**3**	**1%**
Total Fuel Consumption	**5063**		**425**	

The Northeast and Mid-Atlantic manufacturing sector consumed over 425 billion cubic feet of natural gas in 2010. The process that required the most natural gas was process heating, accounting for 178 billion cubic feet of natural gas (42 percent), followed by CHP or Cogeneration at 119 billion cubic feet (28 percent), and conventional boiler use at 65 billion cubic feet (15 percent). This trend was echoed in the national scale as well.

Manufacturing Sector Energy Intensity

By taking the price of energy and electricity into account, against each sub-sectors, additional insight into the total expenditure for energy and electricity is ascertained. Figure 10 may highlight sectors with significant opportunities for cost savings.

[15] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 5.5. 2010. https://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table5_5.pdf

Figure 10. Dollars spent for Energy per Manufacturing Sub-sector[16]

NAICS CODE	Industrial Sub-sector	National Energy Spending (million $)	Regional Energy Spending (million $)	National Electricity Spending (million $)	Regional Electricity Spending (million $)
311	Food	10,597	1,291	5,278	729
312	Beverages and Tobacco Products	1,102	176	735	122
313	Textile Mills	1,206	122	861	65
314	Textile Product Mills	267	-	184	0
315	Apparel	118	-	95	0
316	Leather and Allied Products	35	-	25	7
321	Wood Products	4,219	1,307	1,165	97
322	Paper	14,615	1,964	3,388	353
323	Printing and Related Support	1,520	238	1,247	174
324	Petroleum and Coal Products	36,699	4,187	2,680	335
325	Chemicals	46,903	1,776	7,388	909
326	Plastics and Rubber Products	4,411	437	3,526	319
327	Nonmetallic Mineral Products	5,306	820	2,313	355
331	Primary Metals	12,816	1,328	5,747	727
332	Fabricated Metal Products	4,488	811	3,125	516
333	Machinery	2,399	404	1,733	309
334	Computer and Electronic Products	2,649	619	2,331	539
335	Electronic Equipment/ Appliances/Components	1,245	310	834	173
336	Transportation Equipment	3,990	388	2,912	263
337	Furniture and Related Products	661	124	466	89
339	Miscellaneous	884	290	737	225
311-339	**Manufacturing Total**	171,611	16,882	46,421	6,316

Examining specifically dollar spent on energy and electricity, the largest industries nationally and in the region are similar. There are similarities to the industries with the largest energy consumptions (Petroleum and Coal Products, Paper, and Primary Metals) as highlighted in Figure 6a. Despite the varying prices of energy per Btu, the top manufacturing industries with the largest cost remain at the top of both lists.

[16] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 7.3. 2010. https://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table7_3.pdf

Manufacturing Sector Implementation of Energy Efficiency and Management Activity

Though many industrial customers take part in energy management activities, more than half do not participate. Out of 346,915 total establishments in the United States, 47 percent participate in at least one of the below highlighted activities.

Figure 11. Manufacturing Sub-Sector Efficiency Participation[17]

Type of Activity	Percentage Participation
Facility Lighting	**24%**
Energy Audit or Assessment	**21%**
Technical Assistance	**15%**
Facility HVAC	**15%**
Direct Machine Drive	**12%**
Compressed Air Systems	**12%**
Technical Information	**10%**
Electricity Load Control	**9%**
Training	**9%**
Financial Assistance	**9%**
Special Rate Schedule	**8%**
Power Factor Correction or Improvement	**8%**
Direct/Indirect Process Heating	**6%**
Direct Process Cooling, Refrigeration	**5%**
Steam Production/System	**4%**
Interval Metering	**4%**
Standby Generation Program	**3%**
Participation in One or More of the Following Types of Activities	**47%**

The most common area for energy efficiency or energy management implementation is in facility lighting, where 24 percent of all industrial sites participate in energy efficiency programs. 21 percent of industrial customers participate in an energy audit or assessment, and 15 percent of industrial customers receive technical assistance, such as consultation, demonstrations, engineering design, and analysis.

Potential Savings through Further Action

Figure 12 and 13 below present technical potential electricity savings for industrial energy efficiency measures. While actual achievable potential would depend on a number of market and program variables, the results demonstrate the large electricity savings potential of this sector.

[17] U.S. Energy Information Administration. Manufacturing Energy Consumption Survey website. 2010 MECS Survey Data – Table 8.1. 2010. http://www.eia.gov/consumption/manufacturing/data/2010/pdf/Table8_1.pdf

Figure 12. Total Annual Electricity Savings

State	Industrial Electricity Consumption (million Kwh)	5% Savings	10% Savings	15% Savings	20% Savings
PA	29,946	1,497	2,995	4,492	5,989
NY	18,613	931	1,861	2,792	3,723
NJ	7,488	374	749	1,123	1,498
MA	8,219	411	822	1,233	1,644
ME	2,901	145	290	435	580
MD	3,559	178	356	534	712
DE	1,600	80	160	240	320
CT	3,412	171	341	512	682
NH	1,706	85	171	256	341
RI	799	40	80	120	160
VT	1,224	61	122	184	245
DC	28	1	3	4	6
Total	**79,496**	**3,975**	**7,950**	**11,924**	**15,899**

Figure 13. Total Annual Carbon Savings

State	Annual Industrial Electricity Consumption (million Kwh)	Total Annual C02 Emissions (Metric Tons)	Projected 20% CO2 Savings
PA	29,946	20,649,294	4,129,859
NY	18,613	12,834,613	2,566,923
NJ	7,488	5,163,358	1,032,672
MA	8,219	5,667,420	1,133,484
ME	2,901	2,000,387	400,077
MD	3,559	2,454,112	490,822
DE	1,600	1,103,282	220,656
CT	3,412	2,352,748	470,550
NH	1,706	1,176,374	235,275
RI	799	550,951	110,190
VT	1,224	844,010	168,802
DC	28	19,307	3,861
TOTAL	**79,496**	**54,815,856**	**10,963,171**

As is displayed in Figure 12 and 13 the estimated electricity savings, and associated financial savings, are based on a range of potential energy efficiency improvements ranging from 5-20 percent. The regional savings range from 3 to 18 TWh as compared to the Total Annual Energy Consumption of 79 TWh. Additionally, a projected CO2 savings of 20 percent would amount to almost 11 million metric tons.

Existing Programs/Resources in Support of Industrial Energy Efficiency

There are several existing programs and related resources available to "industrial" customers to implement energy efficiency into their facilities. In addition to the rate-payer funded energy efficiency programs, a number of federal agencies, including the Department of Energy (DOE) and Environmental Protection Agency (EPA), offer a host of resources to promote energy efficiency into the industrial sector.

Current Rate-Payer Funded Energy Efficiency Program Offerings in the Northeast and Mid-Atlantic

Rate-payer funded energy efficiency programs administered by electric and natural gas utilities as well as third-party program administrators[18] (PAs) have a long history of delivering cost-effective energy savings to Industrial customers across the region. The programs currently offer a range of energy solutions to help residents and businesses and communities adopt energy efficient goods and services. This report has aggregated Energy Efficiency Program detailed information in **Appendix 1**. Although programs across the Northeast and Mid-Atlantic region vary in their approach to industrial efficiency offerings, a pattern of two trends emerged in the course of this compilation. The two trends when it comes to program offerings were: **financial incentives for energy efficient equipment (or "capital improvements") and technical assistance (including training/education)**

Financial Incentives for Energy Efficient Equipment

Every program in the region offers financial incentives towards energy efficient equipment or "capital improvements". While several programs offer prescriptive rebates that are technology-dependent, many industrial programs offer customizable rebates due to the fact that each industrial facility and manufacturing process can be unique. Programs may follow specific guidelines concerning incentives for facility lighting or HVAC, but when it comes to the assembly-line processes, one-size-fits all rebate is not always appropriate. To develop customized rebate offerings, on-site engineering assessments are conducted according to program protocols and the customized analysis determines incentive offerings for various equipment upgrades.

Typical Rebate Measures:	
Building Envelope Improvements	HVAC and HVAC Controls (including Chillers)
Compressed air and steam systems	Lighting and Lighting Controls
Control ventilation or exhaust heat recovery)	Motors (including pumps and fans)
Energy Management Information Systems (EMIS)[19]	Motor Speed Controls and Variable Frequency Drives (VFD)
Food Service Equipment	Water/wastewater system improvements

[18] In the Northeast / Mid-Atlantic, these include entities like NYSERDA, the Cape Light Compact & Efficiency Vermont.

[19] Energy Management information systems are a technology used to track and manage energy usage within a facility. There are several different software packages that are custom to the facility in which they are installed. These can include a wide range of technologies such as: energy information systems (EIS), equipment-specific fault detection and diagnostic systems, benchmarking and utility tracking tools, and/or building automation systems.

Technical Assistance

Closely linked to financial incentives for capital improvement projects is **technical assistance**. Programs deploy technical experts to consult with Industrial customers to not only conduct audits and offer suggested improvements but to conduct insightful analysis and/or train staff on energy management practices, including building operator training and strategic energy management.

Some regional energy efficiency programs, as exemplified by Efficiency Vermont[20], include Strategic Energy Management (SEM) as a key component of their industrial efficiency program (Their program is branded Continuous Energy Improvement (CEI)). For Vermont, SEM involves self-assessments, protocol checklists, on-going dialogue with the participants, energy management information systems (EMIS), etc.

Specialized account managers play a major role across many efficiency programs as the main point of contact and interface between industrial customers and the offerings available through the efficiency programs. In order to provide relevant recommendations, account managers are often specialized by industrial sub-sector. Account managers help determine project opportunities, training opportunities, and long-term energy management plans.

Many energy savings opportunities are realized due to behavioral modifications. Programs provide training and educational components to improve industrial customers' energy management practices and investments. Coupled with incentives, education can bolster the energy savings potential from specific capital improvement projects.

Typical Types of Technical Assistance	
Facility Benchmarking	Building Operation Training
Data Collection and Analytics (including Energy Management Information Systems (EMIS))	Strategic Energy Management Training (including energy management assessments, "scavenger hunts", Industry specific "Cohort" processes, etc.)
Monitoring-Based Commissioning	Energy Auditing (occasionally provided by a certified energy advisor who is a sector-specific expert)

Commercial and Industrial (C&I) efficiency initiatives are historically among the most cost-effective programs within rate-payer funded program portfolios, many achieving energy savings for as little as 2-3¢/kwh[21].

Most efficiency programs are provided through the rate-payer funded efficiency programs and offer customer financial incentives for participating in efficiency activities. The Consortium for Energy Efficiency has compiled a dataset[22] which shows the annual budgets for state C&I energy efficiency programs. The numbers listed in Figure 13 are budgets for both commercial and industrial programs, as these are often combined.

[20] https://www.efficiencyvermont.com/services/project-support/strategic-energy-management
[21] http://aceee.org/sites/default/files/low-cost-ieep.pdf
[22] Consortium for Energy Efficiency. Purpose of the Efficiency Program Industry by State and Region Appendices and Limitations of Data. http://library.cee1.org/sites/default/files/library/12206/CEE_2014_AIR_Tables_April_2015.pdf

Figure 13. Regional Program Investment in Industrial Energy Efficiency

State	2014 Commercial & Industrial Energy Efficiency Program Budget (Millions)
NY	$561.2
MA	$319.8
NJ	$236.6
MD	$121.8
CT	$92.3
PA	$92.1
RI	$55.3
VT	$25.9
ME	$12.2
NH	$11.4
DC	$10.5
DE	$0
NEEP REGION	**$1,539.1**

Opt Out/Self-Direct

Energy efficiency programs in the Northeast/Mid-Atlantic region are primarily funded by ratepayers in the form of a systems benefit charge on their bills or a small amount embedded in their rates. These charges are aggregated to fund energy efficiency programs and across all sectors, including Industrial.

In recent years, some large commercial and industrial customers, citing insufficient value from ratepayer-funded efficiency programs, have lobbied for the means to "opt out" of those programs, or self-direct their own energy efficiency efforts.

Self-direct programs allow some customers, usually large industrial or commercial ones, to "self-direct" those collected funds directly into energy efficiency investments in their facilities instead of into a broader aggregated pool of funds. The self-direct option allows major energy users to allocate funds internally, under the condition they provide measurement and verification to a third party. Figure 14 provides a summary of all opt-out of self-direct policies in the Northeast and Mid-Atlantic region.

Opt-out programs, on the other hand, allow large customers to fully opt out of paying their energy efficiency fees with no corresponding obligation to make energy efficiency investments on their own[23].In some states, the larger customers are allowed to opt out of this system because they are seen as able to administer their own efficiency programs more effectively as they know their operation better than a third party program administrator. Though this system is not a failure, there is inadequate evaluation, measurement, and verification

[23] American Council for an Energy-Efficient Economy. State Policy Toolkit website. Self Direct Programs for Large Energy Users. http://aceee.org/sector/state-policy/toolkit/industrial-self-direct

required to understand whether or not these clients are implementing proper efficiency measures into their operations. [24]

When this happens, decreased budgets risk undermining program offerings for all business customers. This means simply, that less efficiency happens overall. Designing and delivering programs that effectively meet the needs of large customers, particularly those with complex industrial processes, is key to successfully capturing some of the most cost-effective efficiency potential. Policymakers and program administrators can learn from best practices, many of which are described in this report as well as a series of guidance materials from the State Energy Efficiency Action (SEE Action) Network. The following table summarizes the various state policies related to opt-out or self-direct.

Figure 14. Regional Summary of Opt-out and Self-Direct Activity

State	Policy
Connecticut	No opt-out or self-direct option allowed
Delaware	No opt-out or self-direct option allowed
Washington D.C.	No opt-out or self-direct option allowed
Maine	Largest energy users are automatically opted out
Maryland	Cost Recovery Mechanism in place, but no self-direct option
Massachusetts	Self-Direct option available to the five largest energy users in each service territory
New Hampshire	Cost Recovery Mechanism in place, but no self-direct option
New Jersey	Self-Direct option available to those who have paid at least $300,000 into the New Jersey Clean Energy Fund
New York	Cost Recovery Mechanism in place, but no self-direct option
Pennsylvania	Pending/Possible self-direct
Rhode Island	Cost Recovery Mechanism in place, but no self-direct option
Vermont	Self-Direct option available for customers who paid at least 1.5 million in energy efficiency charges in 2008

In a paper published by the National Resource Defense Council, entitled, “Stemming the Tide of Industrial Opt-Outs: A Flexible, Attractive and Effective Option for Utility-Sponsored industrial Energy Efficiency”[25], several key findings were discovered. Firstly, while manufacturing energy costs average about $200 million/year, efficiency programs could reduce energy consumption by 18 percent by 2020 (3650 Trillion Btu’s) and individually SEP facilities see an energy use reduction of 3.8 percent in the first year and 10.1% in the second year (with 2.8 percent and 9 percent attributable to SEP, respectively). The report found that there were 62 sites in the United States are certified ISO 50001, 17 sites in the United States are certified SEP, and that the average SEP certification process costs $319,000. On average, the facilities saved 0.174 Trillion Btu with an annual savings of $503,000 and an average payback of 1.7 years.

[24] American Council for an Energy-Efficient Economy. State and Local Policy Database website. Self Direct and Opt-Out Programs. http://database.aceee.org/state/self-direct

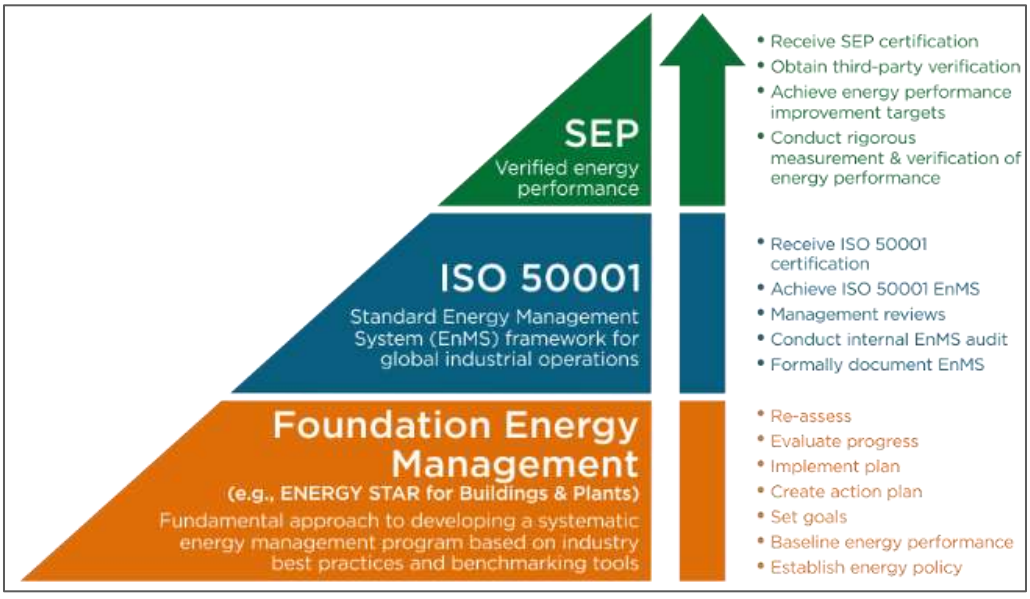
[25] American Council for an Energy-Efficient Economy. Williams, S., et al. Stemming the Tide of Industrial Opt-Outs: Aflexible, Attractive and Effective Option for Utility-Sponsored Industrial Energy Efficiency. 2015 http://aceee.org/files/proceedings/2015/data/papers/5-212.pdf

U.S. Department of Energy

The United States Department of Energy (DOE) has an office dedicated to the advancement of energy efficiency in manufacturing. The Advanced Manufacturing Office (AMO) has lead efforts through a number of different programs including Better Plants, Industrial Assessment Centers, SEE Action Working Group, Combined Heat and Power (CHP) and more recently Strategic Energy Management. This list is not exhaustive of the programs and resources AMO provides.

Strategic Energy Management: Strategic Energy Management is an emerging approach to achieve energy savings in the industrial sector. According to the Consortium for Energy Efficiency, "Strategic Energy Management can be defined simply as taking a holistic approach to managing energy use in order to continuously improve energy performance, by achieving persistent energy and cost savings over the long term. It focuses on business practice change from senior management through shop floor staff, affecting organizational culture to reduce energy waste and improve energy intensity."[26] The concept of effectively managing energy is not new, however, it is only recently becoming a standardized practice. Historically, those in the industry have referenced this concept as continuous energy improvement (CEI), strategic energy management (SEM), as well as other names.

AMO has classified three levels of Strategic Energy Management (SEM). The first level is referred to as Foundational Energy Management. This level is the most basic and includes only the very core aspects of SEM. The next step is becoming certified to meet ISO 50001 energy management standards and the third tier of certification is Superior Energy Performance (SEP). In addition to the three tiers of SEM, DOE provides multiple resources for industrial facilities.



Foundational Energy Management: "This level is designed to help implement a basic energy management program at organizations of any size and any type—including commercial, industrial, and government facilities. This level is the right starting point for you if your organization is new to energy management, or if you're looking to develop a more systematic approach to implementing energy management, but are not yet ready to implement the ISO 50001 energy management standard. Level 1 provides a strong

[26] Consortium for Energy Efficiency. CEE™ Strategic Energy management Minimum Elements. http://library.cee1.org/content/cee-strategic-energy-management-minimum-elements

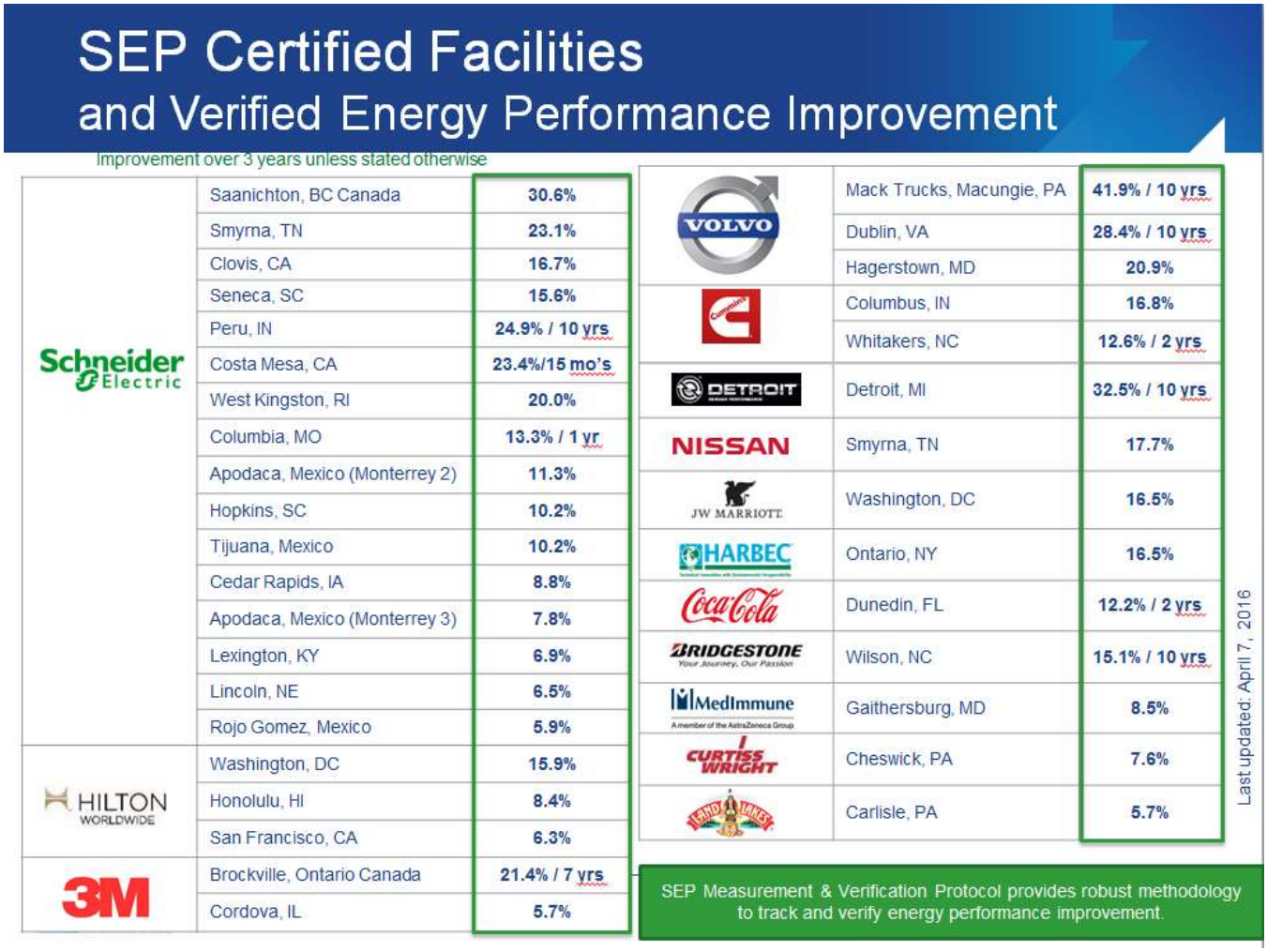
framework to establish a continual improvement approach to implementing energy projects and sustaining the energy savings achieved. Level 1 is organized in a step-by-step approach, with progress made by implementing defined tasks within each step. You and your energy management implementation team will be able to work together, keeping track of your progress by using the eGuide Status Tracker. If you start with Level 1 and later your organization decides it would like to pursue ISO 50001 and/or SEP certification, you can flexibly advance to Level 2 or Level 3."[27]

ISO 50001: "ISO 50001-2011 is an International Standard that specifies requirements for an energy management system (EnMS). The requirements are used to establish and implement a systematic approach to managing energy and achieving energy performance improvements using a Plan-Do-Check-Act continual improvement framework. ISO 50001 can be implemented in any type of organization regardless of the types of energy used. The standard can be used for certification or self-declaration of an organization's EnMS. Based on the common elements of ISO management system standards, ISO 50001 has a high level of compatibility with ISO 9001-2008 quality management systems and ISO 14001-2004 environmental management systems."[28]

Superior Energy Performance: The SEP certification program is designed to drive systematic energy performance improvement across manufacturing facilities and commercial buildings from a wide range of sectors, sizes, and energy management experience — significantly reducing energy use and carbon emissions. SEP builds on the ISO 50001 energy management standard and adds performance metrics that provide credible results of a facility's energy performance improvement. SEP certified facilities must first meet ISO 50001 requirements and in addition, commit to energy use reductions of 5% over three years or 15% over 10 years. Facilities certified to SEP are leaders in energy management and productivity improvement. To become certified, facilities must implement an energy management system that meets the ISO 50001 standard and demonstrate improved energy performance. An independent third party audits each facility to verify achievements and qualify it at the Silver, Gold, or Platinum level, based on their level of energy performance improvement and energy management practices.[29]

[27] U.S. Department of Energy. AMO Energy Resources Center website; https://ecenter.ee.doe.gov/_layouts/ecenter/ppc.eguide/home.aspx#
[28] U.S. Department of Energy. AMO Energy Resources Center; website.https://ecenter.ee.doe.gov/_layouts/ecenter/ppc.eguide/home.aspx#
[29] U.S. Department of Energy. SEP and ISO 50001 Certification Process website. http://www.energy.gov/eere/amo/sep-and-iso-50001-certification-process

Results from SEP Certified Facilities;[30]



Better Plants: Leading manufacturers and industrial-scale energy-using organizations demonstrate their commitment to improving energy performance by signing a voluntary pledge to reduce their energy intensity by 25% over a ten year period[31]. The 160 Partners that are currently comprise the Better Plants initiative have saved about 457 trillion Btu and $2.4 in energy costs. Partners are able to achieve these impressive results once they receive access to program experts, technical training, and analysis and software tools.

SEE Action: The State and Local Energy Efficiency Action Network's (SEE Action) Industrial Energy Efficiency and Combined Heat and Power (IEE/CHP) Working Group addresses cost savings opportunities in the US manufacturing sector by sharing successful practices for state and local policies that encourage industry's

[30] Superior Energy Performance for Program Administrator; see website for latest certified facilities: http://www.energy.gov/eere/amo/certified-facilities

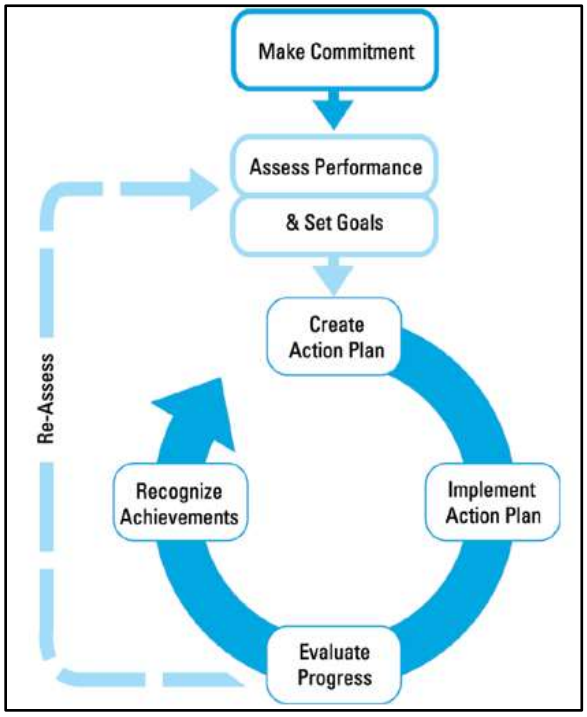
[31] U.S. Department of Energy. AMO Energy Resources Center http://energy.gov/eere/amo/ta

adoption of energy efficiency measures and implementation of CHP[32]. SEE Action has identified four key focus areas in industrial energy efficiency and CHP: reduce barriers to industrial energy efficiency implementation; build the workforce; promote efficient operations and investment; and move the market toward industrial energy efficiency and combined heat and power technologies adoption. The Working Group has produced several useful guidance documents and factsheets that provide an overview of the sector.

U.S. Environmental Protection Agency (EPA)

EPA's ENERGY STAR Program offers a suite of resources targeted at a range of Industrial market actors. Building off of prior experiences of partnering ENERGY STAR organizations, ENERGY STAR put together a series of guidelines as part of their **Guidelines for Energy Management** strategy to help companies continuously improve their energy and financial performance while distinguishing environmental advances. The seven essential steps which are illustrated below in Figure 15 include: Make Commitment; Assess Performance; Set Goals; Create Action Plan; Implement Action Plan; Evaluate Progress; and Recognize Achievement. This matrix in Figure 12 can be used by small/medium sized companies to help them get started and/or advance their energy management program.

Figure 15. Energy Management Assessment Matrix[33]



These recommendations aim to help organizations with their energy management, deliver results, and demonstrate leadership. EPA's ENERGY STAR Program offers a suite of resources targeted at a range of industrial market actors as is displayed in Figure 16.

[32] U.S. Department of Energy. AMO Energy Resources Center http://energy.gov/eere/amo/ta

[33] U.S. Environmental Protection Agency. Energy Star website. Energy Management Assessment Matrix for Small Companies. http://www.energystar.gov/buildings/tools-and-resources/energy-management-assessment-matrix-small-companies

Figure 16. Examples of Applying Guidelines to Small and Medium Companies[34]

ENERGY STAR Guideline Steps	Actions for Small and Medium Manufacturers	Additional ENERGY STAR Resources
Step 1 **Commit to Continuous Improvement**	• Appoint a number of key people to form the energy team. • Create and post an Energy Policy in the break room.	• Teaming Up to Save Energy • Join ENERGY STAR
Step 2 **Assess Performance**	• Gather energy bills and compare the past two year's energy use. • Inventory large energy using equipment and systems. Request a load profile from your utility. • Examine how your rates are structured • Identify an energy metric to track (e.g. total energy or Btu/pound of production). • Use the ENERGY STAR Energy Tracking Tool to track progress.	• Energy Tracking Plan • ENERGY STAR Energy Tracking Tool
Step 3 **Set Goals**	• Create a goal to motivate action. • Establish corporate/plant baseline(s) and a process for tracking energy use over time. • Use the ENERGY STAR Energy Tracking Tool to track progress Consider taking the ENERGY STAR Challenge for Industry	• ENERGY STAR Energy Tracking Tool • ENERGY STAR Challenge for Industry
Step 4 **Create Action Plan**	• Identify no-cost actions to reduce energy use, e.g. turn off unnecessary equipment, fix compressed air leaks, etc. • Identify projects requiring capital, e.g. upgrade lighting, replace old motors, etc. • Take advantage of free or low-cost plant energy assessments from universities, the local utility, or state or local governments. • Write down your plan and share it.	• SMM Energy Guide • Industrial Energy Management Information Center
Step 5 **Implement Action Plan**	• Challenge employees to find ways to save energy at work and at home. • Conduct an energy assessment. • Assign responsibility for carrying out energy projects. • Consider performance contracting to finance energy upgrades.	• Communication Resources
Step 6 **Evaluate Progress**	• Compare progress against baselines. • Evaluate action plan and identify new areas for next year.	• ENERGY STAR Energy Tracking Tool
Step 7 **Recognize Achievements**	• Create an annual award to recognize employees and facilities that achieve significant savings. • Achieve the ENERGY STAR Challenge for Industry.	• ENERGY STAR Challenge for Industry

[34] U.S. Environmental Protection Agency. Energy Star. June 2013. http://www.mbda.gov/sites/default/files/Small_Medium_Manufacturers_Guide.pdf

NEEP Business Leaders

The Northeast Business Leaders for Energy Efficiency Program is a unique opportunity for NEEP Sponsors to profile a customer who demonstrates outstanding acts of leadership and best practices of energy efficiency in their business. Through their participation, these Business Leaders provide important examples of how energy efficiency works.

As the region continues its efforts to make efficiency matter, NEEP brings attention to these business organizations as examples of the strategies and practices deployed across the region that are making significant savings possible. Each year's honorees are recognized at a celebratory dinner during NEEP's annual Summit conference.

Market Barriers to Adoption of Industrial Energy Efficiency

The data indicates that there is a wide market for energy efficiency measures in the Industrial sector, however, there are several persistent obstacles to adoption. To further understand the market for industrial energy efficiency measures in the northeast, the NEEP staff conducted interviews with several program administrators within the Northeast region. Through these discussions several commonalities presented themselves:

Availability or prioritization of capital to cover industrial customers' incremental cost for efficiency measures. A business owner who has limited liquidity may not be in a position to consider extended break-even payback for a marginal up-front cost and may be constrained to hire on-site staff dedicated to energy management activities. Often when a business owner has available cash, the preference is to make profit-making business investments rather than energy saving ones.

Challenge of securing top management buy-in to industrial energy efficiency. In order to preserve the business' ongoing credit availability, borrowing for an incremental added cost can be a barrier.

P**erceived lack of value** for efficiency leaves many savings unclaimed. A facility manager may be naturally averse to borrowing any more than absolutely necessary. In some instances, energy can be less than 5% of overall production costs and can be seen as a low priority. If there are specific investment criteria outlined by the company, energy may not be seen as worthwhile when compared to projects with a shorter payback period or larger return on investment.

Limited education and knowledge of contractors and customers can hamper investment in industrial efficiency measures in the region. Managerial education and perceived risks of new technology are frequent considerations which drives decision makers to the same existing and inefficient model or process rather than upgrading to a new and more efficient option.

Fear of impacting the final product. There are fears that efficiency upgrades in the manufacturing process will change the end-result of the manufactured product. While plant managers may know that the production process is inefficient, they always end-up with the desired final product. Changes to the assembly-line process, while efficient, may alter the production and disrupt the business' bottom line.

Ultimately these barriers to adopting energy efficiency measures need to be addressed in developing robust strategies going forward.

Industrial Energy Efficiency Opportunities

Strategic Energy Management

An ever increasing number of Industrial companies are embracing Strategic Energy Management as a means to more effectively manage energy use and energy related costs. Regional Energy Efficiency programs with energy savings objectives are simultaneously exploring the possibilities of leveraging SEM as practice they can promote and deliver.

Besides the early experiences in Vermont implementing SEM, the Northwestern U.S. has many years of experience developing and implementing SEM programs as well. Some of their program offerings include;

- Embedded Energy managers
- Energy management assessment tools
- Energy Management Information Systems (EMIS)
- Kaizen events/Treasure hunts
- Cohorts

During the round robin session at NEEP's Industrial Energy Efficiency Summit, many stakeholders spoke to the benefits that Strategic Energy Management presented to their customer and programs. Those benefits included;

- Discovery of Deeper C&I savings as SEM is a vehicle to achieve operational savings (No-cost/low-cost savings)
- SEM offers non-energy benefits to customers including productivity and customer satisfaction
- Companies with related quality/safety management certifications such as ISO 9001, and ISO 14001 find SEM a natural extension

In addition to the uptake within the Industrial sector and the support of efficiency programs, there are significant resources being made available through a number of federal agencies highlighted in earlier market assessment section, namely the Department of Energy. DOE's AMO is dedicated to the advancement of energy efficiency in manufacturing. Strategic Energy Management is an emerging approach to achieve energy savings in the industrial sector. To help advance SEM, the DOE provides a series of resources including their **eGuide** as a toolkit designed to help organizations implement SEM through an organized step by step process at three different levels: Foundational, ISO50001 and Superior Energy Performance. These resources include forms, checklists, templates, examples, and guidance to assist the facilities throughout the implementation process.

Recommended Regional Strategies to Accelerate Industrial Energy Efficiency

In order to develop regional strategies to accelerate the adoption of energy efficiency in the industrial sector, NEEP leveraged a number of valuable resources including lessons learned from this sector assessment, feedback from interviewees and working group stakeholders that included attendees of NEEP's November 2015 Regional Industrial Workshop in Bretton Woods, NH. The strategies also pulled from the very relevant resource produced by the SEE Action Network over the past few years related to Industrial Energy efficiency (namely Sustained Energy Savings Achieved through Successful Industrial Customer Interaction with Ratepayer Programs: Case Studies and Industrial Energy Efficiency: Designing Effective State Programs for the Industrial Sector).

This combination of current promotional activities and existing strategies, blended with new market assessment data, lead to the development of the following recommended actions to boost adoption of Industrial energy efficiency in the Northeast/Mid-Atlantic region.

We present the recommendations in two sections; **Recommended Program Strategy** and **Recommended Policy Strategy**

Recommended Program Strategy: Incorporate Strategic Energy Management (SEM) into Rate-payer funded Industrial Energy Efficiency Program Offerings

Strategic Energy Management (SEM) represents a very exciting emerging practice that has the potential to significantly accelerate the near-term and long-term adoption of energy efficient technologies and O&M practices to greatly reduce energy use in the Industrial sector. Rate-payer energy efficiency programs represent a significant facilitator/enabler of energy efficiency in the region and should move to leverage the opportunities associated with SEM to not only achieve increased energy savings but to provide value-add services to Industrial customers.

Given the potential of Strategic Energy Management (SEM) in reducing energy and costs, it has a fundamental role to play in efficiency programs. Program administrators in the Northeast and Mid-Atlantic should expect to serve all sizes and types of commercial and industrial customers, even the small and medium industrial customers that are hard-to-reach and have even less in-house energy expertise than larger customers.

Given that SEM may be entirely new to certain programs, they are encouraged to look to SEM program pioneers for experience and guidance. The Northwest, led by Northwest Energy Efficiency Alliance (NEEA), Bonneville Power Authority and Energy Trust of Oregon have years of experience to leverage. In our own region, Efficiency Vermont has been a front runner implementing a program around Continuous Energy Improvement (CEI). Lessons regarding program design, offerings and evaluation should be gleaned from their early experiences.

We highlight a number of near-term tactics that will be necessary to facilitate the growth of programmatic use of SEM.

- Stakeholder Education

  It has been clear in the course of assessing the region's market for SEM that the most immediate need is for education of all market players from end use customers to service providers and to utility program managers. The lack of common definitions for program-run SEM and uniform approaches can make

coordinated efforts difficult. Therefore the recommended program solutions center on maintaining a dialogue among peers and then building tools and resources to maintain consistency.

At the November summit, DOE presented its new curriculum on SEM, demonstrating the need for consistent language and concepts. Many in the training session came along with varying understanding of SEM definitions and techniques. DOE got off to a good start with its work, but the region's program managers will need to develop a consistent way to deliver training to all levels of players, from themselves all the way down to their end-use customers.

- Develop promotional materials; "Making the case" for Program incorporation of SEM

There is a need to develop a consistent case for SEM and to clearly document and communicate its related costs and benefits for program planners. SEM can make a serious impact on customers' costs and productivity. However the evaluation of what investment lead to what savings is more complicated for SEM versus traditional rebate style programs. SEM attempts to create foundational cultural/behavioral changes for industrial customers with resulting savings through a variety of changes (equipment, operational, maintenance, etc.). Promotional tools such as savings estimators and case studies, which are useful across the region, can be convincing.

- Energy Management Information Systems (EMIS)

Central to potential success of SEM is monitoring and reporting of results, and this is the function of Energy Management Information Systems (EMIS). The energy efficiency industry is in early stages of defining EMIS, so early implementation can help establish definitions, specifications, and availability. Central to a successful EMIS is a valid analysis of all relevant variables including productivity, occupancy, business cycles, weather, etc. Developing a set of educational resources, templates, product listings, etc. will allow the region's programs and customers to get the most out of SEM activity.

- Workforce development

There is a need to develop the availability of implementers and facilitators. Developing a SEM team and program at an enterprise customer is an involved process. Utility program managers have found that skilled facilitators with experience in SEM can carry forth the message and assist the customer committee in making significant progress. Using skilled consultants in this way will compliment program managers and keep a consistent high level of service across the region.

- Peer Exchange

Continue and build upon the current regional industrial peer exchange network. A number of utility and state program managers have been meeting as the Northeast CEI (Continuous Energy Improvement) Discussion Group. This group has met by phone and occasionally in person to discuss issues and share experiences in industrial energy efficiency. This concept should be continued and strengthened. Attendance should be grown to include as many programs as possible, and over a wider or more complete geographic spread. Each meeting tends to focus on specific topic areas; however planning the full year in advance will assure full coverage of topics. Also, a single in-person gathering, such as at the recent Industrial Energy Efficiency Summit in November, 2015 will assure that there is ample opportunity for in-depth relationship

building and for future planning. This peer exchange should function as a working group to manage development of solutions to the 'needs' included here.

Determination of program managers to develop solutions to recognized needs is a huge step toward potential success of SEM but it is essential to have support from users along the way. Therefore it is imperative that the managers operate in an environment of inclusion and transparency with all stakeholders in the region. The working group should identify the region's industrial energy efficiency stakeholders and arrange to share information with them as often as appropriate. This must involve open communication as the group develops solutions as well as an open dialogue at least once a year, either at workshops or at recognition events such as the NEEP Business Leaders.

The incorporation of SEM, and its associated benefits, into programs would complement the successes seen in other Industrial programs that have seen results. The SEEAction Report, Sustained Energy Savings Achieved through Successful Industrial Customer Interaction with Ratepayer Programs: Case Studies calls out a number of success factors found across their case studies.

- Tailoring of specific industry energy efficiency program offerings and support by program administrators to the needs of industrial customers.
- Assignment of dedicated program staff and/or technical contractors to provide technical assistance, project identification and packaging, and/or technical economic performance assessment support.
- Program offerings that include both custom project incentives and prescriptive incentives, and flexibility to specifically structure offerings in ways to best accommodate the budgeting, processing and implementation needs of customers.

Recommended Policy Strategy; Evolve Regulation of Rate-payer funded Energy Efficiency Programs

Rate-payer energy efficiency programs do not operate in a vacuum. Policies must be put in place to enable efficiency programs to adopt new practices/offerings to their customers. To further opportunities for success in industrial energy efficiency programs, and SEM in particular, state energy offices and regulators can support program in several ways, including:

- Encourage energy efficiency program administrators to set aggressive savings targets for the large commercial and industrial sector, with commensurate budgets and performance incentives, focused marketing and appropriate evaluation, measurement and verification (EM&V).
- Avoid taking an overly narrow view of cost-effectiveness when it comes to Industrial energy efficiency programs and encourage the Programs to quantify and claim the numerous non-energy benefits (NEBs) that come along with saving electricity and natural gas. These may include reduced operating and maintenance expenses, water savings, improved worker satisfaction, health and productivity.
- Afford flexibility with things like rolling program budgets, taking into consideration the fact that more involved customer engagement approaches (e.g. Strategic Energy Management) often have long lead times and can take years to fully realize savings.
- Encourage PAs to explore and pilot new program approaches to deliver industrial programs, in particular Strategic Energy Management, energy monitoring and management software, and greater use of sub-metering and incentives for comprehensive, whole-facility performance.

- Understand that non-measure programs and services, including technical expertise and information systems, deliver valued benefits to customers and help ensure continuous engagement and operational efficiency gains. They also serve as a gateway to participation in shared investment opportunities, including traditional rebate programs.

Additionally, policy-makers should set forth strategies that facilitate next-generation efficiency: the integration of "traditional" energy efficiency measures with data-enhanced customer communication/control, real-time EM&V, demand management, distributed renewable generation, energy storage and combined heat and power. Especially when considering the role that commercial and industrial efficiency plays in a modernizing electricity grid: driving down overall and peak energy demand, building resiliency, and supporting two-way energy flow.

Conclusion

The strategies presented, while likely to be impactful for individual states and programs, will be more successful and in a shorter timeframe if coordinated regionally. In addition, a regional approach can leverage the collective experiences of a regional working group to facilitate knowledge transfers, identify best practices, share the cost and risk of new approaches, and scale-up through combined efforts to achieve long term market transformation of the Industrial sector. NEEP has the potential to facilitate a regional initiative with diverse stakeholders in 2016 and onwards to shape and implement the above-recommended strategies. We project that successful incorporation of new program offerings such as SEM to Industrial customers will stem the tide of opt-out requests, as programs will be providing value-add services such as sector specific technical expertise, forming trusted relationships, providing performance-based incentives, and continuous energy improvement to the region's industrial customers. Lastly, it will be essential to monitor and report the success and value of the full range of regional activities in industrial energy efficiency.

NEEP invites regional efficiency programs, the industrial sector and other market interests to work together with NEEP and fellow regional market actors to transform the industrial sector in the Northeast/Mid-Atlantic region.

Appendix 1: Northeast and Mid-Atlantic Industrial Energy Management Program Offerings

The following programs are available to industrial customers across the region to promote the adoption of energy efficiency measures and practices:[35]

Connecticut

Energize Connecticut Business Sustainability Challenge: Provides education and training for strategic energy management installation.

Delaware

Energy Efficiency Investment Fund: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Washington, D.C.

District of Columbia's Sustainable Energy Utility: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Maryland

Delmarva Power's Industrial Energy Savings Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Baltimore Gas & Electric's Commercial Energy Efficiency Program: Provides incentives for commercial and industrial building operators systems training.

FirstEnergy's Commercial and Industrial Efficiency Rebate Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Maryland Energy Administration's Commercial and Industrial Grant Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Massachusetts

Mass Save Efficiency Programs for Businesses: Provides financial incentives and technical assistance to commercial, industrial, and institutional customers.

New Hampshire

NHSaves Retrofits and New Equipment Incentives: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

New Jersey

Smart Start Buildings New Construction and Retrofits: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

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[35] U.S. Department of Energy. Database of State Incentives for Renewables and Efficiency website. http://www.dsireusa.org/

New York

ConEd (Gas) Commercial and Industrial Efficiency Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

National Grid (Electric) Non-Residential Energy Efficiency Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

PSEG Long Island Commercial Energy Efficiency Rebate Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

NYSERDA FlexTech Program: Provides technical assistance to manufacturing facilities pursing a broad range of efficiency measures.

NYSERDA Existing Facilities Performance Based Incentive Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Pennsylvania

FirstEnergy Industrial Energy Efficiency Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

PECO Energy Non-Residential Energy Efficiency Rebate Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Pennsylvania Department of Community & Economic Development's Alternative and Clean Energy Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

PPL Electric Utilities Custom Energy Efficiency Program: Provides prescriptive rebates and custom incentives on commercial and industrial systems.

Rhode Island

National Grid (Gas) Commercial and Industrial Energy Efficiency Program: Provides prescriptive rebates on commercial and industrial systems.

National Grid (Electric) Commercial and Industrial Rebate Program: Provides prescriptive rebates on commercial and industrial systems.

National Grid Large Commercial and Industrial Energy Efficiency Custom Program: Provides custom incentives on commercial and industrial systems.

Vermont

Efficiency Vermont Continuous Energy Improvement: Provides education, training, and custom incentives for commercial and industrial systems.

Appendix 2: Number of Manufacturing Establishments by State

The following chart displays the state-by-state breakdown of manufacturing facilities in each sub-sector.

Industrial Sub-sector	PA	NY	NJ	MA	ME	MD	DE	CT	NH	RI	VT	DC	Regional Totals
Food	1,179	1,989	884	588	190	335	61	272	107	144	170	17	**5,936**
Beverages and Tobacco Products	179	262	63	56	36	39	9	39	16	15	30	2	**746**
Textile Mills	114	174	87	78	22	26	2	28	18	49	7	1	**606**
Textile Product Mills	225	323	170	121	71	96	16	89	41	46	12	2	**1,212**
Apparel	182	1,104	143	64	6	31	6	20	13	11	13	2	**1,595**
Leather and Allied Products	44	116	24	28	23	7	4	4	14	7	6	0	**277**
Wood Products	948	504	131	174	176	100	18	111	118	29	101	0	**2,410**
Paper	246	248	153	130	22	39	5	55	23	27	5	0	**953**
Printing and Related Support	1,190	1,760	933	646	125	453	58	370	153	124	69	41	**5,922**
Petroleum and Coal Products	154	133	57	55	20	34	10	35	21	5	9	1	**534**
Chemicals	603	570	616	329	55	164	48	156	68	61	33	4	**2,707**
Plastics and Rubber Products	616	509	389	282	56	110	38	165	92	52	28	0	**2,337**
Nonmetallic Mineral Products	762	631	302	237	69	183	43	142	76	46	102	8	**2,601**
Primary Metals	359	177	101	95	13	30	4	68	31	48	3	0	**929**
Fabricated Metal Products	2,894	2,351	1,207	1,286	252	404	90	1,158	393	287	103	5	**10,430**
Machinery	1,209	913	579	523	83	142	23	439	156	107	67	0	**4,241**
Computer and Electronic Products	600	732	452	683	52	202	37	279	202	48	36	2	**3,325**
Electronic Equipment/Appliances/Components	288	327	182	209	10	44	14	146	55	29	22	2	**1,328**
Transportation Equipment	356	343	125	148	106	89	16	197	37	51	16	3	**1,487**
Furniture and Related Products	713	1,035	372	310	98	204	28	222	75	57	71	8	**3,193**
Miscellaneous	1,131	2,278	793	772	166	371	47	352	146	273	110	14	**6,453**
State Total	**13,992**	**16,479**	**7,763**	**6,814**	**1,651**	**3,103**	**577**	**4,347**	**1,855**	**1,516**	**1,013**	**112**	59,222