Continuous Energy Improvement Market Evaluation

YEAR 2

Prepared for:

New York State Energy Research and Development Authority

Albany, New York

Carley Murray, NYSERDA Project Manager

Prepared by:

The Cadmus Group LLC

Portland, OR

Karen Horkitz, Principal

Laura James, Associate

Heidi Javenbakht, Senior Associate

David Ladd, Senior Analyst

NYSERDA Contract 104542 September 2018

Record of Revision

Document Title
NYSERDA CEI Market Assessment Report – Year 2 September 2018

Revision Date	Description of Changes	Revision on Page(s)
September 2018	Original Issue	Original Issue

Notice

This report was prepared by Cadmus in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority (hereafter "NYSERDA"). The opinions expressed in this report do not necessarily reflect those of NYSERDA or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, NYSERDA, the State of New York, and the contractor make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. NYSERDA, the State of New York, and the contractor make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

NYSERDA makes every effort to provide accurate information about copyright owners and related matters in the reports we publish. Contractors are responsible for determining and satisfying copyright or other use restrictions regarding the content of reports that they write, in compliance with NYSERDA's policies and federal law. If you are the copyright owner and believe a NYSERDA report has not properly attributed your work to you or has used it without permission, please email print@nyserda.ny.gov.

Information contained in this document, such as web page addresses, are current at the time of publication.

Table of Contents

List of Tables

List of Figures

1. Introduction

The New York State Energy Research and Development Authority's (NYSERDA) Continuous Energy Improvement (CEI) Initiative seeks to achieve substantial, long-term energy savings by increasing uptake of ongoing, strategic energy management tools and practices by New York industrial facilities. The market evaluation for CEI will monitor and measure changes in the market for continuous energy improvement practices over the duration of the NYSERDA CEI Initiative.

1.1 Program Description

The CEI Initiative consists of three pilot programs. The On-Site Energy Manager Pilot, which launched its first pilot offering in September 2016, seeks to demonstrate the value proposition of hiring an on-site energy manager (OsEM) to champion and implement energy and process efficiency improvement projects through close integration with facility operations. The Strategic Energy Management Pilot, which launched in July 2017, will provide training and guidance to help facilities adopt the practices necessary for strategic energy management (SEM). The pilot seeks to overcome the initial adoption barriers and to demonstrate how New York facilities can operate with and benefit from SEM. Finally, the Energy Management Information Systems (EMIS) pilot, launched in November 2017, identifies qualified EMIS providers, and subsidizes the EMIS assessment and installation for participating facilities. The pilot will also develop case studies of successful adoption of EMIS to share with other end users. This pilot is intended to build market linkages by connecting EMIS suppliers to interested customers, overcoming barriers related to risk, cost, and lack of information.

1.2 Evaluation Objectives

This report presents the findings from the Year 2 CEI market evaluation activities. Table 1 lists the objectives for the Year 2 market evaluation, the purpose of each objective, and the Market Evaluation Team’s techniques to collect the data necessary to address the objectives.

Table 1. CEI Market Evaluation Year 2 Research Objectives

Objective	Purpose	Method
Characterize providers of EMIS systems	Understand supply-side drivers and potential barriers to providing EMIS	Interview EMIS providers
Assess the baseline forecast for EMIS adoption over time	Understand the likely EMIS adoption rate without NYSERDA's intervention	Delphi panel estimation, using a Bass-curve model
Develop an algorithm and calculation methodology to measure energy savings and CO_2e reduction impacts resulting from program-induced market adoption	Ensure agreed-upon methods for calculating indirect benefits; ensure necessary data collection occurs to support later calculations	Review initiative documentation (program theory/logic model, Clean Energy Fund Investment Plan: Industrial Chapter, Budget and Benefits workbook); identify specific evaluation activities and methods that will be used to estimate indirect savings
Compare the tools used to measure SEM adoption by the NYSERDA program team and the Market Evaluation Team	Understand the implications of different approaches to measuring SEM adoption, including potential for different estimations of SEM adoption	Comparison analysis of the scoring methodology used by the program and the market evaluation

2 Year 2 Results: Market Characterization and Methodology Updates

In Year 2 of the CEI Market Assessment study, the Market Evaluation Team performed qualitative research to better understand the market for EMIS, and to refine evaluation methods for future research. Primary data collection to update market progress indicators (MPIs) for SEM, OsEM, and EMIS components of the CEI Initiative is scheduled for Year 3. See Appendix A for the Year 1 assessment of each MPI tracked by the market evaluation.

2.1 EMIS Provider Interviews

The Market Evaluation Team conducted interviews with representatives from five of seven EMIS vendors that applied to serve as qualified vendors through the EMIS pilot. These interviews collected data to inform a qualitative assessment of the supply of EMIS in New York. These interviews addressed several research questions included in the CEI workplan and will provide context for MPI measurement in Year 3.

2.1.1 Providers

The EMIS providers interviewed by the Market Evaluation Team described different methods for delivering EMIS products and services. Two EMIS providers characterized their firms primarily as software companies, while the other three providers offered broader energy and facilities management services.

The two providers considering themselves primarily as software companies offer EMIS either as a standalone product or as part of a suite of software solutions for managing industrial and commercial processes. One provider employs a "software as a service" subscription-based model, offering cloud-based data storage; the other offers its software product only as a one-time purchase, citing customer security concerns (i.e., companies did not want their data accessible via the internet).

Representatives from the other three providers identified their firms more broadly as energy management services companies, identifying their EMIS software as one element of a broader array of efficiency and optimization offerings, variously including services and hardware for metering (including non-energy metering), data management, demand response optimization, and building recommissioning and retrofitting. At least two of these providers resulted from mergers, in which larger companies purchased

an EMIS software provider to complement their other business lines; EMIS does not represent a large share of these companies' total revenue.

One provider estimated that there were about five other providers of industrial EMIS serving New York, while another provider estimated the number to be around 10. A third provider noted there were hundreds of other "cookie cutter apps" in the market, while adding that they do not offer the data management or estimation features of that provider's EMIS product.

2.1.2 Products and Services

Four of the interviewed providers offer a branded EMIS software product, customizable to the customer's needs, although one provider does not provide "off the shelf" systems and exclusively develops customized software solutions built on a customer's existing data platforms. These EMIS solutions all provide quantification of energy savings by comparing real-time energy usage from metered and submetered systems to a baseline usage model, calculated through regression analysis. Because different facilities use different industrial processes, the number of submeters installed is highly customized to each facility's requirements.

Businesses deploying EMIS generally install such systems for the first time, rather than replacing a previous EMIS. Therefore, all interviewed providers offer training for customers that deploy their systems, teaching them how to operate the systems and interpret data output. Most staff who receive these trainings are facility managers, building engineers, and, sometimes, accounting staff. (EMIS also can automate and monitor utility bill payments.) For providers that offer additional products and services beyond EMIS software, training is most often provided on site, but also is held at the provider's company offices and sometimes remotely. EMIS providers offering only a software product are less likely to make on-site visits because the software can be downloaded and installed remotely.

Because EMIS deployments are customized for specific systems and facilities being monitored, and because these deployments often require further customization to integrate with preexisting data management and reporting systems, all but one provider interviewed offers EMIS-related support services in addition to training. The only provider not offering support services beyond initial training partners with third-party building systems integrators that offer such services. These support services include developing energy-usage models, establishing baselines to measure progress, and providing ongoing support for customer staff using EMIS. One provider also offers an "energy analyst" service, which provides customers with a consultant who is dedicated to helping them interpret EMIS outputs and

maximize usage of EMIS systems.

EMIS providers expressed differing opinions about integrating EMIS with control systems. Two providers said that they did not offer control systems and that this market is not part of their business model. Two other providers said that their EMIS product worked with control systems, but that this was not a feature that they highlighted for their clients. The remaining provider's legacy business includes control system installations, although EMIS is a relatively new product for the company. Providers that do not focus on control systems attributed it to a reluctance by industrial facilities managers to make energy-saving operational decisions an equal priority to primary company goals such as plant productivity, quality control, and employee safety. Several providers also said their firms face competition from well-established businesses—such as Honeywell, Johnson Controls, and Siemens—for which control systems are a primary line of business.

2.1.3 Marketing and Promotion

Because many company officials are not familiar with EMIS products and have limited knowledge of energy management in general, most EMIS providers provide seminars and presentations at trade shows and conferences to spread awareness of the EMIS concept and its potential benefits. Four providers market their products and services directly to potential end users, and all of them partner with distributers, resellers, engineering consultants, and other relevant actors in the industrial equipment and services markets.

For example, one provider identifying as a software company has partnered with a major engineering firm that sells the providers' EMIS solutions under its own brand name. Some providers also take advantage of opportunities to market EMIS through utility and government energy efficiency programs and pilots. Although all EMIS providers have some degree of EMIS marketing on their company websites, only one representative mentioned traditional advertising, and then it was only to state that the firm did very little of that. Providers also mentioned referrals from firms already deploying EMIS as an important driver of EMIS sales.

For EMIS providers offering additional lines of products and services for industrial customers, EMIS is often sold as part of a larger package of industrial process or building optimization solutions (i.e., recommissioning, retrofitting including DSM programs, data management, installation of metering and data equipment). These providers also can market EMIS products to customers with which they already have ongoing relationships through their other business lines.

Several providers highlighted the importance of their firms' EMIS auditing services. This audit precedes EMIS deployment and is used to determine hardware and software requirements for integrating EMIS with preexisting systems as well as the organizational requirements for effectively implementing EMIS (i.e., reports can be delivered to staff empowered to act in response). Providers reported that these audits (also known as readiness assessments) help customers develop a business case for EMIS deployment—a necessary step in gaining approval for purchasing the systems.

2.1.4 Typical Customers

Providers reported that firms deploying EMIS tended to be larger companies, often with a global reach, because implementation can be more cost-effective for a larger number of facilities. In addition, industrial EMIS customers tend to have processes that use large amounts of energy, providing greater opportunities for savings. One provider estimated that EMIS operates cost-effectively only for those firms with usage capacity of at least 10 MW. Additionally, providers noted that certain industries tend to gain greater immediate benefits from EMIS deployment, hence are more likely to install an EMIS. These included refrigerated storage, food and beverage production, chemical production, and plastic injection molding (the latter three of which are target sectors for the CEI Initiative due to their energy-intensive processes). These industrial processes use large amounts of energy and require strict temperature controls—processes for which EMIS can provide users with deeper insights into energy usage than would be possible without sophisticated monitoring and data modeling. Conversely, certain industrial facilities are less suited for saving energy through EMIS; one provider cited a "clean room" facility that is highly automated with tightly controlled systems, thus offering little opportunity for human intervention to alter the processes or energy usage.

Providers reported that there is little overlap between commercial and industrial EMIS systems. One provider noted that any commercial buildings where they installed EMIS tended to be affiliated with industrial facilities (i.e., the central offices for a company with industrial facilities), and they provided EMIS audits for government and other non-commercial institutions (i.e., universities and hospitals) solely in conjunction with demand-side management (DSM) program funding. A different provider with broader business lines, including commercial building services and equipment, had a more significant share of commercial customers for that reason; the provider noted that industrial and commercial energy savings followed a quite different logic in that energy use in commercial buildings mostly depends on human occupancy and activity (i.e., heating, cooling, and lighting), whereas the human factor often has less impact on energy use for industrial processes.

Most EMIS providers assign dedicated account managers to provide customer support, although, as previously noted, one provider uses a network of building systems integrators to provide training and support.

Of the five EMIS providers interviewed, only two had customers in New York state as of 2018, although all tried to gain business in the state to some extent. EMIS providers estimated that five to 10 firms in New York currently offer EMIS that meets NYSERDA standards, with a dozen or more firms offering energy analytics that do not meet full qualifications for EMIS.[1]

The four EMIS providers selling subscriptions or time-bound service contracts reported that more than 90% of their customers renew their EMIS-related contracts.

2.1.5 Market Barriers

EMIS providers reported that managers at industrial facilities have crucial process goals as their top priorities, including production targets, quality control, and employee safety. Under most circumstances, energy management is less of a priority, thus EMIS deployment is most often driven by making a business case to internal decision-makers, who generally have more authority than plant managers. The providers also stated that having a "champion" for the project within the customer organization makes it more likely that an EMIS will be deployed. Conversely, EMIS projects are unlikely to be deployed without a "champion" or if the person championing EMIS does not have the organizational authority or management access to get the project approved. EMIS providers said that difficulty engaging the appropriate decision-makers is a barrier to initiating EMIS audits, and therefore to EMIS deployment.

Successful EMIS deployments require support and participation by facility-level management in order to realize potential energy savings. Several providers cautioned that issues with organizational lines of authority or communications that constrain a facility manager's ability to take timely and effective action in response to EMIS outputs can greatly impact realized energy savings, citing experiences with deployments that fell short of projected savings. The providers stressed that installing EMIS software and hardware is insufficient to generate savings without accompanying actions, requiring a broad buy-in across an organization, clear and timely communications, and empowered managers in key positions.

[1] For example, an energy analytics tool that quantifies usage but not savings would not meet these qualifications.

EMIS providers reported that a lack of knowledge about EMIS and its benefits is an important deployment barrier. Managers at the facility level often do not consider energy costs because they do not have access to cost data, given that utility bills are processed by central accounting departments (particularly for larger companies with multiple facilities in different countries). Most providers estimated that about one-half of industrial firms are aware of EMIS, although estimates ranged from 20% to 75% (with the latter referring primarily to larger industrial firms).

Industrial firms pose another specific barrier: most already monitor many of their processes and might not see a need to purchase an EMIS when, in theory, they could deploy their own systems. However, as one EMIS provider put it, "This do-it-yourself mentality often leads to doing nothing." A related barrier arises from competition with companies selling proprietary control systems, offering energy analytics that might not meet NYSERDA standards for EMIS.[2] The proprietary nature of these systems gives control system providers a competitive advantage with their existing client base over firms offering full EMIS systems. One provider speculated that increasing penetration of connected devices may drive the industry toward more open data standards, which could mitigate this barrier somewhat.

2.1.6 Solutions and Strategies to Overcome Barriers

In part due to this low level of awareness, the EMIS providers all stressed the importance of the EMIS audit as a first step toward deployment. This audit does more than quantify potential savings to help the customer make a business case for EMIS; it also assesses equipment and data integration needs for EMIS installation and introduces customers to the organizational prerequisites for successfully adopting EMIS (or affirms that the customer has those prerequisites in place). All interviewed EMIS providers reported that a business case for EMIS is crucial for supporting a firm's decision to deploy EMIS. One provider noted that firms typically have target payback periods that can be as little as one year for investments such as an EMIS. Several providers said examples of documented savings from similar facilities and testimonials from companies that had deployed EMIS are important tools for bolstering the business case for EMIS. At the same time, some providers noted that broader economic forces play a role in EMIS deployment: when companies or their industries suffer economic downturns, they may be unwilling to invest in a large capital expenditure, no matter how good the return on investment or short the payback.

[2] To qualify for NYSERDA funding, an EMIS must gather and analyze energy and production data streams in real-time, provide visualization and analysis of energy consumption in parallel with production data, and allow users to track the savings impacts of capital projects or behavioral changes against an energy consumption baseline.

In addition, contacts established during the audit process may help the provider to identify and enable a "champion" within the customer organization. The decision to proceed with a simpler energy audit is often a technical one, whereas the decision to proceed with an EMIS audit is generally a higher management-level decision. These audits—which generally range in cost from at least $15,000 up to $50,000 or more—often involve several steps that allow firms to invest incrementally as they gain more information about whether an EMIS would be appropriate for them. EMIS providers reported that utility demand-side management programs often provide a significant portion of the funding for these audits, for example by refunding a portion of the audit cost upon the customer's commitment to EMIS deployment.

Several providers mentioned that government regulations and higher energy prices increase the market incentives for EMIS deployment, although these factors are often cyclical in nature. Some providers also noted that energy-related policies—such as demand response programs and mandates and time-of-use (TOU) energy pricing—can motivate firms to adopt an EMIS. In addition, increasing use of renewable energy and energy storage systems could present opportunities for expanding EMIS penetration going forward. As one provider noted, "when" energy is used will become a more important factor in energy costs with this evolution in energy distribution.

2.2 EMIS Market Adoption Forecast

Using a Delphi panel approach, the Market Evaluation Team developed a baseline forecast of EMIS adoption over the next 20 years in the absence of NYSERDA interventions. This approach was the same as that used to develop baseline adoption forecasts for OsEMs and SEM, presented in the Year 1 market evaluation.[3] The baseline adoption forecast provided a qualitative reference, intended to be part of a comprehensive assessment to determine the impact of NYSERDA programs on market adoption (see Section 2.3).

The forecast represented a consensus estimate, based on separate estimates provided by a panel of 8 market experts over two iterations. Each expert provided an initial estimate of future market adoption and a brief explanation of the rationale for their estimate. For the second iteration, panelists were instructed to review other panelists' initial responses, and update or maintain their original responses, incorporating the new information. Following the second iteration, the Cadmus Market Adoption Tool (CMAT) calculated

[3] Cadmus. *Continuous Energy Improvement Market Evaluation 2017 (Year 1).* Prepared for New York State Energy Research and Development Authority. September 2017.

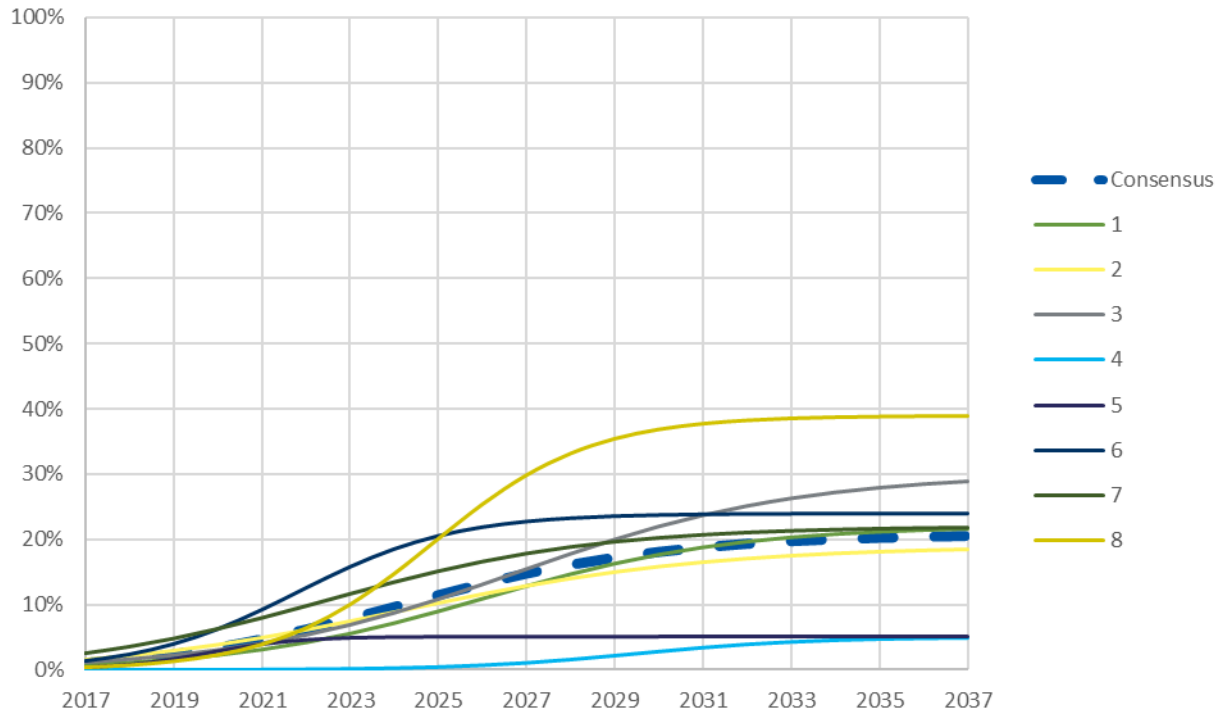
a consensus curve, representing the average market adoption forecast by panelists, fit to a Bass curve model. (See the Year 1 report for more detail on the Bass curve forecast and the Delphi panel selection and process.)

2.2.1 Baseline Adoption Forecast for EMIS

Figure 1 shows second-iteration curves submitted by each panelist and the consensus curve. The consensus curve for EMIS market adoption shows a maximum adoption of 20%, achieved in 2037. Early uptake is very slow. Uptake becomes most rapid in 2025 as followers catch on, but tapers off quickly, reaching a plateau by 2032.

Figure 1. Market Adoption Forecast through 2037 for EMIS

Source: CMAT



Panelists provided comments to explain each of their estimates. Five panelists commented that only the largest facilities could cost-effectively implement an EMIS, with two panelists specifying a threshold of at least $1 million annual energy expenditure, and two panelists specifying at least $500,000. Other panelists noted that barriers to EMIS adoption include the difficulty of getting buy-in from upper levels of management, and industrial facilities' lack of focus on energy management relative to production. However, panelists also cited potential for market penetration of EMIS to increase. One panelist noted

that the growth of Internet of Things applications and data management tools generally should reduce the cost and complexity of EMIS. Others cited potential government controls on energy and demand consumption, or a need to keep pace with competitors as EMIS adoption grows as factors that could make EMIS a more attractive investment. One panelist cited their experience in the New York market specifically, saying demonstrated commitments from customers for similar initiatives offered by other entities caused them to set their estimate for maximum penetration above the panelist average. Complete panelist comments are presented in Appendix F.

This curve is similar in profile to the baseline adoption forecasts for SEM and OsEM. However, the maximum market penetration expected for EMIS (20%), is below the maximum market penetration forecast for SEM (25%) and for OsEM (38%).[4] This result corresponds to panelists statements that the market for EMIS is limited to the largest facilities. According to the Year 1 Market Evaluation, facilities with energy expenditures over $500,000 (the lowest threshold suggested by panelists) make up about 16% of the New York industrial population.

2.3 Continuous Energy Improvement Indirect Impacts Methodology

NYSERDA's CEI Initiative is designed to create sustained market changes that result in increased market adoption of OsEMs, SEM practices, and EMISs. In addition to direct impacts realized by participants in NYSERDA's three pilot programs, the Clean Energy Fund Investment Plan: Industrial Chapter (CEF Industrial Chapter) estimates that the CEI Initiative will generate the indirect benefits summarized in Table 2.[5]

[4] Cadmus. *Continuous Energy Improvement Market Evaluation 2017 (Year 1).* Prepared for New York State Energy Research and Development Authority. September 2017.

[5] New York State Energy Research and Development Authority. *Clean Energy Fund Investment Plan: Industrial Chapter*. Revised November 1, 2017. https://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/CEF-Industrial-chapter.pdf.

Table 2. Estimated CEI Indirect Market Impacts

Source: NYSERDA CEF Industrial Chapter, 2017

Indirect Impact		2020	2025	2030
OsEM				
Energy Efficiency	MWh Cumulative Annual	30,000	105,000	180,000
	MMBtu Cumulative Annual	375,000	1,310,000	2,250,000
CO_2e Emission Reduction (metric tons) Annual	CO_2e Emission Reduction (metric tons) Annual	37,000	129,000	222,000
SEM				
Energy Efficiency	MWh Cumulative Annual	9,270	32,500	55,600
	MMBtu Cumulative Annual	71,600	322,000	430,000
CO_2 Emission Reduction	CO_2e Emission Reduction (metric tons) Annual	8,770	34,600	52,600
EMIS				
Energy Efficiency	MWh Cumulative Annual	-	34,331	91,548
	MMBtu Cumulative Annual	-	530,193	706,925
CO_2 Emission Reduction	CO_2e Emission Reduction (metric tons) Annual	-	48,033	88,124
Total				
Energy Efficiency	MWh Cumulative Annual	39,270	171,831	327,148
	MMBtu Cumulative Annual	446,600	2,162,193	3,386,925
CO_2 Emission Reduction	CO_2e Emission Reduction (metric tons) Annual	45,770	163,600	274,600

Indirect impacts are challenging to evaluate and cannot be directly verified because NYSERDA does not directly engage with companies not participating in the pilots or CEI Initiative and, therefore, does not have access to their energy consumption or savings data. The following sections summarize the Market Evaluation Team's approach to developing a credible estimate of energy savings and emissions reductions resulting from CEI program-induced market adoption.

2.3.1 Estimation Algorithm

The Team will use the following algorithm to estimate indirect benefits from each of the three CEI Initiative components—OsEM, SEM, and EMIS:

$$\boldsymbol{Indirect\ benefits_t} = [(\boldsymbol{Nonparticipant\ Adoption} - \boldsymbol{NOMAD}) + \boldsymbol{Direct\ Influence\ Participant\ Adoption}]_t * \boldsymbol{UEB}$$

Where the equation's variables have the following definitions:

- **Nonparticipant Adoption:** Units of adoption of the technology or practice by nonparticipating targeted end users
- **Naturally-Occurring Market Adoption (NOMAD):** Estimated end users that would have adopted the technology or practice absent NYSERDA's intervention, by type of end user
- **Direct Influence Participant Adoption:** Additional units of adoption by participant companies after they are no longer receiving incentives or direct support from NYSERDA[6]
- **Unit Energy Benefit (UEB):** Energy savings (MWh or MMBtu) or CO_2e reductions per unit of adoption of OsEM, SEM and/or EMIS, by type of end user[7]

Note that this equation must be applied to each of the three CEI components—OsEM, SEM, and EMIS—because NYSERDA estimates indirect benefits for each of the three programs separately. The Team will report on indirect impacts beginning in 2019—Year 3 of the market evaluation.

In reviewing NYSERDA's documentation supporting their estimates for direct and indirect impacts, the Team noted that while the CEI Budget and Benefits workbook uses a single value for the UEB for each CEI component, the CEF Industrial Chapter assumes different savings values for medium and large facilities for OsEM. NYSERDA may want to consider whether it also makes sense to determine a different UEB for the six energy intensive industries targeted by the initiative, relative to other facilities for OsEM or the other initiatives. In this case, the Team would apply the indirect savings algorithm to these populations separately.

2.3.2 Indirect Impact Estimation Methodology

As described above, the indirect benefits algorithm comprises four variables: (1) nonparticipant adoption, (2) naturally-occurring market adoption (NOMAD), (3) direct influence participant adoption, and (4) unit energy benefit (UEB). The Market Evaluation Team designed market research activities and research instruments to estimate each of the first three variables. These research activities and the estimation approach for each variable are summarized in Table 3 and described below.

[6] This type of adoption is also known as participant spillover in the context of traditional utility resource acquisition program evaluations.

[7] Note: impact evaluation falls beyond the scope of NYSERDA's market evaluations. Evaluators will use the values documented in NYSERDA's CEF Industrial Chapter, unless updated or directed otherwise.

Table 3. Indirect Benefits Algorithm Variables and Research Activities

Algorithm Variables	Research Activity/Source	Estimation Method
(1) Nonparticipant Adoption	Industrial Facility Manager Survey (biannual)	The estimated proportion of industrial facilities adopting OsEM/SEM/EMIS multiplied by the total number of facilities.
(2) NOMAD	• Delphi panel/CMAT • Industrial facilities survey	The Market Evaluation Team will average the NOMAD estimate from the Delphi panel and the estimate derived from the industrial survey to determine the NOMAD value it will use to calculate indirect benefits.
(3) Direct Influence Participant Adoption	Participant Survey (annual)	Additional units of adoption by participant companies after they are no longer receiving incentives or direct support from NYSERDA OsEM/SEM/EMIS
(4) UEB	CEF Industrial Chapter assumed/updated values	Unit energy savings and CO_2e reduction values will be applied for OsEM, SEM, and EMIS, by facility type.[a]

[a] Per the CEF Industrial Chapter, the Market Evaluation Team assumes NYSERDA will evaluate distinct UEBs for OsEM, for medium and large facilities. UEBs also could be estimated for targeted, high-intensity industries versus others.

2.3.2.1 Nonparticipant Adoption

The Market Evaluation Team will rely on the industrial facilities survey, repeated every two years, to estimate nonparticipant adoption, using these steps:

- Analyze survey data to calculate the proportion of the nonparticipant population that has implemented OsEM, SEM, and EMIS
- Multiply the proportion of the nonparticipant population that has implemented each measure by the total number of facilities in New York state to determine "units" of adoption; the Team assumes a unit is equal to a single facility, but may distinguish between types of units (i.e., medium and large), as directed by NYSERDA

2.3.2.2 Naturally-Occurring Market Adoption

The Market Evaluation Team will use two sources/methods to estimate NOMAD for each of the three industrial measures: the Delphi panel with Cadmus Market Adoption Tool (CMAT) and the industrial facilities survey. In addition, the Team will triangulate results from market actor surveys with industrial consultants and service providers to substantiate estimated program influence.

Delphi Panel/CMAT. The Delphi Panels ask participating experts to forecast market adoption assuming no NYSERDA market intervention and result in a consensus estimate of NOMAD, for each period (*t*).

Industrial Facilities Survey. Beginning with the second wave of the industrial survey, to be conducted in 2019, respondents who indicate that they have implemented OsEM, SEM, or EMIS will be asked

questions designed to detect program influence. The Market Evaluation Team will analyze the results of these survey questions to estimate the proportion of adoptions for which NYSERDA had zero influence, some influence, or full influence, using a method similar to that used to estimate participant spillover for resource acquisition programs. The Team will multiply the proportion not influenced by the program by the number of adoptions to come up with a second estimate (in addition to the Delphi/CMAT estimate) of NOMAD. The details of this method are described in Appendix B.

The Team will average the NOMAD estimates from the Delphi panel and the industrial survey program influence analysis for each CEI measure and use these average values in the indirect benefits estimation algorithm.

Market Actor Surveys/Interviews. Because market transformation initiatives seek to accelerate and increase market adoption indirectly via market interventions, it is critical to assess causality to develop a credible estimate of indirect benefits. NYSERDA's market transformation initiatives each have a program theory and logic model, which document the hypothesized theory of market change, including causal linkages between program market development activities, outputs, and market outcomes. Beginning in 2019, the Team will include questions in market actor survey and interview research instruments to investigate the validity of the hypothesized initiative theory of market change and to substantiate the causal relationship between initiative market development activities and outcomes. This investigation will become increasingly relevant as time goes on, to substantiate the influence of NYSERDA's market intervention.

2.3.2.3 Direct Influence Participant Adoption

The Market Evaluation Team will rely on longitudinal participant surveys (every two years) to estimate adoption by program participants companies that were directly engaged with NYSERDA and subsequently implemented one or more CEI measures. The participant surveys will include questions that ask respondents to quantify the number of facilities at which their company implemented OsEM, SEM, and EMIS without direct assistance from NYSERDA. The team will consider all such adoptions to be influenced by the program.

Additional detail on the indirect benefits estimation methodology is presented in Appendix B.

2.4 Comparison of SEM Scoring Methods

The Market Evaluation Team compared the NYSERDA implementation team's Energy Management Assessment (EMA) tool to the Team's assessment scoring rubric (assessment tool) used to measure SEM adoption. The comparison sought to identify areas where the EMA tool might produce a different assessment of SEM adoption than the assessment tool. The comparison found that the two tools employ different questions and have some structural differences, but they use a common basis to assess SEM adoption and will produce similar estimates of SEM adoption.

The two tools both use a survey-based approach based on the measurement framework for SEM adoption created by the Consortium for Energy Efficiency (CEE). However, the assessment tool and the EMA tool take different approaches to measuring SEM that reflect their different objectives. The assessment tool, which was designed to consistently measure the number of SEM adopters in the NY industrial market over time, recognizes three levels of adoption for each subelement: no adoption, partial adoption and full adoption. A facility that achieves full adoption in all 14 subelements measured by the tool is then counted as an SEM adopter. The assessment tool scoring does not distinguish between minimum and more advanced levels of adoption.

The EMA tool, on the other hand, is more oriented to identifying progressive levels of SEM adoption. Because the EMA tool measures SEM adoption with more gradation (measuring five levels of adoption of each subelement instead of the three levels measured by the assessment tool), the EMA tool scoring registers progress beyond the minimum level of SEM practice, as defined by the CEE framework. For example, if a facility has an average score of 3 in a given category, the EMA tool can continue to register incremental progress through levels 4 and 5 as the facility improves.

The difference in scoring approach means that results from the EMA tool cannot be directly mapped to the results from the assessment tool. However, while scores do not map exactly, the analysis found that scores of 3 or higher generally correspond with full adoption using the assessment tool. In most cases, facilities that receive average scores of three or higher would be counted as full SEM adopters by the assessment tool.

Appendix D provides more detail on the analysis and a question-by-question comparison of the two tools.

3 Findings and Recommendations

This section presents key findings that the Market Evaluation Team identified from the analysis conducted in Year 2. Recommendations associated with each key finding are intended to improve the quality and utility of remaining market evaluation studies for the CEI Initiative.

3.1 Finding 1

Findings from the market adoption forecast and the EMIS provider interviews corroborate many market barriers documented in the CEF Industrial Plan logic model and reinforce that the market potential for EMIS is limited to the largest industrial facilities. EMIS providers confirmed that the primary barriers to EMIS adoption are general lack of awareness of EMIS and the lack of understanding by facility managers of the potential for cost savings through energy management. In addition, providers noted that the readiness assessment is a critical tool for motivating a facility to move forward with an EMIS, because it demonstrates in concrete terms how the EMIS will integrate with existing systems and the value proposition for EMIS. Panelists cited the need for buy-in across departments as a significant barrier to EMIS adoption. However, both providers and Delphi panelists stated that market potential for EMIS is limited to the largest facilities. One EMIS provider estimated that only facilities with at least a peak draw of 10 MW would be large enough to realize a return from an EMIS system, while panelists estimates varied. Some panelists cited $500,000 in annual energy expenditures as a minimum threshold, while others stated that the threshold would be at least $1 million. Additionally, providers said that energy-intensive industries are the best candidates for EMIS, with one provider citing cold storage warehousing as an example.

3.1.1 Recommendation 1

In the next iteration of the CEF Industrial Chapter, NYSERDA should clarify its assumptions regarding populations that may benefit from uptake of EMIS systems. While the CEF Industrial Chapter defines the target market as firms in energy intensive industries with organization and management able to support the structured long-term engagement necessary for CEI practices, findings from this study suggest the target market is further limited to facilities with the largest energy expenditures—at least $500,000 in annual energy expenditures. In addition, the Market Evaluation Team is currently defining the industrial population as those facilities having an NAICS code of 31 through 33, which is specific to manufacturing. NYSERDA should consider expanding the population of analysis to include cold storage warehousing and purchasing data for facilities in this subsector, to inform the market evaluation.

3.2 Finding 2

Indirect benefits estimation requires estimation of four variables for each measure: nonparticipant adoption, NOMAD, direct influence adoption, and UEB. The input values used for each of the first three variables must correspond to the measure UEB values. For example, if NYSERDA intends to use two different unit energy savings values to estimate savings associated with OsEM adoption in medium and large facilities, the Market Evaluation Team also should estimate nonparticipant adoption, NOMAD, and direct influence adoption separately for medium and large facilities. Alternatively, if NYSERDA intends to use aggregate UEB values, the Market Evaluation Team should also estimate the other values in aggregate. NYSERDA's CEF Industrial Chapter identifies separate OsEM UEB values for medium and large facilities, while the CEI Budget and Benefits workbook (BAB) currently uses a single value for unit energy savings, for all three CEI components.

3.2.1 Recommendation 2

To ensure the Market Evaluation Team performs the data collection and analysis necessary to calculate indirect benefits, NYSERDA should clarify how, and for which segments of the market, it intends to evaluate or estimate UEB values. To ensure effective evaluation of energy savings, NYSERDA should clearly document the sources and assumptions for direct and indirect benefits forecasts in its BAB workbook.

3.3 Finding 3

Although the market assessment tool and the EMA tool use different scales, it is likely that they would provide similar indications of SEM adoption at a population level, and similar year-to-year incremental progress from no or low-level SEM adoption to full SEM adoption at a minimum level.

4 Methods

4.1 EMIS Provider Interviews

The Market Evaluation Team reached out to representatives from seven companies that NYSERDA approved to provide EMIS through the pilot program. Each company provides EMIS for industrial and commercial businesses in North America and globally. The Team conducted five structured interviews by telephone during June and July 2018. Two representatives were unavailable. The interview guide is available in Appendix E.

4.2 EMIS Market Adoption Forecast

To determine the baseline market adoption forecast for EMIS, the team used an exponential diffusion curve (i.e., the S-shaped Bass curve) to model market adoption over time. Frequently used to model market adoption, the Bass curve model is the same model that the team used to develop baseline forecasts for the SEM and OsEM markets in Year 1. Appendix G of the CEI Market Evaluation Year 1 report provides a more detailed description of the model, including the Bass curve function, so those details are not repeated in this report. The Market Evaluation Team defined the evaluation period as 20 years, stretching from 2017 to 2037, and set the 2017 initial adoption level as 2%, based on results from the end-user survey conducted in early 2017.

The team used a Delphi panel approach to gather and refine estimates from a group of 8 subject matter experts to determine the consensus curve. A Delphi panel is a method used to synthesize and stabilize expert opinions on a particular question or topic to improve the precision and quality of responses. The method allows participants to refine their responses to a research question through data sharing and multiple iterations of estimation. In this case, each panelist provided an initial Bass curve estimate for EMIS adoption, then refined this estimated curve in a second iteration after reviewing peers' estimates.

Panelists submitted their estimates through the CMAT, a web-based application developed by the team. Using CMAT, each panelist reviewed background information on New York's industrial sector and EMIS. After reviewing the background information, panelists navigated to the tool's estimation page and used interactive slider bars to adjust the Bass curve's shape, according to their adoption prediction.

In the second iteration, each panelist could access a new page that showed all panelists' estimated curves in addition to an average of first-iteration curves. Each panelist could review comments from other

panelists (presented anonymously) that identified the assumptions behind each curve. Panelists could then revise their original estimates, adopt the Round 1 average estimate, or make no changes.

The Market Evaluation Team recruited panelists based on peer-recognized subject matter expertise, and through the EMIS provider interviews. Table 4 describes the background of the recruited panelists. While the Team targeted a panel of 10 experts, eight panelists ultimately completed both Round 1 and Round 2. The Team reviewed each panelist's comments following each round to ensure that all panelists understood the task and the basic assumptions. The team retained all responses in each round. Each panelist received a $50 gift card as an honorarium for participating.

Table 4. Composition of Delphi Panel

Category	Number of Panelists
EMIS Provider (interviewed in 2018)	4
Energy Consultant (interviewed in 2017)	1
Program Implementer	1
Researcher	2
Total	**8**

4.3 Comparison of SEM Scoring for Program and Market Evaluation

The Market Evaluation Team conducted a side-by-side analysis of EMA and the market adoption tools to assess potential differences in structure and to determine how elements within each structure were scored. The team provided NYSERDA with a workbook containing the comparison analysis to serve as a reference.

The comparison initially relied on the original version of the market adoption tool's scoring matrix, but the team updated the findings from this analysis after updating the end-user survey and the scoring matrix as part of Year 2's research activity.