Clean Energy Fund Workforce Development and Training Industry Partnerships Baseline Study

Final Report

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1   Introduction

The New York State Energy Research and Development Authority (NYSERDA) created the
Workforce Development and Training (WFD) initiative to deliver the clean energy workforce
skills employers need. NYSERDA has a long history of working in partnership with other
organizations to identify and meet workforce training needs. NYSERDA leverages an Industry
Partnership approach, which involves obtaining stakeholder input to help identify, implement,
and replicate workforce development and training initiatives designed to match industry
workforce needs with a supply of skilled workers.

NYSERDA is currently focusing its WFD Industry Partnerships initiative efforts in the area of
building operations and maintenance. However, NYSERDA anticipates that it will assess the
potential for developing follow-on industry partnerships throughout the WFD initiative to address
additional workforce training needs in other target sectors or technologies, such as renewables or
distributed generation technologies. The WFD Initiative is funded by NYSERDA's Clean Energy
Fund (CEF).

This report documents the baseline performance metrics for this initiative.

1.1   The WFD Initiative Description

In the past, NYSERDA has implemented several training development demonstration projects in
building operations and maintenance (O&M) to demonstrate the business case for investing in
workforce training in a wide range of markets (commercial, industrial, and multifamily).
NYSERDA then solicited proposals to develop training through industry partners – that is,
organizations that employ O&M staff and are willing to partner with NYSERDA to develop and
lead training of their O&M staff. NYSERDA specifically funds these partners to develop in-
house, industry-specific training. The partners propose a plan that indicates what training would
cover, who would develop and provide the training, and who would be trained with the
NYSERDA funds. The training could include a train-the-trainer element.[1] The partners are
responsible for contracting with training providers to develop and implement the training.

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[1]   Train-the trainer refers to development of internal trainers to provide continuous and consistent on-the-job
        training.

The initiative targets organizations and leverages the partnership approach referenced above to overcome market barriers through the following pathways:

- Helping identify worker skills needs
- Informing investments in skills and talent development
- Supporting career pathways
- Developing the training infrastructure needed to better link supply and demand in the labor market
- Replicating training throughout each organization without additional NYSERDA funds

1.2 Evaluation Objectives and Methods

The primary objective of this study was to develop baseline indicators for the WFD Industry Partnerships Initiative. Table 1 summarizes the objectives of this study and research methods used to meet those objectives.

Table 1. Initiative Objectives and Main Research Questions

Objectives – Assess	Primary Evaluation Question(s)	Data Sources
Improve and expand the readily available workforce qualified to train others in the area of building operations and maintenance	• What are the benefits of expanding the workforce qualified to train others? • How many, if any, staff are currently qualified to deliver training to their peers either on the job or during designated times? • What is the value of training to new and existing employees? Value could be measured in terms of job placements and/or internships, opportunities for low- and moderate-income workers, starting wages and wage increases, career paths and advancements, and attainment of certifications?	Participant and Non-participant Building O&M Employers across several verticals within the industry (education, healthcare, commercial, multifamily, etc., property owners and managers), via phone interview
Promote an industry partnership approach to workforce training	• Do industry partnerships help inform employer-driven workforce solutions, such as improved skills enhancement for existing workers; increased access to entry level jobs for disadvantaged (including workers from low- and moderate-income communities) New Yorkers; and increased energy savings and net operating income for building owners?	Same as above
Demonstrate the value of training to employers of building workers	• What are the gaps in current curricula and what additions are needed to include new industry standards and technological changes? • Does instituting a culture of continuing professional development among operations and maintenance staff lead to improved worker retention, knowledge transfer as aging workers approach retirement, and decreased employer time to find and hire new talent with the appropriate skills?	Same as above

Table 2 lists the performance indicators the research team evaluated with an explanation of how the research team assessed them and the metrics the research team will use to assess changes over time and differences between participating and non-participating organizations. The table shows both primary and secondary metrics. The primary metrics directly address the indicators as identified by the initiative. For some indicators (e.g., number increase in number of workers trained through the initiative), the primary metrics are, by definition, equal to zero at the 2016 baseline as there are yet no trainees yet at baseline. Further, they do not allow a comparison between participants and non-participants, as the staff of non-participating organizations will not include "trainees," that is, staff who receive training through the initiative.

Most of the secondary metrics, however, may have non-zero baseline values. Further, most apply to both participating and non-participating organizations, allowing comparisons between participants and non-participants at baseline and at each later assessment; these are shown in the following sections of this report. Note that some indicators do not specifically reference an "increase" in change from the baseline (e.g., number of incumbent workers advanced/promoted), but this is implied, and so the research team includes the implied reference to an "increase" in brackets in the table.

To meet the study objectives and assess the baseline indicators, the research team conducted primary research with industry partners or organizations participating in the initiative as well as with comparable organization that were not participating in the initiative.

The primary research with the participating partners or organizations had two components. First, the team interviewed NYSERDA's primary contact for nine of the 12 participating industry partners or organizations . The team refers to these 12 partners as "participants" and to the nine included in the team's interviews as "interviewed participants." The team conducted additional primary research with one of the interviewed participants, an association that represents multiple school districts that will send O&M staff to participate in the training. The primary contact for that organization could not provide the requested information for all the involved school districts. Therefore, the research team staff conducted a web survey of O&M supervisors for those school districts to obtain additional input on performance indicators. (For more details, see Section 4.2.)

Table 2. Performance Indicators, Assessments, and Metrics

Performance Indicator[a]	Baseline Assessment	Primary Metric(s)[b]	Secondary Metric(s)
Increase in number of workers trained through the initiative	N/A – The number of workers trained at baseline is, by definition, zero.	Total number trained (participants only*; by definition = 0 at baseline)	Mean number trained per participating organization (participants only)
Increase in the percent of trainees obtaining national certifications	Number and percent of workers with national certifications in year before beginning of initiative	Percentage of trainees obtaining national certifications (participants only; by definition = 0% at baseline)	Percentage of all O&M staff with national certifications
Increased number of staff qualified to train others	Number of staff qualified to train others in year before beginning of initiative	Total number of O&M staff qualified to train others	Mean number of qualified O&M staff per organization
Increased number of new curricula available	Number of new curricula in use in year before beginning of initiative	Number of new curricula in use	None
[Increase in] Number of incumbent workers advanced/promoted	Number of incumbent workers advanced/promoted in year before beginning of initiative	Total number of incumbent workers advanced or promoted	Percentage of O&M staff advanced or promoted
[Increase in] Number of individuals placed into paid internships/on-the-job training/apprenticeships	Number of individuals placed into paid internships and into apprenticeships	Total number of individuals placed into paid internships and into apprenticeships	Mean number of individuals placed per organization
[Increase in] Number of disadvantaged low-to-moderate income (LMI) workers placed in building operations and maintenance jobs	Number of disadvantaged (LMI) workers placed in building operations and maintenance jobs	Total number of LMI workers placed into O&M jobs	Mean number of LMI workers placed per organization
Increase in wages for trainees	Number of O&M staff who received wages increases in year before beginning of initiative	Total number of trainees with increased wages (participants only; by definition = 0 at baseline)	Percentage of trainees with increased wages (participants only) Percentage of O&M staff with increased wages
Improved employee retention	Number of employees who left employment voluntarily in building operations and maintenance jobs	Total number of O&M employees who left employment voluntarily	Percent of O&M employees who left employment voluntarily
Decreased time for employer to find and hire new talent with the appropriate skills	Time required for employer to find and hire new talent with the appropriate skills	Mean, median, and range of reported time required to find, hire, and train	None

[a] The first seven performance indicators in this table are among the activities, outputs, and outcomes that are required to be reported to DPS for this initiative.

[b] Metrics that refer specifically to trainees apply only to participating organizations, as non-participating organizations, by definition, will not train workers through the initiative.

The primary research with the non-participating organizations was a telephone survey with 68 large commercial and multifamily property managers (owners, managers, etc.) who were not engaged with NYSERDA in development of a training program. (The team refers to this group as "non-participants.") Surveyed non-participating organizations were similar to participants and the overall population in terms of the market sectors represented.

In addition to the above primary research, the team conducted a review of WFD program data and secondary data sources. For more details, see Section 4.3.

1.3 Summary of Participating Organizations

Of the 12 participants, five are property management firms (both non-profit and for profit), three are hospitals, three are universities or colleges, and one is an organization representing K-12 school districts in New York. Based on information collected by program staff, these 12 participants collectively plan to train more than 1,500 staff directly through the WFD Industry Partnerships initiative and about 1,400 indirectly, by staff trained through the program.[2] The approximately 600 staff[3] that will be trained by the nine interviewed participants manage more than 850 buildings, with at least 32 million square feet of building space in New York (see Table 3).[4]

Table 3. Participation Reach, Nine Interviewed Participants[a]

Descriptions	Sum
Total Number of O&M staff at participating organizations (n = 9)	~1,285 staff
Number of staff planned to be trained through NYSERDA WFD program (n = 9)	~570-620 staff[b]
Number of buildings served by O&M staff that will be trained (n = 8)	≥ 851 Buildings
Square footage of buildings served by O&M staff that will be trained (n = 8)	≥ 32,130,494

[a] One out of nine respondents was not able to answer how many buildings and the square footage of those buildings were served by O&M staff the O&M staff who will be trained are employees of the organization and work at multiple locations.

[b] The research team could not establish an exact count for one interviewed participant and so used the range reported in that participant's contract with NYSERDA.

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[2] A "Metrics Master List" *MS Excel* workbook provided by NYSERDA program staff reports 1,578 staff to be trained directly and 1,383 to be trained indirectly.

[3] The research team was not able to establish a single estimated count for one participant. That respondent represented multiple school districts and could not report details for those districts. As detailed in Section 4.1, the research team surveyed contacts for those districts, but only three reported the number of staff to be trained. Therefore, the research team used the range of planned trainees (40 to 90) specified in that participant's contract with NYSERDA rather than data from the interview and subsequent survey.

[4] The square footage estimate is based on self-reports from participants during short answer interviews. Estimate does not include the three participants that did not complete an interview. Given the small number of participants, the research team did not extrapolate data from interviewed participants to the entire participant population.

All interviewed participants reported that the O&M staff who will be trained are employees of the organization and work at multiple locations.[5]

The research team asked interviewed participants what percentage of their buildings were in Class A, B, and C. These classifications represent a subjective quality rating of office space.[6] After observing the challenges for respondents in reporting the classifications of their buildings and determining that many sectors do not use these classifications, the research team removed this line of questioning.

1.4   Summary of Non-participating Organizations

The majority of non-participating organizations surveyed were in the healthcare, education, and property management sectors (see Table 4). These were also the most common sectors based on the research team's analysis of the population (for more information see Section 4.3 Non-Participant Survey).

Table 4. Non-Participant Respondents' Organization Type

Organization Type	Organization Count (Raw)	Percent
Healthcare	18	27%
State-certified K-12 school (public or private)	13	20%
Property management	10	15%
Government	7	11%
Industrial/manufacturing	5	8%
College/University	4	6%
Museum	2	3%
Professional services (office)	2	3%
Entertainment	1	2%
Transportation (trucking, boating, air)	1	2%
Restaurant	1	2%
Other school type	1	2%
Total	**65**	**100%**

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[5]   Of the 18 surveyed school districts (see footnote 3), four reported that all the staff to be trained work at a single location, while the remaining 14 reported that all of the staff to be trained work at multiple locations.

[6]   Visit http://www.boma.org/research/pages/building-class-definitions.aspx for more information.

Based on the survey of 66 individuals representing 65 organizations, respondents' organizations represent more than 3,000 staff and 162 million square feet.[7] When the research team extrapolated these responses to the population of 3,383 organizations, the research team estimate that non-participants represent more than 8 billion square feet in New York State (for more information see Section 4.3 Non-Participant Survey).[8]

Table 5. Non-Participant Reach

Descriptions	Sum (Raw)	Sum (Extrapolated)
Total Number of O&M staff at non-participating organizations	3,413	177,629
Number of buildings served by O&M staff	1,552	80,772
Square footage of buildings served by O&M staff	162,589,948	8,462,181,448

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[7] The research team excluded two outliers based on reported square footage.

[8] As explained in Section 4.5, the extrapolation factor was determined by dividing the total number of distinct organizations in the population (3,383) by the total number of distinct organizations in the sample list (65).

2 Initiative Outcomes and Performance Indicators

The following sections provide details on data collected from primary research on the outcome indicators identified above in Table 2. The team considered the pre-CEF year of 2016 to constitute the baseline period. NYSERDA's CEF Baseline Estimates were zero for some indicators and greater than zero for others. Details of the team's analysis methods can be found in Section 4.

Note that, throughout this section, the research team identifies indicators and metrics showing differences that exist between the participating and non-participating organizations at this baseline assessment, before any potential effect of the NYSERDA-supported training. Such differences suggest that the participants are a self-selected group relative to non-participants, with the current participant population possibly representing the "leading edge" of organizations that are more motivated to adopt practices that promote good O&M performance and – as such – more likely to partner with NYSERDA to improve workforce training. Implications of this are discussed in Section 3, Conclusions and Recommendations.

This research will be repeated in 2019 and 2022 to ascertain change in the indicators over time.

2.1 Training and Certification

The first four performance indicators relate to training and certification: 1) increase in number of workers trained through the initiative; 2) increase in the percent of trainees obtaining national certifications; 3) increase in the number of staff qualified to train others; and 4) increase in the number of new curricula available. By definition, the number of workers trained through the initiative is zero at this baseline; therefore, this section does not address that indicator. It addresses the other three indicators relating to national certifications, staff qualified to train others, and new curricula available.

As documented in the following subsections, a minority of respondents' O&M staff had some specific national certifications at baseline (2016) – across surveyed participating and non-participating organizations, at least 15% of staff had some national certification, with the percentage having any given certification ranging from 0% to 15% for participants and less than 1% to 8% for non-participants. Further, eight of the nine interviewed participating organizations reported that they currently do not have O&M staff qualified to train others, and non-participants reported about 2% of their O&M staff were qualified to train others. All participants indicated

they would be modifying existing curricula and/or creating new curricula to create new training opportunities with NYSERDA funds. As noted above, these results suggest that the participants are a self-selected group relative to non-participants.

2.1.1   Increase in percentage of trainees with national certifications

To help in defining the second indicator – increase in the percent of trainees obtaining national certifications – program staff identified several key national certifications that the initiative is hoped to increase through the initiative:

- Northwest Energy Efficiency Council (NEEC) Building Operator Certification (BOC);
- Building Performance Institute (BPI) Multifamily Building Analyst;
- North American Technical Excellence (NATE) certification for heating, ventilation, air conditioning and refrigeration (HVACR);
- HVAC Excellence Certification for HVACR;
- U.S. Environmental Protection Agency (EPA) Section 608 Technician Certification for proper refrigerant handling techniques;[9]
- Association of Energy Engineers Certified Energy Manager certification, covering electrical, mechanical, process, and building infrastructure systems;
- Association of Energy Engineers Certified Energy Auditor certification, covering evaluation and analysis of facility energy use and identification of energy conservation opportunities;
- Refrigeration Engineers & Technicians Association (RETA) certifications –
  - o Certified Assistant Refrigeration Operator (CARO);
  - o Certified Industrial Refrigeration Operator (CIRO);
  - o Certified Refrigeration Energy Specialist (CRES).

At this 2016 baseline, there were yet no trainees, so the primary metric for the second indicator (percentage of *trainees* obtaining national certifications) is, by definition, zero percent. For this report, the research team assessed the secondary metric for this indicator (percentage of *all O&M staff* with national certifications) by asking how many O&M staff had each certification at baseline. Participants most commonly reported their O&M staff had the EPA 608 (15% of staff across respondents), BOC (8% of staff), and BPI (6%) national certifications (see Table 6). Non-participants had lower percentages of staff with any national certifications and most

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[9]   For this certification, EPA established the requirements and standards but does not administer the test. EPA-approved certifying organizations administer the test.

commonly reported their O&M staff had the NATE (8%) certification and the EPA 608 (7%) national certifications. The research team estimates that at least 15% of the O&M staff of both participants and non-participants have some national certification.[10]

Table 6. Count and Percent of O&M Staff that Have Received National Certification Baseline (2016)

National Certifications		Count of Organizations	Count of Staff	Percent of Staff
EPA 608	Participants	7	187	15%
	Non-participants	1,718	11,552	7%
NEEC Building Operator Certification	Participants	3	106	8%
	Non-participants	364	1,196	<1%
BPI	Participants	2	79	6%
	Non-participants	52	104	<1%
HVAC Excellence	Participants	3	8	1%
	Non-participants	937	5463	3%
Certified Energy Manager	Participants	3	8	1%
	Non-participants	416	936	<1%
NATE	Participants	0	0	0%
	Non-participants	208	14,677	8%
Certified Energy Auditor	Participants	0	0	0%
	Non-participants	208	260	<1%
RETA CARO, CIRO, or CRES	Participants	0	0	0%
	Non-participants	208	833	<1%
Most Commonly Reported Certification[a]	Participants	7	187	15%
	Non-participants	2,238	26,072	15%

[a] For each surveyed participating and non-participating organization, the research team assessed the number of staff who had each of the above-identified national certifications but did not ask respondents to report the total number of staff who had any of those certifications. As a proxy for that number, the research team took the most commonly reported certification for each organization.

While the national certifications identified above were of particular interest to initiative staff, it is possible that the initiative could also drive adoption of other certifications or licensures that might help improve skills of O&M staff. To assess whether this is the case, the research team asked participant respondents to identify any other certifications or licensures achieved by their O&M

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[10]   For each participating and non-participating organization, the research team used the number of O&M staff with that organization's most commonly reported national certification as the proxy for the total number of O&M staff with any national certification (see Section 4.4.1).

staff. Participant respondents mentioned many other such certifications or licensures. Those achieved by the most O&M staff, mentioned by one respondent each, were: New York City Fire Department Certification of Fitness of Refrigeration Engineer (100 staff), Stationary Engineer License (20 staff), Backflow Prevention Test (20 staff), and Retrofit Accelerator (20 staff). The percentage of staff that had any of these other certifications in 2016 ranged from less than 1% to 8%.

2.1.2   Increase in staff qualified to train others

One of the desired initiative outcomes is that participants will replicate the initiative-funded training throughout their organization without additional NYSERDA funds (see Section 1.1). One way to help bring that about is to increase the number of O&M staff that are qualified to train others – the third performance indicator. For this indicator, the research team assessed both the primary metric (number of O&M staff qualified to train others) and a secondary metric (percentage of O&M staff qualified to train others).

At this baseline, one interviewed participant reported that their organization had O&M staff that were qualified to train others. This participant reported that about 1% of O&M staff were qualified to train others (see Table 7). Similarly, non-participants reported that about 2% of staff were qualified to train others.

Table 7. Staff Qualified to Train Others Baseline (2016)

Group	Count of Organizations	Count of Staff	Percent of Staff
Participants	1	4	<1%
Non-participants	781	4,318	2%

2.1.3   Increase in number of new curricula

The initiative aims to improve on or replace existing training curricula, and so the fourth performance indicator is the number of new curricula available. The research team asked participants whether they would be conducting the NYSERDA-funded training with existing curricula that had been used elsewhere without modification, would modify existing curricula (and if so, how), or would develop and use entirely new curricula. The team asked non-participants who reported any training in 2016 whether the organization that conducted the training had developed a new curriculum for that training or used a curriculum that was already in

existence (see Section 4.4.3). The research team identified a single (primary) metric for this indicator: the number of new curricula in use.

One of the interviewed participants indicated they would be using entirely new curricula for the NYSERDA-funded training, three indicated they would be modifying existing curricula, and the remaining five indicated they would be using a combination of new and modified, existing curricula. No interviewed participant indicated that they would be using only existing curricula that have been used elsewhere without modification.

Participants modified existing curricula and developed new curricula primarily to include more content on overall optimal building performance or to include training on specific systems such as: air handlers, hot water and boilers, chillers, HVAC, pump operations, controls, cooling towers, and water treatment processes.

Participants who reported they will use existing curricula indicated a number of sources they will build from. Two participants each said they will build from curricula from Green Professional (GPRO) O&M, City University of New York, and existing internal procedures. One participant each said they would expand on curricula from Green Building Certification Institute Buildings Operations and Maintenance (GBOM), the Refrigeration Institute, New York Power Authority, BPI, and BOC. The participant who indicated they will create new curricula reported that they would use "generic content" from organizations such as the PNW National Labs as examples of trainings. Specifically, they found the Labs provided "good examples on how to optimize equipment/systems." However, that participant reported that "our training content will be developed from scratch based on our facilities."

Most interviewed participants (6 of 9) reported that they would be using a subcontractor or other resources to help improve their curriculum. Of those, three reported they would use City University of New York and two identified Solar One. One each reported Steven Winters Associates, Inc., an unidentified mechanical architect that designed the building, and unidentified HVAC vendors.

More than half (58%) of non-participating organizations reported they provided some sort of support or formal O&M training at baseline, much of the content of which was health and safety related. The majority of non-participant training was conducted with existing curricula, which is consistent with the idea behind the initiative – that the NYSERDA funding is needed to drive the development of new or improved curricula. Sixteen percent of organizations that provided

training (9% of overall organizations) reported that some elements of 2016 O&M training was based on new curriculum. Most common content of training reported included health and safety (58%), electric related training (24%), and HVAC related training (24%).

2.2   Workforce Advancements

Workforce advancement indicators, such as increase in wages, promotions, and internships/ apprenticeships, help measure the value of training to new and existing employees. Thus, the fifth through eighth performance indicators were: 5) increase in the number of workers advanced or promoted; 6) increase in the number of individuals placed into paid internships; 7) increase in the number of disadvantaged LMI workers placed in O&M jobs; and 8) increase in wages for trainees.

As detailed in the following subsections, the metrics for worker advancements and promotion, paid internships and apprenticeships provided, and LMI workers placed into full-time jobs, were low for both participating and non-participating organizations, although most of those metrics were higher for participating and non-participating organizations. Wage increases were more common than these other metrics, but again, more common yet for participant than non-participant organizations. As with the findings on training and certification, these differences, which existed before any potential effect of the NYSERDA-supported training, suggests that the participants may be a self-selected group relative to non-participants.

2.2.1   Number of workers advanced/promoted

For the fifth indicator (increase in the number of workers advanced or promoted), the research team assessed the primary metric (number of incumbent workers advanced or promoted) and a secondary metric (percentage of O&M staff who received advancements or promotions). The estimated percentage of O&M staff who received promotions in 2016 was similar for participating and non-participating organizations, in both cases, representing a small minority of O&M staff (see Table 8).

Table 8. Number of Workers Advanced or Promoted Baseline (2016)[a]

Groups	Count of Organizations	Count of Staff	Percent of Staff
Participants [a]	6	55	6%
Non-participants	1,978	8,272	5%

[a]   Seven participants responded to this question.

2.2.2   Paid internships or apprenticeships

The research team addressed the sixth indicator (increase in the number of individuals placed into paid internships and apprenticeships) with both the primary metric (number of individuals placed into paid internships and apprenticeships) and a secondary metric (mean number of individuals placed per organization).

A minority of both participating and non-participating organizations provided paid internships or apprenticeships or advanced interns to full-time employment (Table 9). Again, baseline differences between participating and non-participating organizations point to self-selection in the participant group. Compared to non-participating organizations, participants reported about six times as many internships and apprenticeships and 19 times as many advancements to full-time employment.

Table 9. Paid Internships or Apprenticeships Baseline (2016)

Metric	Group	Count of Organizations	Total Number of Internships, Advancements, Apprenticeships	Mean Number Provided per Organization
Paid internships provided	Participants	3	12	1.3
	Non-participants	260	780	0.2
Advanced from internship to full-time	Participants	2	5	0.60
	Non-participants	104	104	0.03
Apprenticeships	Participants	2	35	3.9
	Non-participants	364	2,342	0.7
Paid internships and apprenticeships	Participants	4	47	1.7
	Non-participants	520	3,122	0.9

2.2.3   Number of low-to-moderate (LMI) workers placed in O&M positions

For the seventh indicator (increase in the number of LMI workers placed into O&M jobs) the research team assessed the primary metric (number of LMI workers placed) and a secondary metric (percentage of O&M staff who are LMI workers).

A minority of participating and non-participating organizations hired O&M staff through a New York public job training program (Table 10). As with internships and apprenticeships, the mean number reported per organization was several times higher at baseline for participants than non-participants.

Table 10. LMI Workers Placed Baseline (2016)

Groups	Count of Organizations	Count of LMI Workers	Mean Number per Organization
Participants	2	3	0.33
Non-participants	104	260	0.07

2.2.4　Increase in wages for trainees

Since there are no initiative trainees at baseline, the primary baseline metric for this eighth indicator (increase in wages for *trainees*) is, by definition, zero. For this report, the research team assessed the secondary metric, percentage of all O&M staff who received wage increases.

Seven participants provided information on the number of O&M staff who received wage increases beyond the cost of living in 2016. About two-fifths of reporting participants' O&M staff received wage increases beyond the cost of living in 2016, compared to about one-third of non-participants' O&M staff (see).[11] Two of seven respondents said that some of their reported wage increases were for their union O&M staff, which they have fewer insights into. Some non-participating organizations also had difficulty answering questions about wage increases due to lack of visibility into union wage increases. Indicating how many staff receive union vs. non-union wage increases is something the research team may want to consider when measuring year-over-year increases in wages for trainees.

Table 11. Increase in Wages Baseline (2016)[a]

Groups	Count of Organizations	Count of Staff	Percent of Staff
Participants[a]	6	530	41%
Non-participants	1978	57,302	32%

　[a]　Seven participants responded to this question.

2.3　Workforce Hiring and Retention

One of the objectives of this ongoing assessment is to determine whether instituting a culture of continuing professional development among operations and maintenance staff leads to improved worker retention, knowledge transfer as aging workers approach retirement, and decreased

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[11] Percentages are weighted percentages, calculated by summing each respondent's reported count of employees receiving a wage increase and dividing the sum by the total number of reported employees.

employer time to find and hire new talent with the appropriate skills. Thus, the final two indicators were: 1) improved employee retention; and 2) decreased for employer to find and hire new talent with the appropriate skills.

At baseline (2016), participants reported that employee retention was not a significant problem; however, the time needed to hire and especially adequately train new O&M staff is lengthy and so could present a significant problem in the future as more senior O&M staff reach retirement. Both participants and non-participants reported low levels of employee turnover.

2.3.1   Improved employee retention

For the ninth indicator (improved employee retention), the research team assessed the primary metric (number of O&M employees who left employment voluntarily) and a secondary metric (percent of O&M employees who left employment voluntarily). Most surveyed participating organizations (6) reported that some of their O&M staff left on their own[12] in 2016, but this amounted to relatively few staff (Table 12). This was consistent with non-participating organizations.

Table 12. O&M Staff that Left Baseline (2016)

Group	Count of Organizations	Count of Staff Who Left	Percent of Staff
Participant	6	22	~2%
Non-participant	1,718	4,160	~2%

When asked how much of a problem staff turnover was in 2016, most participants (8 of 9) and non-participants (81%) reported that it was not much of a problem.[13] The remaining participant reported that turnover was a problem in 2016 due to an internal re-organization. Note, however, that this participant reported no voluntary staff departures that year other than retirements, so this turnover problem did not contribute to the counts shown in Table 12.

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12   Does not include people who were terminated, laid off or who retired

13   0-3 on a 0-to-10 scale, where 0 means "no problem at all" and 10 means "a very serious problem."

2.3.2   Decreased time to find and train new talent

For the final indicator (decreased for employer to find and hire new talent with the appropriate skills), the research team identified a primary metric (reported time required to find, hire, and train new talent) and no secondary metric.

When asked, "How long would it take, on average, to replace a senior O&M employee and train the new employee to the required level of skill?," responses varied greatly for both participants and non-participants, ranging from one week to several months (Table 13). The wide range of responses may possibly suggest that respondents varied in how they interpreted "the required level of skill."

Table 13. Number of Months Required to Find and Train O&M Staff Baseline (2016)

Group	Range	25th to 75th Percentile	Mean	Median
Participants	1 to 84	3 to 21	13	6
Non-participants	0.25 to 72	2.5 to 12	10	6

While there were extreme responses on both the low and high ends of the continuum for each group, those on the high end were more extreme, as seen by the fact that the mean values were higher than the medians. Given this fact, the median value – 6 months for each group – is probably a better indicator of the central tendency than the mean. In research to assess indicators in the post-baseline period, the research team will attempt to assess factors driving the wide variability in responses. For example, the team will ask separately about the time required to identify a suitable candidate, go through the hiring process, and train the candidate to the required skill level. If a respondent reports an amount of time that is on the high or low end of the range seen in this baseline assessment, the team will follow up with questions to assess what would account for the long or short amount of time.

2.4   Summary of Initiative Outcomes Performance Indicators

Table 14 provides a summary of the baseline outcome indicators for the WFD initiative described in the above subsections. For each indicator where the metric is a number of staff or a number of organizations, the table also shows the percent of all staff or organizations that number represents.

Table 14. WFD Initiative Outputs, Outcomes, and Indicators Summary

Outputs/ Outcomes	Indicators	Data Source[a]	CEF Baseline[b]	Updated CEF Baseline Estimate: Number (Percent) of Staff or Organizations[b]					
				Participants		Non-participants		Combined	
Training and Certification	Percent of trainees with national certifications	1,2	0%	≥15%[c]		≥15%[c]		≥15%[c]	
	Number (percent) of staff qualified to train others	1,2	0	4	(0.3%)	4,318	(2.4%)	4,322	(2.4%)
	Number (percent) of organizations with new curricula	1,2	0	6	(67%)	364	(11%)	370	(11%)
Workforce Advancements	Number (percent) of staff that received a wage increase	1,2	0	530	(41%)	57,302	(32%)	57,832	(32%)
	Number (percent) of incumbent workers advanced/promoted	1,2	0	55	(4.3%)	8,272	(4.7%)	8,327	(4.7%)
	Number (percent) of individuals placed into paid internships and apprenticeships	1,2	0	47	(3.7%)	3,122	(1.8%)	3,169	(1.8%)
	Number (percent) of LMI workers placed	1,2	0	3	(0.2%)	260	(0.1%)	263	(0.1%)
Workforce Hiring and Retention	Improved employee retention – number (percent) of staff who chose to leave	1,2	0	22	(1.7%)	4,680	(2.6%)	4,702	(2.6%)
	Time to find & train new talent (median)	1,2	0	6 months		6 months		6 months	

[a] Sources include: (1) participant interviews, (2) K-12 school district O&M supervisor survey, and (3) non-participant survey.

[b] NYSERDA program staff developed CEF baseline estimates at the time the CEF plan was developed. The team used data sources referenced under Table note "a" to estimate and update the original CEF baseline values.

[c] Recognized national certifications assessed were: NEEC; BPI; NATE; HVAC Excellence; EPA 608; Certified Energy Manager; Certified Energy Auditor; Refrigeration Engineers & Technicians Association (RETA), Certified Assistant Refrigeration Operator (CARO), Certified Industrial Refrigeration Operator (CIRO), or Certified Refrigeration Energy Specialist (CRES). For each surveyed participating and non-participating organization, the research team assessed the number of staff who had each of the above-identified national certifications; the reported percentage of O&M staff with any of the above certifications ranged from 0% to 15% for participants and <1% to 8% for non-participants. The research team did not ask respondents to report the total number of staff who had any certification. As a proxy for that number, the research team took the most commonly reported certification for each organization. See Section 4.4.1.

3   Conclusions and Recommendations

The findings summarized above lead to the following conclusions and recommendations:

Conclusion 1: NYSERDA's WFD Industry Partnership initiative is indeed focusing on the correct market barrier. A minority of participants' O&M staff had any nationally recognized O&M certifications at baseline (2016). The percentage at any given organization with any O&M national certifications ranged from 0% to 15%. Additionally, nearly all (8 of 9) interviewed participating organizations reported that they currently do not have staff qualified to train others on O&M practices. Lack of nationally recognized certifications (which cover energy efficient practices) among participants' O&M staff and lack of staff to teach others about O&M efficient practices may indicate that there is a low knowledge of energy-efficient O&M practices in the market, which is a barrier to saving energy.

> **Recommendation:** The NYSERDA WFD Industry Partnerships initiative is well-positioned to meet its goals and thus should be a continued interest and investment by NYSERDA

Conclusion 2: There may be limited perceivable change from baseline on some indicators. For example, advancements and wage increases for some organizations are a function of union negotiations. If level of knowledge about energy-efficiency or of energy-efficient practices is not a negotiated item in the employee contracts, then increases in these as a result of training may not be reflected in wage increases or advancements. Wage increases also are not very visible to management within the organization. When answering questions about advancements and wage increases, some respondents (both participants and non-participants) mentioned they had little insight or influence because wage increases were determined by the union.

> **Recommendation:** Consider removing advancements and wage increases from the list of metrics for the WFD Industry Partnerships Initiative or redefine the metric as applying only to those organizations whose wage increases are not a negotiated item in employee contracts.

Conclusion 3: If the NYSERDA WFD Initiative succeeds in increasing the knowledge among O&M staff on technologies, energy efficiency practices, and ways to troubleshoot and find efficient solutions to problems, then the time required to hire and train qualified staff to the level needed should decrease. Respondents were able to report on the time it takes to hire and train

senior O&M staff member to the required level of skill, although the reported amount of time needed to hire and train senior O&M staff varied greatly. That may be partly due to variability in how respondents they interpreted "required level of skill." This does not necessarily preclude seeing a decrease over time, but it may be valuable to attempt to assess what "required level of skill" means for each respondent and/or explore ways to establish a shared definition. Reducing the time to hire and train is likely a desirable outcome for employers since some did say the time needed to hire and especially adequately train new O&M staff is lengthy (a median of about 6 months across all participating and non-participating organizations).

> **Recommendation:** Continue assessing the time it takes to hire and train senior O&M staff member to the required level of skill but ascertain what that means for each respondent and/or explore ways to establish a shared definition.

As noted above, participants and non-participants differed on most of the indices at this baseline assessment, with participants more likely to report wage increases, workforce advancements or promotions, and paid internships or apprenticeships. These differences suggest that, notwithstanding the research team's efforts to identify a non-participant sample that represented the target population, the participants are a highly self-selected group relative to non-participants. The current participant population may represent the "leading edge" of organizations that are more motivated to adopt practices that promote good O&M performance. As such, they also are more likely to partner with NYSERDA to improve workforce training.

Therefore, direct comparisons over time between participants and the entire non-participant population may not be informative. Possibly, the current participant population represents the "leading edge" of organizations that are more motivated to adopt practices that promote good O&M performance. As the initiative continues, it may begin recruiting more participants that resemble the larger non-participant population.

If newly recruited participants continue to resemble the current self-selected group, the research team, if selected to continue this research, will work with NYSERDA to further refine the target population and identify ways to generate a more meaningful comparison of participants with non-participants.

4 Methodology

4.1 Secondary Data Review

The team reviewed secondary data to identify the information needed to estimate the baseline indicators NYSERDA wanted to measure, including which data to collect through primary research activities. The secondary data sources aided in the following:

- The development of participant and non-participant surveys instruments
- Identifying the contact information for participants and non-participants
- The development of a sampling strategy for non-participants
- Identifying information to use for estimating the baseline program performance indicators

Table 15 summarizes the documents the team reviewed.

Table 15. Documents Reviewed for Secondary Data

Documents	Summary Contents	File type
Clean Energy Fund (CEF) Workforce Development Industry Partnerships investment plan	NYSERDA investment plan outlining workforce development and training initiatives. Specifically, it details industry partnership approach to workforce training and includes a description of target market characterization, stakeholder/market engagement, theory of change, relationship to utility, budgets and expenditures, and progress and performance metrics.	PDF
Program Opportunity Notice (PON) 3442 Contracts	Received 10 PON 3442 participant contracts. Each contract consisted of a formal agreement; statement of work; general contract provisions, terms and conditions; prompt payment policy statement; names of key contacts, and NYSERDA Report Content Guide 2016.	PDF
PON Application and instructions from NYSERDA	Blank application for PON 3442 regarding workforce training – that is, building operations and maintenance. This application and accompanying materials were available on the NYSERDA website.	PDF
Program Data	A file of all participants. This list includes relevant information available from PON 3442 contracts, when available, including the direct number of employees trained. NYSERDA staff also included contact information of participants for which the team had no contact information in the PON 3442.	Excel, emails

The investment plan provided information on the logic, outcomes/expectations of the initiative, and the initiative's long-term goals.

The blank PON 3442 application provided information on the full scope of the program and criteria for consideration as the research team developed the instrument. The information on the PON 3442 application that specifically informed participant instrument construction included:

targeted building types, targeted occupations or job titles, potential cost reduction and efficiency improvements desired through training, and skills gaps that may be addressed through training.

The participant PON 3442 contracts informed what the team needed to ask participants during the interviews and allowed the team to tailor questions for respondents. PON contracts provided data about participants, which allowed the team to create a more streamlined, appropriate set of questions for each participant. These data also allowed the team to structure the interview survey questions to be most relevant to a particular respondent. Importantly, however, because contracts are still in the negotiation phase, the team still made sure to ask about questions that are specific to the indicators even if the PON contract provided the information. While there were 12 participants total, the team did not have PON contracts for all participants. The 10 available PON Contracts used for instrument development were:

- Memorial Sloan Kettering Cancer Center
- RiseBoro Community Partnership, Inc.
- NYS School Facilities Association, Inc.
- FS Energy, LLC
- NYU Langone Medical Center
- Montefiore Medical Center
- C&C Apartment Management LLC
- The Cooper Union for the Advancement of Science and Art
- Related Management Company – the SANDY Fund
- Rensselaer Polytechnic Institute- Lighting Research Center (LRC)

While most data for participants were derived from the semi-structured interviews, some data were extracted from the PON 3442 contracts themselves. The PON 3442 contracts included the following basic information that informed instrument construction (discussed above), and also served as primary data:

- Facility information (e.g., address, square footage, name of company)
- Targeted areas for training
- Proposed categories for training
- Description and scope of training
- Tasks to be performed

The program data included key information about the participants and their contract with NYSERDA. Contact information in this file was used to create a participant contact list.

Note, the team reviewed additional sources of data referenced in Section 4.3 to develop the non-participant sample.

4.2   Participant Survey

The research team attempted to complete short answer interviews with all 12 participants. The interviews assessed participant characteristics: job title, organization type, number and organization of O&M staff and whether they are employees of the participant or a third-party provider, number and square footage of buildings, building class, and number of clients of participants that are property management firms. They also assessed the initiative's indicators: O&M staff skills and training received; number of paid O&M internships and apprentices, and number of interns advanced to full-time employment; number of O&M staff that received promotions or advancements and number that received wage increases; number of disadvantaged workers hired into O&M jobs; number of O&M staff that left the company and degree to which turnover was a problem; and the time needed to find and hire new talent. Finally, the interview assessed whether the plan for the new training was to use existing curricula without modification, to modify existing curricula, or to develop entirely new curricula. And if modifications or new curricula, what were they and why were they needed?

The research team completed interviews in November 2017 with nine of the 12 participants. The contact for one of those participant organizations reported that it represents some 60 to 75 school districts (out of around 600 school districts in New York) that will participate in the first wave of training. That contact could identify only the 22 school districts that were sending attendees to the first of three sessions to be held in the first wave. That contact represented one of the 22 school districts and provided information pertaining to that school district. Research team staff conducted a web survey of the remaining 21 school district O&M supervisors and obtained responses from 18 of those supervisors. The responses to the survey were summed and counted as the responses for one participant.

Even though the research team obtained information on initiative performance indicators from a large percentage of participating organizations, the small population size argues against extrapolating from the sample to the population. That is, the assumption that the interviewed participants represent the ones not interviewed, which is acceptable when a random and

statistically reliable sample is drawn from a population, is not defensible in this case. Therefore, the indicators that are based on absolute counts (e.g., number of internships and apprenticeships) represent conservative estimates of the overall participant population, but it is not possible to say by how much. Similarly, while the research team may guess that the indicators based on percentages (e.g., of staff with certain certifications, of staff qualified to train others, of staff who have received wage increases or have been promoted) would not change by much if the research team obtained additional data from the remaining participants, the research team cannot state this with any calculable precision or confidence.

4.3   Non-Participant Survey

The non-participant survey was designed to be analogous to the participant survey. This was done so the non-participant responses could be compared to the participant responses. The only difference between the participant and non-participant surveys was that the non-participant survey did not include questions related to training.

NYSERDA staff indicated that the WFD target population for the initiative is organizations that own or manage big buildings or substantial square footage (50,000 square feet or more) and employ at least two O&M staff. This, then, defined the target population for the non-participant survey.

The team examined three sources of data to identify the target population and develop a non-participant sample, settling on the **Trade Press Media ("TPM")** subscriber list of 5,700 building owners and facility engineering and maintenance executives at commercial and institutional facilities in New York.[14]

The team then purchased the TPM list and reviewed it to ascertain that it represented the target population (see Section 4.7). It included O&M contacts from large, medium, and small

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[14]   The team also examined two other sources for surveying non-participants. One was a list that NYSERDA staff had developed of 2,365 contacts of organizations that contacted NYSERDA about NYSERDA's initiatives, with titles suggesting involvement in building O&M (facility manager, plant director, vice president of facilities, plant engineer, etc.). This list could not be a source of a random sample, but the team investigated its use in developing a purposive sample of contacts. The cost per survey completion was prohibitively high, and so the research team abandoned its use. The other source was the CoStar commercial real estate database. CoStar provided data on 11,904 buildings in New York with contact information for the owner, owner's representative, leasing agent, or property manager information. However, that contact information proved inadequate for reaching individuals who could respond to the survey.

organizations. The team randomly sampled from this and excluded duplicate records of the same individual and contacts without an O&M title (e.g., financial analyst).

The research team did not exclude multiple contacts for the same organization. There were several instances of such – often, property management firms – and the team considered it possible that the multiple contacts in some of those cases might have responsibility over separate properties and each contact might be able to provide information only for a given property or set of properties. The team decided that excluding multiple contacts for the same organization would risk biasing the sample.

Survey fielding occurred in two waves: one in December 2017 and the other in July-August 2018. To reach the desired number of completes ($n = 68$), the team attempted to contact each non-participating organization in the sample at least five times or until a final disposition (e.g., survey completion or refusal) was reached. To increase the response rate, the team also offered respondents a $50 gift card for completing the survey.

Table 16 provides a disposition summary from the non-participant survey. Of 871 contacted non-participating organizations, the team was able to complete the survey with 68 respondents to achieve an 8% response rate.

Table 16. Non-Participant Survey Disposition

Disposition	Count
Number of Contacts Called	871
Survey Completions	68
Refused	62
Left VM or Could Not Reach	643
Did not Pass Screening	102

Two of the respondents worked for the same organization. As explained in Section 4.7, the research team summed the counts of metrics from those two respondents and treated them as a single case.

4.4   Outcome Indicator Analysis Methods

The following section provides details of the research team's analysis methods for each outcome indicator described in Sections 2.1 through 2.2.4.

4.4.1   Increase in percent of trainees with national certifications

To calculate the percent of trainees with national certifications, the research team summed respondents' reported counts of staff that hold each of the eight certifications specifically asked about and divided that by the sum of the of respondents' reported O&M staff. These are the percentages reported for each certification in Table 6.

The research team did not ask respondents to report the total number of O&M staff with any certification (that is, the number of staff with at least one of the certifications listed in Table 6). As each organization's proxy for that number, the research team took the number of O&M staff with that organization's most commonly reported certification. For each organization, this represents the minimum number of O&M staff at that organization with some national certification – it would be the total number of O&M staff with some national certification only if all staff with any certification also had that most common one. Therefore, if any O&M staff had some other national certification *and not* that most common one, the total number with a national certification would be greater than the total with the most common one. This, in fact, may be likely at some organizations, but there is no way of knowing how likely it is, and so the research team's approach is a conservative one.

EPA 608 was the most commonly reported certification for all participating organizations, and so the proxy for total number of certified O&M staff in participating organizations was equal to the number with EPA 608. For non-participating organizations, the most commonly reported certification varied among NATE, EPA 608, and HVAC Excellence. For those organizations, then, the proxy for total number of certified O&M staff exceeded that for any single certification. These proxy percentages are provided in the summary table (Table 14). "Other" certifications provided in the open-ended portion of the question were not included in this summary calculation (unless the "other" certification provided was a certification the research team did specifically ask about).

4.4.2   Increase in staff qualified to train others

The research team summed respondents' reported counts of staff qualified to train others, divided by the total sum of respondents' reported O&M staff.

4.4.3   Increase in number of new curricula

For participants, the research team took a qualitative approach to the number of new curricula, since it is a metric that is difficult to quantify. For the metrics provided in the summary table

(Table 14), the research team reported the number of participating organizations that indicated they would be using new curricula (completely new or old curricula with modifications), for their NYSERDA-provided WFD funds. For non-participants, the question was slightly different. The research team asked whether the organization that conducted training had developed a new curriculum for that training in 2016 or used a curriculum that was already in existence in 2016. The research team took the number of organizations that used new curricula in 2016.

4.4.4   Increase in wages for trainees

The research team summed participants' reported counts of staff that received an increase in wages (excluding cost of living), divided by the sum of total O&M staff for organizations that answered this question. Two organizations did not know the number of staff that received wage increases in 2016, therefore the organizations and their staff were excluded from this analysis.

4.4.5   Number of workers advanced/promoted

The research team summed respondents' reported counts of staff that received a promotion, divided by the sum of total O&M staff for organizations that answered this question. Two organizations did not know the number of staff that received wage increases in 2016, therefore the organizations and their staff were excluded from this analysis.

4.4.6   Paid Internships or apprenticeships

The research team summed respondents' reported counts of paid internships, apprenticeships, and interns promoted to regular full-time employment.

4.4.7   Number of low-to-moderate (LMI) workers placed in O&M positions

The research team summed respondents' reported counts of LMI workers placed in O&M, divided by the sum of respondents' reported O&M staff.

4.4.8   Improved employee retention

The research team summed respondents' reported counts of employees that left of their own volition.

For the question posed to participants of "How much of a problem was turnover in 2016 on a scale from 0 -10?," the research team combined responses into the following categories: 0-3 "not much of a problem", 4-6 "a moderate problem", and 7-10 "a serious problem." For the participant that had many school districts, the research team took the maximum rating across all school districts. However, one respondent to the web survey indicated employee retention was a serious

problem, but in the follow up indicated that this was due to "shift work, retirement, death, other opportunities". Since they included retirement and death in their explanation, and the response was supposed to exclude retirement (and presumably death), their response for "How much of a problem was turnover in 2016?" was excluded.

4.4.9   Decreased time to find and train new talent

The research team assessed the qualitative answers to this question from the short answer interviews and determined the time (in months) respondents indicated it would take to find, hire and adequately train a new O&M staff member if a senior O&M staff member left. To represent the participant that consisted of multiple school districts, the research team took the mean length reported by all school districts. If respondents provided a range in their response, the research team took the midpoint of that range.

4.5   Imputing Missing Data for Non-participants

The majority of non-participant respondents (61%) were able to answer all questions that assessed metrics for the various performance indicators. Of 26 respondents (39%) who were not able to answer one or more of those questions, 22 (85%) were able to answer all but one or two questions. The percentage of "don't know" responses was 5% or lower for 16 of the 20 questions that assessed metrics for the various performance indicators. The question with the greatest percentage of "don't know" responses was that assessing whether any training provided in 2016 used a new or existing curriculum: of 38 non-participant respondents who reported any 2016 training, 13 (34%) did not know whether it used a new or existing curriculum. The other three items for which "don't know" responses exceeded 5% were: 1) the number of staff who received wage increases beyond cost of living (14%); 2) the number of staff who received promotions or advancements (8%); and 3) the number of LMI staff placed in full-time jobs (6%).

Three of the four respondents who were unable to answer more than two questions could not answer those about wage increases, promotions/advancements, and LMI placements. Two of those four could not report the number of O&M staff with any of the listed national certifications. (Those two respondents represented the vast majority of "don't know" responses to the questions about national certifications.)

For questions that were significantly correlated with square footage, if the respondent could not answer, the research team used regression analysis to predict missing values based on the square

footage reported that respondent reported. For other questions that respondents could not answer, the research team took the mean of non-missing values.

4.6 Extrapolating Partial Non-participant Survey Responses from Respondents to their Organization

Four of the non-participant respondents reported they could not answer the survey questions for their entire organization but only as they related to the buildings they were responsible for. For those respondents, the research team extrapolated their answers to their entire organization based on the number of contacts for their organization with a similar title who were identified in TPM. For example, one such respondent reported 16 staff for that respondent's area of responsibility. TPM listed one other individual in that organization with a title similar to that respondent's title. The research team assumed that the respondent's responses were representative of the other similarly titled contact for that company, and so multiplied the number of staff (16) by two to obtain 32 for that organization.

4.7 Extrapolating from the Non-participant Sample to the Population

The research team extrapolated the results of the non-participant survey to the entire target population to provide estimates of the total population counts for the various indicators.

If the non-participant sample is representative of the entire population, the most straightforward extrapolation approach is to base the extrapolation on the ratio of the number of organizations in the population to the number in the sample. The sample estimates of the various indices (e.g., number of staff with a given type of training) are then multiplied by this ratio to estimate the quantity of that index in the population.

Two questions must then be answered: 1) Do the organizations and contacts in the TPM list represent the entire population of New York buildings? 2) How well does the sample represent the entire TPM list?

To answer the first question, the team examined how the TPM list related to two other sources: 1) the Primary Land Use Tax Lot Output (PLUTO™) data for NYC; and 2) the CoStar database of commercial properties.

PLUTO is the best source of square footage data for NYC. The New York City Department of City Planning's Information Technology Division developed the PLUTO data file. It contains

extensive land use and geographic data at the tax lot level derived from files maintained by the Department of City Planning (DCP), Department of Finance (DOF), Department of Citywide Administrative Services (DCAS), and from information contained in Landmarks Preservation Commission (LPC) publications and web site. PLUTO does not include data for outside of NYC boroughs, and so the team could not compare the TPM to PLUTO data for the whole state. However, Table 17 shows that building square footage in the TPM list is very close (93%) to the PLUTO total square footage for NYC.[15]

Table 17. Building Square Footage by Source

Source	Reported or Calculated Square Footage		
	NYC	Upstate	Total
TPM List	4,097,977,532	4,094,555,404	8,192,532,936
PLUTO	4,415,642,335	n/a	n/a
CoStar	2,909,864,543	1,457,077,432	4,366,941,975

The only source that the research team found for building square footage outside of NYC is the CoStar database. Table 17 shows that the total CoStar square footage for NYC is less than three-quarters of the TPM and PLUTO totals. CoStar reports square footage as "rentable building area," which may not represent total building area and so may underestimate total square footage. Further, while TPM shows roughly equal square footage in NYC and upstate (which is roughly consistent with the distribution of the state residential population), CoStar shows about twice as much building square footage in NYC than upstate.[16] Thus, CoStar not only underrepresents the

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[15] The research team had to address three aspects of the way building square footage data were recorded in the TPM list to compare it to PLUTO and CoStar.

First, the TPM building square footage data were reported in ranges, so for each range, the team took a value that was not quite the midpoint – taking the midpoint would not be appropriate because the distribution of building size is skewed.

Second, square footage data were missing for a fair number of TPM records. The mean reported square footage differed by both building type and region (NYC vs. upstate), so for each record missing the square footage data, the team used the mean square footage for that building type in that region. For example, if a commercial building outside of NYC was missing square footage data, the team replaced that record's missing value with the mean for all commercial buildings outside of NYC.

Third, in several instances, multiple individuals from the same company reported different square footage values for the same property. Based on prior experience with this type of population, the team reasoned that in such cases, the record with the greatest square footage represented someone with responsibility for the entire property, who reported the total square footage for that property, while records with less square footage represented individuals with responsibility for part of the property, who reported the square footage for that part. The team thus deduplicated the list on the address and selected the highest square footage associated with any given address.

[16] This research excludes Long Island, which NYSERDA does not serve.

total building square footage in NYC but also distributes the square footage between NYC and upstate very differently from how the general population is distributed. This suggests that CoStar may not be a reliable source for assessing how well TPM represents building square footage in the state.

On the other hand, the fact that TPM total square footage was so close to PLUTO NYC total square footage, together with the fact that the distribution of TPM square footage between NYC and upstate is consistent with the distribution of the state residential population, suggests that TPM does capture a large portion of the New York building square footage.

How well does the sample represent the entire TPM list? Table 18 shows that the distribution of building total square footage over building types in the sample is similar to that in the TPM population. Two exceptions are that the sample somewhat overrepresents government buildings and somewhat underrepresents commercial buildings, relative to the population.[17]

Table 18. Building Square Footage by Type – Population Compared to Sample

Building Type	Population	Sample
70 Educational Buildings	22%	25%
20 Government Buildings	10%	31%
50 Medical Buildings	12%	14%
10 Commercial Buildings	45%	18%
30 Industrial Buildings	4%	3%
90 Architectural Firms, Consultants, Contractors	3%	6%
40 Hospitality Buildings	2%	1%
60 Retail Buildings	2%	2%
Total	100%	100%

Further, Figure 1 further shows that the distribution of building square footage across size levels is similar in the sample and TPM population.

Based on the above analyses, the team concluded the most reasonable extrapolation approach is to base the extrapolation on the ratio of the total number of organizations in the TPM population to the number or organizations in the non-participant sample. Two non-participant respondents worked for the same organization, a large property management firm. The research team

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[17] In subsequent years, the research team will investigate the potential effect these exceptions might have on the extrapolation of sample data to the population and attempt to adjust for them.

combined their responses to represent the single organization. The extrapolation was based on the count of 67 organizations rather than the 68 survey respondents.

Figure 1. Building Square Footage in the Survey Sample versus the TPM List