

Combined Heat and Power and Onsite Resilient Power Market Assessment

Final Report

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1 Introduction

1.1 Program Description

The Combined Heat & Power (CHP) intervention worked to advance a modular CHP market which would reduce soft costs and development time and increase penetration of CHP. The major activity of the program focused on providing cost-shared incentives to support the installation of CHP equipment at eligible host site locations. To a lesser extent, the program also provided cost-shared incentives to support site-specific feasibility studies. The program procured a variety of technical outreach services to raise awareness of the opportunity for and value of CHP among good-prospect candidate sites. As a resource acquisition activity, the incentive program was a continuation/modification of New York State Energy Research and Development Authority's (NYSERDA's) previous Technology and Market Development (T&MD) CHP Acceleration and Aggregation and CHP Performance Programs.¹ These two programs were merged into a single offering, NYSEDA PON 2568:² CHP Program. In 2016 NYSEDA conducted an evaluation of the CHP Program, the CHP Baseline Assessment and this report is a follow-up to that assessment.³

NYSERDA is in the process of creating an initiative with the working name of Onsite Resilient Power (ORP) (formerly called "Premium CHP"), defined as Combined Heat and Power when paired with other distributed generation (solar) and storage technologies into an overall system which will better meet end-users' needs, and by leveraging synergies of the various technologies will have the potential to be cost effective in the absence of subsidies and have a lower greenhouse gas footprint compared to the next best resiliency alternative. A main objective of this evaluation was to gain market insights into the ORP market to help shape the initiative.

The market portion of this evaluation had three main tasks:

1. Update to the Combined Heat and Power Baseline Assessment
 - a. Update to the penetration rate by target market

¹ NYSEDA Technology and Market Development Program, Semiannual Report through December 31, 2016, page 25. <https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/tmd-report-2016Dec.pdf>

² https://portal.nyserda.ny.gov/CORE_Solicitation_Detail_Page?SolicitationId=a0rt0000000QnqvAAC

³ <https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2017ContractorReports/CHP-Baseline-assessment.pdf>

- b. Update to the vendor activity (number of projects, revenues)
 - c. Timing and effectiveness of the sales process (from interest to sale)
 - d. Quantification of soft costs (by percentage of the total)
2. Conduct a baseline assessment of the market awareness of and interest in an ORP offering
 3. Provide data to estimate replication to support the impact team.

1.2 Summary of Evaluation Objectives and Methods

The evaluation objectives and main research topics are listed in Table 1.

Table 1. Evaluation Objectives and Main Research Questions

Objective	Evaluation Question(s)	Data Source(s) & Analytic Method(s)
Update to the penetration rate for CHP in certain target markets.	What is the penetration rate for CHP in certain target markets?	A phone survey of CHP professionals active in NYS as well as analysis of secondary data.
Update to the number of vendors (and installers) active in New York, their revenues, number, size, and cost of projects, and the degree of concentration in the market.	How many vendors are active in NYS? What are their revenues? What are the size and cost of their projects? What market areas are they concentrated in?	Reviewing existing data from relevant reports and datasets, and a survey of CHP professionals active in NYS.
Timing and effectiveness of the sales process.	What is the conversion rate from awareness to action-taking, and the timeframe of customer progression from unaware to aware, and from aware to action?	A phone survey of CHP professionals participating in the NYSERDA CHP catalog.
Quantification of soft costs. Soft costs were characterized and quantified (to the extent possible) in the 2016 CHP longitudinal market evaluation, NYSERDA is looking for updated cost numbers to see how the market is evolving.	What is the percentage of total project costs that consists of balance-of-system costs for a typical CHP system installed by CHP professionals in NYS in 2018?	A phone survey of CHP professionals active in NYS. A phone survey of nonparticipant end-users.

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Objective	Evaluation Question(s)	Data Source(s) & Analytic Method(s)
Conduct a baseline assessment of the ORP market potential in NYS.	What are the ORP revenues? What are the size and cost of their projects? What market areas are they concentrated in?	Reviewing existing data, as well as a phone survey of CHP professionals active in New York.
	How can NYSERDA support active vendors to help push the market towards ORP? What are vendors' needs?	A phone survey of CHP professionals active in New York.
	Determine how NYSERDA can smooth out the learning curve for the ORP market.	A phone survey of CHP professionals active in New York.
	What are the barriers to adoption of ORP?	A phone survey of nonparticipant end-users.

2 Market Assessment Results

This section presents the results of the CHP Market Research by each of the five key research objectives described in Table 1. This section describes what CHP Professionals reported, presents summary information from the secondary data review, and offers a few insights gleaned from interviews with end-users that do not have a CHP system, so-called “true nonparticipants”.

To begin, this section reviews the penetration rate for CHP in target markets followed by the other key research objectives.

2.1 Penetration Rate for CHP in Target Markets

2.1.1 Department of Energy (DOE) CHP Database Overview

The following is an update to the NYSERDA Combined Heat and Power (CHP) Baseline study’s overview of the CHP market in New York State using data from the Department of Energy’s (DOE) CHP database.

2.1.1.1 CHP Installations by Region

Slightly more than half of all CHP systems in New York State are in the New York City area and the systems, on average, are smaller than those installed elsewhere in the state. The research team coded the city location of each CHP system in the DOE database. As shown in Table 2, the team filtered by whether the CHP system was located downstate (New York City’s five boroughs and Westchester County) compared to all other areas of New York. Results show that 52% (380 of 737) of all CHP systems are in New York City or Westchester.

Table 2. Number and Capacity of CHP Systems in New York State, by Region and Study Years ^{a, b}

	2015	Through 2015	2018	Through 2018
NYC and Westchester ^c				
Number of CHP Systems	31	279	28	380
Total Capacity (kW)	22,228	1,449,866	21,460	1,494,616
Average Capacity (kW)	717	5,197	766	3,928
Median Capacity (kW)	200	225	200	200

	2015	Through 2015	2018	Through 2018
Rest of State ^c				
Number of CHP Systems	9	301	4	340
Total Capacity (kW)	8,390	4,087,080	2,505	4,102,232
Average Capacity (kW)	932	13,578	626	12,065
Median Capacity (kW)	440	350	650	300
Total				
Number of CHP Systems	41	594	32	737
Total Capacity (kW)	30,693	5,537,531	23,965	5,595,445
Average Capacity (kW)	749	9,322	749	7,592
Median Capacity (kW)	200	300	233	225

^a Source: DOE CHP database downloaded May 28, 2019.

^b Numbers of downstate and rest of state CHP systems do not sum to the total number of systems because some systems in the database are missing data for the city in New York in which they are located.

^c Downstate includes Westchester County and the five New York City boroughs, and “rest of state includes all other areas of New York State including Long Island.

2.1.1.2 CHP Installations by Market Sector

CHP systems occur in many types of buildings and almost one-third of all CHP installations in New York are in multifamily buildings and almost two-thirds are in “vulnerable populations.” Table 3 shows the number of CHP systems, total, and average capacity of systems by market sector. The multifamily sector is the most prominent sector with CHP systems, but many different types of structures operate CHPs. Sixty-three percent of all CHP systems are in buildings with “vulnerable populations” - multifamily, hotels, nursing homes, hospitals, and colleges. Occupants of these buildings either are unable to be transported easily or would be difficult to transport during a protracted power outage like occurred during Superstorm Sandy.

Table 3. Number and Capacity of CHP Systems in New York State, by Market Sector ^{a, b}

	2015	Through 2015	2018	Through 2018
Multifamily Buildings				
Number of CHP Systems	23	144	18	219
Total Capacity (kW)	4,095	117,450	4,880	130,317
Average Capacity (kW)	178	816	271	595
Median Capacity (kW)	150	100	200	100

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	2015	Through 2015	2018	Through 2018
Assisted Living/Nursing Homes				
Number of CHP Systems	2	56	2	63
Total Capacity (kW)	240	11,906	275	12,541
Average Capacity (kW)	120	816	138	199
Median Capacity (kW)	120	145	138	120
Hospitals				
Number of CHP Systems	0	36	2	42
Total Capacity (kW)	N/A	56,550	1,305	68,980
Average Capacity (kW)	N/A	1,571	653	1,642
Median Capacity (kW)	N/A	580	653	560
Colleges/Universities/Schools				
Number of CHP Systems	2	88	0	104
Total Capacity (kW)	5,075	169,743	N/A	175,867
Average Capacity (kW)	2,538	1,691	N/A	1,691
Median Capacity (kW)	2,538	233	N/A	225
Hotels				
Number of CHP Systems	3	21	5	33
Total Capacity (kW)	940	22,340	1,080	24,370
Average Capacity (kW)	313	1,064	216	738
Median Capacity (kW)	130	500	130	200
Offices/Commercial Buildings				
Number of CHP Systems	3	24	1	27
Total Capacity (kW)	1,513	31,769	1,200	33,144
Average Capacity (kW)	504	1,324	N/A	1,228
Median Capacity (kW)	500	735	N/A	720
Restaurants				
Number of CHP Systems	0	2	0	2
Total Capacity (kW)	N/A	390	N/A	390
Average Capacity (kW)	N/A	195	N/A	195
Median Capacity (kW)	N/A	195	N/A	195

	2015	Through 2015	2018	Through 2018
Other ^c				
Number of CHP Systems	8	223	4	247
Total Capacity (kW)	18,830	5,127,383	15,225	5,149,836
Average Capacity (kW)	2,354	22,993	3,806	20,850
Median Capacity (kW)	480	500	813	456
Total				
Number of CHP Systems	41	594	32	737
Total Capacity (kW)	30,693	5,537,531	23,965	5,595,445
Average Capacity (kW)	749	9,322	749	7,592
Median Capacity (kW)	200	300	233	225

^a Source: DOE CHP database downloaded May 28, 2019.

^b The NYSERDA CHP baseline study for 2015 used data for 1995 – 2015, assuming an average 20-year lifespan of CHP systems. However, this was not necessary since the DOE has attempted to include systems in the CHP database that are operational and to exclude systems that are no longer operational. It can be assumed that some CHP systems in the database are likely no longer operational and that there are some operational CHP systems not included in the database. Given that the DOE database mostly includes operational CHP systems, the research team updated the 2015 baseline results from the DOE CHP database using all CHP systems installed in New York State through 2015, not just those installed from 1995 through 2015.

^c Other includes Agriculture, Air Transportation, Amusement/Recreation, Carwashes, Chemicals, Communications, Community Services, Data Centers, District Energy, Fabricated Metals, Food Processing, Food Sales, Furniture, General Government, Ground Transportation, Households, Instruments, Justice/Public Order, Laundries, Machinery, Miscellaneous Manufacturing, Miscellaneous Services, Oil/Gas Extraction, Other/Unknown, Primary Metals, Printing/Publishing, Pulp & Paper, Rubber & Plastics, Solid Waste Facilities, Stone/Clay/Glass, Textiles, Transportation Equipment, Utilities, Warehouses, Wastewater Treatment, Wholesale/Retail, Wood Products, and Zoos/Museums.

2.1.1.3 CHP Penetration Rate by Market Sector

To determine the penetration rate of CHP systems by market sector, the evaluation team relied on the 2016 Technical Potential Study DOE conducted in 2016.⁴ The team looked for and consulted with NYSERDA to identify other more recent sources and were unsuccessful. Therefore, the team relied on the 2016 study.

Market penetration varies substantially when measured by number of projects versus system capacity (kW). DOE estimated a market potential for as many as 16,901 CHP systems in New York but identified only 594 as of 2015 (737 by 2018), a penetration rate of 3.5% (4.3% in 2018). This is not surprising, because early adoption has tended to skew toward the largest (historically most cost effective) opportunities. However, when examined by system capacity,

⁴ DOE CHP Technical Potential Study, March 2016

estimates suggest that over half the capacity potential has been achieved (Table 4). There appears to be noticeable opportunities to increase market penetration in certain sectors, especially restaurants, offices, hotels, and assisted living centers. The penetration rate is less than 10% for each of these sectors.

Table 4. Penetration Rates of CHP Systems and Capacity, by Market Sector

Market Sector	Number of CHP Systems			Capacity of CHP Systems (kW)		
	Through 2015 ^a	2016 Technical Potential ^b	Penetration Rate ^c	Through 2015 ^a	2016 Technical Potential ^b	Penetration Rate ^c
Multifamily Buildings	144	2,301	6%	11,745	510,000	23%
Assisted Living/Nursing Homes	56	547	10%	11,906	141,000	8%
Hospitals	36	227	16%	56,550	462,000	12%
Colleges/Universities/Schools	88	1,592	6%	169,743	1,011,000	17%
Hotels	21	1,123	2%	22,340	442,000	5%
Offices/Commercial Buildings	24	5,927	0.4%	31,769	1,290,000	2%
Restaurants	2	465	0.4%	390	57,000	0.7%
Other ^d	223	4,719	5%	5,127,383	6,905,000	74%
Total	594	16,901	3.5%	5,537,531	10,818,000	51%

^a Source: DOE CHP database downloaded May 28, 2019.

^b Source: DOE CHP Technical Potential Study, March 2016

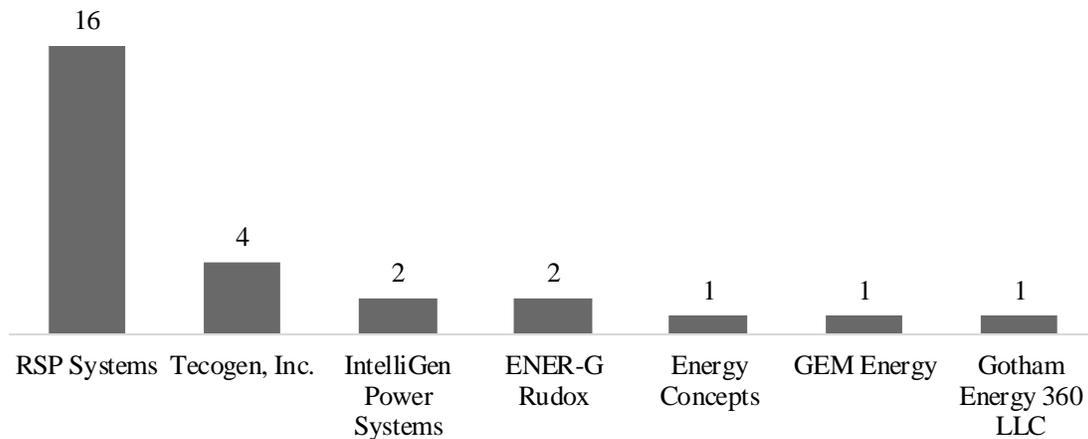
^c Penetration rate = (Through 2015 estimate / 2016 Technical Potential estimate) * 100

^d Other includes Agriculture, Air Transportation, Amusement/Recreation, Carwashes, Chemicals, Communications, Community Services, Data Centers, District Energy, Fabricated Metals, Food Processing, Food Sales, Furniture, General Government, Ground Transportation, Households, Instruments, Justice/Public Order, Laundries, Machinery, Miscellaneous Manufacturing, Miscellaneous Services, Oil/Gas Extraction, Other/Unknown, Primary Metals, Printing/Publishing, Pulp & Paper, Rubber & Plastics, Solid Waste Facilities, Stone/Clay/Glass, Textiles, Transportation Equipment, Utilities, Warehouses, Wastewater Treatment, Wholesale/Retail, Wood Products, and Zoos/Museums.

2.1.2 NYSERDA Distributed Energy Resources (DER) Database Overview

Most CHP systems entered in the DER database in 2018 are in New York City and one provider installed more than half of all the systems. Seven providers installed 27 CHP systems in 2018 according to the New York State Distributed Energy Resources database and one provider, RSP Systems, installed more than half of those systems (Figure 1). Two of the providers, GEM Energy and Gotham Energy installed large systems, 1,100 kW and 9,820 kW systems respectively. The other five providers installed systems averaging between 200 kW and 331 kW. Twenty-six of the 27 projects were installed in New York City and one was installed in central New York state.

Figure 1. CHP Professionals by Number of Projects Completed in 2018, New York State Distributed Energy Resources Database



2.2 Number and Characteristics of CHP Professionals and Projects

The paragraphs below summarize the key characteristics of the CHP professionals interviewed. The paragraphs report about the number of CHP firms, some of their revenue, market sectors they serve, and the number of projects they do.

2.2.1 CHP Professional Characteristics

The evaluation team estimates that there are close to 41 CHP professionals (firms) in New York. As noted in the Methods section (Section 4), the evaluation team reviewed multiple sources to assess how many CHP professionals work in New York. The evaluation team did not conduct a census, and a census was not in the scope of work, the team estimates that there are somewhere close to 41 CHP professionals operating in New York and the team interviewed about 41% of them (17).

Respondents represented firms from a variety of different company sizes and types and the respondents had varying degrees of experience with CHP systems. More than two-thirds represented firms with equipment listed in the October 2018 NYSERDA CHP catalog. About half of respondents had been with their firm five years or less and slightly more than half had at least six years of experience with CHP systems. About half the respondents represented firms with less than 10 employees and not all firms had employees located in New York. In these cases, these firms generally had staff in neighboring states like New Jersey, Massachusetts, and Pennsylvania (Table 5).

Table 5. Overview of Respondents (n=17)

Category	Count
NYSERDA Catalog Vendor Status	
Listed in NYSERDA CHP Catalog	12
Not listed in NYSERDA CHP Catalog	5
NYSERDA Distributed Generation Database Status	
Appear in NYSERDA Database Overview	1
Does not Appear in NYSERDA Database Overview	16
Years with Company	
1 to 5	8
6 to 10	3
11 to 15	3
16 or more	3
Years with CHP Experience	
1 to 5	7
6 to 10	1
11 to 15	2
16 or more	7
Employees in US	
Less than 10	9
10 to 49	3
50 to 100	2
More than 100	3
Employees in New York	
Zero	5
Less than 10	7
10 to 49	5
CHP Became Operational in 2018 in US	
Zero	5
1 to 5	7
6 to 10	3
11 or more	1
Don't know	1

Despite differences between survey responses and the DER database, the survey did provide some important insights into the CHP market that will come out in subsequent sections. Of the 12 respondents reporting at least one operational CHP system in 2018, eight indicated that at least one of the systems was a CHP catalog system and five reported installing non-catalog systems. Only one of those interviewed firms appears in the DER list⁵ of those that installed CHP catalog systems in 2018. Furthermore, the survey responses of that one firm do not match the DER database. This respondent reported 14 CHP systems became operational in 2018 whereas the DER database shows two for this firm. The mismatch between respondents and the database occurred despite asking survey respondents to answer questions about CHP systems that became operational in 2018 in New York. The team hypothesizes that because CHP projects often take years to implement from initial decision to becoming operational that respondents may not fully recall when the system is operational. The definition of “operational” could also be problematic because a system may function but not have been fully commissioned. One respondent told the interviewer about one CHP system that started operating in 2018 but then failed later in 2018 and had not come back online by mid-2019 due to problems with one of the contractors on the project.

2.2.2 CHP Revenue in US

CHP professionals averaged about eight million dollars in CHP revenue in 2018. Twelve of the 17 respondents (71%) had at least one CHP become operational in the US in 2018 and the majority of respondents reported their firm generated more than one million dollars in CHP revenue in 2018. CHP professionals that had revenue in 2018 in the US (n=13), reported a total revenue of almost 100 million dollars in the US and these professionals reported a wide range of revenue from CHP system installation from as little as \$100,000 to more than 30 million dollars (Table 6).

Table 6. CHP Revenue for 2018 in the US (n=13)

Range	Count
Less than 1 million dollars	3
1 to 10 million	6
10 million or more	3
Don't know	1

⁵ One of the firms refused an interview and the others were unresponsive to the interviewer's requests for participation.

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Range	Count
Descriptive Statistics	
Range	\$100,000 to \$31,000,000
Sum	\$96,735,000
Average	\$8,061,250

2.2.3 Market Sectors, Project Size, and Project Cost

Table 7 summarizes what respondents reported about their CHP systems, both catalog and non-catalog systems, installed in 2018. Key findings from the table are below.

Table 7. Market Sectors and Characteristics of Respondent Installed CHP Systems, 2018

Market Sector	Catalog Systems (n=7)					Non-Catalog Systems (n=5)				
	# of resp.	# of Systems	Total kW Capacity	Total Cost to Customer (\$mil)	Dollars per kW	# of resp.	# of Systems	Total kW Capacity	Total Cost to Customer (\$mil)	Dollars per kW
Multifamily	4 ^a	4	4,245	13.8	\$3,251	1	1 ^b	7	.1	\$14,286
College	1	1	500	1.5	\$3,000	0	-	-	-	-
Hotel	1	2	550	2.2	\$4,000	1	1	3,100	No response (NR)	-
Assisted Living	1	1	150	0.7	\$4,667	0	-	-	-	-
Office	1	1	500	1.0	\$2,000	2	1	6,600	29.0	\$4,394
Manufacturing	1	1	400	1.0	\$2,375	1	1	1,500	3.7	\$2,467
Water Treat.	1	1	1,300	4.6	\$3,500	0	-	-	-	-
Landfills	1	1	NR	NR	NR	0	-	-	-	-
Wastewater	1	1	NR	NR	NR	1	1	15,000	NR	NR
Hospital	0	-	-	-	-	1	1	1,000	NR	NR
Rec. Center	0	-	-	-	-	1	1	3,300	NR	NR
Not Specified	0	-	-	-	-	1	1	10,650	31.0	\$2,911
Total	7	13	7,645	24.8	\$3,244	5	8	41,157	63.8	\$3,401^c

^a Two other respondents reported installing three other multifamily projects. However, they could not provide total kW capacity or total cost, so they are not included in this table.

^b One respondent reported installing a 13,300 kW multifamily system but could not estimate a total cost. Therefore, that system is not included in this table.

^c For the purposes of this calculation, the total kW capacity was 18,757, the sum of kW for respondents that could also report the total cost.

Of the seven respondents that reported installing catalog systems in 2018:

- Most respondents (6) installed catalog systems in multifamily buildings.
- One respondent each installed a catalog system in a college, hotel, assisted living, office, water treatment, landfill, or in a wastewater treatment facility.
- kW capacity ranged from 150 kW to 1,855 kW (one multifamily unit was this size).
- The cost per kW installed ranged from as little as \$2,000 for an office to as much as \$4,667 for an assisted living facility.

Of the five respondents that reported installing non-catalog systems in 2018:

- Respondents installed non-catalog systems in various building types.
- kW capacity and the cost of non-catalog system were generally several times larger than corresponding catalog systems.
- The cost per kW installed was in the same ballpark as those of catalog systems except for multifamily. The high cost per kW for the non-catalog multifamily category is presumed attributable to the very small (7kW) modular system, because some costs (such as mobilization) don't scale-down linearly with respect to size.

2.2.4 Pre-2018 CHP Work

Slightly more than half of CHP professionals (9 of 17) reported installing CHP systems in New York State prior to 2018 and roughly half of those were installed in multifamily, schools, hotels, or hospitals. Professionals also mentioned nine other market sectors but only one or two respondents reported doing work in each of these sectors. By far, respondents reported installing the most CHP systems in multifamily buildings followed distantly by schools, hospitals, and assisted living facilities. (Table 8).

Table 8. Summary of Pre-2018 CHP Work

Market Sector	# of Respondents	# of Systems	Total kW Capacity
K-12 Schools and Colleges	5	16	6,025
Hospital	5	16	17,125
Multifamily	4	137 ^a	84,657
Hotel	4	9	4,425
Assisted Living	2	16	2,300
Office	1	6	19,900

Market Sector	# of Respondents	# of Systems	Total kW Capacity
Laundry	1	1	300
Greenhouse	1	1	4,000
Rec. Center	1	1	250
Prison	1	1	75
Museum	1	1	75
Food production	1	6	210
Not Specified	2	6	15,800
Total	9	217	155,142

^a One respondent reported installing 125 systems in multifamily buildings representing 81,000 kW of capacity.

Almost all CHP systems installed by respondents pre-2018 are in New York City or Westchester and were in the NYSERDA catalog. Of the nine respondents that installed CHP systems prior to 2018, most installed catalog systems and most were in the New York City area (Table 9).

Table 9. CHP Systems Pre-2018 by Location

	Catalog Systems	Non-Catalog Systems	Total
New York City or Westchester			
Respondents	51	3	8
Systems	164	9	173
Elsewhere in New York			
Respondents	4 ^a	2	6
Systems	12	10	22

^a One of these respondents could not report how many systems they installed.

2.2.5 CHP Replication

There are few, if any, CHP systems installed in New York that did not receive NYSERDA support over the last four years. The team sought to determine the extent to which end-users with CHP systems were influenced to install CHP systems without NYSERDA support by surveying these end-users. However, as outlined in section 4.3.2, the team determined there were at most 13 CHP systems installed without NYSERDA support over the last four years and survey efforts with those 13 were unsuccessful. To verify that there are few, if any, instances of replication, the team reached out to the three CHP professional firms that installed more than two-

thirds of all systems in New York since 2015 and asked them how many systems they installed in 2018 that did not receive NYSERDA support. Two of the three professionals, representing half of all CHPs installed since 2015 as reported in the NYSERDA database, responded to our requests and both indicated there were no unsupported systems installed.

2.2.6 Project Warranties

2.2.6.1 NYSERDA Catalog Warranties

Seven respondents that installed a CHP catalog system in 2018 reported details about how they cover costs associated with providing the NYSERDA required five-year warranty. Six of the seven respondents characterized how they cover those costs.

- Two respondents reported they set aside a dollar amount per kWh. They set-aside about four or five cents per kWh.
- Two respondents that own the CHP equipment and provide CHP as a service to end-users provide a NYSERDA approved maintenance agreement. One respondent reported that a 150kW system costs the customer about \$50,000 per year. The second respondent did not know how much their firm set aside for warranty/maintenance issues but did report that they provide maintenance and repairs via an insurance-like product. They charge the customer between .78 cents per run hour for a 35-kW system to \$2.45 per run hour for a 100 kW system. Those charges cover any maintenance and repairs including total replacement.
- Two respondents reported they set aside a percentage of the project cost. One sets aside 10% of the project cost and the other sets aside 10-15%.

2.2.6.2 Non-NYSERDA Catalog Warranties

Five respondents that installed non-NYSERDA catalog warranties indicated they offer warranties to these customers and four offered details.

- One offered a one-year parts only warranty and set aside about 1% of project costs for warranty issues.
- One offered a five-year warranty for equipment and labor and did not consider the warranty as a percentage of the project cost. Rather, the warranty costs would be part of the operational costs.

- One respondent could not report about the warranty details because a separate division of the firm offers the warranties. This respondent reported that the warranties are highly customized to the client.
- One respondent indicated that they would set aside about 20% of project costs for warranty issues.

2.3 CHP Project Costs

The 2015 Baseline provided some estimates of soft cost components that they captured from CHP professionals via web survey. When the prior research team asked what percent of each component contributed to the overall soft cost total, only five of the ten respondents provided valid answers. Three respondents provided answers that did not add to 100% of all soft costs and two provided no answer. The 2018 evaluation team attempted to improve upon the 2015 estimates using an adjusted series of questions deployed via a phone interview. However, the team was largely unsuccessful in improving upon the estimates and arrived at similar conclusions to 2015. The paragraphs below present the 2018 project cost estimate findings.

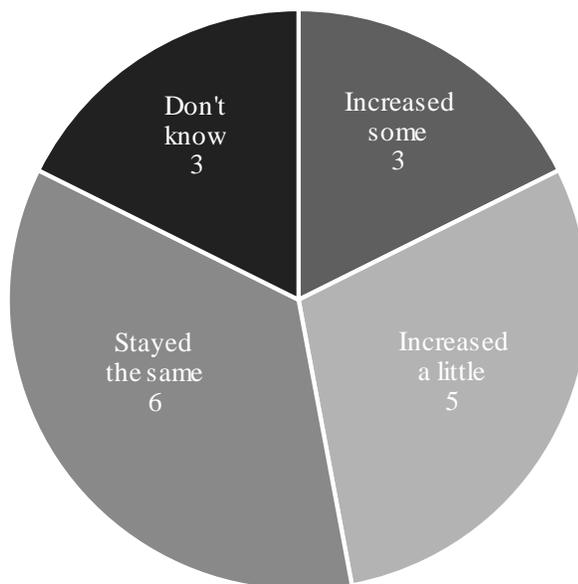
Most respondents reported CHP system components increased in cost over the past two years and the increases were small. Respondents stated that the cost of CHP components over the last two years either increased some, a little, or stayed the same (Figure 2).

Those that reported an increase in CHP costs attributed the increase to rising raw materials prices (3), commissioning labor (2), installation labor (2), parts (1). One of the three that mentioned an increase in raw material prices attributed the increase to the recent tariffs on steel and aluminum.

Respondents varied widely in terms of which of the soft costs they track and there is some variation about whether they track the component in all or

some projects. Table 10 shows that between five and ten respondents track each of the soft costs (see Appendix D for descriptions of the CHP Cost Categories identified by previous NYSERDA

Figure 2. Respondents Perception of CHP Costs



research). Most commonly, respondents reported tracking installation labor/materials costs and engineering costs. Fewer tracked permitting and interconnection costs.

Table 10. Respondent Tracking of Soft Costs

Category	Component	Track Component in All Projects	Track Component in Some Projects	Total
Design	Engineering and Architecture	6	2	8
Construction	Site preparation	5	1	6
	Installation labor/materials	9	1	10
	Rigging and coordination	4	1	5
	Project and construction management	6	2	8
Permitting	Permitting fees	5	2	7
	Permitting labor	5	0	5
Interconnection	Interconnection Fees	6	0	6
	Interconnection Labor	5	1	6
Contingency	Project contingency	7	1	8
Financing	Project financing	7	0	7

Respondents do not track all costs when they are not overseeing that element. General contractors will sometimes track the construction, interconnection, and contingency costs. Customers will sometimes incur the engineering and permitting costs.

Respondents reported that catalog project costs are about half equipment and half soft costs and non-catalog projects were closer to being two-thirds for equipment and one-third for soft-costs. The seven respondents that reported working on catalog projects estimated that soft costs comprised from 40% to 60% of a project’s overall costs. Non-catalog project soft cost estimates ranged from 18% to 40% (Table 11). The respondent that reported doing catalog and non-catalog projects reported that non-catalog projects are generally larger building projects overall.

Table 11. Percent of CHP Project Costs That are Equipment and Soft Costs

Respondent	CHP Catalog		Non-Catalog	
	Equipment	Soft Costs	Equipment	Soft Costs
RIA18	50%	50%	-	-
RIA24	55%	45%	-	-
RIA5	50%	50%	-	-
RIA14	40%	60%	-	-
RIA19	50%	50%	-	-
RIA3	50%	50%	-	-
RIA27	60%	40%	70%	30%
RIA10	-	-	Could not answer	Could not answer
RIA28	-	-	60%	40%
RIA70	-	-	82%	18%
RIA13	-	-	70%	30%
Average	51%	49%	71%	29%

Respondents largely could not break out how much of the soft costs went into each of the 11 soft cost components. Only four of the seven catalog respondents could provide any estimate by soft cost component. The four stated that installation costs were the most expensive and they provided a range of estimates.

- One estimated installation constituted 45% of all soft costs and that 30% went to project and construction management. The remaining 25% was spread across all other components.
- One estimated installation constituted 90% of all soft costs.
- One estimated installation constituted 60% of all soft costs.
- One reported that installation was the largest cost but was unable to provide a percentage estimate.

Two of the five respondents that reported about non-catalog projects provided an estimate by soft cost component.

- One reported installation labor was 50% of all soft costs, followed by engineering (25%) construction management (15%). The balance was spread across all other soft cost components.

- One reported that engineering was half of all soft costs and construction labor constituted the other half of softs.

Respondents struggled to answer the line of questioning about soft cost components. One major CHP provider in New York over the last decade implied that they understood the line of questioning but so much of the soft cost components are “sunk costs” that they just could not answer. Another respondent responsible for both catalog and non-catalog CHP projects in New York could not provide answers, even after the interviewer emailed the soft cost battery of questions to the respondent post interview. In their response to the email with mostly blanks for answers, the respondent stated, “this is all we know.”

2.4 DOE CHP eCatalog Awareness and Use

Most of the interviewed CHP professionals reported awareness of the CHP eCatalog, the majority of those respondents provided feedback to DOE to help develop the catalog, and most have systems in the catalog or plan to soon. Fifteen of the 17 respondents reported awareness and nine of the 15 engaged with DOE in some way to develop the catalog.

Specifically, seven of the 15 specified that they submitted documentation to DOE during catalog development, five reported meeting with DOE representatives to discuss the catalog, and three mentioned attending a webinar or seminar about the catalog. Ten of the 15 have their systems already included in the catalog and three more anticipate including systems in the catalog.

Respondents are in the catalog (or intend to be) to increase their recognition in the CHP market, to increase sales, or add credibility to their company’s work. Seven respondents reported enrolling their systems in the catalog to increase their visibility to customers, six specified that participating in the catalog should help increase sales, and three thought being in the catalog would contribute to their firm’s credibility.

2.5 Onsite Resilient Power (ORP) Assessment

This section summarizes results from CHP professionals about their experience and interest in selling ORP and the results from interviews with three end-users without CHP systems.

2.5.1 Who does ORP and what are the details of ORP projects?

Most CHP professionals indicated some knowledge or experience trying to sell an element of an ORP system. Fifteen of 17 professionals indicated some knowledge of ORP. That is, they were

familiar with the idea of attempting to sell onsite solar, battery storage, and a CHP system as a package.

Few professionals had experience installing any element of an ORP system and those that did installed the systems outside of New York State. Three of the 17 indicated experience installing any of these measures and none of these respondents reported doing an ORP system in New York.

- One professional reported experience with ORP systems in Puerto Rico and California and they did not specify what type of customers used ORP in those locations. However, later in the interview, this respondent implied that ORP is only viable in buildings with long hours of operation. Schools and offices, places with limited hours of operation, are not good candidates for CHP or ORP.
- One professional had experience with ORP systems for greenhouses in the Netherlands. This respondent reported utilities there struggle to deliver the power necessary for greenhouses making ORP a good solution for these customers.
- One professional had experience selling and installing solar systems outside of New York, but they did not specify where outside of New York.

All CHP professionals were listed in the October 2018 NYSEERDA CHP catalog. Non-catalog listed professionals reported no solar or storage installation projects (Table 12).

Table 12. Each Respondent’s Experience with ORP

Respondent Code	NYSEERDA Catalog Status	Could Speak About ORP	Experience Installing	Tangential Experience Installing	Anticipate doing ORP in 2019-20
RIA18	CHP Catalog Professional	✓	✓		
RIA24	CHP Catalog Professional	✓	✓		
RIA2	CHP Catalog Professional	✓	✓		
RIA27	CHP Catalog Professional	✓		✓	✓
RIA13	CHP Catalog Professional	✓		✓	
RIA10	CHP Catalog Professional	✓			✓
RIA3	CHP Catalog Professional	✓			
RIA17	CHP Catalog Professional	✓			
RIA28	CHP Catalog Professional	✓			
RIA26	CHP Catalog Professional	✓			

Combined Heat and Power and Onsite Resilient Power Market Assessment

Respondent Code	NYSERDA Catalog Status	Could Speak About ORP	Experience Installing	Tangential Experience Installing	Anticipate doing ORP in 2019-20
RIA14	CHP Catalog Professional	✓			
RIA19	CHP Catalog Professional	✓			
RIA70	Non-CHP Catalog Professional	✓			✓
RIA7	Non-CHP Catalog Professional	✓			
RIA22	Non-CHP Catalog Professional	✓			
RIA50	Non-CHP Catalog Professional				
RIA5	Non-CHP Catalog Professional				
Total		15	3	2	3

Very few CHP professionals reported tangential experience with ORP in New York. Two respondents, both listed in the October 2018 NYSERDA CHP catalog, noted involvement in a CHP project that included solar and storage, but their CHP work was independent of the solar and battery work and they were not involved in the sale, design, or engineering associated with the solar and battery elements (Table 12).

- One reported doing a large hotel CHP project that also had solar and batteries. Project developers arranged for the solar and battery work and it was done independent of the respondent who completed the CHP work.
- Another professional reported collaborating with another firm that oversaw the development of an ORP system for a multifamily building. The respondent’s firm supplied a 10kW CHP system and other contractors provided the solar and battery work. The CHP respondent did not interact with the solar or storage suppliers.

Three CHP professionals anticipate doing an ORP project in 2019 or 2020.

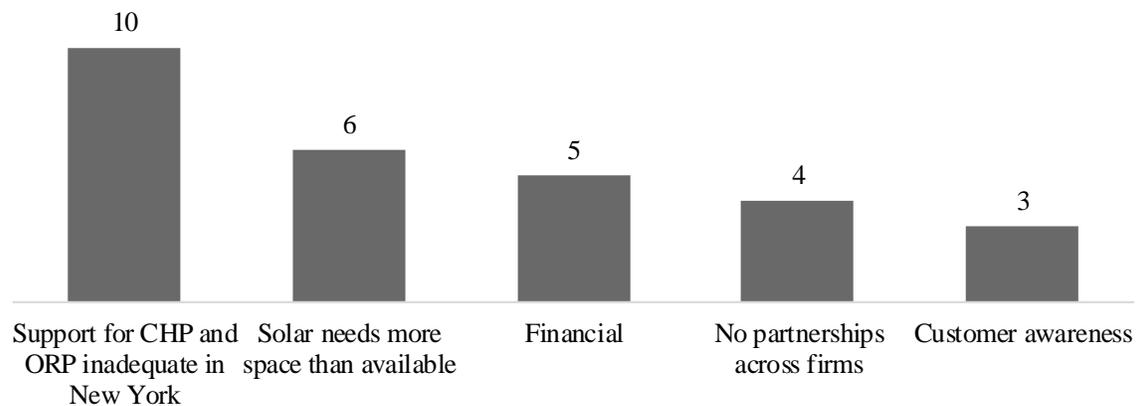
- One stated generally that they expected to begin an ORP project within one year and implied this was because the state government and NYSERDA “want ORP.”
- Another respondent stated his firm was getting ready to start two ORP projects at managed care facilities that were interested in ORP because they had dialysis equipment and ventilators on site that need power all the time. The resilient characteristics of an ORP system are particularly critical to these facility types.

- One respondent reported beginning to work with a Long Island based customer that has expressed interest in energy storage in addition to CHP. It was unclear if the respondent would also offer solar or if the customer expressed interest in solar.

2.5.2 What are the barriers to ORP adoption?

CHP Professionals reported multiple barriers to adopting ORP. They noted barriers related to a lack of support for CHP and ORP, physical space limitations, financial limits, a lack of relationships across firm types (CHP, solar, storage), and customer awareness (Figure 3).

Figure 3. Barriers to ORP Adoption (n=15)



Ten professionals reported difficulties with the programs, permits, and regulations in New York.

- Four respondents reported that the **changing program support for CHP and ORP from NYSERDA has made them reluctant to push either technology**. For example, one respondent implied that the removal of CHP support and lack of ORP support has made them less interested in trying to sell either technology in New York. Another respondent stated NYSERDA does not provide consistent guidance or answers related to project questions making them reluctant to work on ORP projects.
- **The Fire Department in New York City (FDNY) will not allow batteries – especially lithium-ion batteries – to be located inside buildings**. Four respondents noted that fire codes will not allow batteries inside building. Furthermore, there is typically not space outside for battery storage, especially in New York City, the largest potential market for ORP.

- Four respondents reported **moving to installing ORP systems would exacerbate existing problems they experience when working with utilities to complete CHP projects. Three of these four respondents reported specific problems working with Con Edison**, the New York City utility where most potential ORP customers reside. Two reported regular stumbling blocks getting interconnection done with Con Edison and hypothesized even more interconnection problems with ORP systems. The third respondent stated Con Edison does not like onsite generation in any form because of the technical infrastructure required to support it. According to one respondent the **State Public Service Commission and utilities provide a disincentive to installing CHP and solar because of their rules about what can be net-metered**. Current rules do not allow CHP systems to push electricity to the grid, whereas solar (in certain instances) can push electricity to the grid. That means two connections to the grid and two accounts are necessary for an ORP system which “is a mess.”
- Three respondents indicated that **New York’s support of ORP is pushing them to concentrate their CHP sales efforts in other states**. One respondent reported his firm is not prioritizing doing work in New York because the “paperwork associated with CHP... is very convoluted in NY” and adding solar and storage to the mix makes it too difficult to bother with. This respondent plans to search for “lower hanging fruit” CHP projects in New Jersey because these projects are easier to sell and install compared to ORP projects in New York. Another simply stated “New Jersey is much easier” to work in and the third respondent stated the move to ORP in New York “is forcing organizations like theirs” to look for CHP work in other states.

There is not enough roof space in New York City to accommodate solar for ORP. According to six CHP professionals, most sites that would be eligible for ORP – multifamily buildings, hospitals, hotels - are located in New York City. However, most of New York City’s buildings, especially in Manhattan, do not have enough rooftop surface area to accommodate the quantity of solar panels needed to support an ORP system. One professional stated, “I love solar, but it does not work on tall buildings with limited floorspace.” Another professional questioned “Where I am going to put solar in Manhattan?”

ORP is too expensive for most customers and inexpensive power rates in upstate New York exacerbate the problem for upstate customers. Five professionals indicated that the payback and upfront costs associated with ORP systems is far too great for most customers, even with relatively generous subsidies. For example, one professional noted that payback for a typical CHP

system is about seven to ten years – already a difficult sale for some customers. Adding solar and storage extends that payback time, making it an even harder sale. When adding low electricity rates in upstate New York, ORP becomes an almost impossible proposition upstate.

CHP, solar, and battery storage firms do not have a history of working together. Four professionals indicated that traditionally, firms that offer ORP components – CHP, solar, and storage – have operated independently without much knowledge of how the others operate. The networking and cross-training necessary to develop ORP systems, especially packaged ORP systems, has not occurred in the market. One professional indicated that their parent company has CHP, solar, and battery arms, however they have never worked together before and “different divisions for each [ORP component], don’t play well together.” Three other CHP specialists indicated they are just now trying to develop connections and networks with solar and battery providers but finding and developing these connections will take a long time.

Nonparticipant end-users indicated that their awareness and investigation of ORP components was piecemeal, not as one integrated package. Furthermore, none had installed all three ORP components. All three interviewed end-users reported investigating CHP for a site in New York and separately investigating solar for that site. Two of the three investigated battery storage for the site through a vendor different from either the solar or CHP vendors. The low-income housing provider that operates solely in New York dismissed solar as “too expensive” and a market-rate property owner/manager that operates in many states reported the return on investment was inadequate to proceed with solar at the site the interviewers asked about but did suggest installing solar elsewhere (Table 13).

Table 13. End-user Awareness and Use of ORP Components

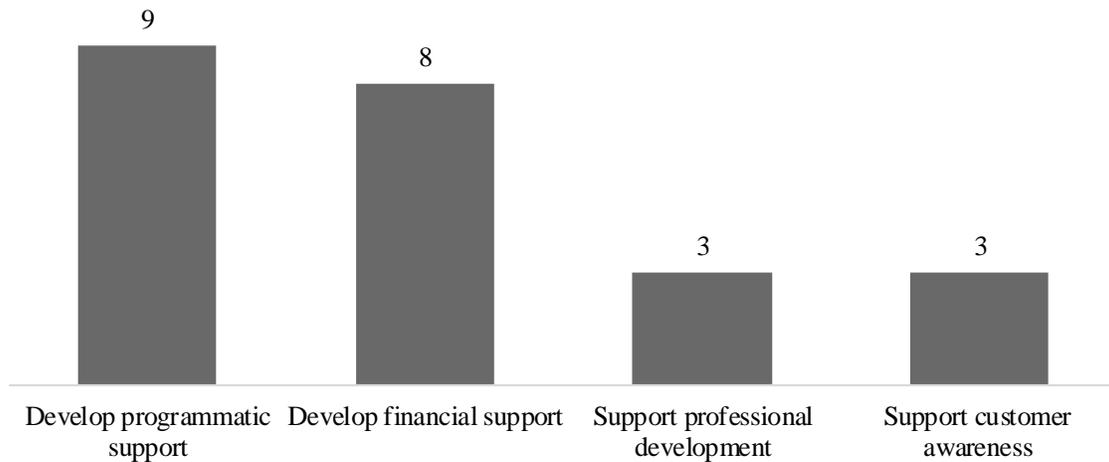
Resp.	Org. Type	CHP		Solar			Battery Storage		
		Investigated CHP for Site	Installed CHP Elsewhere	Investigated Solar for Site	Contacted by Solar Vendor	Installed Solar Elsewhere	Investigated Battery Storage	Contacted by Storage Vendor	Installed Battery Storage Anywhere
OD361	Low-income Housing Provider	✓		✓	✓				
OD2179	University	✓		✓			✓		
OD365	Market-Rate Property Owner/Manager	✓	✓	✓	✓	✓	✓	✓	
Count		3	1	3	2	3	1	1	0

Professionals reported that customers are often unaware of ORP and the potential benefits it could offer and even if they are aware, the project complexity makes it a difficult sell, and the cost of solar is prohibitive. Three professionals reported that potential customers are not even aware that CHP, solar, and storage combined into one package is even an option and two of these professionals implied that ORP does not offer enough of a benefit for most customers to make the project worthwhile. One of these professionals attempted to sell CHP with storage and the project got too complex, even for a “non-risk averse” university client that in the past has expressed interest in adopting new technologies.

2.5.3 How can NYSERDA support the ORP market?

CHP professionals offered many detailed suggestions for how NYSERDA could support the ORP market. Most commonly reported suggestions pertained to how NYSERDA could develop programmatic support for ORP systems followed closely by suggestions related to financial support. Figure 4 depicts all the ways respondents suggested NYSERDA could do to support the ORP market with detailed suggestions provided below.

Figure 4. How NYSERDA Can Support the ORP Market (n=15)



Nine respondents offered suggestions about programmatic support NYSERDA could offer the ORP market.

- Three respondents suggested that **there is room for NYSERDA to support CHP systems and ORP systems, not just exclusively support ORP.** These respondents reported that CHP adoption is plummeting because of the lack of NYSERDA support for exclusive CHP projects and that ORP will only appeal to very few customers. According to one respondent, ORP is three times as expensive as CHP but doesn't provide three times the benefit to the customer. Another respondent predicted that some customers will only install "a token amount of PV (solar) to get the project to pass but it will not offer a real material benefit to the host site". A third respondent stated "there can't be a one-size fits all" approach because some customers and areas could benefit from CHP and never be able to do solar or storage because of site limitations or local codes.
- Two of these nine suggested that **NYSERDA should develop protocols or a method to ensure that customers are good candidates for ORP,** including ensuring that the thermal output of the CHP system matches the needs of the customer site and that the hours of operation of the site are high enough to support the CHP component.
- Two respondents want **NYSERDA to make whatever support they offer an easy to follow and predictable process.** According to one respondent, "NYSERDA has a lot of process issues...[and] they make it more complicated. They don't offer clear guidance or answers. NYSERDA has the bring me a rock problem and the rock is never quite right." This respondent stated that NYSERDA processes remove most end-user risk, but in-turn

put a lot of risk on the supplier. Another respondent implied that NYSERDA program support needs to be predictable because otherwise it undercuts program user support. This person stated that the demise of support for CHP systems in February 2019 happened in one day. They received an email from NYSERDA announcing the end of the program at noon and program support ceased at 4pm. “I never had an incentive ripped out from under me like this”.

- Two CHP professionals stated **NYSERDA should prepare an ORP demonstration project for interested parties.** “The state needs to prove that ORP works” and help CHP sellers and customers understand how to “marry” each component – CHP, solar, and storage – into one functioning system stated one respondent. This respondent also suggested that **NYSERDA could prepare an ORP catalog like the CHP catalog.**
- Two respondents suggested that **NYSERDA should promote renewable energy sources in addition to solar for ORP systems.** One specified that fuel cell technology is a renewable energy source and that fuel cells can go in places where CHP systems have traditionally not been used like grocery stores and bodegas. This respondent implied NYSERDA could showcase demonstration projects using this technology. The other respondent noted that generating energy from municipal waste is another renewable energy source NYSERDA should consider when designing an ORP program.

Eight respondents offered suggestions about financial support NYSERDA could offer the ORP market.

- Seven of these eight reported that **ORP support will require NYSERDA to offer noticeably larger incentive amounts compared to past CHP support.** ORP incentives will have to be “robust” stated one respondent and because ORP costs three times what a CHP system costs, incentives will also have to be three times past CHP incentive amounts stated another respondent. A third respondent stated NYSERDA is “asking for the impossible” if they offer CHP incentive amounts for ORP work. This respondent reported that NYSERDA or the utilities need to pay for the solar and storage components of ORP.
- One of the eight recommended that **NYSERDA offer financing support for ORP.** Specifically, this respondent reported that providing support for power purchase agreements (PPA) related to CHP would help increase adoption of ORP and CHP.

Three CHP professionals suggested **NYSERDA could support the ORP market by creating a professional network of firms familiar with all the components of ORP and supporting vendors technical education** about these systems. According to these respondents, traditionally, the CHP, solar, and storage firms have not interacted with one another and even in cases where all three technologies exist under one firm, they operate independent of one another. These respondents mentioned NYSERDA's Onsite Resilient Power Conference held on June 27, 2019 in Brooklyn as one way to develop this network and they implied that more such opportunities will be necessary to facilitate these firms working with one another to develop ORP systems.

Three CHP professionals recommended **NYSERDA could promote and educate eligible customers about ORP systems and how they are beneficial**. These respondents did not specify how to promote or educate these customers.

When possible, end-users expressed interest in making their facilities more resilient and anything NYSERDA can do lower the cost of increasing building resiliency is key. While uncommon, the three interviewed end-users all noted at least one major occurrence without power that "significantly" disrupted their operations and tenants. The low-income housing provider and the market-rate property owner/manager both expressed great interest in mitigating the negative effects of extended power outages and the university representative expressed limited interest because they deemed the facility as resilient as it could get given constraints of space and cost. The end-users suggested that NYSERDA could:

- Offer large incentives to end-users (2 mentions).
- Encourage large companies or foundations to support ORP work in low-income housing operations (1 mention).
- Organize a cooperative of low-income housing organizations to buy ORP components/services in bulk to lower the cost of a project (1 mention).
- Provide zero percent interest financing (1 mention).

3 Findings and Recommendations

The team provides a summary about what it learned about CHP systems below but because NYSERDA is moving away from supporting solo CHP systems and towards integrated ORP systems, the team elected to limit recommendations to ORP.

3.1 CHP Summary

CHP professionals reported that installation labor and engineering are the largest soft costs and they were largely unable to provide detailed estimates of soft costs associated with CHP installations. Results of the CHP professional survey indicate, as with the 2015 Baseline, that most professionals could only provide a rough estimate of the soft costs versus equipment costs and they struggled to provide details about the soft cost components. Despite the lack of specifics, there is agreement among CHP professionals that installation labor is the largest soft cost followed by engineering and architecture. The other soft costs constitute a relatively small percentage of all other soft costs.

There were about 50 CHP projects that became operational in New York State in 2018. The NYSERDA DER database reports seven contractors installed 27 CHP systems in 2018 and the CHP professionals survey found 25 CHP systems were installed. Of these 25 CHP systems, one survey respondent's projects appeared in the database. Removing the two duplicated projects from that respondent results in a total of 50 CHP projects.

Annual CHP installations are not increasing. The DOE database shows a decline in total number of systems installed between 2015 and 2018 with 41 installed in 2015 and 32 installed in 2018. Across building types, the installations showed no growth and some small declines except for hotels where there was a modest increase from three to five systems. CHP professionals showed a similar decline in installations from 51 systems in the 2015 Baseline report to 25 in 2018. Additionally, one of the most active CHP professionals in 2015 reported planned reduction of CHP work in New York for the future.

As in 2015, more catalog systems are installed than non-catalog systems, non-catalog systems tend to be noticeably larger, and non-catalog systems were completed by a different group of professionals than catalog systems. Consistent with the Catalog having an upper size cap, the kilowatt capacity of non-catalog systems were generally several times larger than corresponding catalog systems across market sectors and an entirely different group of

professionals worked on non-catalog systems than catalog systems. Other than the one outlier of the very small (7kW) microCHP system, the non-catalog systems generally had per-kW-costs somewhat larger than corresponding catalog systems across market sectors. Only one respondent reported doing both catalog and non-catalog systems in 2018.

3.2 ORP Findings and Recommendations

The ORP market is nascent in New York. Existing CHP professionals have limited to no experience selling or installing ORP systems and few have plans to take up ORP work in the near-term. Instead, several are looking at other markets to sell CHP systems, the technology they have many years of experience selling and installing. Furthermore, CHP professionals highlighted several barriers to selling and developing ORP systems including fire code restrictions on batteries, space available for solar panels in New York City, and a lack of a professional ORP network of ORP component firms. To overcome these challenges to developing an ORP market in New York, NYSERDA needs to consider the programmatic, financial, and structural barriers that CHP professionals reported.

Recommendation 1: Continue to engage CHP, solar, battery storage, and other related professionals about ways to create an ORP network of professionals. A strong engaged network of professionals that know how to develop ORP systems will be critical to designing and using any developed program. Continuing to offer opportunities like the Onsite Resilient Power Conference held in Brooklyn will be critical to developing this network. This network will be critical in assisting NYSERDA to design an ORP program. Additionally, firms other than CHP professional firms developed the few ORP projects we heard about in New York. Identifying these ORP early adopters and getting feedback from them could help NYSERDA develop an ORP program and network of ORP professionals.

Recommendation 2: Investigate how other program administrators, states, and countries support ORP-type work. Respondents indicated three locations where they had been involved with ORP systems: California, Puerto Rico, and the Netherlands. Conducting research to see if there has been government or other agency support for ORP systems in these places and how they supported ORP could provide NYSERDA with ideas for how best to support the effort in New York.

4 Methods

This section summarizes the methods used to prepare this report. There were three key data collection activities: Review of secondary data, interviews with CHP Professionals, and interviews with end-users. Each of these are discussed below.

4.1 Secondary Data

The Market Assessment Team reviewed market potential studies, databases, and other sources relating to the quantity and costs of systems installed. These included:

- The 2016 U.S. Department of Energy (DOE) study of technical potential for CHP.
- Commissioning reports submitted to NYSERDA for CHP systems that were installed in New York State in 2018.
- NYSERDA's DER database of CHP systems that received a NYSERDA incentive.
- The U.S. DOE CHP database.

The review of secondary data sources informed two aspects of the market evaluation. The commissioning reports will provide cost data that the Market Assessment Team used, together with survey data, to develop estimates of CHP soft costs. The other sources will aid in estimating the total number of CHP systems installed in New York and the calculation of market penetration rates, to be compared to separate estimates derived from the survey of CHP professionals.

4.2 CHP Professionals

The research team used several sources to identify CHP professionals operating in New York and eligible for interviews. They were:

- Listed in the October 2018 CHP Catalog (n=24).
- Listed in the October 2017 CHP Catalog (n = 20).
- Listed as a CHP vendor in a December 2018 list maintained by NYSERDA staff (n=36).
- Conducted a CHP Project in New York since 2015 according to Department of Energy database (n=8).
- Listed in Environmental Protection Agency (EPA) CHP Partnership List as of February 2019 (n=22).

Professionals often appeared in multiple lists and after review, the team determined there were 55 unique CHP professionals. At the conclusion of data collection, the team determined 14 of the 55

records were duplicates, did not have good contact information, or did not pass screening because they operated outside of New York or did not sell CHP services or equipment (Table 14). This resulted in 41 firms that comprise the eligible population of CHP firms operating in New York.

Table 14. Disposition Summary of CHP Professionals

Category	Count	Percent Eligible	Percent of All
Eligible			
Complete	17	41%	31%
Refused	2	5%	4%
Attempted but not reached	22	54%	40%
Subtotal	41	100%	75%
Ineligible			
Duplicate record	2	n/a	4%
Bad contact information	4	n/a	7%
Did not pass screening	8	n/a	15%
Subtotal	14	n/a	25%

All respondents did not address all topics because the respondents were not always able to provide answers. Therefore, the sample size differs based on the topic. Interviews with CHP Professionals occurred between May 28 and July 17, 2019 and the interviews ranged from 30 to 75 minutes, averaging about 45 minutes.

4.3 CHP End-users

The research plan for this project stated the team would attempt to survey two groups of CHP end-users.

1. End-users that possess CHP systems where the CHP system did not receive NYSERDA support (Group 1).
2. End-users that could have CHP systems but do not have one (Group 2).

The following sections describe the intended methods to reach these groups and the changes the research team made throughout the course of this work to adapt limited responses and smaller population numbers than anticipated.

4.3.1 End-users with CHP that did not receive NYSERDA support (Group 1)

The purpose of interviewing Group 1 was to:

- quantify any soft costs they could tell us about regarding CHP installation
- identify any barriers they faced when installing their CHP (without NYSERDA support)
- identify awareness, interest, and use of ORP components (CHP, solar, and storage), and
- understand replication – did NYSERDA play any role in influencing the installation of the CHP system?

The team identified those with a CHP system using the DOE list of CHP systems and matched that list with the NYSERDA list of incented projects using customer name to identify likely candidates. This process resulted in 41 records. The team contacted these facilities in late June and early July using only phone numbers. The lists did not have names or titles to ask for. As of mid-July and about three attempts per record, the team changed the approach by offering a \$50 incentive to those that passed screening. The team received approval from NYSERDA for this approach and began re-contacting prospective respondents in August. This approach resulted in an interview, however, the team learned that the respondent did actually have a NYSERDA supported CHP system. Based on this result, the team re-reviewed the call list with the program staff and determined only 13 of the 41 records had not received NYSERDA support in the past. In early September, the team elected to abandon this effort because of the small population and the high likelihood that the team would be unable to survey one of these 13 sites.

4.3.2 End-users without CHP systems (Group 2 or end-users)

The purpose of interviewing Group 2 was to:

- identify any barriers to installing a CHP, with or without NYSERDA support, and
- identify awareness, interest, and use of ORP components (CHP, solar, and storage)

4.3.2.1 InfoGroup Approach

In July 2019, the team used NYSERDA's access to InfoGroup records for the hospital, nursing home, hotel, college/university, and multifamily market segments to identify true nonparticipants – those without a CHP system in New York. The team deduplicated the list of hospitals, nursing homes, college/university, and hotels by phone number. The team followed a similar protocol for multifamily properties. The exception was that the team selected Class A or Class B multifamily buildings with over 100,000 square feet in order to target multifamily properties most likely to be eligible for a CHP system. The team then appended emails to the list to facilitate outreach efforts

to the contacts and this resulted in 768 records eligible for contact. By mid-September, the team attempted contact with 375 of these contacts and received no possible leads for a survey. The team elected to pursue a different approach to reaching this group, using a more targeted list source.

4.3.2.2 EGM Global Approach

EGM Global sells lists of subscribers to Building Operating Management Magazine and Facility Maintenance Decisions Magazine. The team determined that subscribers to these magazines are the types of contacts needed to address the key research questions: Are those without CHP and ORP aware of the technology and what barriers exist to installing these technologies at their sites. The team elected to purchase a list of New York based subscribers that work in the hospital, nursing home, hotel, college/university, and multifamily market segments. The team narrowed the list by identifying people with titles most likely to be able to speak to awareness of CHP, solar, and battery storage for their facilities resulting in 181 records.⁶ Contacting these 181 records via phone and/or email up to five times and offering \$50 incentives in late September and early October resulted in three completes.

⁶ Key titles selected were facility managers, building managers, engineers, and property managers.